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THIRD COMMUNICATION FROM THE EUROPEAN COMMUNITY UNDER THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE

30 November 2001

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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

This is the Third Communication of the European Community under the United Nations Framework Convention on Climate Change (UNFCCC) on the basis of article 12 and Decision 4/CP.5. It updates the information given in the European Community's first and second Communications[1].

The ultimate objective of the UNFCCC, which entered into force on 21 March 1994, is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a sufficient time-frame to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

With the adoption in December 1997 of the Kyoto Protocol and taking into account particularly the agreements of COP 6bis in Bonn and COP 7 in Marrakech this year, commitments for Annex I Parties under the UNFCCC- stabilising their CO_2 emissions at 1990 levels, by 2000 and modifying longer-term trends in emissions -, are complemented. The Protocol lays a path for specific action beyond the year 2000, setting a legally binding greenhouse gas emissions reduction target for the European Community of 8% below 1990 levels by 2008-12. Thus the information provided in this communication, which concerns reporting under the UNFCCC, should also be seen in the light of commitments under the Protocol.

Efforts by the European Community to combat climate change have been stepped up considerably since the second Communication. In 1999 and 2000 the European Commission came forward with Communications on its strategy to prepare for implementation of the Kyoto Protocol. Both Communications outlined the strands of action to be taken at European level and in support of national action to reduce greenhouse gas emissions.

At the European Council in Gothenburg in June 2001, Heads of State and Government indicated that combating climate change is to be a priority of the European Union's Sustainable Development Strategy. They confirmed the European Union's determination to meet its commitments under the Kyoto Protocol and to ratify the Protocol so as to allow its entry into force by 2002.

This determination has become even stronger with the successful conclusion of the resumed 6th session of the Conference of the Parties to the UNFCCC (COP-6) in July 2001 in Bonn. In October 2001, the European Commission published a package of measures for the implementation of the Kyoto Protocol, that consists of three measures:

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[1] http://www.unfccc.de/resource/natcom/nctable.html#a1

(a) a proposal for a Council Decision on the ratification, on behalf of the European Community, of the Kyoto Protocol (COM(2001)579 final)[2];

(b) a Communication that outlines the concrete set of implementation measures to be addressed in the coming 24 months that constitute the basis for fulfilling the Community's commitments under the Kyoto Protocol (COM(2001)580 final)[3];

(c) a proposal for a Directive on greenhouse gas emissions trading within the EU (COM(2001)581 final)[4].

The Third Communication of the European Community has been prepared against this background. It will provide a comprehensive overview of climate change related policies and measures at European level since 1998, which contribute to fulfilling the European Community's commitments under the UNFCCC and the Kyoto Protocol, and will give a good indication of the EU implementation strategy for the years to come.

1.2 NATIONAL CIRCUMSTANCES

The European Union has a unique institutional system. The Member States of the European Union delegate sovereignty for certain matters to independent institutions, which represent the interests of the Union as a whole, it's member countries and it's citizens. Each national government is represented within the Council and the European Parliament is directly elected by citizens.

During the 1990s, the population of the 15 EU Member States grew by an average of 0.34% per year and the Gross Domestic Product (GDP) by 2.1% per year. In relation to GDP, energy consumption had declined by 6% between 1990 and 1998. Passenger transport has grown in line with GDP while growth in freight transport has exceeded it.

The whole of the EU is situated either within the Intermediate Climatic Regions or in the subtropics. The climate in most EU Member States is influenced by the proximity of the Atlantic Ocean or the North Sea, which results in relatively low temperature variations from summer to winter and relatively high rainfall. From 1985 to 1999, there were on average 2543 heating degree-days annually in the EU-15, but the number varies considerably between Member States.

On average, 42% of the surface area is forest or wooded land, 39% is agricultural land and 15% is classified as other land area.

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2 http://www.europa.eu.int/comm/environment/climat/com/01579_en.pdf

3 http://europa.eu.int/eur-lex/en/com/pdf/2001/com2001_0580en01.pdf

4 http://www.europa.eu.int/comm/environment/climat/com/01581_en.pdf

1.3 EUROPEAN COMMUNITY (EC) GREENHOUSE GAS EMISSION TRENDS

Inventories for greenhouse gas emissions and removals for 1990 – 1999 are provided.

Table 1.3.1 Overview of EC greenhouse gas emissions and removals from 1990 to 1999

GREENHOUSE GAS EMISSIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Tg = million tons)									
Net CO_2 emissions/removals	3 126	3 129	3 068	2 989	3 015	3 060	3 127	3 068	3 122	3 070
CO_2 emissions (without LUCF)	3 325	3 351	3 277	3 208	3 221	3 258	3 333	3 272	3 317	3 271
CH_4	440	429	418	406	396	394	387	379	370	366
N_2O	394	392	383	368	378	379	389	386	362	338
HFCs	26	25	25	27	32	37	41	47	51	43
PFCs	14	12	10	8	8	8	8	7	8	8
SF_6	8	9	10	10	11	12	12	12	11	11
Total (with net CO_2 emissions/removals)	**4 007**	**3 996**	**3 913**	**3 810**	**3 839**	**3 891**	**3 964**	**3 898**	**3 924**	**3 836**
Total (without LUCF)	**4 199**	**4 209**	**4 112**	**4 020**	**4 036**	**4 080**	**4 161**	**4 095**	**4 111**	**4 030**

Note: Global warming potentials (GWPs) used (100 years time horizon): carbon dioxide (CO_2)=1; methane (CH_4)=21; nitrous oxide (N_2O)=310; sulphur hexafluoride (SF_6)=23900

Source: EC Submission to the UNFCCC (2001)

Total EC greenhouse gas (GHG) emissions decreased by 4 % between 1990 and 1999, but trends of the different gases varied considerably. CO_2 is by far the most important greenhouse gas accounting for 81 % of total GHG emissions in 1999, but emissions were slightly below 1990 levels in 1999 (-1.6 %). Large increases of CO_2 emissions from transport were outweighed by reductions from fossil fuel combustion in energy and manufacturing industries.

CH_4 emissions account for 9 % of total EC greenhouse gas emissions and decreased by 17 % between 1990 and 1999. The main reasons for declining CH_4 emissions were reductions in solid waste disposal on land, the decline of coal mining and falling cattle numbers.

N_2O emissions went down by 14 % and are responsible for 8 % of total greenhouse gas emissions. The main reason for N_2O emission cuts were reduction measures in the chemical industry (adipic acid production) in recent years.

Fluorinated-gas emissions show opposing trends: whereas HFC and SF_6 emissions increased sharply between 1990 and 1999 (+66 % and +34 % respectively), PFC emissions reduced by 38 %.

1.4 COMMUNITY POLICIES AND MEASURES

The European Community as a party to the Kyoto Protocol has an emission reduction target of 8% below the 1990 level. This commitment can only be fulfilled by complementary action at both European and national level. The Council of Ministers has asked the European Commission in various

resolutions[5] to develop common and co-ordinated policies and measures in the main economic areas such as energy, transport and industry. In this Communication, these common and co-ordinated policies and measures are described. Member State policies and measures are described in their own Communications.

EU-wide action against climate change is firmly set within the wider context of a European environmental policy. The environmental objectives and priorities for the EU are set by Environmental Action Programmes, the 6th such plan was presented in January 2001. Tackling climate change is highlighted as one of four key objectives and specific actions were identified including the establishment of an EU-wide CO_2 emissions trading scheme. The European Commission is also engaged in efforts to integrate the environment into other policy areas. These include the publication of a Green Paper on the Security of Energy Supply[6] and a White Paper on a Common Transport Policy[7]. The Green Paper on the security of energy supply gives the fight against global warming a high priority. It identifies packages of measures to increase the energy efficiency on supply and demand side and to develop new and renewable energies. The White Paper on a common transport policy sets out the need for integration of transport in sustainable development. It lists packages of measures aimed at shifting the balance between modes of transport, in particular from road and aviation to the more environmentally friendly modes of rail and waterway transport. These two documents address the call for new policies and measures made in the European Commission's "First Review Report of the Integration of Environmental Aspects and Sustainable Development into Energy and Transport Policies" (SEC(2001) 502) stresses the importance of: enhancing energy efficiency with a strong focus on demand side management;

The climate change dimension is also one of the four priority areas in the EU's 'Sustainable Development Strategy' approved by Heads of State and Government in June this year.

The European Climate Change Programme (ECCP), established in June 2000, was designed to specifically address climate change action. Its aim was to help identify the most environmentally and cost effective additional measures to meet the EU's targets. The ECCP was set up as a multi-stakeholder process that focussed on energy, transport, industry, research, agriculture and the issue of emissions trading. A major part of the ECCP has now been finalised and more than forty cost-effective measures were investigated.

In total the ECCP could identify cost-effective options costing less than 20 €/t CO_2eq. totalling 664 - 765 MtCO_2eq. However, the realisation of the technical potential depends on a number of factors such as the accuracy of data, the timeframe within which measures are implemented and public

[5] http://europa.eu.int/comm/environment/enveco/integration/integration_update.htm

[6] "Towards a European strategy for the security of energy supply", COM(2000)769 final

[7] "European Transport Policy for 2010: time to decide", COM(2001)370 final

acceptance. In order to give a better indication of the short-term potential of cost-effective measures at EU level the report makes a distinction between those that are 'at an advanced stage of preparation', those 'in the pipeline' and those for which 'more work is needed'.

In the **Energy** sector, the main policy actions have been in support of renewables, energy efficiency, the promotion of energy services, energy efficient procurement rules and Combined Heat and Power (CHP). Areas of equal importance are liberalisation of the gas and electricity markets and security of supply. Some of these actions are already well advanced in the political process others will be initiated soon.

In the **Residential and Tertiary** sector, the main policy actions have been in relation to the improvement of energy efficiency in household appliances. Actions planned by the ECCP extend to sectors such as consumer electronics, electric heating equipment and lighting.

Policies and measures in the **Industry** sector are generally related to improvements in energy efficiency in buildings, in electric motor systems and office equipment. There are however also potential savings in process emissions and the reduction of fluorinated gases. Measures investigated within the context of the ECCP included a strengthening of the Directive on Integrated Pollution and Prevention Control[8] with regard to energy efficiency requirements and a framework directive on fluorinated gases.

The **Transport** sector is important because of expected growth and the EU has already taken significant action in negotiating an agreement with the European, Japanese and Korean car manufacturers. These voluntary agreements are to reduce CO_2 emissions from newly registered cars to 140 g/km by 2008. Various measures were investigated by the ECCP, a Directive on the promotion of bio-fuels for transport was adopted by the European Commission in October 2001 and other measures will follow.

Most policy actions in **Agriculture** are not primarily aimed at reductions in greenhouse gas emissions but often do have an impact on greenhouse gases. Reforms in agricultural policy under Agenda 2000 have already reduced emissions. The ECCP is considering a number of options but the work is not complete.

In the **Waste** sector, the main reductions are expected from the Landfill Directive, which was implemented by the EU. Other measures deal with aspects such as reduction of waste and treatment of waste from equipment that has reached the end of its life.

The ECCP also contributed to the European Commission's work on an EU-wide **emissions trading scheme**. On the basis of a Green Paper on

8 Directive 96/61/EC *Official Journal L 257 , 10/10/1996 P. 0026 - 0040*

'Greenhouse Gas Emission Trading within the EU', (COM (2000) 87 final), the main elements of a future Directive were identified. With regard to project related mechanisms such as **Joint Implementation (JI) and Clean Development Mechanisms (CDM)**, issues such as the need for a reliable monitoring system and the links with other policies and measures were addressed.

1.5 PROJECTIONS AND THE TOTAL EFFECT OF POLICIES AND MEASURES

Since the last Communication of 1998 the European Commission has put considerable emphasis on improving its work on the environmental and cost-assessment of its policies and measures. This includes projections until 2010-12.

This year the European Commission's Directorate-General for the Environment concluded a study on the 'Economic Evaluation of Sectoral Emission Reduction Objectives for Climate Change'[9]. This study underwent a review process before and during the ECCP and indicates that the current decrease of greenhouse gas emissions by 4% will not continue. On the contrary, reductions will be outweighed by future increases.

Table 1.5.1 shows in the column with measures projections baseline' that by 2012 emissions will have increased by 1% relative to the base year of 1990 thereby increasing the EC's target to –9% (EC Kyoto emission reduction target of 8% +1%). This is mainly due to increased energy supply to satisfy growing demand in the transport and services sectors, while emissions are decreasing in the other sectors.

Table 1.5.1 'With measures' projections and the potential for additional measures (excl. LUCF)

	Base year emissions ($MtCO_2$ eq.)[a]	**2010 with measures projections 'baseline' ($MtCO_2$ eq.)**	**Potential for additional measures ($MtCO_2$ eq.)**
CO_2	3 232	3 376	3 166
Methane	462	380	380
Nitrous oxide	376	317	317
HFCs	52	84	62[b]
PFCs	10	25	20[b]
SF_6	5	7	5[b]
Total	**4 138**	**4 190**	**3 950**

9 http://europa.eu.int/comm/environment/enveco/climate_change/sectoral_objectives.htm "Economic Evaluation of Sectoral Emission Reduction Objectives for Climate Change: Summary Report for Policy Makers", K Blok, D de Jager and Chris Hendriks, March 2001

[a] The 1990 emissions presented here are from the Sectoral Objectives Study and are based on an earlier submission to the UNFCC and are slightly different to the current estimates for 1999.

[b]These figures are estimated from a total reduction of 30 $MtCO_2$ eq for all fluorinated gases in the ECCP. The individual reduction potentials for the fluorinated gases have been determined by distributing the overall potential identified in the ECCP proportionally in relation to 2010 with measures projection.
Source Sectoral Objectives Study, 2001 and ECCP final report, 2001.

The emission reduction target of –8% can only be achieved by additional measures both at European and national level. In the ECCP the European Commission identified the technical potential of additional measures at Community level. In Table 1.5.1, the column 'Potential for additional measures', gives figures of the technical emission reduction potential for all six greenhouse gases. Figures include only those measures that are at an advanced stage of preparation and represent the technical potential at a cost below 20 €/t CO_2 eq. abated. If this technical potential were to be realised EU-wide measures would contribute about 5% of the 8% Kyoto commitment. However, the realisation of this potential includes a number of factors including political agreement on the measures, the time scales for implementation and the overlaps between measures. A cautious interpretation of these figures is therefore recommended.

1.6 VULNERABILITY, IMPACTS AND ADAPTATION

Patterns from recent climate modelling indicate a continued increase in temperature, with rises of 0.1 – 0.4°C per decade. Most warming is expected in southern and north Eastern Europe. The trend for annual precipitation levels in northern Europe increases, while in southern Europe smaller changes will occur with decreased levels. Sea levels are predicted to rise by 13-68 cm by the 2050s.

Europe's vulnerability has been assessed using the four preliminary marker emissions scenarios generated by the IPCC.

Larger differences between southern and northern European **water resources** are predicted to occur due to climate change, with an increased risk of shortages in southern regions. Adaptation in terms of sustainable water resources will need to involve both demand and supply side approaches to water management.

Soil quality is likely to deteriorate under warmer and drier conditions, leading to loss of soil function. Changes to soil and land resources will be highly dependent on geographical factors and may be moderated by increased precipitation in some areas. Present policies for management and protection of soil and land resources are insufficient – there is a need for policies to preserve the quality of soils and land resources both in the present and future, recognising climate change impacts on degradation processes. These policies will need to be regionalised, targeting specific issues within different European locations.

There is likely to be a net increase in productivity in most European **ecosystems** due to warmer temperatures and CO_2 enrichment. Changes to ecosystem location are likely to occur, including northward displacement of boreal forests, northward expanding broad-leaved temperate forests in eastern Europe and northward movement of frost-intolerant species. Policies for ecosystems adaptation need to be local / regionally based.

Increasing flood risk and storm damage in **coastal areas** due to rising sea levels and increased storminess will have significant economic impacts. The greatest increase in flood risk is expected to be in southern Europe. There are a number of efforts at different levels (local, regional and national) to promote integrated coastal zone management. These need to be encouraged to strengthen the institutional basis for proactive measures.

Significant changes to biotic and cryospheric zones in **mountain** regions could occur, leading to the perturbation of hydrological regimes, the effects of which will be felt downstream. 50–90% of glaciers will disappear by end of the 21st century. There needs to be education and a raising of awareness regarding the increased threat to safety that mountain regions will pose due to environmental change.

In **forestry** the genetic variability of tree species will probably mean most species will be able to acclimatise to changes in temperature and precipitation. The greatest risk to forests in the Mediterranean region and continental Europe will come from increased drought and fire risks. In northern Europe, the use of natural regeneration in forest management provides substantial genetic potential to adapt to climate change. Increased productivity should encourage policies that sustainably use the increasing forest cover and resources. In the south, more adaptive measures will need to be adopted to maintain and preserve forests.

Increased CO_2 concentrations will probably lead to enhanced productivity and plant water use efficiency in **agriculture**. This could be counteracted in southern Europe (where agriculture is moisture-limited) by water shortage, extreme weather events and shorter growth seasons. Policies to support the adaptation of agriculture should encourage flexibility of land use, crop production and farming systems. More information on regional effects is needed so that adaptation measures can be better targeted.

Any impacts of climate change on **fisheries** will be further aggravated by the current over-exploitation of fish stocks. The most vulnerable species are those that have a juvenile stage in freshwater where air temperature increases could lead to local extinction in watersheds at the edges of the current ranges. Freshwater fisheries policy needs to be more closely integrated with water resource and ecosystem management schemes. The potential adaptability of the marine fisheries sector has been undermined by a range of factors, particularly over-exploitation.

Tourism is sensitive to changes in climate, with climate being a significant factor when planning holidays. Therefore, tourism in northern Europe is likely to be stimulated by warmer temperatures. Some Mediterranean areas

may become less popular due to increased frequency of heat waves. Regional policies need to take account of the changes in tourism patterns, particularly with regard to reduced winter tourism and changes in preferences for summer destinations.

Increased exposure to heat and air pollution, the extension of vector-borne disease and increased flooding will have adverse effects on **human health**. A major spread of malaria in Western Europe is unlikely but localised outbreaks could become more common. Predicted less severe cold weather will reduce the effects of winter mortality, particularly in Northwest Europe. Potential adaptation measures to address health impacts include strengthening public health programmes (education and vaccination programmes), supporting methods to detect early climate change health impacts and development of pan-European surveillance system to detect changes in occurrence of infectious disease.

1.7 FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

The European Community (EC), as a distinct entity apart from the bilateral aid programmes of the individual Member States, has become the world's fifth largest aid donor in the 1990s, providing in 2000 $7.4 billion or 12.5 % of all aid disbursed by the OECD countries. This reflects the rapid growth of the Community's aid programme over the past three decades, when it increased steeply in real terms and almost quadrupled as a proportion of total OECD aid. Taken together, the European Community and European Union Member States' aid accounts approximately half of OECD aid (compared to a share of roughly one third in OECD GDP).

The European Commission, the EIB and EBRD manage EU aid. The European Commission has three Directorates General with geographical responsibilities for administering European Community external co-operation (DG Development, DG Enlargement, DG External Relations). Additionally, DG Transport and Energy is involved in external co-operation as part of its Energy Framework Programme. As part of its efforts to reform the management of external aid the European Commission formally set up the EuropeAid Co-operation Office on 1st January 2001. EuropeAid Co-operation Office's mission is to implement the external aid instruments of the European Commission outside the accession countries, which are funded by the European Community budget and the European Development Fund. In addition, a separate Humanitarian Office (ECHO) deals with humanitarian assistance.

The Global Environmental Facility (GEF) assists developing countries specifically in the management of the global commons, i.e. the atmosphere, biological diversity and international waters. The European Community is not contributing directly to the GEF (except for some small project co-financing) as there is no mandate from the Council for this activity. The Member States provide their funding directly to GEF. Similarly, the main part of contributions to international organisations such as the UN occurs through the EU Member States.

Table 1.7.1 gives an estimate of the climate relevant part of the main EU programmes aimed at bilateral co-operation with third countries although no reliable project classification under the heading climate change is presently available. The OECD Development Assistance Committee (DAC) marker system for aid to multi-lateral environmental agreements has not been implemented yet in the European Commission.

Table 1.7.1 Financial contributions to bilateral co-operation (million Euro)

Budget line	Programme	**1999**	**2000**	**2001**	**Comment**
B4-1004	Carnot	0.6	0.6	0.5	Accession Countries
B4-1009	Remaining obligations from SAVE, PACE etc		1.5	0.8	Accession Countries
B4-1030	Altener II	10.2	11.0	12.1	Accession Countries
B4-1031	SAVE II	8.7	14.3	13.5	Accession Countries
B4-1040	ETAP	1.2	1.5	1.2	Accession Countries
	LIFE - Environment				Accession countries
B7-020	ISPA (structural policy instruments for accession: environment/transport		245		
B7-030	Phare	932.5	1 109	1 246	Accession Countries
B7-300	Co-operation with developing countries in Asia	226.7	220.6	262.0	About 10% for Agenda 21 activities
B7-310	Co-operation with developing countries in Latin America	121.0	126.2	150.0	About 10% for Agenda 21 activities
B7-410	Co-operation with third countries in the Mediterranean Area and the Near and Middle East	242.1	222.2	275.0	About 10% for Agenda 21 activities
B7-520	Co-operation with third countries in Eastern Europe and Central Asia (TACIS)	501.1	386.0	411.4	
B7-6200	Environment in developing countries and tropical forests	61.5	63.9	55.0	
B4-1041	Synergy	4.9	5.7	4.4	
B7-810	LIFE – Third countries (European Instrument for Financing Environment; measures outside EU)	4.5	4.4	5.0	
	Total with climate relevance (estimate)	**209.1**	**204.4**	**215.1**	

The EU has reaffirmed that increasing global participation must be in accordance with the principle of common but differentiated responsibilities. Due to their limited resources, developing countries need financial assistance for capacity building, adaptation, and mitigation through technology transfer from developed countries. Compared to domestic investment and private investment flows, the role of public sector financial support in the more

advanced developing economies is likely to be rather limited, however if well focused it can have an important catalytic effect. The main emphasis of Community development co-operation is to fight poverty through fostering sustainable development. Currently activities directly supporting the objectives of the United Nations Framework Convention on Climate Change (UNFCCC) concentrate on capacity building. However, EC economic and development co-operation and other financing instruments support actions in many sectors (e.g. energy, transport, waste management, agriculture and forestry) that have a direct bearing on the objectives of the UNFCCC. The European Community is therefore in a good position to further integrate climate change objectives into its co-operation policies.

1.8 RESEARCH AND SYSTEMATIC OBSERVATION

The principal instrument used so far for research has been the European Union's framework programme for research. Under, the 5th Framework Programme, the majority of climate change activity is being undertaken within the Energy, Environment and Sustainable Development programme (2125 million Euro).

A significant amount of research has been carried out within the EU on climate processes and systems in recent years. Studies have been carried out in:

- Climate process and climate systems. Highlights include the work by CARBOEUROPE on carbon sequestration in forests and the large-scale biosphere-atmosphere experiment in Amazonia.
- Climate modelling and scenario analysis. New models have been developed that couple ocean and atmospheric circulation models.
- Research on the impacts of climate change. The ACACIA report is a comprehensive report on impacts of climate change in the European Union.
- Socio-economic research. Various economic and technology models and simulation tools have been built for the EU and other world regions. These models have been used to support policies and international negotiations.
- Mitigation and adaptation technologies. Numerous studies have been carried out to develop and demonstrate options for renewable energy and for energy efficiency technologies.

Parallel to the general activities, there is one activity particularly dedicated to all areas of climate and global research, ENRICH. This has a budget of 5 million Euros and has the objective to increase the effectiveness of European Global Change research. ENRICH projects have a strong international dimension and/or significant links to international Global Change Programmes. In addition to socio-economic and natural science studies, a more generic integrated system of research is also needed which covers all critical factors

concerning the climate system and the management of its impacts. These need to be made at a regional and global level.

Significant European Commission funds have been used to support Earth Observation-related research and development projects during the last ten years. At present the objective is to support the development of the European component of the global observing systems for climate, terrestrial systems and oceans. Among ongoing projects, MAIA (Monitoring the Atlantic Inflow toward the Arctic), CLIWA-NET (Cloud Liquid Water Network) and POSITIVE (Phenological Observation and Satellite Data – ndvI- Trends In the vegetation cycle in Europe) are particularly important. The overall objective of MAIA, is to develop an inexpensive, reliable system based on coastal sea-level data for monitoring the inflow of Atlantic water to the Northern seas. CLIWA-NET is focused on observations of cloud liquid water, and vertical structures and the evaluation and improvement of model parameterisations. The main objective of POSITIVE is to develop tools and techniques for integrating climate, phenological, ad satellite data for multipurpose use in the field of global change research. Results of ongoing and future projects will contribute to identify and help fill key gaps in existing observation system capacity to ensure that the long term consolidated data sets are collected in a co-ordinated manner, and that such data is quality-assessed and made available to predict, assess the impact of and formulate response options to, global change.

These activities represent the EU's main contribution to Global Monitoring for Environment and Security (GMES). GMES is a European initiative aiming at gathering and processing data and information from various sources (space and ground based) to assist decision-makers.

1.9 EDUCATION, TRAINING AND PUBLIC AWARENESS

The European Commission is committed to the principles of open government and provides a large amount of information to the public in a number of forms. Activities in these areas are focused on Public Awareness as most activities in the area of Education and Training are at the Member State level. The European Commission recognises the crucial importance of Education and Training and provides support in the form of networks and dissemination of good practice.

The Community Information Policy in relation to the Environment and Climate Change has a number of objectives:

- To promote the results of Community Policies and to inform about proposals and actions.
- To make more explicit the links between Community actions and the concerns of the citizens facing environmental problems.
- To ensure transparency of European policy.
- To encourage debate and partnership to create feedback on policies.

The tools used are:

- An information centre which provides a focal point for enquiries regarding the environment and is open both for visitors and Community Staff.
- An internet site which is extensive and includes all types of information such as press releases, reports, studies, policy discussion as well as legislation.
- A publication programme, including a special edition of the magazine Environment for Europeans.
- Relationships with the press and audio-visual sectors, this includes a TV news service, targeted audio-visual material, press releases and briefings.
- Co-operation with business, NGOs and networks to disseminate information.
- Subsidies to awareness raising projects such as the building of a 1km long dike built in the Hague for COP6 to illustrate public concern about climate change.
- Conferences aimed at raising visibility of issues and the European response.

Through these tools, the European Commission is able to provide comprehensive coverage of Climate Change issues and of their response to them.

2 NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

2.1 GOVERNMENT STRUCTURE

The European Union's institutional system is unique in the world. The Member States (of which there are currently 15), delegate sovereignty for certain matters to independent institutions which represent the interests of the Union as a whole, it's member countries and it's citizens[10]. Each national government is represented within the Council and the European Parliament is directly elected by citizens.

The European Parliament is elected every five years. It has three essential functions:

1. It shares with the Council the power to legislate i.e. to adopt European laws (directives, regulations, decisions).
2. It shares budgetary authority with the Council and can therefore influence EU spending.
3. It exercises democratic supervision over the European Commission. It approves the nomination of Commissioners and has the right to censure the European Commission. It also exercises political supervision over all the institutions.

The Council of the European Union is the main decision-making body and has a number of key responsibilities.

1. It is the Union's legislative body in co-decision with the European Parliament.
2. It co-ordinates the broad economic policies of the Member States.
3. It concludes, on behalf of the EU, international agreements with one or more States or international organisations.
4. It shares budgetary authority with Parliament.
5. It takes the decisions necessary for framing and implementing the common foreign and security policy, on the basis of general guidelines.
6. It co-ordinates the activities of the Member States and adopts measures in the fields of police and judicial co-operation in criminal matters.

The European Commission embodies and upholds the general interest of the Union. The President and Members of the European Commission are appointed by the Member States after they have been approved by the European Parliament.

1. It has the right to initiate draft legislation and therefore presents legislative proposals to Parliament and the Council.

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10 http://europa.eu.int/inst-en.htm

2. As the Union's executive body it is responsible for implementing the European legislation, budget and programmes.

3. It acts as guardian of the Treaties and together with the Court of Justice, ensures that Community law is applied properly.

4. It represents the Union on the international stage and negotiates international agreements, chiefly in the field of trade and co-operation.

2.2 POPULATION PROFILE

During the 1990s, the population of the 15 EU Member States has grown by 3.2 %, at an average growth rate of 0.34 % per annum.

Table 2.2.1 Aggregate EU 15 population from 1990 to 1999 (millions)

Year	Total population in EU 15 (as of January each year)
1990	363.8
1991	365.4
1992	367.1
1993	369.0
1994	370.4
1995	371.6
1996	372.7
1997	373.7
1998	374.6
1999	375.3

Source: EUROSTAT[11].

Individual EU Member States vary considerably in size and population density, in Table 2.2.2.

11 New Cronos Database of the EU, Eurostat, Luxembourg

Table 2.2.2 Population, surface area and population density

Country	Population in 1999 (millions)	Area (km^2)	Population density (inhabitants/km^2)
Belgium	10.21	30 520	335
Denmark	5.31	43 090	123
Germany	82.04	356 970	230
Greece	10.52	131 960	80
Spain	39.39	504 790	78
France	58.98	549 090	107
Ireland	3.73	70 290	53
Italy	57.61	301 280	191
Luxembourg	0.43	2 570	167
Netherlands	15.76	41 570	380
Austria	8.08	83 860	96
Portugal	9.98	91 910	109
Finland	5.16	338 150	15
Sweden	8.85	449 960	20
United Kingdom	59.39	244 150	243

Source: EUROSTAT

Compared to the majority of all Parties to the Convention, most EU Member States have a relatively high population density. This has implications for settlement and building patterns and a tendency to relatively short transport distances. However, it facilitates economic integration among communities and regions, resulting in a tendency for more transport intensity.

2.3 GEOGRAPHIC PROFILE

On average, in the EU 42% of the surface area are forests and other wooded land, 39% is utilised agricultural area, and 15% is classified as other land area. Sweden and Finland account for 43% of the forest or wooded land in the EU. The UK, Ireland and Denmark are the Member States with the highest proportion of utilised agricultural area.

Table 2.3.1 Land-use patterns within the EU

	Total area		*Inland waters*		*Total land area*		*Forest and other wooded land (FOWL)*		*Utilised agricultural area*		*Other land area*	
	(1000 ha)	*%*	*(1000 ha)*	*%*	*(1000 ha)*	*%*	*(1000 ha)*	*%*	*(1000 ha)*	*(%)*	*(1000 ha)*	*(%)*
EU-15	323.963	100	12.111	4	311.852	96	136.204	42	126.045	39	49.603	15
Belgium	3.053	100	22	1	3.030	99	672	22	1.383	45	976	32
Denmark	4.309	100	70	2	4.239	98	538	12	2.689	62	1.013	23
Germany	35.702	100	1.089	3	34.613	97	10.740	30	17.160	48	6.713	19
Greece	13.196	100	120	1	13.076	99	6.513	49	3.499	27	3.064	23
Spain	50.596	100	541	1	50.055	99	25.984	51	22.984	45	1.087	2
France	54.919	100	771	1	54.148	99	16.989	31	28.331	52	8.828	16
Ireland	7.029	100	139	2	6.890	98	591	8	4.342	62	1.957	28
Italy	30.132	100	720	2	29.412	98	10.842	36	14.833	49	3.737	12
Luxembourg	259	100	1	0	258	100	89	34	127	49	43	17
Netherlands	3.735	100	347	9	3.388	91	339	9	2.011	54	1.038	28
Austria	8.387	100	135	2	8.252	98	3.924	47	3.415	41	913	11
Portugal	9.204	100	99	1	9.105	99	3.467	38	3.822	42	1.816	20
Finland	33.814	100	3.360	10	30.454	90	22.768	67	2.172	6	5.514	16
Sweden	45.218	100	4.375	10	40.843	90	30.259	67	3.109	7	7.475	17
United Kingdom	24.410	100	322	1	24.088	99	2.489	10	16.169	66	5.430	22

Source: Temperate and Boreal Forest Resources Assessment 2000.

The reference period for the above data is 1990-1999. Figures for total surface area deviate slightly from those used in Table 2.2.2 because they originate from different sources. For agricultural utilisation patterns and forest management practices, see proceeding sections (j) and (k) of this chapter.

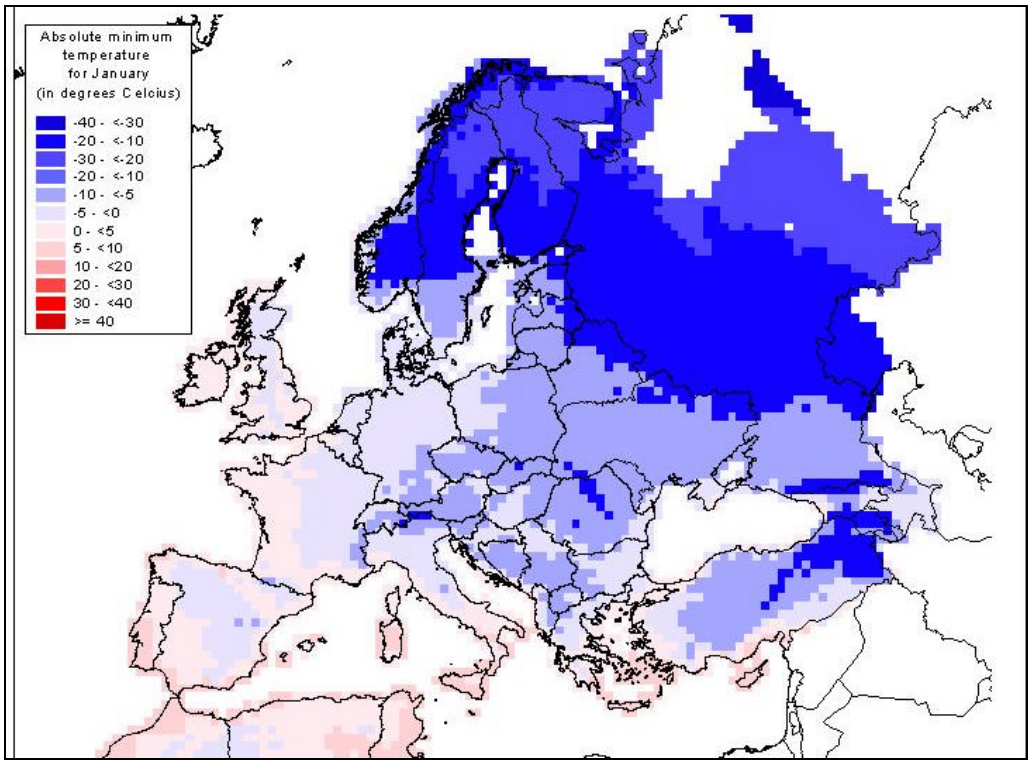
2.4 CLIMATE PROFILE

The whole of the EU is situated either in the Intermediate Climatic Regions or in the subtropics. The climate in most EU Member States is influenced by the proximity of the Atlantic Ocean or the North Sea, which results in relatively low temperature variations from summer to winter and relatively high rainfall. In all countries bordering the North Sea, the Gulf Stream has a warming influence.

In the Scandinavian region, countries have mild summers and cold winters. The central European States have mild winters and mild summers, with more continental climatic conditions further east. In general, the countries bordering the Mediterranean Sea have a hot, dry summer climate and mild, often rainy winters. On the central Spanish plateau, in contrast, winters are relatively cold and dry.

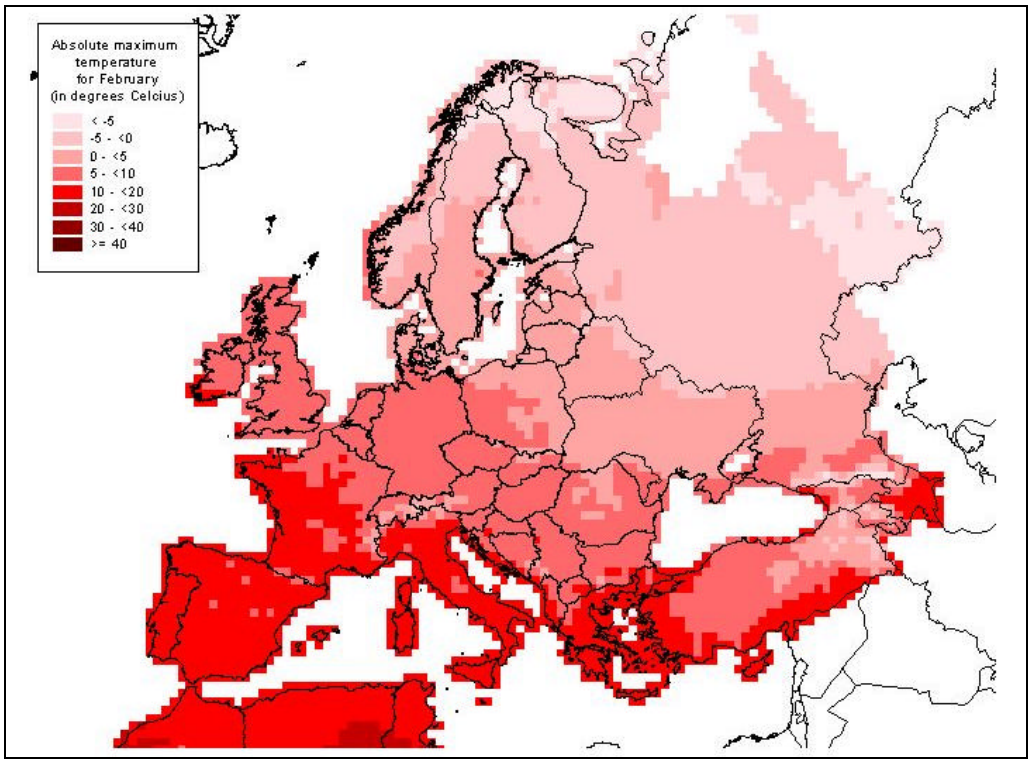
Figures 2.4.1 and 2.4.2 illustrate the geographical distribution in terms of minimum temperatures in January and maximum temperatures in February, i.e., in months when heating is normally necessary in the majority of Member States.

Figure 2.4.1: Minimum temperatures in January across Europe (Long term average interpolated monthly climate data (period: 1975 - 1999)



Source: ISPRA 2001, preparation for this report.

Figure 2.4.2: Maximum temperatures in February across Europe (Long term average interpolated monthly climate data (period: 1975 - 1999)



Source: ISPRA 2001, preparation for this report.

It can be seen that the British Isles, Benelux, Germany, Austria and northern France, which together make up for one half of the EU 15 population, have had, on average, a February maximum temperature of between 5 and 10 degrees Celsius. The southern Member States and the remainder of France experienced a maximum of between 10 and 20 degrees Celsius, which is partly still in the range of heating necessity. The Scandinavian countries have had a February maximum of slightly above or below zero degrees.

From 1985 to 1999, there were on average 2543 heating degree-days in EU 15 (days in which air temperature is below 15°C). The number varies considerably between Member States; by far the highest number of degree-days is found in Finland with 4710 on average between 1985 and 1999, followed by Germany with 3692 and Sweden with 3666. The lowest number is experienced in Portugal with 1248.

The number varies considerably between Member States; by far the highest number of degree-days is found in Finland with 4710 on average between 1985 and 1999, followed by Germany with 3692 and Sweden with 3666. The lowest number is experienced in Portugal with 1248.

Table 2.4.1 Annual number of heating degree-days in Member States (average from 1985 to 1999, Germany 1990-1999)

Country	Number of heating degree days
Belgium	2 933
Denmark	3 309
Germany	3 692
Greece	1 488
Spain	2 032
France	2 290
Ireland	2 262
Italy	1 777
Luxembourg	3 010
Netherlands	3 017
Austria	2 630
Portugal	1 248
Finland	4 710
Sweden	3 666
UK	2 243
Average of EU 15	**2 543**

Source: EUROSTAT

Since the base year for Kyoto reduction commitments for CO_2, 1990, was a warm year relative to the average 1960-1999, it looks possible that in the first commitment period 2008-2012 there will be more heating degree days than 1990, which would exert an additional burden on target fulfilment[12].

2.5 ECONOMIC PROFILE

2.5.1 Changes in overall GDP

The Gross Domestic Product (GDP) of the EU 15 has increased by 20 % in real terms from 1991 to 2000 (average annual increase of 2.1%).

Table 2.5.1 EU 15 GDP growth in million Euro (1995 prices)

Year	EU 15
1991	6 209
1992	6 289
1993	6 259
1994	6 432
1995	6 581
1996	6 686
1997	6 852
1998	7 043
1999	7 221
2000	7 463

Source: EUROSTAT

2.5.2 Development of economic sectors

Agriculture and fishery have maintained their share as an economic sector in term of gross value added, although at a low value of less than 3 %. Industry and construction have grown in absolute terms but their share has slightly declined, together they remain at almost a third of value added. Two thirds are made up by the services sector, with financial services, renting and comparable activities having grown in the nineties.

12 A sensitivity analysis for 6 of the bigger EU Member States by Fraunhofer-ISI and ECOFYS, assuming the 5 year variability would be at the cold end of the range experienced in the 80s and 90s, resulted in an emission increase of approx. 13 Mt in 2008-12. Extrapolating this to the whole EU 15 would result in 18 Mt higher emissions if the first commitment period is relatively cold.

Table 2.5.2 Gross value added at basic prices by main economic sectors (in 1000 Euro at 1995 prices and in terms of percentage shares)

	1991	1991 (%)	1995	1995 (%)	1999	1999 (%)
All branches Total	5.769.304.178	100,0	6.138.354.087	100,0	6.742.094.974	
Agriculture, hunting, forestry and fishing	154.159.169	2,7	163.428.051	2,7	177.684.062	2,6
Total industry (excluding construction)	1.422.179.654	24,7	1.465.745.129	23,9	1.561.354.952	23,2
Construction	362.108.387	6,3	359.169.592	5,9	359.517.830	5,3
Financial intermediation; real estate, renting and business activities	1.379.470.516	23,9	1.520.307.159	24,8	1.773.172.894	26,3
other services	1.205.338.741	20,9	1.287.250.638	21,0	1.451.709.011	21,5
Public adminis-tration	1.246.047.711	21,6	1.345.289.178	21,9	1.418.656.226	21,0

Source: EUROSTAT

The growth in the services sectors has implications for increases in transportation and energy use[13], since services tend to have a higher transportation intensity (miles per gross value added in the sector) than industry. In terms of stationary energy consumption, services do not involve highly energy consuming production processes but tend to have a high, and increasing, use of electric equipment, e.g. for IT and communication purposes.

See Section 2.8. on industry patterns for the development of value added in the various industrial sectors.

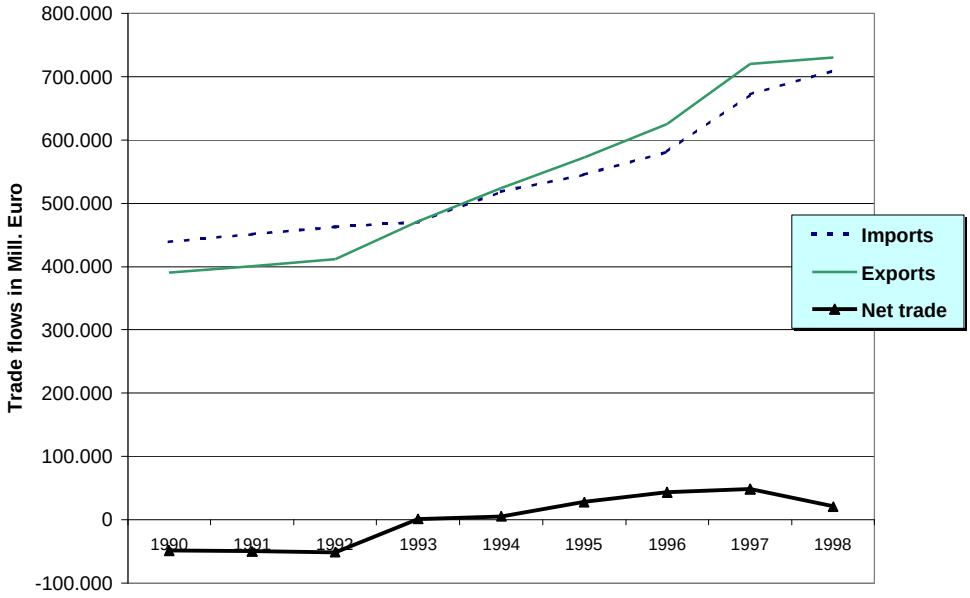
2.5.3 Trade patterns

Importing goods can lead to what is regarded as "exporting emissions", by consuming goods which are produced, and therefore associated with emissions, elsewhere. On the other hand, exporting goods leads to higher emissions at home. Different goods have different emission intensities. Hence, the development and the composition of external trade are important.

Trade within the EU is more than 1.5 times as high as the trade of EU members with the "rest of the world"; however extra-EU trade has grown faster in the 90's. In the context of EU emissions as a whole, extra-EU trade is the important factor. It has shifted during the nineties from a deficit to a surplus, i.e., total exports have outgrown total imports.

13 "Environment in the European Union at the turn of the century", EEA Environmental Assessment Report No 2, 1999.

Figure 2.5.1 Development of Extra-EU trade

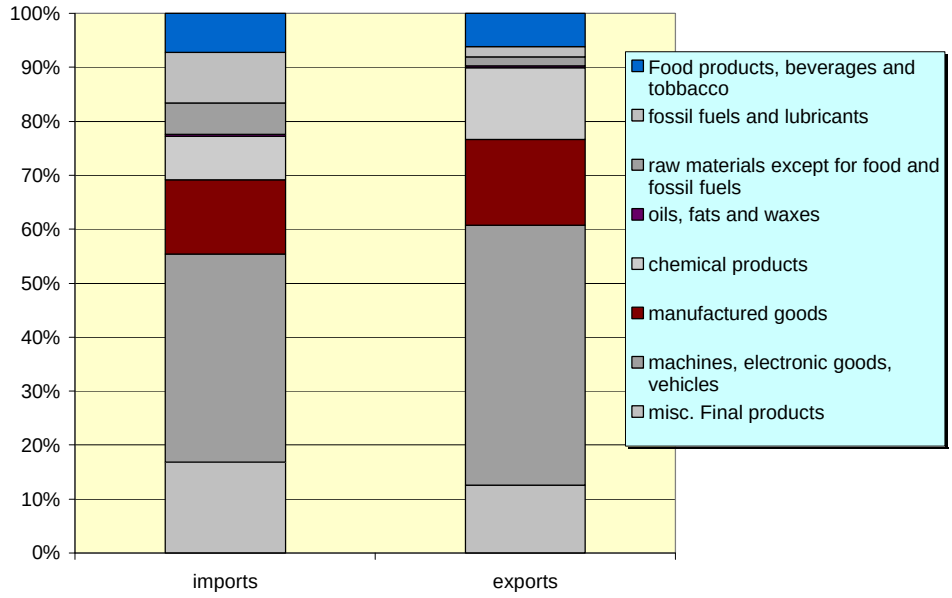


Source: German National Statistical Office, with data from Database COMEXT, EUROSTAT. Note: the figures for 1991 have been interpolated from the 1990 and 1992 figures.[14]

Figure 2.5.2 shows that manufactured goods, including machinery, electronics, vehicles and chemical products make up the largest share of exports, while their share in imports is also significant but not as large. Raw materials play a bigger role in imports.

14 Statistisches Bundesamt (German National Statistical Office) (2000): Statistisches Jahrbuch fuer das Ausland 2000. Wiesbaden.

Figure 2.5.2 Composition of Extra-EU trade



Source: German National Statistical Office, with data from Database COMEXT, EUROSTAT.

2.6 ENERGY PROFILE

The most recent comprehensive energy profile of the EU is reported in the European Commission's Green Paper of 29 November 2000: "Towards a European Strategy for the security of energy supply" [15]. The Green Paper was triggered by the sharply increasing oil prices during 1999 and 2000 and the document intends to launch the broadest possible debate on future EU energy policy in view of expected declining domestic energy production and increasing external environmental constraints particularly due to the need to reduce greenhouse gas emissions.

The document confirms the three pillars on which EU energy policy has been based throughout the 1990's:

- Security of energy supply,
- Competitive energy prices,
- Respecting environmental objectives.

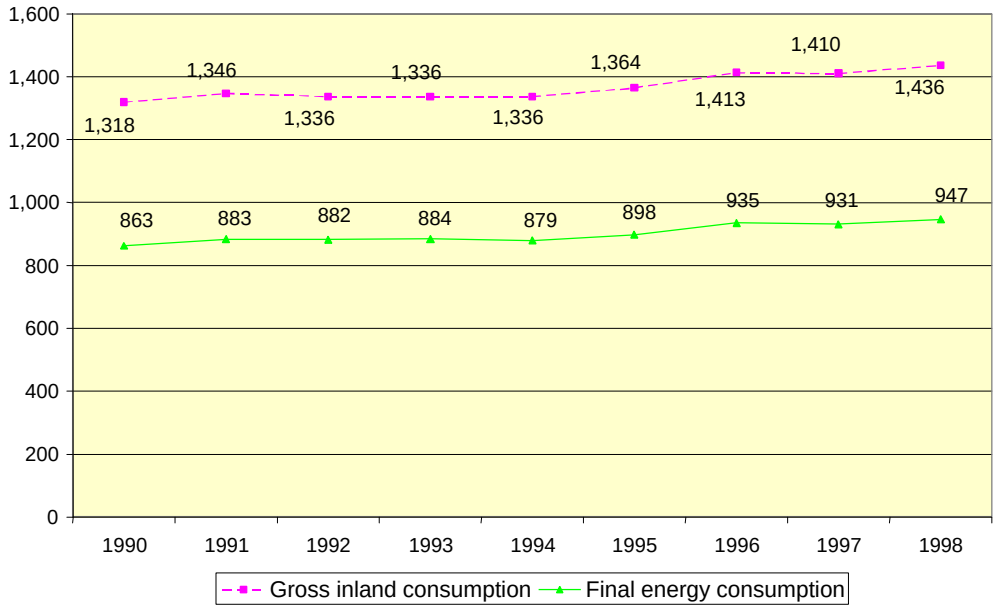
In addition to reporting on the situation at present and in the near future, the Green Paper takes a 30 year perspective on likely developments in the energy sector of the existing and expected future EU Member States (EU-30).

The total energy consumption in the EU is on a slowly growing trend, both in absolute terms and on a per capita basis as seen from Figures 2.6.1. and

15 COM(2000) 769 final

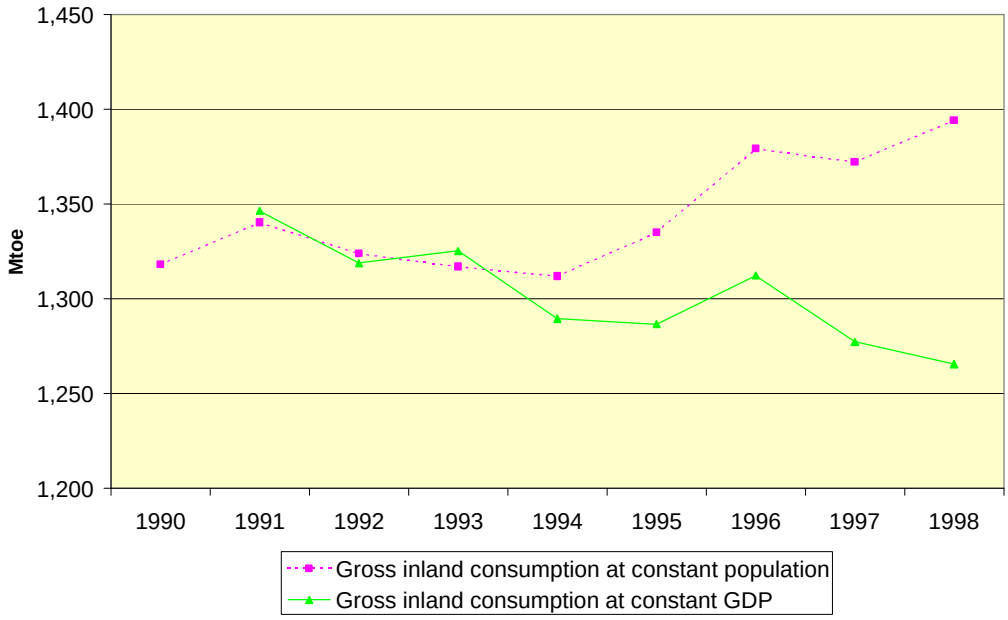
2.6.2. The 6% decline in energy consumption vs. GDP is less than in the 1980's but has to be seen against moderate economic growth and relatively low energy prices during most of the period.

