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Using official statistics to calculate greenhouse gas emissions

A statistical guide

2010 edition

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Foreword

Climate change is one of the great challenges facing humanity, and an increasing number of countries are pursuing concrete actions to deal with this problem. In December 2008, leaders approved a comprehensive package of measures aimed at reducing greenhouse gas emissions by at least 20 % by 2020 compared with 1990 levels, to raise renewable energy's share of the market to 20 %, and to cut overall energy consumption by 20 %. The United Nations Climate Change Conference in Copenhagen did not achieve any further agreement on greenhouse gas emissions, although countries did agree, in the Copenhagen Accord, to the principle of capping the global temperature rise to 2°C by committing to significant emission reductions.

To follow up on these agreements and objectives, detailed figures on greenhouse gas emissions are required. Estimates for greenhouse gas emissions are the responsibility of individual countries, each compiling an emissions inventory. The national bodies that are responsible for this work make frequent use of official statistics from national statistical offices. The individual reports for European countries are then verified and collated by the European Environment Agency to produce European totals.

Most of the official statistics that are used to estimate emissions have primarily been collected to measure economic or social trends, and, their use for calculating greenhouse gas emissions is secondary. However, as Eurostat and other statistical offices place a high degree of emphasis on data quality, and in particular on objectivity and international comparability, these statistics provide a solid basis for the emissions estimates used in the national and European inventories. Official statistics are likely to develop further in the coming years in order to respond to demands for more detailed calculations and new areas of environmental interest.

This publication presents a short overview on calculating greenhouse gas emissions, followed by a collection of data available within the European statistical system that may be used for estimating greenhouse gas emissions. The publication should be useful for those concerned with the further development of official statistics in this domain, while it also addresses itself to the much wider audience of those interested in climate change issues. Indeed, I hope this publication contributes to the global discussion on climate change.

Walter Radermacher

Director-General

Using official statistics to calculate greenhouse gas emissions – a statistical guide

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An *italic font* has been used in statistical tables to denote any data that may change in the future (estimates, provisional data and forecasts).

A *data code* has been inserted under each table and graph as part of the source – this can be used to obtain direct access to the most recent data on Eurostat's website at: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

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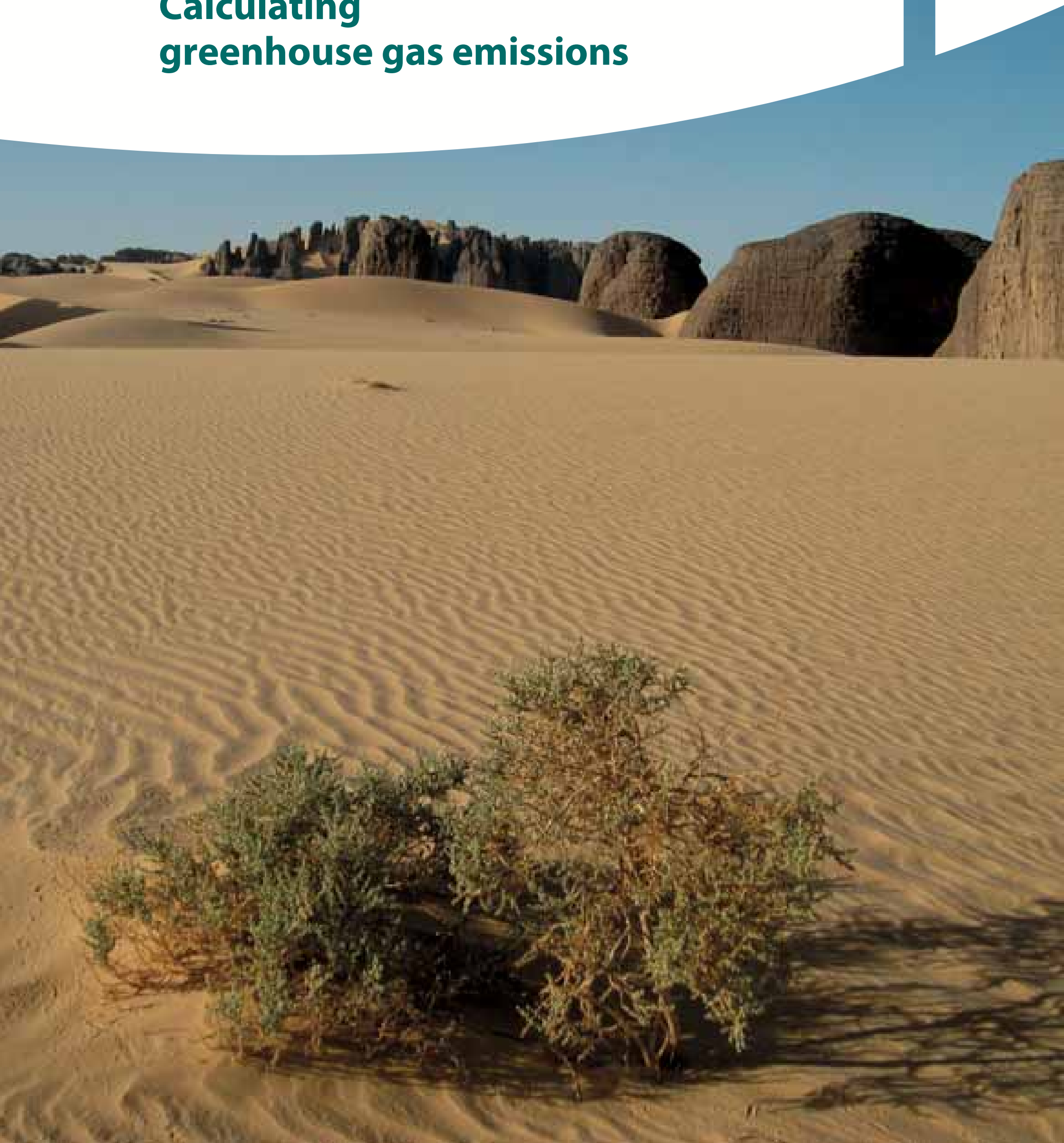
Calculating greenhouse gas emissions



1.1 Emissions: an introduction

The issues

The term 'climate' covers meteorological phenomena over a lengthy period of time, for example, trends in temperature, humidity, or atmospheric pressure. Historically, climate change has resulted from natural phenomena and has imposed itself on life on earth – sometimes with catastrophic effects, for example, the extinction of various species during the ice ages. However, over the past two decades a growing body of scientific evidence has been established that suggests the most recent changes in the earth's climate have been caused by human activity – so called anthropogenic effects.

Human-induced greenhouse gas emissions are likely to have begun at the start of the industrial revolution and are mainly a result of burning fossil fuels – in particular, for the purpose of electricity generation and for transportation. The volume of emissions has grown at a rapid pace in the last 200 years, reflecting increases in the world's population, alongside economic development that has resulted in higher levels of production and consumption and the creation of a global economy. Changes in the level of emissions also reflect phenomena such as deforestation (the clearance of forests). Instead of releasing carbon into the atmosphere, trees and other plants absorb carbon; referred to as 'carbon sinks'. As such, the logging and/or slash-burning of forests releases carbon that was previously stored in these trees, vegetation and decaying matter.

Alongside the growing body of scientific evidence supporting the theory that increased levels of greenhouse gas emissions may be attributed to human activity, a large number of countries have begun to make efforts to reduce their greenhouse gas emissions; to support these, reliable data is required. This publication aims to give an insight into the way greenhouse gas emissions are calculated and to the potential role of official statistics in the data collection. The opening part is based on information sourced from the European Environment Agency (EEA) – presenting details of the most prevalent greenhouse gases and their main source. The second part presents information on a variety of sectors that may contribute to greenhouse gas emissions or removals:

- land use and agriculture;
- energy;
- business (industry and services);
- transport;
- waste.

These five sections contain a selection of official statistics, usually based upon data that has been collected by the statistical office of the European Union, Eurostat. A range of indicators are presented: each may be viewed as an explanatory or contributing factor that can potentially be linked to levels of greenhouse gas emissions.

What are greenhouse gases?

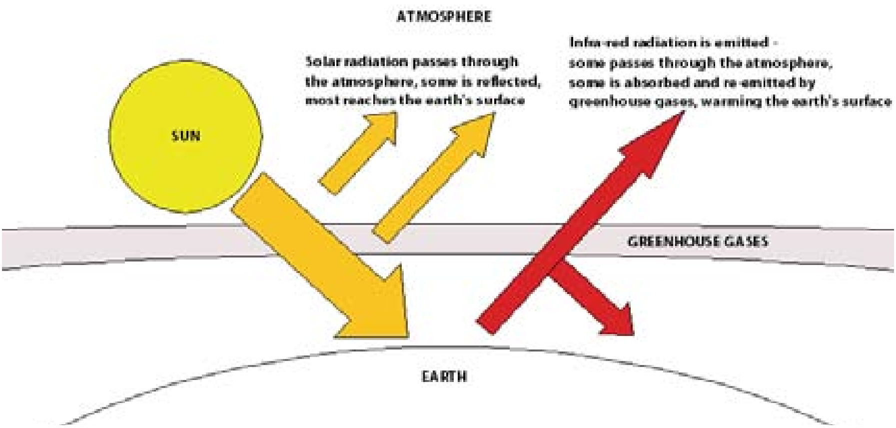
Greenhouse gases make up less than 0.1 % of the total atmosphere, which consists mostly of nitrogen and oxygen. Carbon dioxide is by far the most common greenhouse gas. The main greenhouse gases include: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), as well as ozone depleting chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) – these latter two groups of gases are not covered by the Kyoto Protocol.

What is the greenhouse effect?

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 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, 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 concentration of greenhouse gases in the atmosphere has grown as a result of human activity and this process would appear to be disturbing the natural balance between incoming and outgoing energy.

Figure 1.1: Greenhouse gas effect



Actors and responsibilities

This section outlines some of the most important bodies and international agreements involved in the monitoring of greenhouse gas emissions.

International organisations

Intergovernmental Panel on Climate Change (IPCC)

Just over 20 years ago, a group of governments decided that the issue of climate change needed to be addressed by an independent body. In 1988 the Intergovernmental Panel on Climate Change (IPCC) was established; it is open to all member countries of the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP). The work of the IPCC is driven by scientific literature that is relevant to the understanding of the risk of human-induced climate change. The IPCC presented its first assessment report on climate change in 1990; thereafter, it has published, at regular five-year intervals, a comprehensive report on climate change. The findings of the first IPCC report played an important role in leading to the establishment of the United Nations Framework Convention on Climate Change (UNFCCC), while the second IPCC assessment report (1995) was a key input for the negotiation of the Kyoto Protocol in 1997 and remains the basis upon which greenhouse gas emissions data are collected and published.

United Nations Framework Convention on Climate Change (UNFCCC)

The general assembly of the UN mandated governments to establish a single negotiating process – the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (UNFCCC). The Convention was signed on 9 May 1992. Its ultimate objective is to stabilise greenhouse gas concentrations in the atmosphere 'at a level that would prevent dangerous, human-induced interference with the earth's climatic system'. As of October 2009, 194 individual countries had ratified the UNFCCC.

Kyoto Protocol

The Kyoto Protocol is an international agreement linked to the UNFCCC: while the latter encouraged industrialised countries to stabilise their emission levels, Kyoto committed them to limit or reduce their greenhouse gas emissions. The protocol was signed in 1997, setting legally-binding commitments for reducing greenhouse gas emissions across developed countries in the period 2008-2012. However, it was not until 18 November 2004, when the Russian Federation ratified the protocol, that the prescribed conditions were met for a 90-day countdown to be set in motion – the Kyoto Protocol entering into force on 16 February 2005. It addresses six main greenhouse gases (carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, hydrofluorocarbons and perfluorocarbons), combined into a basket (based on CO_2 equivalents); emission reductions are generally measured against a base year of 1990.

The Kyoto Protocol established different commitments for each developed 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 (the European Community is a party to the protocol), Switzerland and many central and eastern European countries, other countries 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).

Among the EU-15 Member States there was a specific agreement to meet the 8 % reduction, ranging from decreases of 28 % for Luxembourg and 21 % for Denmark and Germany, to increases of 25 % and 27 % for Greece and for Portugal; this EU-15 accord is known as the 'burden-sharing agreement' ([1]). 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 %.

In an attempt to find alternative ways to reduce emissions, three market-based mechanisms ([2]) have been 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 more cost-effective to 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.

The future – COP15 and beyond

The Kyoto Protocol agreement will expire in 2012. International negotiations on a post-2012 climate regime have been afoot for several years under the auspices of the UNFCCC, and more specifically the annual progress meetings of the Conferences of the Parties (COP) which monitor climate change; COP15 took place in Copenhagen (Denmark) from 7 December to 18 December 2009. It did not result in a legally-binding agreement for the next step in mitigating climate change. Instead,

([1]) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:130:0001:0001:EN:PDF.
([2]) http://unfccc.int/kyoto_protocol/mechanisms/items/1673.php.

the parties noted the Copenhagen Accord, which was drawn up by Brazil, China, India, South Africa and the United States on 18 December 2009. Its main points include:

- recognition that global temperature increases should be restricted to two degrees Celsius (compared with pre-industrialisation);
- agreement to provide additional finance for developing countries (in particular small island states and African countries) to help combat the effects of climate change;
- agreeing to provide country-specific details of mitigation actions – for both developed and developing countries, as well as a section on how such pledges should be monitored (pledges under the accord are not legally binding);
- recognition that financial resources are required from developed countries to enhance removals of greenhouse gas emissions by forests;
- agreement on the possibility of pursuing the use of carbon markets.

Details of the mitigation actions foreseen under the Copenhagen Accord should be provided by the end of January 2010, and it is likely that work will continue through to the next climate change conference that is scheduled to take place in Mexico in November 2010 (COP16).

European organisations

European Environment Agency (EEA)

The European Environment Agency (EEA) aims to support sustainable development and to help achieve significant and measurable improvement in Europe's environment, through the provision of timely, targeted, relevant and reliable information to policy-making agents and the public. The European Community adopted a regulation establishing the EEA and its European environment information and observation network (Eionet) in 1990, and the EEA began its work in earnest in 1994. Membership of the EEA is also open to countries that are not EU Member States. There are now 32 member countries: the 27 Member States together with Iceland, Liechtenstein, Norway, Switzerland and Turkey.

The EEA aims to support the information requirements of EU and international environmental legislation; make assessments of the European environment and evaluate policy effectiveness; and improve the coordination and dissemination of environmental data and information about Europe.

In the area of greenhouse gas emissions, the EEA is responsible for the compilation of the EU's greenhouse gas inventory to the UNFCCC, and for the implementation of the QA/QC programme to ensure compliance with UNFCCC and IPCC guidelines. The EEA also produces an annual assessment of the progress achieved by the EU and European countries towards their respective targets under the Kyoto Protocol and under EU commitments regarding 2020. The EEA hosts the environmental data centre for climate change, available at, http://www.eea.europa.eu/themes/climate.

Directorate-General for the Environment

The Directorate-General (DG) for the Environment is part of the European Commission, with the objective of 'protecting and preserving the environment for present and future generations'. The sixth Environment Action Programme (6th EAP) is a decision of the European Parliament and of the Council adopted on 22 July 2002, which set out the framework for environmental policy-making in the EU during the period 2002-2012. The work conducted by DG Environment during this period is founded upon four key priorities, namely:

- climate change;
- nature and biodiversity;
- environment, health and the quality of life, and;
- natural resources and waste.

On 17 December 2008, the European Parliament adopted a number of measures designed to: establish a new energy policy, combat climate change, and boost the EU's energy security and competitiveness. This integrated climate change and energy policy ([3]) aims to ensure that Europe has a sustainable future based on a low-carbon, energy-efficient economy. The agreement sets ambitious targets that are to be achieved by 2020, namely:

- cutting EU greenhouse gas emissions by 20 %;
- reducing EU energy consumption by 20 % through increased energy efficiency;
- meeting 20 % of Europe's energy needs from renewable energy sources.

Eurostat

Eurostat is the statistical office of the EU. Eurostat is responsible for harmonising, collecting and disseminating EU statistics on economic, social and environmental topics relevant for European policies. Although Eurostat data is not specifically collected for the purpose of estimating greenhouse gas emissions, many series of Eurostat data are directly and indirectly used when making such calculations. This publication gives an overview of harmonised European statistical data which is or could be used for the calculation of greenhouse gas emissions.

([3]) http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=20081217&secondRef=TOC&language=EN.

Institute for Environment and Sustainability (IES)

Located in Ispra (on the banks of Lake Maggiore, Italy), the IES is one of seven institutes that constitute the Joint Research Centre (JRC), which is a Directorate-General of the European Commission. The mission of the IES is to provide independent, scientific-technical support to the EU's policies for the protection and sustainable development of the European and global environment.

Historical perspective

Table 1.1: Timeline of main events in relation to climate change

Date	Event
1988	Intergovernmental Panel on Climate Change (IPCC) established by the United Nations to collect scientific evidence
1990	First assessment report on climate change research by IPCC
1990	Council Regulation (EEC) No 1210/90 of 7 May 1990 on the establishment of the European Environment Agency (EEA)
1992	United Nations Framework Convention on Climate Change (UNFCCC); supreme body is the Conference of Parties (COP)
1995	IPCC publishes second major assessment of climate change research; a key input for Kyoto Protocol
1997	Governments sign the Kyoto Protocol
1998	First parties ratify the Kyoto Protocol
1999	Council Regulation (EC) No 933/1999 of 29 April 1999 amends EEA Regulation
2001	IPCC publishes its third major assessment of climate change research
2001	Institute for Environment and Sustainability (IES) is created at ISPRA
2002	Sixth Environmental Action Programme (EAP) is adopted by the European Parliament and the Council on 22 July 2002
2003	Regulation (EC) No 1641/2003 of the European Parliament and of the Council of 22 July 2003 amends EEA Regulation
2004	Russian Federation ratifies Kyoto Protocol setting in motion 90-day countdown
2005	On 16 February, the Kyoto Protocol enters into force
2007	IPCC publishes its fourth major assessment of climate change research
2008	EU climate and energy package agreed by EU leaders at European Council and subsequently by European Parliament in December
2009	Copenhagen Accord reached between Brazil, China, India, South Africa and the United States

1.2 Emissions: how are they estimated?

Emission inventories

Inventories of anthropogenic greenhouse gas emissions provide a common tool through which parties to the UNFCCC can estimate the level of their emissions, in respect to individual gases and their sources. All parties to the Kyoto Protocol are obliged to compile an annual inventory of their greenhouse gas emissions and to submit a report on their actions/efforts to control greenhouse gas emissions. These inventories form the basis upon which greenhouse gas emission trends may be monitored from year to year. The inventories are based on a set of standard guidelines to ensure that submissions are consistent and comparable.

Inventories consist of standardised tables (based on a common reporting format – CRF) and should be accompanied by a written report documenting the methodologies and data sources that have been used (a national inventory report – NIR). Each developed country that is a signatory to the Kyoto Protocol is obliged to submit an inventory by 15 April each year (x), providing estimates of their net greenhouse gas emissions for the period from 1990 onwards (up to reference year of x-2). A complete time-series is provided under each reporting exercise to ensure consistency and to allow for improvements in measurement techniques and calculations to be introduced.

EU Member States, as parties to the Kyoto Protocol, are obliged to submit their individual inventories to the UNFCCC. They also submit their inventories to the EEA, as Member States are obliged to provide information under a Monitoring Mechanism Decision (280/2004/EC). The EEA then compiles an aggregated inventory for the EU-15, as well as aggregates covering the EU-27 and all 32 EEA members.

The EEA is also responsible for the implementation of a quality assurance programme in close collaboration with the European Commission to ensure the timeliness, completeness, accuracy, consistency, comparability and transparency of reporting, following UNFCCC and IPCC guidelines. These quality requirements for greenhouse gas estimates are defined in the UNFCCC reporting guidelines for national greenhouse gas inventories [4].

One of the objectives of the UNFCCC reporting guidelines on annual inventories is to facilitate the process of verification, technical assessment and expert review of the inventory information. This should allow reconstruction of the inventory by expert review teams. This annual process aims to improve the quality of greenhouse gas estimates.

(4) http://unfccc.int/resource/docs/2004/sbsta/08.pdf.

Which gases are covered?

The Kyoto Protocol covers legally binding commitments in relation to the reduction of the following 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 greenhouse gas is defined in relation to a given weight of carbon dioxide and for a set time period (for the purpose of the Kyoto Protocol a period of 100 years). GWPs are used to convert emissions of other greenhouse gases into CO_2 equivalents – making it possible to compare the potential effects of different gases.

Table 1.2: Global Warming Potentials of Kyoto Protocol greenhouse gases

Chemical formula	Greenhouse gas	Gobal Warming Potential (1)
CO_2	Carbon dioxide	1
CH_4	Methane	21
N_2O	Nitrous oxide	310
HFCs	Hydrofluorocarbons	140 ($C_2H_4F_2$) to 11 700 (CHF_3)
PFCs	Perfluorocarbons	5 700 (CF_4) to 11 900 (C_2F_6)
SF_6	Sulphur hexafluoride	23 900

(1) In a 100-year time horizon. Reading guide: for example one tonne of methane equates to 21 tonnes of CO_2.

Source: Climate Change 1995, The Science of Climate Change: Summary for Policymakers and Technical Summary of the Working Group, UNFCCC

Which sectors and categories are covered?

Within the inventory reporting requirements of the UNFCCC and the Kyoto Protocol, estimates of greenhouse gas emissions are produced for a number of sectors delineated according to process-technological characteristics. Amongst these are four main sectors: energy (fuel combustion); industrial processes, solvent and other product use; agriculture; and waste. Each of these sectors (for example, fuel combustion) may be comprised of individual categories (fuel combustion in transport) and sub-categories (fuel combustion in road transportation). Countries should compile their emissions inventories for each greenhouse gas from the bottom-up, using the data at the sub-category level and summing this to obtain categories, sectors and eventually total emissions – see Table 1.3 on page 23 for a detailed picture of the hierarchy that is used.

Land use, land-use change and forestry (LULUCF) activities also have the potential to help reduce emissions, as they seek to protect existing carbon stocks (for example, by reducing deforestation and land degradation), or to encourage new carbon stocks (afforestation/reforestation). The Kyoto Protocol restricts the accounting of the LULUCF sector, with net emissions relating to forest land management, cropland management, grazing land management and/or revegetation considered as optional in relation to inventory reporting requirements. As such, net emissions from LULUCF are treated as a memo item in greenhouse gas inventories and are excluded from the total emissions as used in relation to Kyoto targets.

Note that the use of fuel in ships or aircraft engaged in international transport is also excluded from the reporting of greenhouse gas emissions within the Kyoto Protocol, although these data are generally collected and reported (again as memo items). Hence, it is important to keep in mind that the greenhouse gases as presented in emission inventories consider only those emissions taking place on the territory of a given country. Such figures can be misleading, for example, in cases where a freight transport enterprise operates significant international operations outside of the national territory/economy.

What types of estimation methods are used?

Data collection forms an integral part of any greenhouse gas inventory and is generally reliant on existing statistical sources. Emissions inventories do not 'measure' greenhouse gas emissions per se; rather, they 'estimate' emissions through the application of the 1996 IPCC guidelines which offer a range of methods. The simplest approach involves combining information on the extent of a human activity with a coefficient quantifying the emissions from that activity. Such coefficients are termed 'emission factors', and may be used as follows:

emissions = activity data * emissions factor

For example, one set of activity data is that on fuel consumption, while the corresponding emission factor is the mass of carbon dioxide emitted per unit of fuel consumed. Such basic equations may be modified to include other parameters, for example, building in lags that reflect how long it takes for material to decompose (in the case of landfill), or alternatively, more complex modelling approaches. The degree of calculation complexity is often referred to as a 'tier', whereby the most basic methods are grouped together under tier 1, intermediate calculations are classified as tier 2, while the most complex and demanding calculations – which are also likely to require the most detailed data – are referred to as tier 3. Tier 1 methods are designed to be used with readily available statistics and default emission factors (that are provided by the IPCC), such that it should be feasible for all countries to produce an inventory with a set of emissions estimates.

The methods and data employed for estimating emissions can vary considerably between countries, based upon the tier approach that is chosen, levels of expertise, resources and the data that is available. Inventory compilers in each country are free to decide upon the most appropriate data and calculation methods, and may review their activities on a regular basis in order to obtain progressive improvements (for example, through the use of more detailed data and/or calculation methods). If such changes take place, each series should be revised in its entirety from 1990 onwards, so that the information published in the most recent inventory are coherent and consistent.

Air emissions accounts

Air emissions accounts – as collected every two years by Eurostat – record and present annual data on emissions of greenhouse gases and other air pollutants in a way that is compatible with national accounts. Within these accounts, emissions of greenhouse gases are assigned to the inducing entities according to the classification of economic activities (NACE), whose scope ranges from agriculture, through mining and industry, to services and public administration, as well as private households. In contrast, greenhouse gas inventories are based upon a technology-oriented classification – for example, using categories such as fuel combustion, enteric fermentation or the incineration of waste to categorise emissions (see Table 1.3 on page 23 for a more detailed listing of this classification).

Emissions from transport may serve as an illustrative example of the differences. In greenhouse gas inventories, transport emissions are recorded together under a common technology-oriented category, which has sub-categories for fuel combustion within road, air, or water transport. In contrast, air emissions accounts assign transport-related emissions to the economic activity responsible, in other words, driving a private car is assigned to households, the emissions of an ambulance to health services, the emissions of a tractor to agriculture, or those of a heavy goods vehicle to the road freight transport sector.

Another difference between these two approaches relates to the territorial principle employed. Within greenhouse gas inventories, only emissions originating from the national territory are included (international air and maritime transport are excluded from the national totals reported under the Kyoto Protocol). In contrast, air emissions accounts apply the residence principle; in other words, any emissions that stem from resident economic units are included – for example, emissions from an international shipping company, regardless of where the ships travel; the accounting rules adopted within air emissions accounts therefore treat greenhouse gas emissions from international transport in a consistent way.

Air emissions accounts can be used in a range of different contexts – in particular, to analyse environmental implications of production and consumption patterns. From a production perspective, air emissions accounts can be used to consider all direct air emissions arising from resident economic units, distinguishing the environmental performance of different activities. Total air emissions assigned to a national economy can be obtained simply by summing contributions from each economic branch (including households), revealing where the environmental impact of emissions is greatest. This approach can be extended linking data on emissions and economic output, thereby providing measures of 'environmental performance', such as emissions intensities.

