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STATE HIGHWAY ADMINISTRATION

RESEARCH REPORT

TOOLS TO SUPPORT GHG EMISSIONS REDUCTION: A REGIONAL EFFORT

PART 2 – GHG EMISSIONS IN EUROPE: TRENDS AND POLICIES

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16. Abstract
This project aims to provide a realistic picture of Green House Gas (GHG) emissions in Europe. The report summarizes measures and trends along with statistics from the sectors that result to be the principal contributors. The policies adopted and proposed by the European Commission to meet strategic objectives and targets are also analyzed and a number of recent research projects described.

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EXECUTIVE SUMMARY

This project aims to provide a realistic picture of Green House Gas (GHG) emissions in Europe. The report summarizes the measures and trends along with statistics from the sectors that result to be the principal contributors. The policies adopted and proposed by the European Commission to meet strategic objectives and targets are also illustrated and explained. As an overview of the main actions undertaken and of the resources allocated, a number of projects funded under the 7th research framework (2007-2013) are described.

Greenhouse gas emissions in the EU-27[1] account for approximately 10.5% of the global anthropogenic greenhouse gas emissions. The largest greenhouse gas emitting activities in the EU-27 are the production of electricity and heat, road transportation, fossil fuel combustion from households, agriculture, iron and steel production. Carbon dioxide (CO_2) emissions account for 83% of total greenhouse gas emissions, while methane (CH_4) and nitrous oxide (N_2O) each represent approximately 8% of total emissions. Between 1990 and 2006, greenhouse gas emissions decreased by 7.7% in the EU-27 and by 2.2% in the EU-15[2].

Based on information provided by the 22 Member States, 57% of the policies and measures implemented at the national level to reduce greenhouse gas emissions were introduced in response to EU policies (CCPMs[3]) and 24% more have been reinforced by them. With the existing measures in place, EU-27 greenhouse gas emissions are projected to increase by 1% between 2006 and 2010. With the implementation of additional measures, EU-27 emissions are projected to decrease continuously between 2006 and 2020.

[1] EU-27: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.
[2] EU-15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.
[3] CCPM: Common and Coordinated Policy and Measure.

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1 Introduction

For several years now the European Union has been committed to tackling climate change both internally and internationally and has placed it high on the EU agenda, as reflected in European climate change policy. Indeed, the EU is taking action to curb greenhouse gas emissions in all its areas of activity in a bid to achieve the following objectives: consuming less-polluting energy more efficiently, creating cleaner and more balanced transport options, making companies more environmentally responsible without compromising their competitiveness, ensuring environmentally friendly land-use planning and agriculture and creating conditions conducive to research and innovation.
(http://europa.eu/legislation_summaries/environment/tackling_climate_change/index_en.htm)

The EU is also actively working to revitalize the transport policy; the actions proposed through the White Paper adopted in 2001, will make a significant contribution towards reducing the impact of transport on climate change. Achieving this objective will require, in particular, better management of transportation systems and the harnessing of technology. A wide range of measures have been identified to reduce in particular the impact of road and air transport, including measures reducing levels of polluting emissions, traffic management measures and tax measures. To improve the balance between transport modes and to promote less polluting means of transport, the EU supports the development of measures to promote rail, maritime and waterway transport and to join up different modes of transport (inter-modality).

In order to meet these objectives the European Commission sponsors several specific projects for policy support; specifically the research program aims at:

- Provide scientific and technical support for implementing the European Community GHG inventory system. This include the check of Member States' inventories and the contribution to the EC Inventory Report, as well as efforts for harmonizing, improving and simplifying the measuring and reporting of GHG emissions in Europe, e.g. through several activities with Member States and the creation of EU-wide reference datasets;
- Perform research activities in order to understand and quantify better the role transportation in climate change. This is done through experimental demonstration sites for the measurement of GHG and modeling activities, in the frame of the European research projects.

The objective of this report is to provide a realistic picture of the situation in Europe; in particular measures and trends in GHG emissions are reported along with statistics on the sectors that result to be the principal contributors. The study also focuses on the policies adopted and proposed by the European Commission in order to meet strategic objectives and targets. Finally, a number of projects funded under the 7th research framework (2007-2013) and their relative budget are described for an overview of the main actions undertaken and of the resources allocated.

2 The general situation and the measures in Europe

2.1 The general situation in EU

- Greenhouse gas emissions in the EU-27 account for approximately 10.5% of global anthropogenic greenhouse gas emissions.
- The largest greenhouse gas emitters in the EU-27 are five EU-15 Member States: Germany, the United Kingdom, Italy, France and Spain. Poland is the largest greenhouse gas emitter in the EU-12. In 2006, the EU-15 accounted for 81% of all EU-27 emissions.
- The largest greenhouse gas emitting activities in the EU-27 are the production of electricity and heat, road transportation, fossil fuel combustion from households, agriculture, and iron and steel production. Carbon dioxide (CO_2) emissions account for 83% of total greenhouse gas emissions, while methane (CH_4) and nitrous oxide (N_2O) each represent approximately 8% of total emissions.
- Between 1990 and 2006, greenhouse gas emissions decreased by 7.7% in the EU-27 and by 2.2% in the EU-15. The largest absolute emission reductions took place in Germany, the United Kingdom and in most EU-12 Member States, while emissions increased most (in absolute terms) in southern EU-15 Member States (Spain, Portugal, Greece and Italy). The largest increase among all EEA member countries occurred in Turkey, where emissions doubled over the period.
- Between 2005 and 2006, greenhouse gas emissions decreased by 0.3% in the EU-27 and by 0.8% in the EU-15. The largest absolute emission reductions took place in France, Italy, Spain and Belgium while the largest absolute increases were observed in Poland, Finland and Denmark.
- Greenhouse gas emissions per capita vary widely among European countries, with an EU-27 average of 10.4 tons carbon dioxide equivalent (t CO_2-equivalent) per capita, slightly lower than the EU-15 average (10.7 t CO_2-equivalent per capita) but above the global average of 7.5 t CO_2-equivalent per capita. Average per capita emissions in the EU-27 decreased between 1990 and 2006. However, in the EU-12 per capita emissions have been increasing in recent years.
- With an emission intensity of 442 g CO_2 per unit of GDP (in purchasing power parity) in 2006, the EU-27 is one of the world's least emission intensive economies. Emission intensities have declined in almost all EU-27 Member States between 1990 and 2006, with an average decline of 33% in the EU-27 and 30% in the EU-15.

2.1.1 Greenhouse gas emissions in 2006

In 2006, total greenhouse gas emissions in the EU-27, excluding net CO_2 removals from land use, land use change and forestry (LULUCF), were 5,143 Mt CO_2equivalent. The EU accounts for about 10.5% of global greenhouse gas emissions.

In 2006, the EU-15 accounted for 81% of total EU-27 greenhouse gas emissions (in comparison with 79% of the whole EU-27 population). The five largest emitters of greenhouse gases in the EU-27 were all EU-15 Member States: Germany, the United Kingdom, Italy, France and Spain. Together, they accounted for more than 60% of EU-27 greenhouse gas emissions. Poland was the largest emitter in the EU12.