Figure 2.6.1 Total energy consumption, primary and final (Mtoe)



Source: EUROSTAT

Figure 2.6.2 Energy consumption with population and GDP at 1990 levels



Source: EUROSTAT

2.6.1 Energy Supply

At the turn of the century the **energy supply profile** of the EU can be summarised by the following observations:

Solid fuels (coal and lignite) are on a declining curve from previously being the driver of industrialisation in Europe and from a short revival after the oil price shocks in the 1970s. Solid fuel accounts for a modest 16% of overall energy supply, much of it subsidised for social and employment objectives in the regions where it is produced. Concerning domestic production coal will be expected to continue its declining importance in the overall EU supply as subsidies will gradually be abandoned and CO_2 emission reduction will tighten. On the other side if technologies to sequester (capture and store) CO_2 became economically viable coal could again be considered as a source of energy.

From a security of supply point of view it is important to maintain a certain level of coal production in order to have continuos access to domestic fields and to keep sufficient operational knowledge in coal technology.

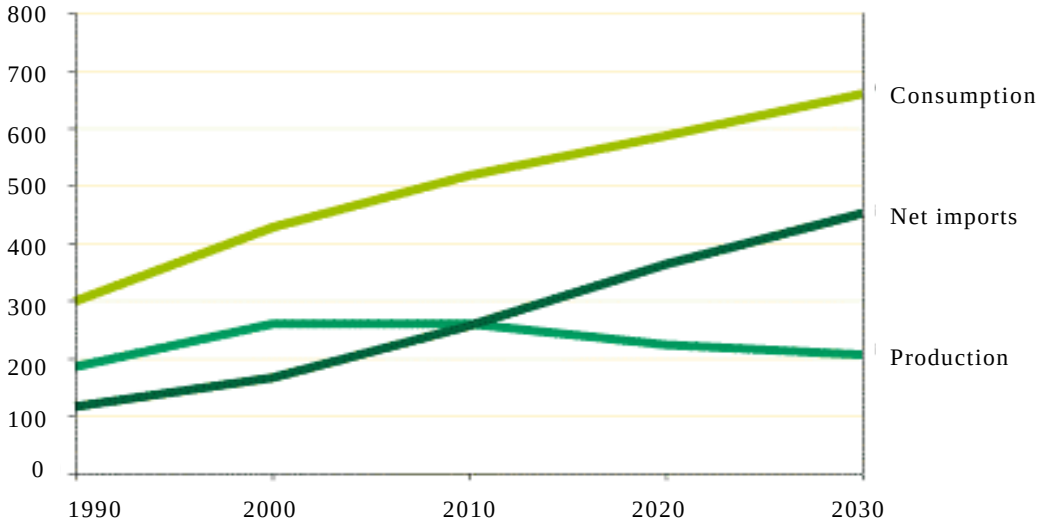
Oil is unchallenged as the major energy source in the EU covering around 40% of total energy supply and more than 60% in some Member States. The percentage has been relatively stable over the last decade, growing slightly in absolute terms.

The present trend reflects the combined effect of continued efforts to replace oil as a fuel in industry, electricity generation and domestic heating on the one side and a steady growth in the consumption of oil products in the transport sector on the other side. As options for substitution in non-transport sectors are gradually being fully explored the transport sector will increasingly determine the quantity of oil required, - the reason why the Green Paper expects a stronger growth of oil in the overall energy supply in the future than in the past, unless strong policy action is taken.

Fig. 2.6.3 shows that whereas EU-30[16] production during the 1990's increased from 30% to almost 50% of EU consumption, the degree of self sufficiency might fall well below 25% over the coming 30 years. In addition, the steadily increasing percentage of transport fuels to be produced from the crude oil leads to increasingly deep conversion of heavier oils into gasoline, diesel and jet fuel with sharply increasing CO_2 emissions per ton of transport fuel produced. In conclusion, - security of supply as well as environmental concerns call for strong policy action to curb the consumption of oil products in the transport sector.

16 EU-15, candidate countries, Switzerland and Norway

Figure 2.6.3 Oil in the EU-30 (in million toe)

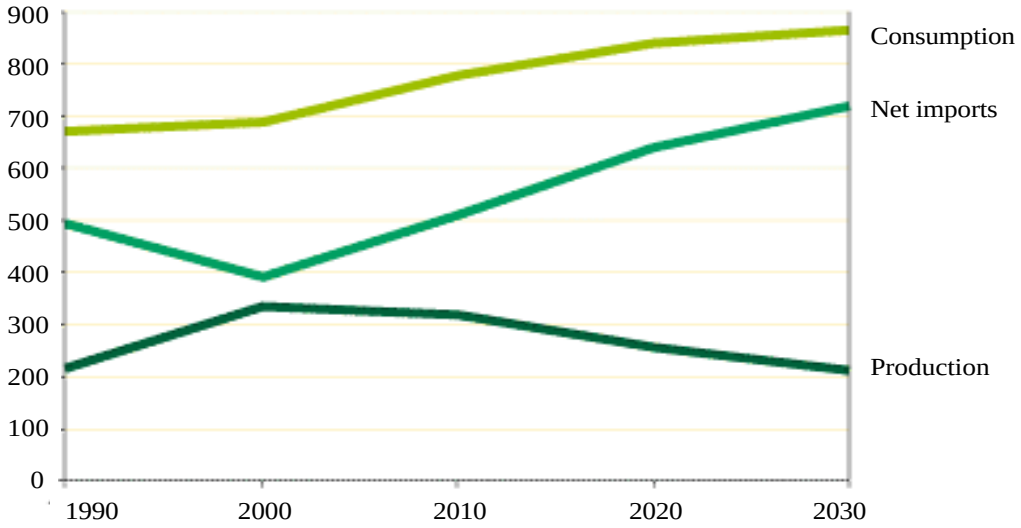


Natural gas has become number 2 after oil with 22% of the overall supply, almost 50% up since 1990. Generous gas field discoveries in the North Sea and willing sellers on the doorstep of the EU (Russia, Algeria, Norway) has made this development possible and forecasts show a continued, albeit not necessarily 50% growth per decade of natural gas in the overall energy supply.

Apart from cheap, imported coal, natural gas is a very competitive energy source, offering at the same time big environmental benefit : no sulphur or particulate emissions and CO_2 emission way below that of coal and significantly better than oil products.

EU gas production is expected to keep up better than oil production, see Fig. 2.6.4. However, due to the “physical” link (via gas pipelines) to very few external suppliers the security of supply aspect of increased natural gas dependency in the overall energy supply scheme has to be addressed as an issue of greatest importance.

Fig. 2.6.4 Natural gas in the EU-30 (in million toe)



Nuclear energy supplies 15% of the overall energy in the EU, roughly the same as solid fuels, and approximately one third of electricity generation. Nuclear energy increased strongly in the 1980s, still somewhat (20%) during the 1990s and is expected to continue at its present level for the next 10 years. After 2010 the share of nuclear in the overall supply pattern may decline if present closing-down plans will be continued without replacement. Any significant decline in production of nuclear energy offers a serious challenge to security of energy supply and future reductions in greenhouse gas emissions making necessary contributions from energy savings, energy efficiency improvements and renewables on a much larger scale than so far envisaged.

Renewables cover a modest 6% of overall EU energy supply, by far the most of this being biomass (2/3) and hydropower (1/3). Because of the highly uneven distribution of biomass and hydropower resources between Member States the relative contribution varies from less than 2% in the United Kingdom to more than 28% in Sweden.

Renewable energy is expected to show strong growth over the next decade towards an agreed EU target of 12% vs. the present 6%. Whereas biomass is seen as having a significant potential to cover part of the increase (and hydropower a little), wind energy is given high priority as a significant future energy resource. While still contributing less than 0.1% to overall EU energy supply, wind energy has doubled every 1.5 years for most of the 1990'es (20 times over 8 years) and the cost reduction following this expansion has brought wind energy into the range of competitive energy supply options under favourable (high) wind conditions.

Solar energy on the other hand seems to have bigger difficulties in taking off and still needs substantial financial incentives to penetrate the energy markets.

2.6.2 Liberalisation and privatisation of energy markets

Markets for electricity and gas are in the process of liberalisation in all EU Member States, as a result of the EU Electricity Directive and Gas Directive. In addition, electricity producers and gas suppliers are increasingly privatised. This process has been implemented over several years in the UK, while it was done as nearly one step in the case of electricity in Germany in 1998. These two countries are at the forefront of liberalisation, but the others follow suit, with further steps envisaged for the next decade. Table 2.6.1 and Table 2.6.2 illustrate the achieved and planned levels of electricity and gas market liberalisation.

Table 2.6.1 EU Electricity market opening

	2000	2003	later
Austria	32%	100% (2001)	100%
Belgium	35%	50%	100% (2007)
Denmark	90%	100%	100%
Finland	100%	100%	100%
France	30%	35%	n.a.
Germany	100%	100%	100%
Greece	30%	35%	n.a.
Ireland	30%	40%	100% (2005)
Italy	35%	70%	70.
Luxemb	40%	+ 56%	75% (2005)
NL	33%	100%	100%
Portugal	30%	35%	n.a.
Spain	54%	100%	100%
Sweden	100%	100%	100%
UK	100%	100%	100%
EU	**66%**	**75%**	**83%**

Source: European Commission (2001): Completing the internal energy market [17]

[17] European Commission (2001): Completing the internal energy market. Commission Staff Working Paper. SEC(2001) 438.

Table 2.6.2 EU Gas Market Opening

Country	2000 (%)	2008 (%)
Austria	49	100
Belgium	58.7	100
Denmark	30	43
France	20	33
Finland	90	90
Germany	100	100
Greece	0	33
Ireland	75	100
Italy	96	100
Luxembourg	51.1	83.4
Netherlands	45	100
Portugal	0	33
Spain	72	100
Sweden	47	100
United	100	100
EU-15		

Source: European Commission (2001): Completing the internal energy market

2.6.3 Energy consumption in different sectors

Whereas the overall energy consumption in the EU has shown a modest but steady growth over the last 10 years this covers very different developments in different sectors.

The transport sector has experienced a strong growth, largely in parallel with growth in GDP and little efficiency improvements. Without strong policy response this trend may well continue over the next decade.

Following the adoption of the EU sustainable development strategy in Göteborg, June 2001, the recent White Paper on the future EU Transport Policy and the completion of the first phase of the European Climate Change Programme (ECCP), a number of measures are in preparation in order to reduce the future energy consumption in the transport sector and the associated greenhouse gas emissions: modal shift, improved energy efficiency of vehicles, road pricing, biofuels and other alternative fuels. The recent merging of the previous energy and transport DG's into one Directorate General in the European Commission offers a particular opportunity to address the special challenge of energy policy from the transport sector.

The industrial sector is using a decreasing share of overall EU energy consumption, partly due to the relative decline in the importance of heavy industry, partly due to extensive energy efficiency improvement programmes in the industrial sector.

The domestic and tertiary sector shows growing energy consumption, particularly because of strong growth in the tertiary sector. On the other hand the specific energy consumption in the tertiary sector is normally much less than in the industrial sector. The potential for energy efficiency improvement in the domestic and tertiary sector is considered to be significant. This potential is the subject of a number of initiatives at EU level and is of big importance in the overall EU climate strategy.

2.6.4 Energy Prices

Electricity prices for industrial consumers have gone down in almost all Member States since the Electricity Directive was implemented. In general, the most significant price reductions can be found in the Member States that are fully liberalised.

The picture is less clear for gas. Markets were liberalised later and the gas price since liberalisation has been significantly influenced by the increase in the crude oil price since 1999 and the development in the Euro/US $ exchange rate.

2.7 TRANSPORT PROFILE

In the 1980s, the average annual growth of passenger transport (measured in passenger kilometres, pkm) in the EU exceeded both GDP growth and industrial production growth, while freight transport growth (measured in tonne kilometres, (tkm)) was roughly in line with them. From 1990 to 1997, the freight transport growth rate overtook the increasing rate of passenger transport as well as GDP growth and industrial production. In recent years, passenger transport is growing roughly in line with GDP and industrial production while freight transport exceeds them considerably. Table 2.7.1 illustrates this development:

Table 2.7.1 Transport growth in EU 15

% annual change	1980-1990	1990-1997	1998	1999
GDP	2.4	1.9	2.9	2.6
Industrial production	1.8	0.7	3.4	2.0
Passenger transport (5 modes)	3.1	2.0	2.1	2.0
Freight transport (5 modes)	1.9	2.7	3.5	3.0

Source: EUROSTAT, European Commission, DG Energy and Transport

2.7.1 Freight transport

Total freight transport in 1998 was 2870 Mtkm, equivalent to a 25 % increase from 1990 to 1998. By far the biggest sectors in freight transport are made up by road transport, accounting for 44 % in 1998 (compared to 41 % in 1990 and 33 % in 1980) and by intra-EU sea transport, accounting for 41% (remaining nearly constant compared to 1990 and 1980). In contrast, railway freight transport has declined from 15% in 1980 and 11% in 1990 to 8 % in 1998.

Table 2.7.2 Freight transport (in Mtkm) and relative shares of transport modes from 1980 to 1998

	Road	Rail	Inland Waterways	Pipelines	Sea (intra-EU)	Total
1980	628	287	107	92	779	1 893
1990	929	255	109	77	919	2 293
1995	1 145	221	114	85	1 070	2 635
1996	1 151	220	111	84	1 070	2 641
1997	1 202	237	115	86	1 124	2 770
1998	1 255	241	121	87	1 167	2 870
1990-1998	**+35%**	**-6%**	**+11%**	**+15%**	**+27%**	**+25%**

Source: EUROSTAT, ECMT, UIC, national statistics

Table 2.7.3 Relative share in goods transport by modes (%)

	Road	Rail	Inland Waterways	Pipelines	Sea (intra-EU)
1980	33	15	6	5	41
1990	41	11	5	3	41
1995	44	8	4	3	41
1996	44	8	4	3	41
1997	44	9	4	3	41
1998	44	8	4	3	41

Source: EUROSTAT, ECMT, UIC, national statistics

The average distance per tonne transported is 110 km on road, ca. 300 km on railways, 280 km on inland waterways, 170 km in pipelines and 1430 km on sea within the EU borders.

The sectors with the biggest shares of transported goods are agricultural products (29 %), manufactured goods and machinery (26 %) and cement/building materials (20 %)[18].

2.7.2 Passenger transport

On average, in the EU, there were 454 passenger cars per 1000 inhabitants in 1998 (EUROSTAT). In 1990, this figure was 394 and in 1980 it was 291. The range in ownership in 1998 was from 254 passenger cars in Greece to 590 in Luxembourg. Absolute car ownership has increased by ca. 15 % between 1990 and 1998.

Mileage has increased by 16 % from 1990 to 1998 and amounts to 4772 000 million passenger-kilometres (pkm) in 1998. Tourism and leisure traffic is an important driving force behind this development. For passenger cars, it has increased by 17 %,

18 European Commission DG Transport and Energy, 2001.

which is a rate similar to that of car ownership. In terms of modal split, the share of mileage with passenger cars has increased from 76% in 1980 and 79% in 1990 remaining at 79% in 1998[19].

Table 2.7.4 Performance in passenger transport by mode (in 1000 million pkm and %)

	Passenger cars	Buses & Coaches	Tram & Metro	Railway	Air	Total
1980	2 294 (76%)	364 (12%)	41 (1%)	253 (8%)	74 (2%)	3 026
1990	3 231 (79%)	395(10%)	49 (1%)	274 (7%)	157 (4%)	4 106
1995	3 577 (80%)	405 (9%)	47 (1%)	277 (6%)	202 (4%)	4 508
1996	3 640 (79%)	413 (9%)	48 (1%)	284 (6%)	209 (4%)	4 594
1997	3 706 (79%)	413 (9%)	49 (1%)	287 (6%)	222 (5%)	4 677
1998	3 776 (79%)	415 (9%)	50 (1%)	290 (6%)	241 (5%)	4 772
1990-98	**+17%**	**+5%**	**+3%**	**+6%**	**+53%**	**+16%**

Source: European Commission, DG Energy and Transport

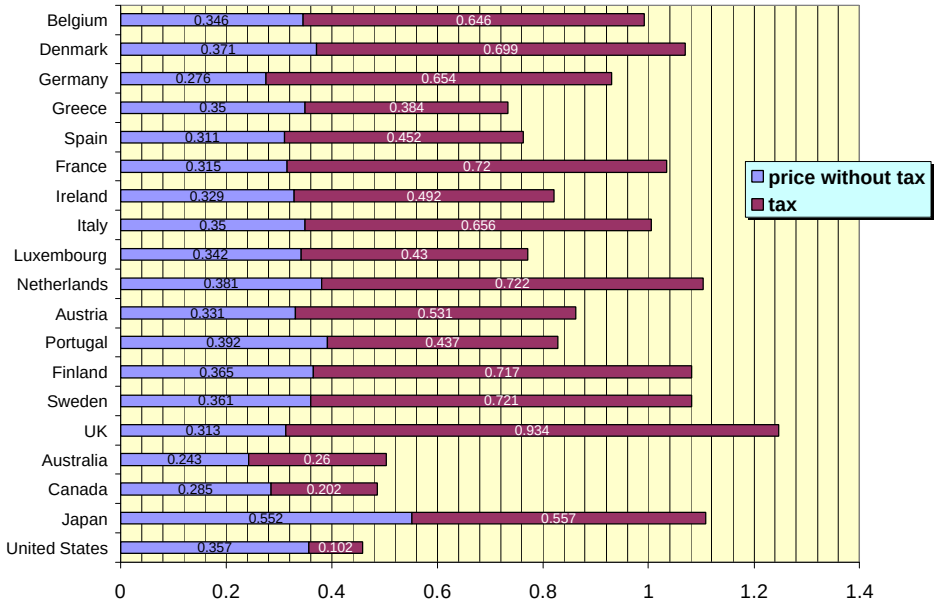
There are considerable differences between EU Member States: while the share of passenger km in passenger cars is 74% (of all land transport) in Greece, it amounts to 88% in the UK. Ownership of motorbikes and mopeds is particularly high in Greece (60 per 1000 inhabitants in 1998), and to a lesser extent in Italy (48 per 1000 inhabitants). Ownership is also relatively high in Germany (36), Spain (35), Portugal (30) and Austria (29). In terms of bus travel, the Mediterranean countries in general have a higher share, with Ireland, Denmark and Austria being "northern" exceptions. Comparing individual and public transport, Austria and Greece have the highest share of public transport use (26%), while the UK has the lowest (12%).

2.7.3 Taxes on and prices of transport fuels

Both fuel prices and fuel taxes differ from Member State to Member State. However, as an average it can be stated that they are lower than in Japan but by far higher than in the US, Canada and Australia.

19 EUROSTAT, national statistics

Figure 2.7.1 Price and tax for unleaded petrol in EU Member States and other OECD countries (in US-$ per litre, 2nd quarter 2000)



Source: IEA Energy Prices & Taxes Quarterly Statistics Second Quarter 2000

2.8 INDUSTRY PROFILE

There are several sub-sectors within manufacturing industry in the EU, which account for about 9 to 13 % of total output. These are electrical equipment, transport equipment, metals and metal products, chemicals, machinery and equipment, food, and paper/printing.

It can be seen from the following Table 2.8.1 that sectors with high energy intensity and/or high process emissions of greenhouse gases, such as the chemical industry, pulp and paper, "other" non-metallic mineral products (i.e., cement, lime etc.), and basic metals/fabricated metal products, have increased by 20-35% from 91-99. The chemicals, pulp and paper and building materials industries are furthermore expected to expand, which has implications for prospective greenhouse gas (GHG) emissions.

Table 2.8.1 Composition of the manufacturing industry based on value added

	1991	1991 in %	1995	1995 in %	1999	1999 in %	Change 91-99 in %
Manufacturing, total value added	*976.490*	*100,0*	*1.053.229*	*100,0*	*1.201.699*	*100,0*	*23,1*
Manufacture of food products and beverages	106.391	10,9	111.646	10,6	122.802	10,2	15,4
Manufacture of textiles and textile products	51.110	5,2	48.226	4,6	47.968	4,0	-6,1
Manufacture of leather and leather products	10.344	1,1	9.086	0,9	8.676	0,7	-16,1
Manufacture of wood and wood products	15.034	1,5	17.227	1,6	19.600	1,6	30,4
Manufacture of pulp, paper and paper products; publishing and printing	81.295	8,3	92.880	8,8	105.724	8,8	30,0
Manufacture of coke, refined petroleum products and nuclear fuel	15.169	1,6	:~c	:~c	23.740	2,0	56,5
Manufacture of chemicals, chemical products and man-made fibres	102.106	10,5	126.644	12,0	135.481	11,3	32,7
Manufacture of rubber and plastic products	42.441	4,3	48.639	4,6	57.963	4,8	36,6
Manufacture of other non-metallic mineral products	45.858	4,7	49.488	4,7	53.544	4,5	16,8
Manufacture of basic metals and fabricated metal products	115.754	11,9	130.024	12,3	140.662	11,7	21,5
Manufacture of machinery and equipment n.e.c.	109.015	11,2	115.882	11,0	132.654	11,0	21,7
Manufacture of electrical and optical equipment	:	:	131.641	12,5	155.070	12,9	17,8
Manufacture of transport equipment	113.958	11,7	117.427	11,1	151.737	12,6	33,2

Remark: Change 91-99 in % refers to change in absolute value added

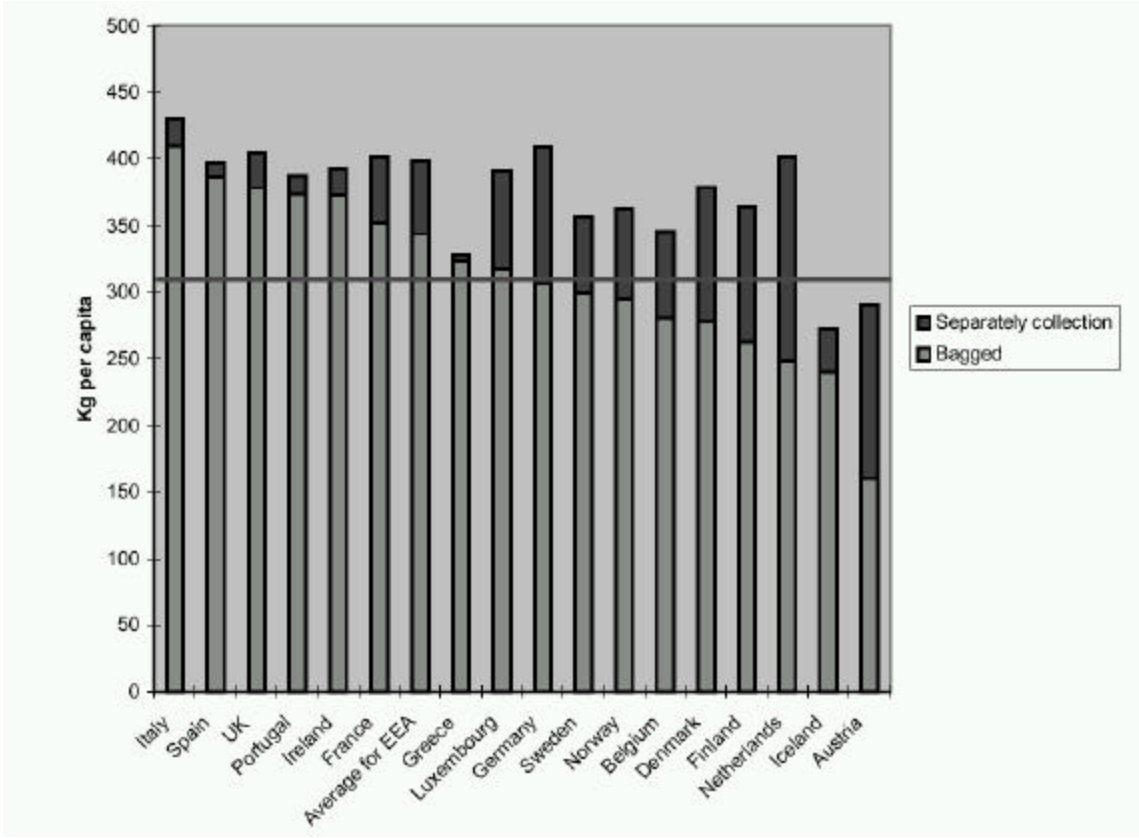
Source: EUROSTAT

2.9 WASTE PROFILE

In 1996, waste generation per capita from daily household and commercial activities was roughly 400 kg per year, i.e., slightly more than one kg per capita per day. It ranges from under 300 kg in Austria to approx. 430 kg in Italy.

Figure 2.9.1 gives an overview of waste generation in all European Environment Agency (EEA) countries, i.e., EU 15 plus Norway and Iceland.

Figure 2.9.1 Waste generation from daily household and commercial activities, 1996

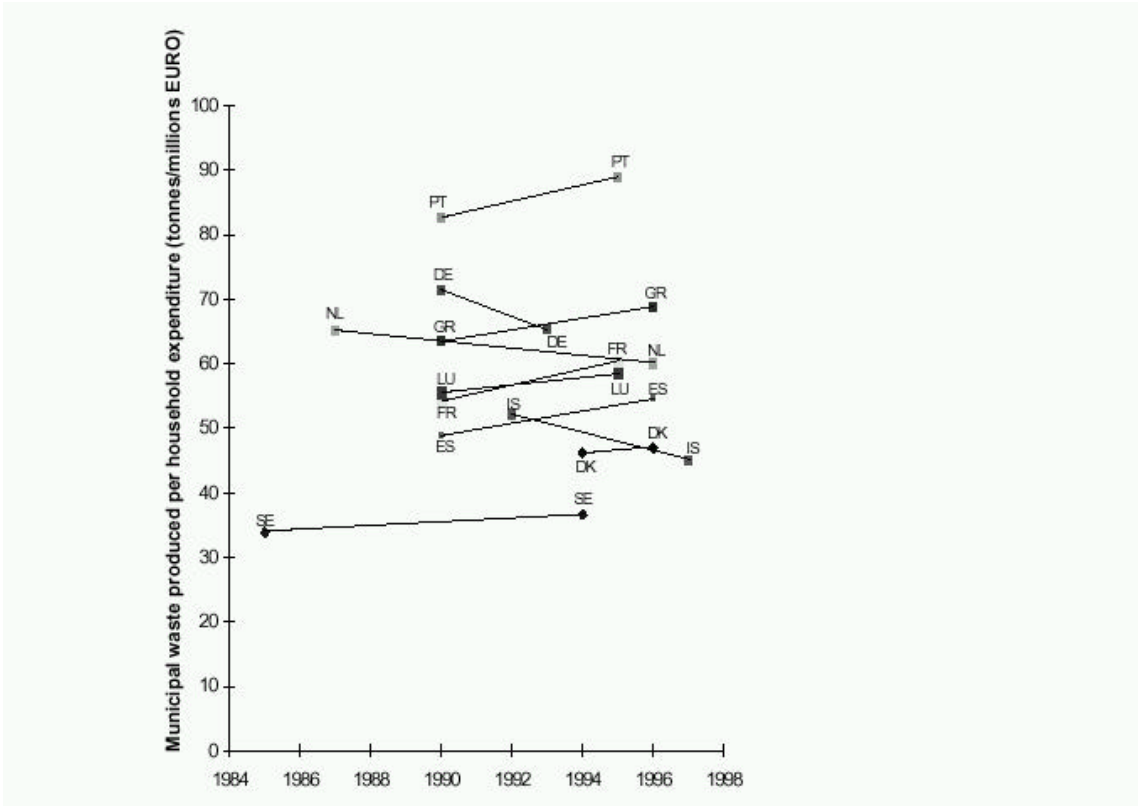


Source: EEA Waste Annual topic update 1999

Of this, packaging waste was on average 136 kg per head, of which 63 kg are paper and cardboard, 35 kg glass, plastics 29 kg and metals 9 kg.

Figure 2.9.2 illustrates the relation between waste generation and household income for several EU Member States and Iceland mainly between 1990 and 1996/97. It shows that Germany and the Netherlands appear to see successful de-coupling of municipal waste generation from economic activity over time, while in others the trend still has to be reversed.

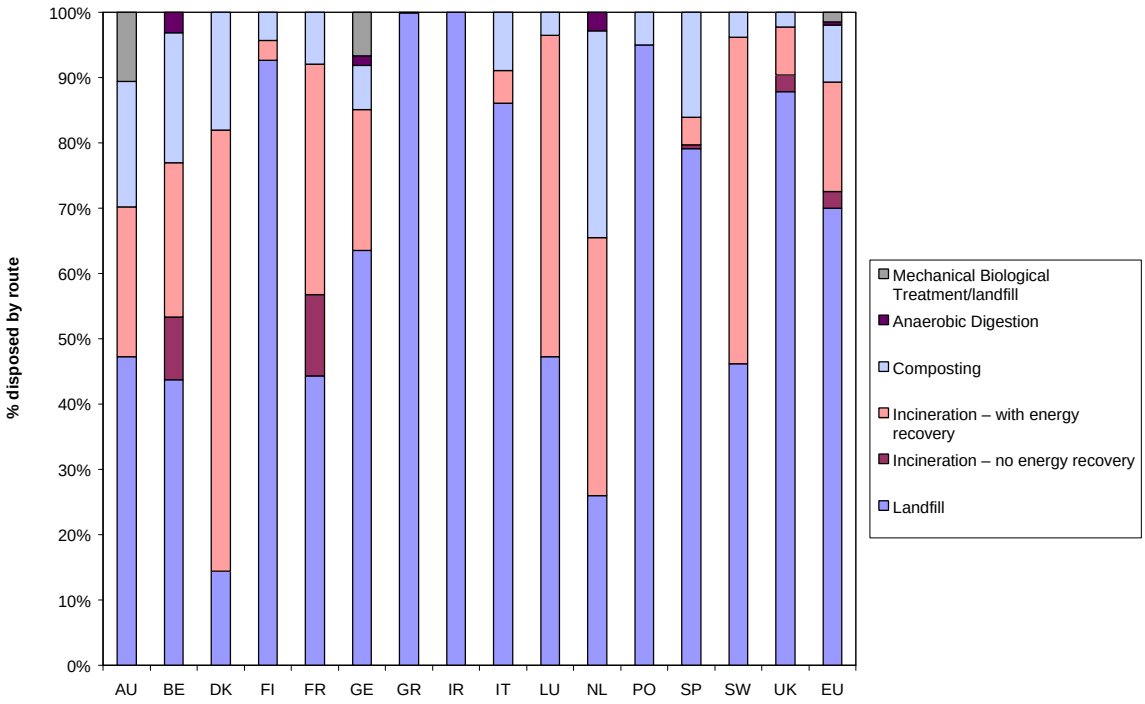
Figure 2.9.2 Development of municipal waste in comparison to household expenditures



Source: EEA Waste Annual topic update 1999

Table 2.9.1 below, gives an overview on types of waste arising, on recycling proportions and on disposal patterns in the Member States. Figure 2.9.3 illustrates the disposal patterns.

Figure 2.9.3 Disposal routes for waste arisings in Member States



Source: EEA Waste Annual topic update 1999

Table 2.9.1 Waste arisings and treatment routes in the EU Member States

		AU	BE	DK	FI	FR	GE	GR	IR	IT	LU	NL	PO	SP	SW	UK	EU
Arising	kt/y	4 110	4 852	2 951	2 100	28 800	36 976	3 900	2 032	26 605	193	8 716	3800	15 307	3 200	29 000	172 542
Composition																	
Paper	%	27 (97*)	16 (18)	20 (34)	26 (60)	25 (43)	41 (58)	20 (26)	33 (13)	22 (42)	19 (43)	27 (52)	23 (37)	21 (56)	44 (82)	32 (37)	29 (47)
Food /garden	%	27 (n.a.)	37 (n.a.)	47 (n.a.)	32 (n.a.)	29 (n.a.)	23 (n.a.)	47 (n.a.)	29 (n.a.)	43 (n.a.)	44 (n.a.)	39 (n.a.)	35 (n.a.)	44 (n.a.)	30 (n.a.)	21 (n.a.)	31 (n.a.)
Plastics	%	18 (8.9)	7 (8.6)	5 (2.3)	5 (0.8)	11 (1.5)	3 (55)	9 (0)	9 (1.2)	7 (3.7)	8 (8.6)	5 (3)	12 (0.4)	11.6 (1.1)	7 (2.5)	11 (0.5)	8 (7.8)
Glass	%	8 (88)	7 (75)	4 (70)	6 (62)	13 (52)	22 (79)	5 (26)	6 (38)	6 (34)	7 (52)	6 (82)	5 (44)	7 (37)	8 (76)	9 (26)	11 (52)
Metal	%	7	4	2	3	4	8	5	3	3	3	2	3	4	2	8	5
Ferrous	*%*	*5.25 (60)*	*3 (56)*	*1.5 (60)*	*2.25 (12.8)*	*3 (38)*	*6 (64)*	*3.75 (n.a.)*	*2.25 (n.a.)*	*2.25 (8)*	*2.25 (55)*	*1.5 (62.4)*	*2.25 (12)*	*3 (18.56)*	*1.5 (49.6)*	*6 (24)*	*4*
Non-ferrous	*%*	*1.75 (n.a..)*	*1 (n.a..)*	*0.5 (n.a.)*	*0.75 (n.a.)*	*1 (n.a.)*	*2 (n.a.)*	*1.25 (n.a.)*	*0.75 (n.a.)*	*0.75 (n.a.)*	*0.75 (n.a.)*	*0.5 (n.a.)*	*0.75 (n.a.)*	*1 (Alu: 19)*	*0.5 (Alu: 33)*	*2 (n.a.)*	*1 (Alu: 16)*
Textiles / other	%	13 (n.a.)	29 (n.a.)	24 (n.a.)	30 (n.a.)	18 (n.a.)	3 (n.a.)	16 (n.a.)	20 (n.a.)	19 (n.a.)	20 (n.a.)	20 (n.a.)	23 (n.a.)	12.4 (n.a.)	9 (n.a.)	19 (n.a.)	15 (n.a.)
Textiles	*%*	*1.37*	*3.05*	*2.53*	*3.16*	*1.89*	*0.32*	*1.68*	*2.11*	*2.00*	*2.11*	*2.11*	*2.42*	*4.80*	*0.95*	*2*	*2 (5)*
Other	*%*	*11.63*	*25.95*	*21.47*	*26.84*	*16.11*	*2.68*	*14.32*	*17.89*	*17.00*	*17.89*	*17.89*	*20.58*	*7.60*	*8.05*	*17.00*	*13.18*
Treatment		**AU**	**BE**	**DK**	**FI**	**FR**	**GE**	**GR**	**IR**	**IT**	**LU**	**NL**	**PO**	**SP**	**SW**	**UK**	**EU**
Landfill	kt/y	887	939	343	1500	9 593	18 978	3 561	1 432	24 000	94	1 768	3 610	11 758	1 200	24 000	103 663
Incineration – no energy recovery	kt/y		207	0	0	2 702	0	0	0	0	0	0	0	78	0	700	3 687
Incineration –with energy recovery	kt/y	431	508	1 602	50	7 650	6 429	0	0	1 400	98	2 693	0	627	1 300	2 000	24 788
Composting	kt/y	360	428	428	70	1 716	2 013	3		2 501	7	2 150	190	2 394	100	628	12 988
AD	kt/y		67				450					197				2	716
MBT/landfill	kt/y	200					2 000										2 200
MBT/incineration	kt/y																0

Source: Data from OECD Environmental Data 1999, Chapter 7, Waste, except where otherwise indicated. Figures in brackets in the composition section resemble the proportion recycled. OECD data shows the total amount of waste incinerated together with the proportion going to incinerators either with or without energy recovery. This breakdown is missing in the case of Germany, Italy, Netherlands and Sweden. We have therefore assumed that for these countries all of the incinerated waste goes to plant with energy recovery. UK waste arising data comes from UK Department of the Environment Transport and the Regions, 1999, "A Way with Waste".

2.10 BUILDING STOCK AND URBAN STRUCTURE

For the whole EU, statistics note 124 738 000 households[20], which means an average household size of 2.46 persons.

Table 2.10.1 shows that household sizes vary significantly between Member States: While in Germany, Austria and the Scandinavian States, single households make up the biggest share, in Spain 4 persons and in Ireland 5 persons or more are the biggest fraction. During the nineties, a general tendency to smaller household sizes was seen for all Member States.

Table 2.10.1: Household size in percentages 1995-1996

	1 person	2 person	3 person	5 persons or more
B	28.4	29.6	18.6	8.2
DK	35.6	33.1	14.0	5.0
D	34.9	32.1	15.8	4.7
EL	19.0	29.0	20.0	10.0
E	11.0	23.0	23.0	18.0
F	26.8	31.5	17.0	9.3
IRL	18.8	21.0	15.4	28.0
L	25.5	28.3	19.7	9.3
NL	27.7	34.9	14.3	7.2
A	29.1	27.6	18.0	10.2
P	14.4	27.4	23.6	13.5
FIN	35.2	29.9	14.9	7.3
S	36.2	36.1	11.0	5.7
UK	28.0	33.9	16.0	7.3
EU-15	**28.0**	**31.2**	**17.0**	**8.3**

Source: Eurostat, Energy Consumption in Households

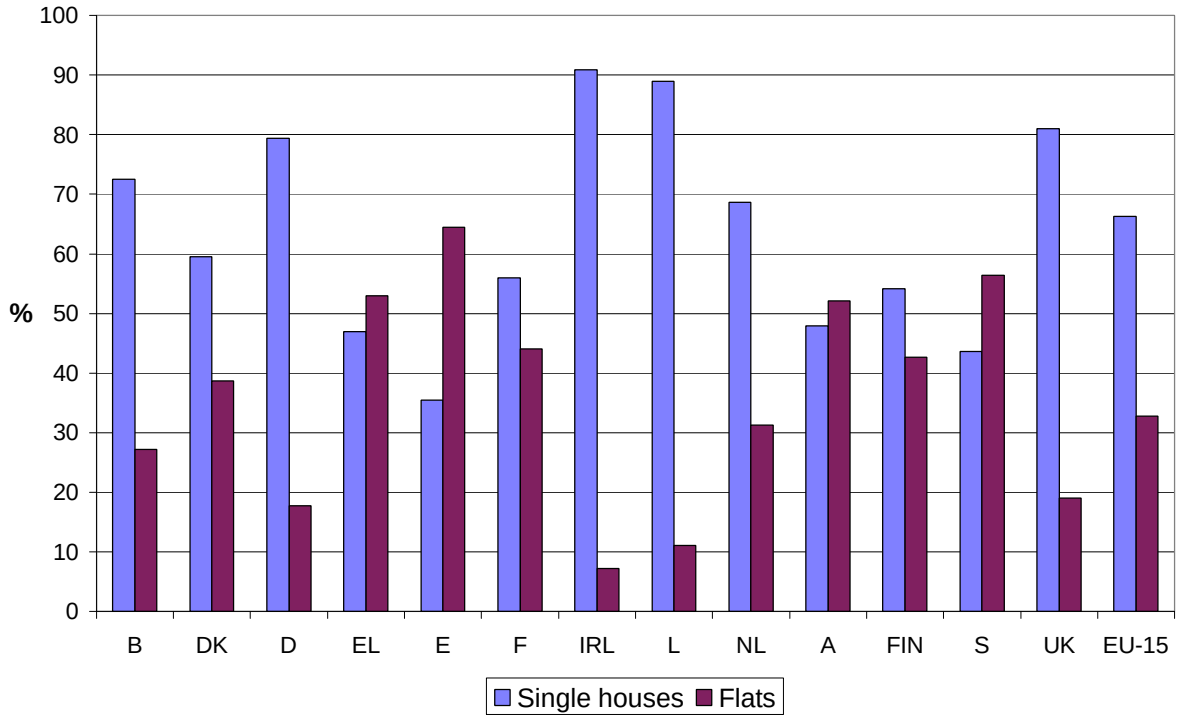
The number of dwellings exceeds the household number by 7.7%, due to secondary dwellings and other dwellings such as hotels etc.

Average floor area per household ranges from 78 m^2 in Germany and Finland to 107.6 m^2 in Denmark. In the other countries, the average floor areas are between 80 and 100 m^2.

In general, single houses need more energy per m^2 for heating than houses with flats. On EU average, 2 thirds of all dwellings are in single houses and one third in flats. Countries with high shares of single houses are the UK, Ireland, Germany and the Benelux States. Spain, Sweden, Greece and Austria, on the other hand, show even a dominance of flat households. This is shown in Figure 2.10.1.

[20] excluding Italy, for which no data were contained in draft household survey by Eurostat.

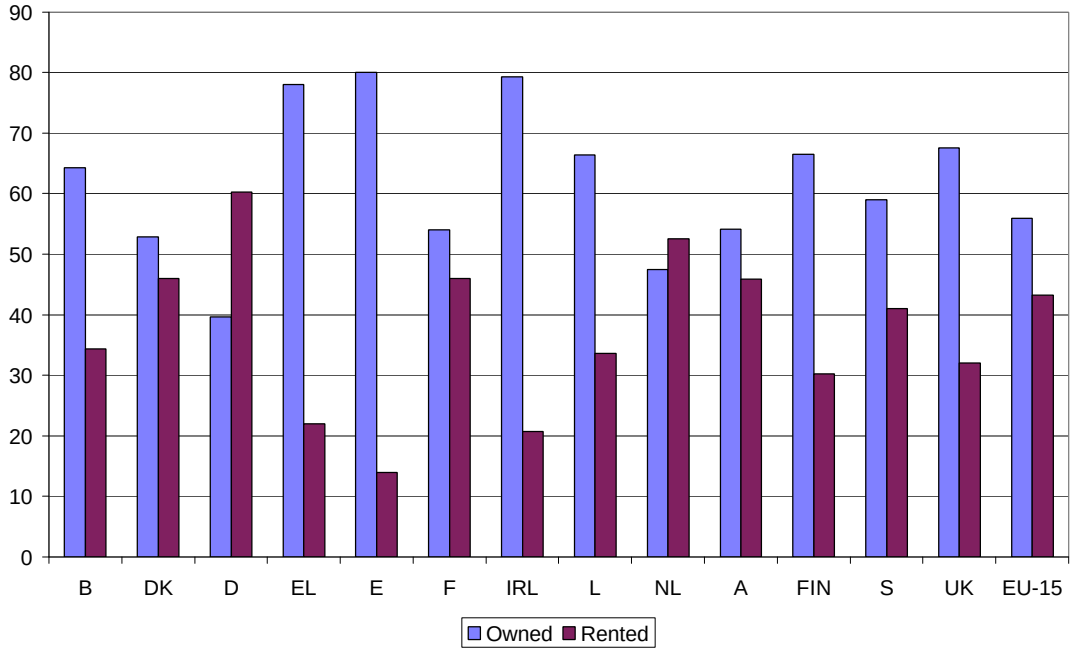
Figure 2.10.1: Dwellings - Housing type 1995-1996



Source: Eurostat, Energy Consumption in Households

In all Member States except for Germany and the Netherlands, the majority of dwellings is owned by the households. Owner occupancy is on average over the EU 56 %. In general is can be stated that in rented dwellings the application of energy saving policies faces potential obstacles due to the two different target groups, the landlords and the households, whose interests are not necessarily the same.

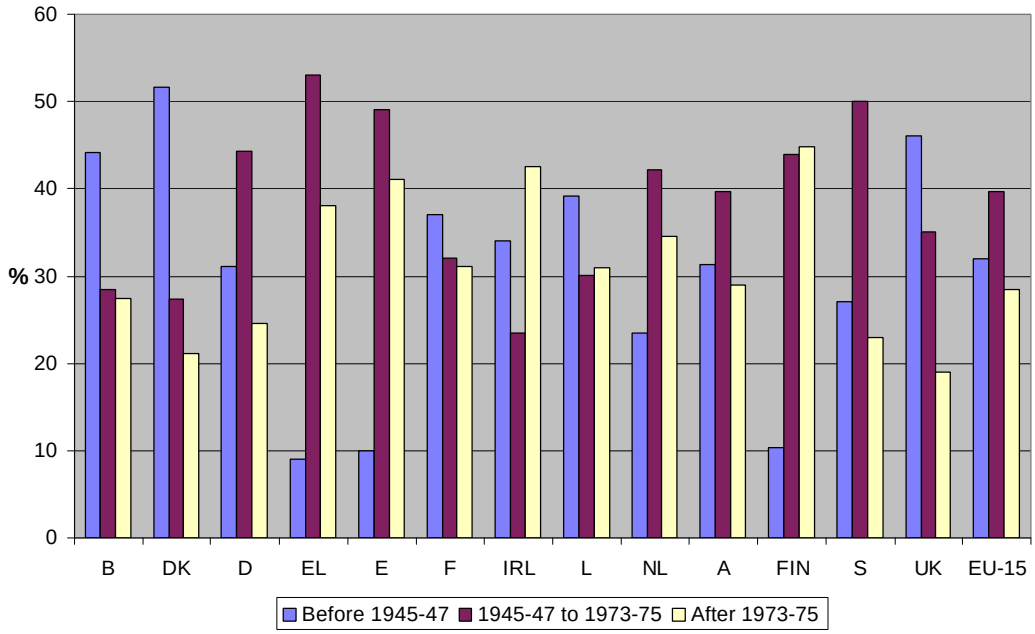
Figure 2.10.2: Tenure of Dwellings 1995-1996



Source: Eurostat, Energy Consumption in Households

39.6 % of all dwellings in the EU are in buildings constructed after World War II and before 1973/77. 31.9 % have been built before this and 28.4 % were built after 1973-75. The highest share of dwellings in old houses is found in Denmark (51.7%), UK (46.0 %), Belgium, Luxembourg and France; the highest share in new buildings is in Finland, Ireland and Spain (all over 40%).

Figure 2.10.3: Age of Buildings 1995-1996



Source: Eurostat, Energy Consumption in Households

In the majority of dwellings in the EU, there is at least loft/roof insulation and double-glazing. Several also have cavity wall and/or floor insulation. Sweden and Finland even show a 100% insulation rate.

Table 2.10.2: Insulation rates 1995-1996

	No insulation	Loft/roof insulation	Cavity wall insulation	Floor insulation	Double glazing
B	21,0	43,0	42,0	12,0	62,0
DK	1,0	75,5	64,5	62,6	90,8
D		42,0	24,0	15,0	88,0
EL	77,0	16,0	12,0	6,0	8,0
F	21,0	71,0	68,0	24,0	52,0
IRL	13,0	72,0	42,0	22,0	33,0
L	55,0	35,0	2,0	5,0	20,0
NL	14,0	53,0	47,0	27,0	78,0
A	39,0	37,0	26,0	11,0	53,0
FIN		100,0	100,0	100,0	100,0
S		100,0	100,0	100,0	100,0
UK	14,9	90,2	24,7	4,1	61,3

Source: Eurostat, Energy Consumption in Households

Private households in the EU have a relatively high availability of electrical appliances, as Table 2.10.3 illustrates:

Table 2.10.3: Availability of electrical appliances 1995-1996
Percentage of households

	Refrigerator (R)	Deep freeze (D)	Combined R+D	Washing Machine	Tumble drier	Dish washer	Tele-vison
B	67.0	67.0	40.0	92.0	55.0	36.0	126.0*
DK	41.4	44.0	38.0	69.3	27.0	32.7	90.5
D	82.0	56.1	27.0	90.5	25.7	36.4	97.0
EL	74.0	7.0	29.0	78.0	4.0	22.0	96.0
E	99.0	25.0		97.0		20.0	99.0
F	98.8	49.1		89.4	20.5	35.4	95.0
IRL	50.9	22.5	49.4	85.6	26.3	18.7	97.9
L	97.0	68.0	68.0	91.0			95.0
NL	63.1	31.7	45.6	97.3	47.9	19.0	98.2
A	98.0	66.0	38.0	83.0	12.0	40.0	99.0
P	83.9	47.0	9.4	74.6	5.4	12.1	93.8
FIN	97.0	83.0		83.0	9.0	41.0	96.0
S	95.6	61.6		48.7	15.4	30.6	92.7
UK	44.0	39.0	59.0	76.0	50.0	19.0	98.0

Source: Eurostat, Energy Consumption in Households

Note: * For Belgium the stated number of televisions is higher than the number of households because some of the households have 2 or more.

Direct energy consumption per household is 80 000 MJ on EU average. This is split up into 68.5% for space heating, 15.3% water heating, 5.3% cooking and 11 % for other purposes. Table 2.10.4 illustrates this.

Table 2.10.4: Energy consumption per household 1995-1996 in MJ

B	72.100	10.604	4.195	4.880	91.778
DK	55.341	13.291	5.387	7.347	81.366
D	56.177	9.482	1.395	6.614	73.669
EL	43.909	1.423	2.652	7.677	55.662
E	15.281	6.797	3.765	8.253	34.095
F	57.734	7.889	4.719	6.921	77.263
IRL	61.054	9.567	22.171	8.656	101.448
L	122.710	12.150	3.440	29.560	167.860
NL	45.579	13.700	2.297	8.482	70.058
A	67.745	9.486	2.251	7.579	87.061
P	10.202	5.933	11.357	8.047	35.539
FIN	58.726	12.496	1.799	13.888	86.910
S	53.891	17.185	2.000	12.640	85.717
UK	39.972	17.811	5.493	9.090	72.366
EU-15 average	48 359	10 618	3 759	7 801	70 536

Source: Eurostat, Energy Consumption in Households

2.11 AGRICULTURE

Agricultural land use area is continuously decreasing in the EU. Reasons for this development are the increasing use of land for settlement and/or leisure areas. In terms of the composition of agricultural areas there are considerable differences between the Member States. In Finland, Denmark and Sweden, the majority of agricultural land is used for crop farming/tillage. In Ireland, on the other hand, nearly 80 % is used for pasture or as fields. Permanent cultures (e.g. vineyards) cover considerable areas especially in the Mediterranean countries Greece, Spain, Italy, Portugal, and France[21].

The composition of livestock is expected to shift from cattle to pigs and poultry[13]. The use of fertilisers is on a declining trend.

2.12 FOREST

Since 1950, forest area has increased particularly in Ireland (more than six-fold), UK (two-fold), Italy (approx. 75 %) and Greece (approx. 60 %). In the other countries,

21 Landesstelle für landwirtschaftliche Marktkunde (LLM) Schwaebisch Gmuend) (2001): Loseblattsammlung Marktwirtschaftliche Erzeugerberatung; Flächennutzung. Internet pages http://www.landwirtschaft-mlr.baden-wuerttemberg.de/la/lel/llm/meb/Kap311.htm

the forest area has risen slightly or remained constant. Forest area has not declined in any of the Member States[22].