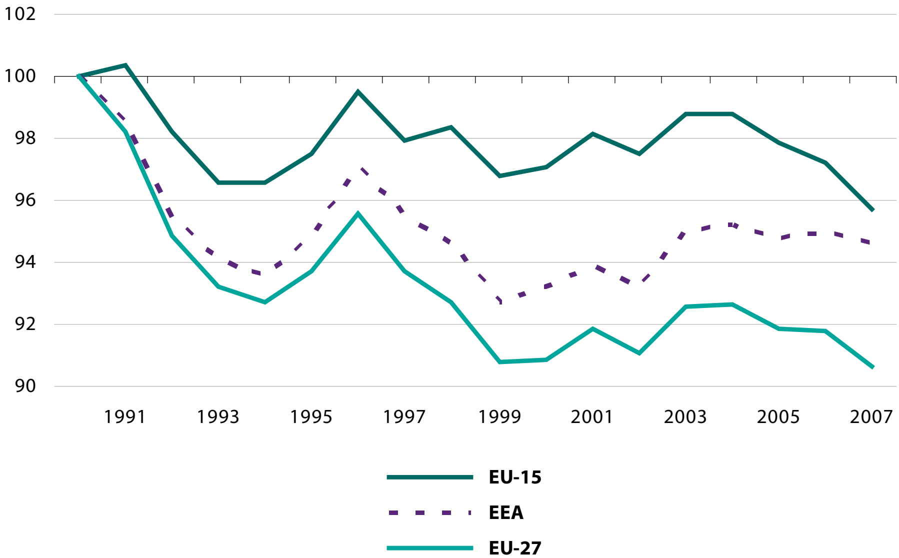
It is also possible to use air emissions accounts from the consumption perspective. Such calculations are likely to be considerably more complex as they should take into consideration all greenhouse gas emissions arising along the entire – and increasingly global – production chain. For example, in the case of food consumption, the emissions relating to a particular product, say a chocolate biscuit, should reflect the complete journey from the farm to the fork (thereby accounting for, among others, greenhouse gas emissions relating to the application of fertilisers and/or manure, the combustion of fuels used in agricultural machinery, the production of electricity consumed in food processing plants, the combustion of fuel in transporting the food to market, or the manufacture, collection and disposal of packaging materials). Policy makers may be interested in greenhouse gas emissions from domestic final use (comprising emissions from domestic production systems and those from imports). Indeed, when air emissions accounts are combined with supply, use and input-output tables, analyses may be extended to cover environmental pressures associated with consumption and production patterns, which are likely to be of particular relevance in relation to sustainable development initiatives. One potential use of this type of analysis is the calculation of 'carbon footprints' for a range of end products, taking account of production, distribution, consumption and disposal.

1.3 Emissions: main indicators

Total greenhouse gas emissions in the EU-27 (excluding Land Use, Land-Use Change and Forestry (LULUCF)) 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. Between 2006 and 2007, greenhouse gas emissions in the EU-27 decreased by 1.2 % (or some 59.8 million tonnes of CO_2 equivalents).

Under the Kyoto Protocol, the EU-15 Member States agreed to reduce their greenhouse gas emissions by 8 % in the first commitment period (2008-2012). Between 1990 and 2007, the overall reduction in EU-15 greenhouse gas emissions (again excluding LULUCF) was 4.3 %, while the reduction in total emissions between 2006 and 2007 was 1.6 %. In 2007, total greenhouse gas emissions in the EU-15 (excluding LULUCF) stood at 4 052 million tonnes of CO_2 equivalents.

Figure 1.2: Greenhouse gas emissions in CO_2 equivalents (1990=100, based on tonnes) (1)



(1) Total emissions (sectors 1-7, excluding LULUCF).

Source: Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009, EEA (http://www.eea.europa.eu)

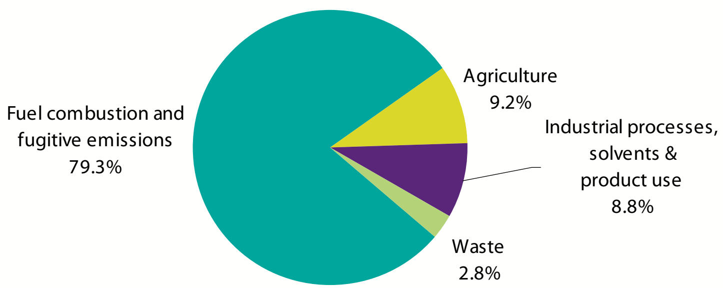
Greenhouse gases by source

By far the most important source of greenhouse gas emissions in the EU-27 is fuel combustion and fugitive emissions (the latter being composed of processing equipment leaks from pipes, valves and flanges). Throughout the period 1990 to 2007, fuel combustion and fugitive emissions accounted for between 77 % and 80 % of all EU-27 greenhouse gas emissions; the latest available information shows a 79.3 % share.

Emissions resulting from fuel combustion (3 912 million tonnes of CO_2 equivalents in 2007) come from two principal sources: oil and gas-fired power stations generating electricity (which are estimated to have accounted for almost one third of all greenhouse gas emissions), and road transportation, which includes the use of cars and collective passenger road transport, as well as freight transport (which accounted for almost one fifth of all emissions). Note that international aviation and shipping activities are excluded from the Kyoto reporting mechanism and are therefore not considered as part of the transport category. The other main contributors to emissions from fuel combustion were manufacturing industries (most notably, energy-intensive activities such as the manufacture of iron and steel or chemicals) and households (in the form of fuel combustion for domestic heating).

Outside of fuel combustion, agriculture accounted for 9.2 % of all greenhouse gas emissions in the EU-27 in 2007, while emissions from industrial processes, solvents and product use were slightly lower (8.8 %) and emissions from waste (which includes disposal and water treatment) accounted for the remaining 2.8 %.

Figure 1.3: Greenhouse gas emissions in CO_2 equivalents, EU-27, 2007 (% of total emissions) (1)



(1) Total emissions (sectors 1-7, excluding LULUCF).

Source: Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009, EEA (http://www.eea.europa.eu)

Table 1.3: Greenhouse gas emissions by source category in CO_2 equivalents, EU-27 (million tonnes) (1)

	1990	1995	2000	2005	2007	Absolute change 1990-2007
TOTAL EMISSIONS (Kyoto)	5 564.0	5 212.6	5 053.6	5 111.0	5 045.4	-518.7
Agriculture	579.5	504.1	493.2	466.4	462.2	-117.3
Agricultural soils	293.3	249.5	247.3	231.1	226.4	-66.9
Enteric fermentation	180.8	159.4	153.3	145.4	145.2	-35.6
Manure management	101.8	92.1	89.7	87.1	87.6	-14.2
Other	3.6	3.1	2.9	2.8	3.0	-0.6
Fuel combustion and fugitive emissions	4 277.4	4 031.5	3 969.6	4 066.4	3 999.1	-278.3
Fuel combustion	4 123.1	3 898.1	3 860.1	3 974.1	3 912.4	-210.6
Energy industries	1 684.3	1 518.0	1 499.0	1 583.0	1 610.7	-73.6
Public electricity and heat production	1 461.7	1 302.3	1 296.8	1 373.7	1 403.9	-57.8
Petroleum refining	116.0	126.5	130.7	138.9	135.4	19.5
Manuf. of solid fuels and other energy ind.	106.7	89.2	71.4	70.4	71.3	-35.3
Manufacturing industries and construction	820.3	744.4	693.1	654.3	643.2	-177.0
Other sectors	812.1	782.1	738.2	754.0	665.6	-146.5
Commercial/institutional	202.1	182.7	174.1	182.7	165.6	-36.5
Residential	517.3	509.7	481.9	491.6	426.5	-90.9
Agriculture/forestry/fisheries	92.7	89.6	82.2	79.6	73.5	-19.1
Transport	779.7	837.9	917.8	971.7	982.5	202.8
Road transportation	715.3	781.9	858.0	910.5	920.4	205.1
Civil aviation	17.3	16.8	21.9	21.8	22.4	5.1
Other transport	47.1	39.2	37.8	39.5	39.7	-7.4
Other (not elsewhere specified)	26.7	15.8	12.0	11.0	10.4	-16.3
Fugitive emissions from fuels	154.3	133.4	109.6	92.3	86.6	-67.7
Industrial processes, solvents & product use	494.2	469.8	418.6	432.4	442.9	-51.3
Industrial processes	478.0	455.9	405.1	420.0	430.6	-47.4
Mineral products	146.7	137.3	140.3	144.7	153.9	7.2
Chemical industry	159.2	149.2	106.3	105.1	95.4	-63.8
Metal production	130.8	110.1	99.3	101.2	108.2	-22.6
Other industrial processes	41.3	59.4	59.1	68.9	73.0	31.8
Solvent and other product use	16.2	13.9	13.5	12.4	12.4	-3.9
Waste	212.9	207.2	172.2	145.7	141.2	-71.8
Solid waste disposal on land	175.1	170.5	138.1	111.2	106.6	-68.4
Wastewater handling	31.5	29.7	27.4	27.4	27.6	-3.9
Other waste	6.3	7.0	6.6	7.1	6.9	0.6
OTHER EMISSIONS (non-Kyoto) (2)	18.6	30.4	112.1	164.7	246.0	227.4
Land use, land use change & forestry (LULUCF)	-334.2	-385.5	-382.7	-439.2	-407.2	-72.9
Forest land	-439.7	-489.9	-485.5	-546.5	-514.2	-74.5
Cropland	93.8	86.9	81.8	79.1	75.1	-18.7
Settlements	18.0	16.5	17.7	18.4	27.0	9.0
Other LULUCF	-6.3	1.1	3.3	9.8	5.0	11.3
CO_2 emissions from biomass	176.7	222.2	247.7	310.6	338.2	161.5
International bunkers	176.2	193.8	247.1	293.3	315.1	138.8
International aviation	66.2	83.9	114.0	129.4	138.8	72.6
International maritime transport	110.0	109.8	133.0	163.9	176.2	66.2

(1) Total emissions (sectors 1-7, excluding LULUCF).
(2) This category and subsequent rows are excluded from total emissions within the Kyoto Protocol.

Source: Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009, EEA (http://www.eea.europa.eu)

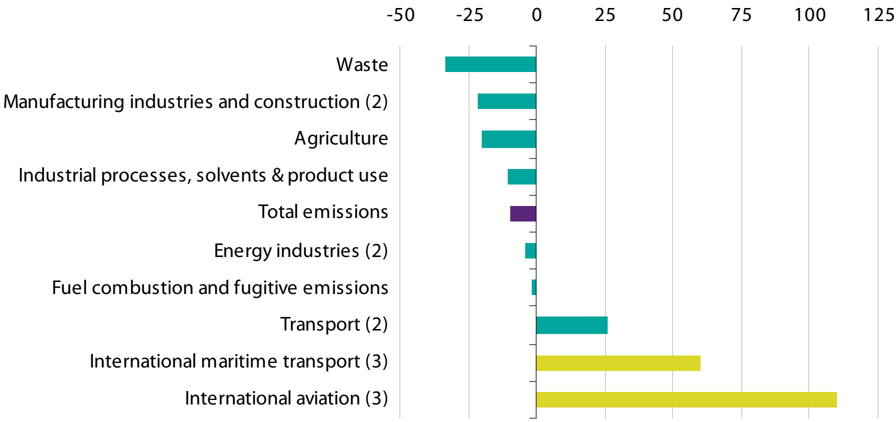
The vast majority of the EU-27's greenhouse gas emissions from agriculture (462.2 million tonnes of CO_2 equivalents in 2007) come from one of three sources: soils (49.0 %), enteric fermentation (31.4 %) or manure management (19.0 %). Contrary to most other areas, where carbon dioxide is the principal greenhouse gas emitted, agricultural emissions are largely composed of nitrous oxide (56.3 %) and methane (43.7 %). Note that the information presented on land use, land-use change and forestry (LULUCF) is excluded from the Kyoto reporting mechanism. Forests can potentially help reduce greenhouse gas emissions. In its latest inventory report, the EEA estimated a net value of some 514.2 million tonnes of CO_2 equivalents of carbon sinks in EU-27 forests in 2007, which, for example, more than offset the total volume of greenhouse gas emissions from agriculture.

Greenhouse gas emissions in the EU-27 from industrial processes, solvents and other product uses were estimated at 442.9 million tonnes of CO_2 equivalents in 2007. The vast majority of this (97.2 %) was accounted for by industrial processes, in particular, the production and consumption of cement, aluminium, ammonia or petrochemicals (for final use or as a feedstock for downstream manufacturing activities).

EU-27 greenhouse gas emissions resulting from waste were estimated to be 141.2 million tonnes of CO_2 equivalents in 2007. Of this, the majority resulted from landfill activities (emitting methane), while the handling of domestic and commercial wastewater was also a relatively important source.

Over the period 1990 to 2007, there were considerable variations in the development of greenhouse gas emissions among the different source categories. By far the highest increases were recorded for the two transport categories which are not part of the Kyoto Protocol, as emissions from international aviation more than doubled (109.7 %) and those from international maritime transport increased by 60.2 %. Of the (sub-) categories covered by the Kyoto Protocol, (national) transport was the only one to record an increase in its volume of greenhouse gas emissions, up 26.0 % overall in the EU-27 between 1990 and 2007. Emissions from energy industries (mainly electricity generation) declined by 4.4 % in the EU-27 during the period considered, while all of the remaining (sub-) categories reported emission reductions that were in excess of the average (-9.3 %) – thus underlining the relatively important contribution to overall emissions that is made by electricity generation and transport. The most significant EU-27 emission reductions (in percentage terms) between 1990 and 2007 were recorded for waste (-33.7 %), fuel combustion within manufacturing industries and construction (-21.6 %) and agriculture (-20.2 %); together these three categories accounted for 24.7 % of total greenhouse gas emissions in the EU-27 in 2007.

Figure 1.4: Change in greenhouse gas emissions by source category, EU-27, 1990-2007 (overall %, based on tonnes of CO_2 equivalents) (1)



(1) Total emissions (sectors 1-7, excluding LULUCF).
(2) Part of fuel combustion and fugitive emissions.
(3) Excluded from total emissions within the Kyoto Protocol.

Source: Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009, EEA (http://www.eea.europa.eu)

While the long-term evolution of greenhouse gas emissions (1990 to 2007) shows some clear patterns as regards the changes in the relative importance of emissions and the ever-growing importance of the transport sector's contribution, such trends may be less evident when analysing a shorter period of time, such as the change in greenhouse gas emissions between 2006 and 2007. Indeed, over the space of a single year there are likely to be a number of factors which could potentially exert an influence on the level of greenhouse gas emissions and these may result in one-off fluctuations that do not follow longer-term trends. For example, it is possible that the energy mix changes to reflect global movements in price and/or security of supply. Alternatively, a relatively warm winter might result in households/offices using their heating less than might otherwise be the case, while a public health scare might result in large numbers of livestock being slaughtered. Finally, government legislation and taxation policy (for example, vehicle scrappage schemes, vehicle taxation linked to emissions and/or engine size, or excise duty rates on fuel) can also shape consumption patterns, sometimes with substantial one-off effects.

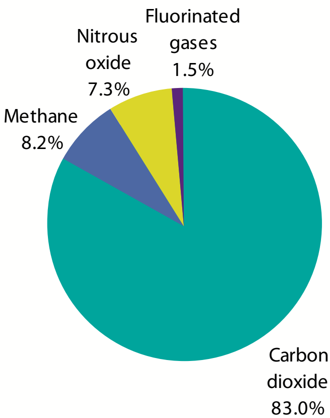
Greenhouse gases by type of gas

Carbon dioxide is the most important gas within the context of greenhouse gas emissions. It accounted for 83.0 % of EU-27 greenhouse gas emissions (excluding LULUCF) in 2007, followed by methane (8.2 %), nitrous oxide (7.3 %) and fluorinated gases (1.5 %).

Although fluorinated gases accounted for a relatively small share of total greenhouse gas emissions in the EU-27 in 2007, their share has been steadily rising since 1990. Indeed, they were the only group of gases to record an overall increase in their volume of emissions between 1990 and 2007 (up 31.1 %). The increase in greenhouse gas emissions of fluorinated gases can be entirely attributed to hydrofluorocarbons (HFCs), which more than doubled (rising by 125.3 % overall), while the volume of emissions of sulphur hexafluoride (SF_6) fell by 13.5 % and those of perfluorocarbons (PFCs) by 77.8 %. HFCs have, in recent years, been increasing used as substitutes for ozone-depleting compounds such as chlorofluorocarbons (CFCs) in production areas such as refrigeration, air conditioning, or the manufacture of insulating foams.

The rate at which carbon dioxide emissions fell in the EU-27 (4.8 % overall between 1990 and 2007) was slower than the average reduction for all greenhouse gases (9.3 %). Nitrous oxide and methane emissions fell considerably faster, by 27.1 % and 31.1 % respectively, reflecting the reductions in emissions recorded across the agriculture and waste categories.

Figure 1.5: Share of total greenhouse gas emissions, EU-27, 2007 (based on tonnes of CO_2 equivalents) (1)



(1) Total emissions (sectors 1-7, excluding LULUCF).

Source: Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009, EEA (http://www.eea.europa.eu)

Greenhouse gases in the Member States

Among the Member States, greenhouse gas emissions were dominated by the largest emitter, namely 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 have 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. For comparison, the relative weight of the EU-15 in the EU-27 total was 93.0 % of GDP and 79.1 % for the number of inhabitants in 2007.

Table 1.4: Greenhouse gas emissions in CO_2 equivalents and Kyoto targets (1)

	Kyoto Protocol base year	Emissions in Kyoto base year (million tonnes)	Emissions in 1990 (million tonnes)	Emissions in 2007 (million tonnes)	Overall change base year to 2007 (%)	Target 2008-2012 under Kyoto Protocol and EU burden sharing (%)
EU-15	1990	4 265.5	4 232.9	4 052.0	-5.0	-8
BE	1990	145.70	143.25	131.30	-10.1	-8
BG	1988	132.60	117.67	75.79	-48.3	-8
CZ	1990	194.20	194.71	150.82	-22.3	-8
DK	1990	69.30	69.06	66.64	-3.8	-21
DE	1990	1 232.40	1 215.21	956.11	-22.7	-21
EE	1990	42.60	41.94	22.02	-49.1	-8
IE	1990	55.60	55.38	69.21	24.6	13
EL	1990	107.00	105.56	131.85	23.5	25
ES	1990	289.80	288.13	442.32	52.9	15
FR	1990	563.90	562.64	531.10	-5.8	0
IT	1990	516.90	516.32	552.77	6.9	-7
CY	-	-	5.47	10.13	-	-
LV	1990	25.90	26.68	12.08	-51.8	-8
LT	1990	49.40	49.08	24.74	-50.3	-8
LU	1990	13.20	13.12	12.91	-2.2	-28
HU	1985-87	115.40	99.21	75.94	-39.8	-6
MT	-	-	2.04	3.03	-	-
NL	1990	213.00	212.00	207.50	-2.6	-6
AT	1990	79.00	79.04	87.96	11.3	-13
PL	1988	563.40	459.47	398.88	-35.8	-6
PT	1990	60.10	59.27	81.84	36.7	27
RO	1989	278.20	243.04	152.29	-51.8	-8
SI	1986	20.40	18.57	20.72	1.7	-8
SK	1990	72.10	73.26	46.95	-34.3	-8
FI	1990	71.00	70.86	78.35	10.4	0
SE	1990	72.20	71.93	65.41	-9.4	4
UK	1990	776.30	771.13	636.68	-18.1	-13

(1) Total emissions (sectors 1-7, excluding LULUCF).

Source: Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009, EEA (http://www.eea.europa.eu)

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). Between 1990 ([5]) and 2007 some of the biggest overall increases in greenhouse gas emissions were recorded on the Iberian Peninsula, with gains of 53.5 % and 38.1 % in Spain and Portugal.

Greenhouse gas emissions were approximately halved between 1990 and 2007 in each of the Baltic Member States, with the largest decrease recorded in Latvia (-54.7 %). There were also significant reductions in Romania, Slovakia and Bulgaria (of more than one third), which was also the case for Poland (although in relation to its base year of 1998). According to the EEA, the main reason for these reductions was a decline in emissions from 'heavy' manufacturing industries that were either closed or modernised as a result of restructuring measures. Cyprus and Malta also recorded significant increases in their emission levels (although they are not parties to the Kyoto Protocol). Among EU-15 Member States, Germany and the United Kingdom reduced their greenhouse gas emissions by a combined 393.5 million tonnes of CO_2 equivalents between 1990 and 2007, recording the biggest reductions in absolute and relative terms.

Emission intensities

Population is one determinant that may explain the differences in emission levels between countries. If used as a denominator for emission levels the information on emissions may be normalised and expressed in tonnes of CO_2 equivalents per capita. Luxembourg recorded by far the highest level of greenhouse gas emissions at 27.1 tonnes of CO_2 equivalents per capita, some 2.7 times as high as the average for the EU-27 (10.2 tonnes of CO_2 equivalents per capita). The figures for Luxembourg are inflated by relatively high emissions of carbon dioxide, which may, at least in part, be attributed to a considerable number of persons who work in Luxembourg but are resident in neighbouring Belgium, France or Germany, as well as a substantial amount of road freight in transit, as well as additional traffic resulting from drivers making a detour to benefit from relatively cheap fuel.

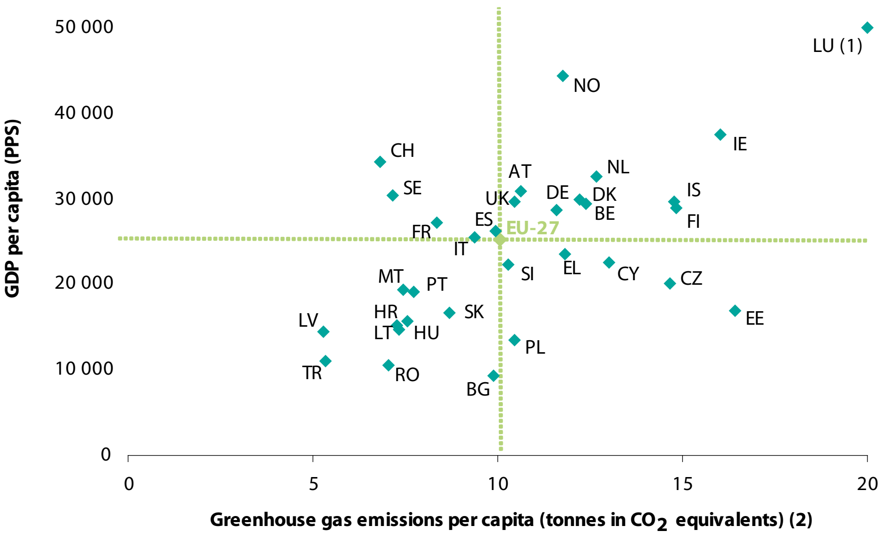
As carbon dioxide emissions account for a majority of greenhouse gas emissions in each country, the ranking of emissions per capita generally reflects the energy intensity (energy use per unit of GDP) as well as the carbon intensity of each economy. An economy that is dominated by 'heavy', traditional industries is more likely to have higher energy intensity than an economy based on services. Likewise, a country that relies on imports of goods (say, iron and steel products) will, a priori, have a lower level of energy intensity than a country that manufactures these goods itself.

([5]) Note that while the base year upon which the Kyoto targets are fixed is, for most countries, generally 1990, there may be differences in the treatment of specific gases, whereby the base year is changed, for example, to 1995 (when more reliable information became available); this explains the discrepancy between the column headings of 'emissions in Kyoto base year' and 'emissions in 1990' in Table 1.4 (even if the base year is reported as 1990).

This analysis can be extended to consider the energy mix, which often reflects indigenous supplies and/or hydropower capacities: for example, a relatively high propensity to use coal in Poland, natural gas in Denmark, nuclear energy in France, or hydropower in Norway. The use of low or carbon-neutral fuel sources will clearly impact on the level of greenhouse gas emissions per capita, as seen in the data for France, Switzerland or Sweden (all well below the EU average). Emission levels per capita also reflect inherent differences between countries for other greenhouse gases. For example, methane and nitrous oxide emissions are strongly linked to agricultural practices. As such, an economy that is characterised by a relatively low population density and which has the necessary climatic and geological/soil conditions to encourage farming (for example, Ireland) is likely to have much higher levels of methane and nitrous oxide emissions per capita than a country which is arid or experiences arctic conditions, or a country where agricultural emissions are dissipated by a relatively sizeable population.

Emissions intensity is generally measured as the level of greenhouse gas emissions per unit of GDP (economic output). The GDP data for this indicator are presented in terms of purchasing power standards (PPS), thereby removing distortions that result from differences in price levels between countries. There is particular interest in this relationship from a sustainable development perspective, in order to analyse whether greenhouse gas emissions can be decoupled from economic growth, in other words, to ascertain in what way environmental pressures are linked to economic growth.

Figure 1.6: Greenhouse gas emissions per capita and GDP per capita, 2007



(1) Broken axis: x-value is 27.12 tonnes; y-value is PPS 66 600. (2) Total emissions (sectors 1-7, excluding LULUCF).

Source: Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009, EEA (http://www.eea.europa.eu) and Eurostat (tec00001)

Greenhouse gas emissions per unit of GDP have fallen across most developed economies in recent decades: reflecting reductions in energy intensity as well as changes in the energy mix (for example, a switch from coal to gas in electricity production). Post-industrialisation has seen developed economies move away from 'heavy' industries to focus on technology and service sectors, and as a result their wealth creation is increasingly decoupled from energy-intensive inputs. For example, some of the countries with the highest standards of living in Europe (as measured by GDP per capita) are found at or near the bottom of the ranking of greenhouse gas emissions per unit of GDP.

The highest greenhouse gas emissions per unit of GDP in 2007 were recorded in Bulgaria and Estonia (the only Member States to report ratios at least twice as high as the EU-27 average). Most of the other Member States that have joined the EU since 2004 also reported relatively high emission intensities, with only Latvia and Malta below the EU-27 average.

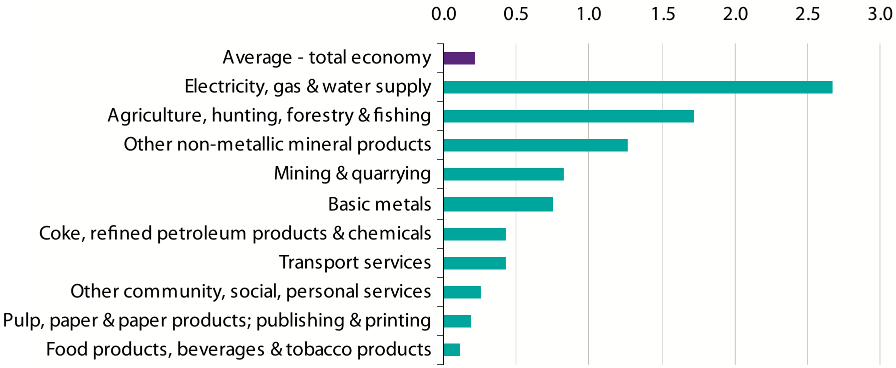
Emission intensities by economic activity

The analysis may be extended by linking greenhouse gas emissions with national accounts data to look in more detail at whether specific activities have become more or less emission-intensive. As already noted, intensities have tended to fall as a result of the structural shift towards services within the European economy, while manufacturing processes have become more energy-efficient and receptive to environmental initiatives.

The data presented in this section refers to greenhouse gas emission intensities based on kilograms of greenhouse gas emissions (CO_2 equivalents) per euro of output; note that these accounts assign emissions to the economic activity where they originated rather than according to any technology-oriented classification of processes (as is the case for inventory reporting under the Kyoto Protocol). Not surprisingly, the most emission-intensive activity was electricity, gas and water supply (NACE Rev. 1.1 Section E), where EU-25 greenhouse gas emissions per euro of output in 2004 were 12.7 times as high as the average for the whole economy. This was followed by agriculture, hunting, forestry and fishing (NACE Rev. 1.1 Sections A and B), where emissions per euro of output were 8.1 times as high as the average, and the manufacture of other non-metallic mineral products (NACE Rev. 1.1 Division 26), six times as high.