Production of public electricity and heat from fossil fuels by the energy industry, together with road transportation, are the two activities responsible for the largest shares of greenhouse gas emissions (Figure 2.1). The total emissions related to energy supply and use, including transport, account for 80% of total greenhouse gas emissions.

As a consequence of the role played by fossil fuel combustion, CO_2 is the predominant greenhouse gas emitted, accounting for 83% of total greenhouse gas emissions. CH_4 and N_2O, mainly due to agriculture and waste management, each account for about 8% of total emissions, while fluorinated gases (from industrial processes) represent 1.5% of total emissions (Figure 2.2).

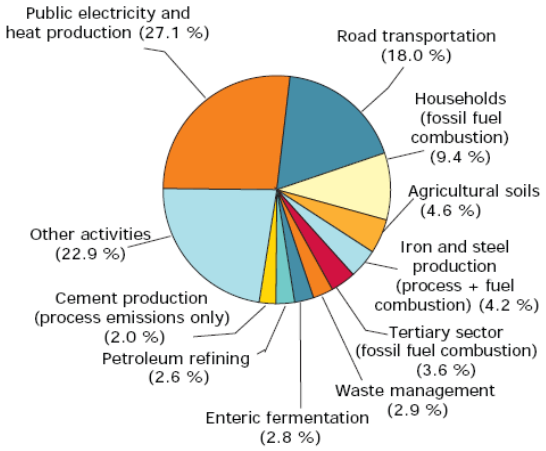

Figure 2.1 Share of 2006 Greenhouse gas emissions in the EU-27, by main activity

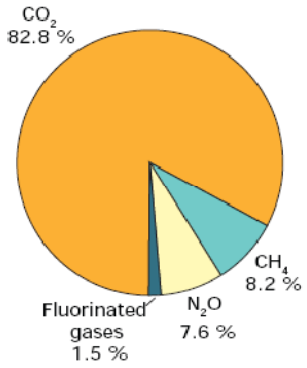

Figure 2.2 Share of 2006 Greenhouse gas emissions in the EU-27, by gas

2.1.2 Greenhouse gas emission trends, 1990–2006

Between 1990 and 2006, total EU-27 greenhouse gas emissions, without LULUCF (Land Use, Land Use Change and Forestry), decreased by 7.7% or 430 Mt CO_2 equivalent (Figure 2.3). This overall change reflects two distinct trends within the EU: while in the EU15, greenhouse gas emissions decreased by 2.2% during the period, they decreased by more than 25% in the EU12.

The overall EU greenhouse gas emission trend is dominated by the two largest emitters Germany and the United Kingdom, which together achieved greenhouse gas emission reductions of 339 Mt CO_2equivalent compared to 1990. This decrease was partly offset by the important emission increases in Spain and, to a lesser extent, Italy (increase of 197 Mt CO equivalent for the two countries).

The economic decline and restructuring that affected Eastern Europe during the early 1990s spawned closure of heavy polluting and energy intensive industries and energy efficiency improvements in power and heating plants. Consequently, large decreases in emissions occurred in the EU12 and the former Eastern Germany, in particular in the energy supply sector. Emissions in the agriculture sector also declined considerably. Nine of the 11 Member States for which the largest decreases (in relative terms) have been observed between 1990 and 2006 (ranging from 56% to 12%) are EU12 Member States, in addition to Germany and the United Kingdom (Figure 2.4). In the United Kingdom, significant improvements in energy efficiency were driven by a wide range of policies across the main energy using sectors, and, partly resulting from the liberalization of the energy market. The major shift away from more carbon intensive fuels such as coal and oil towards lower or zero carbon electricity generation, such as gas, nuclear and renewable energy

sources led to significant emission reductions in the country, and subsequently EU-15 emissions. By contrast, seven of the ten EU Member States that experienced the largest relative increases in greenhouse gas emissions belong to the EU-15 (Figure 2.4).

In the second half of the 1990s, further significant emission reductions occurred in the energy sector in Germany, Poland and Romania. Reductions in N_2O emissions were also observed in the chemical industry (adipic acid production) in France, Germany and the United Kingdom. These reductions in the EU-15 were partly offset by emission increases in south European countries (in particular in Spain, Italy and Greece). In 1996, a particularly severe winter across Europe led to significant increases in heating demand, to which is attributed the emission peak observed that year.

Since 2000, greenhouse gas emissions in the EU12 have been increasing, driven by sustained economic growth (Figure 2.3). The two decreases observed in 2002 and 2005 were offset in 2006 by a larger increase in absolute terms. Emissions from transport have been steadily increasing. These countries seem to be repeating the experience of Ireland, Portugal and Spain; starting from a relatively low transport level, all these countries experienced high economic growth accompanied by strong growth in transport and related greenhouse gas emissions.

In the EU15, after an overall increase between 2000 and 2004, greenhouse gas emissions decreased in 2005 and 2006. Germany, France, Belgium, Italy and the Netherlands made significant contributions to this overall EU-15 trend.

In terms of individual greenhouse gas trends between 1990 and 2006, CO_2 and hydrofluoro carbons (HFCs) are the only greenhouse gases for which increasing trends have been observed. The emissions of all other greenhouse gases have decreased in EU as a whole. CO_2 emissions decreased by 3.1% in the EU27 (compared to a 7.7% decrease of total greenhouse gas emissions). However, CO_2 emissions increased by 3.4% in the EU15, largely because of a large increase in road transport a related CO_2 emission that was only partly offset by reduction mainly in energy related emissions from manufacturing industries.

Under relatively stable economic conditions, such as those observed across Europe from the mid 1990s until recently, greenhouse gas emission trends can better reflect the effects of climate mitigation policies. For example, the significant decrease of greenhouse gas emissions from

transport experienced by Germany between 1999 and 2006, both in absolute terms (− 26 Mt CO_2equivalent) and relative terms (-14%) — while all the other Member States have seen their transport greenhouse gas emissions grow during the same period — could not be fully explained without referring to the measures implemented in this country to reduce transport emissions.

All the other EEA member countries have experienced an increase in their total greenhouse gas emissions between 1990 and 2006, including a doubling of total emissions in Turkey during the period. This increase is mainly attributed to the country's important demographic growth. However, emissions per capita in Turkey are still relatively low compared to other European countries.

Greenhouse gas emissions in Croatia decreased by 5% during the period 1990–2006. This decrease occurred exclusively between 1990 and 1994 (− 31%), but emissions have been steadily increasing since.