Wood growth in forests is quantified by the Net Annual Increment. Annual Fellings (of which ca. 90 % are Annual Removals) give an idea on the amount of wood that is cut per year. At the global level the sustainability of the exploitation of wood resources can be shown by the ratio of Fellings to Increment (average values over at least five years should be used). Values below 100 % thereby mean sustainability in wood production. The average for EU-15 is about 65 %. No Member State exceeds 90 % and for 11 states it is below 70 %. Based on this indicator, EU-15 forests are managed in a sustainable way[22] [Zanatta et al.2000]. In quantitative figures for the EU as a total, in the nineties the ACTUAL Net Annual Wood Increment (i.e., subtracting removals from forest) was 191 million m^3, which resulted from a Net Annual Increment of 487 million m^3 and removals of 298 million m^3. ACTUAL Net Carbon Increment (subtracting removals) was 63.21 million tons per year, or 0.46 tons per hectare per year, which resulted from Net annual Increment of 164.15 million tons and harvest of 103.47 million tons. [FAO Forest Resource Assessment 2000].

Those removals that are used for sawn woods and wood-based panels have a high proportion being used in permanent constructions, which means that the carbon stored in the wood is bound in these materials over a long period. Other materials produced from wood, like fuel wood and paper, keep the carbon stored for a shorter time period.

However, comparing the total removals with the annual emissions of EU Member States, the amount of CO_2 that is rebound by the forests by increments of wood is less than 50 % of total emissions in most Member States, 12 % on average in EU 15 [Zanatta et al. 2000]. Forestry can be an important sector that contributes to mitigate climate change but measures in other sectors responsible for greenhouse gas emissions are fundamental in the combat against climate change.

However, latest research results based on inverse model calculations of the atmospheric transport, eddy flux measurements and ecosystem inventories for Europe reveal a carbon sink between 200 and 300 million tons (report EUR 19883). The report also concluded that there is a considerable potential for protecting and enhancing the current European carbon sink. It is estimated that by improved management methods in addition up to 200-300 million tons could be achieved.

[22] Zanatta, Yves; Mikkola, Eero; Engels, Markus (2000): Forest and environment. In: Statistics in focus, Theme 5 – 07/2000. Luxembourg, European Communities.

3 GREENHOUSE GAS INVENTORY INFORMATION

3.1 INTRODUCTION

This chapter presents greenhouse gas emission trends of the European Community (EC) as a whole (EU15) for 1990-1999. The legal basis of the compilation of the EC inventory and the inventory methodology and data availability are also described briefly.

The greenhouse gas data presented in this chapter is consistent with the 2001 Submission of the EC to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat (see EEA, 2001. *Annual European Community Greenhouse Gas Inventory 1990-1999.* Technical report No. 60). The EC inventory has been compiled on basis of data delivered by the Member States by 1 April 2001 under Council Decision 99/296/EC. The annex of the EC Third National Communication includes the Summary Reports 1.A of the European Community for 1990-1999. This data and also the complete submissions of the Member States under Council Decision 99/296/EC are available on the EEA website (http://reports.eea.eu.int/Technical_report_No_60/en). Information in section 3.4 (greenhouse gas emission trends) is in addition based on and consistent with the EEA report 'EC and Member States Greenhouse Gas Emission Trends 1990-1999' (EEA, 2001).

3.2 THE EC MONITORING MECHANISM

The legal basis of the compilation of the EC inventory is Council Decision 99/296/EC amending Council Decision 93/389/EEC for a *Monitoring Mechanism of Community CO_2 and other Greenhouse Gas Emissions*[23]. The purpose of this decision is to monitor all anthropogenic greenhouse gas emissions not controlled by the Montreal Protocol in the EC Member States and to evaluate progress towards meeting greenhouse gas reduction commitments under the UNFCCC and the Kyoto Protocol (KP).

Under the provisions of Art 3.2 of Council Decision 99/296/EC, the Member States shall report to the European Commission each year, not later than 31 December:

- their anthropogenic CO_2 emissions by sources and removal by sinks for the previous calendar year;
- final national inventory data on emissions by sources and removals by sinks for the other greenhouse gases for the previous year but one and provisional emission data (inventories) for the previous year.

Other greenhouse gases include the five other Kyoto Protocol greenhouse gases: methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). In addition, annual information on emissions of the following gases shall be provided: carbon monoxide (CO), nitrogen oxides

23 OJ L 117, 5.5.1999, p. 35

(NO_x), non methane volatile organic compounds (NMVOCs) and sulphur oxides, in line with the reporting requirements under the UNFCCC.

The reporting requirements for the Member States under Council Decision 99/296/EC are elaborated in additional Guidelines under this Decision, in particular "Part 1: Guidelines for Member States and EC annual inventories". According to the Decision and these additional Guidelines the reporting requirements are exactly the same as for the UNFCCC, regarding content and format. The Member States therefore use the *UNFCCC guidelines on reporting and review* (document FCCC/CP/1999/7), which contain many elements, including the new Common Reporting Format (CRF) and a "National Inventory Report" that contains background information.

In addition, the Member States use the report "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories" (IPCC, 2000), which is consistent with the Intergovernmental Panel on Climate Change (IPCC) (1996) Guidelines. The use of this report by countries is expected to lead to more reliable estimates of the magnitude of absolute and trend uncertainties in reported greenhouse gas inventories.

Based on the data provided by the Member States, the European Commission establishes the Community greenhouse gas inventory and circulates this to all Member States by 1 March each year. This procedure aims at achieving the best available Member States' data on greenhouse gas emissions and removals for the compilation of the final annual EC greenhouse gas inventory (due 15 April each year). In exceptional cases, Member States have the possibility to provide updated information to the European Commission until 1 April each year. This final inventory is required for two purposes:

1. **The annual greenhouse gas inventory submission to UNFCCC:** The European Community, as the only regional economic integration organisation to have joined the UNFCCC as a Party, has to report annually on greenhouse gas inventories within the area covered by its Member States. The EC greenhouse gas inventory including data of the EC as a whole (EU15) and of the individual Member States has to be submitted by the European Commission to the UNFCCC by 15 April each year, i.e. 1½ month after the circulation under the Monitoring Mechanism.

2. **The progress evaluation report under Decision 99/296/EC:** Under the Monitoring Mechanism, the European Commission has to assess annually, whether the actual and projected progress of Member States is sufficient to ensure fulfilment of the EC's commitments under the UNFCCC and the Kyoto Protocol. For this purpose, the European Commission has to prepare a progress evaluation report, which has to be forwarded to the European Parliament and the Council by October each year. The annual EC inventory is an important element for the evaluation of actual progress.

The European Environment Agency (EEA) assists the European Commission in the compilation of the annual EC inventory for both purposes, through the work of the European Topic Centre on Air and Climate Change (ETC/ACC). The activities of the EEA result in:

- Draft EC inventory by 1 March
- Final EC inventory by 15 April (to be submitted by the European Commission to the UNFCCC Secretariat)

The annual process of reporting, review and compilation of the EC inventory is summarised in Table 3.2.1.

Table 3.2.1 Annual process of submission and review of Member States inventories and compilation of the EC inventory [1)]

Element	Who	When	What
1. Submission of annual inventory by Member States	Member States	31 December annually	Anthropogenic CO_2 emissions and CO_2 removals by sinks, for the year n-1 Emissions by source and removals by sinks of the other greenhouse gases; Final data for the year n-2 and provisional data for the year n-1 [2)]
2. Initial check of Member States (MS) submissions	European Commission (incl. Eurostat), assisted by EEA	up to 1 March	Initial checks (by EEA) Comparison of energy data in MS IPCC Reference Approach with Eurostat energy data (by Eurostat and MS)
3. Compilation and circulation of draft EC inventory	European Commission (incl. Eurostat), assisted by EEA	1 March	Draft EC inventory (by EEA), based on MS inventories and additional information where needed Circulation of the draft EC inventory on 1 March
4. Submission of updated or additional data by Member States	Member States	up to 1 April	Updated or additional data submitted by MS [3)]
5. Final annual EC inventory	European Commission (incl. Eurostat), assisted by EEA	15 April	Submission to UNFCCC of the final annual EC inventory. This inventory will also be used to evaluate progress as part of the Monitoring Mechanism
6. Additional review of Member States submissions and EC inventory	European Commission (incl. Eurostat), assisted by EEA	June to December	Additional review aimed at improving the next annual MS and EC inventories In November Eurostat makes available to MS energy balance data (1990 to inventory year)

1) In accordance with Council Decision 1999/296/EC
2) In accordance with Art. 3(1) and 3(2) of Council Decision 1999/296/EC
3) Preferably updating is limited to the following situations: to remove major inconsistencies, to fill major gaps or to provide essential additional information. Documentation should be included describing which data is updated or is additional, compared to the submission of 31 December.

Source: EC Submission to the UNFCCC (2001)

The European Commission is currently considering a review of the Monitoring Mechanism which will need to include provisions for extended reporting requirements under the Kyoto Protocol and a forthcoming EU Emissions Trading scheme as well as enhanced provisions on the reporting of national policies and measures.

3.3 THE EC INVENTORY METHODOLOGY AND DATA

3.3.1 Methodology

The EC greenhouse gas inventory is compiled according to the Council Decision Guidelines and, in addition, in accordance with the recommendations for inventories set out in the UNFCCC *Guidelines for the Preparation of National Communications by Parties included in Annex 1 to the Convention, Part 1: UNFCCC Reporting Guidelines on Annual Inventories*. They are part of a comprehensive document *UNFCCC Guidelines on Reporting and Review* (document FCCC/CP/1999/7), adopted as Decision 3/CP.5. In addition, the *IPCC 1996 Guidelines for National Greenhouse Gas Inventories* have been applied.

The EC greenhouse gas inventory is compiled on basis of the inventories of the 15 EC Member States. Therefore, the quality of the EC inventory depends on the timeliness and the quality of the Member States submissions.

Table 3.3.1 summarises time series and reporting formats available from Member States by 1 April 2001.

Table 3.3.1 Time series and reporting formats available from Member States by 1 April 2001

Member State	Years available	Reporting format	Tables[1)]
Austria	1990-1999	CRF	All
Belgium	1990-1998	CRF	Sectoral Report Tables and Summary Tables for 1998 only
Denmark	1990-1999	CRF	All
Finland	1990-1999	CRF	All
France	1990-1999	CRF	All
Germany	1990-1999	CRF	Summary Tables only
Greece	1990-1999	CRF	Sectoral Report Tables, Summary Tables
Ireland	1990-1999	CRF	Almost all CRF Tables for 1999 only; no F-Gases
Italy	1990-1999	CRF	All CRF Tables for 1998 and 1999
Luxembourg	1990; 1994-1998	IPCC 1996 Guidelines	Summary Tables 7A
Netherlands	1990-1999	CRF	All
Portugal	1990-1999	CRF	All
Spain	1990-1999	CRF	Sectoral Report Tables, Summary Tables
Sweden	1990-1999	CRF	All
United Kingdom	1990-1999	CRF	All

1) All = all or almost all (more than approx. 90 %) of the CRF Tables

Source: EC Submission to the UNFCCC (2001)

3.3.2 CRF Tables and Reference Approach

The annex presents greenhouse gas emission data for the European Community (EU15) in the Summary Tables 1.A of the Common Reporting Format for 1990 to 1999. The complete CRF tables (including all background tables) for individual Member States are available on the EEA website.

3.3.3 Data gap procedure

The EC greenhouse gas inventory is compiled by adding up the inventories of the 15 EC Member States. For data gaps the following procedure has been applied:

1. Emissions reported for the most recent previous year were taken as first estimates for the missing year.

2. For CO_2 emissions from fossil fuels combustion, however, the latest estimates reported by the Member States in combination with trend information for more recent years from latest calculations of CO_2 emissions from fossil fuels by Eurostat have been used. The Eurostat estimates are compiled using the IPCC Reference Approach and consistent energy balance data, which are regularly collected by Eurostat from the EU Member States. The trend information of Eurostat CO_2 emission estimates from fossil fuels has been used to extrapolate CO_2 emission data for the CRF category 1 "Energy".

For CO_2, CH_4 and N_2O the data gap procedure has been applied for Luxembourg (1991-1993, 1999) and Belgium (1999). For Fluorinated-gas emissions, the data gap procedure has been applied for Belgium (several years).

3.3.4 International bunkers

International bunker emissions of the EC inventory are the sum of the international bunker emissions of the Member States. Therefore, in the EC inventory, all international (including intra-EU) marine and aviation emissions are included in the Memo Item "International Bunkers".

3.3.5 Quality assurance/quality control (QA/QC) procedures

Part 1 of the Guidelines for MS and EC Annual Inventories under the Monitoring Mechanism (1999/196/EC) aims at improving the timeliness and quality of the annual EC inventory. These guidelines provide guidance on the content, format and organisational aspects of the EC inventory. The EC inventory is based primarily on the annual inventories of the Member States and their national QA/QC procedures. However, at European level, the annual process of reporting, review and compilation of the EC inventory summarised in Table 3.3.1 (above), aims at improving the quality of the EC greenhouse gas inventory.

Uncertainties in industrial greenhouse gas emission estimates (HFCs, PFCs, SF_6) remain high because of remaining data gaps on industrial greenhouse gases as reported by Member States by 1 April 2001: Fluorinated-gas emissions estimates are not available for Ireland and Luxembourg; for Belgium data from previous years were used to complete the time series to 1999 (see Table3.4 4).

3.4 EC GREENHOUSE GAS EMISSION TRENDS

Total EC greenhouse gas emissions decreased by 4 % between 1990 and 1999, but trends of the different gases varied considerably. Figure illustrates that the share of CO_2 and fluorinated-gases in total greenhouse gas emissions increased, whereas the importance of CH_4 and N_2O declined.

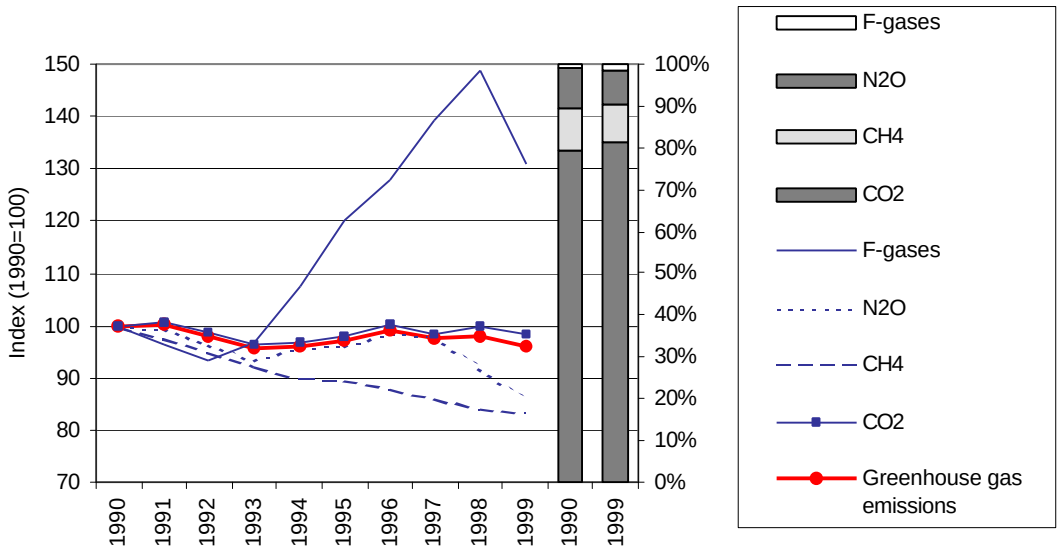
CO_2 is by far the most important greenhouse gas accounting for 81 % of total GHG emissions in 1999, but emissions were slightly below 1990 levels in 1999 (-1.6 %). This means that the Community is in line with its target path, under the UNFCCC, for the stabilisation of CO_2 emissions at the 1990 level by 2000 (see Figure 3.4.1 below). Large increases of CO_2 emissions from transport were outweighed by reductions from fossil fuel combustion in energy and manufacturing industries.

CH_4 emissions account for 9 % of total EC greenhouse gas emissions and decreased by 17 % between 1990 and 1999. The main reasons for declining CH_4 emissions were reductions in solid waste disposal on land, the decline of coal mining and falling cattle numbers.

N_2O emissions went down by 14 % and are responsible for 8 % of total greenhouse gas emissions. The main reason for N_2O emission cuts were reduction measures in the chemical industry (adipic acid production) in recent years.

Fluorinated-gas emissions show opposing trends: whereas HFC and SF_6 emissions increased sharply between 1990 and 1999 (+66 % and +34 % respectively), PFC emissions reduced by 38 %. Despite the sharp increase of Fluorinated-gas emissions since 1992 (+31 %), they account for only 2 % of total greenhouse gas emissions. The decline of fluorinated-gas emissions in 1999 compared to 1998 is due to large emission reductions of HFCs in the UK.

Figure 3.4.1 Greenhouse gas emissions according to gases (excl. LUCF)



Fluorinated-gases include HFC, PFC and SF6 emissions.
Source: EEA (2001)

Table 3.4.1 Overview of EC greenhouse gas emissions and removals from 1990 to 1999

GREENHOUSE GAS EMISSIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Tg = million tons)									
Net CO_2 emissions/removals	3 126	3 129	3 068	2 989	3 015	3 060	3 127	3 068	3 122	3 070
CO_2 emissions (without LUCF)	3 325	3 351	3 277	3 208	3 221	3 258	3 333	3 272	3 317	3 271
CH_4	440	429	418	406	396	394	387	379	370	366
N_2O	394	392	383	368	378	379	389	386	362	338
HFCs	26	25	25	27	32	37	41	47	51	43
PFCs	14	12	10	8	8	8	8	7	8	8
SF_6	8	9	10	10	11	12	12	12	11	11
Total (with net CO_2 emissions/removals)	**4 007**	**3 996**	**3 913**	**3 810**	**3 839**	**3 891**	**3 964**	**3 898**	**3 924**	**3 836**
Total (without LUCF)	**4 199**	**4 209**	**4 112**	**4 020**	**4 036**	**4 080**	**4 161**	**4 095**	**4 111**	**4 030**

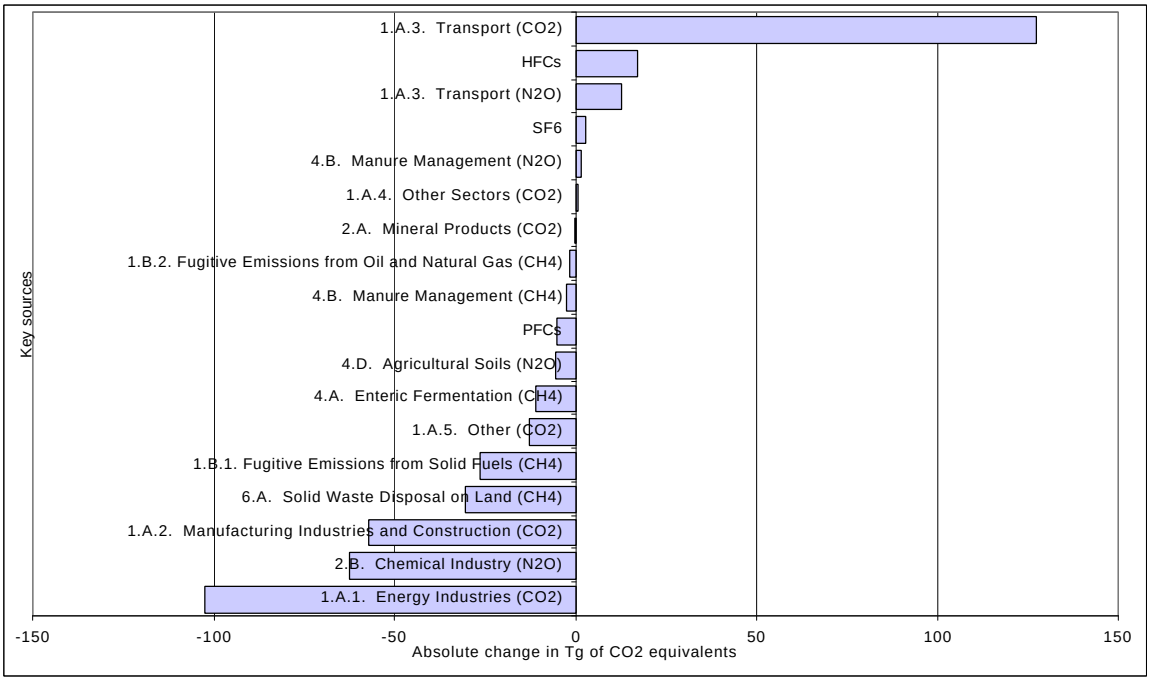
Note: Global warming potentials (GWPs) used (100 years time horizon): carbon dioxide (CO_2)=1; methane (CH_4)=21; nitrous oxide (N_2O)=310; sulphur hexafluoride (SF_6)=23900

Source: EC Submission to the UNFCCC (2001)

Sectoral analysis: To analyse the sectoral greenhouse gas trends in more detail and to focus on the most important sources, key source indicators are identified on the basis of the IPCC Tier 1 method. The aim of the key source analysis is to identify source categories that cover 95 % of GHG and/or show substantial changes in emissions between 1990 and 1999. In a first step, 14 key source categories have been identified covering 95 % of EC GHG emissions. In a second step four categories have been added because of their remarkable trend performance. Therefore, in the analysis 18 key source categories have been identified for the EU covering 96 % of total EC GHG emissions.

The emission trends of the key source categories vary widely. Figure 3.4.2 shows the ranking of key source categories according to absolute changes between 1990 and 1999.

Figure 3.4.2: Absolute GHG emission trends 1990-1999 in the EC key source categories (Tg or million tonnes of CO_2 equivalents)



Source: EEA (2001)

Sectors with increase in emissions: Emissions from transport have risen rapidly since 1990 (mainly CO_2, but also N_2O emissions). This is mainly due to growth rates of road transport in almost all Member States (but in particular in the cohesion states Ireland, Spain, Portugal and Greece). N_2O emission increases from transport are mainly due to the increased use of catalytic converters, which reduce emissions of air pollutants, but produce N_2O as a by-product.

The second key source category with substantially increasing emissions is HFC emissions from industrial processes. Some HFCs are used as substitutes for ozone depleting CFCs which have been gradually phased out in the 1990s.

Sectors with reductions in emissions: The largest reductions in absolute terms were achieved in the energy sector (electricity and heat production) mainly due to fuel shifts from coal to gas in several Member States (above all in the UK) and efficiency improvements (above all in Germany).

The second largest were reductions of N_2O in the chemical industry in the UK, Germany and France mainly due to specific measures in the adipic acid production in these countries.

The third largest were reductions of CO_2 emissions from fossil fuel combustion in the manufacturing industries mainly due to economic restructuring and efficiency improvements in the German manufacturing industry after German reunification.

Substantial CH_4 emission reductions were achieved from solid waste disposal on land (landfilling) and fugitive emissions from solid fuels. These reductions are mainly due to measures related to the implementation of the landfill directive and the decline of coal mining after cuts in coal subsidies mainly in the UK, Germany and France.

3.4.1 Contribution of Member States to the EC greenhouse gas trends

Table 3.4.2 shows large variations in greenhouse gas emission trends between Member States. Five Member States reduced their emissions below base year levels in 1999, but ten Member States were higher in 1999 than in 1990.

The overall EC greenhouse gas emission trend is dominated by the two largest emitters Germany and the UK, accounting for about 40 % of EU greenhouse gas emissions. These two Member States achieved total greenhouse gas emission reductions of 330 Tg of CO_2 equivalents (compared to 1990).

The main reasons for the favourable trend in Germany are efficiency increases in German thermal electricity production and the economic restructuring in the five new Länder after the German reunification. Accordingly, German CO_2 emissions from energy and manufacturing industries declined by 83 Tg and 57 Tg respectively between 1990 and 1999.

The reduction of GHG emissions in the UK was primarily the result of the liberalisation of the energy market and the subsequent fuel switches from oil and coal to gas in the electricity production. CO_2 emissions from energy industries declined by 49 Tg between 1990 and 1999 in the UK. In addition, substantial N_2O emission reductions were achieved in the chemical industry (-26 Tg of CO_2 equivalents).

Table 3.4.2 Greenhouse gas and CO_2 emissions in Tg (=million tons) of CO_2 equivalents (excl. LUCF)

	GHG emissions			CO_2 emissions		
MEMBER STATE	1990[1)]	1999	Change 1990-1999	1990	1999	Change 1990-1999
Austria	769	79.2	2.6%	62.1	65.8	5.9%
Belgium	136.7	140.4	2.8%	114.0	117.0	2.6%
Denmark	70.0	73.0	4.0%	53,0	57.0	7.4%
Finland	77.1	76.2	-1.1%	62.5	64.2	2.8%
France	545.7	544.5	-0.2%	385.5	404.7	5.0%
Germany	1 206.6	982.4	-18.7%	1 014.5	858.5	-15.4%
Greece	105.3	123.2	16.9%	84.3	98.5	16.7%
Ireland	53.5	65.3	22.1%	31.6	41.9	32.7%
Italy	518.3	541.1	4.4%	437.7	456.5	4.3%
Luxembourg	10.8	6.1	-43.3%	10.2	5.4	-46.3%
Netherlands	215.8	230.1	6.1%	161.2	174.1	8.0%
Portugal	64.6	79.3	22.4%	44.1	57.9	31.2%
Spain	305.8	380.2	23.2%	226.1	281.1	24.3%
Sweden	69.5	70.7	1.5%	55.1	56.5	2.5%
United Kingdom	741.9	637.9	-14.0%	583.5	531.5	-8.9%
EU-15	**4 199**	**4 030**	**-4.0%**	**3 325**	**3 271**	**-1.6%**

[1)] For the fluorinated gases some Member States have selected a base year other than 1990, as allowed for under the Protocol. However, for the analysis of EU emissions trends in this report 1990 emissions data have been used for the base year for all gases, for consistency reasons.

Source: EEA (2001)

The third and fourth largest emitters, France (14 %) and Italy (13 %), show opposing trends. Whereas France was slightly below 1990 levels in 1999, Italy's GHG emissions were higher in 1999 compared to 1990. In France, large reductions were achieved in N_2O emissions from the chemical industry, but CO_2 emissions from

transport increased considerably. Italian GHG emissions rose between 1990 and 1999 primarily in the transport sector and in electricity production.

Spain as the fifth largest emitter in the EU accounts for 9 % of total EC GHG emissions and increased emissions by more than 20 % between 1990 and 1999. The main sources contributing to the increase are the same as in Italy, i.e. transport and electricity production.

Table 3.4.3 illustrates that most Member States reduced CH_4 emissions between 1990 and 1999. The main reasons for this was declining solid waste disposal on land, reduced coal mining and falling cattle numbers. Only the cohesion states (Greece, Ireland and Spain) and Italy increased CH_4 emissions. Again, Germany and the UK achieved the bulk of the reductions in absolute terms (-70 Tg of CO_2 equivalents) between 1990 and 1999. In relative terms, Finland, the Netherlands and Austria achieved substantial CH_4 emission cuts (apart from Germany and the UK) mainly in the waste sector (solid waste disposal on land).

Table 3.4.3 CH_4 and N_2O emissions in Tg (= million tons) CO_2 equivalents

	CH_4 emissions			N_2O emissions		
MEMBER STATE	1990	1999	Change 1990-1999	1990	1999	Change 1990-1999
Austria	11.3	9.5	-15.5%	2.0	2.3	12.1
Belgium	12.9	12.2	-5.0%	9.6	10.5	8.8%
Denmark	5.9	5.6	-3.6%	11.0	9.6	-12.7%
Finland	6.1	3.9	-36.0%	8.4	7.7	-7.9%
France	65.3	59.7	-8.6%	94.8	78.7	-17.0%
Germany	117.0	68.7	-41.3%	66.2	43.7	-33.9%
Greece	9.5	10.8	14.1	10.4	10.2	-1.5%
Ireland	12.8	13.3	3.7%	9.1	10.1	11.6
Italy	40.2	41.3	2.6%	39.7	39.9	0.4%
Luxembourg	0.5	0.5	-3.7%	0.2	0.2	13.4%
Netherlands	27.1	21.7	-20.1%	19.8	22.7	14.8%
Portugal	12.9	12.7	-1.5%	7.6	8.6	12.4%
Spain	34.7	45.0	29.7%	41.2	44.0	6.8%
Sweden	6.8	6.2	-9.4%	7.1	7.2	1.4%
United Kingdom	77.1	55.2	-28.3%	66.9	42.9	-35.9%
EU-15	**440**	**366**	**-16.7%**	**394**	**338**	**-14.1%**

Source: EEA (2001)

Spain increased CH_4 emissions by 30 % between 1990 and 1999 (+10 Tg of CO_2 equivalents); CH_4 emissions from solid waste disposal on land increased more than average (+76 %). In Greece and Italy increases of CH_4 emissions in the waste sector played a dominant role, whereas in Ireland the increased CH_4 emissions were mainly from enteric fermentation.

In most Member States, N_2O emissions increased between 1990 and 1999 mainly in the transport sector. The main reason for this was the increasing penetration of catalytic converters in petrol-engined cars. The largest increases of N_2O emissions in absolute terms were in the Netherlands and Spain (+3 Tg of CO_2 equivalents each). In the Netherlands emission increased mainly in the chemical industries and from agricultural soils, whereas Spanish N_2O emissions occurred mainly from transport and manure management.

The largest cuts in N_2O emissions were achieved in Germany, the UK and France mainly due to emission reduction measures in the adipic acid production. In the United Kingdom only, there were reductions in the production of adipic acid, but this did not account for all the emissions in reductions. Denmark and Finland reported reduced N_2O emissions mainly in the agricultural sector (agricultural soils).

Table 3.4.4 illustrates that fluorinated-gas emission data availability has improved considerably in recent years. Only for Ireland and Luxembourg were no data available by April 2001. For Belgium a data gap procedure had to be used for the missing years.

Fluorinated-gas emissions grew in all Member States except for the UK. The main reason for rapidly growing fluorinated-gas emissions in the EU is the phase out of ozone depleting substances like chlorofluorocarbons under the Montreal Protocol and the replacement of these substances with HFCs (mainly in refrigeration, air conditioning, foam production and as aerosol propellants). PFC emissions mainly occur in the primary aluminium production and the production of semiconductors, but have declined between 1990 and 1999 in most Member States. The main sources of SF_6 emissions are the casting and production of primary and secondary magnesium and the manufacture and use of gas insulated switchgear in the electricity sector. SF6 emissions increased in most Member States.

Table 3.4.4 Data availability of actual HFC, PFC and SF_6 emissions as reported by Member States by 1 April 2001 in Gg (=thousand tons) of CO_2 equivalents

EC Member State		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	HFC	4	6	9	12	17	546	625	718	816	870
Austria	PFC	963	974	576	48	54	16	15	18	21	25
	SF_6	518	683	725	823	1 033	1 175	1 246	1 148	955	730
	HFC	*332*	*332*	*332*	*332*	*332*	332	418	527	527	*527*
Belgium	PFC	63	*63*	*63*	*63*	*63*	*63*	*63*	*63*	0	*0*
	SF_6	335	*335*	*335*	*335*	*335*	206	206	239	206	*206*
	HFC	0	0	3	30	58	126	278	344	503	621
Denmark	PFC	0	0	0	0	0	0	0	4	14	30
	SF_6	43	61	89	135	122	107	61	73	59	65
	HFC	0	0	0	0	7	30	78	168	246	317
Finland	PFC	1	1	1	1	1	1	1	1	1	29
	SF_6	71	48	32	26	26	14	14	16	12	32
	HFC	2 253	1 514	1 061	804	818	1 302	2 186	3 095	3 752	4 815
France	PFC	3 195	2 469	2 147	1 650	1 390	1 350	1 410	1 471	1 661	1 915
	SF_6	2 195	2 216	2 238	2 262	2 288	2 314	2 387	2 444	2 405	2 411
	HFC	2 340	2 340	2 470	3 750	3 980	3 130	2 580	3 450	4 278	4 278
Germany	PFC	2 694	2 352	2 138	2 012	1 676	1 764	1 830	1 554	1 709	1 709
	SF_6	3 896	4 350	4 876	5 401	5 784	6 238	5 808	5 688	5 473	5 473
	HFC	935	1107	908	1 607	2 144	3 253	3 746	3 960	3744	3 744
Greece	PFC	367	315	222	130	82	78	74	64	54	28
	SF_6	0	0	0	0	0	0	0	0	0	0
	HFC	-	-	-	-	-	-	-	-	-	-
Ireland	PFC	-	-	-	-	-	-	-	-	-	-
	SF_6	-	-	-	-	-	-	-	-	-	-
	HFC	351	355	359	355	623	919	761	1 097	1332	2 885
Italy	PFC	237	231	206	204	212	255	161	167	187	172
	SF_6	198	230	249	272	293	321	327	351	420	386
	HFC	-	-	-	-	-	-	-	-	-	-
Luxembourg	PFC	-	-	-	-	-	-	-	-	-	-
	SF_6	-	-	-	-	-	-	-	-	-	-
	HFC	5 144	4 863	4 594	5 107	6 449	6 724	7 524	7 884	8 695	8 836
Netherlands	PFC	2 432	2 437	2 099	2 118	1 890	1 867	2 042	2 154	2 469	2 594
	SF_6	145	100	106	110	148	174	160	182	132	137
	HFC	0	0	0	0	0	0	0	0	0	0
Portugal	PFC	0	0	0	0	0	157	157	157	157	157
	SF_6	0	0	0	0	0	1	1	1	1	1
	HFC	2 894	2 574	2 869	2 258	3 885	5 595	6 412	6 923	7 015	9 146
Spain	PFC	828	787	782	794	785	790	759	784	750	696
	SF_6	78	84	86	90	98	118	127	151	175	225
	HFC	1	3	4	17	47	94	141	239	303	375
Sweden	PFC	440	427	414	402	390	389	343	316	306	329
	SF_6	81	82	82	88	97	115	103	146	92	96
	HFC	11 374	11 859	12 346	12 905	13 814	15 205	16 290	18 447	20 183	6 206
United Kingdom	PFC	2 281	1 790	959	811	980	1 094	905	661	652	678
	SF_6	724	776	833	889	1 061	1 134	1 270	1 263	1 289	1 314
	HFC	**25 627**	**24 954**	**24 957**	**27 178**	**32 174**	**37 256**	**41 039**	**46 851**	**51 394**	**42 620**
Total	**PFC**	**13 502**	**11 847**	**9 606**	**8 232**	**7 524**	**7 825**	**7 761**	**7 414**	**7 979**	**8 361**
	SF_6	**8 283**	**8 965**	**9 651**	**10 431**	**11 284**	**11 917**	**11 711**	**11 701**	**11 221**	**11 076**

Note (1): For Belgium values are given in italics where emission estimates have been taken from the most recent previous year.
Source: EC Submission to the UNFCCC (2001)

More than 80 % of EU Fluorinated-gases are emitted by five Member States (Netherlands, Germany, Spain, France and the UK). There were large increases in absolute terms in Spain (+6 Tg of CO_2 equivalents) and the Netherlands (+4 Tg of CO_2 equivalents), whereas large reductions were achieved by the UK (-6 Tg of CO_2 equivalents) due to emission reduction measures in HCFC production in 1999.

4 POLICIES AND MEASURES

4.1 POLICY-MAKING PROCESS

In the European Union, polices and measures are developed both at the Member State level and at the level of the EU (see also Section 2.1). Those policies and measures developed by the European Union and applying across Europe are called common and co-ordinated policies and measures. Both these sets of measures will influence greenhouse gas emissions. In this Communication, we describe the common and co-ordinated policies and measures at the EU level. Member State policies and measures are described in their own Communications.

The legal instruments available to the Community institutions to carry out their tasks under the Treaty establishing the European Community with due respect for the subsidiarity principle are:

- *regulations*: these are binding in their entirety and directly applicable in all Member States;

- *directives*: these bind the Member States as to the results to be achieved; they have to be transposed into the national legal framework and thus leave a margin for manoeuvre as to the form and means of implementation;

- *decisions*: these are fully binding on those to whom they are addressed;

- *recommendations and opinions*: these are non-binding instruments.

Common and co-ordinated measures are used in areas in which common action strengthens and supports national efforts to reduce greenhouse gases most effectively. The need for these measures is increasing with the development of the internal market. The free movement of goods places certain restrictions on national policies and measures, and means that common approaches to, e.g., norms and standards are expedient. Free competition also means that consideration of the competitive abilities of companies has become more important in regulation of businesses.

Common policies and measures can also make it possible to take on projects which individual countries cannot do on their own. An example of this is the agreement with the automotive industry on improving the efficiency of new cars (see Section 4.4). Larger markets also give increased demands to products far greater effect in relation to product development.

The following sections describe the strategy of the European Union for sustainable development and its implications for climate change as well as the concrete measures initiated to translate the strategies into practical steps up to the first commitment period 2008/2012.

4.1.1 European Union Strategy for Sustainable Development[24]

Article 2 of the Treaty on the European Union defines sustainable development as a fundamental objective for the Community[25].

At its meeting in Helsinki in December 1999 the European Council[26] invited the European Commission "to prepare a proposal for a long-term strategy dovetailing policies for economically, socially and ecologically sustainable development to be presented to the European Council in June 2001" (Gothenburg). The European Commission responded with a Communication to which the European Council at Gothenburg gave its endorsement "A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development". This strategy forms also part of the EU preparations for the 2002 World Summit on Sustainable Development.

The European Council at Lisbon (2000) set a new strategic goal for the Union: "to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion". The Stockholm European Council then decided that the EU sustainable development strategy should complete and build on this political commitment by including an environmental dimension. This recognises that in the long term, economic growth, social cohesion and environmental protection must go hand in hand. Decoupling environmental degradation and resource consumption from economic and social development requires a major reorientation of public and private investment towards new, environmentally-friendly technologies. The sustainable development strategy should be a catalyst for policy-makers and public opinion in the coming years and become a driving force for institutional reform, and for changes in corporate and consumer behaviour. Clear, stable, long-term objectives will shape expectations and create the conditions in which businesses have the confidence to invest in innovative solutions, and to create new, high-quality jobs.

To bridge the gap between this ambitious vision and practical political action, the European Commission proposes that the strategy should focus on a small number of problems which pose severe or irreversible threats to the future well-being of European society. Emissions of greenhouse gases from human activity causing global warming are considered to be one of the threats. Climate change is likely to cause more extreme weather events (hurricanes, floods) with severe implications for infrastructure, property, health and nature.

To meet the challenges posed by the threats addressed in the Communication on Sustainable Development the European Commission proposes an EU strategy in three parts:

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24 http://europa.eu.int/comm/environment/eussd/index.htm

25 http://europa.eu.int/eur-lex/en/treaties/index.html

26 The European Council brings together the Heads of State or Government of the fifteen Member States of the European Union and the President of the European Commission. It should not be confused with the Council of Europe (which is an intergovernmental organisation) or with the Council of the European Union (which consists of the Ministers of the fifteen Member States). The European Council is hosted by and takes place in the Member State holding the Presidency of the Council, and punctuates the political life and development of the European Union by meeting at least twice a year (generally in June and December).

- A set of cross-cutting proposals and recommendations to improve the effectiveness of policy and make sustainable development happen. This means making sure that different policies reinforce one another rather than pulling in opposite directions.
- A set of headline objectives and specific measures at EU level to tackle the issues which pose the biggest challenges to sustainable development in Europe.
- Steps to implement the strategy and review its progress.

To combat climate change the European Commission has proposed in particular:

- To reduce greenhouse gas emissions beyond the Kyoto commitments, by 1% of their 1990 levels every year until 2020;
- To set more ambitious environmental targets for energy taxation, such as automatically indexing taxes at least to the level of inflation;
- To phase out all subsidies for fossil fuel production and consumption by 2010, undertaking steps to develop alternative sources of employment for the sectors concerned. The European Union also needs to think about the specific situation of coal in some candidate countries, within the framework of the accession negotiations.
- That by 2010, alternative fuels, including biofuels, should account for at least 7% of the fuel consumed by cars and trucks

4.1.2 The 6th Environmental Action Programme

The 6th Environmental Action Programme (EAP) for the EU was presented in January 2001[27]. This sets the environmental objectives and priorities that will be an integral part of the European Community's strategy for sustainable development. The programme sets out the major priorities and objectives for environment policy over the next five to ten years and details the measures to be taken. Tackling climate change is highlighted as one of four key objectives. The first priority is the ratification and implementation of the Kyoto Protocol to cut greenhouse gas emissions by 8% below 1990 levels by 2008-12. This is considered to be the first step to a long term target of a 70% cut. Given this long-term objective, a global reduction of 20-40% below 1990 by 2020 will need to be aimed at, by means of an effective international agreement.

Actions on climate change identified in the 6th EAP include:

- Establishment of an EU-wide CO_2 emissions trading scheme (see section 4.1.7).
- Undertaking an inventory and review of energy subsidies in the Member States, with consideration to the compatibility with climate change objectives.

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27 "On the sixth environment action programme of the European Community. Environment 2010: Our future, our choice" Communication COM (2001) 31 final, 2001

- Support to renewable energy sources through the new Directive (see Section 0) and by ensuring adequate support in the liberalised energy market.
- Use of market instruments, for example through the adoption of proposals for energy taxation.
- Promotion of energy saving on both heating and cooling in buildings.
- Environmental agreement with industry on energy efficiency and to reduce specific emissions.
- Identifying specific action to reduce greenhouse gas emissions from aviation, if no such action is agreed within the International Civil Aviation Organisation by 2002.
- Climate change as a major theme of Community policy for research and technological development and in the co-ordination of research in the Member States.

Actions to adapt to the effects of climate change fall in the first instance to the Member States but their efforts will be supported by the Community.

4.1.3 Integrating Environment and Sustainable Development into Sectoral Policies

Article 6 of the Treaty on the European Union requires that environmental aspects must be integrated into the definition and implementation of Community policies. In March 1998, the European Council in Cardiff started a new initiative to implement these two Treaty obligations more effectively in practical policy making. The principal idea was to shift responsibilities and control from environmental authorities to the different sectoral policies that prepare and implement measures. Targets, timetables and monitoring procedures with indicators should ensure better prioritisation, transparency and provide additional political momentum.

The integration initiative started at the Cardiff summit has progressed substantially. The Council has so far adopted environmental integration strategies in the areas of energy, transport and agriculture. Council reports have been adopted in the areas of industry, internal market, development, and economic/finance. In addition, there are Council strategies under development in the areas of fisheries and General Affairs Council (external relations and trade). The Gothenburg Council underlined that the process of integration of environmental concerns in sectoral policies, launched by the European Council in Cardiff, must continue and provide an environmental input to the EU Sustainable Development strategy, similar to that given for the economic and social dimensions by the Broad Economic Policy Guidelines and the Employment Guidelines. The sectoral environmental integration strategies should be consistent with the specific objectives of EU Sustainable Development strategy.

After the adoption of the first sectoral “integration initiatives”, the European Council in Helsinki (December 1999) asked for regular reviews. Monitoring became an

essential part of the "Cardiff process" to set further priorities towards sustainable development. [28]

In the European Community's Development Policy, as presented in April 2000 (The European Community's Development Policy COM(2000)212), environmental concerns are central. The objective of achieving a reversal of current trends towards degradation of environmental resources by 2015, agreed by the OECD Development Assistance Committee in its strategy for the 21st century (OECD, 1996) is testimony to this.

However, in terms of climate change the situation will still be increasing in severity well beyond 2015. Developing countries and particularly the rural poor within these countries are projected to be among those most seriously affected. The European Community's Development Policy already aims at improving conditions for the rural poor and future efforts will increase with particular regard to disaster preparedness, rural adaptation and the protection of water resources.

As was expressed at the Council Meeting on 31 May 2001 (Strategy for the integration of environmental considerations into development policy to promote sustainable development), efforts at strengthening the capacities of developing countries in negotiations under the UNFCCC, and in the implementation of the results, will be supported by the European Community. Since developing countries are most at risk from climate change, the most important underlying concern in the Community's development policy must be that obligations under the UNFCCC and its Kyoto Protocol are met. This was underlined in the Council, as was the principle of maintaining 'common but differentiated responsibilities' in meeting these obligations.

In accordance with the European Commission's efforts at improving overall policy coherence, potentially adverse effects on developing countries from European measures in combating European greenhouse gas emissions, have to be minimised. In order to improve the transparency of the European Community's efforts a uniform system of accounting for environmental expenditure is required. The European Commission has therefore introduced a marker system of accounting for contributions towards international environmental agreements.

4.1.4 Preparing for Implementation of the Kyoto Protocol

The first Community strategy to limit CO_2 emissions and improve energy efficiency was presented in October 1991 (SEC(91)1744 final). The overall objective was to stabilise CO_2 emissions in the Community by 2000 at the 1990 level[29]. In June 1992, a Communication from the European Commission (COM(92)246 final) proposed a mutually reinforcing package of measures and programmes described in the Community's first Communication to the UN Framework Convention on Climate Change (UNFCCC). Progress on the implementation of the strategy up to November

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28 Commission working paper "Integrating Environment and Sustainable Development into Energy and Transport policies: Review Report 2001 and Implementation of the Strategies", Brussels, 21.3.2001, SEC(2001) 502

29 The EU has indeed achieved the stabilisation of greenhouse gas in 2000 on 1990 levels

1997 was presented in the Community's second Communication to the UNFCCC (SEC(98)1770).

In December 1997, the EU agreed under the Kyoto Protocol to a target to achieve an overall 8 % reduction of greenhouse gas emissions, compared to 1990 levels, in the commitment period 2008-2012. The main means of reaching this target under the Kyoto Protocol is foreseen to be domestic action.

In May 1999, the European Commission presented a Communication to Council and Parliament, on 'Preparing for Implementation of the Kyoto Protocol' (COM(1999) 230 final) which outlined the necessary action within the EU to enable the full application of the Kyoto provisions. The Communication reviewed progress on common and co-ordinated policies and measures, fiscal incentives, and environmental agreements, and considered the preparation of a policy action on the halogenated gases covered by the Kyoto Protocol and the preparation required for the implementation of the Kyoto Mechanisms. Data were presented that illustrated that domestic action within the EU could be sufficient to achieve the Kyoto target, and that one third of this reduction, (358 Mt CO_2 eq), could be achieved at low cost; two thirds were estimated to be achievable at costs ranging from 5 to 50 Euro/tonnes of CO_2.

In response to the May 99 communication, the Council asked for a list of priority actions and policy measures. The European Commission responded by coming forward with this list in October 1999 and by making proposals to advance the policies through the European Climate Change Programme (see next Section). This programme is described in its Communication 'EU policies and measures to reduce greenhouse gas emissions: Towards a European Climate Change Programme' (COM(2000) 88 final).

For the EU, the Agreement at COP 6bis in Bonn (confirmed by results from COP 7 in Marrakech) has clearly paved the way for ratification of the Kyoto Protocol. In line with the conclusions of heads of State and Government at the Göteborg Summit mid June 2001, the EU will pursue ratification and entry into force of the Kyoto Protocol by 2002. The European Commission has therefore adopted three elements of a package that is destined to maintain this momentum. They are:

1) A proposal for the European Community to ratify the Kyoto Protocol (COM2001) 579);[30]

2) A Communication that outlines the concrete set of implementation measures to be addressed in the coming 24 months that constitute important elements for fulfilling the Community’s commitments under the Kyoto Protocol; Communication on the implementation of the first phase of the ECCP COM (2001)580;[31]

30 http://www.europa.eu.int/comm/environment/climat/docs.htm

31 http://www.europa.eu.int/comm/environment/climat/eccp.htm

3) A proposal for a Directive on greenhouse gas emissions trading within the European Community COM (2001)581[32].

4.1.5 European Climate Change Programme (ECCP) – The main frame for policy action

The European Climate Change Programme[33] was established in June 2000 to help identify the most environmentally and cost effective additional measures to meet it's target. The ECCP is one of the instruments to implement the 6 EAP. The preparatory work carried out under the ECCP since then will enable the EU to present a strategy document in the second half of 2001 on the basis of concrete policy proposals to be submitted to the Council and the European Parliament.

The ECCP has been set-up as a multi-stakeholder consultative process that focussed on energy, transport, industry, research and agriculture and on the issue of emissions trading within the EU. Seven technical Working Groups were established under the co-ordination of an ECCP Steering Committee. The programme was not carried out in isolation but built on links with going activities at the EU level such as the Joint Expert Group on Transport and Environment[34]. It also dovetails with the 6th EAP and the EU Strategy for Sustainable Development.

A major part of the European Climate Change Programme (ECCP) has now been finalised[35]. The programme investigated more than 40 measures in total using selection criteria such as cost effectiveness and time frames. Eight measures were identified as being at an advanced stage of preparation. For these common and co-ordinated measures in an advanced state of preparation additional an estimated cost-effective emission reduction potential of about 240 $MtCO_2$ eq has been identified, thereby effectively supporting Member State policies and measures. Additional measures identified by ECCP are in the pipeline with an estimated cost-effective emission reduction potential of about 140 $MtCO_2$ eq. In total the ECCP could identify cost-effective options costing less than 20 €/t CO_2eq. totalling 664 - 765 $MtCO_2$eq. However, the realisation of the technical potential depends on a number of factors such as the accuracy of data, the timeframe within which measures are implemented and public acceptance. In order to give a better indication of the short-term potential of cost-effective measures at EU level the ECCP report makes a distinction between those that are 'at an advanced stage of preparation', those 'in the pipeline' and those for which 'more work is needed'.

In the following discussion of the sectors, material from the ECCP Working Groups on the potential for greenhouse gas emissions reductions from these eight measures being at an advanced stage of preparation is presented for 2010. For the other measures, which are at an earlier stage of development, figures are presented which indicate a technical potential also beyond 2010. For some of the measures, part at least of the technical potential could be realised in the first commitment period, but because of the uncertainty (technical potential depending on factors including

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32 http://www.europa.eu.int/comm/environment/climat/emission.htm

33 http://europa.eu.int/comm/environment/climat/home_en.htm#eccp

34 The joint expert group involves transport and environment experts from the european Commission as well as Member States experts

35 http://europa.eu.int/comm/environment/climat/eccp.htm

political agreement on the measure, the timeframe of implementation, public acceptance and overlaps) this is not included.

In October 2001 the European Commission has adopted a Communication that outlines the first concrete set of implementation measures of the ECCP to be addressed in the coming 24 months (Communication on the implementation of the first phase of the ECCP COM (2001)580)[36]. These measures fall into four categories: crosscutting, energy, transport industry. Those measures represent a cost-effective reduction potential of some 122 –178 Mt CO_2 eq. However, the ECCP also highlighted the importance of measures, which are particularly promising in a long term perspective, and for which the cost-effectiveness constraint of € 20 per tonne of CO_2 eq. needs to be qualified. In this respect, the emission reduction potential could increase with another 100 Mt of CO_2 eq. in view of reflecting pro-active policies in the field of CHP and Biofuels. In any case, caution is needed in interpreting figures of the emission reduction potential. For some of these measures quantification proved difficult. This applies particularly to actions in the transport sector. These measures are taken from the recently adopted White Paper on a Common Transport Policy[37] which proposes a package of 60 measures in total of which some will also be instrumental in reducing greenhouse gas emissions.

4.1.6 Action Plan to Improve Energy Efficiency in the European Community – Enhancing demand side reduction measures

The Energy Efficiency Action Plan[38] has been prepared in response to the Council and Parliament and in consultation with Member States, the Economic and Social Committee, industry and other stakeholders. It aims to realise the available economic potential for energy efficiency in line with the proposed target for reduced energy intensity of 1% per year above and beyond business-as-usual trends[39]; it has been estimated that this will result in avoided CO_2 emissions of nearly 200Mt/year.