The reduction in EU-25 greenhouse gas emission intensities between 1995 and 2004 was highest (in absolute terms) for the most emission-intensive activity, as emissions from electricity, gas and water supply were 416 g less per euro of output in 2004 than they had been in 1995. In relative terms, bigger reductions were recorded for the manufacture of coke, refined petroleum, chemicals and chemical products (NACE Rev. 1.1 Divisions 23 and 24) and for other community, social and personal service activities (NACE Rev. 1.1 Section O), where emission intensities fell by 37 % overall during the period considered.

Figure 1.7: Greenhouse gas emission intensities – top ten activities, EU-25, 2004 (kg of CO_2 equivalents per EUR output)



Source: Eurostat (NAMEA-Air survey 2006; EU KLEMS)

Public perceptions

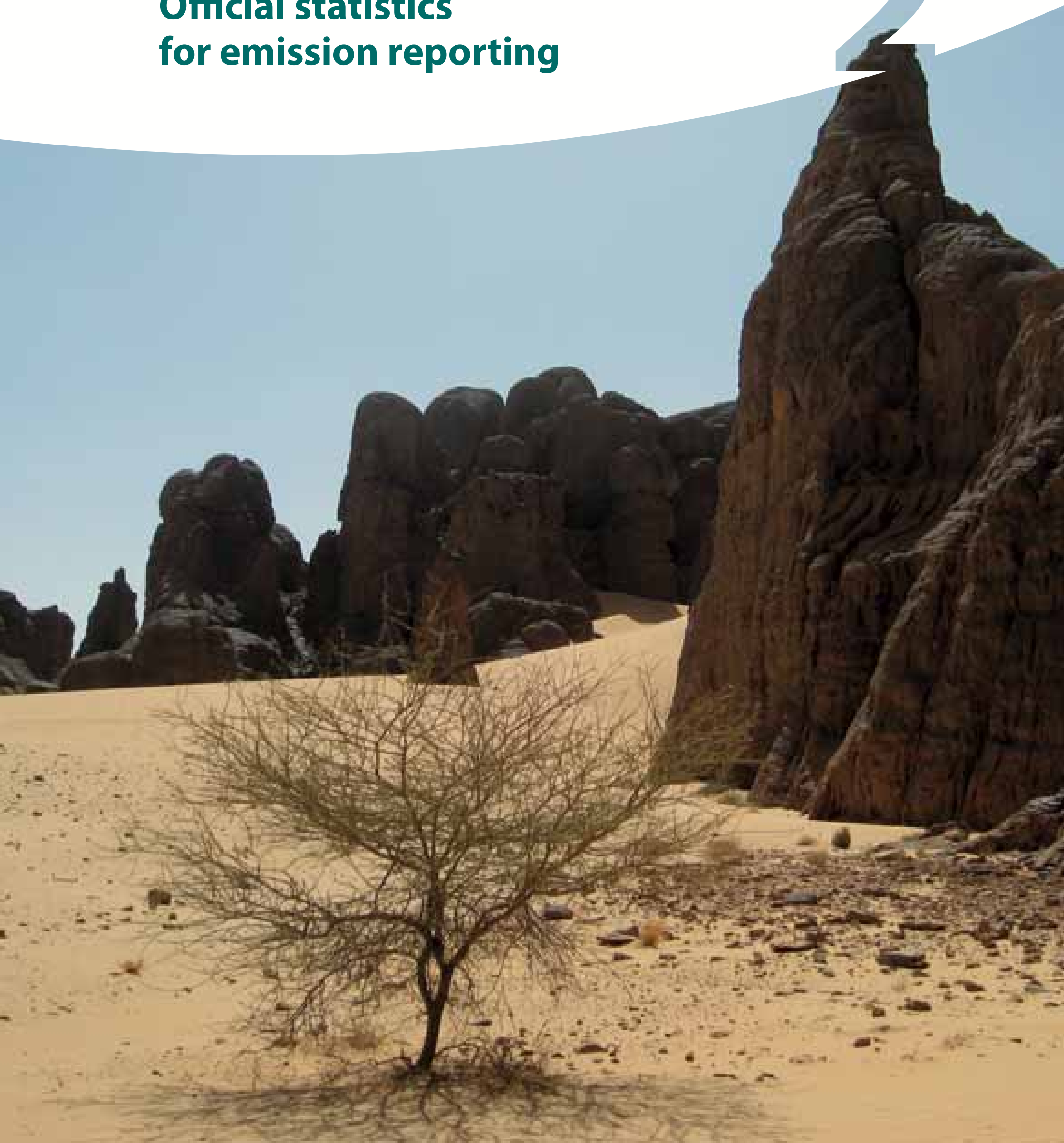
A Eurobarometer survey ([6]) was conducted in January 2009 in relation to Europeans' attitudes towards climate change. Just under one third of those surveyed (31 %) were pessimistic, agreeing that climate change is an unstoppable process, while 30 % thought that carbon dioxide emissions have a marginal impact on climate change. In contrast, more than half of the respondents agreed that fighting climate change could have a positive impact on the economy (62 %); that using alternative fuels would help reduce emissions (75 %); and that they personally had taken action to fight climate change (59 %).

When asked which actions they had personally taken in order to combat climate change, the majority of respondents surveyed between March and May 2008 in the EU-27 ([7]) said they were engaged in three separate actions within the confines of the home: 76 % separated waste for recycling, 64 % reduced their energy use, and 55 % reduced their water use. The proportion of respondents who made changes to their travel patterns in an attempt to combat climate change was considerably less – 25 % reduced their use of a car, 18 % purchased a car that consumed less fuel/was more energy/fuel efficient, and 12 % avoided taking short-haul flights.

([6]) Special Eurobarometer 313: http://ec.europa.eu/public_opinion/archives/ebs/ebs_313_en.pdf.
([7]) Special Eurobarometer 300: http://ec.europa.eu/public_opinion/archives/ebs/ebs_300_full_en.pdf.

2

Official statistics for emission reporting



2.1 Land use and agriculture

Within the context of emission inventories prepared for annual reporting in relation to the Kyoto Protocol, the measurement of greenhouse gases should be confined to anthropogenic (human-induced) emissions that occur on managed lands. Nevertheless, almost the entire surface of the earth is affected, at least to some degree, by human influence, as witnessed by concerns surrounding the environment in areas seemingly as remote as the polar ice caps or the Galapagos Islands.

The effects of agriculture or changes in land use are often difficult to measure, as they may involve complex biological or ecological processes – which can result in greenhouse gas emissions or removals (known as sinks). These can be widely dispersed over time (for example, carbon stocked in forests) or highly variable from one year to the next (for example, an outbreak of forest fires due to particularly dry weather).

Greenhouse gas emissions from agricultural practices are primarily in the form of nitrous oxide (N_2O) resulting from the application of fertilisers and manure, or in the form of methane (CH_4) that results, among others, from livestock emissions, stored animal manure, or (to a lesser degree) rice cultivation. Indeed, agriculture is the main source of nitrous oxide and methane emissions in the EU. However, in contrast to most other sources, there are relatively low levels of carbon dioxide emissions resulting from agriculture practices; rather, agricultural land and forests generally sequester (hold) carbon reserves and help to reduce levels of carbon dioxide in the atmosphere.

The relative importance of agriculture in terms of its contribution to the overall level of greenhouse gas emissions in the EU-27 fell from 10.4 % of the total in 1990 to 9.2 % by 2007, when emissions stood at 462.2 million tonnes of CO_2 equivalents. Greenhouse gas emissions from agriculture fell overall by 20.2 % between 1990 and 2007, at a considerably faster pace than the reduction in total EU-27 greenhouse gas emissions (-9.3 %). The reduction in agricultural emissions may, at least in part, be attributed to declining livestock numbers, more efficient farming practices, the reduced application of nitrogen-based fertilisers (following the implementation of the Nitrates Directive), as well as better forms of manure management.

Changes in land use – in particular, the growth of low-density, suburban approaches to city and town centres – have led to increased consumption of energy, resources, transport and land, raising greenhouse gas emissions and air pollution. Most of these changes can be attributed to an expansion of the housing stock, although land is also converted, for example, into out-of-town shopping centres, for transport infrastructure, or for waste disposal (landfill). Aside from the growth of built-up areas, rural landscapes have also changed as a result of more intensive agricultural practices and forest management, while some previously remote coastal or mountainous areas have witnessed considerable investment in their local infrastructure as a result of tourism. All of these changes in the use of land have implications on the level of greenhouse gas emissions in the EU.

Table 2.1: Land use by main category (km^2)

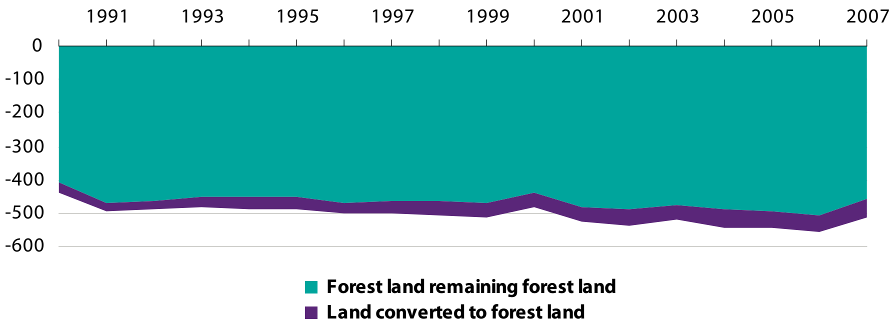
	Total area		Agriculture		Forest & other wooded land		Built-up areas		Water	
	1990	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**
BE	30 528	30 528	18 078	17 361	*6 734*	6 790	4 980	5 640	200	200
BG	:	:	61 590	62 525	38 714	39 144	:	:	:	:
CZ	78 864	78 865	42 875	42 799	26 295	26 373	8 119	8 100	1 575	1 593
DK	43 093	43 093	27 883	26 470	4 450	4 863	5 887	7 291	700	700
DE (1)	248 611	357 031	133 206	191 028	74 287	105 314	33 720	45 735	4 522	8 085
EE	:	:	1 358	986	1 919	:	:	:	283	:
IE	:	:	45 344	44 184	4 812	6 498	:	:	:	:
EL	:	:	:	:	:	:	:	:	:	:
ES	504 685	:	306 657	:	159 596	:	19 292	:	5 575	:
FR	549 190	549 192	321 334	305 756	162 857	170 930	35 148	42 104	7 136	7 780
IT	301 277	301 333	194 474	:	67 601	68 531	:	:	:	:
CY	9 251	9 251	:	:	1 701	3 855	:	205	:	:
LV	64 589	64 589	25 687	24 849	27 913	28 682	2 632	:	2 543	2 543
LT	65 301	65 300	35 136	34 968	:	19 723	1 574	1 984	2 637	2 625
LU	2 597	:	1 406	:	950	:	220	:	18	:
HU	93 032	93 030	64 731	58 539	16 954	17 733	:	:	:	:
MT	:	:	:	107	:	13	:	:	:	:
NL	39 858	41 526	23 991	23 508	3 098	3 233	5 386	5 754	5 936	7 653
AT	83 859	83 859	34 581	33 899	34 349	34 333	3 112	3 817	1 331	1 426
PL	312 683	312 685	187 838	185 044	88 837	91 221	19 830	20 531	8 257	8 336
PT	91 990	89 371	40 199	37 002	32 290	:	14 140	16 367	:	:
RO	238 391	238 391	147 690	148 569	66 854	64 573	10 112	10 210	9 036	8 678
SI	:	20 273	:	6 908	:	12 175	:	795	:	132
SK	49 038	49 038	24 486	24 407	19 890	20 013	3 737	3 684	924	934
FI	338 145	:	26 665	:	233 665	:	7 520	:	33 552	:
SE	450 000	450 000	32 730	32 980	280 990	:	11 720	:	39 000	39 000
UK	:	:	188 840	:	:	27 940	:	:	:	:
HR	87 609	87 609	31 857	31 557	20 776	19 765	3 561	4 877	31 415	31 410
MK	:	:	13 200	12 360	989	1 030	:	:	:	:
TR	:	:	423 930	409 160	205 680	207 632	:	:	:	:
IS	103 300	103 300	19 000	19 000	1 250	1 310	1 250	1 450	2 700	2 700
NO	323 877	323 758	9 941	10 436	119 200	120 000	:	:	17 070	17 505

(1) Pre-unification for 1990.

Source: Eurostat (env_la_luq1)

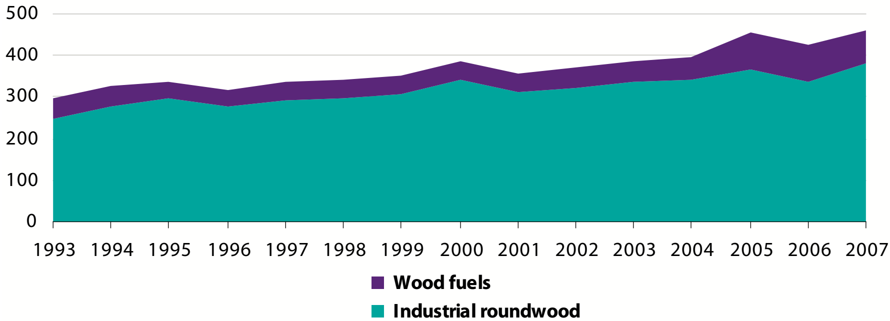
Globally, deforestation (in particular, the clearance of tropical rainforests) has an impact on greenhouse gas emission levels. Nevertheless, forests and soil have the potential to play an important role in climate change mitigation by acting as a carbon sink. Estimates of greenhouse gas emissions/sinks from forestry vary considerably due to tree species, forest density, clearing rates, amounts of biomass, and modes through which carbon dioxide is released (one-off emissions from burning or emissions that are spread over time from decay). Figure 2.1 shows details from the latest EEA inventory reporting for 2007, whereby the net result of forest management and land converted to forest in the EU-27 was 518 million tonnes of carbon dioxide being removed from the atmosphere (almost 90 % of which was accounted for by existing forests absorbing carbon).

Figure 2.1: Net CO_2 emissions, EU-27 (million tonnes)



Source: Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009, EEA (http://www.eea.europa.eu)

Figure 2.2: Roundwood removals, EU-27 (million m^3 underbark)



Source: Eurostat (for_remov)

Approximately one third of Europe's area is covered by forest, a proportion that is gradually rising. While the area covered by forest increases, the volume of round-wood removals (trees being felled and removed) has also increased in the EU-27 in the last decade (see Figure 2.2), in particular for wood fuels that are primarily used in the production of renewable energy (see Subchapter 2.2 for more details). There would appear to be further potential to intensify forest utilisation, given that the share of fellings in net annual increment declined from 62.8 % to 59.3 % between 1990 and 2005. The United Nations estimates that the carbon stock in above-ground biomass reached 7 443 million tonnes by 2005 in the EU-27.

Table 2.2: Biomass stock and carbon stock in forest, 2005 (million tonnes)

	Biomass			Carbon stock				
	Above-ground	Below-ground	Dead wood	Above-ground biomass	Below-ground biomass	Dead wood	Litter	Soil
EU-27	15 119	:	:	7 443	:	:	:	:
EU-15	10 179	:	:	5 000	:	:	:	:
BE	104	26	3	52	13	1	14	47
BG	395	132	:	197	66	:	:	:
CZ	612	113	36	276	51	16	39	190
DK	40	12	:	20	6	:	:	:
DE	2 020	585	54	1 010	293	27	:	858
EE	259	75	16	130	38	8	:	356
IE	33	7	0	16	3	0	:	:
EL	98	19	:	49	10	:	:	:
ES	661	210	:	297	95	:	:	:
FR	1 850	602	:	879	286	:	125	1 015
IT	1 043	230	159	521	115	80	67	825
CY	4	1	:	2	1	:	:	4
LV	357	105	9	178	52	5	64	284
LT	210	48	21	105	24	10	50	151
LU	17	2	:	8	1	:	:	:
HU	257	83	0	131	42	0	56	73
MT	0	0	:	0	0	:	:	:
NL	43	9	2	21	4	1	9	40
AT	773	:	:	379	:	:	:	474
PL	1 379	412	13	690	206	7	:	:
PT	146	82	:	73	41	:	:	:
RO	904	229	181	452	115	91	59	723
SI	229	65	48	115	32	24	:	89
SK	334	73	32	167	36	16	21	270
FI	1 351	281	35	675	140	15	:	:
SE	1 810	530	670	905	265	335	:	:
UK	190	34	3	95	17	2	25	719
HR	304	80	54	152	40	27	:	:
MK	33	8	:	16	4	:	:	:
TR	1 400	233	:	700	117	:	:	:
IS	3	0	0	1	0	0	0	4
LI	1	0	:	0	0	:	:	:
NO	587	103	37	293	51	19	:	:
CH	248	60	8	124	30	4	16	93

Source: UNECE/FAO FRA 2005 database

Acid rain can potentially have a negative impact on forest resources as defoliation reduces the capacity of trees to remove carbon dioxide through photosynthesis. The United Nations Economic Commission for Europe (UNECE) convention on long range transboundary pollution was enacted to reduce acidic emissions and combined with subsequent legislation has generally improved acid depositions across Europe.

Despite sometimes considerable reductions in acid rain levels, some of the highest rates of forest trees being damaged by defoliation continue to be recorded in central European forests, peaking at 51.1 % in the Czech Republic in 2006. Aside from defoliation, forests may also be affected by a range of other factors, including drought, storms or forest fires.

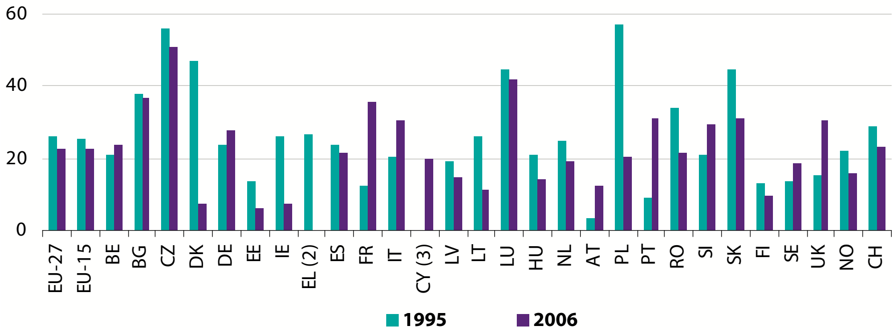
Table 2.3: Forest – annual fellings

	Net annual increment (1 000 m³ over bark)			Annual fellings (1 000 m³ over bark)			Annual fellings as a share of net annual increment (%)		
	1990	2000	2005	1990	2000	2005	1990	2000	2005
EU-27	451 606	662 798	687 450	378 652	443 649	441 995	62.8	61.7	59.3
EU-15	408 267	614 635	638 730	353 971	425 594	420 327	86.7	69.2	65.8
BE	5 176	5 289	5 289	4 352	3 526	4 475	84.1	66.7	84.6
BG	11 239	13 563	14 120	4 681	3 755	5 768	41.6	27.7	40.8
CZ	17 000	19 800	20 500	13 030	15 860	17 190	76.6	80.1	83.9
DK	4 552	4 849	5 176	2 023	2 099	1 837	44.4	43.3	35.5
DE	:	122 000	122 000	42 177	48 818	60 770	:	40.0	49.8
EE	10 168	11 363	11 015	3 770	12 746	5 730	37.1	112.2	52.0
IE	:	:	:	:	:	:	:	:	:
EL	3 813	:	:	2 979	2 221	1 842	78.1	:	:
ES	:	28 589	:	18 517	17 965	19 093	:	62.8	:
FR	84 050	97 578	102 456	56 302	63 125	56 623	67.0	64.7	55.3
IT	26 296	31 836	38 320	10 397	10 559	10 105	39.5	33.2	26.4
CY	47	42	40	41	18	6	88.2	42.1	16.0
LV	16 500	16 500	16 500	4 820	11 574	11 290	29.2	70.1	68.4
LT	:	8 966	9 888	3 780	6 343	7 238	:	70.7	73.2
LU	650	650	650	706	306	249	108.6	47.1	38.3
HU	11 002	11 711	12 899	7 415	7 287	7 167	67.4	62.2	55.6
MT	:	:	:	0	0	0	:	:	:
NL	2 200	2 227	2 230	1 715	1 312	1 552	78.0	58.9	69.6
AT	27 337	31 255	:	19 521	18 797	:	71.4	60.1	:
PL	:	:	67 595	22 021	32 531	37 156	:	:	55.0
PT	:	12 900	:	11 922	10 590	13 286	:	82.1	:
RO	32 100	34 600	34 600	20 000	14 300	15 900	62.3	41.3	46.0
SI	5 116	6 546	7 277	:	2 572	3 203	:	39.3	44.0
SK	10 155	11 748	11 980	5 454	6 683	8 962	53.7	56.9	74.8
FI	76 031	79 362	92 860	52 320	67 173	64 526	68.8	84.6	69.5
SE	90 174	90 724	91 355	62 709	74 089	78 127	69.5	81.7	85.5
UK	18 000	20 700	20 700	8 000	9 400	9 900	44.4	45.4	47.8
TR	32 740	35 029	36 609	11 241	13 301	14 107	34.3	38.0	38.5
IS	44	56	67	0	0	1	0.7	0.5	0.7
LI	25	25	:	16	16	:	64.0	64.0	:
NO	20 121	22 676	23 954	13 414	11 080	11 119	66.7	48.9	46.4
CH	:	8 981	:	:	7 204	:	:	80.2	:

Source: Eurostat (tsdnr520)

Most forest fires in Europe take place in the southern Member States (in particular, Portugal, Spain, France, Italy and Greece). There is a considerable variation in both the number of fires and the area affected by fires from one year to the next, often reflecting seasonal meteorological conditions. As most climate models predict more heat waves in the coming years, there would appear to be an increased risk of forest fires, which would lead to higher carbon emissions as trees are burnt; it should however be noted that the annual volume of forest lost to fires in Europe plays a relatively minimal role in contributing to increments of greenhouse gases.

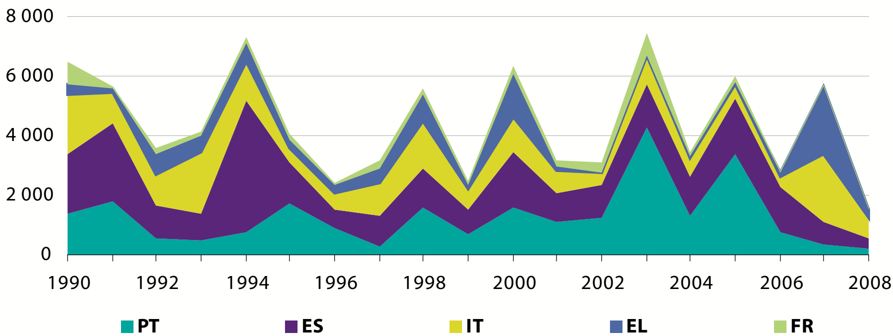
Figure 2.3: Forest trees damaged by defoliation (%) (1)



(1) Malta, not available. (2) 2005 instead of 2006. (3) 1995, not available.

Source: Eurostat (tsdnr530)

Figure 2.4: Area affected by forest fires in southern Europe (km^2) (1)



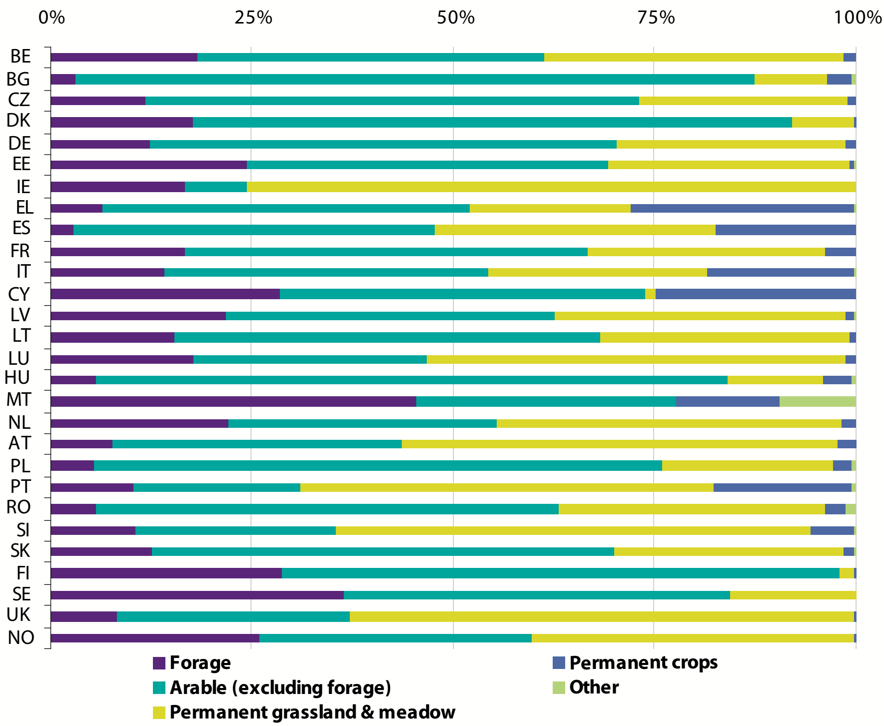
(1) Greece, provisional for 2008.

Source: Forest fires in Europe, 2008; European Commission, Joint Research Centre - Institute for Environment and Sustainability (http://effis.jrc.ec.europa.eu/reports/fire-reports)

Around half the EU's total area is farmed, with country shares generally in the range of 40 % to 65 %; the importance of agriculture is considerably lower in Finland, Sweden and Norway (single-digits). Aside from the area of land devoted to farming, the type of farming practised also impacts on emission levels, with the use of machinery or fertilisers, tillage, or the intensive rearing of animals likely resulting in higher emissions. While the intensiveness of farming practices has increased considerably in the last 50 years, the reformed Common Agricultural Policy (CAP) attempts to decouple farm support subsidies from production and thus remove incentives to further intensification.

The level of carbon stocks in soils also depends, to some degree, on the type of farming practised; extensively farmed land such as grassland tends to accumulate carbon, while carbon losses may occur on intensively farmed areas (croplands), where soils may be drained of nutrients and organic matter. Carbon levels in soils are also related to the spatial distribution of soil types, for example, peat lands – such as those principally found in Ireland, Finland, Sweden and the United Kingdom – have high carbon stocks.

Figure 2.5: Structure of utilised agricultural area, 2007 (% of UAA)



Source: Eurostat (ef_ov_lusum)

Methane emissions from agricultural sources are generally from livestock, manure storage or the application of manures to land. The EEA estimates that enteric fermentation accounted for 31.4 % of the EU-27's agricultural greenhouse gas emissions in 2007. Livestock (indirectly) accounts for approximately half of all agricultural emissions in the EU, given a further 19.0 % of agricultural emissions were attributed to manure management practices. The volume of livestock-related greenhouse gas emissions in the EU-27 fell between 1990 and 2007 by 35.6 million tonnes of CO_2 equivalents for enteric fermentation and by 14.2 million tonnes of CO_2 equivalents for manure management.