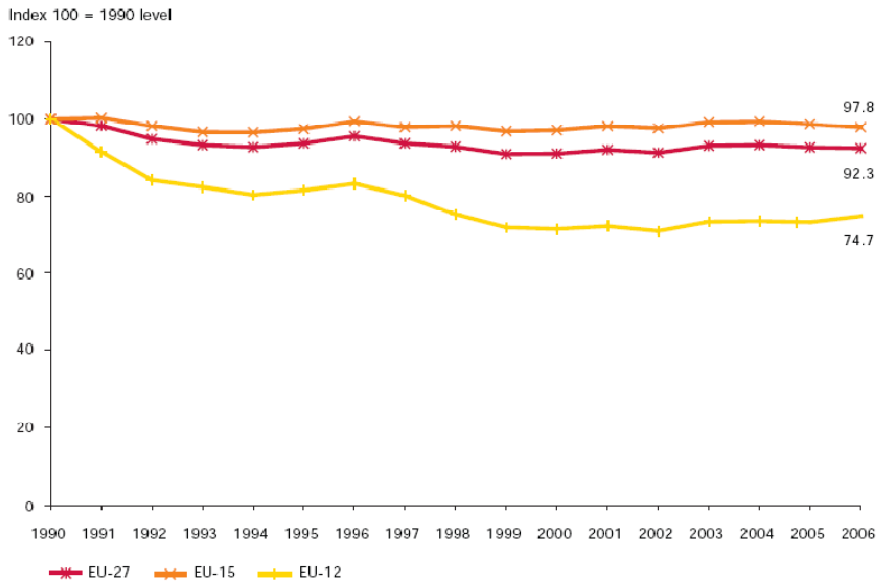

Figure 2.3 Greenhouse gas emission trends for EU-27, EU-15 and EU12, 1990-2006

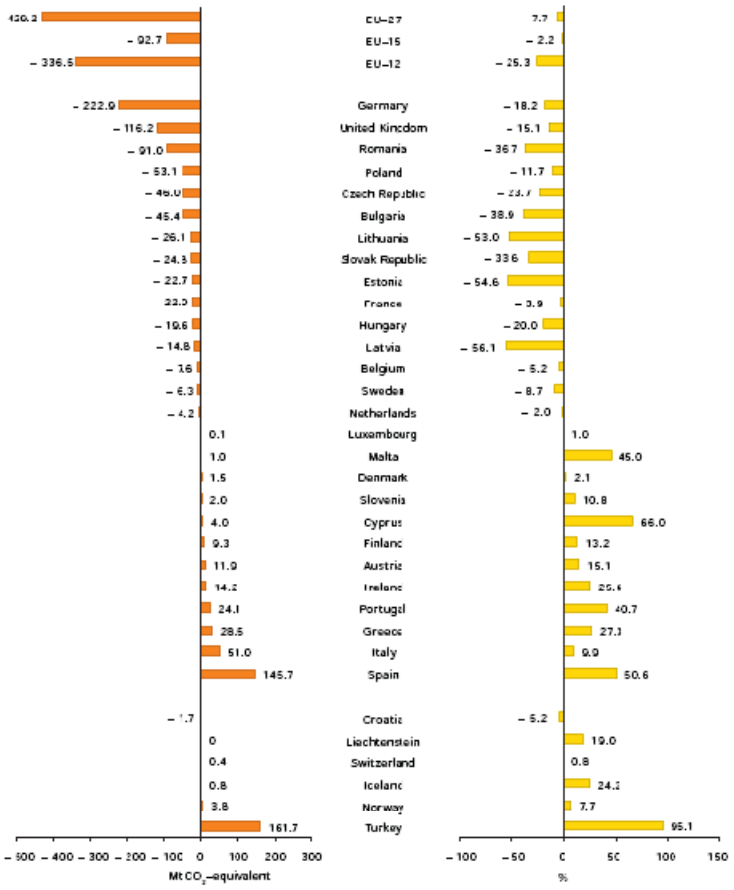

Figure 2.4 Changes in greenhouse emission trends in Europe between 1990-2006

2.2 Measures adopted by EU

2.2.1 Current policies and measures

- Based on information provided by 22 Member States, 57% of the policies and measures implemented at national level to reduce greenhouse gas emissions were introduced in response to EU policies (CCPMs) and 24% more have been reinforced by them.

- The sectoral EU policies and measures through which Member States plan to obtain the largest greenhouse gas emissions reductions by 2010 are:
  - the Emissions Trading Directive;
  - the Directive on the promotion of electricity from renewable energy sources;
  - the Bio-fuels Directive;
  - the voluntary agreements to reduce per km CO_2 emissions from new cars reached with the European, Japanese and Korean automobile industries;

- the Directive on the energy performance on buildings;
- the Directive on taxation of energy products and electricity;
- the Cogeneration Directive.

- Some Member States still need to implement or reinforce existing EU policies through additional measures at national level. The largest further emission reductions projected from such measures correspond to the Directive on the promotion of electricity from renewable energy sources, the Directive on the energy performance on buildings and the Cogeneration Directive.

2.2.2 Future policies and measures

- The European Commission, through the second phase of the European Climate Change Programme, has proposed further domestic policies and measures to contribute to meeting the EU Kyoto target. Specific areas for which additional emission reductions measures for 2008–2012 are being developed include aviation, fuel quality and CO_2 from cars.

- Looking beyond the first commitment period, the EU is committed to achieving at least a 20% reduction of greenhouse gas emissions by 2020 compared to 1990. The EU is also ready to reduce emissions by 30% by 2020 compared to 1990 under a new global and comprehensive climate change agreement, when other developed countries make comparable efforts.

- The Commission presented in January 2008 a climate change and energy package which proposes legislation to expand and strengthen the EU ETS (European Union Emission Trading System) for the period beyond 2012, to further increase the use of renewable energy and bio-fuels, and to set a regulatory framework for the capture and geological storage of CO_2.

- According to Member States, green certificates and feed-in tariffs were the most successful means of promoting electricity generated from RES (Renewable Energy Sources) across the EU.

- Information about avoided CO_2 emissions due to the use of RES-E provided under UNFCCC (United Nations Framework Convention on Climate Change) and pursuant the Renewables Directive is scarce and lacks consistency.

- **CCPM implementation and reinforcement before 2012**

ECCP II working groups met throughout 2006 and 2007 to review ECCP I and explore new policy areas to be implemented in the 2008–2012 period. As a result, the Commission has proposed several actions:

- Aviation: legislative proposal (December 2006) to integrate aviation into EU ETS.
- Revision of Fuel quality Directive: legislative proposal (January 2007), which would reduce greenhouse gas emissions from transport fuels by 10% between 2010 and 2020, partly through improved efficiency in refineries.
- CO_2 and cars: Communication (February 2007) and legislative proposal (December 2007) to set target for average CO_2 emissions from new cars at 130 g CO_2/km by 2012 relying on improvements in vehicle motor technology. This measure would further the voluntary agreements to reduce per km CO_2 emissions from new cars reached with the European, Japanese and Korean automobile industries.

These proposals, if adopted in a timely manner, could still contribute to help Member States and the EU reach their targets for the period 2008–2012.