The Action Plan presents an integrated and coherent combination of policy instruments that are designed to reinforce each other and to complement Member state activity in this area over the period up to 2010. Three types of measures are proposed:

- Measures designed to integrate the energy efficiency dimension into Community non-energy policies and programmes

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36 http://www.europa.eu.int/comm/environment/climat/eccp.htm

37 European Transport Policy for 2010:Time to Decide, COM(2001) 370

38 http://europa.eu.int/eur-lex/en/com/cnc/2000/com2000_0247en01.pdf

39 During most of the nineties the reduction in final energy intensity was rather slow due to the economic crisis in Europe in the first half of the decade. Depending on the years taken for the comparison it varied from 0 to -0.87 % per annum (Odyssee, 2000). Taking this as a baseline would imply an overall improvement of final energy intensity of 1 to 2 % per annum. The European Parliament, in its resolution on the Commission Communication on an Action Plan to Improve Energy Efficiency in the European Community suggested that the overall target for energy intensity reductions was raised to 2.5 % per year. The Call for an Energy Intelligent Europe (EI-Europe)- A cross-party and cross-nation initiative to make Europe's economy the most energy intelligent in the world by several Members of the European Parliament underlines this target with a series of concrete measures.

- Measures to strengthen and expand existing energy efficiency policies and measures e.g. labelling and standards
- New policies and measures.

Details of the individual policies and measures are given in the Action Plan and are described in the following sectoral chapters. The plan includes a set of implementation plans and complementary measures for specific ongoing programmes. The SAVE programme will be used as the principal co-ordinating arm of the Action Plan, although other Community programmes such as the 5th Framework RTD Programme are also important. It is envisaged that most activities will be initiated during the present life span of SAVE and other programmes (i.e. up to 2002). However, the Communication to Council and Parliament, on 'Preparing for Implementation of the Kyoto Protocol' (COM(1999) 230 final) criticises the insufficient provisions by the Council in particular for the programmes SAVE II and ALTENER II which seem by far too small to cope with the emphasis put on demand side and renewable energy sources.

4.1.7 Flexibility instruments – Their future role in relation to domestic action

In March 2000, the European Commission adopted a Green Paper on 'Greenhouse Gas Emission Trading within the EU', (COM(2000) 87 final), to launch a discussion on emissions trading within the EU, and on the relationship between emissions trading and other policies and measures to address climate change. The responses received were overwhelmingly in favour of emissions trading. The case for a Community-wide scheme is also supported by several studies demonstrating efficiency gains[40]. The European Commission has put forward a proposal for a Directive on Emissions Trading to provide a Community-wide framework.

The proposed Directive would not harmonise the method of allocation and quantities of allowances[41] but Member States would be required to communicate in advance to the European Commission their proposed intentions in respect of the allocation of allowances. The reporting requirements on Member States will ensure transparency and the European Commission will continue to exercise vigilance in respect of state aid, anti-competitive behaviour etc.

The scheme would apply to most of the significant emitting activities already covered by the Integrated Pollution Prevention and Control (IPPC) Directive (see Section 4.5.2) as well as some others. The only gas covered by the proposal is carbon dioxide.

The ECCP working group on flexibility mechanisms also recommended early development of an EU emissions trading scheme. Use of Joint Implementation (JI) and Clean Development Mechanisms (CDM) by companies should also be encouraged. This can be done by recognising JI and CDM credits towards fulfilment of domestic obligations. Member States and the Community should work together to

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40 e.g. Shared Analysis Project, Vol. 1 and 2 (www.shared-analysis.fhg.de); The Economic Effects of EU-Wide Industry-Level Emission Trading to Reduce Greenhouse Gases, NTUA Report, May 2000, Economic Evaluation of Quantitative Objectives for Climate Change (http://europa.eu.int/comm/environment/enveco/studies2.htm#5)

41 Allowances entitle the holder to emit a corresponding quantity of greenhouse gases.

provide clear and consistent guidance on project eligibility, additionality and baseline criteria. In addition consideration should be given to the establishment of domestic greenhouse gas reduction projects to generate credits that could be used towards the fulfilment of domestic obligations.

4.1.8 Monitoring Mechanism

The monitoring mechanism is an instrument to assess accurately and regularly the extent of progress being made towards the Community's commitments under the UNFCCC and the Kyoto Protocol. It is described in detail in Chapter 0.

4.2 ENERGY SECTOR

Table 4.2.1 Development of greenhouse gas emissions in the energy sector[42]

	CO_2 (Mt CO_2 eq)	CH_4 (Mt CO_2 eq)	N_2O (Mt CO_2 eq)	Total (Mt CO_2 eq)	% CO_2	% CH_4	% N_2O
1990	1 173	85	15	1 273	92%	7%	1%
1999	1 068	58	15	1 141	94%	5%	1%

Source: EEA (2001)

The development of the sectoral greenhouse gas emissions between 1990 and 1999 and the relative importance of the main greenhouse gases in the energy sector are shown in Table 4.2.1. The energy sector, and in particular the electricity supply sector, is the largest contributor to greenhouse gas emissions (approximately 30 %). This is closely related to the efficient use of electricity in the demand sectors. The reduction of greenhouse gases from this sector can potentially occur in several ways including the development of clean, new forms of energy supply, improvement of the fossil fuel power plants and a shift towards fuels with lower carbon content, as well as reductions in the demand for electricity.

4.2.1 Strategy development

The Commission's Green Paper on Security of Energy Supply (COM(2000) 769 final)[43] from November 2000 is a response to the concern raised by sharply increasing oil prices during 1999 and 2000. The document raises a number of fundamental questions about how to shape the future energy policy within the EU in a way that will at the same time cope with the expected increase of energy demand, the reduction in domestic energy production and the constraints on use of fossil fuels, needed to meet agreed and future commitments under the Kyoto Protocol.

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42 The figures include emissions from the energy sector and fugitive emissions from fuels.

43 http://europa.eu.int/comm/energy_transport/en/lpi_en.html

In addition to launching a European debate on future energy policy the Green Paper suggests a number of policy orientations of major importance for future greenhouse gas emissions:

- Priority must be given to **demand side management**, through energy savings and improved energy efficiency. This applies at EU level and where necessary measures will be part of Member States' policy. Transport, buildings and appliances offer important potential in this context.

- Increased use of **renewable energy** is essential. The earlier target of 12% by 2010 is confirmed and specific action in electricity generation and biofuels for transport are highlighted.

- The importance of **nuclear energy** is underlined. The necessity of agreeing ways to manage radioactive waste is identified as an element in improving public acceptability of nuclear energy.

- The need for EU wide measures on **energy taxation** is stressed if energy pricing is going to play its proper role in a demand side oriented energy policy.

Many of the suggestions in the Green Paper are already on their way through the legislative process in Council of Ministers and the European Parliament. Others will follow in the near future as the consultation period over the document comes to an end. Furthermore, the European Climate Change Programme investigated a number of measures on their environmental and cost-effectiveness. Five of these measures were put forward in a Communication to the Council and the European Parliament and will be part of the European Commission's work programme for the next 24 months. The following sections give a more detailed description of a number of important actions from the Green paper. Table 4.2.3 provides an overview about policies and measures to reduce CO_2 and other greenhouse gas emissions in the energy sector.

4.2.2 Policy Actions

Developing the internal market

The completion of the internal energy market is a priority for Community Energy policy. The objective is to improve the competitiveness of European industries and to foster economic growth and employment in Europe. In parallel, energy policy will have to contribute to achieving the Community's other goals towards the protection of the environment, in particular the reduction of greenhouse gas emissions, and security of energy supply. It is therefore important that the environmental effects of the liberalisation of the energy markets are closely monitored.

Recent developments in the electricity and natural gas markets can be summarised as follows:

- The adoption of the **Electricity Directive** in 1997 has further activated the process for achieving competitive electricity markets in the European Community. Today two thirds of electricity consumption in the EU are open for competition.

The market has witnessed a drop in electricity prices in almost all Member States and for all groups of consumers. In May 2000 the Commission took stock of the process and reviewed the progress in a Communication to the Council and the European Parliament "Recent Progress with Building the Internal Electricity Market" (COM(2000)297 final).

- The vast majority of Member States have implemented the **Gas Directive** on time (10 August 2000), with almost all of them going further than legally required in terms of market opening. Only a few Member States have not yet implemented the directive. Faced with this situation the European Commission began the necessary legislative procedures. By opening up national markets to competition and by integrating the national gas markets into one single market, wide scope for gas to gas competition will be created, with the view for better services and lower prices. Today three quarters of the gas consumption in the EU is open for competition.

In spite of current progress the objective of a real integrated single market has not yet been achieved and further steps are needed. Therefore Heads of State and Government, at the European Councils of Lisbon, Feira and Gothenburg have mandated the European Commission to put forward proposals to accelerate the process of achieving a fully operational internal market. On 13th March 2001 the European Commission proposed a set of new measures[44] aimed at completing the internal energy market. The objective of the Commission's proposal is to have the electricity and gas markets fully open to all consumers by 2005.

Renewables

The EU and its Member States have made significant progress in terms of technological development and installed capacity as well as production growth of renewable energy sources. This applies in particular for wind energy and on the demand side, less noticed, for solar thermal energy. Recent measures for photovoltaics (PV) will significantly enhance this industry in terms of market growth. Progress has been achieved with respect to biogas from landfill and agricultural applications as well as for biofuels.

In November 1997 the European Commission adopted a Communication entitled "Energy for the Future: Renewable Sources of Energy – a White Paper for a Community strategy and action plan" (COM(1997)599 final) proposed that renewable sources of energy should make up 12% of the Community's gross inland energy consumption by 2010. This target has since been confirmed in the Green Paper on the security of energy supply. In the field of renewables the interaction between Member States activities and the framework set by the European Commission is particularly evident. Though it is clear that some Member States are advanced in certain fields, the framework and the indicative targets set by the Community increasingly encourages national activities in many Member States. The quantitative estimates given at the end of this chapter therefore certainly include to a large degree the activities of the Member States.

New developments in key policy fields have been the following:

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44 COM (2001) 125 prov

- On 27 October 2001 a Directive on the **promotion of electricity from renewable energy sources** in the internal electricity market[45], came into force. The strategic objective of the Directive was to create a framework for the medium-term significant increase of electricity from renewable energy (hereafter "green electricity")- in the EU and to facilitate its access to the internal electricity market. The Directive aims to create regulatory certainty for stakeholders, while at the same time respecting the principle of subsidiarity by providing for a wide degree of autonomy to each Member State to allow for their particular circumstances to be taken into account. It is based on the following principles. Member States will be obliged to establish national targets for the future consumption of green electricity. If they are all met, around 22% of the EU's electricity will be provided from renewable energy in 2010, compared to 14% today. The European Commission will monitor the compliance of national targets with Community objectives and will have an obligation to propose amendments to national objectives if the two are inconsistent. The Directive also obliges the European Commission to make, if necessary, a proposal for a harmonised support system. This will be done on the basis of a European Commission report assessing the various support schemes in favour of electricity production from renewable as well as from conventional energy sources, which will enable it to assess the type of support system needed to establish a level playing field for both. In addition the Directive tackles a number of technical issues, which are fundamental to the development of green electricity by, for example, introducing accurate and reliable certification of green electricity and assuring its priority access to the electricity grid.

- In December 2000, the Commission adopted new Community **Guidelines on State aid for environmental protection**[46]. These guidelines authorise Member States to grant important State aid in the field of energy savings and renewable energies.

- On 7 November 2001 the Commission adopted a Communication on **alternative fuels for transportation** and a set of measures to promote the use of biofuels. This Communication puts forward an action plan to meet the objective to substituting 20% of traditional fuels by alternative fules in the road transport sector by 2020.

- **Community wide standardisation** is important for facilitating the commercialisation and market penetration of renewable energy sources. Therefore, the Commission has taken initiatives on standards for solar thermal, solar PV and wind equipment. Concerning biomass, the Commission has taken two initiatives, namely three standards for biodiesel and seven standards for solid biomass. Through the involvement of the European Standardisation Committee (CEN), these standards aim to reinforce traditional markets and to develop new competitive markets.

- Further measures, which have been forward in the **ECCP** are listed in Table 4.2.3.

45 http://europa.eu.int/eur-lex/en/dat/2001/l_283/l_28320011027en00330040.pdf
46 OJ 2001/C37/03

The promotion of research into, and the development, demonstration and market introduction of new and advanced technologies, which play an important role in achieving a sustainable energy future, is one of the Community's key priorities. The action being taken by the Community in this field is set out in Chapter 8.

As can be seen from the following table, the share of renewables in total electricity generation is 14.2 %. The share in total primary energy production is 11.3%, and the share in gross inland consumption (including net imports of fuels) is 5.9%[47].

Table 4.2.2 Energy production from Renewable Energy Sources (RES) in EU-15

General index (%)	1995	1996	1997	1998*	target 2010
Primary production of RES	10.0	10.0	10.8	11.3	-
Share of electricity of RES origin	13.8	13.5	14	14.2	22.1
Gross inland consumption of RES	5.3	5.4	5.8	5.9	12.0

Source: European Commission, Progress Report "on the implementation of the Community Strategy and Action Plan on Renewable Energy Sources (1998 – 2000)"; COM(2001) 69 final

In long-term perspective, liberalised energy markets on a European Level are beneficial for all decentral forms of energy, including renewables. This is because they give up the principle of state-guaranteed (regional) monopolies for a few energy suppliers. Furthermore, every supplier can use the transmission infrastructure. This gives scope for a more open market, in which all renewables that have become competitive can grow or exist next to each other.

In the short term, however, decreased electricity prices, apart from reducing the incentives for energy consumers to use energy efficiently, strongly increase competition pressures on emerging renewable energy sources, which are in the process of becoming competitive. This can be a serious obstacle for their development. Therefore, special provisions such as those outlined above have to be made to ensure both targets' fulfilment – liberalisation of energy markets and expansion of renewable energy.

Action Plan 'Campaign for Take-Off

The Action Plan 'Campaign for Take-Off' resulted from a White Paper , 'Energy for the Future: Renewable Sources of Energy (COM(97)599 final). The White Paper set an indicative objective of 12% for the contribution of renewable sources of energy to the European Union's gross inland energy consumption by 2010. It was estimated

47 It has to be noted that the share of RES would be bigger when measured as final energy consumption, since for RES like wind, hydro and PV, final energy consumption is equal to primary energy consumption by convention, for fossil-fuel based energy, in contrast, it is far lower due to transformation losses.

that the achievement of this goal could result in around 400 Mt/year reduction in CO_2 emissions. The Action Plan is planned to run for 5 years (1999-2003) and is designed to act as a catalyst for the development of key renewable sectors by sending clear signals for the greater use of renewables and by encouraging investment.

In the White Paper it was emphasised that, to reach the Community indicative objective, Member States had to encourage the increase of Renewable Energy Sources (RES) according to their own potential. Furthermore, as far as Community measures need to be complemented by national, regional and local measures, Member States have a key role to play in taking the responsibility to promote renewable energy through national strategies and programmes. It has to be highlighted that, while the promotion and support to RES, both at Community and Member States level, had already started when the White Paper was published, public support to RES projects through national programmes has been clearly encouraged and fostered by the White Paper. Moreover, a number of Member States have recently introduced national strategies for the development of RES, as called for in the White Paper. Such strategies typically include targets and multi-annual Action plans addressing capacities of RES systems to be installed, as well as administrative, legal and other promotional measures and activities. The White Paper also contains a comprehensive Strategy and Action Plan setting out the means to reach this objective. The Communication from the European Commission on the implementation of the Community Strategy and Action Plan on Renewable Energy Sources (1998 – 2000) (COM(2001) 69 final) is the first progress report on the implementation of the Strategy and Action Plan on Renewable Energy Sources. The document contains in particular an overview of national strategies and objectives in Member States to implement the "Campaign for Take-off".

Intermediate targets for 2003 are set between 15% to 25% of the overall White Paper objectives for 2010 are as follows:

- *1,000,000 PV systems:* This target is equivalent to an installed capacity of 1.000 MWp , only 650 MWp of which are to be installed in the EU. The other 350 MWp are to be realised in Third Countries.
- *15 million m^2 solar collectors***:**
- *10,000 MW of wind turbine generators*
- *10,000 MWth of combined heat and power biomass installations*
- *1,000,000 dwellings heated by biomass*
- *1,000 MW of biogas installations*
- *5 million tonnes of liquid biofuels*

In addition to the key energy sectors, a stated goal of the Campaign for Take-off (CTO) as presented in the White Paper is the identification of "100 communities" which can reasonably aim at 100% power supply from renewable energy sources. The "100 communities" action as initially proposed in the White Paper has already aroused much interest across the EU and could also be a benchmark for the implementation of decentralised energy supply. The European Commission's role is to establish the framework, to provide technical and financial assistance, where appropriate, and to co-ordinate actions. This objective will be certainly reached in

2003: Renewable Energy Partnerships, signed with such communities, are progressing rapidly and more than 100 eventual candidates have been identified.

Despite the undeniable development of renewable energy sources presented by the first progress report, the document points out that it is far from certain that the indicative target of the White Paper of 12 % RES contribution to the EU gross inland consumption will be achieved in 2010. In particular, this objective will never be achieved if the gross energy consumption continues to increase in line with the current trend and demand management and energy efficiency measures are not implemented vigorously. This underlines the complementarity between demand side options to reduce greenhouse gases and the introduction of renewable energy sources.

The progress report also refers to recent investigations in employment effects of renewables' market growth. From a study carried out for the European Commission (Impact of Renewable Energy Sources on job creation), and only considering the domestic market, the impact of the White Paper objectives' on employment can be calculated according to expected individual penetration rates by sector in net operation and maintenance (O&M), construction and installation (C&I) and total employment, taking into account the jobs displaced from employment in conventional energies.

The results suggest that around 530,000 jobs may be created between 1999-2010 across the 15 EU Member States within the renewable energy sector. In order to provide more accurate information to decision-makers on job creation generated by RES investments, the progress report states that further work should now concentrate on developing and expanding information directly related to the types of technologies discussed in the White Paper. In any case, estimates will be updated on a regular basis and job creation data will be included in the monitoring scheme of the Action Plan.

The following are the main recommendations of the progress report aimed at reaching the indicative target:

- Define further individual RES strategies and objectives by Member States both for electricity and thermal use of energy.

- Member State responses to Community measures, mainly in the field of structural funds for the period 2000-2006, should be proactive with respect to building new RES capacities in Member States.

- The biomass sector represents the largest potential in RES. Therefore, while the impact of new regulations under the Common Agricultural Policy is not yet known, specific attention needs to be attached to biomass and the framework conditions should be further improved.

- Concerning the building sector, which represents more than a third of the overall EU energy consumption, measures will therefore be proposed by the European Commission in order to improve and multiply at an EU-wide level experiences made in specific demonstration sites.

- At an international level, the Community should show the way to sustainable and environmentally friendly energy schemes for supporting and financing RES development programmes. One building block in that context is the G8-RES-Task created after the last G8 summit in Okinawa.

- Concerning support measures, the Community RES related programmes should address: the consolidation of proactive measures in MS by the cross-fertilisation of good and successful practices between MS, the inclusion of energy in urban planning, the elaboration of appropriate standards, codes and guidelines and the launching of targeted campaigns.

- In addition, the removal of legal and administrative barriers should be accompanied by innovative market instruments at Community level. This relates particularly to the fiscal sector.

Renewable Energy Partnership

Under the CTO investment opportunities have to be highlighted by promotional and public relations activities. Therefore, a Renewable Energy Partnership scheme which includes public authorities, energy agencies, industry and other key players has been created. Actors involved in the Campaign for Take-Off become "Partners" at the Community level by signing a Renewable Energy Partnership Declaration, describing the actions, programmes or initiatives which form their contribution to the CTO. The RE Partnership is intended to promote investments and to highlight the European dimension of both public and private initiatives in the key sectors of the CTO. Potential partners are: national, regional and local authorities, energy agencies, industry (including utilities, oil companies, and manufacturers), and farmers associations, etc. By July 2000, more than 30 RE Partnership Declarations have already been signed. This includes regional programmes, oil and RES manufacturing industry, national agencies, and cities with programmes in the "100 communities aiming at 100% of RES supply" action.

Agores

To facilitate the dissemination of relevant information on RES the virtual centre "AGORES" (Global Overview of Renewable Energy Sources) was created and funded under the ALTENER II programme. AGORES constitutes the first one-stop-shop to provide information on Community and national strategies, regulations and programmes, to disseminate project results and to facilitate contacts between the main actors. For this purpose AGORES provides also automatic links with public bodies, agencies, industry associations, universities and any kind of organisation acting in the field of RES[48].

Combined Heat and Power

Combined Heat and Power (CHP) is, via the simultaneous utilisation of fuel input energy for the generation of electricity and for thermal energy supply, an often very efficient technology. Similarly to renewable energy sources, its long-term perspectives in decentralised energy markets look promising, but in the short term

48 http://www.agores.org

especially decreased electricity prices impose an obstacle to further expansion, and currently even induce disinvestments.

The European Commission's Communication on CHP (COM(97)514 final) outlines the barriers and strategy for the increased use of combined heat and power in the European Union. The Communication presents a Community-wide target of doubling the use of co-generation to 18 % of EU electricity production by 2010. It is estimated that this will result in avoided CO_2 emissions of more than 65 Mt CO_2 eq/year by the year 2010 (European Co-generation Review, July 1999). A Council Resolution (18.12.97) adopted in December 1997 stressed that, while there is scope for action at Community level, the main responsibility for promoting combined heat and power lies with the Member States. It underlines that the Member States and the Community, within their respective competencies, need to actively promote the use of combined heat and power, by stimulating, where appropriate, the market for combined heat and power and by removing the barriers to this market through:

- Increased use of existing Community programmes within the budgetary limits.
- Encouraging negotiated agreements with industry and in the service sector.
- Internalisation of external costs and environmental benefits.
- Financial and/or fiscal instruments, if appropriate.
- Monitoring the impact of the liberalisation of the Community's energy markets.
- Measures encouraging market participants to buy energy produced from combined heat and power plants.
- Arrangements to promote district heating and cooling schemes.
- Measures to support research and technological development.

The recent Action Plan on Energy Efficiency reaffirmed this target and it listed a range of measures to promote CHP. The proposal for a revised large Combustion Plants Directive also promotes the use of co-generation. In the framework of the European Climate Change Programme, CHP has been identified as a promising area for achieving emissions reductions. A directive on CHP is scheduled to be published by the European Commission in 2002.

Promoting Effective Implementation of the Integrated Pollution Prevention and Control Directive (IPPC Council Directive - 96/61/EC)

The IPPC Directive covers all combustion plants with a rated thermal input exceeding 50 MW. The IPPC Directive takes integrated approach to pollution prevention and control in large industrial (and agricultural) installations. The IPPC Directive focuses on prevention. It favours upstream measures (like clean technologies) rather than “end-of-pipe” pollution control. The Directive introduces an obligation to prevent all forms of pollution and to use energy efficiently. The ECCP made a clear recommendation to make better use of the existing IPPC Directive. For information about the implementation of the IPPC Directive, see section 4.5 on Industry.

4.2.3 Programmes

CARNOT

In December 1998, the Council approved the CARNOT Programme (Directive 1999/24/EEC, 13 January 1999), a multi-annual programme of technological actions promoting the clean and efficient use of solid fuels (1998-2002). The aim is to limit emissions, including CO_2 emissions, from the use of solid fuels and encourage the uptake of advanced clean solid fuel technologies in order to improve Best Available Technologies, at reasonable cost.

ALTENER

ALTENER is the EU's non-technological programme aimed at promoting the use of renewable energy. The first ALTENER Programme ran from 1993-1997 and the decision to launch a second phase of the Programme was adopted by Council in May 1998. Phase II was initially scheduled to run until the end of 1999 but was extended to 2002 following the Council Decision to adopt the 'Energy Framework Programme', a pluri-annual programme for actions in the energy sector (1998-2002). The ALTENER Programme is an integral part of the Community Strategy and the Campaign for Take-off. In 2001 a proposal for a European Parliament and Council Decision on a pluri-annual programme aimed at the promotion of renewable energy and energy saving (2003-2006) (follow-up to the SAVE and ALTENER programmes) will be under debate.

4.2.4 Relation to ECCP

The policies and measures in this sector fall into the remit of Working Group 2 Energy Supply. The group concluded that the simultaneous achievement of energy supply and climate change objectives can be best reached by a globally oriented and technology-geared approach, including all energy sources. Two priority objectives are reducing the carbon content per unit of energy supply and increasing the conversion efficiency. Community institutions should set up a coherent and coordinated framework of policy instruments, avoiding double or multiple regulation and providing security for long-term investment in cleaner technologies. Preference is given to certain policies and measures in addition to the implementation of emissions trading instruments. The preferred policies and measures include the launch of a co-generation initiative, followed possibly by a co-generation directive, an initiative to promote heat production from RES, and an initiative aiming at increased utilisation of liquid and gaseous bio-fuels (where their production and utilisation are environmentally benign), as well as amending the liberalisation directives as described above, to complete the internal energy market. These, and some more, are included in the summary table below.

4.2.5 Non-CO2 greenhouse gases

Emissions of methane occur from oil and gas extraction, transport and distribution and from coal mining. Various technical measures are available to reduce emissions and there are voluntary agreements at the Member State level to implement them. In the sectoral objectives study, cost effective measures amounting to 46% of the 1990 emissions were identified.

Table 4.2.3: Summary of the policies and measures in the energy sector

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						2000	2010[49]	Beyond 2010[50]
Directive on the promotion of Biofuels	Increase environmentally benign use of liquid and gaseous bio-fuels	Mainly CO_2	Proposed framework directive	Adopted by European Commission 7 November 2001	EU/Member States		Included below	35-40 (at a cost of 100 Euros/tonne)
Initiative on the promotion of heat production from RES (see footnote 51)		Mainly CO_2		Planned 2002	EU/Member States		Included below	
Communication – CHP Policy Action	18% of EU electricity from CHP by 2010	Mainly CO_2	Framework Directive	Directive planned 2002	EU/Member States			1-12 (cost effective) *(53-64)* 65 (overall potential)
CO_2 capture and sequestration[51]	Promotion of further technological efforts	CO_2	RTD (Pilot project)		EU			*(50)*
Directive for an EU Emissions Trading	To establish the framework for an EU	CO_2	Regulation	Adopted by Commission	EU/Member States			

49 Figures in italics are the potential at a cost of more than 20 Euros/tonne CO_2

50 The figures in the column are measures from the ECCP, the timescale is uncertain and some measures may be agreed and implemented before the end of the first commitment period. The potential in italics is at a cost of greater than 20 Euro/tonne CO_2.

51 Identified as a measure for possible further Community action under the second phase of the ECCP

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						2000	2010[49]	Beyond 2010[50]
Scheme	emissions trading scheme for carbon dioxide			October 2001				
Policy Action-Action Plan 'Campaign for Take-Off'	12% contribution by renewables to primary energy supply by 2010	Mainly CO_2		Implemented	EU/Member States			
Minimum efficiency requirements for end-use equipment				Proposal planned for 2002				
Directive for promotion of renewable energies in electricity generation	Increase the contribution of renewables to primary energy supply by 2010	Mainly CO_2	Framework Regulation	Adopted	EU/Member States		126 *(74)*	.
Directive on full liberalisation of electricity and gas markets by 2005	To encourage the development of a liberalised energy market within the EU	Mainly CO_2	Proposed framework agreement	Proposal adopted by European Commission March 2001	EU/Member States			88 (includes 63Mt from installation of NGCC rather than clean coal) *(125)*
Directive on energy demand management			Directive	Proposal planned for 2002				
Encouragement of	To encourage the	CH_4	Voluntary	To be launched	EU/Member	34		3

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						2000	2010[49]	Beyond 2010[50]
energy industry reduction of methane	continued effort to reduce the emissions of methane from pipeline infrastructure and to promote methane capture from closed mines		agreement		States			
Programme - ALTENER	Non-technical programme to promote use of RES	mainly CO_2	RTD	Implemented 1998 –2002	EU			
Programme - CARNOT	Technological actions to promote the clean and efficient use of solid fuels.	mainly CO_2	RTD	Implemented 1998-2002	EU			
E2MAS energy audit and management scheme (see footnote 51)								

4.3 RESIDENTIAL AND TERTIARY SECTORS

Housing and buildings account for around 40% of final energy consumption, of which around 57 % is used for space heating, followed by 25 % for water heating and 11 % for electrical appliances and lighting.

Table 4.3.1 Development of greenhouse gas emissions in the residential and tertiary sectors[52]

	CO_2 (Mt CO_2 eq)	CH_4 (Mt CO_2 eq)	N_2O (Mt CO_2 eq)	Total (Mt CO_2 eq)	% CO_2	% CH_4	% N_2O
1990	631	11	11	653	97%	1.5%	1.5%
1999	631	8	10	649	97%	1%	2%

Source: EEA (2001)

The development of the sectoral greenhouse gas emissions between 1990 and 1999 and the relative importance of the main greenhouse gases in the residential and tertiary sectors are shown in Table 4.3.1.

Buildings have a short term economic savings potential of over 20 % (COM(2000) 247 final). However, under the subsidiarity principle, most actions are primarily the responsibility of Member States and the savings are the combined effect of measures at the European and Member States level. Nevertheless, the European Union has initiated important measures to reduce energy consumption from buildings, and hence CO_2 emissions.

The following policies and measures relate to the reduction of CO_2.

4.3.1 Policy Actions

Policy actions to reduce greenhouse gases in the residential and tertiary sectors cover a wide range (see details in Table 4.3.1). Two areas are of particular importance:

Enhancing energy efficiency

In April 2000 the Commission presented an "Action plan to improve Energy Efficiency in the European Community"53, which outlines further policies and measures to

52 The figures presented here are related to the category emissions from fuel combustion in "other sectors, which is essentially the residential and tertiary sector. Please note that the figures only include direct emissions from the sector, i.e. increasing emissions through the larger use of electricity are taken into account in the energy sector. Nevertheless, for reasons of electricity savings they are also relevant for this sector and would change the apparent stability of greenhouse gas emissions in the residential and tertiary sectors to an increase, given the still growing demand for electricity in both sectors.

53 COM (2000) 247 final

promote energy efficiency. While some of these policies and measures remain voluntary and non-legislative, an increasing proportion consists of Community legislation in the form of Directives and regulations.

Measures proposed in the Action Plan include:

- broader, more horizontal measures designed to enhance the integration of energy efficiency into other policy and programme areas, such as regional and urban policy, transport policy, taxation, etc.;

- measures for re-focusing and re-enforcing existing successful Community energy-efficiency measures and

- new common and co-ordinated policies and measures.

A number of these measures have been assessed within the context of the ECCP and have been included in the European Commission's work programme for the next 24 months (see Table 4.3.2).

Energy Performance of buildings

The building sector consumes around 40% of total EU energy. It is estimated that around 22% of the energy consumed in buildings can be saved at zero or negative cost. To realise this potential, the Commission recently proposed a "Directive on the Energy Performance of Buildings"[54], which is currently under consideration by the European Parliament and the Council. If the proposal is adopted in its present form it will impact favourably on the energy efficiency of both new and existing buildings. In addition to requiring an integrated approach to calculate the energy performance of buildings, the proposal requires Member States to apply and update their minimum energy requirements for new and existing buildings and to certify and audit the energy performance of these buildings, while proposing possible improvements. It also requires Member States to ensure the implementation of programmes for the regular inspection of boilers and heating/cooling installations.

The buildings proposal promotes renewable energy sources, CHP, passive heating and cooling and other alternative energy sources by including them in the integrated methodology requirements.

Other Community actions in the buildings sector include the extension of the "Labelling Directive" (92/75/EEC) to include heating and cooling equipment; revision of the minimum energy requirements in the "Boilers Directive" (92/42/EEC) and continued extension and implementation of the "Construction Products Directive" (89/106/EEC). European and international standards and norms in the buildings sector will increase in importance as a means of promoting energy efficiency.

54 COM(2001) 226 final

4.3.2 Programmes

SAVE Programme

Since 1991, the SAVE Programme has been the principal focus of the Community's action in the energy efficiency field. The first phase SAVE I, ran for 4 years up to 31 December 1995 and focused on a non-technological approach to energy efficiency, complementing the technology-based programmes (i.e. THERMIE-JOULE).

The SAVE II programme was adopted in December 1996 (Council Decision 96/7373/EC), with an indicative budget of 45 MECU for the 5 year period 1996-2000. The scope of SAVE II has increased, compared to SAVE I, by the addition of a regional and urban energy efficiency programme and an electricity end-use programme and since March 1998, the programme has also been open to Bulgaria, Lithuania, Poland, Romania, Slovakia and the Czech Republic. It has now been extended to 2002 following the adoption of the 'Energy Framework Programme'. The SAVE programme within the Energy Framework Programme is used in the Energy Efficiency Action Plan to analyse, prepare and test possible future policies and measures, often through the use of studies, pilot actions and evaluations. The RTD Framework Programmes also play an important role in this process by providing useful results from larger research and demonstration projects, in addition to diffusing new technology.

4.3.3 Non CO_2 gases

Both CH_4 and N_2O emissions from the buildings sector are relatively small (only about 2-2.5 % of the amounts released of each of the two gases in total from all sectors). CO_2 emissions constitute more than 97 % of the emissions from this sector. Both types of emissions are mainly linked to boiler operation and improve in parallel with the improvement of boiler efficiency and lowering of the demand. In addition, there is a small but increasing contribution of fluorinated gases mainly due to air conditioning.

Table 4.3.2: Summary of the policies and measures in the tertiary sector

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status[55]	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in Mt CO_2 equivalent)		
						2000	2010	beyond 2010[56]
Framework Directive for Minimum Efficiency Requirement of Electrical and Electronic End-use Equipment	To facilitate achievement of energy efficiency targets through minimum efficiency requirements and/or voluntary agreements	CO_2	Directive	Planned for 2002	EU/Member States			
Revision of the Energy Labelling Directive 92/75/EC	To provide additional and effective information to consumers	CO_2	Directive	Planned for 2003	Member States			10
Agreement with lamp manufacturers to increase sales of compact fluorescent lamps (CFLs) by 2005	To promote sales of energy efficient CFLs	CO_2	Negotiated agreement	In process of implementation	Manufacturers			7
Energy Star Programme and Code of Conduct for Digital TV Services	To reduce energy consumption of information and communication technology	CO_2	Voluntary agreements	Adopted	Manufacturers			13

55 Unless the measure is already implemented, the timescales are indicative and are largely drawn from the ECCP working groups. These actions do not yet have political agreement.

56 The figures in the column are measures from the ECCP, the timescale is uncertain and some measures may be agreed and implemented before the end of the first commitment period.

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status[55]	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in Mt CO_2 equivalent)		
						2000	2010	beyond 2010[56]
Adoption of EEE Directive (Environmental impact of Electrical and Electronic Equipment)	To minimise the environmental impact of electrical and electronic equipment	CO_2	Directive	Planned 2003 – effective on market 2008				
Initiative on energy efficient public procurement	To aggregate demand for energy-efficient technologies in public sector	CO_2	Voluntary agreements/ Directive Contribution to "Greening Public Procurement" Handbook	Planned 2002	European Commission/ Member States		25-40[57] *(5)*	
Energy Demand Management Directive	To promote energy efficiency services for smaller consumers	CO_2	Directive	Planned 2002	Member States (with support from EU)			40-55 *(7)*)
Audit schemes, best practice initiative and voluntary agreements	To provide harmonised methods, indicators, certification, labelling, networks and support	CO_2	Non-legislative	Pilots on-going.	EU			20-35 *(4)*
Technology procurement initiative	To promote the use of procurement	CO_2	Non-legislative	Pilots on-going.	EU			15-25 *(3)*

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status[55]	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in Mt CO_2 equivalent)		
						2000	2010	beyond 2010[56]
EU Recommendations or Guidelines for Member States supporting action	To increase speed of replacement of inefficient equipment, to introduce accelerated depreciation rules, to introduce low or zero VAT for most efficient equipment, to develop initiatives of research	CO_2	non legislative		EU			25
Motor challenge programme	to achieve system optimisation in motor driven processes	CO_2	non legislative	Planned for 2002	EU			30
Directive on Energy performance of buildings	Improve energy performance of new (and partially existing) buildings and	CO_2	Directive	Adopted Implementation by Member states by 2004	Member States	0	35-45[57] *(6)*	
EU Boiler Directive 92/42/EEC	Improve minimum boiler efficiency	CO_2	Regulation	Implemented	Member States	8	22 [1)]	
Labelling and minimum energy efficiency requirements for	Improve share of energy efficient electric	CO_2	Regulation	Implemented	Member States	1.5-2 [2)]	10-15	

57 The quantification of the effect of this measure is taken from the ECCP, it represents a technical potential with some consideration of cost. The achievement of this technical potential will be dependent on political agreement on the measure, the extent of overlap with other measures and public acceptability.

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status[55]	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in Mt CO_2 equivalent)		
						2000	2010	beyond 2010[56]
household appliances	appliances							
Negotiated agreements stand-by losses televisions / video recorders; washing machines	Reduce stand-by losses and increase minimum standards	CO_2	Negotiated agreement	Implemented	Manufacturers		4 [2)]	
Programme – SAVE I and II	Improving end-use energy efficiency	CO_2	Dissemination programme	Implemented	European Commission			

[1)] MURE Database Case Study: Impact of the Introduction of the EU Boiler Directive 92/42/EEC (see www.mure2.com). Scenario B which takes into account future improvements in the building insulation, i.e. a reduced energy demand.

[2)] The saving is based on the emissions per unit of generation for 2010 from the Shared Analysis Project, 1999, and a saving of 14TWh of electricity.

4.4 TRANSPORT SECTOR

Table 4.4.1 Development of greenhouse gas emissions in the transport sector[58]

	CO_2 (Mt CO_2 eq)	CH_4 (Mt CO_2 eq)	N_2O (Mt CO_2 eq)	Total (Mt CO_2 eq)	% CO_2	% CH_4	% N_2O
1990	698	5	12	714	98%	0%	2%
1999	825	3	25	853	97%	0%	3%

Source: EEA (2001)

The Transport sector accounts for more than 30% of final energy consumption and about 20 % of overall greenhouse gas emissions. The development of the sectoral greenhouse gas emissions between 1990 and 1999 and the relative importance of the main greenhouse gases in the sector are shown in Table 4.4.1.

Energy Efficiency is the most important measure to reduce CO_2 emissions in the energy demand sectors. Energy efficiency in the sector has technically improved[59] at about 0.75% per year which unfortunately has been largely compensated by non-technical factors.

In view of the expected further increase of greenhouse gas emissions in transport in the near future, measures in this area are of central importance. Transport policy is therefore one of the most important sectoral policies to mitigate climate change. The main action lines relevant for climate change as concluded in the recent White paper on a common transport policy are:

- Shifting transport from road and air to more environmentally friendly modes
- Improving efficiency through technological development and improved management
- Internalising costs through full payment for the use of infrastructure
- Introducing and promoting alternative energy for transport

The European Climate Change Programme (ECCP) undertook the first quantitative assessments of a number of policy actions in the transport field. A first set of measures has been included in the European Community's Communication on the implementation of the

58 The presentation does not include emissions from International Bunkers (Aviation, Marine). They have increased even stronger in the EU by +36.5% between 1990 and 1999. For the transport sector the construction of the aggregate index was based upon the following single technical indicators: cars (litres/100 km), motorcycles and buses (toe/veh), trucks (goe/ton-km), air transport (toe/passengers), water and rail (toe/ton-km). The comparison indicator shown for the transport sector (final energy for transport per unit of GDP) includes in addition to technical progress also non-technical factors due to changes in lifestyle such as the increased size, weight and power of cars, longer distances driven, lost shares of public transport in the modal split.

59 The technical improvement is measured with a aggregate technical bottom-up energy efficiency index developed in the Odyssee/SAVE project on Energy Efficiency Indicators (see http://www.enerdata.grenet.fr/odyssee). For the construction of the index all energy efficiency progress defined at a technical level of end-uses and appliances are aggregated according to the weight in the total final energy consumption in the sector under consideration.

first phase of the ECCP (COM(2001)580 final). The second phase (until the end of 2002) will explore additional measures such as voluntary agreements and fiscal measures.

4.4.1 Strategy development

Revision of the Common Transport Policy

Future increase in traffic, as projected by the White Paper on a common transport policy[60] (38% freight, 24% passengers between 1998 and 2010) will exacerbate current problems of congestion, pollution and lack of safety. The White Paper tackles rising congestion by developing the modes of transport with spare capacities, which are also those that are more environmentally friendly, notably in respect of lower CO_2 emissions. The White Paper also deals with important issues not directly relevant to climate change objectives such as safety and users' rights.

Following the Gothenburg European Council in June 2001, the modal shift objective has been subsumed in the more general objective of decoupling transport growth from economic growth. The scope of this objective goes beyond the Common Transport Policy and reaches areas such as territorial, urban and industrial planning which are decisive in the control of transport demand. Within the transport system, decoupling will require a better use of existing vehicles and infrastructure, among other things by shifting traffic towards railways, inland waterways and short sea shipping.

Greenhouse gas emission reductions will be mainly sought through modal shift, with the objective of going back, by 2010, to the 1998 modal split and through improved efficiency in the use of the transport system. Instruments such as pricing and taxation, market regulation and investment in infrastructure and Intelligent Transport Systems will be aimed at rebalancing the attractiveness of the different modes. An approximate estimate of the emission reductions that could result from the application of the measures foreseen in the White Paper is 135 Mt CO_2 eq per year with respect to the emissions expected otherwise in 2010.

Regulatory measures aim at the opening of markets, at establishing a level playing ground for all the modes and at reducing either administrative burdens or co-ordination problems. A legislative package came into force on 15 March 2001 within the program for the revitalisation of railways (Directives 2001/12, 2001/13, 2001/14). It will open EU TEN freight railway networks to international operations by 2003, and all railway freight networks by 2008. The White Paper proposes further opening of the rail markets by allowing national cabotage by international operators. In the road transport sector, the White Paper proposes to better enforce social and safety rules through tightening of controls and penalties. Within the Single Sky initiative, air traffic control co-ordination should reduce delays and energy consumption. Intermodality should be promoted by the proposed harmonisation of procedures, the standardisation of equipment and by enhanced financial support (Marco Polo programme). Collective means of land passenger transport should benefit from the adoption of a new draft regulation on public service requirements and on the award of public service contracts, including compensation for public service obligations (COM(2000)7).

60 "European Transport Policy for 2010: time to decide", COM(2001)370 final

Pricing should reflect the real costs of transport including greenhouse gas emissions and other external costs. A gradual harmonisation of pricing principles should be carried out at EU level for all modes of transport in a significant move from a previous approach largely focussed on road transport. The European Commission intends to propose a Directive in 2002 providing a common methodology for determining costs and charge levels. Tax harmonisation for the professional use of diesel will be proposed to support fair pricing. These instruments will open the possibility of internalising the external costs of greenhouse gas emissions.

Infrastructure investment should favour those modes, which respect the environment most, notably freight railways. A first revision of the Trans European Networks proposed in parallel with the White Paper on a common transport policy will include measures to develop the rail freight network. The financing of these projects should be facilitated by cross financing between road infrastructure and railway projects. The development of the TEN High Speed Railway network should increasingly provide alternatives to air transport. Intelligent Transport Systems equipment should be developed through various programmes of which the most ambitious is the Galileo satellite navigation system, which is now entering its development stage.

Communication on Air Transport and the Environment

In December 1999, the Commission adopted a Communication, 'Air Transport and the Environment: Towards Meeting the Challenges of Sustainable Development' (COM(99) 640 final). This communication is the first to specifically address the environmental impacts of air transport and it analyses and identifies ways for developing coherent and integrated policy action for the EU in the air transport field. This Communication will form the point of reference for the Commission's next 5 year work programme in this area. It includes initiatives targeting the impact of aviation on Climate Change, in particular negotiated agreements and economic instruments, to reduce the environmental impact of air transport.

Biofuels Directive

A Commission proposal for a Directive on the promotion of biofuels[61] foresees a gradual increase in the market share of biofuels in transport to 6% in 2010. In support, the Commission proposes derogation from excise duty on certain mineral oils containing biofuels and on biofuels. The contribution of biofuels according to these proposals would amount to around 17.5 Mt by 2010. This would result in the avoidance of CO_2 emissions of about 35-40 Mt.

4.4.2 Policy Actions

Strategy for improving the fuel efficiency of passenger cars (COM(95)689 final)

Voluntary agreements

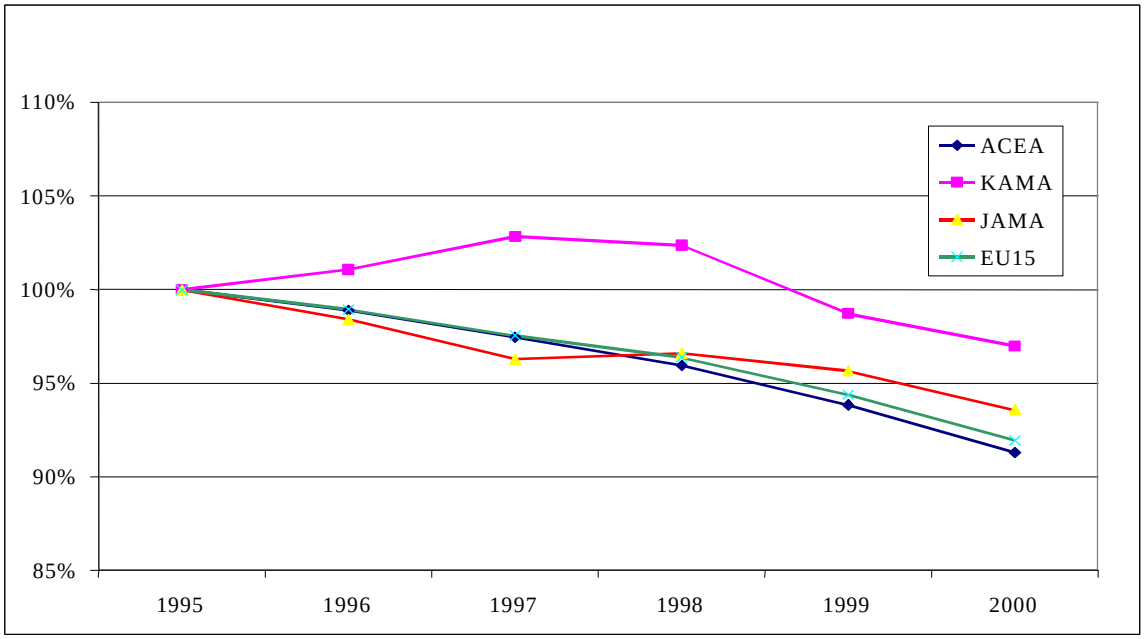
In December 1995, the European Commission launched a strategy for improving the fuel efficiency of passenger cars (COM(95)689 final) through labelling and fiscal measures. The strategy aimed to reduce emissions to 120g/km as an average for newly registered cars

61 Directive on the promotion of the use of biofuels for transport, COM(2001)547

in the EU by (2010). Substantial progress has been made towards achieving this initiative by means of three voluntary agreements which have been signed with European (*European Automobile Manufacturers Association – ACEA*), Japanese (*Japanese Automobile Manufacturers Association – JAMA*) and Korean motor manufacturers (*Korea Automobile Manufacturers Association – KAMA*), setting a target of 140 g/km by 2008 (European producers) and 2009 (Asian producers), respectively.

A recent energy modelling study[62] has estimated that the impact of the voluntary agreement would be to reduce EU CO_2 emissions by 82 Mt CO_2 eq. The joint monitoring report by the ACEA and the European Commission Services from November 2001 states that from an average for new cars of 186 g/km in 1995, CO_2 emissions reduced to 169 g/km in 2000. In each year since 1995 sizeable cuts have been achieved, culminating in a 2.9 % reduction from 1999 to 2000. ACEA CO_2 figures by fuel-type show that, between 1995 and 2000, new gasoline-fuelled cars reduced average CO_2 emissions by 5.9 %, and for diesel engine there was a reduction of 10.8 %. This corresponds to 177 g/km and 157 g/km respectively in 2000. Figure 4.4.2. shows the trends of the average specific CO_2 emissions of new passenger cars for each association and the European Union.

Figure 4.4.2 Trends of Average Specific CO_2 Emissions of new passenger cars for each association and the EU



Source: COM(2000)643 final

While the main part of this period was before the signing of the agreements, and other factors such as national mineral oil and ecotaxes may also have had an important influence[63], these numbers indicate that there is indeed scope for sizeable emission reductions, in particular as a large part of the technical progress over the 5 year period

62 The Shared Analysis Project, Vol5. EU Energy Outlook to 2020. Energy in Europe Special Issue, November 1999 (www.shared-analysis.fhg.de).

63 The ACEA for 2000 show that the overall specific emissions have fallen to 169 g/km within the ACEA fleet, which is the combined result of the voluntary agreements undertaken, the eco taxes on carburettor fuels which have been introduced in a variety of Member States and the rising oil prices in 2000.

considered has still been compensated by the increase in comfort factors such as engine size and power. An extension of the voluntary agreement to light commercial vehicles is currently being considered.

Vehicle labelling scheme "Cleaner Drive Project"

The overall goal of CLEANER-DRIVE is to specify and test actions that remove barriers to market entry of new generation vehicles, with a particular focus on information barriers. Specific objectives are:

- To pilot the dissemination of credible information on vehicle options to market actors through national Web-sites, based on a common European framework for data inputs.
- To develop a robust European methodology for vehicle environmental rating that draws attention to cleaner vehicles and technologies, and to pilot its use in a Web-based tool.
- To define a scheme for eco-labelling of cars, based on the rating methodology, if possible with negotiated voluntary acceptance from stakeholders.
- To secure stakeholder and institutional support for the continuation of eco-labelling, rating and information actions in the longer-term, with dissemination to attract interest from other Member States.
- To identify the conditions under which a commercially viable infrastructure for gaseous fuels could be made available for long-distance road transport, including policy support such as short-term fiscal incentives and the introduction and harmonisation of standards and regulations.

The policy is aimed to be implemented in Summer 2001 by 15 institutes all over Europe.

Air Quality Legislation

Motor vehicles emit a range of pollutants including, nitrogen oxides, unburnt hydrocarbons, particulate matter, carbon monoxide, benzene and other toxic exhaust emissions. At the European level, the first phase of the Auto Oil programme (Auto Oil I) produced instruments on vehicle emissions from light commercial vehicles (Directive 98/69/EC) and from compression-ignition engines as well as those fuelled with natural gas or liquefied petroleum gas for use in vehicles (Directive 99/96/EC), and on fuel quality (Directive 98/70/EC). The aim is to cut atmospheric pollution from private cars and light commercial vehicles by 60-70% in 2010, relative to 1990 levels. The follow-up programme, Auto Oil II, did not lead to additional legislation but helped to analyse the situation further. Although climate change objectives are not the major objective of air quality activities, many of the policies and measures that are possible in this area (e.g. improved vehicle efficiency, demand management techniques) will also lead to a reduction in greenhouse gases. The European Commission launched a new package of technical analysis and policy development in the communication “The Clean Air for Europe (CAFE) Programme: Towards a Thematic Strategy for Air Quality” (COM(2001)245 final), which will lead to a thematic strategy on air pollution as foreseen in the 6th Environmental Action Programme.

Provision on low sulphur content in motor fuels

The above mentioned Directive 98/70/EC prescribes that from 2005, sulphur content of petrol sold in any Member State must not exceed 50 parts per million (ppm). Fuels with low sulphur content make the use of very efficient engine technologies, such as direct injection motors for gasoline, possible and furthermore facilitate the use of better catalysts, thereby reducing the emissions of ozone precursor substances. The Commission has proposed a revision of Directive 98/70/EC that aims to take the sulphur content down to 10ppm between 2005-11. The First Reading in the European Parliament and the adoption of a Common Position in the Council of Ministers are not yet complete.