Methane is produced as a by-product of enteric fermentation and is particularly common within ruminating animals (that regurgitate semi-digested plant-based food and then chew it again). Cattle are the principal animal producers of methane, while emissions from livestock categories other than cattle, sheep and swine tend to be limited. The amount of methane released depends on the breed, age and weight of an animal, the quality and quantity of their feed, and the animal's energy expenditure. The higher the volume of food intake, the greater the emissions, with feed intake positively related to an animal's size, its growth, whether or not it is pregnant, or its milk production.

Table 2.4: Animal populations (1 000 heads) (1)

	Cattle		Sheep		Pigs	
	1990	2007	1990	2007	1990	2007
EU-27	:	89 037	:	:	:	160 039
BE	3 146	2 573	136	:	6 426	6 200
BG	1 482	611	7 938	1 526	4 187	889
CZ	3 360	1 367	430	184	4 569	2 662
DK	2 241	1 545	111	98	9 282	13 170
DE	19 488	12 707	3 240	1 926	:	27 113
EE	758	241	139	74	960	375
IE	6 100	5 902	5 864	3 531	1 249	1 575
EL	687	682	10 150	*8 984*	1 143	1 038
ES	5 104	6 585	24 022	*22 194*	15 949	26 061
FR	21 446	19 124	11 071	8 285	12 013	14 969
IT	8 235	6 577	10 848	8 237	8 837	9 273
CY	55	56	310	292	278	467
LV	1 439	399	165	54	1 401	414
LT	2 322	788	57	43	2 436	923
LU	215	193	7	8	70	86
HU	1 571	705	1 865	1 232	8 000	3 871
MT	:	19	:	12	54	77
NL	4 830	3 820	1 880	1 715	13 788	11 710
AT	:	2 000	:	351	:	3 286
PL	9 024	5 406	3 798	316	19 739	17 621
PT	1 367	1 443	3 359	3 356	:	2 374
RO	5 381	2 819	14 062	8 469	12 003	6 565
SI	533	480	20	131	588	543
SK	1 563	502	600	347	2 521	952
FI	:	903	:	90	:	1 427
SE	:	1 517	:	521	:	1 728
UK	11 967	10 075	30 513	23 676	7 479	4 671

(1) Data relate to December surveys.

Source: Eurostat (apro_mt_lscatl, apro_mt_lssheep and apro_mt_lspig)

The livestock sector, in keeping with other agricultural sectors, has experienced consolidation alongside a move to more intensive farming practices. Indeed, although cattle populations fell in most Member States during the last couple of decades (with a reduction of more than one fifth in the total number of cattle in Denmark and the Netherlands between 1990 and 2007), their concentrations in holdings has considerably increased. Such changes in farming practices have resulted in methane and nitrous oxide emissions occurring more frequently as a result of the decomposition of manure under anaerobic (lacking in oxygen) conditions, for example, when large numbers of animals are managed in confined areas.

Table 2.5: Main indicators relating to cattle, 2007

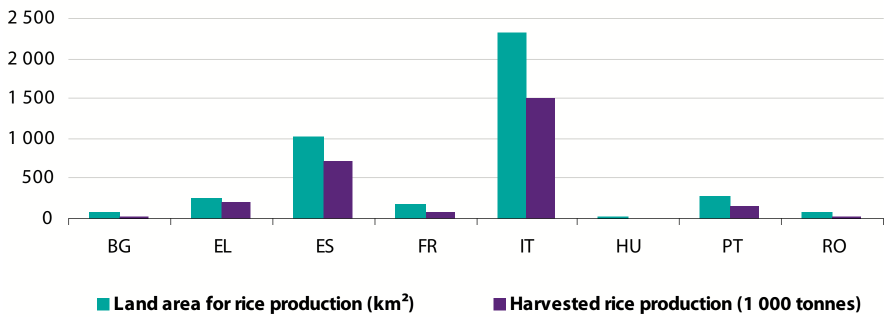
	Area for fodder crops and grass (km^2)	Dairy cows (1 000 heads) (1)	Quantity of milk collected (1 000 tonnes)	Fat content of dairy milk collected (%) (2)	Bovines <1 year (1 000 heads)
EU-27	17 248.5	*24 176*	132 856	:	25 291
BE	137.4	524	2 879	4.14	774
BG	305.1	336	746	:	136
CZ	351.8	407	2 446	3.89	384
DK	266.3	*551*	4 484	4.31	521
DE	1 693.2	4 087	27 321	4.22	3 916
EE	90.7	103	593	4.13	52
IE	413.9	1 088	5 241	3.75	1 609
EL	407.6	*150*	716	3.64	221
ES	2 489.3	903	5 729	3.74	1 665
FR	2 747.7	3 759	22 970	4.07	5 165
IT	1 274.4	1 839	10 265	3.67	1 739
CY	14.6	24	144	3.49	20
LV	177.4	180	631	4.16	108
LT	264.9	405	1 347	4.09	165
LU	13.1	40	259	4.20	53
HU	422.9	266	1 448	3.73	189
MT	1.0	8	41	:	5
NL	191.4	1 490	10 799	4.45	1 502
AT	318.9	525	2 661	4.23	623
PL	1 547.7	2 677	8 744	3.97	1 500
PT	347.3	306	1 837	3.85	380
RO	1 375.3	1 573	1 136	3.59	620
SI	48.9	*117*	530	4.16	148
SK	193.7	180	964	3.77	145
FI	229.2	296	2 293	4.23	311
SE	311.8	*366*	2 985	4.25	489
UK	1 613.0	1 977	13 647	3.99	2 852

(1) Data relate to December survey.
(2) 2004.

Source: Eurostat (ef_ls_gzforage, apro_mk_cola, apro_mk_pobta, apro_mk_fatprot and apro_mt_lscatl)

Anaerobic decomposition of organic material in flooded fields – such as wetland environments or paddy rice fields – produces methane which may escape into the atmosphere primarily through plants. The amount of methane emitted in rice production is a function of the species, the number and duration of harvests, soil type and temperature, irrigation practices, as well as fertiliser use. The relative importance of methane emissions from rice cultivation in the EU-27 is limited, with total harvested rice production of 2.73 million tonnes in 2007. The EEA estimates that rice cultivation contributed approximately 0.5 % of the EU-27's greenhouse gas emissions from agriculture in 2007. The largest area devoted to rice production was recorded in Italy at 2 325 km^2; this area equated to less than 1 % of the land given over to rice cultivation in either India or China.

Figure 2.6: Rice cultivation, 2007 (1)

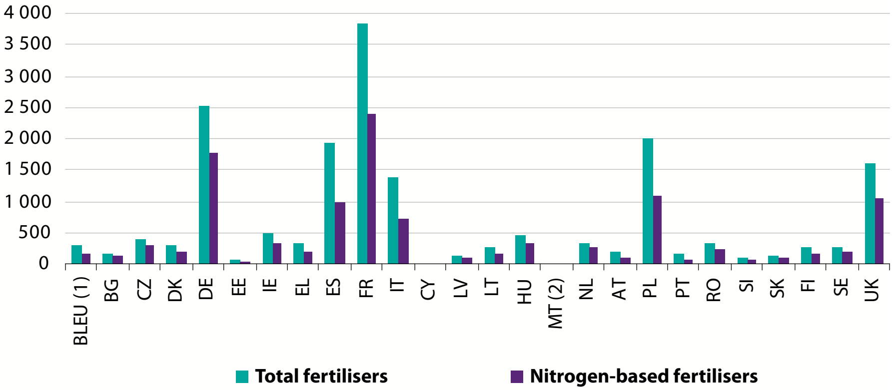


(1) Information shown only for those countries which produce rice.

Source: Eurostat (apro_cpp_crop)

Aside from livestock-related emissions, the other main source of greenhouse gases within the agricultural sector is managed agricultural soils. The EEA estimates that soils accounted for 49.0 % of total agricultural emissions in the EU-27 in 2007, or some 226.4 million tonnes of CO_2 equivalents. Such emissions from soils are primarily associated with the application of, among others, fertilisers, manure, lime and urea. Most of these emissions are in the form of nitrous oxide, which results from the high nitrogen content of mineral fertilisers and livestock manures. When nitrogen-based fertilisers and manures are applied to soil, larger amounts of nitrous oxide are emitted than if these products were kept in storage. The level of greenhouse gases emitted following the application of nitrogen-based fertilisers or manures generally increases if farmers do not plough in the substances that they have spread onto fields.

Figure 2.7: Consumption of fertilisers, 2008
(1 000 tonnes of active ingredient)



(1) BLEU: Belgo-Luxembourg Economic Union.
(2) 2005.

Source: European Fertiliser Manufacturers Association (available on Eurostat's website, env_ag_fert)

Organic farming is a system promoting the protection of the environment and animal welfare. It reduces or eliminates the use of fertilisers, pesticides and growth regulators and is governed by a set of regulated standards and production rules, certification procedures and specific labelling schemes, which should comply with Council Regulation (EEC) No 2092/91 (and its amendments).

A number of Member States have set specific targets for the uptake of organic farming (generally in the range of 10 to 20 %), with the hope that such changes in agricultural systems will curtail greenhouse gas emissions through the promotion of more extensive farming methods that are environmentally sustainable. For this purpose, the relative importance of organic farming is often measured as a share of the total utilised agricultural area (UAA). Within the Member States, the relative importance of organic agriculture continued to grow, peaking at 11.7 % in Austria in 2007.

Table 2.6: Organic agriculture, 2007

	Organic crop area (km^2)	UAA under organic farming (%)	Bovines (heads)	Pigs (heads)	Sheep (heads)
BE	326.3	2.4	37 897	11 441	12 688
BG	136.5	0.4	395	0	1 690
CZ	2 936.5	8.3	137 382	1 844	58 936
DK (1)	1 501.0	*5.2*	141 896	182 449	13 394
DE	8 653.4	5.1	:	:	:
EE	795.3	8.8	*13 774*	256	22 626
IE	411.2	1.0	29 000	1 000	38 000
EL	2 799.0	6.9	25 104	196 291	431 434
ES	9 883.2	4.0	85 598	15 462	217 755
FR	5 571.3	2.0	:	:	:
IT	11 502.5	9.0	244 156	26 898	859 980
CY	23.2	1.6	:	:	:
LV	1 481.3	9.8	50 530	6 090	15 474
LT	1 204.2	4.5	19 964	275	10 539
LU	:	*2.4*	:	:	:
HU (2)	*1 067.9*	2.5	*17 174*	*5 739*	*11 826*
MT	:	*0.2*	:	:	:
NL	470.2	2.5	40 129	56 454	12 408
AT (3)	3 720.3	11.7	342 055	69 092	84 081
PL	*2 894.4*	*0.5*	33 436	26 688	29 340
PT	*2 334.8*	6.7	:	:	:
RO (1)	1 401.3	*0.8*	7 567	416	121 175
SI	293.2	6.0	*17 488*	2 372	34 525
SK	*1 179.1*	6.1	28 922	312	87 607
FI	1 487.6	6.5	*25 512*	2 050	7 249
SE	3 082.7	9.9	110 000	24 483	42 986
UK	6 602.0	4.1	*250 376*	50 435	863 122
NO	488.6	4.7	20 311	1 453	35 905

(1) 2008, except for UAA under organic farming.
(2) Sheep, 2008.
(3) Excluding alpine pastures.

Source: Eurostat (food_in_porg1, tsdpc440 and food_in_porg3)

2.2 Energy

Within the context of emission inventories, fuel combustion is defined as 'the intentional oxidation of materials within an apparatus that is designed to provide heat or mechanical work to a process, or for use away from the apparatus'. In contrast to reporting under the UNFCCC and Kyoto Protocol, where all combustion-related headings (fuels combusted to generate heat or power for energy industries, manufacturing and transport) are included within the same chapter, this publication separates energy industries from the remainder of the industrial economy, while also presenting a separate analysis for transport (see Subchapters 2.3 and 2.4). The term 'energy industries' is therefore used here to define the extraction of primary energy sources, as well as the primary or secondary conversion of energy, and transformation to derived energy products.

Greenhouse gas emissions from fuel combustion emissions within the EU-27's energy industries amounted to a 31.9 % share of total greenhouse gas emissions in 2007; the overwhelming majority (1 404 million tonnes of CO_2 equivalents or 27.8 % of total emissions) coming from the electricity and heat production subsector, while emissions from petroleum refining (135.4 million tonnes of CO_2 equivalents) were almost double those from the manufacture of solid fuels (71.3 million tonnes of CO_2 equivalents). The relative importance of electricity and heat production and of petroleum refining increased between 1990 and 2007 in the EU-27, while that of solid fuels diminished (reflecting not only a reduction in indigenous supply but also a change in the EU's energy mix).

The burning of fossil fuels (oil, gas and coal) results in carbon dioxide, which accounts for the most important share of the energy industry's emissions (as well as the vast majority of emissions from the transport sector). Carbon dioxide emissions from the combustion of these fuels is primarily linked to the carbon content of the fuel in question; as such, emissions inventories are generally constructed on the basis of estimates that link energy supply data with 'typical' carbon contents. For example, natural gas has approximately 40 % less carbon content than coal, and 25 % less than oil. Therefore, changes in the energy mix can have considerable implications for the level of greenhouse gas emissions.

It is generally more difficult to establish estimates of the other greenhouse gases that are emitted by energy industries, as these need to be based upon combustion conditions, technologies in use, emission control policies, as well as fuel characteristics. Methane and nitrous oxide emissions often result from fugitive emissions (intentional or unintentional releases of gases which arise from the production, processing, transmission, storage and use of fuels – for example, flaring at oil and gas production facilities). In absolute terms, fugitive emissions in the EU-27 were almost halved between 1990 and 2007 (86.6 million tonnes of CO_2 equivalents); in relative terms, the share of fugitive emissions in total greenhouse gas emissions fell from 2.8 % to 1.7 % in the EU-27 over the period considered.

In December 2008, EU leaders agreed on a climate change and energy package aimed, among others, at reducing the EU's contribution to global warming. The reform is designed to consolidate the EU's position as a world leader in renewable energy and low-carbon technologies, committing it to: reduce its overall greenhouse gas emissions by at least 20 % (below 1990 levels) by 2020; increase the share of renewables in energy use to 20 % by 2020, and; save 20 % of its energy consumption by 2020 through developing energy-efficient technologies, products and services.

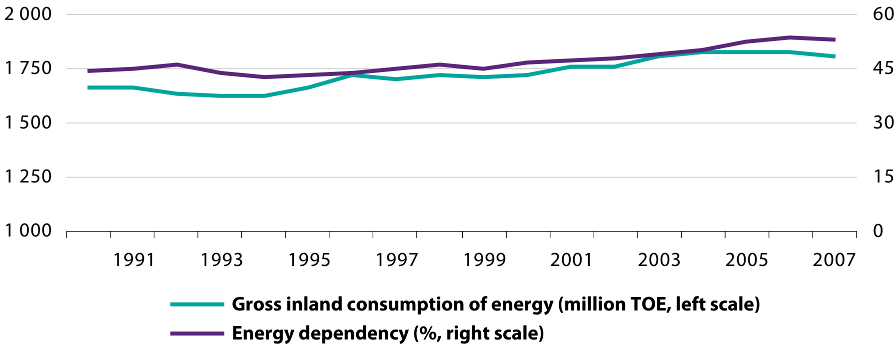
Climate change itself will likely transform energy demand patterns in the future, with an increase in electricity consumption in southern Europe associated with additional demand for space cooling (air conditioning), while the demand for heating in northern Europe should fall as a result of experiencing warmer winters. Power generation may also be affected by climate change – for example, hydropower production is likely to rise in northern Europe (where most climate models predict rain levels and river runoff will increase), while in southern Europe more severe, summer droughts are expected to reduce hydropower generation and may also result in lower volumes of water being available for cooling purposes within conventional thermal power stations.

Another likely development in the energy sector is the introduction of carbon dioxide capture and geological storage. This is a bridging technology that has the potential to contribute to mitigating emission levels. It consists of the capture of carbon dioxide, compressing it, transporting it to a storage site, and injecting it into suitable underground geological formations for the purposes of permanent storage. There remains some work to be done in this area with respect to ensuring the environmental integrity of the process, namely, to make sure that the carbon dioxide captured and stored remains isolated from the atmosphere in the long-term and does not present other health or ecological risks.

Between 1990 and 2007, EU-27 gross inland consumption of energy rose at an average rate of 0.49 % per annum. The EU-27's energy dependency rate, which shows the extent to which the economy relies upon imports in order to meet its energy needs increased rapidly to reach 53.1 %, fed by the opposing trends of lower indigenous primary energy production (particularly coal and oil) together with increased energy demand. This level of dependence is particularly marked for oil, as EU-27 oil reserves become exhausted and there are currently few substitute products that can be used to replace petrol or diesel.

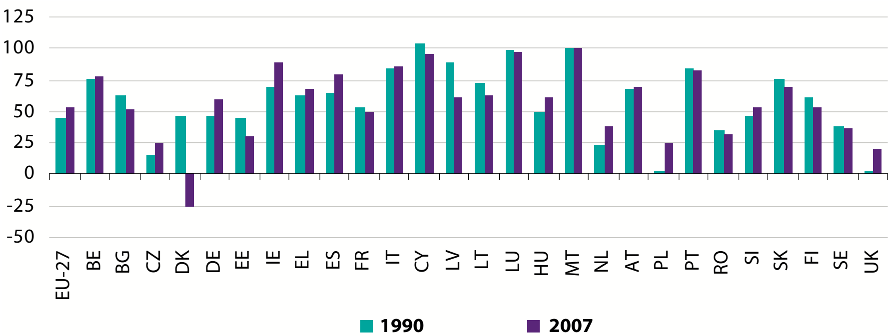
Given the scarcity and decline in European indigenous fossil fuel reserves, it would appear that any efforts to increase domestic production will need to be based on the promotion of low- or zero-carbon technologies in the EU's energy mix. These are primarily renewable energy sources (wind, solar, hydropower and biomass), while hydrogen may also play an important role in the energy mix in the more long-term future; an alternative would be to have nuclear energy as part of the energy mix. Any such changes in the EU's energy mix are likely to have a beneficial effect on greenhouse gas emissions.

Figure 2.8: Gross inland consumption and energy dependency, EU-27



Source: Eurostat (nrg_100a and tsdcc310)

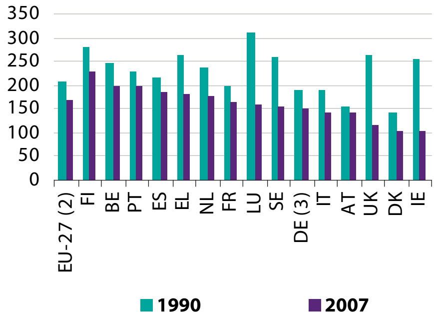
Figure 2.9: Energy dependency (%)

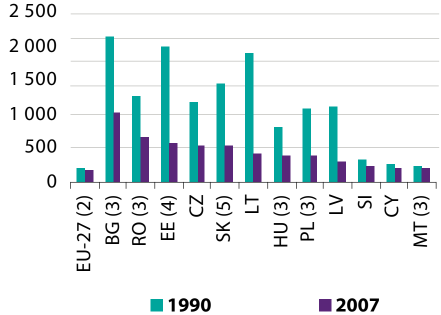


Source: Eurostat (tsdcc310)

The energy intensity of an economy is measured as the amount of energy required to produce a unit of economic output (GDP); reductions in energy intensity mean that less energy is needed to produce the same level of output – a pattern that was reproduced across all Member States between 1990 and 2007. This decoupling of economic growth from gross inland energy consumption was likely due to a range of factors, including: structural changes, such as the shift from industry towards services and a shift within industry to less energy-intensive activities; the closure of inefficient, high-polluting units; or end-use efficiency gains, such as lower energy-consuming appliances. Despite reductions in energy intensity, the demand for energy continued to rise in the EU-27.

Figure 2.10: Energy intensity of the economy – gross inland consumption of energy per EUR 1 000 of GDP (kilogram of oil equivalent) (1)

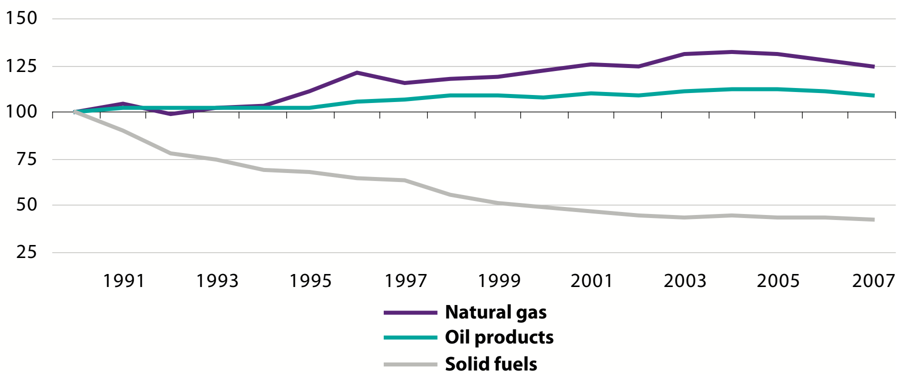




(1) Note the difference in scales between the EU-15 Member States and the Member States that have joined the EU since 2004.
(2) 1995 instead of 1990. (3) 1991 instead of 1990. (4) 1993 instead of 1990. (5) 1992 instead of 1990.

Source: Eurostat (nrg_100a and nama_gdp_k)

Figure 2.11: Final energy consumption, EU-27 (1990=100, based on TOE)



Source: Eurostat (nrg_101a, nrg_102a and nrg_103a)

Transformation output is the result of the transformation process as primary commodities (such as crude oil) are converted into secondary goods for final use, export or stocks (such as motor spirit or diesel oil). These secondary commodities include a range of products that have the potential for creating greenhouse gas emissions, in particular, following their combustion. During the transformation process itself when converting primary commodities to secondary goods there is also the potential for emissions and air pollution, as many such processes require considerable heat in order to change the chemical and/or physical properties of material inputs (for example, the distillation/cracking of crude oil into petroleum products).

Within energy statistics, renewable energy sources cover biomass, biodegradable waste, hydropower, geothermal energy, biogas, wind, biofuels, solar energy and photovoltaic power. Since renewable energy has a lower environmental impact than fossil fuels, policy-makers hope that renewable energy will provide the stimulus for major emission reductions in the EU-27. Since the 1990s, the EU has been developing and promoting the use and production of renewable energy, especially in relation to replacing fossil fuels. A range of laws has been adopted, alongside European (and national) targets for renewable energy use, such as a 20 % share of renewables in final energy consumption by 2020, or the obligation for each Member State to have at least a 10 % share of biofuels in their transport fuel mix by 2020.

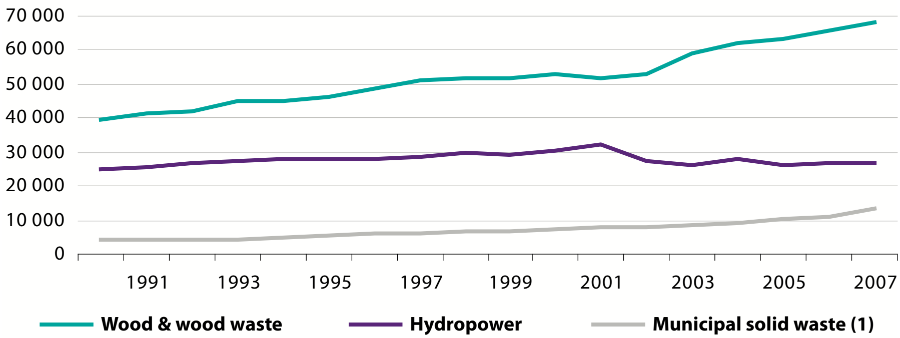
Table 2.7: Transformation output, EU-27 (1 000 TOE)

	1990	1995	2000	2005	2006	2007
Refinery gas	24 774	25 607	25 892	29 160	29 666	30 382
LPG	17 799	19 901	21 621	22 732	22 089	19 223
Motor spirit	151 672	159 799	154 427	160 261	159 423	151 900
Kerosenes - jet fuels	41 801	43 686	46 386	46 311	48 124	47 265
Naphtha	40 374	45 890	48 107	46 267	42 822	38 048
Gas/diesel oil	212 338	234 642	255 738	272 350	270 852	269 989
Residual fuel oil	136 113	117 533	114 674	108 767	107 732	105 113
Other petroleum products	48 029	50 863	55 608	62 605	63 181	59 461
Coke-oven gas	14 662	11 059	9 292	7 823	8 284	8 271
Blast-furnace gas	17 246	15 484	14 986	14 599	15 256	15 532
Gasworks gas	3 707	1 154	603	531	539	520
Patent fuels	1 499	838	574	284	286	249
Hard coke	57 763	44 142	36 965	34 164	35 443	35 329
Brown coal briquettes	23 969	5 583	3 459	3 517	3 609	3 471

Source: Eurostat (nrg_102a, nrg_103a and nrg_101a)

Some forms of primary production of renewable energy had very low levels in 1990; for example, wind turbines were scarcely visible on the horizon of European landscapes. Primary production from renewables rose from 72.7 million TOE (tonnes of oil equivalent) in 1990 to 138.8 million TOE in 2007; renewables accounted for 7.8 % of gross inland energy consumption in 2007. A large part of the growth in the primary production of renewable energy may be attributed to biomass, biogas and biofuels. Biomass and biogas can be provided by forestry, agriculture or organic waste, while liquid biofuels are principally produced from crops. Considered together these three forms of bioenergy accounted for about 60 % of the renewable energy produced in the EU-27 in 2007.

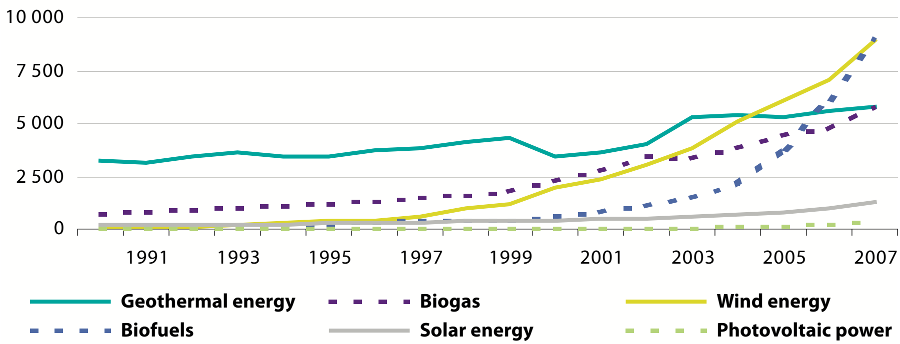
Figure 2.12: Primary production of renewable energies, EU-27 (1 000 TOE)



(1) Includes non-biodegradable materials that are incinerated.

Source: Eurostat (nrg_1071a and nrg_1072a)

Figure 2.13: Primary production of renewable energies, EU-27 (1 000 TOE)



Source: Eurostat (nrg_1071a, nrg_1073a and nrg_1072a)

Differences in resource endowments and national policies may, at least in part, explain why renewables accounted for less than 3 % of gross inland energy consumption in the United Kingdom, Luxembourg, Cyprus and Ireland, while their share rose to in excess of 20 % in Sweden, Latvia, Austria and Finland. In each of the latter four countries there is a relatively high importance for electricity generated from hydropower, while forest-based resources are increasingly used for biomass; in Denmark, the relative importance of wind energy is high.