- **EU commitments and policy proposals beyond 2012**

EU commitments by 2020 and the EU climate change and energy package

In March 2007, the Council of the European Union underlined the need for an integrated approach to climate and energy policy, in order to realize the strategic objective of limiting the global average temperature increase to not more than 2°C above pre-industrial levels. The Council decided that the EU would make a firm independent commitment to achieving at least a 20% reduction of greenhouse gas emissions by 2020 compared to 1990. The European Council also endorsed an EU objective of a 30% reduction in greenhouse gas emissions by 2020 compared to 1990 as its contribution to a global and comprehensive agreement for the period beyond 2012, provided that other developed countries commit themselves to comparable emission reductions and that economically more advanced developing countries should contribute adequately according to their responsibilities and respective capabilities. The European Council also adopted a comprehensive energy Action Plan for the period 2007–2009, based on the Commission's Communication 'An Energy Policy for Europe' of January 2007. The plan included a mandatory target of 20% for the share of renewable energy in overall EU energy consumption

by 2020 including a 10% minimum share of bio-fuels in transport fuels by 2020, provided this is produced in a sustainable way.

The European Council invited the Commission to come forward with concrete proposals, including how efforts could be shared among Member States to achieve these targets. As a response, the Commission adopted a climate change and energy package on 23 January 2008, which includes:

- a proposal for amending the directive on emissions trading system of the Community in order to improve and extend it (the EU ETS review);
- a proposal for a Decision of the European Parliament and the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (Effort Sharing Decision);
- a proposal for a directive on the promotion of the use of energy from renewable sources;
- a proposal for a directive on the geological storage of carbon dioxide.

These proposals are now discussed under the co-decision procedure with the European Parliament and Council. The French EU presidency aims at achieving a political agreement on the European Climate Change and Energy package by the end of 2008 in order to have it formally adopted before the current term of the European Parliament (June, 2009).

General principles of the Commission proposal for a future EU effort sharing

Under the Kyoto Protocol and current EU legislation, Member States are responsible for the entirety of greenhouse gas emissions in their country and the Kyoto or burden-sharing targets cover all these emissions. The proposals under the climate change and energy package abolish this concept of overall national targets:

- Emissions from installations included in the trading scheme ('trading sector', representing approximately 40% of total emissions) are covered in one single EU-wide target, with uniform allocation rules for installation allowances.
- Member States remain only responsible for emissions that are not covered by the EU ETS ('non-trading sector') and targets are proposed for these emissions under the effort-sharing Decision.

A linear target path is also proposed for emissions from both trading and non-trading sectors, requiring Member States and operators to reduce emissions gradually between 2013 and 2020.

The reference year for the overall obligation is 1990, but all specific quantitative commitments are based on 2005, the first year for which both national greenhouse gas inventory data and verified emission data under the EU ETS are available. The 20% reduction of 1990 greenhouse gas emissions translates to a 14% reduction compared to 2005. It is proposed that the trading sector reduce its emissions by around 21% compared to 2005 by 2020, while the sectors not covered by the EU ETS reduce their emissions by around 10% compared to 2005 by 2020. The proportion between the reduction efforts of the trading and non-trading sectors is supposed to remain constant where an adequate international agreement is reached with stricter EU reduction obligations. Both the Effort Sharing Decision and the EU ETS review proposals contain an automatic procedure for increasing the targets after the conclusion of such agreement.

Proposal for the sectors covered by the EU ETS

Overall target: In the absence of an international agreement stationary installations covered by the EU ETS would need to reduce emissions by approximately 21% compared to the average emissions in 2005. In the case of an international agreement with a reduction commitment of -30% by the EU, the EU ETS target would increase. This average target for the entire trading sector does not apply to individual Member States, due to the different shares of auctioning in the different sectors and the auction revenue distribution mechanism. The agreement for the aviation sector includes a 5% reduction effort in 2020 compared to the average emissions of the sector in 2004 to 2006.

Allocation rules: According to the Commission proposal, rules governing free allocation, new entrants and closures would be harmonized, in order to minimize distortion of competition between industries in different Member States. The Commission proposes a shift to almost full auctioning of all EU allowances in 2020. Installations in the power sector would not receive any free allowances as of 2013, whereas free allocation in industrial sectors would be gradually phased out by 2020. Exceptions to this rule would only be allowed for sectors where there is a considerable danger of carbon leakage, i.e. relocation of production to countries without similar emission reduction obligations due to the trading scheme. 10% of the overall allowances for auctioning would be redistributed to Member States according to their economic situation:

Member States with an above average GDP per capita ratio would have to transfer some share of the allowances for auctioning to Member States with below average GDP per capita. Member States would have to use at least 20% of the revenues raised through auctioning for purposes related to climate change, e.g. supporting adaptation in developing countries and domestic emission reduction efforts.

Scope extension: According to the proposal, the scope of the emission trading scheme would be extended to cover new sectors (e.g. aluminium and ammonia producers) and new gases (N_2O, PFCs). In addition, the European Council and the European Parliament already agreed to include aviation in the EU ETS starting in 2012. At the same time, the proposal includes provisions for the exclusion of very small emitters to reduce the burden for operators and administrators.

Use of credits: The use of credits from CDM projects by operators would be restricted. In the absence of an international agreement, operators would only be allowed to use any remaining shares of the limit during the second trading period of the EU ETS; after an international agreement has been reached, operators would be allowed to further acquire half of the additional reduction commitment.

Proposal for the sectors not covered by the EU ETS

Overall target: In the absence of an international agreement, the non-trading sector would need to reduce emissions by approximately 10% compared to the average emissions in 2005. In the case of an international agreement with a reduction commitment of –30% by the EU, the average reduction required of the non-trading sector would increase.

Individual targets: In contrast to the sectors covered by the ETS, Member States would have targets for emissions not covered by the trading scheme, e.g. from sources such as surface transport or heating. Targets for individual Member States would range between a 20% reduction to a 20% increase compared to 2005, depending on the national GDP per capita ratio. This approach aims to ensure that the actual efforts and the associated costs are distributed in a fair manner. The reductions required by Member States with below average GDP per capita would therefore be less than the EU average of –10%; some Member States would even be allowed to increase emissions from these sectors until 2020.

Use of credits: To ensure achievement of domestic reduction efforts, the Commission proposed a cap on the use of CDM by Member States. In the absence of an international agreement, Member States are allowed to use external credits up to a maximum of 3% of their 2005 emissions; after an international agreement has been reached the limit would be increased by half of the additional reduction effort per Member State.

Proposal for the promotion of renewable energy sources

The EU climate change and energy package includes a proposal for a new comprehensive directive on the use of all renewable energy sources. The proposal sets the national renewable energy targets for each member state to achieve the overall EU binding target of a 20% share of renewable energy sources in energy consumption in 2020. The Directive will cover the electricity, heating and cooling and transport sectors; however, Member States are given flexibility to decide the contribution of each sector in meeting their target. Each Member State has to prepare a National action plan that sets out how they intend to meet their targets and how they will effectively monitor progress. Member States will be allowed to achieve their targets by supporting the development of renewable energy in other Member States and third countries, providing that the EU's overall target is still achieved.

The proposal also establishes the binding 10% minimum target for bio-fuels in transport to be achieved by each Member State, as agreed at the European Council. The Directive sets out environmental sustainability criteria to ensure that bio-fuels that are to count towards the European targets are sustainable and do not conflict with the EU's overall environmental goals.

The Directive also aims to remove unnecessary barriers to the growth of renewable energy, through the simplification of the administrative procedures for new renewable energy developments, and by setting sustainability standards should encourage the development of better types of renewable energy.