Research project "Advisors and Trainers"

This project aims to develop driver assistance systems as well as training schemes in order to promote reductions in fuel consumption.

4.4.3 Non CO_2 gases

In the transport sector non CO_2 gases represent a minor component of the emissions: CH_4 emissions from transport in 1999 were less than 0.4 % of the overall sectoral emissions (about 0.8 % of all methane emissions), while N_2O emissions are more relevant with approximately 3 % of the sectors overall greenhouse gas emissions (more than 7 % of all N_2O emissions). Two fields are of particular relevance for the non-CO_2 gases:

- The problem of the increase of N_2O emissions from cars by increasing penetration of catalytic converters. N_2O emissions from vehicles equipped with modern catalysts are thought to be lower than those equipped with early generations of catalysts but more data on emissions factor for European cars are needed.

- Hydrofluorocarbons in air conditioning systems of cars (air conditioning systems in cars have also impact on fuel consumption hence on CO_2). Under the ECCP it is proposed to integrate this in the ACEA agreements from which air conditioning is absent now.

Table 4.4.3: Summary of the policies and measures in the transport sector

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in Mt CO_2 equivalent)			
						2000	2005	2010	beyond 2010[64]
Fiscal measures		CO_2	Taxes, Road-Pricing	Under preparation	EU/Member States				17
Environmental Agreement with car industry on reductions of CO_2 emissions from Light Commercial Vehicles	Reduce average CO_2 emissions of light vehicles	CO_2	Voluntary agreement	Under preparation	EU/ Manu-facturing industry				*(5-10)*
Infrastructure charging	Structure and levels of charging for all modes of transport	Primarily CO_2	Framework directive	Under preparation	EU/Member States				40-60
Technological improvements in passenger cars and fuels	Environmentally Enhanced Vehicle concepts, improved mobile air conditioning, alternative fuels etc (not in ACEA agreement)	Primarily CO_2	Various		EU/Member States				*(40)*
Modal shift	Shift of transport from	CO_2	Directives/	Proposed	EU/ Member				

64 The figures in the column are measures from the ECCP, the timescale is uncertain and some measures may be agreed and implemented before the end of the first commitment period. The figures in italics are the potential at a cost of more than 20 Euros per tonne

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in Mt CO_2 equivalent)			
						2000	2005	2010	beyond 2010[64]
	road/air to rail/water		regulations/ funding		States				
Promotion of biofuels	Increase penetration rate of biofuels	Primarily CO_2	fiscal	Proposed October 2001	EU/Member States			35-40	
Voluntary agreements with European, Japanese and Korean car manufacturers	Reduce average CO_2 emissions of newly sold cars to 140 g/km until 2008/2009 (25 % reduction compared to levels in the mid-90s)	CO_2	Voluntary agreement	Implemented	EU Com. together with car manu-facturers' associations	6-7[65]	31	82[66]	
Air quality legislation, e.g. Auto-Oil I and II	Regulations and Research on pollution, i.e. ozone precursors, indirect effect on fuel consumption	Ozone precursors indirectly CO_2	Regulation, Research	Implemented	EU/Member States				
Air quality legislation, Directive 98/70/EC*	Limits sulphur content in road fuels to 50 ppm	CO_2, 0_3 precursors	Regulation	implemented	EU/Member States				
Car Labelling Directive 1999/94/EC	Indication of CO_2 emissions for car purchasers	CO_2	Labelling	adopted	EU/Member States + institutes				

65 Estimate from the ACEA/European Commission Monitoring Report

66 Shared Analysis Project

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in Mt CO_2 equivalent)			
						2000	2005	2010	beyond 2010[64]
Revision of Common Transport Policy	Integration of Sustainable Development	Primarily CO_2	Strategy	under preparation	EU/Member States			135[67]	
Communication "Air Transport and the Environment"	Encounter growing importance of air transport for climate change	CO_2	Strategy Communi-cation	adopted	EU/Member States			-	
Communication on Clean Urban Transport		CO_2	Strategy	under preparation	EU/Member States			-	
Motor Challenge Programme Initiative[68]									

67 An approximate estimate of the emission reductions that could result from the application of the measures foreseen in the White Paper with respect to the emissions expected otherwise in 2010

68 Identified as a measure for possible further Community action under the second phase of the ECCP

4.5 INDUSTRY SECTOR

Table 4.5.1 Development of greenhouse gas emissions in industry[69]

	CO_2 (Mt CO_2 eq)	CH_4 (Mt CO_2 eq)	N_2O (Mt CO_2 eq)	F-gases (Mt CO_2 eq)	Total (Mt CO_2 eq)	% CO_2	% CH_4	% N_2O	% F-gases
1990	787	2	120	47	956	82%	0%	13%	5%
1999	724	2	56	62	844	86%	0%	7%	7%

Source: EEA (2001)

The industrial sector has been the sector from which greenhouse gas emissions (see Table 4.5.1) have been decreasing most for a variety of reasons including the switch from manufacturing industry to services, internal structural changes to less energy intensive industries and substantial progress in energy efficiency due to the increase of competition. The measure of choice in most Member States were voluntary or negotiated agreement which were carried out with a wide range of variants concerning the negotiation process, the targets, the monitoring procedures and the threats in case of non-compliance. Unlike the transport sector and the electronic equipment sector, where the European Commission has concluded agreements directly with the associations of manufacturers, in the industrial sector in general no agreements were concluded. The reduction of N_2O from the industrial sectors (mainly from the production of adipic acid) occurred also partially through voluntary agreements (VAs) and partially through regulation at the level of the Member States. Table shows the strong reduction of N_2O which occurred in this sector through this measure. The development of HFC emissions from the sector is less favourable.

Energy Efficiency is the most important measure to reduce CO_2 emissions in the energy demand sectors. Energy efficiency in the sector has technically improved[70] at

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69 The greenhouse gas emissions include next to emissions from the manufacturing industry and the construction industry also emissions from industrial processes and from solvents. Please note that the figures only include direct emissions from the sector, i.e. increasing emissions through the larger use of electricity are taken into account in the energy sector. Nevertheless, for reasons of electricity savings they are also relevant for this sector and would make the decrease of greenhouse gas emissions in industry less important.

70 The technical improvement is measured with a aggregate technical bottom-up energy efficiency index developed in the Odyssee/SAVE project on Energy Efficiency Indicators (see http://www.enerdata.grenet.fr/odyssee). For the construction of the index all energy efficiency progress defined at a technical level of end-uses and appliances are aggregated according to the weight in the total final energy consumption in the sector under consideration. For the industrial sector the construction of the aggregate index was based upon the following single technical indicators: steel (toe/t), cement (toe/t), paper (toe/t), the production index for all other branches (10 branches). The comparison indicator shown for the industrial sector (final energy per industrial value added) includes in addition to technical progress also non-technical factors, mainly structural changes in industry. These can either compensate or enhance the technical progress in energy efficiency.

more than 1% per year, which has been partially compensated, partially enhanced by non-technical factors.

Reduction of greenhouse gases from the industrial sectors can also occur through activities that save materials through the whole life cycle of products, for example renewable raw materials and recycling. In particular an increased use of solid timber, engineered wood and wood-based panels, paper and wood fuels has a positive impact on the overall carbon balance by increasing the amount of carbon stored in wood products and reducing GHG emissions during production processes, compared to other energy-intensive materials (steel, cement, bricks and plastics) (cf. IPPC Report on LULUCF, May 2000). Current strategies focus increasingly on this way because it also offers also the advantage of reducing local pollution.

4.5.1 Strategy development

Green Paper on integrated product policy (COM(2001) 68 final)

This Green Paper presents a strategy with the aim to promote a gradual increase in the environmental quality of goods and services in a life cycle perspective. This strategy has been put together with a view to a broad debate both on strategy itself and all its elements. Details of actions and instruments covering all aspects of integrated product policy are presented in the annex to the green paper.

The following policies and measures relate to the reduction of CO_2.

4.5.2 Policy action

Integrated Pollution Prevention and Control (IPPC) Directive

The most relevant Community Directive in the area of industrial installations is Council Directive 96/61/EC concerning integrated pollution prevention and control (IPPC)[71]. It covers a wide range of activities such as plants for the production and processing of metals and mineral products (steel, non-ferrous metals, cement, ceramics, glass etc.), refineries and chemical plants, pulp and paper mills and food processing installations.

The IPPC Directive lays down a certain number of general obligations for operators of installations, including two that are particularly relevant:

- To take preventive measures against significant emissions of nitrous oxide, methane and fluorinated greenhouse gases, in particular through application of the Best Available Techniques (BAT).
- To use energy efficiently.

The tool that is used to ensure that the general obligations are fulfilled is a permit. If the authorities are not convinced that the installation complies with these obligations, they will not grant any permit. All new or substantially changed installations have had to comply since November 1999, whereas Member States have until 30 October

71 OJ L 257, 10.10.1996, p. 26

2007 to bring the remaining "existing installations" in full compliance with the Directive.

The IPPC Directive takes an integrated approach to pollution prevention and control. This means that operators and authorities should determine the measures that yield the best results for the environment as a whole. Efforts should be concentrated to those aspects of the environmental performance of the installation that are most harmful. The best solution in an individual case is often influenced by local factors (i.e. the technical characteristics of the installation concerned, its geographical location and the local environmental conditions).

In order to help operators and authorities to make sure that the general obligations are met, the European Commission is required to organise an exchange of information on best available techniques. This work is carried out through a close co-operation with government authorities and technological institutes and experts from the industries concerned. It is structured according to different sectors and for each sector a technical working group prepares a BAT Reference Document ("BREF") containing conclusions on the techniques that currently are considered to fulfil the "BAT criteria", not only for direct emissions but also for other performance aspects such as the generation and consumption of electricity and steam. When determining BAT in a specific licensing case, the BREFs should be used as a starting point but the authority should also take account of local considerations. BREFs are made available on the Internet.[72]

While most Member States have long experience of regulating direct air emissions, they all have very limited experience of regulating energy efficiency in operating permits. The European Commission has identified this as a major implementation challenge and in co-operation with the Member States it will promote the development of good practice in this field.

At this stage it is not possible to predict the quantitative effect that the implementation of the IPPC Directive will have, in terms of direct and indirect greenhouse gas emissions. A study on the potential for Energy Management and Optimisation in Industry concerned by IPPC was carried out in 2000[73].

The ECCP made a clear recommendation to make better use of the existing IPPC Directive. The Directive introduces an obligation to prevent all forms of pollution and to use energy efficiently. The technical reference documents elaborated on EU level, the so-called BREFs, should help bring about greenhouse gas emission reductions and a more efficient use of energy in the sectors concerned. National authorities granting the permits shall ensure that greenhouse gas emissions are prevented or controlled, unless they are subject to the future emissions trading system for greenhouse gases.

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72 http://eippcb.jrc.es/pages/FActivities.htm

73 'Study on energy management and its potential optimisation in the industrial sectors considered by Council Directive 96/61/EC', AEA Technology for DG Environment, 2000 http://europa.eu.int/comm/environment/ippc/index.htm#ippc

Energy Efficiency Action Plan

Measures proposed for the industrial sector under the Energy Efficiency Action Plan are summarised with their time frame in Table 4.5.2 below.

Table 4.5.2: Proposed measures under the Energy Efficiency Action Plan

Industry (including the electricity and gas supply industry)

All industrial sectors including the energy transformation sector are included in the sector dealing with industry. Energy-intensive as well as less energy-intensive industry comprise the enterprises dealt with here. In addition to information dissemination and best practice, Long –term Agreements, audits, technology procurement and innovative financing schemes are important elements in industrial energy efficiency actions.

Definition of Action	**Current Status and timetable**	**Action by**	**Comments, (financing, impact, etc.)**
a. Programmes			
Draft Communication on Long- Term Agreements.	Launch 2000.	European Commission, Council & Parliament.	Application in collaboration with Member State industry.
Long-Term Agreement at EU level with the chemical industry.	To be negotiated during 2001.	European Commission with Member States and industry.	Preceded by a SAVE pilot project or feasibility study. (Cost 200 k€.)
Long-Term Agreements in steel, pulp and paper, cement, textile, energy supply industry.	To be negotiated during 2001-2002.	European Commission With Member States and industry.	Preceded by pilot projects or feasibility studies.
Promotion of Electric Motor System database **EuroDEEM** to end-users; linked to VSDs, pumps, fans and compressors.	To be carried out during 2001.	European Commission With Member States.	Development cost of 600 k€ from the 4th RTD Framework Programme.
Promotion of energy services and agreements in the electricity supply industry to foster demand-side measures.	Amended Proposal for a Directive on Rational Planning Techniques.COM (97) 69 final under review.	European Commission, Eurelectric and individual ESI companies.	Joint study - Commission/Eurelectric on energy services; pilot actions.
Use of technology procurement at EU level for equipment procurements.	EU pilot actions on procurement 2000-2001.	European Commission with Member States and industry.	Cost of pilot project /feasibility study 300 k€).
Energy audits in Member States reviewed and analysed. Pilot actions to co-ordinate and harmonise methods.	Study 2000. Community Initiative 2001.	European Commission in collaboration with Member States, industry, tertiary.	Study cost 200k€.
Industry Best Practice Programme.	Pilot action 2000-2001.	European Commission, Member States, nat. agencies, industry.	Co-ordination with EMAS, IPPC Directive, etc. (See "Buildings").

Flexibility instruments

Flexibility instruments were discussed in Section 0, and included in the Table for the Energy Sector.

4.5.3 Studies

Study on the role of Energy Management in Integrated Pollution Prevention Control

In this study, the potential energy savings options in processes covered by the IPPC Directive were examined[73]. These opportunities also offer the potential for reduced emissions, largely by the reduction of combustion-related emissions. The study covered all IPPC sectors in the 15 Member States. The study concluded that cost effective and currently available energy efficiency measures which are technically proven, still offer the potential to make a contribution to reduction of pollution in the EU. The study identified a number of opportunities, of which Combined Heat and Power (CHP) was a major one, and gave figures for savings and implied costs. In many cases, the opportunities implied a large capital cost but were cost-effective in terms of the energy saved.

Study on integrated product policy

In 1997, the European Commission contracted a study on integrated product policy (IPP)[74], characterising it as a comprehensive approach, addressing actions, actors and impacts along the whole life cycle of products. The study looked at the development of IPP in Member States and the use of the product life cycle concept by industry and consumers. The authors put forward a general analysis of IPP, constructed around five "building blocks" of policy initiatives, on the themes of waste, innovation, markets, information, responsibility. They saw the role of an EU policy as articulating a common vision of what IPP is trying to achieve, diffusion of best practice, integration of the concept in EU policies, and some specific EU IPP measures.

A follow-up study on recent developments in IPP policies in Member States and implications for EU policy[75] confirmed that the majority of Member States do not yet have an active policy. For those which do, despite there being reasonable consensus on key principles underpinning IPP, there is considerable diversity as regards implementation.

4.5.4 Relation to ECCP

Industry under the European Climate Change Programme (ECCP) is the responsibility of the Working Group 5 which concentrated on the following issues:

- Fluorinated Gases
- Renewable raw materials (RRM)
- Voluntary agreements (VA)

For fluorinated gases, the group agreed that although they make up only a small percentage of the total emissions, the potential growth warrants specific actions from regulators and industry.

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74 Ernst & Young/SPRU for the European Commission 1998, Integrated Product Policy. Executive summary see www.europa.eu.int/comm/environment/ipp/ home.htm).

75 Ernst & Young for the European Commission 2000, Developing the Foundation for Integrated Product Policy in the EU. Download as above

The renewable raw materials group focussed on their use in the chemical industry sector. As well as having benefits in greenhouse gas reductions, RRMs were seen as a new business and employment opportunity.

For voluntary agreements, a distinction is made between those that are process emission based and those that are product emissions based. Experience to date suggests that in some cases Member State level VAs are more efficient and in others more efficient at EU level. VAs can be seen as long-term instruments for addressing climate change and have a potential role both in parallel to emissions trading and the Kyoto mechanisms and with a direct link to them.

The Joint Services Working Group mentioned in the discussion of the tertiary sector looked at the rational use of energy in industrial processes.

Measures proposed from the ECCP working groups are included in the summary table below.

Table 4.5.2: Summary of the policies and measures in the industry sector

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						2000	2010[76]	Beyond 2010[77]
Industrial Processes Long term agreements with energy intensive industries Comprehensive energy audit and management scheme (E2MAS) Adapting existing IPPC Directive active energy services for SMEs	renew old and inefficient production plants for energy intensive industries Energy efficiency in non-core areas of industry and SMEs	Mainly CO_2	Agreements and regulation	Proposed 2001-02 2001-03 2002	EU/Member States			40*(60)*

76 The potential in italics is at a cost of more than 20 Euros per tonne CO_2

77 The figures in the column are measures from the ECCP, the timescale is uncertain and some measures may be agreed and implemented before the end of the first commitment period. The figures in italics are the potential at a cost of more than 20 Euros per tonne

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						2000	2010[76]	Beyond 2010[77]
Fluorinated gases • Framework directive for improved containment of F-gases • Links to other EU legislation (IPPC, WEEE, End of life vehicles) • Voluntary agreements • Development of alternative fluids and Not in Kind technologies • Sector specific recommendations	Improve monitoring and verification, improve containment and apply marketing and use restrictions	HFC, PFC and SF_6	Regulation and agreements	Proposed for 2002 2001-02 2002 2002	EU and Member States		30 *(20)*	
RRM Secure supply through inclusion of RRM in development of CAP Promote research and fiscal incentives Help commercialisation through EU standards and public procurement policy Include RRM in EU ECO-labelling scheme to boost consumer awareness Develop political strategy with White Paper and benchmarking scheme Include RRM in emissions trading	To promote the greater use of RRM in the EU	Mainly CO_2	Research, consumer information, support		EU			
Voluntary agreements Framework guidelines for good practice Framework for VAs at EU-level (possibly a Directive)	Promote VAs as part of an appropriate mix of policy instruments and promote best practice	All	Agreements	Proposed Guidelines 2002 Directive 2003	EU, industry, Member States			
Policy Action – IPPC Directive*	Integration of pollution issues into permits for	All gases	Regulation[1]	Implemented	EU/Member			

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						2000	2010[76]	Beyond 2010[77]
	plant operation			Being implemented by Member States	States			
Policy Action- Voluntary agreements	Recovery rates for waste packaging	All gases	Framework		EU/Member States			
Policy Action – EMAS*	Environmental auditing	CH_4	Voluntary agreement	Implemented	EU/Member States			

4.6 AGRICULTURE AND FORESTRY

4.6.1 General aspects

Table 4.6.1 Development of greenhouse gas emissions in agriculture[78]

	CO_2 (Mt CO_2 eq)	CH_4 (Mt CO_2 eq)	N_2O (Mt CO_2 eq)	Total (Mt CO_2 eq)	% CO_2	% CH_4	% N_2O
1990	3	191	222	415	1%	46%	53%
1999	2	177	218	397	1%	45%	55%

Source: EEA (2001)

The development of the sectoral greenhouse gas emissions between 1990 and 1999 and the relative importance of the main greenhouse gases in agriculture are shown in Table 4.6.1.

In 1990, agricultural emissions were about 11% of all greenhouse gas emissions in the EU. The main sources in agriculture are:

- N_2O emissions from soils;
- CH_4 emissions from enteric fermentation and
- CH_4 and N_2O emissions from manure management.

In addition, the use of biomass and the impact of carbon sequestration in forests are important issues.

The issues in agriculture and forestry are diverse and none of the policy actions are targeted specifically at greenhouse gas reduction. Assignment of savings to a particular policy is therefore difficult.

4.6.2 Policy Actions

Agenda 2000

In July 1997, the European Commission published the Agenda 2000 document which included proposals for the reform of the Common Agricultural Policy (CAP), and after wide discussion a further package of CAP reforms was adopted in 1999. The new CAP is a further step towards supporting the broader rural economy rather than agricultural production and has two main aims:

- To achieve increasing market orientation and ensure the competitiveness of the EU agricultural sector, both on the Community market and on export markets, as a precondition for a viable European agri-food sector
- To reinforce the structural, environmental and rural development aspects of sustainable agriculture.

78 The presentation does not include figures for land-use change.

Agenda 2000 also continued to strengthen the rural development policy (see below).

Another measure related to the Market Policy under CAP is non-food biomass production on set-aside land. The non-food set aside scheme has been running since 1993 and provides the opportunity to increase the production of energy crops which can replace conventional fossil fuels. Such crops can be grown on set-aside land and are eligible for compensation.

The 1992 CAP Reforms have already had a noticeable impact on greenhouse gas emissions from the agricultural sector, which have dropped by 4% between 1990 and 1999. This results from the changes in agricultural practices and production such as:

- Changes in livestock types and numbers.
- Increases in livestock productivity.
- The shift from production based support mechanisms to direct area payments in arable production which has tended to lead to an optimisation and overall reduction in fertiliser use.

Reduction in fertiliser use is also due to directives such as the nitrate directive and to the extensification measures included in the agro-environment programmes.

Rural Development Policy

In order to comply with European Commission Regulation number 1750 (99) laying down detailed rules for the application of Council Regulation number 1257 (99) on support for Rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) concerning "usual good farming practices", Member States should set out verifiable standards in their rural development programming documents which should entail compliance with general environmental requirements. In the interest of proper programming of rural development spending and proper implementation of programmes, Member States must thus have fulfilled their obligations under the Community policies and schemes for protecting and improving the environment. The rural development programming documents must clear an irrevocable commitment to guarantee consistency of their programmes with the existing community environmental protection legislation.

European Commission regulation number 1750 (99) laying down the detailed rules for the application of Council Regulation specifies the following provision (Article 6 (1), last indent of the annex): the need to describe "the extent to which the strategy takes into account all relevant international Community and national environmental policy obligations, including those relating to sustainable development, in particular the quality and use of water, conservation of biodiversity including on-farm conservation of crop varieties, and global warming".

EU has encouraged measures with positive effects on environment, such as farming practices compatible with environment, enlargement of forestry areas and afforestation of arable lands and burned areas. Such measures have been implemented as accompanying measures of the CAP in 1992 and as core elements of rural development programmes for the period 2000-2006.

The latest CAP Reforms include the setting up of a new framework for Community support for sustainable rural development (Council Regulation 1257/1999) which covers both geographical regions covered by Objectives 1 and 2, as defined by the Community Structural Funds (Council Regulation 1260/1999) and others. This support aims to create a stronger agricultural and forestry sectors. More specifically, these are for regions whose development is lagging behind and regions facing structural difficulties. The overall objectives are to improve the competitiveness of these rural areas whilst maintaining the environment. A number of selected measures have the potential to influence greenhouse gas emissions:

- Agri-environmental schemes. The measure provides support for agricultural production methods designed to protect and improve the environment and to maintain the countryside. Farmers observe a minimum level of environmental practice as part of the support regimes, but any additional environmental services, beyond the basic level of good agricultural practice and respecting European environmental legislation (such as Natura 2000 and the Nitrates Directive), should be paid for by society through agri-environmental programmes, which form a compulsory part of Rural Development policy. This means that all farmers should follow compulsory laws in relation to pesticide use, to fertiliser application, water use and, where appropriate, national or regional guidelines on good farming practice.

- Compensatory support. This may also be given to farmers in less-favoured areas (e.g. mountain areas, areas in danger of abandonment of land-use and where the conservation of the countryside is necessary) and areas with environmental restrictions. This support aims to ensure continued agricultural land use, maintenance of the countryside and promotion of sustainable farming systems. In any case beneficiaries are required to comply with European environmental legislation.

- Investment in agricultural holdings. Support in agricultural holdings can contribute to preserve and improve the natural environment, hygiene conditions and animal welfare standards.

- Training. Training could make familiarise farmers with modified production methods to reduce greenhouse gas emissions.

Forest strategy for the European Union

Support for forestry is part of the EU forestry strategy[79], aimed at ensuring the protection and sustainable management and development of forests in the European Union. This strategy recognises the multifunctionality of forests and focuses on the essential role played by forests in ecological, economical and social terms. The aids are available for woodlands, which are owned by individuals, associations or local authorities in the framework of the Rural Development policy (Council Regulation 1257/1999). They cover the following measures:

- Investments in forests to improve their economic, ecological or social value.

79 "Council Resolution of 15th December 1998 on a forest strategy for the European Union (1999/C 56/01", Dec 98.

- Investments designed to improve and rationalise the production, processing and marketing of forestry products.
- Investments related to the use of wood as raw material, limited to operations prior to industrial processing.
- Promotion of new outlets for processing and marketing forestry products.
- Creation of forester's associations aimed at helping their members to improve forestry management.
- Restoring the potential of forestry production following damage by natural disasters and fire, and introducing appropriate preventive measures.
- Maintaining and improving the ecological stability of forests in areas which act to protect the public interest, and maintenance of fire breaks through agricultural measures.

In addition, support may be granted for the afforestation of agricultural land, provided that the plantation is adopted to local conditions and compatible with the environment.

Other forestry measures

A number of other forestry measures can have an indirect effect on greenhouse gas emissions, these include:

Forest fires

The reg. 2158/92 on protection of Community forests against fire has set up a coherent action framework, mainly for prevention of forest fires. This framework is consisting in a classification by Member States of their territory according to high, medium and low risk areas as well as the establishment of national and regional forest-fire protection plans for the areas classified as medium and high risk. Subject to the existence of such plans, the Community is supporting :

- Measures to set up or improve prevention action with particular emphasis on the launching of protective infrastructures (forest paths, tracks, water supply points, firebreaks).
- Measures to identify the causes of fires and the means of combating them (studies, information campaigns).
- Measures to set up or improve forest monitoring systems with emphasis on the installation of fixed and mobile monitoring facilities and purchase of communication equipment.
- Accompanying measures, such as training of highly specialised personnel, analytical studies and pilot or demonstration projects to test new methods and technologies.

Furthermore a common forest fire information system has been established to collect information on forest fires, their causes and to improve the understanding of forest fires and their prevention.

Protection of forests against atmospheric pollution

The Council Regulation 3528/86 and its amendments forms the legal basis for a systematic network which serves as the basis for a periodic and harmonised assessment of forest damage (level I) and the intensive monitoring of forest ecosystems based on permanent representative experimental plots (level II). Based on a common methodology, the Member States are collecting relevant information about forest condition and are presenting the data from their observation network to a centralised co-ordination structure of the European Commission which is ensuring the processing, evaluation and dissemination of all relevant information in a coherent way. This Programme has shown the state of the forest and the development over the years covering almost the whole area of Europe making it an unique source of data.

Agricultural and forest research

Agricultural and forest research is covered within the Community's RDT Framework Programme. Under the 4th Framework Programme research was supported under the FAIR Programme as well as under the Environment and Climate Programme. Under the 5th Framework Programme this area of work has been included in the Quality of Life and Management of Living Resources Programme. Greenhouse gas and carbon related aspects are taken care in the Programme Environment and Sustainable Development in the areas dealing with ecosystem vulnerability and the interactions between ecosystems and the carbon and nitrogen cycles.

4.6.3 Relation to ECCP

The agriculture working group has been established and meetings held to examine potential mitigation options. The working group discussed the options set out in the Sectoral Objectives study (see below) and recognised that there is heterogeneity of conditions within Europe. The issue of reform of agriculture to meet changing market conditions, environmental concerns and consumer preference is an important one. It has been recognised by the European Climate Change Programme (ECCP) working group that greenhouse gas concerns need to be addressed but will not be the main driving force. A significant reduction is possible due to a reduction of animal stocks by changing consumer behaviour (less meat and milk, milk products). Agricultural policy cannot change the consumer behaviour but there are some elements within CAP, which promote a higher consumption of meat and milk products (subsidies of butter for bakery and ice-cream industry). These elements should be considered in the context of the midterm review. The implementation of measures to mitigate greenhouse gas emissions from agriculture relies on information and (financial) incentives. Good integration with other environmental policies (N2O reduction) and climate change policies in other sectors (bioenergy) is essential. The climate aspect should be integrated more in CAP[80], especially in the rural Development Policy.

The ECCP also includes a working group on renewable raw materials (defined as materials derived from agriculture and forestry and being used for purposes other

80 When discussing milk quotas, methane production may be one of several aspects, which should be taken into consideration.

than nutrition). This working group concluded that the scope for greenhouse gas reduction from the use of renewable raw materials is small in the short term, but over the longer term could be significant. Energy crops were not considered as part of this working group.

4.6.4 Studies

Economic Evaluation of Emission Reductions of Nitrous Oxide and Methane in Agriculture in the EU

This study is part of the Sectoral Objectives Programme of the EU, which aims to identify the (least-cost) contribution of different sectors and gases for meeting the Community's quantitative reduction for greenhouse gases under the Kyoto protocol; and to determine packages of cost-effective policies and measures for all sectors and gases towards meeting the goals.

The agricultural sector study was carried out by AEA Technology and finalised in March 2001. Some reduction options at relatively low cost have been identified - 4% of 2010 baseline. These relate to changes in the diet for cattle and for changes in set aside under the CAP reforms. The changes in diet may be difficult to implement in full because of concerns over the intensification of farming and public acceptability of additives in animal feed. Measures already introduced and improvements in productivity are projected to result in a 8% fall in methane and nitrous oxide emissions by 2010.

In Table 4.6.2, a summary of the policies and measures in the agriculture sector is presented.

Table 4.6.2 Summary of the policies and measures in the agriculture sector

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO equivalent) d		
						2000	2005	2010
CAP (market policies)*	Sustainable agriculture	CH_4, N_2O	Regulation [1]	Implemented	EC	20[81]		28[82]
CAP (rural development policy)	Sustainable agriculture	CH_4, N_2O	Regulation	Implemented	Member States			
Forestry strategy	Sustainable forestry	CO_2	Regulation	Implemented	EC			
Other forestry measures	Prevention of damage to forests	CO_2	Regulation	Implemented	EC			

81 Based on 1999 emissions from agriculture

82 Nitrous oxide and methane projections from sectoral objectives study

4.7 WASTE MANAGEMENT

4.7.1 General aspects

Table 4.7.1 Development of greenhouse gas emissions in the waste sector[83]

	CO_2 (Mt CO_2 eq)	CH_4 (Mt CO_2 eq)	N_2O (Mt CO_2 eq)	Total (Mt CO_2 eq)	% CO_2	% CH_4	% N_2O
1990	6	145	4	155	4%	94%	3%
1999	4	117	5	125	3%	93%	4%

Source: EEA (2001)

The development of the sectoral greenhouse gas emissions between 1990 and 1999 and the relative importance of the main greenhouse gases in the waste sector are shown in Table 4.7.1.

The management of waste can give rise to a number of emissions relevant to climate change, such as methane from the disposal of waste in landfill, when biodegradable waste decays in anaerobic conditions. Waste management operations account for about one third of all anthropogenic methane emissions.

Landfill gas usually contains around 55% methane, 45% CO_2 and over a hundred trace gaseous compounds. The discussions, however, tend to focus on the methane content of the gas, because of its powerful global warming potential and because the CO_2 generated is of biogenic origin. Additional problems arise from methane produced from the treatment of sewage sludge. Emissions from waste incinerators are also relevant and these include emissions of CO_2, CO, N_2O, NO_X and NMVOC.

The Strategy Paper for Reducing Methane Emissions (COM(96)557 final 15.11.1996) deals with all anthropogenic methane emissions including those from the waste management sector. Specific measures and proposals focusing on how an integrated waste management strategy can divert biodegradable waste away from landfills are described there.

The Communication from the European Commission of 30 July 1996 on the *Review of the Community Strategy for Waste Management* (COM(96)399 final) updates the 1989 European Commission Strategy on waste management. Central to this is the reconfirmation of the hierarchy of waste management principles. The prevention of waste remains the first priority, failing which it should be recovered and, failing either of those, the last option is its safe disposal. Within the range of recovery operations, recycling or composting should be preferred, where they are more environmentally sound than, for example, the use of waste as a fuel. The promotion of waste minimisation and material recovery operations has additional climate benefits, as it helps to ensure the conservation of raw materials and energy.

83 CO_2 emissions from waste incineration are mostly included in the energy sector.

Although to date little information is available on the precise reduction potentials of various waste management scenarios and on their costs, recent and ongoing studies give an indication of possible areas of intervention:

- Considering the EU mix of waste management options, it is estimated that each ton of municipal waste generated in 2000 produced emissions of 50 kg CO2 eq/ton;
- For materials such as glass, plastics, ferrous metal, textiles and aluminium, recycling offers overall net greenhouse gas flux savings of between about 30 (for glass) and 95 (for aluminium) kg CO_2 eq/tonne MSW, compared with landfilling untreated waste. For these materials, the benefits are essentially independent of landfill standards and carbon sequestration.
- In the case of paper, recycling is the best greenhouse gas reduction option equalled only by incineration only on very favourable energy scenarios such as low humidity content and combined heat and power (CHP);
- In the case of putrescible waste, diversion from landfill has strong advantages in terms of reduction of greenhouse gas emissions. Organic treatment is always advantageous whereas thermal treatment of unsegregated MSW is advantageous in cases where energy efficiency is high and the energy displaced is not of the most benign types (renewable energy). Thus, it is important that waste, including putrescible components, to energy does not compete with renewable energy sources (e.g. through allocation of economic incentives) as the overall balance would then generate a positive figure for the emissions of greenhouse gases instead of the wanted negative figure. Overall, the net greenhouse gas fluxes associated with the management of separated putrescible waste via composting or anaerobic digestion range from -12 to -58 kg CO_2 eq/tonne MSW, with an overall average of -26 kg CO_2 eq/tonne MSW.

4.7.2 Policy Actions

Directive on the Landfill of Waste (1999/31/EC)

The main recent legislation in the waste management area affecting greenhouse gas emissions is the Landfill Waste Directive. This was agreed in Council in April 1999, came into force on 16/7/99 and will be implemented by Member States during 2000/1.

It introduces requirements on Member States to reduce the amount of biodegradable wastes disposed untreated to landfills. To achieve this objective, the Directive has introduced targets for reducing biodegradable waste disposed of in landfills to 75% of 1995 levels by 2006, reducing to 50 and 35% by 2009 and 2016. Member States which currently rely heavily on landfill have up to 4 years additional time to comply with these targets.

The directive also requires Member States to fit all new landfills which receive biodegradable waste with a landfill gas control mechanism (capture or flaring), and where possible, use the gas collected for energy production. From 2007, almost all existing landfill sites have to have these mechanisms as well. There are exceptions only for small existing sites or those serving islands and isolated communities. Finally, the Directive also includes requirements for monitoring of emissions. The

Directive is supported by incentives at the level of the Member States, for example landfill taxes in seven countries.

The strategy paper for reducing methane emissions (COM(96)557 final) estimated that the implementation of a set of additional measures (essentially those subsequently proposed in the Landfill Directive) would lead to a reduction in methane emissions of 95 Mt CO_2 eq. In a subsequent study[84] commissioned by the European Commission (discussed previously in Section 2.2.2) these results were confirmed as the potential methane reduction arising from these measures was estimated to be 4.5 Mt of CH_4. However, the level of methane savings calculated is very sensitive to the assumptions made concerning the generation of methane and the rate of recovery. Furthermore, there are national policies in several Member States which have similar effects, so it is difficult to separate the quantification of the EU level policies from these national actions. The most recent estimate for the effect of the Landfill Directive is from the Sectoral Objectives study (see below) and is 34 Mt CO_2 eq.

Directive on Waste Packaging

The Council Directive on Packaging and Packaging Waste (94/62/EC), requires Member States to minimise the packaging waste produced and to achieve, within 5 years of the implementation date (1996), a minimum of 50% and maximum of 65%, by weight, recovery rate for packaging waste. In this case, recovery refers to all kinds of recycling, energy recovery and composting.

A second target prescribes that Member States must reach a recycling level of between 25% and 45% by weight of all packaging wastes. A third obligation is to reach a minimum recycling level of 15% on specific packaging waste materials[85].

In 1999, the European Commission found that recovery quotas have been fulfilled by nearly all Member States four years before they were due[86]. In a revision of the Directive, the European Commission is aiming to achieve higher levels of recycling by proposing a set of new targets. The overall effect on greenhouse gas emissions of increasing the targets has not been quantified.

Directive on End-of-Life Vehicles

The Directive on End-of-Life Vehicles (2000/53/EC) of 18 September 2000, requires the producers of cars and light freight vehicles to accept the vehicles at the end of their life time from the last user and recover the materials in them. An owner of a vehicle produced from 2002 on can give back his vehicle at any time; vehicles produced before 2002 can be given back at any time from the year 2007 onwards. Recovery rates have to be of at least 80% from 2006 onwards[86]. Since wastes from old vehicles are predominantly inert, they give little scope for methane emission reductions. However, via the potential recovery of materials from old cars for re-use in new vehicles, the emissions connected with vehicle production might be reduced

84 Reduction Options for Non-CO_2 Greenhouse Gases, AEA Technology, Final Report for CH_4, September 1998.

85 "EEA Waste Annual topic update 1999" Topic Report 2/2000, 2000.

86 "Abfallwirtschaftspolitik aktuell: Auswirkungen europäischer Richtlinien und Stand der Umsetzung abfallrechtlicher Projekte in Deutschland". March 2001

to a certain extent. Additional reductions will result from the recycling of some substances such as aluminium and plastics, where recycling results in considerable energy savings compared to primary production and by appropriate capture and treatment of refrigerant fluids. The overall effect on greenhouse gas emissions has not been quantified.

Proposed Directives on Waste Electrical and Electronic Equipment

The European Commission has issued two proposals for legislation on Waste Electrical and Electronic Equipment (WEEE). The first, a Directive on WEEE, requires that Member States collect at least 4 kg of waste per person, per year, mainly through municipalities. Manufacturers will then be liable to pay for reuse or recycling of 50-80% of the waste, depending on the type of product, starting 5 years after the Directive comes into force. It is envisaged that this proposed Directive will be beneficial with respect to the reduction of greenhouse gas emissions as it will lead to capture and treatment of refrigerant fluids and will increase the level of recycling which, in turn, will lead to a reduction in energy consumption.

Landfilling of 'old' WEEE from which CFCs have not been removed makes this material the most concentrated source of greenhouse gas emissions at almost 5,600 kg CO_2 equivalents/tonne. Even recycling this material creates a net greenhouse gas flux of over 1,500 kg CO_2 equivalents/tonne, due to emissions of CFC from refrigerator foam, unless effective measures are taken to trap CFC emissions. On the other hand, recycling of WEEE containing refrigerators using HFCs (*New WEEE') shows a net benefit in greenhouse gas terms, because the impacts of HFC releases are more than compensated for by the savings due to metal recycling. These benefits are of course absent when new WEEE is landfilled, and releases of HFC from foam and refrigerant contribute to a substantial net greenhouse gas emission of some 390 kg CO_2 equivalents/tonne. Landfilling of WEEE will reduce significantly in the future following the implementation of the WEEE Directive, but agreement is still to be reached over the best way of reducing emissions from refrigerator foam during the crushing and shredding stages of WEEE recycling. Because of the relatively long product lifetime of refrigerators (10-15 years), equipment containing the banned CFCs will be coming through into the waste stream for several years to come.

Revision of the Sewage Sludge Directive

An important implication of the revision of the Sewage Sludge Directive relates to the safe use of sewage sludge in agriculture; as opposed to its disposal by landfill where it leads to methane emissions, or by incineration which, due to the high water content of sewage sludge, is a process with a net energy consumption. The composting of sewage sludge leads to the chemical binding of carbon in the waste in the form of humic and fulvic acids which are then largely retained in the soil. Assuming that sewage sludge in a landfill environment behaves as putrescible waste, it can be estimated that each ton of sewage sludge diverted from landfilling does not generate 730 kg CO2 eq/t (this figure does not include any credit for mineral fertiliser displacement, which is likely to occur when sewage sludge is used as organic fertiliser).

4.7.3 Studies

Biological treatment of biodegradable waste

Following from the requirements of the Landfill Directive, there is an increasing need for improved treatment of biodegradable wastes. Anaerobic digestion of the waste results in the production of biogas which can be used for energy and a unified organic material in which the carbon is locked in humic and fulvic acids. The resultant material can then be spread on land where the soil acts as a sink for the carbon substances. Topsoil typically contains around 1-2% organic matter but this may be increased to 3%. This increase to 3% would give the potential across Europe for increasing the level of organic material in topsoil by around 51 million tonnes of carbon over the next 50-60 years. The potential may be even higher depending on the 'tilling practice' adopted. Anaerobic digestion is suitable for many biodegradable wastes such as animal wastes and food wastes but is not suitable for wood waste.

A study[87] reviewing the different options for the disposal of biodegradable waste has recently been commissioned by the European Commission and will be completed by the end of 2001.

In case of biological treatment of biodegradable waste, preliminary estimates evaluate the impact of greenhouse gas to be -30 kg CO_2-eq/t treated waste in case of composting and -90 kg CO_2-eq/t treated waste in case of anaerobic digestion. Given the fact that about 35% of municipal solid waste (MSW) is putrescible waste, the biological treatment of biodegradable waste Community wide has a yearly potential of saving GHG emissions of 2 Mt CO_2 eq in case of composting and 6 Mt CO_2 eq in case of anaerobic digestion.

Waste management and climate change

A further study[88] is being carried out for the European Commission to assess the net impact of different MSW options on emissions of greenhouse gases. Costs of the alternative waste management systems have also been gathered. The waste management options covered are

- Recycling.
- Composting.
- Anaerobic digestion.
- Mechanical-biological waste treatment and stabilisation.
- Landfilling.
- Incineration.

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87 Review of the different options for the disposal of biodegradable waste, ongoing study commissioned by DG Environment.

88 Study on waste management options and climate change, AEA Technology, Final Report to DG Environment, July 2001.

The overall ranking of the options depends on the waste stream and considerations such as combined use of heat and power or power only from incineration.

The study has shown that overall, source segregation of MSW followed by recycling (for paper, metals, textiles and plastics) and composting / anaerobic digestion (for putrescible wastes) gives the lowest net flux of greenhouse gases, compared with other options for the treatment of bulk MSW. In comparison with landfilling untreated waste, composting / anaerobic digestion of putrescible wastes and recycling of paper produce the overall greatest reduction in net flux of greenhouse gases. The largest contribution to this effect is the avoidance of emissions from landfills as a result of recycling these materials. Diversion of putrescible wastes or paper to composting or recycling from landfills operated to EU-average gas management standards decreases the net greenhouse gas flux by about 260 to 470 kg CO_2 eq/tonne of MSW, depending on whether or not the negative flux credited to carbon sequestration is included. This represents a potential total net reduction of GHG emissions of over 100 Mt CO_2 eq per year.

The study has evaluated four alternative scenarios for waste management in the year 2020 and compared the impacts on greenhouse gas fluxes with the year 2000. Achievement of the landfill directive's target to reduce the landfilling of untreated wastes in 2016 to 35 % of 1995 levels is predicted to result in an overall reduction in greenhouse gas flux from a positive flux of 50 kg CO_2 eq/tonne in 2000 to a negative flux of almost 200 kg CO_2 eq/tonne in 2020. If achievement of the Directive's target is delayed until 2020 (rather than 2016), then a negative flux of about 140 kg CO_2 eq/tonne results. Further yearly reductions in greenhouse gas fluxes to about -490 kg/ CO_2 eq/tonne could be achieved through investment in recycling, incineration with CHP and mechanical biological treatment. Alternatively, a scenario with no incineration and maximum biological treatment of waste achieves an overall greenhouse gas flux of -440 kg CO_2 eq/tonne.

Economic Evaluation of Emission Reductions of Methane in the Waste Sector in the EU

This study is part of the Sectoral Objectives Programme of the EU, which aims to identify the (least-cost) contribution of different sectors and gases for meeting the Community's quantitative reduction for greenhouse gases under the Kyoto protocol; and to determine packages of cost-effective policies and measures for all sectors and gases towards meeting the goals.

Core results from the study are that there are considerable reduction options – over 40% of 2010 baseline emissions – at relatively low cost compared to reductions in other sectors. However a significant proportion of this potential arises from measures already introduced such as the Landfill Directive.

4.7.4 Relation to ECCP

As of November 2001, the working group on waste has not been formed.

Table 4.7.2: Summary of the policies and measures in the waste sector

Name of the policy	Objective and /or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						2000	2005	2010
Landfill Directive*	Amount of waste to landfills; recovery of landfill gas	CH_4	Regulation[1]	To be implemented by Member States 2000/1	Member States			34 Mt
Directive on Waste Packaging	Recovery rates for waste packaging	CH_4 CO_2	Regulation[1]	Implemented / revision planned	Member States			
Directive on End-of-Life Vehicles	Acceptance of used vehicles and recovery by their producers	CH_4 CO_2 ODSs	Regulation[1]	Implemented	Member States			
Directive on Waste Electrical and Electronic Equipment (WEEE)	Recovery of WEEE	CH_4 CO_2 ODSs	Regulation[1]	Planned	Member States			
Revision of Sewage Sludge Directive	Re-direct the use of sewage sludge	CH_4	Regulation[1]	Planned	Member States			

[1] Implementation by Member States can involve other instrument types as well

5 PROJECTIONS AND THE TOTAL EFFECT OF POLICIES AND MEASURES

5.1 INTRODUCTION

This Chapter presents projections of greenhouse gases from the European Union, based on a study for the European Commission published in April 2001. Results are reported for a 'with measures' scenario, which includes the policies already implemented by the EU and some of those implemented by Member States.

The projections are taken from a study that aimed to determine the most cost-effective distribution of emission reductions between different sectors and gases to meet the EU quantitative reduction objective for greenhouse gases under the Kyoto protocol[89]. The energy related CO_2 emissions were projected using the energy system model PRIMES[90], while other emissions are projected on the basis of activity and emissions factors.

For the 'with additional measures' scenario the particular situation of the EU (with responsibilities shared between Member States and the EU) requires different consideration. The trajectory of emissions from the EU will be determined both by the action of EU common and co-ordinated policies and measures and Member State policies and measures. The 'with additional measures' scenario presented here includes only the additional common and co-ordinated policies and measures and indicates the EU potential contribution to the achievement of the Kyoto target. Projections in the National Communications for the Member States will include the effect of common and co-ordinated policies and measures at the individual Member State level, but also the effect of national policies and measures.

5.2 WITH MEASURES PROJECTIONS

Table 5.2.1 below shows the emissions in 1990/1995 and the with measures projection for 2010. The measures included in the with measures projection are those that have been agreed before 1998, details of which are given below.

89 http://europa.eu.int/comm/environment/enveco/climate_change/sectoral_objectives.htm "Economic Evaluation of Sectoral Emission Reduction Objectives for Climate Change: The baseline projection for CO_2 of the mentioned Sectoral Objectives Study was based on the "European Union Energy Outlook 2020:", P. Capros, L. Mantzos, D. Petrellis and K. Delkis November 1999 with the main difference that the impact of the agreement with ACEA was included in the baseline. The energy outlook 2020 is a volume of the Shared Analysis project http://www.shared-analysis.fhg.de/Pub-fr.htm

90 Developed and maintained at the National Technical University of Athens, Greece.

Table 5.2.1 Base year and 2010 emissions for the 'with measures' projections

Sector	Base year emissions[a] ($MtCO_2$ eq.)	2010 emissions ($MtCO_2$ eq.)
Energy supply	1 190	1 206
Energy related CO_2	*1 132*	*1 161*
Non-CO_2	*58*	*45*
Fossil fuel extraction[b]	95	61
Industry	894	759
Transport[c]	753	984
Households	447	445
Services	176	200
Agriculture	417	398
Waste	166	137
Total	**4 138**	**4 190**

[a] Emissions are for 1990 for all gases except the fluorinated-gases, where the base year is 1995. The figures shown are from the study and are slightly different from those reported in this Communication.

[b] Non-CO_2 greenhouse gas emissions from fossil fuel extraction, transport and distribution

[c] Emissions data for international aviation are included in this total as there is not enough data to separate them.

Source: Sectoral Objectives Study 2001

In the 'with measures' projection, emissions increase by 1% relative to the base year. This is mainly due to increased energy supply to satisfy growing demand in the transport and services sectors. Emissions are decreasing in the other sectors.

Emissions from transport are projected to increase by 31% between the base year and 2010 even with the inclusion of ACEA, the Association of European Motor Manufacturers, agreement due to a strong growth in both road and air transport. The service sector emissions also increase due to a strong growth in building stock.

In industry, total emissions are projected to decrease by 15%, due to decreases in CO_2 arising in part from changes in the fuels used by industry and N_2O from process emissions (which is already strongly reduced since 1990).There is a slight increase projected in the fluorinated gases.

The 'with measures' emissions are assumed to remain stable in the household sector despite some growth in housing stock because of improvements in energy efficiency.

Agriculture and waste are both projected to have decreasing emissions due to the effect of existing policies such as Agenda 2000 in agriculture and the Landfill Directive in waste.

The breakdown by gas is shown in Table 5.2.2. Carbon dioxide and the fluorinated gases are projected to increase, with methane and nitrous oxide decreasing. Details of the sectoral breakdown by gas are discussed in the Sections below.

Table 5.2.2 Base year and 2010 with measures projections by gas

Gas	**Base year emissions ($MtCO_2$ eq.)[91]**	**2010 emissions ($MtCO_2$ eq.)**
CO_2 – energy related	3 068	3 193
CO_2 – other	164	183
Methane	462	380
Nitrous oxide	376	317
HFCs, PFCs, SF_6	67	116
Total	**4 138**	**4 190**

Source: Sectoral Objectives Study 2001

Table 5.2.1 and Table 5.2.2 show the base year emissions from the study. These are based on earlier UNFCCC submissions and are slightly different from those presented in Chapter 4. Table 5.2.3 shows the current base year estimates, those used in the study and the inventory for 1999. For 1990, the split between the gases is slightly different and the total reported in this communication is 2% higher than that used in the Sectoral Objectives study.

91 These base year emissions are taken from the sectoral objectives study and are the EU Member States' submissions to the UNFCCC made in 1997. In each Member State's submission to the UNFCCC, there have been slight changes in the base year estimates due to improvements in data and methodology, hence the difference compared to the current Member States' and EU total greenhouse gas emission estimates as presented in chapter 3 of this communication.

Table 5.2.3 Current estimates of base year and 1999 emissions and those used in the study

Gas	Base year emissions - this communication ($MtCO_2$ eq.)	Base year emissions - used in projections ($MtCO_2$ eq.)	1999 emissions ($MtCO_2$ eq.)
CO_2	3 325	3 232	3 271
Methane	440	462	366
Nitrous oxide	394	376	338
HFCs, PFCs, SF_6	45	67	51
Total	**4 205**	**4 138**	**4 026**

Source: Sectoral Objectives Study 2001 and Chapter 3 of this document.

5.3 WITH MEASURES PROJECTIONS BY GAS

5.3.1 CO_2 emissions

Table 5.3.1 shows the CO_2 emissions by sector for the base year and for 2010 for the 'with measures' projections. Emissions are projected to fall in industry and households, but are projected to rise in the other sectors. The largest increases are in transport and services.