Table 2.8: Share of renewables in gross inland energy consumption (%)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
EU-27	4.4	5.1	5.8	*5.8*	*5.7*	6.0	6.4	6.7	7.1	7.8
EU-15	4.9	5.4	5.9	*5.9*	*5.8*	6.1	6.5	6.7	7.2	8.0
BE	1.3	1.3	1.3	1.5	1.5	1.9	2.0	2.4	2.9	3.1
BG	0.6	1.6	4.2	3.6	4.4	4.8	5.2	5.6	5.5	4.7
CZ	0.2	1.4	1.5	1.7	2.0	3.3	3.9	4.0	4.3	4.7
DK	6.7	7.6	10.9	11.4	12.4	13.5	15.1	16.4	15.6	17.3
DE	1.6	1.9	2.8	3.0	3.4	3.9	4.5	5.1	6.0	8.3
EE	4.5	8.7	10.3	10.6	11.0	10.6	10.6	10.6	9.8	10.0
IE	1.6	1.4	1.6	1.6	1.7	1.6	1.8	2.4	2.7	2.9
EL	4.9	5.3	5.0	4.5	4.7	5.1	5.0	5.2	5.7	5.0
ES	7.0	5.4	5.7	6.5	5.4	6.9	6.3	6.0	6.5	7.0
FR	7.2	7.7	7.0	6.9	6.3	6.5	6.5	6.3	6.6	7.0
IT	4.2	4.8	5.2	5.5	5.3	5.8	6.8	6.5	7.0	6.9
CY	0.4	2.1	1.8	1.8	1.8	1.8	2.0	1.9	1.9	2.4
LV	13.2	27.2	31.8	31.7	31.3	30.9	33.1	33.0	31.0	29.7
LT	2.0	5.7	9.2	8.4	8.1	7.9	8.0	8.8	9.3	8.9
LU	1.3	1.4	1.6	1.3	1.4	1.4	1.6	1.6	1.7	2.5
HU	1.8	2.4	2.1	1.9	3.4	3.4	3.6	4.4	4.8	5.3
MT	:	:	:	:	:	:	:	:	:	:
NL	1.4	1.5	2.4	*2.4*	*2.6*	2.6	2.8	3.4	3.6	3.6
AT	20.0	21.8	22.8	22.2	22.1	19.8	20.8	21.1	22.3	23.8
PL	1.6	3.9	4.2	4.5	4.6	4.5	4.7	4.8	5.1	5.1
PT	18.7	16.2	15.3	16.1	13.9	16.9	14.7	13.2	17.1	17.6
RO	4.1	5.9	10.9	9.3	9.7	9.9	11.5	12.6	11.7	11.9
SI	4.6	9.3	12.3	11.5	10.5	10.3	11.5	10.6	10.5	10.0
SK	1.6	2.8	2.8	4.0	3.7	3.3	3.9	4.3	4.6	5.5
FI	19.0	21.1	23.8	22.4	21.8	20.9	23.0	23.1	22.7	22.6
SE	24.9	25.9	31.4	28.3	26.3	25.3	25.7	29.6	29.4	30.9
UK	0.5	0.9	1.1	1.1	1.2	1.3	1.5	1.7	1.9	2.1
HR	19.3	10.1	11.2	10.7	9.2	9.0	11.0	10.1	9.9	7.4
TR	18.4	17.3	13.1	13.2	13.4	12.6	13.2	11.9	11.1	9.5
IS	64.8	67.5	71.3	73.1	72.7	72.7	72.2	72.9	*74.9*	:
NO	53.1	48.8	50.9	44.0	51.7	38.2	37.6	40.3	46.5	46.7
CH	13.7	16.4	16.4	17.6	17.2	15.8	15.8	13.9	18.3	18.2

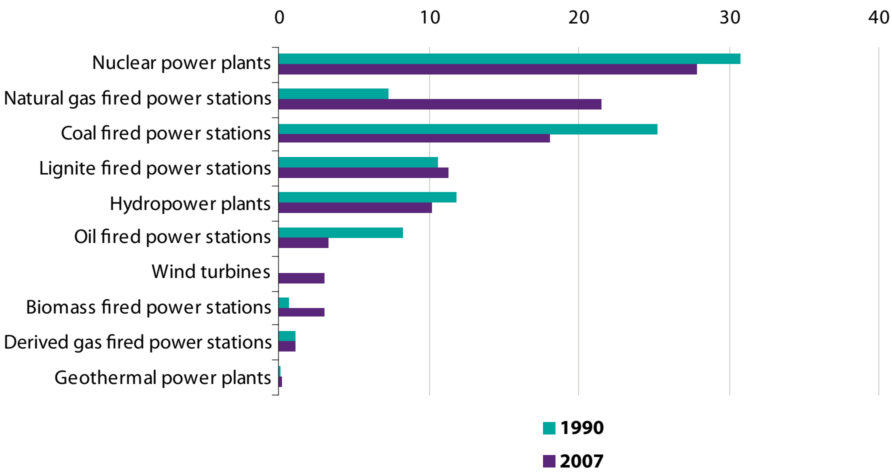
Source: Eurostat (tsdcc110)

Electricity generation is the single most important source of greenhouse gas emissions in the EU. The level of emissions from thermal power plants in the EU-27 fell slightly during the period from 1990 to 2007 largely as a result of changes in the fuel mix. The switching from coal to gas in the power generation sector was encouraged through the implementation of environmental legislation and the liberalisation of electricity markets, stimulating the use of combined-cycle gas plants; furthermore, natural gas prices were relatively low during most of the 1990's in relation to the price of coal. These factors may help explain how the share of natural gas in EU-27 electricity generation rose by a factor of three between 1990 and 2007, helping to offset greenhouse gas emissions despite an increase in total electricity generation.

Aside from changes in the energy mix, reductions in emissions from energy industries may also be attributed to: the closure of inefficient power plants; environmental efficiency (end-of-pipe abatement techniques which relate to non-carbon dioxide emissions); and a range of policy measures (such as directives on renewable electricity, combined heat and power and large combustion plants, or the EU's emissions trading scheme).

Nuclear energy provides opportunities for largely emission-free electricity generation (although there may be other concerns relating to safety or waste disposal). While the volume of electricity generated from nuclear fuels grew in the EU-27 between 1990 and 2007, the relative share of nuclear power plants in electricity generation fell. This pattern may well change in the coming years as a number of countries (including Bulgaria, the Czech Republic, France, Italy, Lithuania, the Netherlands, Romania, Slovakia and Finland) have new reactors planned or under construction.

Figure 2.14: Electricity generation by origin, EU-27 (% of total, based on GWh)

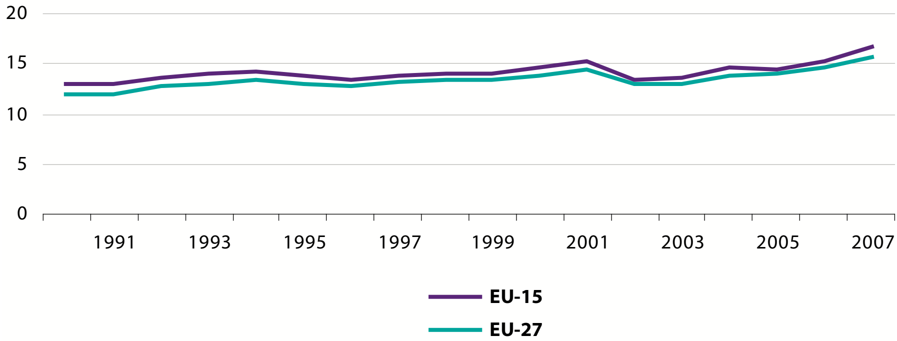


Source: Eurostat (nrg_105a)

Electricity production from renewable energy sources increased in both absolute and relative terms between 1990 and 2007, although the pace at which the demand for electricity grew partially offset this. Renewable energy contributed 15.6 % of the electricity consumed in the EU-27 in 2007, a 3.7 percentage point increase on 1990. Hydropower dominated renewable electricity production, followed by biomass, waste and wind generation.

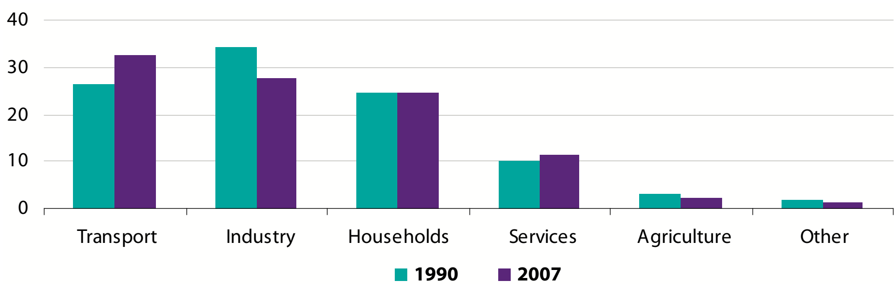
Energy intensity (the amount of energy required to produce one unit of output) plays an important role when analysing the breakdown of final energy consumption. Transport and industry are energy-intensive sectors, in contrast to agriculture and services. Energy intensity improvements may be driven, among others, by new production processes, more energy-efficient products and more efficient buildings.

Figure 2.15: Electricity generated from renewable sources (% of gross electricity consumption)



Source: Eurostat (tsien050)

Figure 2.16: Breakdown of final energy consumption, EU-27 (%, based on TOE)



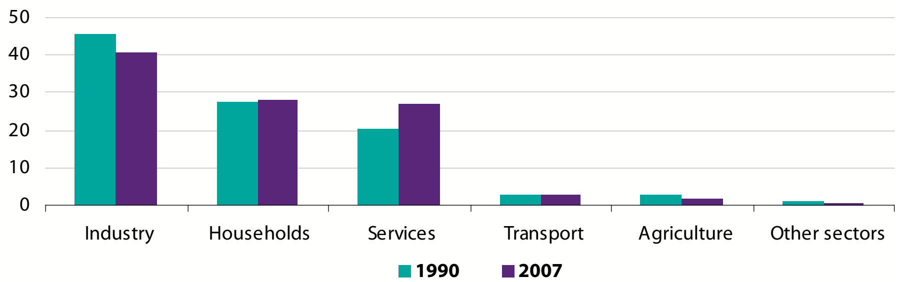
Source: Eurostat (tsdpc320)

When making a temporal comparison of energy consumption, it is important to consider any structural changes, such as the increasing share of EU-27 economic activity that is accounted for by the service sector or the shift within industry away from traditionally 'heavy' activities towards more technologically-advanced and higher added value manufacturing. The composition of final energy consumption is, to a large degree, reflected in the amount and type of greenhouse gas emissions that take place. During the period 1990 to 2007 the breakdown of final energy consumption showed a rapid increase in the relative importance of the transport sector which was offset by a decline observed in the final energy consumption of industry. As a result of these changes, transport accounted for almost one third of the EU-27's final energy consumption in 2007, while industry and the households sector had shares that were close to one quarter.

Final electricity consumption grew across the EU-27 at a slightly slower pace than economic growth between 1990 and 2007. The increase in electricity consumption resulted not only from a growing economy, but also from an increasing share of electricity in final energy consumption. This was particularly evident within the services sector and, to a lesser degree, for households. It is likely that the increased demand for electricity was driven by growing demand to run heating, air conditioning and lighting in more offices and dwellings, as well as increased demand related to a host of new electrical/electronic devices that have become commonplace in homes and offices (computers, audio-visual, information and communications equipment).

The increase in the relative importance of the EU-27's service sector in terms of its share of final electricity consumption (up 6.4 percentage points between 1990 and 2007) was largely offset by a reduction for industry (down 5.3 points). There was a very different picture for transport (when compared with its share of final energy consumption), as transport consumed a relatively low proportion of the total electricity generated in the EU-27 (2.5 % in 2007). The majority of the electricity consumed within the transport sector may be attributed to the electrification of Europe's railways (especially in France and the United Kingdom).

Figure 2.17: Final electricity consumption by sector, EU-27 (%, based on GWh)



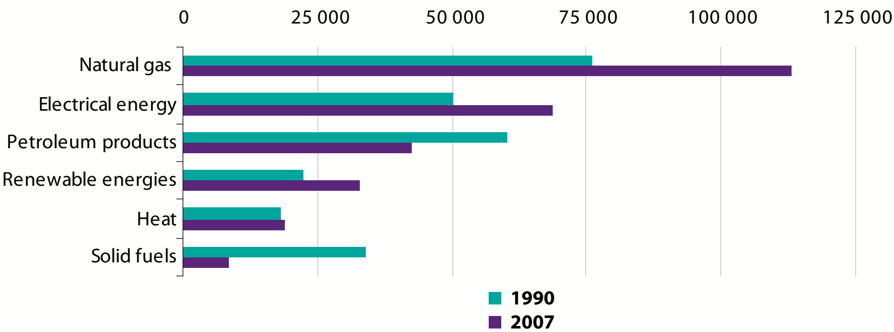
Source: Eurostat (ten00094)

Energy consumption patterns among households may be related to increasing living standards and lifestyle changes, such as the reduction in the average number of persons per dwelling (as a result of more divorces, single parents and older people living alone) or the growth in the number of people with a second home (commuters, holiday houses). Such changes are likely to result in increased greenhouse gas emissions as each dwelling will, to some degree, be equipped with items that consume energy.

A relatively high proportion of household expenditure is devoted to heating homes and water. This share can be mitigated, to some degree, through a range of initiatives, such as: insulation and energy-saving equipment; switching off lights; not leaving appliances in standby mode; taking a shower instead of a bath; or sorting/recycling waste; all such initiatives have the potential to reduce the 'carbon footprint' of households.

Short-term variations in greenhouse gas emissions may be linked to the influence of temperature on the energy consumed for space heating not only within households, but also across the services sector (for example, heating offices, schools or hospitals) and, to some degree, within industrial activities.

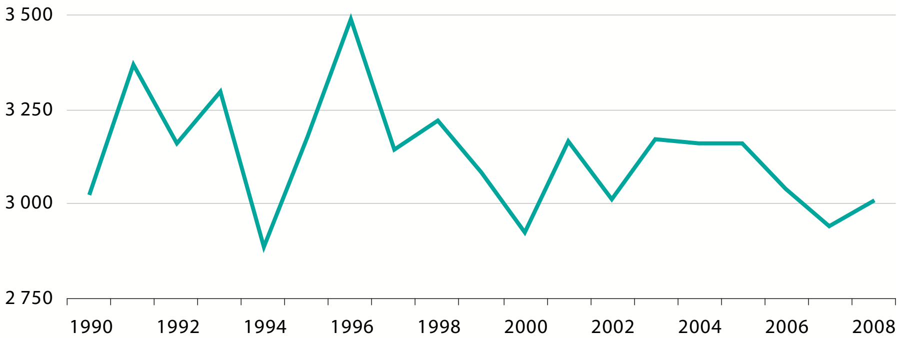
Figure 2.18: Energy consumption of households by product, EU-27 (1 000 TOE)



Source: Eurostat (nrg_103a, nrg_105a, nrg_102a, nrg_1071a, nrg_106a, nrg_101a)

Actual heating degree-days express the severity of the cold taking into consideration outdoor and room temperatures, when the mean outdoor temperature is below 15°C; these calculations are based on daily information, which is then summed up to produce monthly and subsequently annual data. Unsurprisingly some of the highest numbers of heating degree days are found in Finland, Sweden and Estonia, while the lowest values are recorded for Malta, Cyprus and Portugal. As well as varying considerably between countries, energy consumption as a result of space heating may also vary at the regional level. For example, the north of Finland has a very cold climate but the population density in these areas is very low, as the Finnish population is particularly concentrated in the south of the country where winters are (relatively speaking) less severe. While the number of heating degree days fluctuates from one year to the next as a function of the climate, the trend for this indicator seems to indicate a reduction over recent years, in keeping with the hypothesis that the earth is gradually becoming warmer.

Figure 2.19: Actual heating degree days, EU-27 (heating degree days)



Source: Eurostat (nrg_esdgr_a)

2.3 Business (industry and services)

As noted at the start of the last subchapter, emissions inventories for reporting under the UNFCCC and the Kyoto Protocol keep all forms of fuel combustion together under the same heading. However, given that most official European business statistics are based on an activity (not process) classification, for the purpose of this publication all industrial and service activities are covered here.

Non-energy industrial greenhouse gas emissions are principally related to processes which physically or chemically transform materials: for example, the use of blast furnaces to produce iron and steel, or the production of ammonia and other chemical products that are manufactured from fossil fuels used as feedstocks. There are also a range processes that result in carbon being stored (or sequestered) in products. One feature of these products is that a significant time period may elapse between their manufacture and the subsequent release of any greenhouse gas, ranging from a few weeks or months (in the case of an aerosol can) through a period of years (for tyres on a car) to several decades (for insulating foams that are injected into wall cavities). In some cases – for example, refrigeration equipment – it is possible to recover at least some of the greenhouse gases used in these products at the end of their life.

Fuel combustion is the primary source of greenhouse gas emissions from the services sector, as a result of space heating and water heating within offices and other buildings; note that emissions from the combustion of fuels used within transport services – for example, road freight or aviation – are covered in the next subchapter.

Industry and services (including fuel combustion – other than for transport and energy sectors) accounted for 24.8 % of all greenhouse gas emissions within the EU-27 in 2007; some 1 251.8 million tonnes of CO_2 equivalents. EU-27 greenhouse gas emissions from industry and services fell by 17.4 % between 1990 and 2007. As such, the relative importance of emissions from industry and services fell by 2.4 percentage points during the period under consideration, as emissions were reduced by 264.8 million tonnes of CO_2 equivalents. This decline in emissions equated to slightly more than half (51.1 %) of the overall reduction in EU-27 greenhouse gases between 1990 and 2007.

The majority (51.1 %) of EU-27 emissions from industry and services in 2007 were from fuel combustion within manufacturing and construction, while just over a third (35.4 %) came from industrial processes and product use; the only other major contributor was service-related commercial/institutional activities (13.2 %). Some of the biggest reductions in greenhouse gas emissions among industry and services during the period 1990 to 2007 were recorded in relation to: the production of halocarbons and sulphur hexafluoride (-93.3 %); industrial processes in the chemicals industry (-40.1 %); emissions relating to the application of paint (-27.5 %); fuel combustion in iron and steel (-25.0 %), and; fuel combustion in commercial/institutional activities (-18.1 %).

Emission reductions among industrial processes have mainly resulted from abatement technologies (in new plants or through retrofitting) or from the substitution/phasing-out of industrial processes (for example, hydrofluorocarbons (HFCs) being used as an alternative to ozone-depleting substances in aerosols). Some of these changes may be attributed to environmental legislation, as industry was one of the first areas where efforts were made to curb greenhouse gas emissions (and also air pollution). A Directive concerning Integrated Pollution Prevention and Control (IPPC) provides principles for granting permits, establishing environmental controls and ensuring best available techniques are used. So-called 'Sectoral Directives' lay down minimum requirements for emissions across a range of activities. The European Commission adopted a proposal in 2007 for a Directive on Industrial Emissions, seeking to recast seven existing Directives (including the IPPC and the Sectoral Directives).

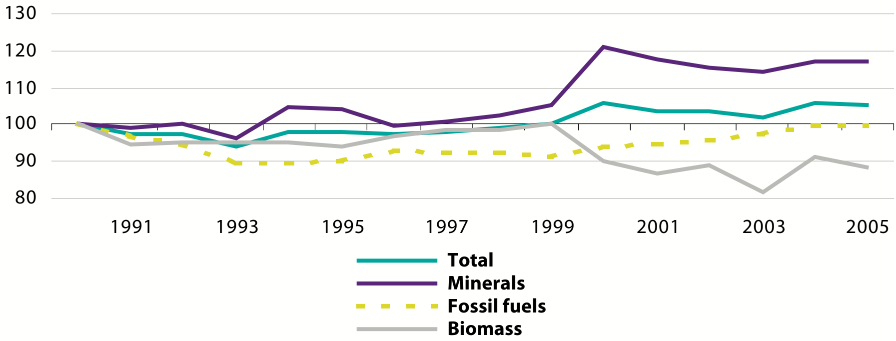
Structural changes within the EU-27 economy may also be used to explain emission reductions in the business economy, as a move away from 'heavy' manufacturing towards services may be expected to result in fewer emissions per unit of value added. Note that if traditional manufacturing (like iron and steel) moves away from the EU, then emissions can potentially be transferred to other regions (for example, China, South Korea, Brazil, Russia or the Ukraine). Any change in global emissions will likely depend on production levels in these emerging economies, as well as the environmental controls they enact.

Industry often suffers from having a clichéd image – smoke billowing from chimneys in a grey landscape – and is frequently portrayed as being a major source of emissions. However, at least within the European context, industry and services have made considerable progress in reducing their environmental impact and emissions. This has led many commentators to cite industry as a potential source of economic growth based on low- or zero-emissions in what is often referred to as the 'green' industrial revolution. An action plan for sustainable consumption, production and industry was proposed by the European Commission on 16 July 2008. It aims to promote the manufacture and adoption of eco-friendly products. The plan details a list of actions, including the promotion of: eco-design standards; energy and environmental labelling, and; 'green' public procurement. Improving energy efficiency is one of the simplest ways to cut greenhouse gas emissions and many products have already been subject to legislation or voluntary agreements, for example: energy ratings for appliances such as refrigerators and dishwashers; energy-saving light bulbs; or the Energy Star programme which provides guidance on efficiency ratings with respect to office and computer equipment.

The European economy is based on a high level of resource consumption, which puts pressure on the environment not only within Europe but also in other world regions. The negative environmental impact of additional European consumption may be felt across the globe, as a result of resource extraction, production, processing and transportation in a globalised economy. Domestic material consumption is defined as the total amount of material used (domestic extraction minus exports plus imports). The overall use of materials rose in the EU-15 by 5.2 % between 1990 and 2007, with higher growth (17.0 %) for minerals (often used in building), while the consumption of fossil fuels (-0.6 %) and biomass (-11.3 %) fell.

The structural shift in the European economy from industry to services has not prevented the volume of industrial and construction output from rising. When considering the likely effects of this trend on greenhouse gas emissions, it is necessary to study not only the structural shift between sectors, but also within sectors, for example, has the expansion of industrial activity resulted from the increased use of technology compared with energy-intensive processes; any such change would likely result in emissions being decoupled from growth.

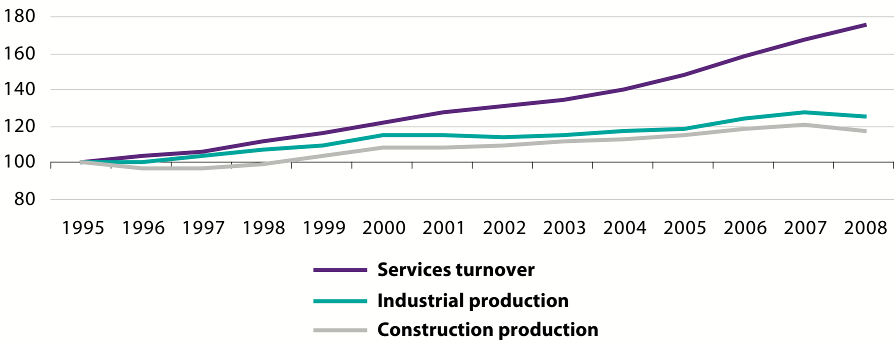
Figure 2.20: Domestic material consumption, EU-15 (1990=100, based on tonnes) (1)



(1) Estimates.

Source: Eurostat (tsdpc230)

Figure 2.21: Short-term indices, EU-27 (1995=100) (1)



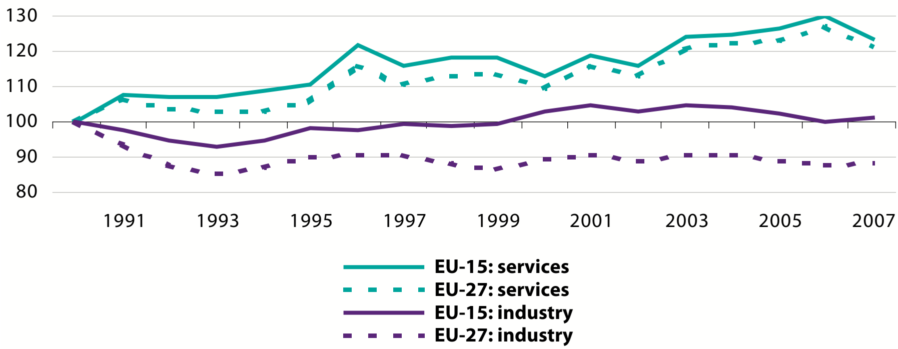
(1) The services' turnover index is in current prices; the industrial and construction production indices are volume measures.

Source: Eurostat (sts_trtu_a, sts_inpr_a and sts_copr_a)

It is perhaps not surprising to find that final energy consumption has risen at a much faster pace in the services sector than for industry, given the lion's share of growth in the European economy during the last couple of decades may be attributed to services.

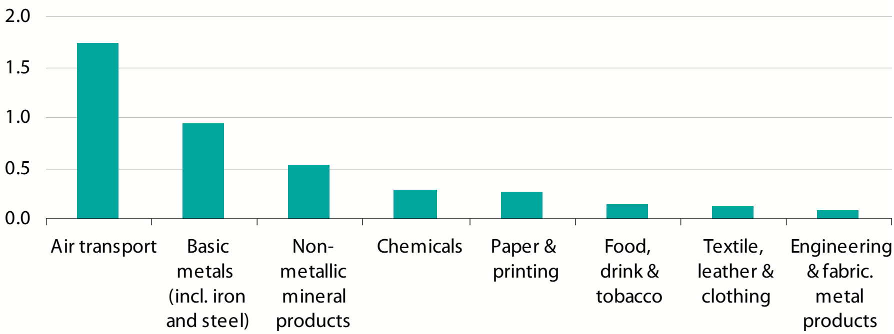
Energy intensity shows the considerable differences that exist between activities when relating the potential for emissions (measured here in tonnes of oil equivalents) to units of value added. The emissions potential of air transport services was almost double that of iron and steel, which in turn was almost double that of the manufacture of non-metallic mineral products (for example, cement or glass). As such, activity specialisations and industrial concentrations (which are often based on resource endowments) will to a large degree affect greenhouse gas emissions at a regional level.