These measures are being complemented by the revised Fuel Quality and Energy Taxation Directives which are expected to further stimulate demand for bio-fuels.

Promotion of electricity produced from renewable energy sources and Promoting combined heat and power (CHP) and high efficiency cogeneration

The Directive sets an indicative target of 22.1 % for the share of electricity produced from renewable energy sources in total EU-15 electricity consumption by 2010 (21 % for the whole EU), with individual indicative targets for all Member States (Figure 2.5).

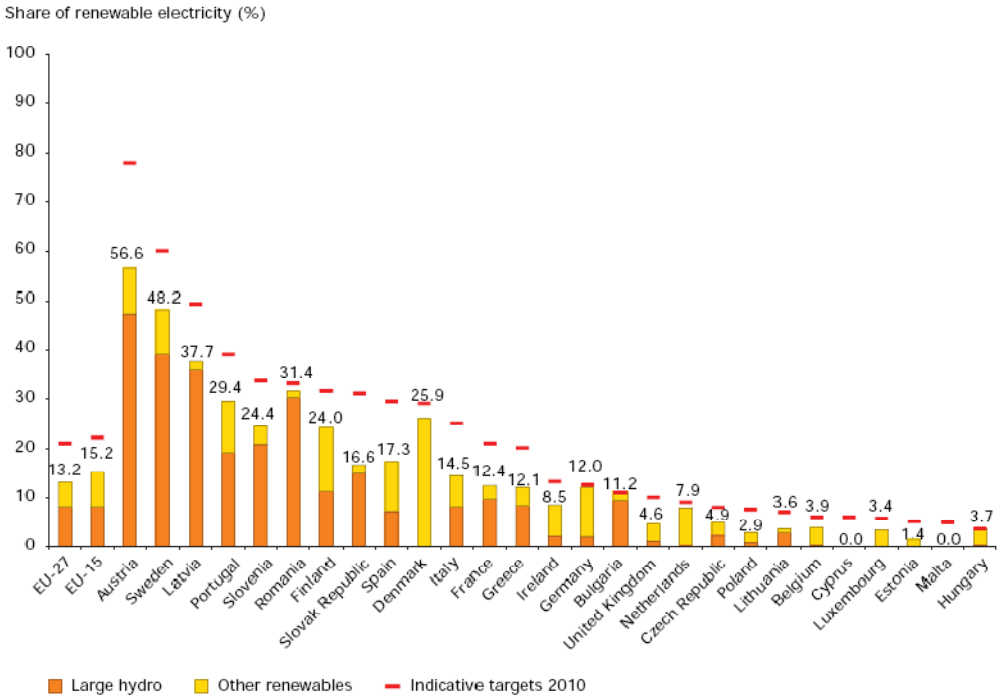

Figure 2.5 Share of renewable electricity in gross electricity consumption in EU-27 in 2006 (and 2010 indicative targets)

According to the information reported by Member States under the Renewable Directive and under the UNFCCC, renewable energy feed-in tariffs, green certificates, green electricity acts, regulations, funds, action plans, national strategies, tender systems and others policies and measures implemented at national level contributed to increasing the share of RES-E (Table 2.1).

In 2006, the share of total gross electricity production from combined heat and power (CHP) in the EU−27 was 10.9 % (Figure 2.6). Latvia, Denmark, Finland, and the Netherlands had the highest share of CHP electricity generation. In Denmark, CHP has received strong government policy support through tax incentives and subsidies, and growth has been seen mainly in public supply as a result of investments in district heating infrastructure. Government support was also an important factor in the Netherlands, combined with widespread availability of natural gas, the favored fuel for CHP. The high level of CHP production in Finland and Latvia reflects both the significant demand for heat and the development of district heating networks, due to the cold

climate and regulations in favor of district heating development. Poor infrastructure for natural gas and less demand for heat has hindered CHP development in some countries, for example Greece.

Table 2.1 Policies and measures supporting the development of RES-E

Austria	• Green electricity act • Feed-in tariffs combined with regional investment incentives
Belgium	• Investment support schemes, subsidies for photovoltaic • Quota obligation system/tradable green certificates combined with minimum prices for electricity from RE
Bulgaria	• Combination of feed-in tariffs, tax incentives and purchase obligation
Cyprus	• Feed-in tariffs, supported by investment grant scheme for promotion of RES
Czech Republic	• Feed-in tariffs, supported by investment grants
Denmark	• Premium feed-in tariffs (environmental adder). • Tender schemes for wind offshore
Estonia	• Feed-in tariff system
Finland	• Energy tax exemption combined with investment incentives • Feed-in tariff project
France	• Feed-in tariffs, purchase obligation • Tender system for large renewable projects • Wood energy plan • Tender for investment (wind and biomass) • Green certificates
Germany	• Feed-in tariffs
Greece	• Feed-in tariffs combined with investment incentives • Liberalization of RES E development
Hungary	• Feed-in tariffs combined with purchase obligation and grants
Ireland	• Feed-in tariff schemes (since 2006) replacing a tendering scheme
Italy	• Minimum quota obligation for production RES-E • Incentive program for the use of RES • Tradable green certificates • Feed-in tariff system for photovoltaic
Latvia	• Quota obligation system combined with feed-in tariffs
Lithuania	• Feed-in tariffs combined with a purchase obligation • Tradable green certificates • Development of hydro energy use • Wind power use program
Luxembourg	• Feed-in tariffs
Malta	• Low VAT rate and very low feed-in tariff for solar
Netherlands	• Premium payments (until 2006) • Energy research subsidy • Energy investment subsidy & allowance • Green investment/funds
Poland	• Quota obligation system • Tax exemption (small excise tax) for tradable green certificates and renewables
Portugal	• Feed-in tariffs combined with investment schemes • Solar hot water program • Improvement of energy efficiency in RES E
Romania	• Quota obligation with tradable green certificates since 2005
Slovak Republic	• Feed-in tariffs and tax incentives
Slovenia	• Feed-in system and premium • CO_2 taxation • Public funds for environmental investments • Certification • Incentives for RES-E in households
Spain	• Feed-in tariffs and premium
Sweden	• Market introduction aid (reduced tax) for wind power • Quota obligation system with tradable green certificates
United Kingdom	• Support programme for new and renewable energy • Quota obligation system with tradable green certificates