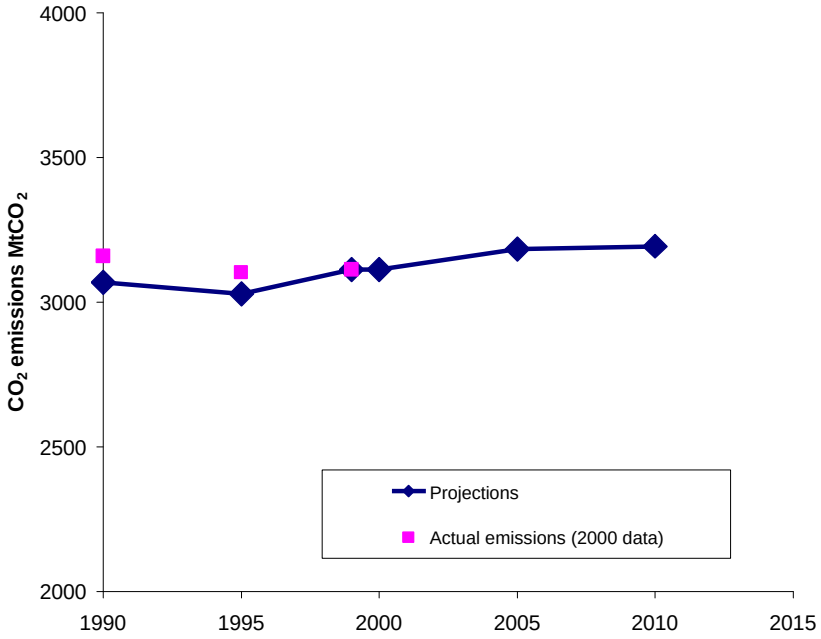
Table 5.3.1 CO_2 emissions by sector in the base year and 2010

Sector	Emissions in base year ($MtCO_2$ eq)	2010 with measures projections
Energy supply	1 132	1 161
Fossil fuel extraction	0	0
Industry	718	626
Transport	735	919
Households	447	444
Services	176	194
Agriculture	17	26
Waste	8	8
Total	3 233	3 378

Source: Sectoral Objectives Study 2001

The projections from the PRIMES model for CO_2 from energy use for the years to 2010 are shown in Figure 5.3.1 below, with the actual emissions for 1990, 1995 and 1999 from this Communication. The projected rate of increase between 2000 and 2010 is relatively smooth.

Figure 5.3.1 CO_2 emissions from energy – projections and actual emissions



5.3.2 Methane emissions

The most significant sectors for methane emissions are fossil fuel extraction, agriculture and waste.

Table 5.3.2 With measures projections of methane emissions

Sector	Emissions in base year ($MtCO_2$ eq)	2010 Emissions ($MtCO_2$ eq)
Energy supply	12	12
Fossil fuel extraction	95	60.5
Industry	0	0.4
Transport	5	3
Agriculture	194	178
Waste	155	126
Total	**462**	**380**

Source: Sectoral Objectives Study 2001

Methane emissions are projected to fall by 18% due to reductions in waste from the Landfill Directive and in fossil fuel extraction due to decreasing coal production. Emissions from agriculture are projected to decrease due to decreasing animal numbers because of increases in productivity and changes in agricultural policy.

5.3.3 Nitrous oxide emissions

The most important sectors for nitrous oxide emissions are industry and agriculture, with increasing emissions from transport. In 2010, the emissions are projected to be 84% of the 1990 levels.

Table 5.3.3 With measures projections of nitrous oxide emissions

Sector	**Emissions in base year ($MtCO_2$ eq)**	**2010 Emissions ($MtCO_2$ eq)**
Energy supply	42	29
Fossil fuel extraction	0.3	0.3
Industry	113	53
Transport	12	38
Agriculture	206	194
Waste	4	4
Total	**376**	**317**

Source: Sectoral Objectives Study 2001

Emissions from industry have already been reduced by actions in adipic acid manufacture to abate emissions. The increasing use of catalysts in cars is projected to give a significant increase in N_2O emissions from that sector. As for methane, falling livestock numbers in agriculture reduce nitrous oxide.

5.3.4 Fluorinated gases emissions

The main source of fluorinated gases is the industry sector. Emissions are projected to increase nearly 74% by 2010 due to their increased use in refrigeration arising from the Montreal Protocol on ozone depleting substances. In transport, the increased use of mobile air conditioning results in a projected increase in fluorinated gases.

Table 5.3.4 With measures projections of fluorinated gas emissions

Sector	Emissions in base year ($MtCO_2$ eq)	2010 Emissions
Energy supply	4	4
Industry	62	80
Transport	1	25
Households	0	1.7
Services	0	5.7
Total	**67**	**116**

Source: Sectoral Objectives Study 2001

5.3.5 Potential for 'additional measures'

In Chapter 4, certain additional measures were identified as being in an advanced state of preparation. The aggregate effect of these on the 'with measures' projection is shown in Table 5.3.5 below. The common and co-ordinated policies and measures included in the 'with measures' projection and the potential for additional measures are listed below.

The table below shows the 1990 emissions, the 'with measures' projections and the potential for with additional measures. If the whole technical potential were realised the common and co-ordinated policies and measures would reduce the 2010 emissions by 6% which represents 5% of the 8% Kyoto commitment. In addition to these, Member States' additional policies and measures will deliver emissions reductions and it is through a combination of measures that the EU will meet its target.

Table 5.3.5 'With measures' projections and the potential for additional measures

	Base year emissions ($MtCO_2$ eq.)[a]	2010 with measures projections ($MtCO_2$ eq.)	Potential for additional measures ($MtCO_2$ eq.)
CO_2	3 232	3 376	3 166
Methane	462	380	380
Nitrous oxide	376	317	317
HFCs	52	84	62[b]
PFCs	10	25	20[b]
SF_6	5	7	5[b]
Total	**4 138**	**4 190**	**3 950**

[a] The 1990 emissions presented here are from the Sectoral Objectives Study and are based on earlier Member States' greenhouse gas inventory submissions to the UNFCC and are slightly different to the current estimates for 1990.

[b]These figures are estimated from a total reduction of 30 $MtCO_2$ eq for all fluorinated gases in the ECCP. The individual reduction potentials for the fluorinated gases have been determined by distributing the overall potential identified in the ECCP proportionally in relation to 2010 with measures projection.

Source Sectoral Objectives Study, 2001 and ECCP final report, 2001.

5.3.6 Common and co-ordinated policies and measures included in the projections

Table 5.3.6 lists the common and co-ordinated policies and measures included in the with measures and with additional measures projections. Details of the policies and measures can be found in Chapter 4.

Table 5.3.6 Common and co-ordinated policies and measures included in the projections

Sector	With measures	With additional measures
Energy supply	• Liberalisation of electricity market • Promotion of renewables (existing measures)	• Directive on Renewable Energy Sources and biofuels • Directive on Emissions Trading • Campaign for Take off
Tertiary	• Boilers directive • Labelling of household appliances • Negotiated agreement on stand by losses	• Directive on energy efficiency in buildings • Amended SAVE directive • Directive on public procurement in buildings
Transport	• ACEA agreement • Air quality legislation	
Industry	• IPPC directive • Energy Audit and Management System (EMAS)	• Framework directive for fluorinated gases
Waste	• Landfill Directive	
Agriculture	• Agenda 2000	

5.4 DISCUSSION OF EU PROJECTION AND POTENTIAL FOR ADDITIONAL MEASURES

In this Chapter, a 'with measures' projection has been presented which was made on the basis of top-down and bottom-up analysis as discussed below. Member States will, in their own Communications, present projections which may differ in detail from the PRIMES projections making up the EU wide projection. This is in part due to the date at which the projections were made, as many Member States will have revised projections for their 3rd National Communications, and in part to different assumptions regarding which policies are included. A reconciliation between the individual Member States projections and the EU wide projection has not been possible over the timescale needed for this Communication. As part of the Monitoring Mechanism (see Chapter 4.1.8), work will be carried out to understand and reconcile any such differences.

For the estimate of the effect of additional measures there will be differences between the Member States projections and the analysis presented here as the Member States will include both their domestic action and common and co-ordinated policies and measures.

Table 5.3.5 above shows the potential effect of specific policies and measures on greenhouse gas emissions. A complementary approach to identifying the potential is the one adopted in the Sectoral Objectives study. This was to identify mainly technical measures to reduce greenhouse gas emissions with their potential (Mt CO_2 eq) and costs (Euro/tonne CO_2 eq abated). A least cost methodology was then used to calculate the mix of measures which could be implemented to achieve the Kyoto target of –8% at least cost. The study concluded that the Kyoto target could be reached at a marginal cost of 20 Euro/ tonne CO_2 eq abated. This amounts to compliance costs of 3.7 billion Euro per year for the period 2008-2012 (0.06% of EU GDP in 2010).

The Sectoral Objectives study thus identifies technical measures which could be implemented to reduce EU greenhouse gas emissions to –8% of the 1990 level by 2008-2012. The implementation of these technical measures will in part be stimulated by the policies and measures discussed in Section 4 and included in the projection. For the additional measures identified as being in an advanced state of preparation, the technical potential for reductions is similar to or less than the potential identified in the Sectoral Objectives study for those sectors. The two approaches are thus consistent. Other policies discussed by the European Climate Change Programme (ECCP) and shown in Section 4 and also Member State policies are likely to be required to realise the full potential. Additional qualitative illustrations are also given in the European Commission's Green Paper on the security of energy supply and the White Paper on a common transport policy.

5.5 MODEL METHODOLOGY

5.5.1 CO_2 emissions from energy

The model used for the projection of energy related CO_2 emissions for Europe is the PRIMES model[92]. PRIMES is a modelling system that simulates a market equilibrium solution for energy supply and demand in the European Union (EU) member states. The model determines the equilibrium by finding the prices of each energy form such that the quantity producers find best to supply, match the quantity consumers wish to use. The equilibrium is static (within each time period) but repeated in a time-forward path, under dynamic relationships. The model is behavioural but also represents in an explicit and detailed way the available energy demand and supply technologies and pollution abatement technologies. The system reflects considerations about market economics, industry structure, energy/environmental policies and regulation. These are conceived so as to influence market behaviour of energy system agents.

PRIMES is a general purpose model. It is conceived for forecasting, scenario construction and policy impact analysis and covers a medium to long-term horizon. Economic and fiscal instruments are included in the model in a straightforward manner and can be explicitly represented for all energy forms and uses. Other economic instruments such as tradable emissions permits, and new funding for energy technologies can also be evaluated in the model. Command and control regulation can be included through the use of constraints and binding within the

92 For comprehensive information on the model the reference manual available at http://www.e3mlab.ntua.gr can be consulted

optimisation modules. Voluntary agreements can also be analysed through the use of constraints, although in this case they are not necessarily imperative and must be handled slightly differently.

Demand-side management instruments are more difficult. The model associates generic load patterns, the aggregation of which over the consumer's electricity use gives the load shape faced by electricity generation. A demand side measure can be simulated by a change either in the shape or the area of a particular energy use. However, allocation of the implementation costs of the measure to the consumer and generator must be evaluated outside the model.

5.5.2 Assumptions

The CO_2 from energy projections builds on the base line scenario from the Shared Analysis project[93]. Key assumptions for this baseline are given below.

Table 5.5.1 Population trends (EU Average)

Annual growth rates %	
1995/2010	2010/2020
0.2	0.03

Table 5.5.2 Energy prices

	1990	**2010**	**2020**
World crude price ($90/barrel)	23.8	16.9	20.1
Gas import prices ($90/boe)	15.3	15.2	19.8

Table 5.5.3 GDP Growth (EU Average)

Observed	**Forecast**				
1990/95	1995/00	2000/05	2005/10	2010/15	2015/20
1.4	2.6	2.5	2.3	1.9	1.7

93 "European Union Energy Outlook to 2020 – Special Issue of Energy in Europe", P Capros, ISBN 92-828-7533-4, 1999.

Table 5.5.4 Transport (EU Average)

					Annual growth rates (%)	
	1990	1995	2010	2020	95/10	10/20
Travel per person (km/capita)	11 662	12 287	15 201	17 545	1.4	1.4
Total passenger travel (Gpkm)	4 247	4 567	5,823	6 742	1.6	1.5

In terms of policies, the baseline assumes:

- The liberalisation of electricity and gas markets proceeds in line with EU directives and is assumed to fully develop in the second half of the first decade.
- Restructuring is enabled by mature gas-based power generation technologies.
- Policies promoting renewable energy are assumed to continue.
- On-going infrastructure projects involving the introduction of natural gas are assumed to gain full maturity
- The different policies of Member States on nuclear capacity are taken into account
- The ACEA agreement reduces average emissions from cars to 170g/km in 2003, 140 g/km in 2008 and 120 g/km in 2012.

5.5.3 Process related CO_2 emissions

Process related CO_2 emissions are projected by extrapolating from the emissions reported to the UNFCCC for 1990 on the basis of physical growth rates assumed in the PRIMES baseline[94].

5.6 METHANE

Agriculture

The two main sources of methane emissions in agriculture are enteric fermentation and manure management, which are largely dependent on livestock numbers. A projection of livestock numbers in 2010 was therefore made to provide a basis for estimating future agricultural emissions[95]. Data on livestock numbers in 1990 and

94 Details of the growth rates for the different industrial sectors are given in "Economic Evaluation of Sectoral Emission Reduction Objectives for Climate Change: Top-down Analysis of Greenhouse Gas Emission Reduction Possibilities in the EU", Prof. P. Capros, N. Kouvaritakis and Dr. L. Mantzos, NTUA, 2001 http://europa.eu.int/comm/environment/enveco/climate_change/sectoral_objectives.htm

95 "Economic Evaluation of Emissions Reduction of Nitrous Oxides and Methane in Agriculture in the EU: Bottom-up Analysis", J Bates, AEA Technology, 2001 http://europa.eu.int/comm/environment/enveco/climate_change/sectoral_objectives.htm

1998 (1997 for some animals) is available from EUROSTAT, and this provides information on current trends in livestock numbers at the Member State level. Information on trends in markets for agricultural products between 1997 and 2006 was taken from Prospects for Agricultural Markets 1999-2006[96]. The projections include a substantial reduction in the number of dairy cows despite almost constant milk production due to a continuation of the trend in improved milk yield.

Projections for 2010 emissions were made on the basis of emissions factors and the forecast livestock numbers. A new emissions factor for enteric fermentation for 2010 was calculated to take account of improved milk yields based on the net energy system recommended by the Intergovernmental Panel on Climate Change (IPCC)[97]. For manure management, the emissions were projected on the basis of the 1990 emissions and forecast changes in livestock numbers.

The strength of this approach is it's relative simplicity and dependence on the physical measure of activity i.e. the number and types of livestock. However, with this approach it is difficult to identify the effect of individual policies and measures.

Waste

In the study from which the projections are taken[98], a 'no action' baseline was estimated against which to assess the impact of further measures. The projections presented above are this 'no action' baseline minus the calculated effect of the Landfill Directive. They therefore represent a 'with existing EU measures' projection. Measures taken at the Member State level are not included.

The 'no action' baseline was calculated assuming that waste generation per capita, the proportion of waste disposed of in landfills and the landfill gas recovery rates remain constant. The landfill emissions were estimated using the time dependant IPCC methodology, and values for the per capita waste generation rate, fraction of municipal solid waste (MSW) disposed to landfill, and degradable organic content from the same reference unless new country specific data was available from Second National Communications on Climate Change (as submitted to the UNFCCC). The percentage of methane recovered was derived from information in the Second National Communications wherever possible; in all other cases, estimates were taken from the Common Policies and Measures Paper on Landfill[99].

The Landfill Directive requires that the proportion of biodegradable waste disposed to landfill is decreased and that landfill gas recovery rates are increased. The effect of the Landfill Directive was calculated by first decreasing the amount of waste going to landfill, then increasing the landfill gas recovery rate. The projections are at a Member State level, and therefore allow for the different rate of compliance required by the Directive. In the projections, the alternative routes for treatment of

96 "Prospects for Agricultural Markets 1999-2006, DG Agriculture, European Commission.

97 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, published by IEA/OECD, 1996 Revisions

98 "Economic Evaluation of Emissions Reduction of Methane in the Waste Sector in the EU: Bottom-up Analysis", J Bates and A Haworth, AEA Technology, 2001 http://europa.eu.int/comm/environment/enveco/climate_change/sectoral_objectives.htm

99 Common and Co-ordinated Policies and Measures, 1997. "Measures to reduce landfill methane emissions in the EU". A paper to the EU Ad Hoc Group on Climate, March 1997.

the biodegradable waste have not been quantified, so any greenhouse gases from those routes have not been included.

Estimates of landfill emissions generally have a fairly high level of uncertainty, mainly because of the difficulties in estimating accurately emissions from what is a complex emissions mechanism. In addition, accurate waste statistics can be difficult to collect especially when waste management is unregulated, and an improvement in the collection of statistics often reveals that previous figures were underestimates.

5.7 NITROUS OXIDE

Process related N_2O emissions

The two major industrial processes that lead to emissions of nitrous oxide are the production of adipic and nitric acid. In the EU, adipic acid is produced in 4 countries, Germany, France, Italy and the UK. Nitric acid is produced widely within the EU. The baseline projections are made on the basis of projections of the production of adipic and nitric acid and associated emissions factors. Emissions are estimated at 300g N_2O per kg of adipic acid[100] and 7g per kg of nitric acid[101]. The following assumptions are made for the activity:

- Production of adipic acid increases by an average of 2% per year over the period 1990-2000, and then by 1.5% per year up to 2010[102].

- Production of nitric acid decreases by 13% over the period 1990 to 2010.

For adipic acid, all the major manufacturers in Europe, with the exception of Radici Chimica in Italy, have installed abatement equipment since 1990 and the consequent reduction in the emissions factors have been taken into account on a plant-by-plant basis. The efficiency of the abatement ranges from 94 to 98%.

Transport

For road vehicles, N_2O emissions in 2010 are based on projections of vehicle kilometres and appropriate emissions factors (g of pollutants per km). Vehicle kilometres for petrol and diesel passenger and goods vehicles were derived by converting the passenger-kilometres and tonne kilometre projections to vehicle kilometres using Member State-specific load factors.

The emissions factors used were taken from IPCC emission inventory guidelines and differentiate between petrol and diesel vehicles and vehicles equipped with catalytic converters. By 2010, it is assumed that turnover of the vehicle fleet will mean that all passenger cars are equipped with a catalytic converter. N_2O emissions from vehicles equipped with modern catalysts are thought to be lower than those equipped with early generation catalysts and the IPCC recommended emission factor is thus

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100 "Nylon production: an unknown source of atmospheric nitrous oxide", MH Thiemans and WC Trogler, Science 251 p932-934

101 "Economic Evaluation of Carbon Dioxide and Nitrous Oxide Emissions Reductions in Industry in the EU: Bottom-up Analysis", J de Beer, D Phylipsen and J Bates, http://europa.eu.int/comm/environment/enveco/climate_change/sectoral_objectives.htm

102 "Chemical Profile: Adipic Acid", www.ChemExpo.com, June 1998.

thought to be too high for modern and future vehicles. In the absence of an updated emission factor for European vehicles, the value used to estimate emissions in 2010 is the US Tier 1 vehicles of 0.0288 g/km[103] (US EPA, 1998) This factor lies somewhere between a Euro I/II and Euro III/IV vehicle[104].

Agriculture

The main sources of N_2O emissions from agriculture are from manure management and from soils. Emissions from manure management were projected on the same basis as methane discussed above i.e. based on an emissions factor and livestock numbers.

The projections for emissions from soils used the IPCC methodology which assumes that 1.25% of the nitrogen contained in mineral fertilisers is released directly as N_2O, with further N_2O emissions arising from volatilisation and subsequent deposition of NH_3 and NO_x from the application of fertilisers. Emissions in 2010 have been forecast using as a basis:

- A recent forecast by the European Fertiliser Manufacturer's Association of changes in cropped area and application rates for nitrogen for major crops[105] (1999).

- The forecast of livestock numbers described in the section on methane.

The projections were on a Member State level, allowing for differences in cropping and livestock.

The uncertainty surrounding the emissions factor is high (± 1% i.e. 0.25% to 2.25%), meaning that estimates of emissions have a relatively high level of uncertainty. As with the methane emissions, it is difficult to identify the effect of individual policies and measures using this approach.

5.8 FLUORINATED GASES

The projections have been made on the basis of an abstracted bottom-up approach[106]. The baseline scenario includes autonomous technological improvements and policies and measures in place. The different sources of fluorinated-gases are treated separately and are discussed below. The breakdown of assumptions on activity and the emissions factors used is complex and details can be found in Harnisch, 2000[106].

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103 'Emissions of Nitrous Oxide from Highway Mobile Sources: Comments on the Draft Inventory of US Greenhouse Gas Emissions and Sinks', EPA420-R-98-009, Office of Mobile Sources, US Environmental Protection Agency, 1998.

104 The average turnover time for cars is about 11 years, so the fleet in 2010 will include a small number of Euro I and II cars, but will consist predominantly of Euro III and IV vehicles. The use of a single emission factor for all these vehicles is therefore an oversimplification, but is unlikely to introduce further uncertainty into the projection, given the level of uncertainty in the emission factor itself.

105 EFMA, 1999. "Food, Farming and Fertiliser Use", European Fertiliser Manufacturers Association, Brussels.

106 "Economic Evaluation of Emissions Reductions of HFCs, PFCs and SF6 in Europe", J Harnisch and C Hendriks, 2000.

- HFC-23 from HCFC-22 production. Production is assumed to be constant in the first commitment period, with emissions reductions of 95% for 6 out of 10 European plants.
- HFCs - production and use of foam. The projections are made on the basis of the growth rate of the European foam market and assumptions regarding emissions factors.
- HFCs - refrigeration and stationary air conditioning. The bank of HFCs in this application will be approximately 50% mature in 2010 (due in part to the long lifetimes of CFCs and HFCs).
- Other sources of HFCs – see Harnisch 2000.
- SF_6 – magnesium production. Primary and secondary production remains at 1995 levels while the amount of magnesium for casting triples from 1995. Emissions factors are assumed to remain constant at 2 kg per tonne of processed metals.
- SF_6 – manufacture and use of gas insulated switchgear. Emissions are assumed to remain constant as leakage emissions are significantly lower than present.
- SF_6 – other sources. Stabilisation at the 1995 level is assumed based on projected decrease in use but increased emissions from sound insulated windows.
- PFCs - primary aluminium production. It is assumed that the production numbers and emissions remain constant from 1998 to 2010.
- PFCs – semiconductor manufacture. Between 1995 and 2010 a growth rate of 15% per year is assumed (based on current trends) this leads to a projected increase of 740%.
- PFCs – other sources. Emissions are projected to remain at the 1995 estimate of 500 tonnes per year.

6 VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

6.1 INTRODUCTION

The European ACACIA Project Report[107], published in 2000 by the European Commission, is a comprehensive report based upon an expert review of current knowledge, assessing the impacts of climate change, providing a vulnerability assessment, and evaluating the potential for adaptation. It has drawn upon all available knowledge including the most up-to-date projections of likely future climate change and is the main reference study for this chapter of the 3rd National Communication.

6.2 EXPECTED IMPACTS OF CLIMATE CHANGE

Significant changes in the European climate have occurred during the last 100 years, particularly notable being the 0.8°C rise in global temperature. Patterns from recent climate modelling indicate a continued increase in temperatures, with European temperatures rising by 0.1-0.4°C every decade. Most warming is expected to occur in southern and north Eastern Europe.

Other predicted climatic changes concern seasonal, precipitation and sea level changes. In terms of seasonal change, 'cold' winters (currently 1 in 10) will be rare in Europe by the 2020s and will have disappeared by the 2080s. By the 2080s, every summer is predicted to be hotter than the presently classified 'hot' summer (currently 1 in 10 summers). The trend for annual precipitation levels in northern Europe increases over the coming decades while in southern Europe, smaller changes will occur with decreased levels. In general, most of Europe will be wetter during the winter season.

Sea level rise is predicted to increase, rising 13 – 68 cm by the 2050s. This does not account for potential landmass re-adjustment, with northern Europe rising and central and southern Europe slowly sinking.

6.3 VULNERABILITY ASSESSMENT

A vulnerability assessment of Europe to changes in climate is made within the ACACIA project report. Many aspects of this assessment are subject to different degrees of certainty, depending on the level of research in different subject areas and development of models. The scenarios used within ACACIA are the four preliminary marker emissions scenarios generated by the IPCC Special Report on Emissions Scenarios (SRES)[108]. The following topic areas have been highlighted in the ACACIA report to determine potential impacts of climate change:

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107 "Assessment of the Potential Effects and Adaptations for Climate Change in Europe", The Europe ACACIA Project, EC Research DG (2000).

108 See http://www.ipcc.ch/activity/sres-out.htm for further information.

6.3.1 Water Resources

Larger differences between southern and northern European water resources are predicted to occur due to climate change, with an increased risk of shortages in southern regions. This will in part be due to greater stream flow variability, with greater precipitation during winter months. Annual stream flow is predicted to increase in northern Europe. Flood risk across Europe is also likely to increase although peak flood times may change due to changes in seasonal precipitation levels.

6.3.2 Soil and land resources

Soil quality is likely to deteriorate under warmer and drier conditions, leading to loss of soil function. This will be influenced by a variety of processes that are likely to effect soils due to prevailing conditions resulting from climate change. Under the increased arid conditions, land degradation processes such as salinisation and soil erosion are likely to increase, particularly in southern Europe. Changes to soil and land resources will be highly dependent on geographical factors and may be moderated by increased precipitation in some areas.

6.3.3 Ecosystems

There is likely to be a net increase in productivity in most European ecosystems due to warmer temperatures and CO_2 enrichment. Changes to ecosystem location are likely to occur, including northward displacement of boreal forests, northward expanding broad-leaved temperate forests in eastern Europe and northward movement of frost-intolerant species. Changes to vegetation composition, particularly in critical habitats, may lead to loss of plant and animal species in some areas. Therefore, diversity in some areas may be threatened. Fire disturbances within ecosystems are likely to become more frequent and severe in the Mediterranean region.

6.3.4 Coastal zones

Increasing flood risk and storm damage in coastal areas due to rising sea levels and increased storminess will have significant economic impacts. The greatest increase in flood risk is expected to be in southern Europe. There is also likely to be increased degradation of salt marsh and intertidal ecosystems, particularly on the Baltic and Mediterranean coasts.

6.3.5 Mountain regions

Significant changes to biotic and cryosperic zones in these regions could occur, leading to the perturbation of hydrological regimes, the effects of which will be felt downstream. 50–90% of glaciers will disappear by end of the 21st century. Lower and southern regions of discontinuous permafrost are likely to shift upwards and northwards. Snow and tree lines will increase in altitude with warming, and changes in plant species distribution could be seen. Decreased slope stability is likely due to reduced permafrost and changes in vegetation composition / distribution.

6.3.6 Forestry

Genetic variability of tree species will probably mean most species will be able to acclimatise to changes in temperature and precipitation. The greatest risk to forests in the Mediterranean region and continental Europe will come from increase drought and fire risks. Increased precipitation in northern Europe is likely to offset risks from increased evapotranspiration. Increased growth may be the likely effect in this region due to increasing temperatures and CO_2 levels.

Effect of pest and insects are uncertain. Non-damaging organisms could reach pest level and invading species may become more dangerous.

6.3.7 Agriculture

Increased CO_2 concentrations will probably lead to enhanced productivity and plant water use efficiency. This could be counteracted in southern Europe (where agriculture is moisture-limited) by water shortage, extreme weather events and shorter growth seasons. Warming in northern Europe (where agriculture is temperature limited) is predicted to lead to northward expansion of areas suitable for crop production and increased growing seasons for certain crops. Northern Europe will see an overall positive effect while in southern Europe, some agricultural systems will be threatened.

6.3.8 Fisheries

Any impacts of climate change on fisheries will be further aggravated by the current over-exploitation of fisheries. The most vulnerable species are those that have a juvenile stage in freshwater where air temperature increases could lead to local extinction in watersheds at the edges of the current ranges. Climate change could lead to faunal shifts in species, leading to an adverse effect on biodiversity. In general, productivity is predicted to be affected positively by a temperature increase in the north of the region. However, possible breakdown of the thermo-haline circulation caused by polar ice melt could lead to cooler ocean temperatures and to fisheries collapse.

6.3.9 Insurance

The insurance industry could face high costs primarily due to property damage from flooding and the more frequent extreme weather events. The major impacts are likely to be from coastal flooding and windstorm damage in north west Europe. Climate change is unlikely to threaten the overall solvency of the European insurance industry, but could endanger regional insurers.

6.3.10 Transport, energy and other industries

Sea level rise and the more frequent extreme weather events predicted by modelling will increase costs in these sectors. Transport is sensitive to extremes of weather which may become more frequent due to climate change. However, certain parts of Europe will have less frost and snow and therefore, this would be beneficial for transport.

Fewer severe winters are also likely to be beneficial to manufacturing industry. However, hotter and drier summers may lead to lack of water for industries that

require large amounts such as power stations. Predicted increasing temperatures will have a direct impact on energy demand during both winter and summer.

6.3.11 Tourism and recreation

Tourism is sensitive to changes in climate, with climate being a significant factor when planning holidays. Therefore, tourism in northern Europe is likely to be stimulated by warmer temperatures. Coastal resorts may have longer seasons and new resorts could be situated increasingly northwards. Some Mediterranean areas may become less attractive due to increased frequency of heat waves. The winter sports season is likely to be shortened, affecting winter tourism.

6.3.12 Human health

Increased exposure to heat and air pollution, the extension of vector-borne disease and increased flooding will have adverse effects on human health. A major spread of malaria in western Europe is unlikely but localised outbreaks could become more common. Increased temperatures may increase cases of food-borne illness. Predicted less severe cold weather will reduce the effects of winter mortality, particularly in north west Europe.

6.4 ADAPTATION MEASURES

There are a variety of adaptation measures which will have a significant bearing on the extent of the above. The ACACIA report outlines some of the measures that need to be taken to ensure impacts are limited.

Adaptation in terms of sustainable *water resources* will need to involve both demand and supply side approaches to water management. However, planning adaptation measures will be difficult given the amount of uncertainty in water resource changes. Therefore, managers will need to develop methodological procedures for adopting a scenario-based approach to strategy or scheme management, and develop adaptive techniques to allow incremental adjustments over time.

Present policies for management and protection of *soil and land resources* are insufficient – there is a need for policy to preserve the quality of soils and land resources both in the present and future, recognising climate change impacts on degradation processes. These policies will need to be regionalised, targeting specific issues within different European locations. Policies for *ecosystems* adaptation need to be local / regionally-based. They need to be based on detailed regional assessment of ecosystems plus greater certainty in the modelling. Policy should not see greater ecosystem productivity necessarily as a benefit since disruptions in present ecological balance are likely to follow. As soil respiration increases with higher temperatures, the higher net productivity does not imply increases in carbon storage. Systems under particular threats will need greater monitoring – for example, dry ecosystems will need greater protection from fire hazards.

There are a number of efforts at different levels (local, regional and national) to promote integrated *coastal zone* management. These need to be encouraged to strengthen the institutional basis for proactive measures. The challenge is to develop strategic management policies that allow both continued human utilisation and preserve coastal ecosystems under conditions of rising sea levels.

There needs to be education and awareness raised of increased threats to safety that *mountain* regions will hold due to environmental change. Changes in mountain regions need to be carefully assessed due to the impact on hydrological regimes, particularly downstream. In northern Europe, the use of natural regeneration in *forest* management provides substantial genetic potential to adapt to climate change. Increased productivity should encourage policies that sustainably use the increasing forest cover and resources. In the south, more adaptive measures will need to be adopted to maintain and preserve forests.

Policies to support adaptation of *agriculture* should encourage flexibility of land use, crop production and farming systems. Long term adjustments include more efficient irrigation, use of different crop types, land use changes and different farming systems. Short term adjustments to mitigate negative effects include changes in agronomic practices, changes in use of external outputs and practices to conserve moisture.

More information on regional effects is needed so that adaptation measures can be better targeted.

Freshwater f*isheries* policy needs to be more closely integrated with water resource and ecosystem management schemes. The potential adaptability of the marine fisheries sector has been undermined by a range of factors, particularly over-exploitation. Adaptive policies need to make provision for reduced levels of production because of ice and snow melt in the north and to focus on vulnerable geographical zones. Greater capacity for adaptation will be possible if sustainable management of fisheries can be implemented.

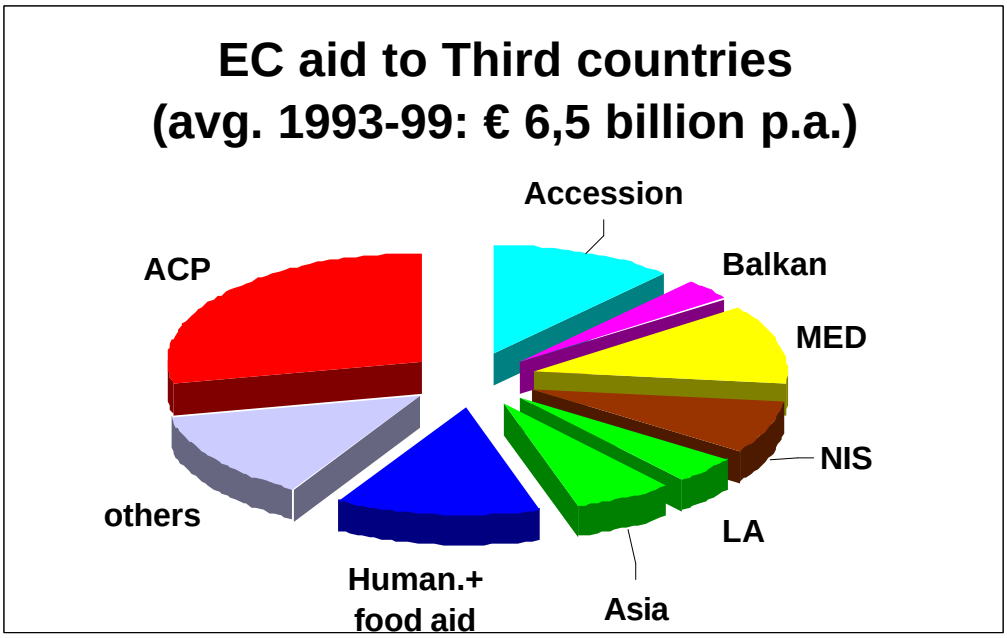
Estimates of climate change impacts should be incorporated into risk assessments of and investment decisions in *transport and energy* developments and installations. Building standards and codes need to be reviewed, particularly in flood risk areas. Regional policies need to take account of the changes in *tourism* patterns, particularly with regard to reduced winter tourism and changes in preferences for summer destinations. Policies need to recognise new opportunities in tourism and ensure infrastructure can cope. Potential adaptation measures to address *health* impacts include strengthening public health programmes (education and vaccination programmes), supporting methods to detect early climate change health impacts and development of pan-European surveillance system to detect changes in occurrence of infectious disease.

7 FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

7.1 GENERAL CONTEXT: EXTERNAL AID OF THE EUROPEAN UNION AND ITS ORGANISATION

The European Community (EC), as a distinct entity apart from the bilateral aid programmes of the individual Member States, has become the world's fifth largest aid donor in the 1990s, providing in 2000 $7.4 billion or 12.5% of all aid disbursed by the OECD countries. This reflects the rapid growth of the Community's aid programme over the past three decades, when it increased steeply in real terms and almost quadrupled as a proportion of total OECD aid. Taken together, the European Community and European Union Member States' aid accounts for approximately half of OECD aid in 1997 (compared to a share of roughly one third in OECD GDP). The geographical distribution is shown in the pie chart below[109].

Figure 7.1.1 EC aid to Third countries



The main sources of EC aid were the

- EC Budget, funding almost three-quarters of all European Community external assistance, and the
- European Development Fund (EDF), which provided the rest.

On average, € 6.5 billion per annum were provided to Third countries. During the 90's, the EC assistance programme has grown considerably. The financial perspectives for 2000 – 2006 allow the European Commission to commit up to € 11.5 billion per annum. In addition to the Community budget and the EDF, the EIB provides some finance from its 'own resources'.

109 SEC(2001)1013 of 27.6.2001, Annex 1

The European Commission, the EIB and the EBRD manage EC aid. The European Commission has three Directorates General with geographical responsibilities for administering European Community external co-operation (DG Development, DG Enlargement, DG External Relations). As part of its efforts to reform the management of external aid the European Commission formally set up the EuropeAid Co-operation Office on 1 January 2001[110]. EuropeAid Co-operation Office's mission is to implement the external aid instruments of the European Commission outside the Accession countries. This includes funding from the European Community budget and the European Development Fund. It does not deal with pre-accession aid programmes (Phare, ISPA and SAPARD), humanitarian activities, macro-financial assistance, the Common Foreign and Security Policy (CFSP) or the Rapid Reaction Facility. In addition, a separate Humanitarian Office (ECHO) deals with humanitarian assistance.

Both offices are responsible for all phases of the project cycle (identification and appraisal of projects and programmes, preparation of financing decisions, implementation and monitoring, evaluation of projects and programmes). They ensure the achievement of the objectives of the programmes established by the Directorates-General for External Relations and Development and approved by the European Commission.

7.2 GLOBAL FINANCIAL RESOURCES FOR EXTERNAL AID IN THE FIELD OF CLIMATE CHANGE

The following Table 7.2.1 gives an overview of the resources relevant for climate change.

Table 7.2.1 Financial resources relevant for climate change

Million Euro	Mean 1986/1998	1997	1998
TOTAL	5 627	6 515	8 614
Natural Resources	395	224	437
(1) Agriculture	331	176	368
(2) Forestry	47	51	60
Econ. Infrastructure & Services	946	1 015	1 850
(3) Transport & Communication	441	438	928
(4) Energy	290	287	434
Multisector/Crosscutting	468	321	481
(5) Environment	119	113	146
Total relevant for climate change (1)+(2)+(3)+(4)+(5)	1 227	1 065	1 936

Source: A.Cox and J. Chapman (1999), ODI Database

The figures in the table are only a rough approximation, as in some of the categories displayed, only a minor part is directly related to climate change. With the

110 see http://europa.eu.int/comm/europeaid/index_en.htm

classification used within the EU it has not been possible to identify only those parts directly relevant to climate change. Further, programmes from the European Commission's DG Transport and Energy and DG Research open for accession countries and directly relevant for climate change are not taken into account here (see below)[111]. The EC has not yet introduced the OECD/DAC marker system for aid to the multi-lateral environmental agreements.

7.3 PROVISION OF FINANCIAL RESOURCES BY PROGRAMME

7.3.1 Global Environment Fund (GEF)

The GEF assists developing countries specifically in the management of common global issues, i.e. the atmosphere, biological diversity and international waters. In terms of the Climate Convention, the GEF primarily meets the incremental costs of investment projects, which have additional benefits for climate change, i.e. mitigation and sequestration. Furthermore, it meets the full costs of gathering basic information, the preparation of non-Annex I national communications, and planning for adaptation. Many Annex I Parties make contributions to the GEF. The European Community does not contribute directly to the GEF (except for some small project co-financing with GEF) as there is no mandate from the Council for this activity. The Member States provide their funding directly to the GEF. Similarly, the main part of contributions to international organisations such as the UN occurs through the EU Member States.

Over the last three years the EC has provided support to specific UN programmes relevant in the context of climate change including the:

- UN National Communications Support Programme (UNDP).
- strategy for sustainable energy in ACP countries (UNDP).
- the participation of developing country scientists in the International Panel on Climate Change (WMO/UNEP).
- Global Environment Outlook for the Small Island Developing Countries (UNEP).
- Sub-Sahara African Initiative on Clean Air (World Bank).

7.3.2 Financial contributions to multilateral institutions and programmes

The main budget line for contributions to multilateral institutions and programmes outside EBRD is shown in Table 7.3.1.

111 see also http://europa.eu.int/comm/development/publicat/descript/en/pub503.htm

Table 7.3.1: Participation in International Environment Measures in million € (including participation to the Global Environment Fund)[112]

1999	2000	2001
5.4	5.89	6.50

The budget line covers in particular measures in support of the Agenda 21 (e.g. co-financing of actions in co-operation with international organisations in charge of sustainable development and environment protection). It supports international conferences, workshops and publications on forests, biodiversity, climate change and global warming. It is contributing the core funding for the running of the Secretariats in accordance with the UN scale plus some voluntary funding.

7.3.3 Climate change relevant projects in co-operation with the European Bank for Reconstruction and Development (EBRD)

The European Bank for Reconstruction and Development (EBRD) has the mandate to promote environmentally sustainable development in all of its activities. In July 2000 the EBRD approved a new Public Information Policy, which strengthens the Bank's commitment to openness and public consultation on environmental issues. The bank has been set up with the aim of financing the economic transition in central and eastern Europe and the Community of Independent States (CIS).

The European Union provided € 512 million of grant funding, through the Phare and Tacis programmes, to the European Bank for Reconstruction and Development (EBRD), over the period 1992-98. These grants were essentially used to finance technical co-operation (TC) activities (€ 232 million) in support of EBRD loans and to co-finance EBRD investment operations (€ 280 million). The EC is a shareholder in the EBRD's € 20 billion capital (with a capital subscription of € 600 million). Contributions to the capital amounted to € 5.4 million in 1999, € 6.4 million in 2000, and in € 7.4 million in 2001.[113]

The energy sector comprises a significant part of the overall EBRD loan portfolio and it has been a major recipient of EC funding for technical co-operation and other projects. TC commitments funded by Phare and Tacis in the energy sector in co-operation with the EBRD totalled € 15 million by mid 1998 and € 23 million by February 1999[114].

There had been 20 EC-EBRD co-financed investment projects by the end of 1997, 19 of which were co-financed between Phare and EBRD and one between Tacis and EBRD. The EC had committed € 277 million from Phare (of which roughly half went to energy and transport related projects in direct relationship with climate change: improvement of railways infrastructure, energy efficiency credit etc.) and EBRD had committed nearly € 540 million. Ten projects were for investments in

112 Budget line B7-8110 (direct means + programme administration; payments) Source: Official Journal L 56 (26 February 2001)

113 Budget line B7-510 (payments)

114 An evaluation of PHARE and TACIS Co-Financing Programmes with the EBRD, April 1999 (http://europa.eu.int/comm/europeaid/evaluation/evinfo/phare/951462_ev.html)

infrastructure, three for investments in environment and seven for SME support through PPFs and energy efficiency/conservation credit lines. The total investment for these projects is estimated to be about € 2.1 billion; this includes the investment of other co-financiers and project clients.

7.3.4 Relation to the European Investment Bank (EIB) in the field of climate change

The EIB is the European Union's long-term lending institution. Although the European Commission makes direct funds available to the EIB, e.g. risk capital, interest subsidies under the European Development Fund, most funds are raised on the markets, for financing of capital projects on favourable terms. The European Commission is the EIB's principal partner in the Community system. It is represented on the EIB's Board of Directors and delivers an opinion on Bank financing proposals.

Between 1996 and 2000, EIB loans for safeguarding and improving the natural and urban environment within the EU totalled € 26 billion. In the same period, environmental objectives were supported in the Accession countries and in developing countries (mainly Mediterranean Region and Balkans) with € 1.2 billion and more than € 1.5 billion, respectively.

Very recently the EIB has published a new Environmental Statement (May 2001) emphasising its environmental commitments[115]. The environmental objectives of the EIB include in particular the promotion of the EU's climate change policy, especially projects to abate and mitigate the emissions of greenhouse gases, notably improvements in energy efficiency and the introduction of less carbon-intensive sources of energy, in particular renewable energy. This includes the development of projects that promote the objectives of the Kyoto protocol and its arrangements for the transfer/acquisition of credits associated with projects designed to reduce or capture greenhouse gas emissions.

[115] http://www.eib.org/pub/divers/envir_en.pdf

Table 7.3.2: Financial contributions to multilateral institutions and programmes

Institution or programme		**Contribution** [7]	
	(millions of Euro)		
	1997	**1998**	**1999 ***
Multilateral institutions:			
1. World Bank	-	-	-
2. International Finance Corporation	-	-	-
3. African Development Bank	-	-	-
4. Asian Development Bank	-	-	-
5. European Bank for Reconstruction and Development EBRD -European Investment Bank EIB	1992-1998: € 512 million (about € 150 million with direct climate relevance)		
6. Inter-American Development Bank	-	-	-
7. United Nations Development Programme - specific programmes	1997-1999: € 117.7 million [116]		
8. United Nations Environment Programme - specific programmes	1997-1999: € 2 million [8]		
9. UNFCCC[117]	0.135	0.263	0.191
- Supplementary Fund			
10. Other	n.a.	n.a.	n.a.
Multilateral scientific, technological and training programmes			

116 European Union – United Nations Statistics (http://europa.eu.int/comm/external_relations/un/doc/pack/10.pdf)

117 2000: € 0.275 million, 2001: € 0.299 million (Source: DG Environment)

Table 7.3.3: Financial contributions to bilateral co-operation, in million €

Budget line	Programme	1999	2000	2001	Comment
B4-1004	Carnot	0.6	0.6	0.5	Accession Countries
B4-1009	Remaining obligations from SAVE, PACE etc	2.3	1.5	0.8	Accession Countries
B4-1030	Altener II	10.2	11.0	12.1	Accession Countries
B4-1031	SAVE II	8.7	14.3	13.5	Accession Countries
B4-1040	ETAP	1.2	1.5	1.2	Accession Countries
B4-1041	Synergy	4.9	5.7	4.4	Accession Countries + other Third countries
B7-020	ISPA (structural policy instruments for environment/transport)		245	350	Accession countries
B7-030	Phare	932.5	1 109	1 246	Accession Countries
B7-300	Co-operation with developing countries in Asia	226.7	220.6	262.0	About 10% for Agenda 21 activities
B7-310	Co-operation with developing countries in Latin America	121.0	126.2	150.0	About 10% for Agenda 21 activities
B7-410	Co-operation with third countries in the Mediteranean Area and the Near and Middle East	242.1	222.2	275.0	About 10% for Agenda 21 activities, including SMAP
B7-520	Co-operation with third countries in Eastern Europe and Central Asia (TACIS)	501.1	386.0	411.4	
B7-320	Co-operation with South Africa	99.9	91.4	135	
B7-10	European Development Fund	1 439.6	1 275.3	1 548.1	ACP countries
B7-6200	Environment in developing countries and tropical forests	61.5	63.9	55.0	
B7-810	LIFE (European Instrument for Financing Environment; measures outside EU)	4.5	4.4	5.0	Countries bordering the EU
Total with climate relevance (estimate)		**209.1**	**204.4**	**215.1**	

Source: Official Journal L 56 (26 February 2001), COM(2001)402 of 16 July 2001.

7.4 PROGRAMMES IN SUPPORT OF BILATERAL CO-OPERATION

The main EU programmes relevant for bilateral co-operation with third countries in the context of climate change are described in the following section. Table gives an estimate of the climate relevant part, although no reliable project classification under the heading 'climate change' is available because the European Commission is not yet using the OECD/DAC marker for support to the UNFCCC.

7.4.1 Accession countries

Phare was established in 1989 and originally stood for "Poland Hungary Aid for the Reconstruction of the Economy". However, it was quickly extended, in terms of both countries and budget, and by 1997, 13 Central European Countries (CEECs) had become eligible for Phare support. At the end of 1998, cumulative commitments amounted to some 8.7 billion Euro, all in the form of non-reimbursable grants, financed from the EU budget. During the first years it was the European Union's financial instrument to assist the CEECs in their transition from an economically and politically centralised system to a decentralised market economy and democratic society. Phare took a new turn after the Copenhagen Summit (June 1993) confirmed the prospect of EU membership for the CEECs, and the Essen Summit (December 1994) designated Phare as the main financial instrument to support pre-accession strategies.

Following the publication of the European Commission's Opinions (July 1997) on accession of the candidate member states, the Phare Programme became fully focused on accession. From 1998 onwards, Phare programmes were based on Accession Partnerships, which indicate the areas of the 'Acquis Communautaire' (the set of EU legislation and regulations) where candidate member states need to make further progress in order to pave the way for full membership. Phare provides both technical assistance and investment support to help them implement their "National Programme for Adoption of the Acquis".

Energy and environment programmes financed by Phare over the period 1990-1997 in the candidate member states to the EU represented a total financial commitment of some € 570 million, or more than 7 per cent of the Phare programme. € 350 million (61 %) and € 220 million (39 %) were spent on environment and energy, respectively. Energy savings (incl. district heat) accounted for roughly 20 % and energy supply for 21 %.

Since 2000, Phare has been complemented by an opening up of the EU's Cohesion Fund (**ISPA,** € 1.5 bn/year) and Agricultural Funds (**SAPARD**, € 0.5 bn/year) to the candidate member states. ISPA funding in particular is relevant to climate change as it concentrates on energy and waste management. Through improved project designs it also focuses on the emission of greenhouse gases, particularly carbon dioxide and methane. For instance, Latvia is using ISPA support for investment improved recovery of landfill gases which is enlisted to become a future Joint Implementation project co-funded by the World Bank Prototype Carbon Fund (PCF).

Though the main EU energy, environment and research and technology development (RTD) programmes are mainly designed for EU Member States, a significant part has become accessible to the Accession countries:

- the SAVE II programme (energy efficiency), the Altener programme (renewables), Synergy , the ETAP programme, CARNOT
- The Fifth Framework Programme of Research and Technological Development, including Demonstration (1998-2002), has identified energy-environment-climate change as among its priorities and set a specific programme **on "Energy, Environment and Sustainable Development" (EESD)**. It includes significant support for EC research on climate change (understanding, mitigation, impacts, socio-economic issues) and for technology research, development and demonstration in cleaner energy systems, including renewables, and for economic and efficient energy supply and use. Under the specific programme "Competitive and sustainable growth" 14% of the funds are allocated to sustainable mobility and inter-modality of various forms of transport. As many of the issues to be addressed by the programme can only be tackled effectively in a broader international context – e.g. cross-border environmental issues, environmental consequences of energy policies, energy supply interdependency - , RTD projects in collaboration with entities from third countries, notably developing countries, is encouraged. For this purpose, priority is given to non-Annex I countries with high emission potential and with whom the EC has concluded or is about to conclude RTD co-operation Agreements (e.g. China, Argentina).
- In the context of the 5th RTD Framework Programme the European Commission runs **ENRICH**, a specific activity in the Key Action on Global Change, Climate and Biodiversity which aims at networking institutions from the EU as well as from other countries dealing with research on climate change. ENRICH can also provide support to accompanying measures, such as workshops and studies related to climate. In addition, support is foreseen for global observation systems for monitoring and detection of climate change.
- Also within the Fifth Framework Programme of RTD, research and development co-operation with developing countries is a major part of the horizontal programme "**Confirming the International Role of European Research (INCO)**". The objective of this part of the programme is to tackle research problems linked directly to development challenges of long-term mutual interest, e.g. mechanisms and socio-economic and political conditions for sustainable development, sustainable management and use of natural resources, health improvement (see Section 8).

7.4.2 Africa, Caribbean and Pacific (ACP) countries

77 countries (including South Africa) are linked with the European Union through a special international agreement known as the Cotonou Agreement (former Lomé Convention), which has been renegotiated or amended every five years since 1974. This agreement provides the legal and policy framework not only for a major programme of financial and technical assistance through the European Development Fund, but also for trade. The agreement covers the regions of sub-Saharan Africa, the Caribbean and Pacific (ACP) – and is the main focus of European co-operation with many of the world's poorest and most heavily indebted countries.

The **European Development Fund (EDF)** is supporting the ACP countries and is additional to the budget lines under the heading External Actions in the Community budget. In addition, ACP countries benefit from various thematic budget lines, like food aid, environment, forests (budget chapter B7) and a specific budget line for South Africa.

The 8th EDF entered into force in 1998 following ratification of the agreement amending the Lome IV Convention signed in Mauritius on 4 November 1995. Its total funding of € 12.967 billion is divided between the ACP States and the Overseas Countries and Territories (OCTs) who receive € 12.8 billion and € 165 million, respectively. Operations are programmed in fields such as education, health, rural development, infrastructure and private investment.