Figure 2.22: Final energy consumption by industry and services, EU-27 (1990=100, based on TOE)



Source: Eurostat (nrg_100a and ten00099)

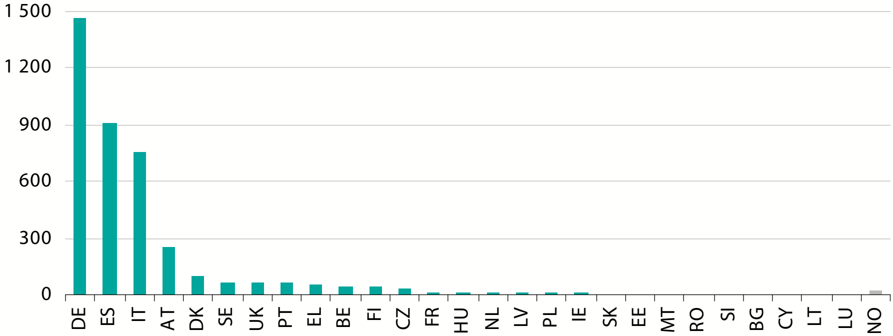
Figure 2.23: Energy intensity within selected activities, EU-27, 2006 (TOE per EUR 1 000 of value added)



Source: Eurostat (nrg_100a and ebd_all)

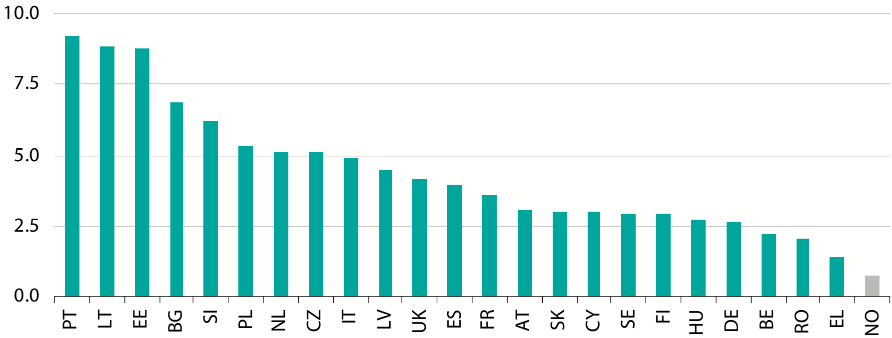
There are a number of initiatives that enterprises can take in order to demonstrate their environmental commitment, reducing greenhouse gas emissions, as well as other air pollutants. The eco-management and audit scheme (EMAS) has been open to all economic sectors since 2001; participation is voluntary. Enterprises can make a range of capital expenditures on methods, technologies, processes or equipment to collect or remove air emissions, effluents and solid waste; these statistics are not available for more detailed breakdowns by type of pollution control.

Figure 2.24: Number of organisations with a registered environmental management system (EMAS), 2007 (units)



Source: Eurostat (tsdpc410)

Figure 2.25: Investment in plant and equipment linked to cleaner technology or pollution control, total industry, 2006 (% of gross investment in tangible goods) (1)

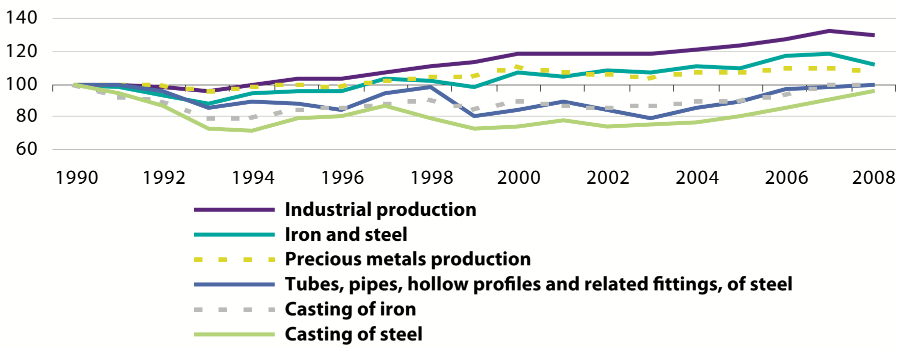


(1) Belgium NACE Rev. 1.1 Section C, 2005; Germany, 2005; Greece, France and Latvia, NACE Rev. 1.1 Section E, 2005. Belgium and Germany, NACE Rev. 1.1 Section E, not available. Bulgaria, investment in plant and equipment linked to cleaner technology, not available. Denmark, Ireland, Luxembourg and Malta, not available.

Source: Eurostat (sbs_env_2b_02)

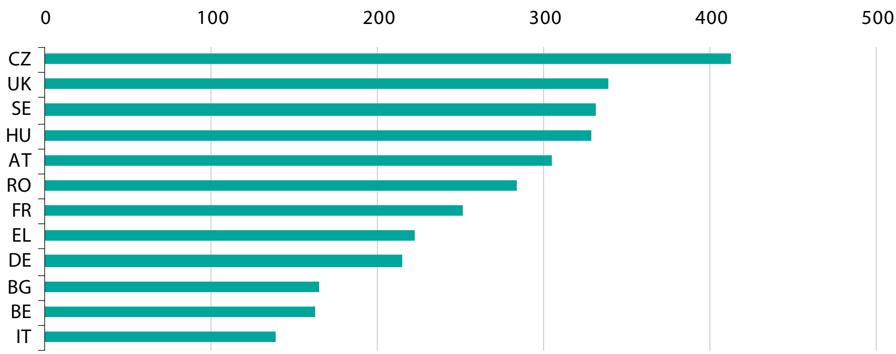
The remainder of this subchapter presents information relating to a number of industries that have the potential to emit relatively high levels of greenhouse gas emissions: the metals industry (in particular, the manufacture of iron and steel and aluminium), the chemicals industry, and the manufacture of non-metallic mineral products. The data are derived mainly from short-term business statistics (the index of production) or from PRODCOM (which provides information on the volume and value of products sold). A simple method used when compiling emissions inventories is to estimate greenhouse gas emissions from industrial processes/activities as a function of a fixed emission coefficient multiplied by the volume of output.

Figure 2.26: Short-term indices of production for metals, EU-27 (1990=100)



Source: Eurostat (sts_inpr_a)

Figure 2.27: Arisings of steel relative to electrical energy consumed within steel plants, 2008 (kg of steel/MWh) (1)



(1) Bulgaria, France, Romania and Sweden, 2007; Germany and Hungary, 2006; Greece, 2005; all remaining Member States, not available.

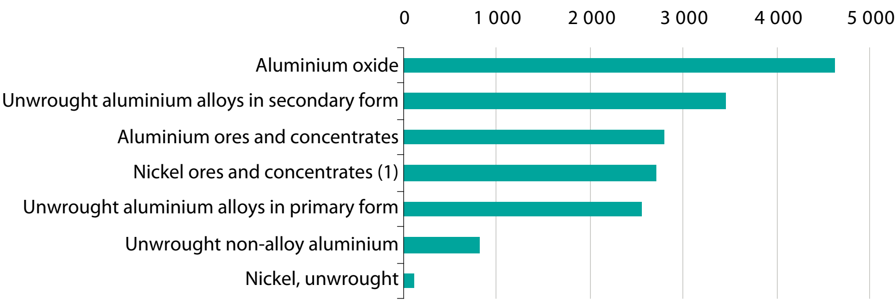
Source: Eurostat (ste_s10_scra and ste_s2b_elec)

For inventory accounting purposes, emissions of carbon dioxide from metals production, should be split between the industry sector (process-related emissions) and the energy sector (combustion-related emissions). Emissions depend to a large degree upon the processing method employed, for example, the production of steel using electric arc furnaces has become more efficient leading to a decoupling between steel production and related emissions.

The main air pollutants from chemical processing include sulphur oxides, nitrogen oxides, halogens and their compounds and volatile organic compounds. Trends in nitrous oxide emissions are strongly related to the manufacture of acids in a few large chemical plants across Europe. In some cases, increases in emissions, for example, of hydrofluorocarbons (HFCs), have occurred as a result of changes in environmental legislation. Hydrofluorocarbons were introduced in a range of applications, such as aerosol propellants, blowing agents for the production of thermal insulation foams, or the manufacture of refrigeration and air conditioning equipment, to replace ozone-damaging chlorofluorocarbons (CFCs).

Emissions from chemical processing can be divided into ducted and non-ducted emissions. The former include emissions released through a vent/pipe during the manufacturing process. Examples of this type of emission include flue gases from energy-providing furnaces; waste gases from emission control equipment, such as filters or incinerators; tail gases from condensers; waste gases from catalyst and solvent regeneration; and discharges from safety relief devices (such as safety valves). Non-ducted (or fugitive) emissions arise from the normal operation of manufacturing plants, for example: losses from storage equipment or during handling operations; emissions during start-up, maintenance or shutdown of a plant. Only ducted emissions can be controlled through abatement techniques.

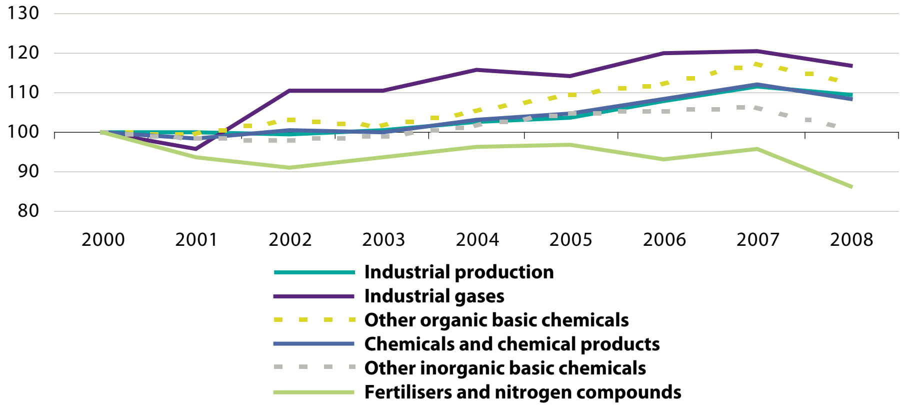
Figure 2.28: Volume of sold production of selected metals, EU-27, 2008 (1 000 tonnes)



(1) Rounded estimate, +/- 5 000 tonnes.

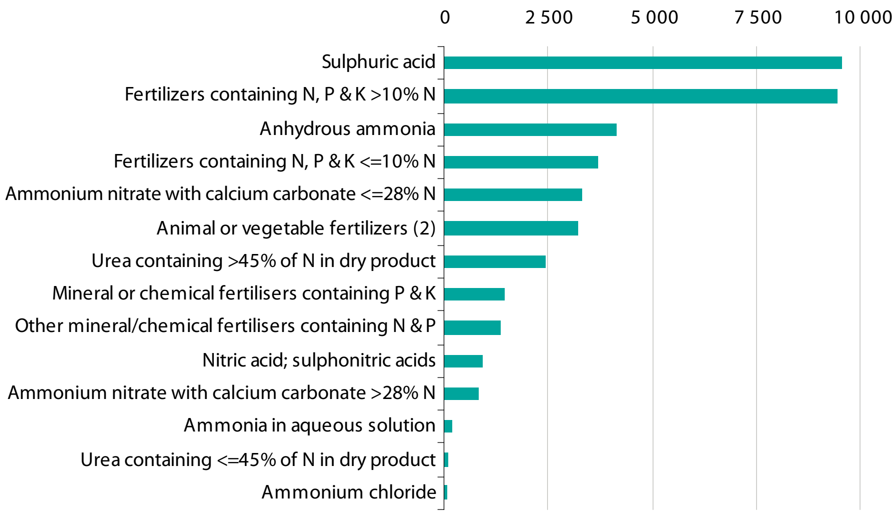
Source: Eurostat, from http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database go to Data Navigation Tree/Database by themes/Industry, trade and services/Statistics on the production of manufactured goods (prom)/NACE Rev. 2 (prodcom_n2)/Prodcom Annual Sold (NACE Rev. 2.) (DS056120)

Figure 2.29: Short-term indices of production for chemicals, EU-27 (2000=100)



Source: Eurostat (sts_inpr_a)

Figure 2.30: Volume of sold production of selected chemicals, EU-27, 2008 (1 000 tonnes) (1)



(1) N: nitrogen; P: phosphorus; K: potassium.
(2) Rounded estimate, +/- 80 tonnes.

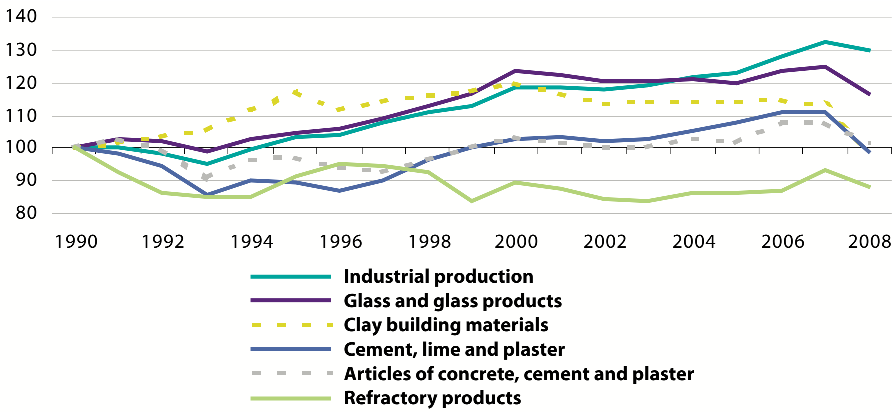
Source: Eurostat, from http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database go to Data Navigation Tree/Database by themes/Industry, trade and services/Statistics on the production of manufactured goods (prom)/NACE Rev. 2 (prodcom_n2)/Prodcom Annual Sold (NACE Rev. 2.) (DS056120)

Aside from metals and chemicals, many of the remaining energy-intensive manufacturing activities transform non-metallic minerals into a range of materials that are used within the construction sector. As such, the level of greenhouse gas emissions from these manufacturing activities is likely to reflect, to some degree, the cyclical nature of housing starts, as well as other factors that are common to all manufacturing activities (like the evolution of energy-efficiency within each production process); emissions can also be reduced through the recycling and recovery of materials.

The manufacture of Portland cement can be produced using either a dry or wet process; the former uses less energy. The main emissions from the production of cement include emissions to the air that result from physical and chemical reactions. Most of these gases are composed of nitrogen and excess oxygen from the combustion of air, or carbon dioxide from the combustion of raw materials.

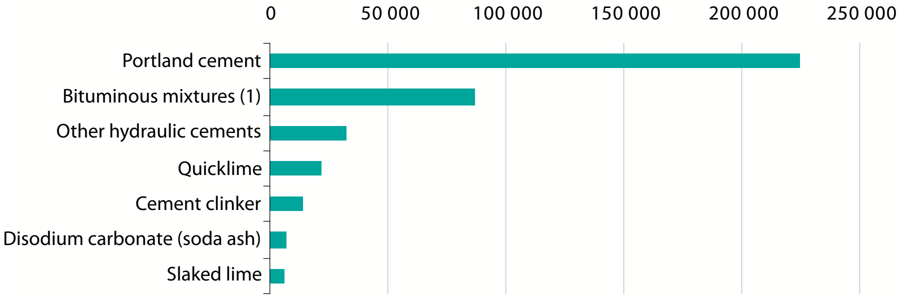
Combustion-related emissions are a common feature of almost all processing techniques used with the non-metallic mineral products manufacturing sector, ranging from cement, to asphalt, or from glass to ceramics and enamel. There are a number of other industrial activities which also require considerable amounts of energy (often in the form of heat and steam): these include the manufacture of pulp and paper, or food and beverage processing.

Figure 2.31: Short-term indices of production for other non-metallic mineral products, EU-27 (1990=100)



Source: Eurostat (sts_inpr_a)

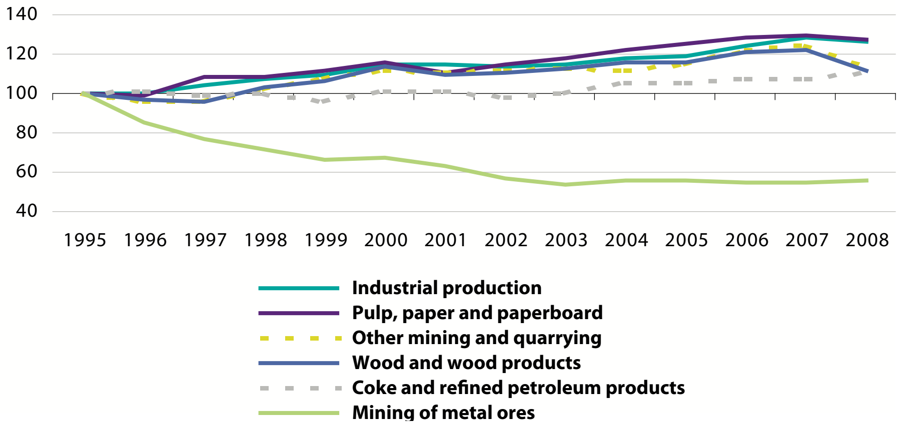
Figure 2.32: Volume of sold production of selected other non-metallic mineral products, EU-27, 2008 (1 000 tonnes)



(1) Rounded estimate, +/- 100 000 tonnes.

Source: Eurostat, from http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database go to Data Navigation Tree/Database by themes/Industry, trade and services/Statistics on the production of manufactured goods (prom)/NACE Rev. 2 (prodcom_n2)/Prodcom Annual Sold (NACE Rev. 2.) (DS056120)

Figure 2.33: Short-term indices of production for other energy-intensive activities, EU-27 (1995=100)



Source: Eurostat (sts_inpr_a)

2.4 Transport

Mobility is one of the key aspects influencing the quality of day-to-day life in Europe and is also vital for the EU's competitiveness. However, it imposes costs on society and can potentially have a significant environmental impact. Contrary to all other sources of greenhouse gas emissions, those from transport grew during the period from 1990 to 2007; this was most apparent for aviation, road transport and maritime freight. The growth in transport emissions has resulted, among others, from: globalisation, leading to an increase in the circulation of goods (generally by sea when across continents and by road for shorter distances); people moving to live in suburban areas, resulting in a higher use of the car (for work, shopping or leisure); tourism, both in terms of the increasing range of global destinations and the frequency with which people take a break.

Energy consumption in the transport sector depends almost exclusively on imported fossil fuels – largely in the form of crude oil that is converted into a range of products from petrol and diesel to gasoline, kerosene or liquid petroleum gas. Greenhouse gas emissions from the transport sector result from the combustion of these fuels and are almost exclusively composed of carbon dioxide; there are limited emissions of methane and nitrous oxides, for example, from the use of catalytic converters.

The EU-27's transport sector (excluding international aviation and maritime transport) contributed 982.5 million tonnes of CO_2 equivalents in 2007, with transport emissions increasing, on average, by 1.4 % per annum from 1990. Some 19.5 % of the EU-27's greenhouse gas emissions in 2007 were related to transport, a share that was 5.5 percentage points higher than in 1990. Road transport was by far the largest emission source (93.7 % of transport emissions in 2007). Emissions from other transport modes stood at just over 2 % of the EU-27's transport emissions for civil aviation and for inland waterways, while railways accounted for less than 1 % of transport emissions.

For the purpose of Kyoto reporting, emissions inventories exclude international aviation and maritime transport. However, between 1990 and 2007 emissions from these two transport modes grew at a more rapid pace than any other, rising by an average rate of 4.5 % per annum for international aviation and 2.8 % per annum for international maritime transport.

Road transport emissions were almost three times as high as the combined emissions from international aviation and maritime transport. While emissions from international aviation and maritime transport (see above) grew at a faster rate than those for road transport (1.5 % per annum between 1990 and 2007), the absolute increase in emissions was higher for road transport, up by 205.1 million tonnes of CO_2 equivalents between 1990 and 2007, compared with 72.6 million tonnes for international aviation and 66.2 million tonnes for international maritime transport.

The main driving force behind increased emissions from transport were increased freight transport (more specifically, by road and inland waterway), as well as an increase in the use of the passenger car. Indeed, the volume of freight increased at a pace that was faster than economic growth (GDP).

There were considerable differences between the Member States, with the most rapid growth in the use of passenger and freight transport generally recorded in some of the Member States that joined the EU since 2004.

Table 2.9: Volume of passenger and freight transport

	Volume of passenger transport (1 000 million passenger-kilometres)				Volume of freight transport (1 000 million tonne-kilometres)			
	1995	2005	2006	2007	1995	2005	2006	2007
EU-27	4 788.7	5 523.4	5 655.7	5 707.5	1 777.3	2 343.6	2 432.6	2 507.6
EU-15	4 233.9	4 831.2	4 928.7	4 959.1	1 440.0	1 868.9	1 916.7	1 947.6
BE	118.9	136.5	138.4	141.8	58.9	60.5	60.5	58.9
BG	38.7	43.2	45.0	48.1	11.1	20.3	19.9	20.9
CZ	88.8	98.8	100.4	102.3	54.3	58.4	66.2	64.5
DK	60.9	66.2	67.7	69.1	24.4	25.3	23.1	22.7
DE	969.2	1 016.3	1 024.0	1 029.3	372.3	469.6	501.0	522.8
EE	7.7	13.0	13.2	13.0	5.4	16.5	16.0	14.8
IE	31.4	46.6	48.9	51.5	6.1	18.2	17.7	19.1
EL	66.5	110.1	115.2	120.5	13.5	24.4	34.7	28.6
ES	310.8	418.6	418.6	430.7	112.6	244.9	253.4	269.9
FR	746.2	860.1	860.2	867.9	233.0	254.9	261.6	271.0
IT	753.8	846.7	904.8	880.1	184.9	234.7	211.3	204.8
CY	4.4	6.1	6.3	6.8	1.1	1.4	1.2	1.2
LV	11.0	18.6	20.1	21.4	11.6	28.2	27.6	31.5
LT	21.3	38.9	43.6	43.1	12.4	28.4	31.0	34.7
LU	5.5	7.4	7.6	7.8	6.4	9.5	9.6	10.3
HU	72.9	76.6	76.7	69.6	23.7	36.4	42.6	48.2
MT	2.1	2.5	2.6	2.6	:	:	:	:
NL	161.1	177.2	177.4	178.9	105.6	132.3	131.8	127.0
AT	84.3	92.7	93.3	95.2	41.8	57.8	62.0	61.4
PL	176.4	248.9	270.0	290.6	120.3	162.1	182.2	205.4
PT	57.5	85.8	87.4	89.9	20.8	45.0	47.3	48.8
RO	73.2	82.4	84.6	86.5	47.1	76.6	81.2	83.5
SI	21.0	26.3	26.9	27.1	8.6	14.3	15.5	17.3
SK	37.1	36.9	37.6	37.2	41.7	32.1	32.3	37.8
FI	61.6	73.5	74.1	75.6	33.9	41.6	40.8	40.3
SE	105.3	117.1	117.5	120.6	51.0	60.2	62.2	63.8
UK	700.9	776.6	793.6	800.1	175.0	190.0	199.7	198.0
HR	18.2	29.2	30.5	32.1	:	12.3	13.6	14.2
MK	5.3	5.9	6.0	6.1	:	6.1	8.9	6.7
TR	144.1	195.0	208.3	219.6	121.0	175.9	186.9	191.1
IS	3.4	5.1	5.5	5.7	0.5	0.8	0.9	:
NO	51.2	60.6	61.0	62.5	12.4	21.3	22.6	22.8

Source: Directorate-General for Transport and Energy (http://ec.europa.eu/transport/publications/statistics/statistics_en.htm)

The modal split of transport is defined as the proportion of each transport mode in total inland transport, expressed in terms of passenger-kilometres or tonne-kilometres. The data presented are generally based upon movements on the national territory, regardless of the nationality of the vehicle or vessel. Road transport dominates both inland passenger and inland freight transport and its share of the transport market has generally increased during the last couple of decades. There are, nevertheless, considerable differences between countries mainly due to geographical and topographical constraints. Changes in the modal composition of inland transport have the potential to impact upon emission levels (for example, an increased share for rail transport would likely reduce greenhouse gas emissions).

Table 2.10: Modal split of inland transport, 2007 (%)

	Passengers			Freight		
	Cars	Buses	Trains	Roads	Inland waterways	Railways
EU-27	83.4	9.5	7.1	76.5	5.6	17.9
EU-15	84.1	8.7	7.1	78.4	6.6	15.0
BE	80.1	13.3	6.7	71.1	15.7	13.2
BG	71.3	23.6	5.1	70.0	4.8	25.1
CZ	75.7	17.0	7.3	74.7	0.1	25.3
DK	80.2	10.8	8.9	92.2	:	7.8
DE	85.8	6.4	7.8	65.7	12.4	21.9
EE	77.2	20.7	2.1	43.2	0.0	56.8
IE	76.3	18.6	5.1	99.3	:	0.7
EL	77.0	21.2	1.9	97.1	:	2.9
ES	80.9	13.9	5.2	96.1	:	3.9
FR	84.9	5.5	9.6	81.4	3.4	15.2
IT	82.4	11.9	5.7	88.3	0.0	11.6
CY	:	:	:	100.0	-	-
LV	79.5	15.0	5.5	41.9	0.0	58.1
LT	90.7	8.4	0.9	58.5	0.0	41.5
LU	84.9	11.1	4.1	92.5	3.3	4.1
HU	61.8	25.2	13.1	74.4	4.6	21.0
MT	:	:	:	100.0	-	-
NL	86.7	3.8	9.5	61.4	33.0	5.7
AT	79.2	10.8	10.1	60.9	4.2	34.8
PL	83.6	9.6	6.8	73.5	0.1	26.4
PT	83.3	12.2	4.5	94.7	:	5.3
RO	75.3	15.3	9.4	71.3	9.8	18.9
SI	85.1	11.9	3.0	79.2	:	20.8
SK	72.4	21.6	6.0	71.8	2.7	25.5
FI	84.9	10.0	5.0	73.9	0.3	25.9
SE	84.1	7.2	8.7	63.6	:	36.4
UK	87.3	6.3	6.4	86.6	0.1	13.3
HR	82.9	12.1	5.0	74.0	0.8	25.2
MK	:	:	:	88.5	:	11.5
TR	51.9	45.5	2.5	94.9	:	5.1
IS	88.6	11.4	0.0	100.0	-	-
NO	88.0	7.0	4.9	84.9	:	15.1

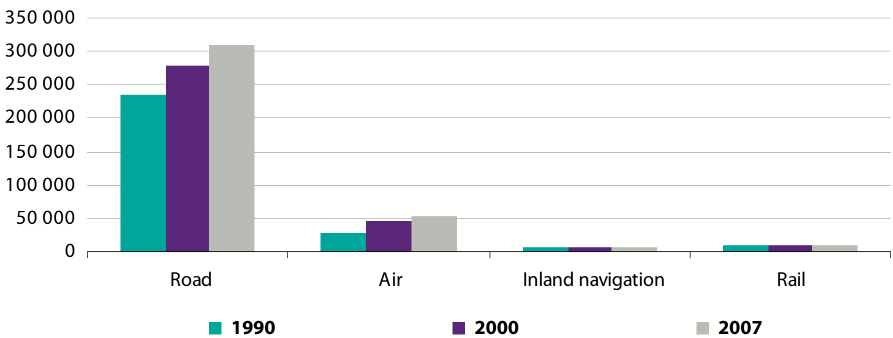
Source: Eurostat (tsdtr210 and tsdtr220)

Final energy consumption within the EU-27's transport sector increased overall by 34.4 % between 1990 and 2007, from 280.7 to 377.2 million TOE (tonnes of oil equivalent). Road transport consumed 81.9 % of the energy consumed within transport, followed by national and international aviation (14.2 %), rail (2.5 %) and inland navigation on rivers and canals (1.4 %). While the energy consumed by rail and inland navigation remained relatively unchanged, the fastest growing energy consumer was aviation (up, on average, by 3.6 % per annum), more than twice the growth rate recorded for road transport (1.6 % per annum).