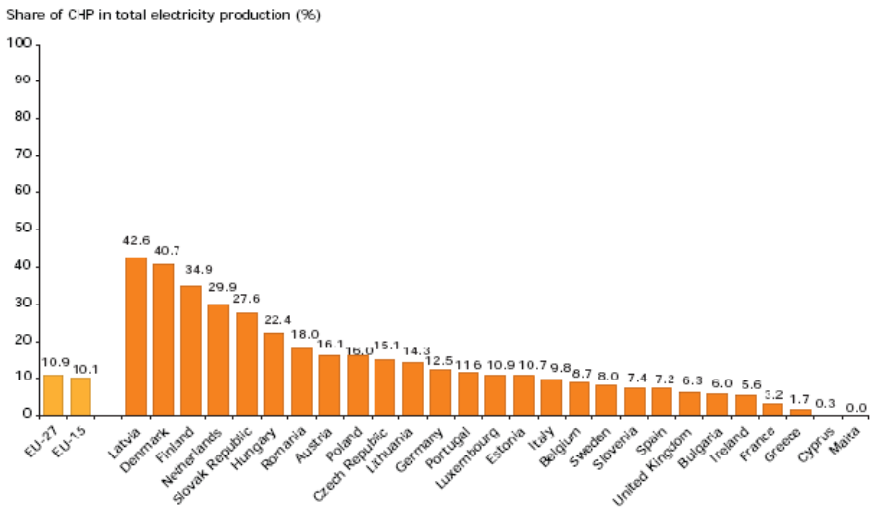

Figure 2.6 Share of CHP in gross electricity production in 2006

2.2.3 The European Climate Change Program (ECCP)

The European Climate Change Program (ECCP), launched in 2000, provides a cohesive framework to identify and develop all the necessary elements of an EU strategy to implement the Kyoto Protocol. Under the first phase of the Program, the focus was on the Kyoto flexible mechanisms, the energy supply, energy consumption, transport and industry sectors and research. The Commission committed to 12 priority actions in ECCP I, and almost all have been or are close to being implemented. In October 2005, the Commission launched ECCP II. It investigated new policy areas such as adaptation, aviation and carbon capture and storage, as well as reviewing ECCP I and doing further work on the implementation of existing policies and measures.

Table 2.2 provides a full description of the key CCPMs referred to in this section. The CCPMs are generally EU-wide Directives, which are then transposed into national policies and measures by each Member State.

Table 2.2 Full descriptions of key EU CCPMs

CCPM reference	CCPM full description
EU Emission Trading Scheme (ETS)	Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC
RES-E Directive	Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001on the promotion of electricity produced from renewable energy sources in the internal electricity market
Kyoto Protocol project mechanisms	Directive 2004/101/EC of the European Parliament and of the Council of 27 October 2004 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in respect of the Kyoto Protocol's project mechanisms
Co-generation Directive	Directive 2004/7/EC on the promotion of cogeneration
Energy performance of buildings	Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings
Directive on energy taxation	Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity
Efficiency of new boilers	Council Directive 92/42/EEC of 21 May 1992 on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels
Motor Challenge Programme	European Commission voluntary programme launched in February 2003, through which industrial companies are aided in improving the energy efficiency of their Motor Driven Systems.
Biofuels Directive	Directive 2003/30/EC of the European Parliament and the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport
ACEA agreement	Commission Recommendations of 5 February 1999 and 13 April 2000 on the reduction of CO_2 emissions from passenger cars (voluntary agreement with car manufacturers from EU, Japan and Korea to reduce fleet average CO_2 emissions to 140 g/km by 2008/09)
F-gas regulation	Regulation (EC) No. 842/2006 of the European Parliament and of the Council of May 17, 2006 on certain fluorinated greenhouse gases
IPPC Directive	Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control
HFC motor vehicle air conditioning	Directive 2006/40/EC of the European Parliament and of the Council of 17 May 2006 relating to emissions from air conditioning systems in motor vehicles
Large combustion plant Directive	Council Directive 88/609/EEC of 24 November 1988 on the limitation of emissions of certain pollutants into the air from large combustion plants
Common rules for CAP direct support	Council Regulation (EC) No. 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers
Landfill Directive	Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste
Directive on waste	Directive 2006/12/EC of the European Parliament and of the Council of 5 April 2006 on waste

- **Common and coordinated policies and measures**

A number of the CCPMs have been adopted or are at an advanced stage of preparation. Many are included in the Member States reporting on policies and measures. In several Member States, similar national policies and measures were already in place, and EU-wide policies and measures enhance these. Furthermore, many Member States have specific national policies and measures in place, which are not directly related to the EU-wide common and coordinated policies and measures.

The most important common and coordinated policies and measures are summarized in Table 2.3.

Table 2.3 Main common coordinated policies and measures

Sector	Common coordinated policies and measures
Cross-cutting	EU emission trading scheme (Directive 2003/87/EC, adopted by the Council and the Parliament in October 2003, started 1 January 2005; changes to strengthen ETS proposed for post 2012)
	Directive linking the EU CO_2 emission trading scheme with the Kyoto mechanisms (COM(2003) 403 final, adopted in October 2003 implemented by Member States)
Energy supply and use (energy industries, industry and households)	Directive on the promotion of electricity from renewable energy sources (2001/77/EC, adopted in 2001)
	Directive on Combined Heat and Power to promote high efficiency cogeneration (2004/8/EC, adopted in February 2004)
	Directive on the Energy Performance of Buildings (2002/91/EC, adopted in January 2003 transposed by Member States in 2006)
	Directive restructuring the Community framework for the taxation of energy products and electricity (2003/96/EC, adopted in October 2003, transposed by Member States in 2005)
	Directive on establishing a framework for the setting of ecodesign requirements for energy-using products (2005/32, adopted in July 2005, to be transposed by Member States in 2007)
	Motor Challenge Programme, voluntary programme launched in February 2003 through which industrial companies are aided in improving the energy efficiency of their Motor Driven Systems.
	Directive on energy end use efficiency and energy services (2006/32/EC adopted on May 2006 and due to be transposed by Member States in 2008)
Industry	Regulation on certain fluorinated greenhouse gases (EC 842/2006 adopted in July 2006, most measures apply in Member States from July 2007)
Transport	Reduction in average CO_2 emissions of new passenger cars (voluntary commitment by car manufacturers in EU, Japan and Korea; 1998/1999)
	Directive on use of biofuels in transport (2003/30/EC, adopted by Council and Parliament May 2003, transposed by Member States in 2005)
	Directive relating to emissions from air-conditioning systems in motor vehicles (2006/40/EC, adopted in January 2006, to be transposed by Member States in 2008)
Agriculture	Common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers (premium payment for energy crops) (Regulation 1782/2003)
Waste management	Recovery of methane from biodegradable waste in landfills (Landfill directive 1999/31/EC, transposed by Member States in July 2001)

- **Linkages between CCPMs and national policies and measures**

There is a strong link between national policies and measures (PAMs) and EU CCPMs. CCPMs demonstrate the collective determination of the EU-27 to take action on climate change and they help to deal with the Member States concerns about competitiveness. The following describes the implementation of CCPMs at national level, and shows its consequences on existing or new national policy.

For each Member State, three categories of national PAMs can be identified:

- New national PAMs implemented after a CCPM was adopted;
- National PAMs already in force but reinforced by a CCPM; and
- National PAMs already in force before a CCPM was adopted.

Member States supplied information on their implementation of CCPMs by reporting on the linkages of national PAM to CCPMs in a questionnaire sent by the European Commission. Member States also provided the name of the national PAM which implemented the CCPM and the quantitative effect of the measures on emission reductions. This process aimed at improving the transparency of national policymaking.

All EU15 Member States and eight EU12 Member States (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic and Slovenia) have provided information on policy linkages. Good quality information was provided on the linkages between national policies and measures to CCPMs. However, only a limited number of Member States quantified emission savings, so the overall effects of CCPMs could not be assessed. Almost all reporting Member States are implementing the CCPMs.