The 9th EDF will come on stream in early 2002 and be under implementation until the end of 2006. For 2002-2006, the overall indicative financial envelope amounts to € 13.5 billion. Of this amount € 2.2 billion will be set aside for the Investment Facility (handled by the European Investment Bank), € 10 billion for bi-lateral development and € 1.3 billion for regional development programmes.

ACP countries have received significant assistance for projects and programmes that are climate-relevant. In future, the European Commission will continue to support climate-relevant programmes. Recent funding decisions include:

- Improving climate observation facilities through providing access to METEOSAT 2nd generation data for African countries.
- CONGO BRAZZAVILLE: Technical assistance to the preparation of a national transport plan, € 1.95 million.
- MALI: Environmental programme to combat desertification, € 14 million.
- REGIONAL West Africa: Regional solar programme (Phase II), € 59.70 million.
- GUINEA: National support programme for the wood-energy economy (PANEB), € 1.56 million.
- TCHAD: Ouaddaï-Biltine village hydropower, € 2 million.

7.4.3 Mediterranean region

The ***MEDA programme*** is the principal financial instrument of the European Commission (EC) for the implementation of the Euro-Mediterranean Partnership. It accounts for Euro 3.4 billion out of a total budget of Euro 4.7 billion in grants, allocated by the EU for financial co-operation with its Southern and Eastern Mediterranean partners for the period 1995-1999. Apart from the MEDA grant programme, there is substantial lending from the European Investment Bank (EIB) to the partner countries. The priorities for MEDA resources at the bilateral level are to support economic transition and to strengthen the socio-economic balance (the aim of which is to alleviate the short-term costs of economic transition through appropriate measures in the field of social policy).

One particular programme funded from MEDA is the Short and Medium Term Action Programme **(SMAP)** for the environment. Actions related to climate change are particularly undertaken in the waste management sector.

Mediterranean countries also have access to the **LIFE – Third countries** budget line. Climate-relevant projects supported in 1998 and 1999 included technical assistance for the waste management of Bodrum (Turkey), strengthening the permitting and auditing system for industries (Lebanon), eco-efficiency for companies in the MED region.

7.4.4 Asia and Latin America (ALA)

The EC co-operates with the developing countries in Asia and Latin America, referred to as "ALA countries". For 1991-95, around € 2.7 billion was made available for co-operation with these countries; in the period 1996-98 at least 500 million Euro was committed each year. The recipients of ALA aid can include not only states and regions but also decentralised authorities, public agencies, local or traditional communities, private institutes and operators, including co-operatives and non-governmental organisations.

Important programmes linked to climate change in Asia include the Asia COGEN[118], and Asia Eco-Best[119].

In Latin America, the Community is supporting the ALURE programme[120] in order to foster the rational use of energy through improved energy policies, energy efficiency, and the use of renewables.

7.4.5 Newly Independent States and Mongolia (TACIS programmes)

Tacis stands for "Technical Assistance to the Commonwealth of Independent States". It was launched in 1991 as the EU's instrument for assistance to the New Independent States – Russia, Ukraine, Moldova, Belarus, Georgia, Armenia, Azerbaijan, Uzbekistan, Turkmenistan, Kazakhstan, Tajikistan and Kyrgystan - and Mongolia. Its main objectives are to foster the development of harmonious and prosperous economic and political links between the EU and these partner countries, and to support the partner countries' transition to market economies and democratic societies. By the end of 1998, it had committed some € 3.8 billion in grants to finance more than 2,500 projects. Tacis financing is used primarily for technical assistance that transfers know-how from the EU, in the form of policy advice, consultancy teams, studies and training, by developing and reforming legal and regulatory frameworks, institutions and organisations, and by setting up partnerships, networks, twinnings and pilot projects. It also provides limited support for investment projects. In order to ensure that Tacis funding is relevant to each country's own reform policies and priorities, it works closely with the partner countries to determine how funds should be spent.

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118 http://www.cogen.ait.ac.th/

119 http://www.riet.org/aeb/index.html

120 http://www.alure.net/

7.4.6 Horizontal/thematic programmes

In addition to the geographically oriented budget lines and the EDF, there are some horizontal/thematic budget lines that have supported actions in the field of climate change.

Budget lines **B7-6200 'Environment in Developing countries'**[121] and B7-6201 'Tropical forests' have supported actions including those already listed in section 7.3.1. In addition, the development of pico-hydro power in Ethiopia, carbonisation of biomass in Senegal, regional network on biomass energy in SADC, Start-up of CDM in sub-Sahara Africa (Senegal, Uganda, Zambia)[122] have received support.

Furthermore, the **SYNERGY programme** has promoted energy programmes in many developing countries, especially renewables, energy efficiency and energy conservation. The most recent call for proposals in 2001 focuses particularly on assistance for the implementation of the Kyoto mechanisms in the energy sectors of developing countries.

Under the humanitarian aid programmes, ECHO has been supporting measures in order to improve **disaster preparedness in developing countries (DIPECHO)**. This is particularly important to better cope with the most devastating effects of global climate change, i.e. natural disasters. Programmes include:

- Operations to boost local capabilities: improving disaster response and forging closer relations between communities, local institutions and civil protection bodies to achieve this goal. These operations include education, training and risk mapping.

- Early-warning system networks: the aim of these is to detect disasters and rapidly transmit a warning, and to facilitate the organisation of rescue work.

- Pilot projects with a demonstration value: this entails the use of new technology in disaster prevention in a manner that is suited to the cultural and socio-economic environment of the vulnerable populations in question.

In 1999, the EC spent € 7.4 million on DIPECHO activities in the Caribbean, Central America, Andean Community and South-East Asia. In 2000, South East Asia and Central America received € 7.5 million.

7.5 EU ECONOMIC AND DEVELOPMENT CO-OPERATION: RESPONDING TO THE NEW CHALLENGE OF CLIMATE CHANGE

The European Commission Communication "Preparing for Implementation of the Kyoto Protocol" submitted to the Cologne European Council calls for an overview of all the areas where the Community already provides assistance to developing countries in the field of climate change (COM(1999)230 final).

The European Commission has laid down strategic thoughts with respect to the role of co-operation with other countries in the context of global climate change in a

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121 http://europa.eu.int/comm/development/sector/environment/b7-6200budgetline/index.htm

122 http://cdmsusac.energyprojects.net/

working document[123]. Some major lines from this document are summarised in this section.

Most projections indicate that with forecast rates of economic and population growth, the share of future greenhouse gas emissions from developing countries will increase considerably. It is therefore crucial that developing countries increasingly participate in global efforts to combat climate change. However, developing countries differ significantly in terms of their developmental status, contribution to climate change and also in terms of their vulnerability to its effects. The EU has reaffirmed that the dialogue for increasing global participation must be in accordance with the principle of common but differentiated responsibilities.

Due to their limited resources, developing countries have considerable need for assistance to cope with the challenges of adaptation and mitigation through capacity building and technology transfer from developed countries. Compared to domestic investment and private investment flows, the role of public sector financial support in the more advanced developing economies is likely to be rather limited, however if well focused it can have an important catalytic effect. In the least developed countries, Official Development Assistance (ODA) will be of significant importance.

The main emphasis of Community development co-operation is to reduce poverty through fostering sustainable development. Currently activities directly supporting the objectives of the United Nations Framework Convention on Climate Change (UNFCCC) concentrate on capacity building. However, as outlined in the previous sections EC economic and development co-operation and other financing instruments support actions in many sectors (e.g. energy, transport, waste management, agriculture, forestry) that have a direct bearing on the objectives of the UNFCCC. The EC also has some comparative advantages in its development co-operation, which could be used to support initiatives on climate change. The European Community is therefore in a good position to further integrate climate change objectives into its co-operation policies.

The main challenges in this regard are:

- Initiating an in-depth discussion within the European Community to make full use of its comparative advantages.

- Identifying country specific needs and increasing country dialogue on climate change.

- Using official development finance for mainstreaming and supporting Climate Convention objectives.

- Developing sector specific measures and facilitating experience sharing on such measures within the EU and among developing country partners and economies in transition.

[123] http://europa.eu.int/comm/development/lex/en/work99676.pdf

- Identifying the EU's role in the development of Joint Implementation and the Clean Development Mechanism and improving completeness of scope using different donors and forms of finance.

As regards the latter aspect, the ECCP Working Group 1, Sub-Group Joint Implementation and Clean Development Mechanism[124] has reviewed the up-coming challenges for the European Commission concerning the implementation of JI and CDM in early 2001. This review included the regulatory and legislative aspects as well as the implications for Community co-operation programmes. As part of this an overview of existing EC programmes relevant in the context of JI/CDM[125] was compiled.

7.6 EXAMPLES OF ACTIVITIES RELATED TO TRANSFER OF TECHNOLOGY

A selection of activities related to the transfer of technology in the field of climate change is described in detail in Annex 2.

124 http://europa.eu.int/comm/environment/climat/jicdm/jicdm.htm

125 http://europa.eu.int/comm/environment/climat/jicdm/overexist.htm

8 RESEARCH AND SYSTEMATIC OBSERVATION

8.1 GENERAL INTRODUCTION

The Treaty of Rome provides the European Union with a legal basis for measures to help to support European co-operation in research and technological development. While the principal framework for research activities in Europe is national, it is the EU's mission to address issues that could not be taken up by national governments alone as the volume of investments would be too large or a European wide networking and exchange of experiences would be required. For adding value to the national components of research and technological development, the funding of the various initiatives of the European Community or intergovernmental scientific and technological co-operation provides funds of the magnitude of 17% of the total public expenditure on European Research.

In January 2000, the European Commission adopted the Communication *Towards a European Research Area*[126] which calls for concerted mobilisation of the relevant policies and instruments at all levels. It identifies seven priority areas for creating a coherent research area in terms of human, material and financial resources:

- Optimise the stock of material resources and facilities at the European level
- Make more coherent use of public instruments and resources
- Make private investment more dynamic
- Establish a common scientific and technical reference system for policy implementation
- Give rise to more abundant and more mobile human resources
- Make the European landscape more dynamic, open and attractive to researchers and investments
- Create an area of shared values.

Guidelines for realising the European research area 2002-2006 were presented in a Communication in October 2000[127].

8.2 FUNDING OF RESEARCH AND SYSTEMATIC OBSERVATION

The principal instrument used so far in Europe has been the European Union's framework programme for research. The 4th Framework Programme ended in 1998 and comprised fifteen specific programmes of which two were of direct relevance to

126 "Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions – Towards a European research area", COM (2000) 6, January 2000

127 "Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions – Making a reality of The European Research Area: Guidelines for EU research activities (2002-2006)" COM (2000) 612, October 2000

climate change research. These were the non-nuclear energy Programme and the Environment and Climate Programme.

Under the 5th Framework Programme, the majority of climate change activity is being undertaken within the Energy, Environment and Sustainable Development (EESD) Programme (2125 million Euro)[128]. Three key actions are of particular importance in supporting climate change research. They include:

- Global change , climate and biodiversity (with a budget of 301 Meuro)
- Cleaner energy systems including renewables (with a budget of 479 Meuro)- targeted research in clean production of electricity (in particular off-shore wind), technologies for converting new and renewable forms of energy; integration of new and renewable energy into energy systems and the reduction of damage to the environment caused by power stations.
- Economic and efficient energy for a competitive Europe (with a budget of 547 Meuro) – targeted research on rational and efficient end-use of energy; transmission and distribution, micro and macro-scale energy storage technologies; exploration, extraction and production technologies for fossil fuels and energy supply and demand scenarios and interactions with economic and environmental policies.

In addition there is research and technological development (RTD) in Earth observation generic technologies which includes the development of satellite remote sensing for understanding and monitoring climate change processes. RTD activities of a generic nature of the ENERGIE programme deal with the socio-economic aspects of climate change, especially with the quantitative evaluation of policies, measures and instruments to reduce greenhouse gas emissions.

Two key actions under the Programme Competitive and Sustainable Growth focussing on Sustainable Mobility and Intermodality (budget 371 Meuro) as well as on Innovative Products, Processes, Organisation (731 Meuro, of which, however, only a smaller fraction is directly climate relevant) have relevance for climate change RTD.

Proposals for the Research Framework Programme (2002-2006) are for a budget of 17.5 billion Euro (compared to 14.96 for the current framework programme), of which 1.7 billion is for sustainable development and global change, energy and transport[129] which also includes policy support and long term frontier research. The increase in the overall budget essentially benefits to fields with strong current economic activity such as information and communication technologies, bio sciences and the projected European Research Area.

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128 Further information on this programme can be found at http://www.cordis.lu/eesd/

129 "Budget breakdown for the Research Framework Programme (2002-2006) as proposed by the European Commission" Memo/01/50 February 2001.

Under the European Climate Change Programme[130] the role of Working Group 6 is to focus on the contribution of the research programmes to the overall ECCP. In line with their mandate,[131] the Research Working Group is undertaking the following tasks:

- Collect information on knowledge
- Assess future RTD needs
- Investigate and provide help in formulating policy options
- Mobilise all European resources

8.3 RESEARCH

8.3.1 Research Highlights

Climate process and climate systems studies

A significant amount of research has been carried out within the EU on climate processes and systems in recent years. Below are some of the areas in which research has occurred.

Carbon cycle

The increase in atmospheric CO_2 levels by over 25% since pre-industrial times has been confirmed by ice-core measurements. Measurements of atmospheric oxygen and carbon isotope distribution indicate that oceans take up approximately 30% of anthropogenic CO_2 while 45% accumulates in the atmosphere. The remaining 25% is assumed to be taken up by the terrestrial biosphere. The carbon sink of the terrestrial biosphere is still uncertain and shows a high interannual variability. The processes that constitute this sink and its location are not well-known. A large fraction of this terrestrial uptake probably occurs in temperate latitudes of the northern hemisphere. An important source of carbon to the atmosphere is attributed to land use change , mainly due to tropical deforestation. The carbon source associated with land-use change is of similar magnitude as the terrestrial sink but with opposite sign. A recent report by CARBOEUROPE concludes that it is more important to preserve existing old growth forests than to plant new ones[132] As they still sequester large amounts of carbon up to 6 t C/ha. Recent results also show that about 1/3 of the total carbon emissions in the EU are absorbed in European forests.

Methane

Atmospheric measurements and modelling have shown that concentrations stabilised in 1990-93 but increased again since then. In east Europe, there are high concentrations and large sources of methane due to natural gas leakage and coal. Most western Europe sources are biogenic (e.g. livestock, landfill, sewage).

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130 "EU policies and measures to reduce greenhouse gas emissions: Towards a European Climate Change Programme (ECCP)", COM (2000) 88. http://europa.eu.int/comm/environment/docum/0088_en.htm

131 http://europa.eu.int/comm/environment/climat/wg6_mandate.pdf

132 See http://www.bgc-jena.mpg.de/public/carboeur/ for further information.

Farmed European organic soils contribute significantly to methane budgets, even if they are a minor part of the total agricultural area; wetlands also, including rice fields, are important emitters of methane.

Aerosols and clouds

There remain major uncertainties in models in terms of the effect of aerosols and clouds. Overall, integrated aerosol forcing indicates a cooling over Europe. Aerosols play a role in climate change comparable in magnitude to greenhouse gases but are the source of large uncertainties in climate forcing.

Uncertainties also exist concerning the contrails formation and subsequent cirrus cloud formation caused by air traffic.

Past climates

Greenland ice cores (GRIP) have indicated that during glacial conditions, several abrupt climate changes have occurred in Greenland due to iceberg discharges. Oceanic sediment cores have helped show that the climate system is extremely sensitive to freshwater inflow including minor changes in rainfall over north Atlantic. This raises questions over the stability of the current climate in the future. Several palaeoclimate studies are documenting climate variability during past years, differentiating between natural and human-induced changes.

Upper atmospheric processes

Changes in ozone concentrations in the atmosphere and temperature in the stratosphere are important indicators of anthropogenic forcing of climate. Modelling studies and long term observational data show cooling of –0.4C per decade in lower stratosphere and –4C / decade in mesosphere. The amplitude of these temperature changes are of a higher magnitude to earth surface data, indicating that upper atmospheric changes are likely due to ozone depletion and increased CO_2 and cannot be attributed to natural forcing alone.

International research

Activities include the LBA (Large-scale Biosphere-atmosphere experiment in Amazonia) study interactions between regional climate and land use change and their effect on global climate. Amazonian deforestation is thought to significantly effect the functioning and composition of the global atmosphere.

Climate modelling and scenario analysis

At a global scale, new models that include coupled ocean and atmospheric circulation models show that multiple feedback exists between the atmosphere, oceans and biosphere. Techniques are developed for downscaling global results to regional / local scale. The assessment of climate change impacts at regional scale should improve with progress in global climate modelling.

Research on the impacts of climate change

Research on the impacts of and adaptation to climate change has been undertaken in various research topics included in the Environment and previous research

programmes. The terrestrial Ecosystem Research Initiative-Concerted Action co-ordinated several projects related to issue like implications of biodiversity for ecosystem functioning, providing an ecosystem understanding to support the management of particularly sensitive European ecosystems. The core findings are presented in a EUR 19375 publication « Terrestrial Ecosystem research in Europe : Successes, challenges and policy ». The EUR 19337 publication highlights the « sea level change and coastal processes implications for Europe « on a basis of outcomes from different EC funded projects in the area. Other EC research projects related to climate change impacts on land degradation/desertification, agriculture, forestry and water have contributed to the findings published in the Acacia –Concerted Action report[133]. Information on these findings can be found in Chapter VI of this communication.

Socio-economic research

The socio-economic content of the Framework Programmes is well balanced and covers various categories as outlined below:

Decision support to policies and international negotiations

Various economic and technology models and simulation tools have been built for the EU and other world regions, e.g. GEM-E3, HERMES, MURE, MEDEE, NEMESIS, POLES, PRIMES. Such models appears to have provided crucial quantitative information to RTD, energy and environmental policies[134]. All models, for example, agree that there are significant benefits from emissions trading while marginal costs in the absence of trading varying significantly among countries. There remains a significant divergence between model results, particularly due to different assumptions concerning reference cases. A non nuclear energy initiative called ACROPOLIS is comparing the different models through common scenarios developed within EU, American, Canadian and Japanese research activities.

Emissions trading

Models have been effective in providing policy with information regarding costs and benefits, and impacts of scenarios for greenhouse gas reduction [135]. Most models developed in the EU research programme agree on the total benefits of trading both at the world level and among sectors at the EU-level. Some RTD projects funded by the ENERGIE programme deal with the feasibility of the Joint Implementation and the Clean Development Mechanism (cf. the projects “JOINT” and “CD-MED”).

External costs of energy

Several large studies in the socio-economic non nuclear energy programme commonly known as EXTERNE[136] have contributed to a better understanding of the

133 “Assessment of the Potential Effects and Adaptations for Climate Change in Europe: The Europe Acacia Project.” Jackson Environmental Institute, University of East Anglia, Norwich, UK 2000.

134 “Climate Technology Strategy”, EC, DG Research, non nuclear energy programme.

135 http://europa.eu.int/comm/environment/enveco/climate_change/primes.pdf, http://europa.eu.int/comm/environment/enveco/climate_change/poles.pdf

136 The last ExternE publications are available from DG Research (ENERGIE); Email: domenico.rossetti-di-valdalbero@cec.eu.int.

issue of external costs and the methodological issues around this concept. Though a general agreement on external costs of energy generation modes is still not fully achieved, the EXTERNE project has provided some scientifically robust results. For example, in the European Union, external costs (essentially in terms of human health and global warming impacts from air pollution) for electricity production from gas are comprised between 1 and 3 Euro cents/kWh and from coal between 3 and 10 Euro cents/kWh. EXTERNE has been an important scientific input in the Community guidelines on State aid for environmental protection (OJEC, C 37/3 of 3 February 2001). This document allows the Member States to *"grant operating aid to new plants producing renewable energy that will be calculated on the basis of the external costs avoided (…). The amount of the aid granted to the renewable energy producer must not exceed 5 Euro cents/kWh"*.

European Research Networks for Climate and Energy RTD

The European Commission has initiated and continued a large number of networks to promote co-operation among research institutes in EU Member States (and increasingly in accession countries). Examples of Networks in the field of climate change are, e.g.

- The European Network for Energy Economics Research ENER (http://www.eu.fhg.de/ENER/Enerhome.htm) (ENERGIE Programme)

- The Odysee/MURE Network (SAVE Programme, http://www.enerdata.grenet.fr/odyssee and http://www.mure2.com)

- European Tropical Forest Research Network (ETFRN) (http://www.etfrn.org/etfrn/)

The forth-coming 6th Framework Programme places even more emphasis on the important contribution of networks to combine the best scientific competence on given topics in networks of excellence[137]. The objectives is to reinforce European and scientific excellence through a progressive and lasting integration of research capacities existing or emerging in Europe.

Mitigation and adaptation technologies

Renewable energy.

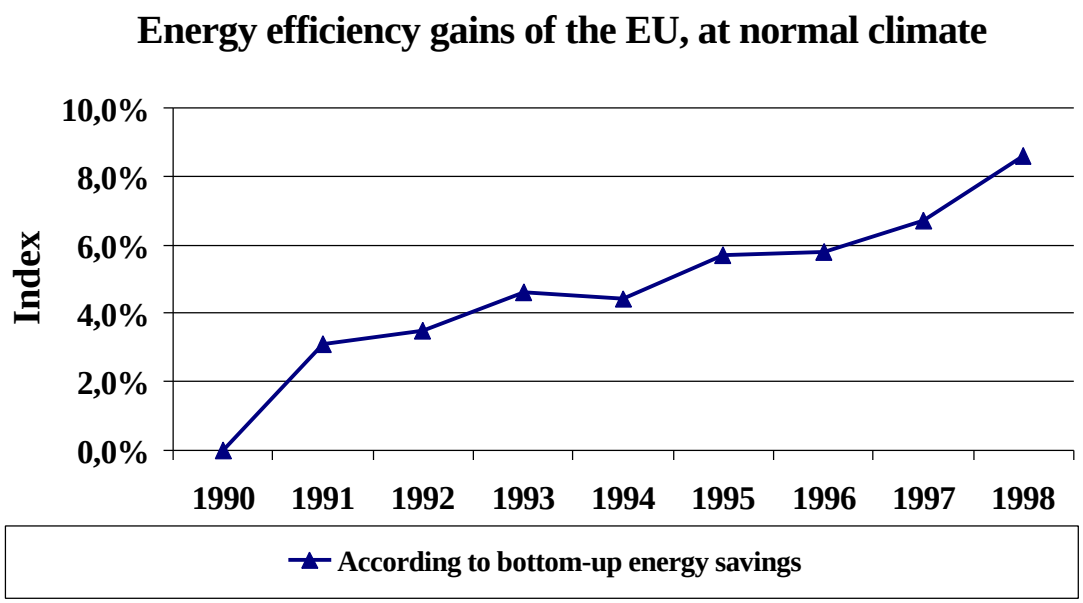
Two significant studies have been carried out under the Framework Programmes, providing a mechanism for stakeholders to develop concepts for implementation. SAFIRE (Strategic Assessment Framework for the Implementation of Rational Energy) has provided a basis for setting the target for the use of renewables, and in particular for the White Paper on Renewable energy of 1997 and for the recent proposed Directive for Renewables COM(2000)279. REALM (Renewable Electricity in Liberalising Markets) has led to a better understanding at the EU-level of the "green certificates" system, directly helping policy makers in different countries.

137 http://europa.eu.int/comm/research/nfp/networks-ip.html

Energy Efficiency

There has been extensive work within the Framework programme on energy efficiency, which can be demonstrated by many individual examples of research in the framework programmes but the impact of research in this area appears to have been low, with no significant policy change resulting in difference to the progress achieved on the renewables side. Another problem is also that it is difficult to demonstrate how the development in energy efficiency differs to renewables where the progress in Europe is evident. For this purpose, an aggregate bottom-up indicator of energy efficiency was developed in the Odyssee/SAVE project (see for an explanation of this indicators the Energy Efficiency Indicator Report for the European Union 2000, www.enerdata.grenet.fr/odyssee). This indicator was different to aggregate indicators such as final energy related to GDP which excludes most factors of influence not related to energy efficiency such as influence of climate, structural changes, influence of the business cycle etc. In particular, it is constructed as far as possible from physical indicators which at the disaggregated level provide a better measure for energy efficiency. The message from this figure is that over the past decade energy efficiency in its narrow sense has improved by less than 1 % annually. It is impossible to detail the impact of research on this development due to the difficulty of dissociating European-wide research impacts from the impact of national and private research. Nevertheless the message to be drawn is that, given the other factors that impact on energy consumption, hence greenhouse gas emissions, such as activity levels are tending to grow, this figure is too low compared to short and long-term targets. Research has to enable the sustainability of this path over the coming decades, otherwise energy efficiency would indeed soon exhaust the available potential for improvement.

Figure 8.3.1 Bottom-up aggregate indicator for energy efficiency in the European Union



Source: Odyssee / SAVE

The structures, as set up in the Framework Programmes 4 to 6, and the dissemination oriented SAVE Programme do not fully reflect the importance which energy efficiency is given in the political agenda to Kyoto as stated by the Energy Efficiency

Action Plan: “There is a pressing need to renew commitment both at Community and Member State level to promote energy efficiency more actively.” The figures in Table 8.3.1 are an indication of the importance that demand side research has among European Energy and Climate relevant research, but more funds are provided in other parts of the framework programme such as research on new materials and communication technologies, as well as in private research[138].

[138] e.g. (ACEA/EUCAR/CLEPA) announced a joint CO_2 R&D Programme, to identify, develop and demonstrate new technologies and system concepts enabling reduction of CO_2 emissions from vehicles. With wide participation from across the sector’s research base (car manufacturers, suppliers, research establishments, and universities), project proposals were specified in each of the Programmes main areas of R&D (Powertrain, Materials and Manufacturing, Systems Efficiency, Mobility, System Assessment and Demonstrators). The duration of the Programme is until 2004. Its expected overall budget is of the order 300M Euro.(COM(2000)615)

Table 8.3.1 Climate/Energy related RTD in Framework Programme 4, 5 and 6 (Meuro)

FP 4 (1994-1998)	**13 215**	**FP5 (1998-2002)**	**14 960**	**FP6 (2002-2006)**	**17 500**
Environment and Climate	**914**	**Energy, Environment and Sustainable Development**	**2 125**	**Sustainable development and global change, Energy, Transport**	**1 700**
(*part of climate related R&D* ?)		Key action 16: Global change, climate and biodiversity	301		
Non-Nuclear Energy	**1 076**	Key action 19 Cleaner energy systems	479		
		Key action 20: Economic and efficient energy for a competitive Europe	547		
Transport	**263**	**Competitive and Sustainable Growth** - Key action 12: Sustainable mobility and intermodality	371		
Nuclear fission safety, Controlled thermonuclear Fusion (1336 MECU)	**1 336**	**Euratom (979 Meuro) (+ ISPRA nuclear)**	**1 260**	**Activities under Euratom Treaty**	**1 230**
Controlled thermonuclear Fusion (895 MECU	895	Nuclear fusion (788 Meuro)	788	Nuclear fusion (700 Meuro)	700
Nuclear fission, safety, JRC	441	Nuclear fission + other	191	Nuclear fission + other	200
		Euratom actions of the Joint Research Centre	281	Euratom actions of the Joint Research Centre	330

From the figures in Table above it is estimated that only about 20-25 % of the research for energy and climate for the period 1994-2006 is for the improvement of demand side options. In the light of the long-term nature of research, this gives rise to the worry that the path of energy efficiency cannot be improved substantially over the 1 % per annum observed in the past. This is particularly so as the situation in the Member States is similar, although there is undeniably a slow trend to strengthen demand side in research (see Table 8.3.2).

Table 8.3.2 Share of energy efficiency research and development in Government energy R&D budgets 1999

Member State	% contribution to energy efficiency
Austria [1)]	25
Belgium [1)]	18.9
Denmark	21.9
Finland [1)]	51.9
France	1.9
Germany	4.1
Greece	n.a.
Ireland	n.a.
Italy [1)]	21.1
Luxembourg	n.a.
Netherlands [1)]	36.5
Portugal	8.9
Spain	23.9
Sweden [1)]	28.1
UK	1.3

1) 1998

Source: Energy Policies of International Energy Agency (IEA) countries, 2000 Review (OECD/IEA 2000)

Accompanying measures in support of global change research.

Parallel to the general accompanying measure activities there is one activity particularly dedicated to all areas of climate and global change research. ENRICH (European Network for Research into Global Change), equipped with a budget of 5 Meuro under 4th as well as under the 5th Framework Programme. This has the main overall purpose of increasing the effectiveness of European Global Change research and enlarging its scope in a wider international and global context. ENRICH projects have a strong link to current concerns within European Global Change research and also have a significant international dimension (reaching outside the EU and the countries associated with the EESD programme) and/or significant links to international Global Change Programmes. Projects often include activities like capacity building, training courses and networking beyond the EU member states and address topics ranging from climate change impacts to improvements of agricultural methodologies. ENRICH is therefore an important component of the Key Action on Global Change, Climate and Biodiversity.

INCO-II is *targeted on the following types of activity*, shown with corresponding 4-year budget (MEUR):

Table 8.3.3 Co-operation in research with Third countries

		Gross:	Net:	Net plus 3rd countries contribution
A.:	**Cooperation with third countries**			
A1	States in the pre-accession phase	26	23.5	25
A2	NIS and CEEC's not in that phase	116.4	105	111.7
A3	Mediterranean Partner Countries	55	49.6	52.8
A4	Research for Development	210	189.4	201.5
A5	Emerging economies and countries	5	4.5	4.8
B.	Training of researchers	10.6	9.5	10.1
C:	Coordination		46.9	49.9
	TOTAL	**475**	**428.4**	**455.8**

(NIS: New Independent States of the former Soviet Union; CEECs: Central and East-European Countries).

8.3.2 Future priorities for research

The European Climate Change Programme (ECCP) Working Group 6: "Research" has indicated what further research is needed to address gaps in information and understanding. An identified need is to improve detection, attribution and understanding of climate change, particularly to reduce uncertainties, and to undertake additional observational, modelling and process research. The priorities for research are based around Intergovernmental Panel on Climate Change (IPCC)[139] recommendations that have identified two high priority areas for further research:

- Systematic observation (see following chapter) and reconstruction of past climate periods.
- Modelling and process studies.

The modelling and process studies area includes greater understanding of radiative forcing, less understood processes and feedbacks in climate systems, quantifying uncertainties of projections and scenarios, improving regional modelling and link more effectively models of physical climate and biogeochemical systems.

139 See http://www.ipcc.ch/index.html for further information.

Further knowledge of abatement is also needed to ensure appropriate policy decisions are taken. Areas which have been identified by the IPCC Third Assessment include:

- Understanding economic, social and institutional issues in developing countries relating to climate change mitigation.
- Assessing mitigation options in the context of development, sustainability and equity.
- Developing methodologies for analysing potential mitigation options and associated costs which ensure the comparability of results.
- More exploration at different levels for potential of technological and social innovation options.

Natural Sciences

There are a number of specific areas within the natural science category that the ECCP Working Group 6 have been identified as needing further research for improved assessment of impacts and responses:

- Improved understanding of climate system processes and their subsequent representation in climate models. Improvements needs to come through observation, experimental process studies and modelling. Models need better parameterisation and resolution including the need for regional assessment.
- Atmospheric chemistry is a key area for research as chemical processes are important in determining the concentration of some greenhouse gases. The coupling between stratospheric ozone and climate change is essential to be understood quantitatively.
- Improved quantitative understanding and estimation of changes in the global carbon cycle, in particular the carbon sinks in the land biosphere. There needs to be greater understanding of carbon exchange and budgets.
- A European effort is needed to quantitatively assess the patterns of change in the hydrological cycle and its regional impacts.
- Continued research into impact assessment by improving techniques and methodologies is necessary. Socio-economic scenarios need to be linked into global climate models with the view to generate climate change predictions and assess impacts at the European level.
- Future research in agriculture needs to focus on development of methods to integrate climate change impacts with future socio-economic and technological changes.
- Climate change research should be linked to biodiversity and the functioning of terrestrial and marine ecosystems.

Socio-economic research

A future priority is to study how market mechanisms can be used to manage climate change. ECCP outlines a number of topics for further research:

- Inclusion of non-greenhouse gases in trading regimes
- Impacts of multi-gas flexibility and carbon sinks on global greenhouse gas emission control strategies.
- Socio-economic drivers of land use change and potential societal impacts of sink projects.
- European market in renewable energy and its relationship to CO_2 trading.
- Options for trading scheme implementation within the EU.
- Benefits of mitigation.
- Parameterisation of technical progress and the impact of policy on diffusion of new technology.

Technological development

Favouring new, clean and more efficient energy technologies will have a positive impact for mitigating climate change. Through its "Key actions" Cleaner energy systems, including renewables and Economic and efficient energy for a competitive Europe, the 5th Research and Technological Development & Demonstration programme aims to contribute to a more sustainable energy systems. For short and long term, specific "target actions" have been defined. They deal with Fuel Cells and Hydrogen, Biomass, Integration of Renewables, Sustainable Communities, Clean Urban Transport and Cleaner Fuels for Transport, Eco-Buildings, Gas Power Generation, Storage of Energy and Photovoltaics.

Future proposed research priorities for the next Framework Programme are:

- for the short term: Renewable energy sources, more efficient and clean use of energy, especially in urban areas, new concepts of energy efficient and cleaner transport; and sustainable transport;
- for the longer term: Fuel Cells, Hydrogen, Solar photovoltaic technologies and biomass.

Integrated Assessment

In addition to socio-economic and natural science studies, a more generic integrated system of research is also needed which covers all critical factors concerning the climate system and the management of its impacts. These need to be made at a regional and global level.

Regional studies need to be initiated in Europe and areas of significant global environmental or economic importance. It would be useful to install high level modelling forum to analyse data and results from different studies.

8.4 SYSTEMATIC OBSERVATION AND GLOBAL CLIMATE OBSERVATION (GCOS)

Significant European Commission funds have been used to support Earth Observation - related research and development projects during the last ten years. Work carried out in these projects and results constitutes an important patrimony for research in this field.

At present the objective is to support the development of the European component of the global observing systems for climate, terrestrial systems and oceans. Among ongoing projects, MAIA, CLIWA-NET and POSITIVE are particularly important. The overall objective of MAIA (Monitoring the Atlantic Inflow toward the Arctic), research project started on January 2000, is to develop an inexpensive, reliable system based on coastal sea-level data for monitoring the inflow of Atlantic water to the Northern seas. CLIWA-NET (Cloud Liquid Water-NETwork) a three year project started on March 2000 is focused on observations of cloud liquid water, and vertical structures and the evaluation and improvement of model parameterisations. The main objective of POSITIVE (Phenological Observation and Satellite Data – ndvI- Trends In the vegetation cycle in Europe), project started on February 2000, is to develop tools and techniques for integrating climate, phenological, ad satellite data for multipurpose use in the field of global change research. Results of ongoing and future projects will contribute to identify and help fill key gaps in existing observation system capacity to ensure that the long term consolidated data sets are collected in a co-ordinated manner, and that such data are quality-assessed and made available to predict, assess the impact and to formulate response options to global change.

Moreover these activities represents the EU main contribution to GMES **(**Global Monitoring for Environment and Security). GMES is a European initiative aiming at gathering and processing data and information from various sources (space and ground based) to assist decision-makers, in support of Community policies contributions towards sustainable development. By doing so, it will federate Europe's disparate activities for providing information for environmental and security policies, including earth observation and remote sensing. GMES will seek to better exploit Europe's existing and planned capabilities and infrastructures and to develop coherent and complementary data-gathering and distribution mechanisms to meet the user requirements of policy makers at a European level.

GMES will develop around three strands of action:

- the supply of policy relevant information and services to users;
- the permanent improvement of the efficiency of the production and delivery of information, and the animation of a permanent dialogue between data gatherers, information producers and information users;
- the development of coherent networks of monitoring infrastructures and the improvement of related knowledge and models.

Sustainable development policies must be supported by information on the conditions of the environment and the use of resources, regionally and globally. As a responsible partner in a globalised world, Europe needs to secure access to such information. GMES is also a concrete element in the European Space Strategy, endorsed simultaneously by the EU and European Space Agency Councils in their 16 November 2000 Resolutions.

The European Commission has included GMES in its proposal for the next Framework Programme for Research and Development (2003 – 2006). European Commission-sponsored R&D activities will mainly serve to improve knowledge and models necessary to use space and ground data, also pooling user requirements for earth observation and remote sensing at the European level and will thus be complementary to ESA's and national programmes for the development of monitoring systems.

According to the ECCP "Research" Working Group, the verification, improvement and validation of models needs long-term and continuous in situ and satellite observations within a 'European component of the Global Observing System' framework backed by long-term commitments from policy makers and funding agencies.

The IPCC 3rd Assessment report identifies the need to improve systematic observation:

- Reverse decline in observational networks around the world.
- Improve observations of GHG and aerosol spatial distributions.
- Expand observational foundation for climate studies

8.4.1 Meteorological and atmospheric observation

The main contribution of the European Union in this area relates to the Global Atmosphere Watch (GAW) Regional Network as well as to questions of data analysis, data quality, data bases and archiving programmes. (There are currently no direct contributions to GSN and GUAN).

Global Atmosphere Watch (GAW)

The Joint Research Centre of the EU is the GAW World Data Centre on aerosols Regional Stations. It collects, process, analyses and distribute the data obtained from the GAW stations. The operation of the Ozone Mapping Center of World Meteorological Organisation (WMO) at Thessaloniki (GR) has been supported through research projects of the European Union. The Center uses data from GAW stations.

Regional Background Stations

Many of the GAW European stations are a subset of the EU air quality exchange of information network[140] In addition over 1100 monitoring stations report ozone levels and exceedances, of which some 250 in rural areas[141].

EU contributions to data analysis, data quality, archiving programmes

- The ERA-40 project objectives are: i) to create and maintain an archive of global meteorological and oceanographic in situ and satellite observations from 1957-2001; ii) to perform validations; iii) to generate assessments on the quality of observing systems.

- A global oceanic climatic database for the 1750-1850 period will be prepared based on vessels log books (CLIWOC project).

- The objective of the QUILT project is i) create and make available a homogeneous, quality controlled data set out of the existing NO_2, BrO and OCIO data; ii) to work with these to validate models of seasonal variation and trends of O3 and related species.

- A number of EU research projects supported the world-wide Network for the Detection of Stratospheric Change (NDSC). These project were part of the Third European Stratospheric Experiment on Ozone (THESEO) Data archiving is taking place at NILU in Norway.

- Automated data processing techniques for the retrieval of integrated water vapour data from the Global Positioning System have been designed (MAGIC project) and regional GPS networks for water vapour retrievals have been demonstrated for near real-time operations (WAVEFRONT).

8.4.2 Oceanographic observations

A number of EU funded project contribute to different aspects of the improvement of oceanic observations, amongst which are:

facilitating and fostering the co-operation between countries

- A Mediterranean network will be set up to help identify gaps in the present capacities for monitoring, modelling and forecasting in the Mediterranean. The project will also foster improvements and capacity building in the region. The MAMA project constitutes an important component of midges, the ocean observing system for the Mediterranean.

data quality, data standards and interfaces

- SEANET-DI is implementing a data interface in order to integrate different monitoring networks to allow the creation of one North Sea monitoring system.

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140 Council Decision 97/101/EC of 27 January 1997 establishing a reciprocal exchange of information and data collected from networks and individual stations measuring ambient air pollution within the Member States

141 Directive 92/72/EEC on air pollution by ozone.

- SEA-SEARCH, MEDAR/MEDATLAS (Mediterranean Data Archaeology and Rescue) and other similar projects are working to establish common schemes, standards and protocols for archiving and accessing oceanographic data.

- Both real-time and a seven year archive of TOPEX-POSEIDON and ERS altimetry data have been processed by the DUACS (Developing Use of Altimetry for Climate Studies) project to generate long time-series of satellite altimetry data adapted for use in climate models. The following files are available on CD-ROMs for general publication: corrected sea surface heights (CORSSH), along track sea level anomalies (SLA) and maps of SLA and associated errors (MSLA).

preparation and implementation of observation infrastructures

- The EDIOS project will deliver a European Directory core of ocean-observing sites and devices (location, characteristics, frequency and type of observations, owner). Such meta-information is essential to progress towards a European ocean observing system. This project will provide an important foundation towards the implementation of EuroGOOS, the European contribution to Global Ocean Observing System (GOOS).

- The focus of the ESODAE (European Shelf seas Ocean Data Assimilation and Forecast Experiment) project is the exchange between institutes of data, models and data assimilation schemes. The overall goal of the project is to design an experiment to provide a practical demonstration of the overall capabilities of ocean analysis/ assimilation and forecasting models for the North West European shelf

- The purpose of the ANIMATE project is to improve the eastern North Atlantic European observing infrastructure for CO2 and carbon cycle measurements.

- The GAVDOS project will establish a sea level calibration facility, produce a regional geoid and sea surface topography model.

- The GYROSCOPE project will prepare a European component of a global in-situ observing system of ocean variability by testing a pilot array of 80 autonomous profiling floats (temperature, salinity, velocity).

8.4.3 Terrestrial observations

Contributions to FLUXNET

In the framework of EUROFLUX (Long term Carbon dioxide and Water Vapour Fluxes of European Forests and Interactions with the Climate System), fluxes of carbon dioxide, water vapour, and energy exchange have been measured at 13 forest sites encompassing the entire range in European climate, species distribution, and site conditions. The selected sites are representative of the regional features of the European basin.

- The CarboEurope Cluster brings together six projects designed to better understand, quantify and predict under current and future scenarios the carbon balance of Europe, from local ecosystem to regional and continental scale. Two of these projects, CARBOEUROFLUX and CARBODATA are of direct relevance to terrestrial observing systems.

- CARBOEUROFLUX. At 30 study sites representative of European ecosystems, carbon, energy and water exchanges will be investigated together with ecological processes controlling the ecosystem biospheric exchanges. The net flux of carbon entering or leaving the ecosystem will be measured, to provide the annual estimate of Net Ecosystem Exchange.

- CARBODATA. This project is designed to exploit and to make widely available the results of the mentioned EU funded research projects which have produced data on C fluxes and C stocks in European ecosystems.

Other EU relevant monitoring activities

- Land Cover change. The Land Cover situation has been mapped for over 30 European countries under the programme of the European Environment Agency. (digital maps; scale 1/100.000; 42 land cover classes; reference years: end 8O's early 90's). An update for the year 2000 is in progress.

- Fire distribution. The characteristics and location of forest fires of the Mediterranean countries of the European Union have been assembled into a database from which yearly analysis reports are produced[142].

- The condition of forest ecosystems in Europe have been monitored at 840 stations in 30 countries[143] since 1994 (crown and foliar conditions, soil conditions, atmospheric deposition and soil solution chemistry, meteorological parameters).

8.4.4 Space based observing programmes

Participation in space based observing programmes and programme using space data for climate information

- The European Commission participate in the Integrated Global Observing Strategy (IGOS) through its partnership to the Committee on Earth Observation Satellites (CEOS). It has played a leading role in the activities initiated by the CEOS working groups in the fields of space data calibration/validation and space-based information systems and services

contributions to missions, instruments, data management, applications

- The European Commission contributed significantly to the development of the VEGETATION instrument onboard SPOT4, successfully launched in March 1998. Support was also given to ensure the improvement and the continuity of the VEGETATION mission through improving the products and services to the users and designing and developing technological improvements for the VEGETATION 2 payload to be flown onboard SPOT5 in 2002. VEGETATION provides accurate, daily, global measurements of basic characteristics of vegetation canopies on an operational basis.

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142 Commission Regulation (EC) No 804/94 of 11 April 1994 laying down certain detailed rules for the application of Council Regulation (EEC) No 2158/92 as regards forest-fire information systems

143 European Commission and UN/ECE. Intensive Monitoring of forest ecosystems in Europe.Technical report 2000. ISSN 1020-6078

- Twelve different feasibility studies (phase A studies) for new satellite missions have been supported to stimulate the development of new future Earth observation space systems. These studies had in common the identification of user requirements, the identification of the potential Earth observation technologies and the definition of the instruments, mission characteristics and ground structure. These new mission studies mainly focussed on cloud and radiation (CLOUDS, REFIR), fires detection (FUEGO), surface temperature (MUST), Ozone (OASE), agriculture (SAAGE, SAFE) sea ice (OSIMS). Some of them have been proposed as ESA Earth Explorer or Earth Watch candidates; others have been adapted and proposed to complement NASDA or NASA missions or target a demonstration onboard the International Space Station (ISS).

8.4.5 Infrastructure support for research

Research needs that have been outlined need an infrastructure from which to be accomplished. An example is that of observation networks – these need to be fully established in order to gain a complete set of results relating to global processes. At present, they are scattered and incomplete, not operating in a coherent way. GMES is pointing in the right way as are the G30S at the global scale.

Databases on land use and land cover are inadequate due to being incomplete and often inaccessible. Large, costly platforms such as technical equipment and monitoring vessels / aircraft need to be more available for research. This will improve the efficiency and level of European participation in global research.

9 EDUCATION, TRAINING AND PUBLIC AWARENESS

9.1 INTRODUCTION

The European Commission is committed to the principles of open government and provides a large amount of information to the public in a number of forms. Activities in these areas are focused on Public Awareness as most activities in Education and Training are at the Member State level. The European Commission recognises the crucial importance of Education and Training and provides support in the form of networks and dissemination of good practice.

The Community Information Policy in relation to the Environment and Climate Change has a number of objectives:

- To promote the results of Community Policies and to inform about proposals and actions
- To make more explicit the links between Community actions and the concerns of the citizens facing environmental problems
- To ensure transparency of European policy
- To encourage debate and partnership to create feedback on policies.

The tools used are:

- Information centre, which handles all types of enquiries and visitors
- Internet site, this is extensive and includes all types of information such as press releases, reports, studies, policy discussion as well as legislation
- Publication programme, including special magazines
- Relationships with the press and audio-visual sectors, this includes a TV news service, targeted audio-visual material, press releases and briefings
- Co-operation with business, NGOs and networks to disseminate information
- Subsidies to awareness raising projects
- Conferences aimed at raising visibility of issues and the European response.

Through these tools, the European Commission is able to provide comprehensive coverage of Climate Change issues and of their response to them.

In May 1999, the European Commission held a conference to review activities in the field of Environmental Education and Training (EE&T) and to explore new challenges for it's role in the future.

The objectives of the conference were to:

- Put the opportunities for EE&T on the agenda of decision-makers within the European Commission and national Governments

- Exchange information on the present and future roles of EE&T in Member States
- Discuss in that light the added value of activities and the new challenges for the European Commission
- Stimulate networking and informal contacts among experts from the European Commission and Member States

The conference produced a number of conclusions and policy recommendations. Potential future activities for the European Commission were identified in the role of:

- Management of networks
- Stimulation of innovations and professional development
- External integration of EE&T in other areas such as agriculture
- Establishing minimum standards and guidelines.

Key policy recommendations included:

- Integrating and clarifying the role of EE&T in the next Environmental Action Plan
- Formulating a special program to assist accession countries.

9.2 INFORMATION CENTRE

The information centre provides a focal point for enquiries regarding the environment and is open both for visitors and Community Staff. Nearly 8000 publications are held at the centre, including books, publications and CD ROMs. It also subscribes daily newspapers and environmental magazines. The number of requests for information from the Centre is declining as the website has been developed. It is estimated that around 1% of the enquiries relate directly to climate change.

9.3 INTERNET SITE

The European Community internet site provides a comprehensive source of data on Community actions and concerns. Most information on Climate Change issues is accessed through the European Commission's DG Environment website http://europa.eu.int/comm/dgs/environment. Other DGs as well as the European Environment Agency (EEA) (http://www.eea.eu.int/) also include information on Climate Change which is accessed through their websites, there are plans to provide more extensive cross-links for common themes. The DG Environment website covers a number of areas including:

- Policy areas – links to pages discussing policy on, for example air, land, climate change.
- Legislation – information and links to existing and proposed legislation in the environmental field.

- Funding opportunities for environmental projects under a variety of programmes.
- Publications – books, newsletters and reports on aspects of the environment including climate change. Most of the reports and newsletters are downloadable.
- Press releases – covering press releases, audiovisual material and news about activities.
- Key speeches – transcripts of speeches.
- 6th Environmental Action Programme – includes the downloadable text of the 6th Environmental Action Programme.

Climate change is covered as a separate policy area through the page http://europa.eu.int/comm/environment/climat/home_en.htm, but information relating to climate change can also be accessed through the other areas. The number of hits on the climate change pages has been steadily increasing starting from around 2000 per month in 1999 and reaching over 6000 per month by the end of 2000. In November 2000 (coinciding with COP 6) there were 28,000 hits.

9.4 PUBLICATION PROGRAMME

The number of publications is decreasing as more information is disseminated through the internet and through the audio visual sector. However, there is a publication programme and part of this covers climate change issues. In November 2000, a special addition of 'Environment for Europeans', which is a magazine publication of the European Commission's DG Environment, covered issues on Combating Climate Change. It included descriptions of the processes arising from Kyoto and the negotiations at COP6 and also gave information regarding emissions in the EU.

9.5 CO-OPERATION WITH THE PRESS AND AUDIO-VISUAL SECTOR

These included pre-council press briefings, presidency press visits when there is a switch in the presidency and video news releases. An extraordinary session of the pre-council briefings was devoted to the subject of climate change ahead of the Council of Parties (COP) 6 negotiations. During COP6, a special arrangement was made to ensure that the press were provided with daily updates as well as information such as fact sheets, briefing papers and glossaries of terms used. For COP5, a video was produced to give information on climate change to television journalists.

Information on press releases and audio visual material can be found via the web page http://europa.eu.int/comm/environment/press_en.htm. Two videos specifically on Climate Change have been produced:

- 'Kyoto - More than hot air' (released 2000)
- 'Climate Change - Isle of Wight' (released 1999).

In addition, the European Commission runs a European TV news service, Europe by Satellite http://europa.eu.int/comm/ebs, which provides raw materials to be used by broadcasters. These include live transmissions, unedited pictures and full programmes.

9.6 CO-OPERATION WITH THE BUSINESS SECTOR AND NGOS AND NETWORKS

The European Awards for the Environment given by the Community are designed to recognise and promote companies that make an outstanding contribution to sustainable development (http://www.eu-environment-awards.org). The awards were created in 1987 and are presented every two years.

Council Decision 97/872 is an Action Plan promoting European environmental NGOs. NGOs can apply for funding to support their activities in the field of environmental protection. Successful applicants during 2000 included the Climate Network Europe which is a coordinating office for environmental groups in Western Europe working on climate change issues.

The Green Spider network is composed of the information officers of the central environmental administrations of Member States and is an instrument of information and mutual support between the European Commission and national administrations.

9.7 SUBSIDIES TO AWARENESS RAISING PROJECTS

The objectives of the funding o pportunities are to:

- Increase awareness of the general public on environmental matters
- To inform regarding European environmental policy and
- To encourage the creation of European partnerships.

As part of the awareness raising, a public event on climate change organised by Vereniging, MileauDefense and Friends of the Earth (NL) for COP6 at the Hague was subsidised. In this event a 1km long dike was built to illustrate public concern about climate change. Video news releases, daily newspapers, a website and press kit were produced to publicise this event.

9.8 CONFERENCES

The European Commission organises conferences to disseminate the results of environmental projects and also discuss future activities. Examples of these are the 'Life' week held in October 1999 http://europa.eu.int/comm/environment/lifeweek/index.htm and the Hanover conference discussed above. The Life week conference was held to strengthen the visibility of the Life Programme and to encourage the exchange of experiences between Life projects' beneficiaries. More than 2300 people took part in the conference and 25 workshops were held on a wide range of issues including waste management, environment and regional policy and integration of environmental policies in industrial management.