The motorisation rate is defined as the number of passenger cars per 1 000 inhabitants. One of the main driving forces behind rising emissions within the transport sector has been the increasing number of cars on Europe's roads. The motorisation rate in the EU-27 rose from 333 cars per 1 000 inhabitants in 1991 to 466 cars per 1 000 inhabitants by 2006, with five Member States (Luxembourg, Italy, Germany, Malta and Austria) reporting an average of more than one car for every two inhabitants. The most rapid growth in motorisation rates during the period considered was in the Baltic Member States, Greece and Portugal, with relatively rapid growth in most of the other Member States that joined the EU since 2004.

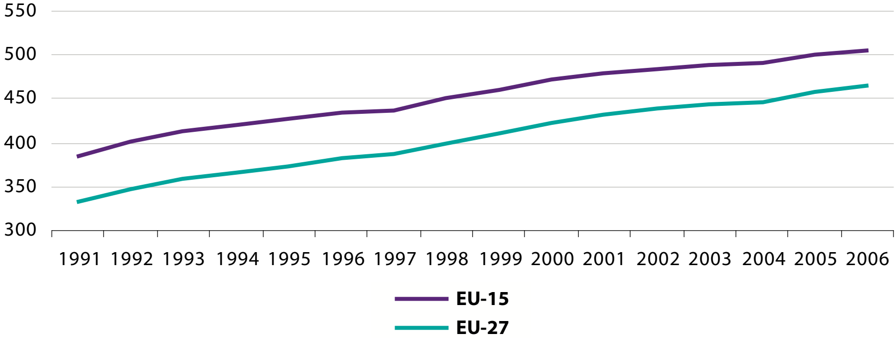
The energy efficiency of car travel depends upon a range of factors, such as: the average number of passengers per vehicle (with a growing car fleet, it is likely that an increasing number of journeys are made with only one person in the vehicle, for example, the daily commute to work); the type of engine (there has been a significant shift to diesel engines which may be a reflection of their higher fuel efficiency or taxation policy on fuel costs); the age of the vehicle fleet (generally modern cars tend to be more efficient both in terms of their fuel consumption, carbon dioxide emissions and other pollutants); and European emission standards which define limits for exhaust emissions from new vehicles (these have become progressively more stringent).

Figure 2.34: Final energy consumption within transport, EU-27 (1 000 TOE)



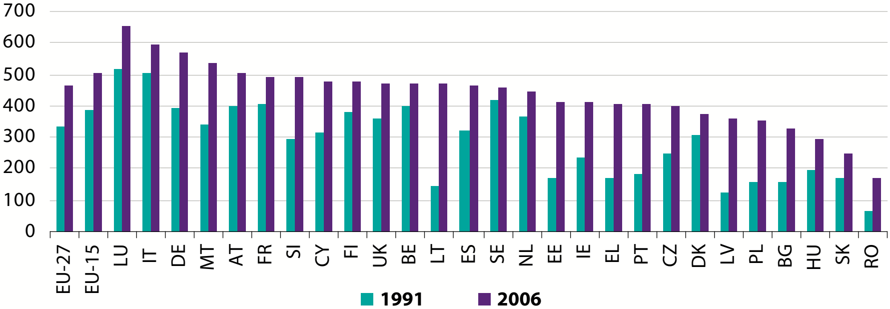
Source: Eurostat (nrg_100a)

Figure 2.35: Motorisation rate (number of cars per 1 000 inhabitants)



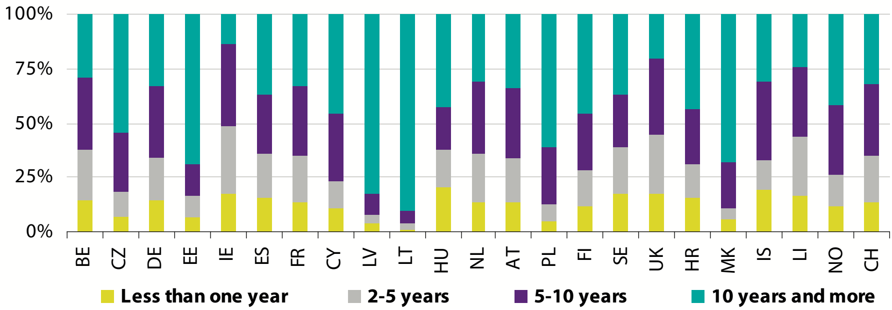
Source: Eurostat (tsdpc340)

Figure 2.36: Motorisation rate (number of cars per 1 000 inhabitants)



Source: Eurostat (tsdpc340)

Figure 2.37: Passenger cars by age, 2005 (% share of stock of passenger cars) (1)



(1) Ireland, the Netherlands and Liechtenstein, 2004; remaining Member States for which no information is presented, not available.

Source: Eurostat (road_eqs_carage)

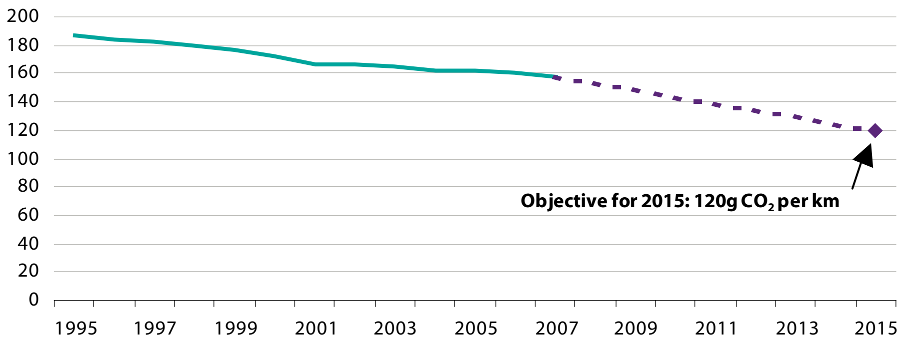
Many governments recently adopted car scrappage schemes. The main motivation behind these measures may well have been to provide a boost to car sales and to help an ailing industry during recession, however, these initiatives may also have had a beneficial effect on greenhouse gas emissions from cars, given that a relatively high number of old, more polluting cars, have been removed from Europe's roads and replaced with more efficient and less-polluting models.

Emissions from road transport rose, on average, by 1.5 % per annum between 1990 and 2007. Manufacturing developments may help reduce energy consumption and emissions in the future, including: new types of internal combustion engine (gasoline direct injection, controlled auto-ignition, hybrids); new fuels, such as biofuels, reformulated grades, and the likely introduction of hydrogen; or the use of fuel cell vehicles. Furthermore, passengers might, in the future, use increasingly more energy-efficient ways of transport, such as car-pooling, or switching to more energy-efficient modes of transport, such as rail, bus or bicycle.

Following the introduction of carbon dioxide-related taxation in Germany in 2009, all the EU-15 countries now have car tax systems that are based on a car's emissions and/or fuel consumption. While the average carbon dioxide emissions of a new passenger car in the EU-15 were reduced by 15.4 % between 1995 and 2007, progress slowed from 2001 onwards.

Regulation No 443/2009 of the European Parliament and of the Council set emission performance standards for new cars. The main objective of this law is to reduce the contribution of road transport to global warming, reducing average greenhouse gas emissions to 120 g of carbon dioxide per kilometre (through engine technology and more efficient vehicle features, such as air-conditioning or tyres). These objectives will become binding for the fleet of each car manufacturer (65 % of the fleet by 2012, 75 % by 2013, 80 % by 2014 and 100 % by 2015).

Figure 2.38: Average carbon dioxide emissions from new passenger cars, EU-15 (grams of CO_2 per km)



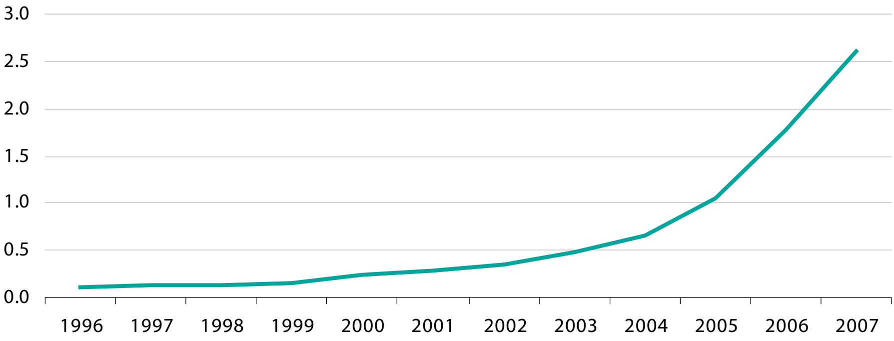
Source: Eurostat (tsdtr450)

At the end of 2008 there was an amendment to the Fuel Quality Directive (98/70/EC). This should, among others, facilitate the widespread blending of biofuels into petrol and diesel. By 2020, fuel suppliers have to decrease by 6 % the climate-harming emissions in their products either by adding biofuels to petrol and diesel, or by improving production technologies in refineries.

Biofuels may be used as a substitute for petrol and diesel fuel in transport. Their use has the potential to promote more sustainable energy use in transport as biofuels generally have a better greenhouse gas performance than fossil fuels. The production of agricultural biofuels within the EU is possible from a range of crops, including wheat and oilseeds. Alternatively, biofuels from alternative sources – such as sugar cane – may be imported from non-member countries, while it is likely that in the future biofuels will be produced from a wider range of agricultural and forest products, as well as organic wastes.

The number of road freight kilometres travelled is a leading indicator for measuring greenhouse gas and air pollutant emissions from lorries, alongside the average age of the vehicle fleet. There has generally been a rapid increase in the volume of road freight transported within Europe, to the detriment of rail and inland waterways. Indeed, many estimates suggest that the road freight sector has contributed more to the rise in transport emissions than cars. These increases are related to continued growth in transport volumes, despite policies designed to help shift traffic from roads to other modes.

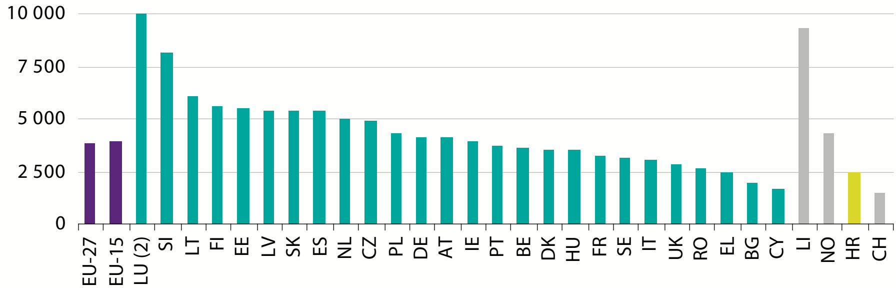
Figure 2.39: Share of biofuels in total fuel consumption of transport, EU-27
(%)



Source: Eurostat (tsdcc340)

The Eurovignette Directive is currently under revision, its amendment should allow Member States to internalise the costs related to pollution and congestion caused by heavy goods vehicles. As such, the Member States will likely be authorised to integrate air and noise pollution, as well as the cost of congestion in accord with the 'polluter pays' principle. The charges for using lorries will likely vary according to their Euro emission category, the distance travelled, as well as the location and the time of road use. Such tolls will be collected through electronic systems so as to avoid creating any additional hindrances to the free flow of traffic (for example, at tollbooths).

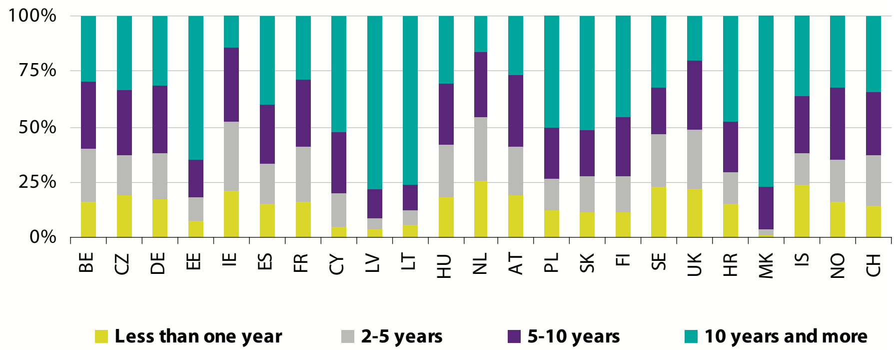
Figure 2.40: Volume of road freight transport, 2008 (tonne-kilometres per inhabitant) (1)



(1) EU-27, EU-15, Greece, Italy and the United Kingdom, 2007; Malta, not available.
(2) Broken y-axis, 21 234 tonne-kilometres per inhabitant.

Source: Eurostat (road_go_ta_tott and tps00001)

Figure 2.41: Lorries by age, 2005 (% share of stock of lorries) (1)

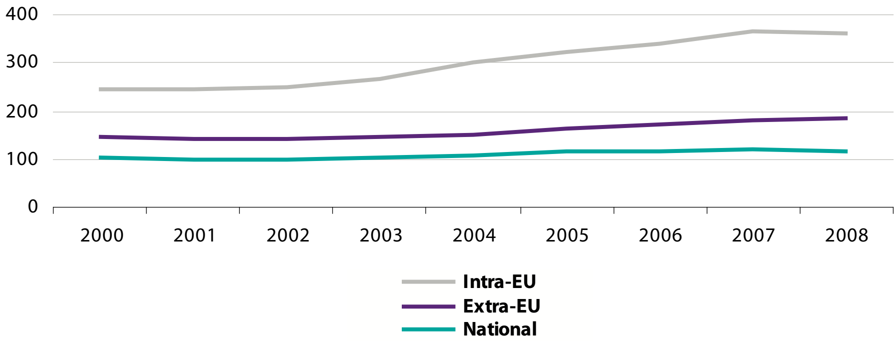


(1) Ireland, the Netherlands, Slovakia and Sweden, 2004; remaining Member States for which no information is presented, not available.

Source: Eurostat (road_eqs_lorroa)

The emissions linked to aviation come from the use of jet fuel (kerosene and gasoline). Consequently, the principal pollutants are common with those from other combustion activities, namely, carbon dioxide, along with lower levels of carbon monoxide, hydrocarbons, nitrous oxides, sulphur dioxide, methane and particulate matter. Aside from combustion, emissions from aviation may arise, among others, from: starting-up engines, auxiliary power operations, (re-)fuelling, fuel dumping in emergencies, or anti-icing and de-icing.

Figure 2.42: Evolution of air passenger transport in Germany, Spain, France and the United Kingdom (million passengers carried) (1)



(1) Information for 2008 suggests that the four countries for which data are shown accounted for 93.5 % of total passengers carried (national, intra- and extra-EU aggregated) in the EU-27.

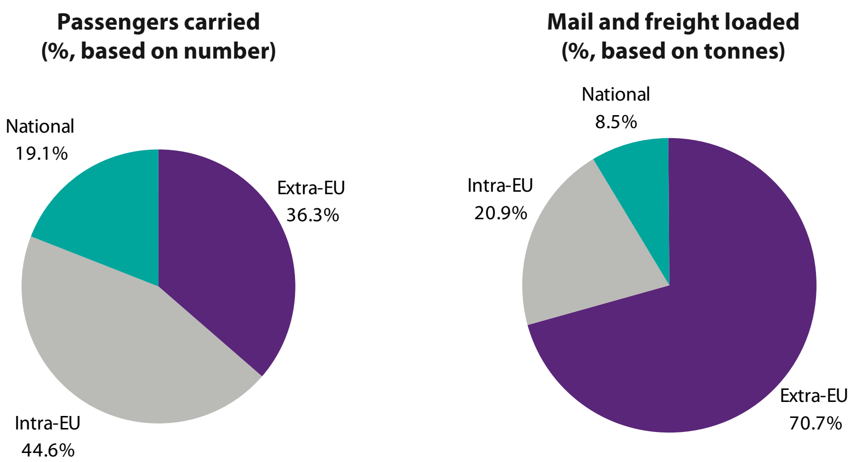
Source: Eurostat (avia_paoc)

Rapid growth in intra-EU passenger numbers travelling by air have likely resulted from the expansion of low-cost airlines. The coverage of official statistics within this domain is weak; however, based on information for four of the largest Member States (Germany, Spain, France and the United Kingdom) the overall growth in intra-EU passenger numbers was 54.5 % between 2000 and 2008, while extra-EU passenger numbers grew by 27.8 % and the number of nationally transported passengers by 17.7 %.

There has been an increasing focus on the environmental damage caused by the aviation industry, with flying labelled as the world's fastest growing source of carbon dioxide emissions. Environmentally-aware consumers may choose alternative transport modes instead of short-haul air journeys (such as the growing high-speed rail network), while there are a host of schemes that allow frequent flyers to 'offset' their carbon emissions through organisations which invest in renewable energies and/or tree-planting.

Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 integrates aviation into the Emissions Trading Scheme (ETS). One aim of this legislation is to encourage other non-Member countries to follow suit, leading to the inclusion of air transport emissions in international agreements on greenhouse gas emissions.

Figure 2.43: Breakdown of civil aviation transport, EU-27, 2008 (%)

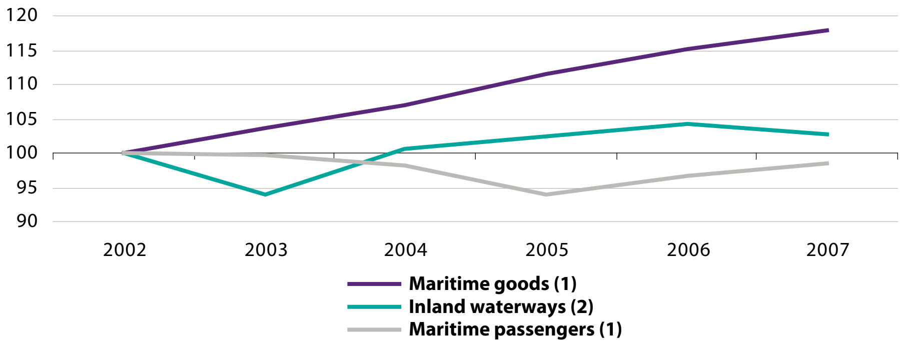


Source: Eurostat (avia_paoc and avia_gooc)

International maritime transport (which is not part of the Kyoto Protocol) was the second largest source of greenhouse gas emissions in the EU-27's transport sector emitting 176.2 million tonnes of CO_2 equivalents in 2007 – which was above the corresponding figure for international aviation (138.8 million tonnes).

The growth in emissions from EU-27 maritime transport may be attributed to the transportation of goods, which reached 3 934 million tonnes in 2007, an overall increase of 18 % when compared with levels from 2002. In contrast, there was almost no change in the volume of goods transported by inland waterways during the same period; the number of maritime passengers that were carried in the EU-27 was also relatively unchanged between 2002 and 2007. Inland navigation on waterways is generally only significant in countries with major rivers, such as the Rhine or the Danube, or countries with extensive canals or lakes.

Figure 2.44: Volume of maritime and inland waterway transport, EU-27 (2002=100)



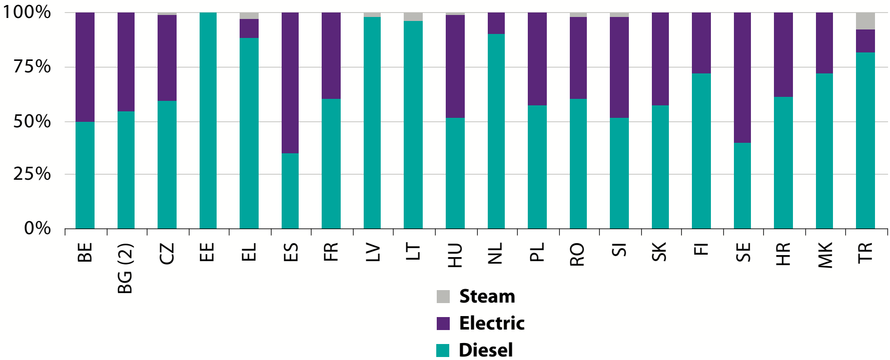
(1) Inwards and outwards.
(2) Based on information available for Belgium, Bulgaria, the Czech Republic, Germany, France, Luxembourg, the Netherlands and Austria; information for 2007 suggests that the eight countries for which data are shown accounted for 94.0 % of the EU-27 total.

Source: Eurostat (mar_go_aa, iww_go_atyve and mar_pa_aa)

There has been a considerable decline in the use of rail in a number of the Member States that joined the EU since 2004 (both for freight and for passengers). In contrast, the growing high-speed network has seen passenger numbers rise in several EU-15 Member States. The low share of railways in total transport emissions (less than 1 % of the EU-27 total in 2007) mainly results from its modest share of passengers and goods transported, although rail is generally less energy-intensive than other modes of transport. Emissions from the rail industry reflect, to some degree, the type of fuel used for electricity generation, especially in those countries with highly electrified networks.

An increase in the modal share of rail would likely result in less greenhouse gas emissions from the transport sector. The EU has addressed this issue through developing a high-speed rail network for passenger travel, while also promoting rail corridors with preference for freight transport. Directive 96/48/EC on high-speed rail and its subsequent amendments aim to promote the interoperability of European high-speed train networks so that locomotives can freely move from one country to another. The strategic goals of developing rail transport are contained within the trans-European networks initiative; completed high-speed lines reached 10 677 km in 2005 and it is hoped that this figure can be almost doubled by the year 2020.

Figure 2.45: Railway locomotives by source of power, 2005
(% of total locomotives) (1)



(1) Member States for which no information is presented, not available.
(2) 2004.

Source: Eurostat (rail_eq_loco_n)

2.5 Waste

Waste management policies in the EU seek to protect public health and the quality of the environment, while supporting the conservation of natural resources, through paying attention to the impact that waste may have on the air, water and soil. EU policies increasingly emphasise resource use and waste, for example, the EU's sustainable development strategy and the sixth environment action programme, which expressly calls for 'breaking the linkages between economic growth and resource use'. This issue is repeated across a range of different themes, such as the common agricultural policy, the common fisheries policy, regional development policy, transport and energy policies.

The EU's waste policy is based on what is often referred to as the 'waste hierarchy', which focuses on waste prevention, followed by reducing waste disposal through re-use, recycling and recovery. Achieving a significant overall reduction in the volume of waste generated within Europe will depend, among others, upon waste prevention initiatives, better resource efficiency, and a shift towards more sustainable production and consumption patterns. Effective waste management, including high levels of recycling or incineration with energy recovery, has the potential to partly offset greenhouse gas emissions released when raw materials and products are extracted or manufactured; if recovery rates are sufficiently high, waste management practices can even help achieve Kyoto targets, as net emissions from the waste sector can be negative.

Waste accounted for some 2.8 % of total greenhouse gas emissions in the EU-27, or 141.2 million tonnes of CO_2 equivalents, in 2007. Between 1990 and 2007, emissions from EU-27 waste management activities fell by 71.8 million tonnes of CO_2 equivalents (contributing 13.8 % of the reduction in total greenhouse emissions). Waste emissions were reduced by a third (33.7 %) overall, or by an average of 2.4 % per annum, which was considerably more than the corresponding reduction in total greenhouse gas emissions (where an overall decline of 9.3 % was registered between 1990 and 2007, at an average rate of 0.6 % per annum).

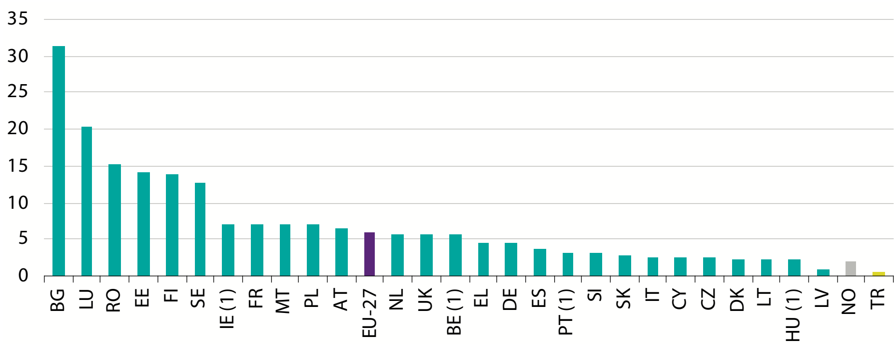
Greenhouse gas emissions from waste management activities are typically composed of methane from solid waste disposal sites or wastewater treatment and discharge. Waste processing also results in emissions of carbon dioxide, for example, from the incineration or the open burning of waste. Nitrous oxide and ammonia emissions may result from the biological treatment of solid waste or from septic tanks and latrines.

Solid waste disposal on land is the main source of greenhouse gas emissions from waste management, accounting for three quarters (75.6 %) of the EU-27 total in 2007. Around one fifth (19.5 %) of the emissions from waste management were attributed to wastewater handling, while waste incineration accounted for a further 3.1 %.

Greenhouse gas emissions from each of these three waste management systems were reduced during the period 1990 to 2007. However, there was a shift in the relative importance of each, as emissions from solid waste disposal on land were cut at a faster pace (-39.1 % overall) than emissions from either waste incineration (-24.2 %) or wastewater handling (-12.5 %). This reflects the gradual change in the way that waste is treated in Europe, with a move away from solid waste disposal on land to a variety of alternative waste management practices, with particular emphasis on re-cycling, re-use and recovery. Reductions in greenhouse gas emissions have also been achieved as a result of more efficient waste management policies, for example, the creation of value for waste as a raw material or energy source (composting or landfill gas recovery installations).

There was 2 953 million tonnes of waste generated in the EU-27 in 2006, with the highest amount attributed to France (15.1 % of the total); while Germany and the United Kingdom followed as the second and third most important generators of waste. There were, however, often considerable differences in the volume of waste generated per inhabitant – as, for example – the next most important contributions to total waste generated were from Romania, Poland and Bulgaria, each of which produced considerably more waste than either Spain or Italy. In per capita terms, the total amount of waste generated was highest in Bulgaria and Luxembourg, followed by Romania, Estonia, Finland and Sweden.

Figure 2.46: Generation of waste, 2006 (tonnes per capita)

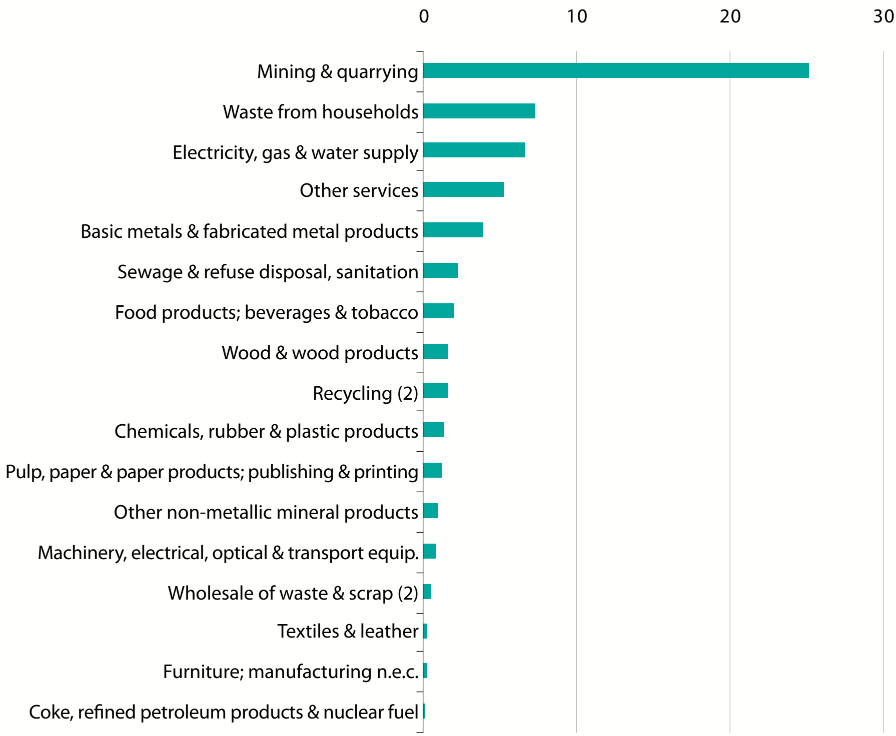


(1) Estimate.