Based on responses from 23 Member States, more than 60% of the PAMs implemented at national level were introduced in response to CCPMs and 20% more have been reinforced by them. The role of CCPMs in prompting the implementation of PAMs at a national level has been particularly strong in the EU12, although on average the number of PAMs implemented by Member State is higher in the EU-15. EU policies that were most influential in terms of adoption of new PAMs at national level were the creation of the EU ETS, promotion of bio-fuels, and provision of consumer information (energy labelling of appliances, labelling of cars, energy labeling for office equipment). CCPMs on energy using appliances (efficiency fluorescent lighting and eco-design requirements for energy-using products) have been implemented in several EU15 Member States but not yet in the EU12.

Based on the more detailed information by Member State and CCPM:

- The emissions trading Directive led to the adoption of new national measures in all Member States except in Denmark and the United Kingdom, where similar schemes were introduced before this CCPM;
- The bio-fuels Directive is a new policy in most Member States, but reinforced existing national policies in France, Germany and Sweden;
- The EU had been active in promoting both electricity generation from renewable energy sources and in promoting cogeneration before the corresponding directives were introduced in 2001 and 2004 respectively. Many EU-15 Member States either took action before the directives were adopted or had existing measures reinforced by the directives. More EU12 Member States needed to introduce new policies to implement these two directives;
- In the case of the energy performance of buildings Directive, more than half of reporting Member States needed to introduce new policies and measures when the directive was adopted.

- In general for the CCPMs on which EU12 Member States reported, new national policies and measures were implemented once a CCPM was adopted. Transfer of good practice and CCPM implementation experience from old Member States will help to facilitate implementation of CCPMs in the EU12.

- **Quantified reductions from CCPMs**

Responses by EU-27 Member States to the questionnaire indicate that the Emissions Trading Directive and the RESE Directive are the two CCPMs projected to deliver the largest emission savings by 2010.

Some Member States anticipate further reductions of their greenhouse gas emissions resulting from the implementation or reinforcement of existing EU policies through additional policies and measures. This means that some Member States consider that they have not yet fully implemented or enforced these CCPMs. Proper and timely implementation of additional domestic policies and measures is expected to bring further significant emission reductions to the EU for the following CCPMs:

- The Directive on the Promotion of Electricity from Renewable Energy Sources,
- The Directive on the Energy Performance on Buildings,
- The Cogeneration Directive.

2.3 The use of Kyoto mechanisms

2.3.1 Flexible mechanisms under the Kyoto protocol (Kyoto mechanisms)

In addition to domestic measures, Member States are allowed to make use of the flexible mechanisms under the Kyoto Protocol (Kyoto mechanisms) to achieve their EU Kyoto or burden sharing targets by contributing to and/or benefiting from emission reductions taking place abroad.

The Kyoto Protocol defines three 'flexibility mechanisms' to lower the overall costs of achieving its emissions targets. These mechanisms enable Parties to access cost-effective opportunities to reduce emissions, or to remove carbon from the atmosphere, in other countries. While the cost of limiting emissions varies considerably from region to region, the effect for the atmosphere of limiting emissions is the same, irrespective of where the action is taken. This system aims to be economically cost-effective, while addressing concerns about environmental integrity and equity. The three Kyoto mechanisms are (see more detailed description below):

- Joint implementation (JI)
- The clean development mechanism (CDM)
- Emission trading

Domestic actions (as opposed to use of the mechanisms) must constitute a 'significant element' of the efforts made by each Member State to meet its target under the Kyoto Protocol. Although no quantified proportion that is to be met through domestic action was set, Member States must demonstrate that their use of the mechanisms is supplemental to domestic action to achieve their targets.

Joint implementation

Joint implementation (JI) is provided for under Article 6 of the Kyoto Protocol. It enables industrialized countries to work together to meet their emission targets. A country with an emissions reduction target can meet part of that target through a project aimed at reducing emissions in any sector of another industrialized country's economy. Any such projects need to have the approval of the countries involved and must result in emission reductions that would not otherwise have occurred in the absence of the JI project. The use of carbon sinks (e.g. forestry projects) is also permitted under JI.

Clean development mechanism

Article 12 of the Kyoto Protocol sets out a clean development mechanism (CDM). This is similar to joint implementation, but project activities must be hosted by a developing country. As with JI, CDM projects must result in reductions that are additional to those that would have been achieved in the absence of the project. They also have the additional aim of promoting sustainable development in the host developing country. The CDM is supervised by an Executive Board, which approves projects. CDM projects have been able to generate credits since January 2000 and these can be banked for use during the current first commitment period (2008–2012). The rules governing CDM projects allow only certain types of sinks project (afforestation and reforestation), and countries will not be able to use credits generated by nuclear power projects towards meeting their Kyoto targets. To encourage small-scale projects, special fast-track procedures are under development.

Emissions trading

Article 17 of the Kyoto Protocol allows countries that achieve emissions reductions over and above those required by their Kyoto targets to sell the excess to countries finding it more difficult or expensive to meet their commitments. In this way, it seeks to lower the overall costs of compliance.

2.3.2 Current and projected progress towards greenhouse gas emission targets

Emission targets under the Kyoto Protocol

- The EU, its 27 Member States and four of the five additional EEA member countries (Iceland, Switzerland, Liechtenstein and Norway) have ratified the Kyoto Protocol. Turkey, an EEA member country, has ratified the UNFCCC, but not the Kyoto Protocol. The EU candidate country Croatia ratified the Kyoto Protocol in May 2007.

- The EU Member States Cyprus and Malta do not have a target under the Kyoto Protocol.

- The achievement by the EU-15 and EU-12 Member States of their respective Kyoto targets by 2008–2012 would contribute to a 2.4% reduction of the total greenhouse gas emission of industrialized countries compared to 1990 levels.

Actual progress in 2006 towards Kyoto targets

- 2006 greenhouse gas emissions in four EU-15 Member States (France, Greece, Sweden and the United Kingdom), nine EU-12 Member States (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and the Slovak Republic) and Croatia were below these countries' respective Kyoto or burden-sharing targets.

- Taking also into account the projected use of Kyoto mechanisms and carbon sinks, four other EU-15 Member States (Belgium, Luxembourg, the Netherlands and Portugal) and Slovenia stand below their target.

- Seven EU-15 Member States (Austria, Denmark, Finland, Germany, Ireland, Italy and Spain), in addition to Iceland, Liechtenstein, Norway and Switzerland, therefore need further

reductions of their domestic greenhouse gas emissions between 2006 and 2012, and/or the use of Kyoto flexible mechanisms, in order to meet their respective targets.

Projected progress between 2006 and 2010

- Total EU-15 emissions, which were in 2006 at a level of 2.7% below base-year emissions, are projected to decrease between 2006 levels and 2010, by 1.0% of base-year emissions. The implementation of additional measures in ten Member States is projected to bring a further reduction of 3.3% (relative to base-year emissions). Large decreases are projected in Germany, Italy, the United Kingdom and Spain.