10 ANNEX: UNFCCC SUMMARY REPORTS 1.A OF THE COMMON REPORTING FORMAT FOR THE EUROPEAN COMMUNITY (EU15)

EU15 1990

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**3,325,370**	**-199,850**	**20,955**	**1,272**	**-**	**25,627**	**-**	**13,502**	**-**	**0.3**	**13,292**	**49,817**	**16,633**	**16,325**
1. Energy	**3,159,538**		**4,832**	**154**							**13,019**	**44,805**	**8,760**	**15,905**
A. Fuel Combustion — Reference Approach	-													
A. Fuel Combustion — Sectoral Approach	3,133,575		811	153							12,988	44,624	7,405	15,429
1. Energy Industries	1,147,030		34	46							2,880	480	58	10,114
2. Manufacturing Industries and Construction	638,446		57	31							1,707	3,544	142	2,865
3. Transport	697,683		216	39							6,972	32,210	6,097	677
4. Other Sectors	630,585		501	36							1,334	8,248	1,081	1,522
5. Other	19,832		2	0							96	142	26	251
B. Fugitive Emissions from Fuels	25,963		4,021	1							31	181	1,355	476
1. Solid Fuels	6,762		2,417	0							1	96	11	163
2. Oil and Natural Gas	19,201		1,604	1							30	85	1,345	314
2. Industrial Processes	**149,000**		**22**	**356**	**-**	**25,627**	**-**	**13,502**	**-**	**0.3**	**180**	**3,544**	**966**	**395**
A. Mineral Products	108,070		0	0							43	28	210	44
B. Chemical Industry	11,874		10	356	-	2,340	-	70	-	0.0	83	124	379	153
C. Metal Production	25,137		8	0				11,782		0.1	25	3,226	20	92
D. Other Production	980										16	13	226	71
E. Production of Halocarbons and SF_6						22,576		560		0.0				
F. Consumption of Halocarbons and SF_6					-	360	-	856	-	0.3				
G. Other	2,939		4	0	-	351	-	237	-	0.0	14	154	132	35
3. Solvent and Other Product Use	**5,997**			**11**							**0**	**2**	**4,303**	0
4. Agriculture	**3,215**	**0**	**9,077**	**715**							37	519	939	1
A. Enteric Fermentation			6,748											
B. Manure Management			2,010	89									1	
C. Rice Cultivation			109	1									0	
D. Agricultural Soils	3,215	0	184	625							17		867	
E. Prescribed Burning of Savannas			0	0							0	0	0	
F. Field Burning of Agricultural Residues			25	1							21	519	72	1
G. Other			0	0							0	0	0	0

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 2 of 2)

5. Land-Use Change and Forestry	**-**	**-199,850**	**122**	**19**							**8**	**209**	**1,561**	**1**
A. Changes in Forest and Other Woody Biomass Stocks	-	-240,229												
B. Forest and Grassland Conversion	13,377		24	0							6	209	19	1
C. Abandonment of Managed Lands	-	-122												
D. CO_2 Emissions and Removals from Soil	24,315	-												
E. Other	2,808	-	98	19							2	0	1,542	0
6. Waste	**5,544**		**6,901**	**14**							**47**	**738**	**102**	**22**
A. Solid Waste Disposal on Land	263		6,478	0							1	41	37	1
B. Wastewater Handling			302	12							0	0	5	
C. Waste Incineration	5,170		40	2							46	696	45	21
D. Other	111		80	0							0	1	16	0
7. Other	**2,076**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Memo Items:														
International Bunkers	**163,869**		**9**	**4**							**1,482**	**276**	**181**	**955**
Aviation	60,073		5	2							224	160	59	15
Marine	103,796		5	3							1,258	116	122	940
Multilateral Operations	**0**		**0**	**0**							**0**	**0**	**0**	**0**
CO_2 Emissions from Biomass	**129,961**													

Notes:

Since not all Member States reported data on the Reference Approach for CO_2 from fossil fuel combustion, they are omitted in Annex A. Instead they are presented in Annex B.

Category 5 "Land-Use Change and Forestry" provides "net" emissions (Member States emissions minus Member States removals) of CO_2 following CRF recommendations..

EU15 1991

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**3,350,679**	**-221,908**	**20,444**	**1,264**	**-**	**24,954**	**-**	**11,847**	**-**	**0.4**	**13,195**	**47,964**	**16,071**	**14,801**
1. Energy	**3,193,327**		**4,739**	**160**							**12,931**	**43,355**	**8,421**	**14,447**
A. Fuel Combustion — Reference Approach	-													
A. Fuel Combustion — Sectoral Approach	3,169,569		806	159							12,902	43,185	7,104	14,141
1. Energy Industries	1,151,292		38	48							2,788	471	61	9,534
2. Manufacturing Industries and Construction	616,580		51	30							1,700	3,419	140	2,513
3. Transport	712,095		205	44							6,973	31,148	5,805	651
4. Other Sectors	673,718		510	37							1,355	8,049	1,083	1,241
5. Other	15,885		1	1							86	98	15	202
B. Fugitive Emissions from Fuels	23,758		3,933	1							29	170	1,317	306
1. Solid Fuels	6,056		2,310	0							1	99	10	17
2. Oil and Natural Gas	17,702		1,623	1							28	71	1,307	289
2. Industrial Processes	**140,982**		**21**	**350**	**-**	**24,954**	**-**	**11,847**	**-**	**0.4**	**165**	**3,049**	**968**	**329**
A. Mineral Products	103,300		0	0							44	29	244	45
B. Chemical Industry	11,148		10	350	-	2,340	-	70	-	0.0	68	117	360	133
C. Metal Production	23,042		7	0				10,189		0.1	24	2,763	19	84
D. Other Production	554										16	13	222	37
E. Production of Halocarbons and SF_6						21,875		479		0.0				
F. Consumption of Halocarbons and SF_6					-	384	-	878	-	0.3				
G. Other	2,938		4	0	-	355	-	231	-	0.0	14	128	123	31
3. Solvent and Other Product Use	**5,974**			**11**							**0**	**2**	**4,170**	0
4. Agriculture	**2,815**	**0**	**8,812**	**706**							38	537	883	1
A. Enteric Fermentation			6,562											
B. Manure Management			1,933	88									1	
C. Rice Cultivation			107	1									0	
D. Agricultural Soils	2,815	0	185	616							16		815	
E. Prescribed Burning of Savannas			0	0							0	0	0	
F. Field Burning of Agricultural Residues			26	1							21	537	67	1
G. Other			0	0							0	0	0	0

EN

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A) (Sheet 2 of 2)

5. Land-Use Change and Forestry	**-**	**-221,908**	**113**	**19**							**6**	**124**	**1,517**	**0**
A. Changes in Forest and Other Woody Biomass Stocks	-	-264,846												
B. Forest and Grassland Conversion	11,604		14	0							4	124	14	
C. Abandonment of Managed Lands	-	-162												
D. CO_2 Emissions and Removals from Soil	28,713	-												
E. Other	2,783	-	98	19							2	0	1,504	0
6. Waste	**5,548**		**6,757**	**14**							**55**	**896**	**113**	**23**
A. Solid Waste Disposal on Land	321		6,346								1	45	39	1
B. Wastewater Handling			281	12							0	0	5	
C. Waste Incineration	5,227		47	2							54	850	51	22
D. Other	0		83	0							0	1	18	0
7. Other	**2,033**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Memo Items:														
International Bunkers	**163,947**		**9**	**5**							**1,432**	**264**	**180**	**914**
Aviation	59,649		5	1							207	157	58	16
Marine	104,298		4	3							1,225	107	122	898
Multilateral Operations	**0**		**0**	**0**							**0**	**0**	**0**	**0**
CO_2 Emissions from Biomass	**136,993**													

Notes:

In order to obtain a complete EC inventory, for Luxembourg the following data gap filling procedure was used: Emissions reported for 1990 were taken as first estimates. However, for CO_2 emissions from fossil fuel combustion (CRF category 1 "Energy"), the 1990 estimates in combination with trend information for 1991 from latest calculations of CO_2 emissions from fossil fuels by Eurostat have been used (Eurostat, 2000).

Since not all Member States reported data on the Reference Approach for CO_2 from fossil fuel combustion, they are omitted in Annex A. Instead they are presented in Annex B.

Category 5 "Land-Use Change and Forestry" provides "net" emissions (Member States emissions minus Member States removals) of CO_2 following CRF recommendations.

EU15 1992

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**3,277,471**	**-209,145**	**19,895**	**1,234**	**-**	**24,957**	**-**	**9,606**	**-**	**0.4**	**12,882**	**46,046**	**15,549**	**13,590**
1. Energy	**3,124,449**		**4,621**	**162**							**12,637**	**41,669**	**8,209**	**13,274**
A. Fuel Combustion — Reference Approach	-													
A. Fuel Combustion — Sectoral Approach	3,100,933		759	161							12,608	41,515	6,923	12,975
1. Energy Industries	1,115,762		38	48							2,617	425	55	8,814
2. Manufacturing Industries and Construction	593,245		51	30							1,618	3,337	140	2,309
3. Transport	736,492		202	48							6,989	30,220	5,683	636
4. Other Sectors	643,356		467	35							1,305	7,440	1,031	1,024
5. Other	12,078		1	1							80	92	14	192
B. Fugitive Emissions from Fuels	23,516		3,863	1							28	154	1,286	300
1. Solid Fuels	5,880		2,238	0							1	93	8	14
2. Oil and Natural Gas	17,635		1,625	1							28	61	1,278	286
2. Industrial Processes	**137,048**		**21**	**331**	**-**	**24,957**	**-**	**9,606**	**-**	**0.4**	**151**	**2,935**	**966**	**291**
A. Mineral Products	101,669		0	0							43	30	244	45
B. Chemical Industry	10,115		10	331	-	2,340	-	70	-	0.0	57	124	361	115
C. Metal Production	21,394		6	0				8,049		0.1	22	2,668	18	72
D. Other Production	761										15	13	225	32
E. Production of Halocarbons and SF_6						21,716		380		0.0				
F. Consumption of Halocarbons and SF_6					-	543	-	901	-	0.3				
G. Other	3,108		5	0	-	359	-	206	-	0.0	13	101	117	27
3. Solvent and Other Product Use	**5,746**			**11**							**0**	**2**	**3,997**	0
4. Agriculture	**2,321**	**0**	**8,647**	**686**							33	414	815	1
A. Enteric Fermentation			6,416											
B. Manure Management			1,920	88									1	
C. Rice Cultivation			106	1									0	
D. Agricultural Soils	2,321	0	186	596							16		760	
E. Prescribed Burning of Savannas			0	0							0	0	0	
F. Field Burning of Agricultural Residues			20	1							17	414	54	1
G. Other			0	0							0	0	0	0

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 2 of 2)

5. Land-Use Change and Forestry	**-**	**-209,145**	**117**	**25**							**8**	**196**	**1,449**	**0**
A. Changes in Forest and Other Woody Biomass Stocks	-	-252,575												
B. Forest and Grassland Conversion	13,239		23	6							6	196	12	
C. Abandonment of Managed Lands	-	-171												
D. CO_2 Emissions and Removals from Soil	27,626	-												
E. Other	2,735	-	95	19							2	0	1,437	0
6. Waste	**5,758**		**6,486**	**14**							**54**	**830**	**113**	**24**
A. Solid Waste Disposal on Land	369		6,080								2	48	40	1
B. Wastewater Handling			273	12							0	0	5	
C. Waste Incineration	5,389		45	2							52	781	49	23
D. Other	0		89	0							0	1	20	0
7. Other	**2,149**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Memo Items:														
International Bunkers	**169,439**		**9**	**4**							**1,481**	**309**	**187**	**898**
Aviation	65,448		5	2							244	199	68	18
Marine	103,991		5	3							1,237	110	120	881
Multilateral Operations	**0**		**0**	**0**							**0**	**0**	**0**	**0**
CO_2 Emissions from Biomass	**135,900**													

Notes:

In order to obtain a complete EC inventory, for Luxembourg the following data gap filling procedure was used: Emissions reported for 1990 were taken as first estimates. However, for CO_2 emissions from fossil fuel combustion (CRF category 1 "Energy"), the 1990 estimates in combination with trend information for 1992 from latest calculations of CO_2 emissions from fossil fuels by Eurostat have been used (Eurostat, 2000).

Since not all Member States reported data on the Reference Approach for CO_2 from fossil fuel combustion, they are omitted in Annex A. Instead they are presented in Annex B.

Category 5 "Land-Use Change and Forestry" provides "net" emissions (Member States emissions minus Member States removals) of CO_2 following CRF recommendations.

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SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**3,208,245**	**-218,829**	**19,353**	**1,187**	**-**	**27,178**	**-**	**8,232**	**-**	**0.4**	**12,246**	**43,746**	**14,865**	**12,351**
1. Energy	**3,060,806**		**4,379**	**163**							**12,019**	**39,652**	**7,765**	**12,061**
A. Fuel Combustion — Reference Approach	-													
A. Fuel Combustion — Sectoral Approach	3,037,289		739	162							11,990	39,520	6,567	11,741
1. Energy Industries	1,059,132		40	46							2,371	440	54	7,883
2. Manufacturing Industries and Construction	570,552		49	27							1,525	3,253	132	2,084
3. Transport	740,970		192	53							6,729	28,620	5,371	644
4. Other Sectors	653,578		456	35							1,286	7,125	998	957
5. Other	13,057		1	1							78	83	13	173
B. Fugitive Emissions from Fuels	23,516		3,641	1							29	132	1,197	321
1. Solid Fuels	5,682		2,008	0							1	82	7	14
2. Oil and Natural Gas	17,834		1,633	1							28	50	1,190	307
2. Industrial Processes	**131,854**		**22**	**302**	**-**	**27,178**	**-**	**8,232**	**-**	**0.4**	**138**	**2,809**	**957**	**265**
A. Mineral Products	97,146		0	0							43	30	261	41
B. Chemical Industry	9,527		9	302	-	2,340	-	70	-	0.0	45	125	353	102
C. Metal Production	21,910		7	0				6,578		0.1	20	2,542	18	69
D. Other Production	644										15	13	223	30
E. Production of Halocarbons and SF_6						22,517		281		0.0				
F. Consumption of Halocarbons and SF_6					-	1,965	-	1,100	-	0.3				
G. Other	2,628		6	0	-	355	-	204	-	0.0	15	100	101	23
3. Solvent and Other Product Use	**5,339**			**11**							**0**	**2**	**3,905**	0
4. Agriculture	**2,230**	**0**	**8,577**	**674**							26	267	739	1
A. Enteric Fermentation			6,376											
B. Manure Management			1,897	90									1	
C. Rice Cultivation			106										0	
D. Agricultural Soils	2,230	0	185	584							14		702	
E. Prescribed Burning of Savannas			0	0							0	0	0	
F. Field Burning of Agricultural Residues			13	0							12	267	36	1
G. Other			0	0							0	0	0	0

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 2 of 2)

5. Land-Use Change and Forestry	**-**	**-218,829**	**117**	**19**							**8**	**201**	**1,386**	**1**
A. Changes in Forest and Other Woody Biomass Stocks	-	-261,887												
B. Forest and Grassland Conversion	13,624		22	0							6	201	22	1
C. Abandonment of Managed Lands	-	-190												
D. CO_2 Emissions and Removals from Soil	26,938	-												
E. Other	2,687	-	95	19							2	0	1,364	0
6. Waste	**5,826**		**6,257**	**14**							**55**	**815**	**114**	**22**
A. Solid Waste Disposal on Land	357		5,850								1	47	40	1
B. Wastewater Handling			266	12							0	0	5	
C. Waste Incineration	5,469		44	3							53	767	47	21
D. Other	0		96	0							0	1	21	0
7. Other	**2,190**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Memo Items:														
International Bunkers	**179,831**		**9**	**4**							**1,558**	**298**	**185**	**959**
Aviation	72,065		5	2							279	182	66	19
Marine	107,766		4	3							1,280	116	119	940
Multilateral Operations	**0**		**0**	**0**							**0**	**0**	**0**	**0**
CO_2 Emissions from Biomass	**140,006**													

Notes:

In order to obtain a complete EC inventory, for Luxembourg the following data gap filling procedure was used: Emissions reported for 1990 were taken as first estimates. However, for CO_2 emissions from fossil fuel combustion (CRF category 1 "Energy"), the 1990 estimates in combination with trend information for 1993 from latest calculations of CO_2 emissions from fossil fuels by Eurostat have been used (Eurostat, 2000).

Since not all Member States reported data on the Reference Approach for CO_2 from fossil fuel combustion, they are omitted in Annex A. Instead they are presented in Annex B.

Category 5 "Land-Use Change and Forestry" provides "net" emissions (Member States emissions minus Member States removals) of CO_2 following CRF recommendations.

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SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**3,220,706**	**-205,731**	**18,842**	**1,219**	**-**	**32,174**	**-**	**7,524**	**-**	**0.5**	**11,872**	**41,862**	**14,745**	**11,198**
1. Energy	**3,067,953**		**3,925**	**168**							**11,651**	**37,519**	**7,417**	**10,910**
A. Fuel Combustion — Reference Approach	-													
A. Fuel Combustion — Sectoral Approach	3,041,926		687	166							11,619	37,353	6,223	10,627
1. Energy Industries	1,063,455		42	47							2,262	427	63	7,093
2. Manufacturing Industries and Construction	593,094		51	28							1,504	3,441	131	1,895
3. Transport	749,211		184	58							6,525	26,786	5,085	668
4. Other Sectors	624,692		409	33							1,252	6,619	930	798
5. Other	11,475		1	1							75	80	13	174
B. Fugitive Emissions from Fuels	26,027		3,238	1							32	166	1,194	283
1. Solid Fuels	5,660		1,634	0							1	85	7	11
2. Oil and Natural Gas	20,367		1,605	1							32	81	1,186	272
2. Industrial Processes	**137,602**		**23**	**315**	**-**	**32,174**	**-**	**7,524**	**-**	**0.5**	**133**	**3,126**	**930**	**265**
A. Mineral Products	101,283		0	0							42	30	241	42
B. Chemical Industry	9,344		10	315	-	2,340	-	20	-	0.0	45	126	352	97
C. Metal Production	22,790		6	0				5,729		0.1	20	2,842	15	66
D. Other Production	657										16	12	232	25
E. Production of Halocarbons and SF_6						26,256		228		0.0				
F. Consumption of Halocarbons and SF_6					-	2,955	-	1,335	-	0.3				
G. Other	3,528		6	0	-	623	-	212	-	0.0	11	115	90	35
3. Solvent and Other Product Use	**5,319**			**11**							**0**	**2**	**3,907**	0
4. Agriculture	**2,069**	**0**	**8,553**	**685**							27	259	804	1
A. Enteric Fermentation			6,334											
B. Manure Management			1,906	88									1	
C. Rice Cultivation			115	1									0	
D. Agricultural Soils	2,069	0	186	596							16		770	
E. Prescribed Burning of Savannas			0	0							0	0	0	
F. Field Burning of Agricultural Residues			12	0							12	259	33	1
G. Other			0	0							0	0	0	0

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 2 of 2)

5. Land-Use Change and Forestry	**-**	**-205,731**	**113**	**21**							**7**	**167**	**1,574**	**0**
A. Changes in Forest and Other Woody Biomass Stocks	-	-246,914												
B. Forest and Grassland Conversion	12,748		19	0							5	167	17	
C. Abandonment of Managed Lands	-	-192												
D. CO_2 Emissions and Removals from Soil	25,868	-												
E. Other	2,759	-	94	21							2	0	1,557	0
6. Waste	**5,560**		**6,225**	**14**							**53**	**789**	**114**	**21**
A. Solid Waste Disposal on Land	290		5,813								1	41	39	1
B. Wastewater Handling			267	12							0	0	5	
C. Waste Incineration	5,270		44	3							52	747	47	20
D. Other	0		101	0							0	1	24	0
7. Other	**2,203**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Memo Items:														
International Bunkers	**178,171**		**9**	**4**							**1,529**	**341**	**187**	**919**
Aviation	73,341		5	2							280	223	79	19
Marine	104,830		4	2							1,249	118	107	900
Multilateral Operations	**0**		**0**	**0**							**0**	**0**	**0**	**0**
CO_2 Emissions from Biomass	**141,829**													

Notes:

Since not all Member States reported data on the Reference Approach for CO_2 from fossil fuel combustion, they are omitted in Annex A. Instead they are presented in Annex B.

Category 5 "Land-Use Change and Forestry" provides "net" emissions (Member States emissions minus Member States removals) of CO_2 following CRF recommendations.

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SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
						P	A	P	A	P	A				
		(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals		**3,258,070**	**-197,831**	**18,782**	**1,224**	**-**	**37,256**	**-**	**7,824**	**-**	**0.5**	**11,509**	**40,513**	**14,313**	**10,138**
1. Energy		**3,102,658**		**3,927**	**176**							**11,291**	**36,046**	**7,103**	**9,867**
A. Fuel Combustion	Reference Approach	-													
	Sectoral Approach	3,078,842		672	175							11,259	35,908	5,957	9,595
1. Energy Industries		1,077,058		45	48							2,176	429	68	6,444
2. Manufacturing Industries and Construction		599,090		50	30							1,474	3,310	128	1,753
3. Transport		756,149		177	63							6,270	25,691	4,823	559
4. Other Sectors		633,530		398	34							1,265	6,398	925	671
5. Other		13,015		1	1							74	80	13	168
B. Fugitive Emissions from Fuels		23,816		3,255	1							32	139	1,146	272
1. Solid Fuels		5,816		1,707	0							2	91	7	8
2. Oil and Natural Gas		17,999		1,548	1							31	48	1,138	264
2. Industrial Processes		**141,082**		**23**	**315**	**-**	**37,256**	**-**	**7,824**	**-**	**0.5**	**131**	**3,321**	**946**	**250**
A. Mineral Products		102,488		0	0							43	21	251	46
B. Chemical Industry		9,993		11	314	-	1,170	-	0	-	0.0	42	132	368	104
C. Metal Production		24,944		6	0				5,789		0.1	21	3,046	16	55
D. Other Production		671										16	13	230	24
E. Production of Halocarbons and SF_6							29,798		175		0.0				
F. Consumption of Halocarbons and SF_6						-	5,369	-	1,605	-	0.4				
G. Other		2,986		6	0	-	919	-	255	-	0.0	10	110	81	21
3. Solvent and Other Product Use		**5,347**			**11**							**0**	**2**	**3,805**	0
4. Agriculture		**1,726**	**0**	**8,551**	**683**							25	230	784	1
A. Enteric Fermentation				6,322											
B. Manure Management				1,918	87									1	
C. Rice Cultivation				114										0	
D. Agricultural Soils		1,726	0	185	595							15		755	
E. Prescribed Burning of Savannas				0	0							0	0	0	
F. Field Burning of Agricultural Residues				11	0							10	230	29	1
G. Other				0	0							0	0	0	0

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
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5. Land-Use Change and Forestry	**-**	**-197,831**	**109**	**21**							**6**	**132**	**1,561**	**0**
A. Changes in Forest and Other Woody Biomass Stocks	-	-238,355												
B. Forest and Grassland Conversion	11,877		15	0							4	132	13	
C. Abandonment of Managed Lands	-	-198												
D. CO_2 Emissions and Removals from Soil	26,061	-												
E. Other	2,783	-	94	21							2	0	1,547	0
6. Waste	**5,037**		**6,171**	**14**							**55**	**781**	**114**	**20**
A. Solid Waste Disposal on Land	124		5,753									28	35	
B. Wastewater Handling			266	12							0	0	5	
C. Waste Incineration	4,545		43	3							51	753	46	18
D. Other	368		109	0							3	1	28	1
7. Other	**2,219**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
Memo Items:														
International Bunkers	**182,808**		**11**	**5**							**1,549**	**312**	**183**	**938**
Aviation	76,571		5	2							297	194	72	20
Marine	106,237		6	3							1,253	118	111	918
Multilateral Operations	**0**		**0**	**0**							**0**	**0**	**0**	**0**
CO_2 Emissions from Biomass	**149,412**													

Notes:

Since not all Member States reported data on the Reference Approach for CO_2 from fossil fuel combustion, they are omitted in Annex A. Instead they are presented in Annex B.

Category 5 "Land-Use Change and Forestry" provides "net" emissions (Member States emissions minus Member States removals) of CO_2 following CRF recommendations.

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SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
						P	A	P	A	P	A				
		(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals		**3,332,938**	**-205,973**	**18,446**	**1,254**	**-**	**41,039**	**-**	**7,761**	**-**	**0.5**	**11,326**	**39,231**	**13,831**	**8,840**
1. Energy		**3,179,916**		**3,788**	**181**							**11,100**	**35,009**	**6,896**	**8,575**
A. Fuel Combustion	Reference Approach	-													
	Sectoral Approach	3,155,827		691	180							11,069	34,872	5,758	8,312
1. Energy Industries		1,086,066		49	49							2,099	459	74	5,501
2. Manufacturing Industries and Construction		588,702		50	27							1,470	3,141	142	1,525
3. Transport		773,011		174	67							6,111	24,588	4,538	477
4. Other Sectors		695,931		417	35							1,320	6,623	994	641
5. Other		12,117		1	1							68	60	10	168
B. Fugitive Emissions from Fuels		24,088		3,098	1							31	137	1,138	263
1. Solid Fuels		5,419		1,526	0							2	91	7	9
2. Oil and Natural Gas		18,669		1,572	1							30	46	1,131	254
2. Industrial Processes		**138,607**		**23**	**323**	**-**	**41,039**	**-**	**7,761**	**-**	**0.5**	**139**	**3,037**	**909**	**245**
A. Mineral Products		100,061		0	0							45	20	217	47
B. Chemical Industry		9,988		15	323	-	0	-	0	-	0.0	50	167	385	99
C. Metal Production		23,954		6	0				5,696		0.1	28	2,810	19	65
D. Other Production		705										15	13	235	25
E. Production of Halocarbons and SF_6							31,537		175		0.0				
F. Consumption of Halocarbons and SF_6						-	8,741	-	1,729	-	0.4				
G. Other		3,899		1	0	-	761	-	161	-	0.0	0	27	53	9
3. Solvent and Other Product Use		**5,373**			**11**							**0**	**2**	**3,761**	0
4. Agriculture		**1,825**	**0**	**8,585**	**700**							30	275	713	1
A. Enteric Fermentation				6,358											
B. Manure Management				1,910	92									1	
C. Rice Cultivation				119	1									0	
D. Agricultural Soils		1,825	0	185	606							17		675	
E. Prescribed Burning of Savannas				0	0							0	0	0	
F. Field Burning of Agricultural Residues				13	0							12	275	38	1
G. Other				0	0							0	0	0	0

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
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5. Land-Use Change and Forestry	**-**	**-205,973**	**109**	**21**							**6**	**126**	**1,435**	**0**
A. Changes in Forest and Other Woody Biomass Stocks	-	-246,305												
B. Forest and Grassland Conversion	11,528		15	0							4	126	13	
C. Abandonment of Managed Lands	-	-200												
D. CO_2 Emissions and Removals from Soil	26,337	-												
E. Other	2,666	-	95	21							2	0	1,423	0
6. Waste	**4,850**		**5,939**	**15**							**52**	**783**	**117**	**18**
A. Solid Waste Disposal on Land	82		5,492									24	35	
B. Wastewater Handling	3		271	12							0	0	5	
C. Waste Incineration	4,765		44	3							50	758	47	17
D. Other	0		133	0							2	1	31	1
7. Other	**2,367**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
Memo Items:														
International Bunkers	**194,577**		**11**	**5**							**1,641**	**319**	**193**	**994**
Aviation	81,665		6	2							310	202	75	21
Marine	112,913		5	3							1,332	117	118	973
Multilateral Operations	**0**		**0**	**0**							**0**	**0**	**0**	**0**
CO_2 Emissions from Biomass	**153,605**													

Notes:

Since not all Member States reported data on the Reference Approach for CO_2 from fossil fuel combustion, they are omitted in Annex A. Instead they are presented in Annex B.

Category 5 "Land-Use Change and Forestry" provides "net" emissions (Member States emissions minus Member States removals) of CO_2 following CRF recommendations.

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SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
						P	A	P	A	P	A				
		(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals		**3,272,091**	**-204,354**	**18,051**	**1,244**	**-**	**46,851**	**-**	**7,415**	**-**	**0.5**	**10,872**	**37,470**	**13,232**	**7,969**
1. Energy		**3,119,782**		**3,639**	**183**							**10,655**	**33,037**	**6,506**	**7,726**
A. Fuel Combustion	Reference Approach	-													
	Sectoral Approach	3,096,202		648	183							10,625	32,905	5,412	7,468
1. Energy Industries		1,045,530		48	48							1,923	395	59	4,972
2. Manufacturing Industries and Construction		606,499		50	29							1,505	3,236	134	1,432
3. Transport		783,278		165	72							5,853	22,992	4,274	327
4. Other Sectors		645,558		384	33							1,274	6,217	934	558
5. Other		15,338		0	1							70	65	11	180
B. Fugitive Emissions from Fuels		23,580		2,991	0							30	132	1,094	258
1. Solid Fuels		5,701		1,449	0							1	91	7	6
2. Oil and Natural Gas		17,879		1,542	0							29	41	1,087	252
2. Industrial Processes		**138,269**		**20**	**315**	**-**	**46,851**	**-**	**7,415**	**-**	**0.5**	**132**	**3,186**	**978**	**226**
A. Mineral Products		103,063		0	0							44	21	283	45
B. Chemical Industry		9,883		13	315	-	0	-	0	-	0.0	35	123	362	89
C. Metal Production		24,231		6	0				5,364		0.1	22	2,888	16	52
D. Other Production		699										16	14	245	24
E. Production of Halocarbons and SF_6							33,183		175		0.0				
F. Consumption of Halocarbons and SF_6						-	12,571	-	1,708	-	0.4				
G. Other		398		0	0	-	1,097	-	167	-	0.0	15	140	72	16
3. Solvent and Other Product Use		**5,514**			**11**							**0**	**2**	**3,755**	0
4. Agriculture		**2,065**	**0**	**8,531**	**698**							28	254	382	1
A. Enteric Fermentation				6,301											
B. Manure Management				1,915	91									1	
C. Rice Cultivation				119	1									0	
D. Agricultural Soils		2,065	0	184	606							16		348	
E. Prescribed Burning of Savannas				0	0							0	0	0	
F. Field Burning of Agricultural Residues				12	0							11	254	34	1
G. Other				0	0							0	0	0	0

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 2 of 2)

5. Land-Use Change and Forestry	**-**	**-204,354**	**106**	**18**							**6**	**145**	**1,493**	**0**
A. Changes in Forest and Other Woody Biomass Stocks	-	-242,848												
B. Forest and Grassland Conversion	11,418		16	0							4	145	15	
C. Abandonment of Managed Lands	-	-201												
D. CO_2 Emissions and Removals from Soil	28,061	-												
E. Other	-	-785	90	18							2	0	1,478	0
6. Waste	**4,292**		**5,753**	**15**							**51**	**846**	**118**	**15**
A. Solid Waste Disposal on Land	65		5,269									22	32	
B. Wastewater Handling			279	12							0	0	6	
C. Waste Incineration	4,081		47	3							49	823	50	14
D. Other	145		158	0							2	1	30	1
7. Other	**2,170**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Memo Items:														
International Bunkers	**209,989**		**11**	**5**							**1,798**	**339**	**209**	**1,088**
Aviation	86,900		6	2							332	217	81	23
Marine	123,089		5	3							1,466	122	129	1,065
Multilateral Operations	**0**		**0**	**0**							**0**	**0**	**0**	**0**
CO_2 Emissions from Biomass	**153,688**													

Notes:

Since not all Member States reported data on the Reference Approach for CO_2 from fossil fuel combustion, they are omitted in Annex A. Instead they are presented in Annex B.

Category 5 "Land-Use Change and Forestry" provides "net" emissions (Member States emissions minus Member States removals) of CO_2 following CRF recommendations.

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SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
						P	A	P	A	P	A				
		(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals		**3,316,965**	**-195,368**	**17,636**	**1,167**	**-**	**51,394**	**-**	**7,979**	**-**	**0.5**	**10,499**	**35,497**	**12,398**	**7,549**
1. Energy		**3,162,620**		**3,462**	**181**							**10,288**	**31,109**	**5,990**	**7,309**
A. Fuel Combustion	Reference Approach	-													
	Sectoral Approach	3,138,599		662	181							10,257	30,989	5,014	7,046
1. Energy Industries		1,082,775		66	48							1,839	407	62	4,662
2. Manufacturing Industries and Construction		588,101		56	25							1,429	2,870	138	1,274
3. Transport		809,112		159	76							5,676	21,635	3,921	411
4. Other Sectors		646,440		380	31							1,266	6,018	885	514
5. Other		12,170		0	0							47	59	8	185
B. Fugitive Emissions from Fuels		24,022		2,800	0							31	119	976	264
1. Solid Fuels		5,466		1,265	0							1	77	7	3
2. Oil and Natural Gas		18,556		1,535	0							30	41	970	261
2. Industrial Processes		**139,852**		**20**	**237**	**-**	**51,394**	**-**	**7,979**	**-**	**0.5**	**128**	**3,022**	**934**	**224**
A. Mineral Products		105,960		0	0							44	23	277	50
B. Chemical Industry		9,983		13	237	-	0	-	0	-	0.0	40	146	333	91
C. Metal Production		22,784		6	0				5,969		0.1	28	2,839	19	63
D. Other Production		655										15	14	254	20
E. Production of Halocarbons and SF_6							33,984		217		0.0				
F. Consumption of Halocarbons and SF_6						-	17,410	-	1,793	-	0.4				
G. Other		475		0	0	-	0	-	0	-	0.0	0	2	50	1
3. Solvent and Other Product Use		**5,593**			**11**							**0**	**2**	**3,661**	0
4. Agriculture		**2,031**	**0**	**8,357**	**701**							29	275	374	1
A. Enteric Fermentation				6,264											
B. Manure Management				1,781	90									1	
C. Rice Cultivation				113	1									0	
D. Agricultural Soils		2,031	0	185	610							16		337	
E. Prescribed Burning of Savannas				0	0							0	0	0	
F. Field Burning of Agricultural Residues				13	0							12	275	37	1
G. Other				0	0							0	0	0	0

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 2 of 2)

5. Land-Use Change and Forestry	**-**	**-195,368**	**120**	**18**							**10**	**261**	**1,320**	**0**
A. Changes in Forest and Other Woody Biomass Stocks	-	-237,279												
B. Forest and Grassland Conversion	15,485		30	0							7	261	27	
C. Abandonment of Managed Lands	-	-201												
D. CO_2 Emissions and Removals from Soil	27,559	-												
E. Other	-	-932	90	18							2	0	1,294	0
6. Waste	**4,354**		**5,676**	**15**							**45**	**828**	**119**	**14**
A. Solid Waste Disposal on Land	59		5,171									21	32	
B. Wastewater Handling			285	12							0	0	6	
C. Waste Incineration	4,111		46	3							43	806	50	13
D. Other	185		174	0							2	1	32	1
7. Other	**2,514**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Memo Items:														
International Bunkers	**219,161**		**12**	**5**							**1,766**	**348**	**220**	**1,095**
Aviation	91,250		6	2							361	225	84	25
Marine	127,911		5	3							1,405	123	136	1,070
Multilateral Operations	**0**		**0**	**0**							**0**	**0**	**0**	**0**
CO_2 Emissions from Biomass	**143,673**													

Notes:

Since not all Member States reported data on the Reference Approach for CO_2 from fossil fuel combustion, they are omitted in Annex A. Instead they are presented in Annex B.

Category 5 "Land-Use Change and Forestry" provides "net" emissions (Member States emissions minus Member States removals) of CO_2 following CRF recommendations.

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SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
						P	A	P	A	P	A				
		(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals		**3,270,520**	**-200,984**	**17,445**	**1,092**	**-**	**42,620**	**-**	**8,361**	**-**	**0.5**	**10,136**	**33,602**	**12,004**	**6,803**
1. Energy		**3,113,743**		**3,337**	**186**							**9,925**	**29,574**	**5,603**	**6,572**
A. Fuel Combustion	Reference Approach	-													
	Sectoral Approach	3,089,406		661	185							9,892	29,471	4,721	6,338
1. Energy Industries		1,044,485		73	48							1,716	395	65	4,306
2. Manufacturing Industries and Construction		581,506		55	26							1,419	2,935	140	1,150
3. Transport		824,974		152	80							5,464	20,044	3,597	383
4. Other Sectors		631,319		381	31							1,252	6,045	911	492
5. Other		7,121		0	0							42	52	8	8
B. Fugitive Emissions from Fuels		24,337		2,676	0							32	103	882	233
1. Solid Fuels		6,042		1,156	0							1	67	5	1
2. Oil and Natural Gas		18,296		1,520	0							31	36	877	232
2. Industrial Processes		**142,214**		**20**	**155**	**-**	**42,620**	**-**	**8,361**	**-**	**0.5**	**129**	**2,758**	**909**	**216**
A. Mineral Products		107,724		0	0							44	22	282	45
B. Chemical Industry		9,410		13	155	-	0	-	0	-	0.0	42	149	310	91
C. Metal Production		23,883		6	0				6,272		0.1	27	2,571	18	60
D. Other Production		735										16	13	255	20
E. Production of Halocarbons and SF_6							20,432		85		0.0				
F. Consumption of Halocarbons and SF_6						-	22,189	-	2,005	-	0.4				
G. Other		466		0	1	-	0	-	0	-	0.0	0	2	43	1
3. Solvent and Other Product Use		**5,614**			**11**							**0**	**2**	**3,628**	0
4. Agriculture		**2,016**	**0**	**8,431**	**703**							28	249	390	1
A. Enteric Fermentation				6,222											
B. Manure Management				1,901	94									1	
C. Rice Cultivation				112	1									0	
D. Agricultural Soils		2,016	0	185	607							17		357	
E. Prescribed Burning of Savannas				0	0							0	0	0	
F. Field Burning of Agricultural Residues				12	0							11	249	33	1
G. Other				0	0							0	0	0	0

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A) (Sheet 2 of 2)

5. Land-Use Change and Forestry	**-**	**-200,984**	**105**	**18**							**6**	**138**	**1,352**	**0**
A. Changes in Forest and Other Woody Biomass Stocks	-	-238,871												
B. Forest and Grassland Conversion	12,153		16	0							4	138	3	
C. Abandonment of Managed Lands	-	-202												
D. CO_2 Emissions and Removals from Soil	26,788	-												
E. Other	-	-851	90	18							2	0	1,349	0
6. Waste	**4,388**		**5,549**	**15**							**49**	**881**	**121**	**14**
A. Solid Waste Disposal on Land	53		5,025									21	30	
B. Wastewater Handling			286	12							0	0	5	
C. Waste Incineration	4,151		48	3							46	860	53	13
D. Other	184		191	0							2	1	33	1
7. Other	**2,544**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Memo Items:														
International Bunkers	**223,690**		**10**	**5**							**1,729**	**356**	**220**	**1,030**
Aviation	97,963		5	2							396	244	89	24
Marine	125,727		5	3							1,334	112	131	1,005
Multilateral Operations	**0**		**0**	**0**							**0**	**0**	**0**	**0**
CO_2 Emissions from Biomass	**146,569**													

Notes:

In order to obtain a complete EC inventory, for Belgium and Luxembourg the following data gap filling procedure was used: Emissions reported for 1998 were taken as first estimates. However, for CO_2 emissions from fossil fuel combustion (CRF category 1 "Energy"), the 1998 estimates in combination with trend information for 1999 from latest calculations of CO_2 emissions from fossil fuels by Eurostat have been used (Eurostat, 2001).

Since not all Member States reported data on the Reference Approach for CO_2 from fossil fuel combustion, they are omitted in Annex A. Instead they are presented in Annex B.

Category 5 "Land-Use Change and Forestry" provides "net" emissions (Member States emissions minus Member States removals) of CO_2 following CRF recommendations.

11 ANNEX 2 EXAMPLES OF ACTIVITIES RELATED TO TRANSFER OF TECHNOLOGY

Project title:	**COGEN**
Host region:	**ASEAN**
Partner:	**EU-Commission**
Executing agency:	COGEN Secretariat AIT, Bangkok
Project period and costs:	1991 – 1998 (current 5 MEURO programme). A new 25 Mio. EURO programme approved.

- *What are the project's main targets?*

  What technologies are applied and how do they contribute to the targets?

  The EC-ASEAN COGEN Programme is a co-operation programme between the European Commission (EC) and the Association of South East Asian Nations (ASEAN), co-ordinated by the institute of Technology (AIT, Bangkok, Thailand). Its aim is to accelerate the implementation of proven technologies generating heat and/or power from wood and agro-industrial residues, through partnerships between European and ASEAN companies.

  Target groups

  Since the primary objective is to transfer technology from Europe to ASEAN, the overall approach has, on the European side, been to identify relevant and interested equipment suppliers, and on the ASEAN side to identify potential equipment end-users and business partners, and to investigate overall market potential. The EC-ASEAN COGEN Programme is thus designed to support European companies producing biomass energy technology, who are interested in expanding their markets in ASEAN, but do not have sufficient capacity to cultivate the market alone.

  The programme focuses on proven technologies only.

- *Which instruments, methods and procedures are applied by the project in order to respond to the concrete needs of users and beneficiaries of the respective technology? Which instrument are used to improve the respective group's access to information and their knowledge of climate relevant technologies?*

  Some technologies are technically and economically viable but are not implemented in ASEAN because they are not well-known and have not been tested under ASEAN conditions. To overcome this obstacle, the EC-ASEAN COGEN Programme will bring technical and financial assistance to implement FSDPs. An FSDPs can be defined as the implementation of a proven technology on a full scale basis in order to demonstrate its technical reliability and economic viability. Therefore, an FSDP constitutes a shop window in ASEAN, aimed at convincing other potential end-users to select the technology.

- *Which positive experience has been gained up to now (lessons learned / best practices) and how is it diffused / applied in other projects?*

  To ensure the maximum replication of the demonstration projects, an independent technical and economic monitoring of the equipment will be performed. The project results, including economic benefits for the end-users, will be widely advertised in the region, through media and printed material, as well as visits to the plants by publics and private sector representatives from all ASEAN countries.

- *How does the project support access to financing of technologies?*

  The EC-ASEAN COGEN programme can support:

  - Investment assistance,
  - Training in Europe and ASEAN,
  - Monitoring by an independent organisation.

  The requirements are that the end-users must allow both technical and economic monitoring, diffusion of the technical and economic results of the project, and visits to the installation by interested parties throughout ASEAN.

- *With respect to technology transfer, which factors and conditions are crucial to the success of the project?*

  The technology must already be proven elsewhere and must use biomass (wood or agro-residues) as fuel. The project must offer scope for an EURO-ASEAN partnership, it must not have negative impact on the environment, and finally, it must be replicable.

- *Do you know of other, similar projects? Please indicate.*

  EU/SOUTH AMERICA

  UNDP/ESMAP

- *Other ideas/information:*

  Further to the approval of the Member states of the European Union, the EC-ASEAN COGEN programme will enter a new 5-year phase in 1999 with funding of 25 MEURO. The technical scope of the programme will be extended to include, not only biomass energy projects, but also clean and efficient cogeneration technologies utilising gas and coal.

Project Title: Pico-hydro village power
Host country: Ethiopia
Partner: EU-Commission
Project Purpose: Establish sustainable local manufacture and installation of innovative pico hydro systems
Executing Agency: The Nottingham Trent University
Project period: 1998 – 2001
Financial support: EC Environment in Developing Countries Budgetline: 0.1 mio. € DfiD co-funding: 0.1 mio. €; Nottingham Trent: 0.05 mio. €
➢ *Main Targets:* The major objective is to develop the use of renewable sources of energy for sustainable economic growth. Specific targets are the installation of demonstration units and infrastructure to encourage manufacture, sales and productive use of standardized pico hydro systems.
➢ *Methods and Procedures:* 1. Transfer of pico hydro technology (up to 5 kW) to private workshops, so as to enable local manufacture to take place. 2. Instalment of two demonstration units and assess their socio-economic impact. 3. Appraisal of key markets for pico-hydro in Sub-Saharan Africa. 4. Identification of technical and non-technical barriers to technology transfer. 5. Production of guidelines for pico-hydro programmes in SSA. 6. Establishment of a network for information dissemination. 7. Publication of manuals and practical handbooks on pico hydro manufacture, installation and end-uses/income generation from pico hydro systems.
➢ *Experience*: Similar programmes in Indonesia, Nepal and Sri Lanka have proven to be viable. The major advantages of Pico hydro systems are their affordability by local communities, low risks, low transaction costs, portability and easy to re-sell (can be used by banks as collateral), installation by purchaser possible. Usable for battery charging services. In Nepal, installations have increased from ten per year to more than hundred per year.
➢ *Access to financing:* Pilot testing, training,
➢ *Crucial factors and conditions:* Existence of natural hydro power resources and locally interested private sector manufacturers.

Programme title:	**Optimal Utilisation of Energy in Latin America (ALURE)**
Host region	**Latin America**
Partner:	**EU-Commission**
Project purpose (approach used):	ALURE is a co-operation programme between the EC and the Latin America which aims at bringing European and L.American energy actors closer to each other
Executing agency:	ALURE is made of different projects in various LA countries. There has been assigned to various executing agencies (mainly energy consortia from the EU)
Project period	1998-2002
and costs:	50.000.000 Euro (EC contribution: 25 Mio .Euro)

- *What are the project's main targets?*

  To bring in contact European and Latin American energy actors seeking the mutual benefit, taking into account both economic and environmental impacts.

- *Which instruments, methods and procedures are applied by the project in order to respond to the concrete needs of users and beneficiaries of the respective technology?*

  The programme aims at improving the performance of the energy companies at technical, economic and financial level with emphasis on the rapidly growing sub-sectors (electricity, natural gas,….)

  It also contributes to the adaptation of institutional and regulatory framework

  All of its activities are planned with a view to promoting sustainable development.

  ALURE is demand-driven; it is based upon calls for proposals.

- *Which instruments are used to improve the respective groups' access to information and their knowledge of climate relevant technologies?*

  We have established an outside information office (Alure Support Team) who has created a website (www.ALURE.NET) disseminating information in Spanish, Portuguese, French and English.

- *Which positive experience has been gained up to now (lessons learned / best practices) and how is it diffused / applied in other projects?*

  The companies involved are interested primarily, in energy efficiency oriented projects which shows that this is a much promising area for co-operation in the region.

  Intended generally to promote rational energy use, this type of projects aim specifically to reinforce policy for more efficient energy by demonstrating the feasibility of new schemes at all different policy levels (federal, state, provincial and local). Some, examples, can be mentioned:

- Strategic support for energy efficiency in Brazil: In cooperation with ELETROBRAS and a EU consortium (France, Spain and the United Kingdom).

- Energy savings in industry, transport and services in Peru: Partners from Spain, Italy and the Netherlands are supporting CENERGIA in its cogeneration efforts.

- Establishment and enforcement of energy standards and rules in the Chilean building industry: The ministry for housing and town planning is receiving advice from partners in Spain, Greece, Italy, the Netherlands and Portugal.

- Development of a policy for rational use of electricity in Argentina: The energy board has partners from Denmark, Spain and France.

  The experience gained by this programme in Latin America is transferred to other EC programmes in other geographical regions.

- *(How) does the project support access to financing of technologies?*

  ALURE is not targeted specifically at technology financing issues. However, these issues can be part of a broader project

- *With respect to technology transfer, which factors and conditions are crucial to the success of the project?*

  To be successful, a technology transfer or know-how transfer must be done between actors able to assimilate this transfer (basically local private companies). A correct policy framework conducive to the right energy pricing is necessary for encouraging investment and innovation

Project Title:	**Regional Biomass Energy Conservation Programme for Southern Africa**
Host countries:	**Lesotho, Malawi, Mozambique, Namibia, South Africa, Zimbabwe**
Partner:	**EU-Commission**
Project Purpose:	Enhance capacities and commitments of governments and institutions to plan and implement integrated biomass energy conservation programmes.
Executing Agency:	GTZ
Project period:	1998 – 2001
Financial support:	EC Tropical Forest Budgetline: 1.6 mio. € GTZ co-funding: 0.5 mio. €

➢ *Main Targets:*

Fulfil energy needs of households and small-scale industries in a socially and environmentally sustainable manner.

A major aim is to increase energy efficiency of biomass energy through technology transfer and thereby to reduce

- the workload of women for collecting biomass fuel by 30 %,
- air pollution caused by cooking by at least 50 %,
- the consumption of biomass energy in small scale industries (e.g. tobacco curing, fish smoking, brick burning, bakeries) by at least 20 %.

➢ *Methods and Procedures:*

1. South-south exchange of information on good practice: A management information system about biomass energy demand and supply, energy-efficient technologies, national biomass conservation strategies has been set up and is accessible to partner organisations.
2. Capacity building: Partner-country specialists are trained in planning, implementing and monitoring integrated and sustainable biomass energy conservation projects
3. Pilot projects: The introduction of integrated energy-saving measures for households and small businesses into interested projects in pilot areas is enhanced.
4. Advisory services for planning integrated biomass energy conservation measures are used by national policy and decision-makers of institutions/organisations.
5. South-south networking: A support network of local organisations in the region has been established and provides advisory services for the implementation of biomass energy conservation measures.

➢ *Experience:*

Similar programmes in West and East Africa were very successful in cutting down biomass energy requirements.

➢ *Access to financing:* Training, pilot programmes, networking
➢ *Crucial factors and conditions:* Strong local ownership of governments, development institutions/organisations and private sector is seen as essential.

Project Title: Programme Régional Solaire (Regional Solar Programme)

Host region: **Sahel Countries (West Africa)**

Partner: *EU-Commission*

Project Purpose: Village water supply and solar pumping in the Sahelian countries.

Executing Agency: CILSS (Comité Permanent Inter-Etats de Lutte contre la Sécheresse au Sahel) and the national "Directions de l'Hydraulique".

Project period: 1989 (signature of the financing convention) – ± 1997

Financial support: European Development Fund: 64 Mio. €

- *Main Targets:*

  The Regional Solar Programme (RSP) has installed approximately 630 photovoltaic (PV) pumping systems, which provide water to over one million rural dwellers. Approximately, 1.300 kWp were installed in nine Sahelian countries (Niger, Tchad, Cap Vert, Gambie, Guinée-Bissau, Mauritanie, Sénégal, Burkina Faso, Mali).

  The Programme was based on a rational use of natural resources with a global objective to successfully improve the overall living conditions of rural people. The RSP is a technology transfer programme with the specific goal to provide a cost-efficient safe drinking water supply service for the rural poor in the Sahel.

- *Methods and Procedures:*

  The Programme is based on two important principles:

  - A strong user participation,
  - The promotion of the private sector in the Sahel.

  Strong beneficiary participation was considered as the main element to guarantee the life span of the equipment. A financial contribution is made by the local population to pay for recurrent costs: salaries of watchmen and caretakers, maintenance and repair, and spare parts (except for solar panels).

  The private sector plays an important role in the maintenance of the systems and the transfer of technology in the Sahelian countries.

- *Experience:*

  The RSP is considered a success and a point of reference in terms of PV pumping. PV pumping is now considered a viable option for rural water supply in West Africa. However, this Programme has not yet created a 'snowball' effect and, for the moment, other donors have not replicated it.

➢ *Access to financing*: The technology (PV panels) was financed by EDF grants. EDF financed also tests and monitoring of the PV panels to prove its viability under Sahelian conditions.
➢ *Crucial factors and conditions:* As indicated strong participation of the users was considered as the main condition of success.