Source: Eurostat (env_wasgen)

The generation of waste may be attributed to either production or consumption activities, with the actor handing over the waste to the waste management system regarded as the source of waste. A breakdown of waste generation is available using the NACE Rev. 1.1 classification of economic activities, which presents the total amount of waste generated. By far the highest proportion (25.1 % in 2006) of waste generated in the EU-27 came from mining and quarrying activities – explaining, to some degree, the relatively high levels of waste generated in Bulgaria, Poland or Romania. Other important contributions came from households (7.3 %), electricity, gas and water supply (6.6 %), services outside of the treatment of waste (5.2 %), basic metals and fabricated metal products (3.9 %) and sewage and refuse disposal, sanitation (2.3 %).

Figure 2.47: Generation of waste by economic activity, EU-27, 2006
(% of total waste) (1)

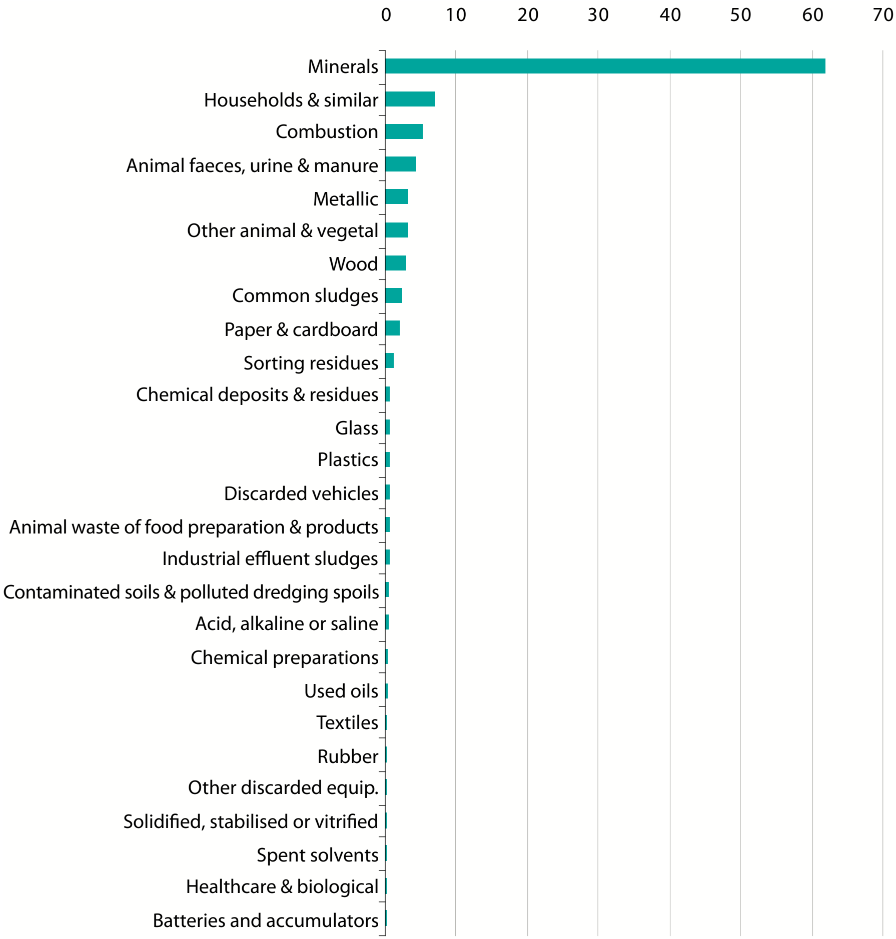


(1) Provisional.
(2) 2004.

Source: Eurostat (env_wasgen)

The generation of waste can also be presented in relation to the amounts of waste according to its material characteristics. Almost two thirds of the waste generated in the EU-27 in 2006 could be classified as coming from minerals. The next highest waste streams were household waste (6.9 %) and combustion (5.4 %). It is interesting to note the relatively modest importance of waste streams of paper and cardboard (2.2 %), glass, plastics and discarded vehicles (each 0.5 %), despite their high profile and the significant efforts that are made to collect these materials.

Figure 2.48: Generation of waste by waste stream, EU-27, 2006
(% of total waste) (1)



(1) Provisional.

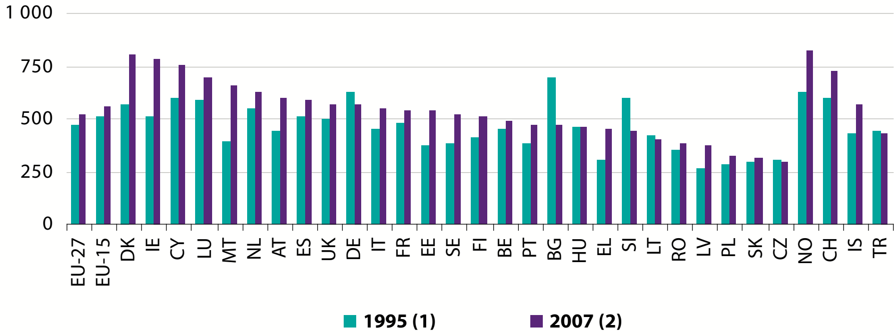
Source: Eurostat (env_wasgen)

Municipal waste is the unwanted material collected by, or on behalf of, local councils (municipalities). This waste generally originates from households; however, it may also be collected from small businesses, shops, restaurants and offices. It consists of combustible and non-combustible materials, including, among others, paper, plastics, food, glass, household appliances and other non-hazardous materials. The average European threw away 522 kg of municipal waste in 2007. The volume of waste per inhabitant rose overall by 10.1 % in the EU-27 between 1995 and 2007. Municipal waste generated per inhabitant increased by more than 200 kg between 1995 and 2007 in Ireland, Malta and Denmark; together with Luxembourg and Cyprus these five Member States each reported in excess of 650 kg of waste per inhabitant in 2007.

Waste treatment activities are regulated by the Landfill Directive, the Waste Incineration Directive and the Integrated Pollution Prevention and Control (IPPC) Directive. Policy-makers have acted to legislate against landfill as a result of its environmental impact, notably in terms of methane emissions, as well as its potential to pollute groundwater, surface water and soil.

In 1994 and 1999, two directives aiming to increase the recycling and recovery of packaging waste (Packaging and Packaging Waste Directive) and to divert biodegradable municipal waste away from landfill (Landfill Directive) were introduced; both have further reinforced the diversion of waste from landfill.

Figure 2.49: Municipal waste generated (kg per capita)



(1) The Czech Republic, Germany, Latvia, Malta and Finland, estimates.
(2) Belgium, Denmark, Germany, Estonia, Spain, France, Luxembourg, Poland, Portugal, Romania, Turkey and Iceland, estimates.

Source: Eurostat (tsien120)

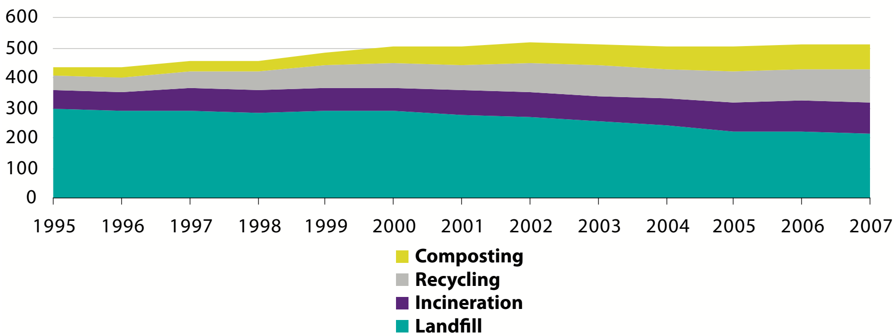
Almost two thirds (62.4 %) of the EU-27's municipal waste was treated through landfill in 1995; this proportion fell from 296 kg per inhabitant to 213 kg by 2007. Landfill remained the most popular form of municipal waste treatment in the EU-27 in 2007 (40.8 % of the total), while the share of recycling rose from 9.6 % in 1995 to 21.4 % in 2007, that of incineration from 13.7 % to 19.9 %, and that of composting from 5.8 %% to 16.3 %.

The level of methane emissions from solid waste disposal is closely related to the composition of the waste, which may vary considerably between countries and regions. The amount of methane produced will generally rise as a function of the share of biodegradable, organic material contained within the waste to be treated. The Landfill Directive set limits for the amount of biodegradable waste sent to landfill, such that by 2016 this should be no more than 35 % of its 1995 level; it also requires all new landfill sites to have gas recovery facilities fitted and required these facilities to be retroactively installed across existing landfill sites by 2009.

Moisture content is another important contributing factor linked to the production of methane within landfill facilities. Moisture is required for bacterial growth and metabolism, and will generally depend upon the initial moisture content of the waste, the extent of infiltration from surface and/or groundwater, and the amount of water produced during decomposition. Under anaerobic (lacking oxygen) conditions, landfill temperatures often reach in excess of 30°C and are maintained regardless of the surface temperature, further promoting bacterial growth.

Methane emissions from landfill facilities are characterised by a lag between the waste being treated and emissions being produced. It is quite typical for biodegradable waste sent to landfill to only start producing methane after a period of more than a year, and for the peak of gas production to be reached some four to ten years after landfill, while gases may continue to be given off for a period of up to 50 or 60 years. This pattern is in direct contrast to waste incineration, where gases are given off during waste processing.

Figure 2.50: Municipal waste by type of treatment, EU-27 (kg per capita)



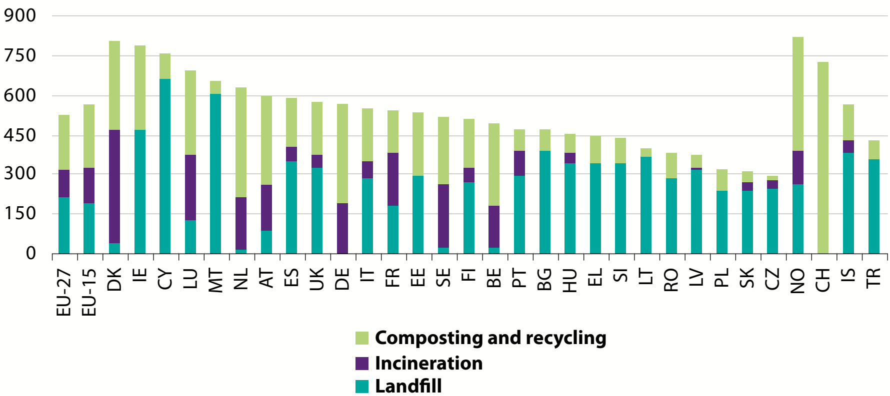
Source: Eurostat (tsien120 and tsien130), http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/documents/Municipal_%20waste_%20recycled_kg_per_capita_%20update_%20websit.mht and http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/documents/Municipal_%20waste_%20composted_kg_per_capita_%20update_%20websi.mht

Incineration can be used to reduce volumes of waste, save land space that would otherwise be devoted to landfill, or recover energy through combustion (either in the form of district heating and/or for electricity generation). The Waste Incineration Directive aims to prevent or to reduce the negative effects on the environment caused by the incineration of waste.

Composting is a biological process that submits biodegradable waste to anaerobic or aerobic decomposition; it should result in a product that is recovered. It has seen rapid growth within a number of Member States in recent years, accounting for upwards of 50 % of the municipal waste treated in the Netherlands, Germany, Belgium and Austria in 2007.

Recycling and recovery are waste management operations that divert materials away from traditional forms of waste treatment. The EU has adopted an approach of looking at the whole life cycle of various products (including packaging materials, vehicles, electrical and electronic equipment) from material extraction, through production and use, to collection and waste treatment. These policies have generally resulted in the introduction of targets for recycling and recovery with the twofold aim of reducing greenhouse gas emissions from waste treatment, while also making production and consumption more sustainable, thereby decoupling the use of resources and the generation of waste from the rate of economic growth. The energy and secondary materials produced when incinerating and/or recycling waste have the potential to replace energy production from fossil fuels and/or the use of raw/virgin material within the manufacture of plastics, paper, metals, with demand for new goods being, at least in part, serviced by recycled or recovered materials.

Figure 2.51: Municipal waste treated, 2007 (kg per capita) (1)



(1) Belgium, Denmark, Germany, Estonia, Spain, France, Luxembourg, Austria, Poland, Portugal, Romania, Turkey and Iceland, estimates.

Source: Eurostat (tsien120 and tsien130)

As such, in much the same way as carbon sinks within forests or soils have the potential to help reduce emissions, the waste sector also has the potential to play a role in climate change mitigation. Indeed, countries with very low landfill rates and high levels of recycling and/or energy recovery can report negative net emissions of greenhouse gases from the waste sector. The following pages therefore look at some specific examples of goods that may be re-used, recycled or recovered.

Packaging fulfils an important role, protecting food and other goods on their journey from farm or factory to homes, offices or wherever they are used. The main role of packaging is to avoid spoilage and damage in the supply system and in the home. Packaging policy aims to minimise the environmental impact of packaging over its whole life cycle, without compromising its ability to protect the product.

Table 2.11: Packaging waste, 2007 (1 000 tonnes)

	Total	Paper & board	Glass	Plastics	Wood	Metals	Other
EU-27 (1)	81 298	31 771	16 597	14 950	12 852	4 903	225
EU-15	*73 842*	*29 378*	*14 768*	*13 405*	*11 705*	*4 377*	*209*
BE	*1 669*	*640*	*367*	*309*	*201*	*136*	*17*
BG	318	107	71	102	24	12	3
CZ	963	358	195	217	114	50	29
DK	979	519	105	192	108	35	21
DE	16 113	7 148	2 825	2 644	2 620	853	22
EE	162	69	33	37	12	12	0
IE	1 056	409	177	238	107	83	41
EL	1 050	400	150	295	60	145	0
ES	8 420	3 625	1 680	1 679	944	480	12
FR	12 797	4 472	3 145	2 114	2 388	673	5
IT	12 541	4 619	2 157	2 270	2 860	635	0
CY	78	25	19	15	9	6	4
LV	323	115	68	39	83	17	0
LT	342	102	84	64	64	14	13
LU	102	30	27	25	10	6	4
HU	968	348	144	218	188	67	2
MT (1)	44	16	10	7	5	4	1
NL	3 469	1 550	572	606	515	220	6
AT	1 185	517	258	245	68	58	39
PL	3 134	959	778	516	727	154	0
PT	1 713	697	405	378	117	113	3
RO	1 287	387	233	375	213	76	3
SI (1)	204	70	31	47	36	18	1
SK	318	119	85	75	22	17	0
FI	696	265	69	99	214	47	1
SE	1 443	686	181	191	301	70	14
UK	10 610	3 801	2 650	2 121	1 192	823	23
NO	506	283	63	141	:	14	5

(1) 2006.

Source: Environment Directorate-General (available on Eurostat's website, http://ec.europa.eu/environment/waste/packaging/data.htm)

The Packaging and Packaging Waste Directive (2004/12/EC) set a target for recycling 55 % of the EU-27's packaging waste by 2008 (a share that was already exceeded in 2006). Of the 81.3 million tonnes of packaging waste that was generated in the EU-27 in 2006, some 56.5 % was recycled, a share that rose to 68.9 % when also taking account of recovery. There were, nevertheless, large variations between Member States, with 14 countries reporting a recycling rate above 55 % in 2007.

Table 2.12: Packaging waste treatment, 2007

	Total packaging waste generated (1 000 tonnes)	Recycling (1 000 tonnes)	Recovery/ incineration with energy recovery (1 000 tonnes)	Recycling rate (%)	Recycling & recovery rate (%)
EU-27 (1)	81 298	45 948	10 071	56.5	68.9
EU-15	73 842	44 101	10 673	59.7	74.2
BE	1 669	1 342	246	80.4	95.2
BG	318	175	0	54.8	54.8
CZ	963	634	52	65.9	71.2
DK	979	556	389	56.8	96.5
DE	16 113	10 784	4 482	66.9	94.7
EE	162	80	3	49.6	51.7
IE	1 056	640	32	60.6	63.6
EL	1 050	504	0	48.0	48.0
ES	8 420	4 405	487	52.3	58.1
FR	12 797	7 296	1 333	57.0	67.4
IT	12 541	7 129	1 267	56.8	67.0
CY	78	20	0	25.7	25.7
LV	323	128	4	39.6	40.9
LT	342	147	4	42.9	44.1
LU	102	64	30	62.5	92.0
HU	968	449	79	46.4	54.6
MT (1)	44	5	0	10.8	10.8
NL	3 469	2 107	1 075	60.7	91.7
AT	1 185	795	274	67.2	90.2
PL	3 134	1 509	338	48.2	58.9
PT	1 713	967	45	56.5	59.1
RO	1 287	393	78	30.6	36.6
SI (1)	204	82	12	40.3	46.4
SK	318	194	1	61.1	61.4
FI	696	361	217	51.9	83.1
SE	1 443	856	320	59.3	81.5
UK	10 610	6 294	477	59.3	63.8
NO	506	346	108	68.4	89.9

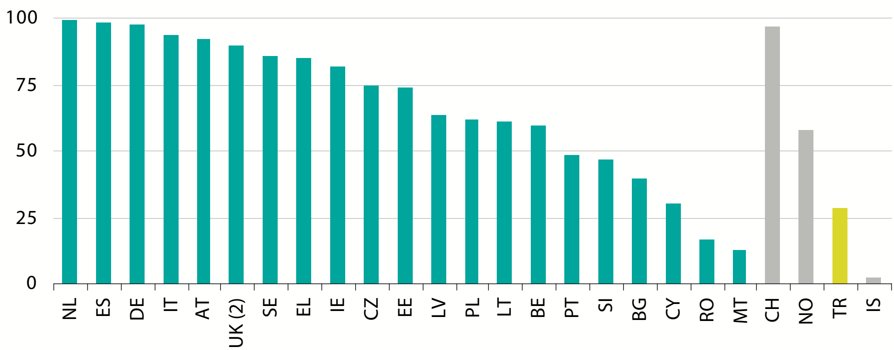
(1) 2006.
Source: Environment Directorate-General (available on Eurostat's website, env_waspac)

Greenhouse gas emissions from wastewater treatment plants are largely in the form of methane and nitrous oxide. Emissions depend on the wastewater composition and the treatment technologies that have been employed and cannot be linked directly to treatment capacities (actual loads). As noted at the start of this subchapter, greenhouse gas emissions from wastewater treatment account for approximately one fifth of the emissions from the waste sector.

Wastewater treatment facilities play an important environmental role in improving the quality of water bodies (rivers, lakes, estuaries and the sea). Over the last couple of decades marked changes have occurred in the proportion of the EU population connected to wastewater treatment systems, while the technologies employed have also evolved. Primary treatment (mechanical) removes part of the suspended solids, while secondary treatment (biological) uses aerobic or anaerobic micro-organisms to decompose most of the organic matter and retain some nutrients. Tertiary treatment (or advanced treatment technology) removes organic matter even more efficiently than secondary treatment.

Directive 91/271/EEC and its subsequent amendments cover the collection, treatment and discharge of urban wastewater. They prescribe a basic level of water treatment for agglomerations of various sizes. In northern Europe most of the population is now connected to wastewater treatment plants with tertiary treatment; southern Member States tend to report lower rates. The increase in connection rates to wastewater treatment systems has resulted in improvements relating to levels of phosphates, ammonium and organic matter; although there is less evidence of any considerable change in the level of nitrates. One by-product of increasing wastewater treatment is that more sewage sludge has been produced.

Figure 2.52: Urban wastewater treatment: at least secondary treatment, 2007 (% of effluent BOD) (1)



(1) BOD: biological oxygen demand; the Netherlands, Austria, Sweden and Turkey, 2006; Germany, Ireland, Italy, Cyprus, Romania, Scotland, Iceland and Switzerland, 2005; Denmark, France, Luxembourg, Hungary, Slovakia and Finland, not available.
(2) Scotland only.

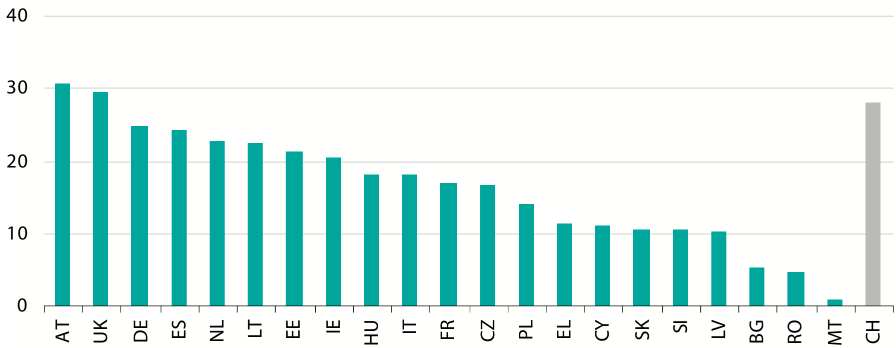
Source: Eurostat (env_watq5)

The application of sewage sludge to land is seen as the most sustainable solution to managing the growing quantities of sewage sludge produced across Europe. Despite potential health risks, sludge can be seen as a valuable fertiliser for agriculture, as it is rich in nutrients such as nitrogen and phosphorus and contains organic matter that may replenish depleted soils that have been over-farmed or soils that are subject to erosion. The Sewage Sludge Directive (86/278/EEC) seeks to encourage the use of sludge in agriculture and to regulate its use in such a way as to prevent harmful effects on soil, vegetation, animals and man, through prohibiting the use of untreated sludge on agricultural land.

Sewage sludge exhibits wide variations in its properties depending on its origin and previous (wastewater) treatment. As such, physical parameters are used to determine the degree to which sludge can be processed and handled; chemical parameters are relevant to the presence of nutrients and toxic/dangerous compounds; while biological parameters give information on microbial activity and organic matter.

On the basis of the data available for each of the Member States, the main reuse of sludge is within the agriculture sector (around 40 % of the overall production of sludge), while around 20 % of the sludge produced in the EU was incinerated (possibly to reduce it to ash, which is subsequently landfilled), 15 % was landfilled, 13 % composted and 10 % was destined for other uses.

Figure 2.53: Sludge production from urban wastewater treatment, 2007 (kg in dry solids per capita) (1)



(1) Germany, Greece, Malta, the Netherlands, Austria and Switzerland, 2006; Italy, Cyprus and the United Kingdom, 2005; France and Hungary, 2004; Belgium, Denmark, Luxembourg, Portugal, Finland and Sweden, not available.

Source: Eurostat (env_watq6ind)

Abbreviations

EU	European Union
EU-27	European Union of 27 Member states from 1 January 2007 (BE, BG, CZ, DK, DE, EE, IE, EL, ES, FR, IT, CY, LV, LT, LU, HU, MT, NL, AT, PL, PT, RO, SI, SK, FI, SE, UK)
EU-25	European Union of 25 Member states from 1 May 2004 to 31 December 2006 (BE, CZ, DK, DE, EE, IE, EL, ES, FR, IT, CY, LV, LT, LU, HU, MT, NL, AT, PL, PT, SI, SK, FI, SE, UK)
EU-15	European Union of 15 Member states from 1 January 1995 to 30 April 2004 (BE, DK, DE, IE, EL, ES, FR, IT, LU, NL, AT, PT, FI, SE, UK)

BE	Belgium
BG	Bulgaria
BLEU	Belgo-Luxembourg Economic Union
CZ	Czech Republic
DK	Denmark
DE	Germany
EE	Estonia
IE	Ireland
EL	Greece
ES	Spain
FR	France
IT	Italy
CY	Cyprus
LV	Latvia
LT	Lithuania
LU	Luxembourg
HU	Hungary
MT	Malta
NL	Netherlands
AT	Austria
PL	Poland
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
FI	Finland
SE	Sweden
UK	United Kingdom

HR	Croatia
MK	former Yugoslav Republic of Macedonia
TR	Turkey
IS	Iceland
LI	Liechtenstein
NO	Norway
CH	Switzerland
AAUs	assigned amount units
BOD	biological oxygen demand
CAP	Common Agricultural Policy
CDM	clean development mechanism
CFCs	chlorofluorocarbons
CH_4	methane
CO_2	carbon dioxide
COP	Conference of the Parties
CRF	common reporting format
DG	Directorate-General (of the European Commission)
EAP	Environment Action Programme
EEA	European Environment Agency
EMAS	eco-management and audit scheme
ETS	Emissions Trading Scheme
EUR	euro
FAO	Food and Agriculture Organization (of the United Nations)
g	gram
GDP	gross domestic product
GWh	gigawatt hour
GWP	global warming potential
HCFCs	hydrochlorofluorocarbons
HFCs	hydrofluorocarbons
IES	Institute for Environment and Sustainability
IET	international emissions trading
IPCC	Intergovernmental Panel on Climate Change

IPPC	integrated pollution prevention and control
JI	joint implementation
JRC	Joint Research Centre
K	potassium
kg	kilogram
km	kilometre
km^2	square kilometre
LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
m	metre
m^3	cubic metre
MWh	megawatt hour
N	nitrogen
N_2O	nitrous oxide
NACE	statistical classification of economic activities in the European Community
NAMEA	national accounting matrix including environmental accounts
n.e.c.	not elsewhere classified
NIR	national inventory report
P	phosphorus
PFCs	perfluorocarbons
PPS	purchasing power standard
SF_6	sulphur hexafluoride
TOE	tonne of oil equivalent
UAA	utilised agricultural area
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organisation
%	per cent
°C	degrees centigrade

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Using official statistics to calculate greenhouse gas emissions – a statistical guide

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Using official statistics to calculate greenhouse gas emissions

A statistical guide

Climate change is recognised to be one of the great challenges facing humanity, and an increasing number of countries are actively pursuing concrete actions to alleviate this problem. The Kyoto Protocol committed industrialised countries to reduce their greenhouse gas emissions, with the EU agreeing to an 8 % decrease between 1990 and the period 2008-2012. In December 2008, EU leaders approved a comprehensive package of emission-cutting measures aimed at reducing greenhouse gases by at least 20 % by 2020 compared with 1990 levels. At the United Nations Climate Change Conference in Copenhagen, countries agreed to the principle of capping the global temperature rise to 2°C by committing to significant emission reductions.

To follow-up on these agreements and objectives, detailed emissions inventories have been established in Kyoto Protocol countries, based on commonly agreed rules. Official statistics, as collected by national statistical offices, constitute an essential input to these inventories.

After a short overview on the principles of emissions calculations, this publication presents a selection of official European statistics with relevance for the calculation of greenhouse gas emissions. Topics covered include land use and agriculture, energy, business (industry and services), transport and waste.

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