- In the EU-12, Cyprus, the Czech Republic, Estonia and Slovenia are the only Member States projecting that their emissions will decrease between 2006 and 2010.

Projected progress from base year to 2008–2012 Kyoto targets

- Existing and additional domestic policies and measures alone will not be sufficient for the EU-15 to meet its Kyoto target. If all projected reductions from domestic policies and measures, use of carbon sinks and use of Kyoto mechanisms are fully achieved, total EU-15 greenhouse gas emissions could be reduced by a total of 11.3% compared to base-year emissions, so well below the EU-15 Kyoto target of – 8.0%.

- Most projections do not fully account for the effects of the EU emission trading scheme, which is expected to bring significant emission reductions across the EU.

- Four EU-15 Member States project that they will meet their burden-sharing target with the existing measures in place: Germany, Greece, Sweden and the United Kingdom.

- Eight EU-15 Member States project that they will meet their burden-sharing target with a combination of additional measures, use of carbon sinks and/or use of Kyoto mechanisms: Austria, Belgium, Finland, France, Ireland, Luxembourg, the Netherlands and Portugal.

- Three EU-15 Member States project that they will not manage to reach their burden-sharing target: Denmark, Italy and Spain.

- All EU-12 Member States project that they will meet their Kyoto target. Slovenia intends to meet its target with the use of Kyoto mechanisms.

- Croatia, Iceland, Norway and Liechtenstein project that they will meet their targets. Switzerland currently projects that it will not reach its Kyoto target.

Projected use of Kyoto mechanisms

- Governments in ten EU-15 Member States (Austria, Belgium, Denmark, Finland, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain) as well as Slovenia will use the Kyoto mechanisms in order to meet their targets under the Kyoto Protocol.

- The projected use of Kyoto mechanisms in ten EU-15 Member States equals 126.5 Mt CO_2-equivalent per year of the commitment period (19). This corresponds to 3.0 of the 8.0% emission reduction required for the EU-15.

- The total financial resource allocated for the use of Kyoto mechanisms by twelve Member States (Austria, Belgium, Denmark, Finland, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and Sweden) amounts to EUR 2 951 million for the whole five-year commitment period.

- Although the Member States projecting to use Kyoto mechanisms to reach their targets are the same as in 2007, the projected reduction increased by 18% (19 Mt CO_2-equivalent per year, which represents 0.5 of the 8.0% emission reduction target), while the reported allocated budget increased only by 3% (EUR 91 million for the whole five-year commitment period).

Projected use of carbon sinks

- Although most EU-15 Member States intend to use carbon sinks to achieve their Kyoto target, the total amount of CO_2 projected to be removed between 2008 and 2012 is relatively small and will amount to 57.5 Mt CO_2 per year for the EU-15.

- This corresponds to 1.35 of the 8.0% emission reduction required for the EU-15 (compared to the base-year emissions). Three EU-12 Member States (the Czech Republic, Poland and Slovenia) expect an additional reduction of 5.9 Mt CO_2 per year of the commitment period.

EU progress towards 2020 targets

- According to current projections from Member States, existing and additional domestic policies and measures will not be sufficient for the EU‑15 to meet its Kyoto target, but adding all possible reductions from domestic policies and measures, use of carbon sinks and use of Kyoto mechanisms would lead to a total reduction of 11.3 % compared to base-year emissions, by 2008–2012, therefore well below the EU‑15 Kyoto reduction target of -8 % (Figure 2.7).

- With the existing measures in place, EU-27 greenhouse gas emissions are projected to increase by 1% between 2006 and 2010 (Figure 2.8). With the implementation of additional measures, EU-27 emissions are projected to decrease continuously between 2006 and 2020.

- According to the current projections from Member States for 2020, the EU-27 will not be able to reach the 20% reduction target. However, most projections from Member States do not take into account the effects of the EU climate change and energy package proposed in January 2008.

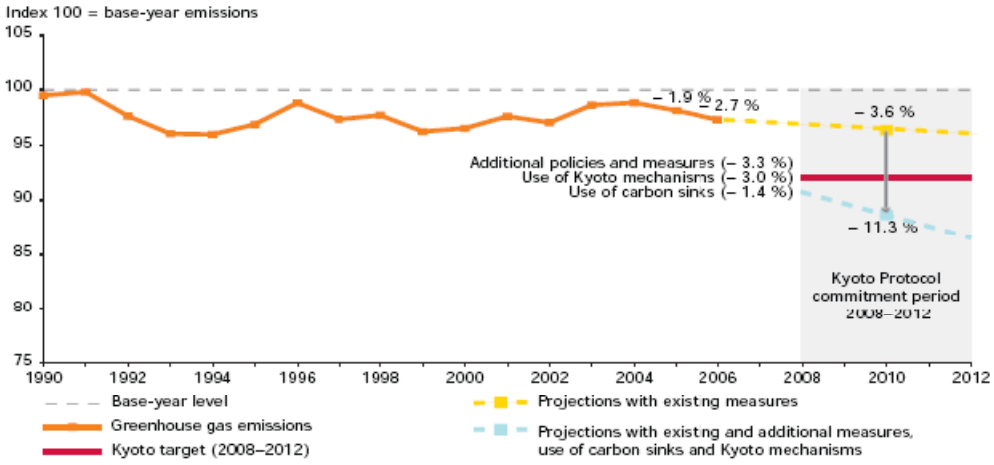

Figure 2.7 Past and projected EU-15 greenhouse gas emissions compared with Kyoto target for 2008-2012

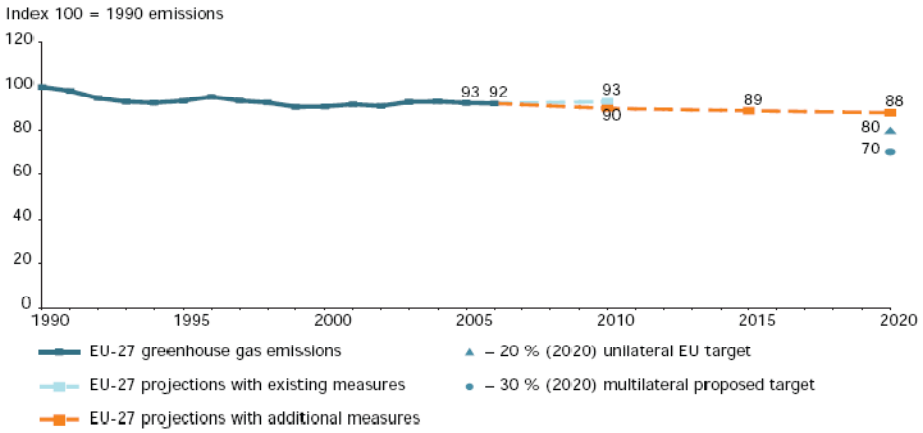

Figure 2.8 EU-27 greenhouse gas emission trends and projections to 2020

3 The contribution of transportation to GHG—Category and Trends

Definition (IPCC sector 1A3): *emissions from the combustion and evaporation of fuel for all transport activity, regardless of the sector, specified by sub-sectors as follows. This category does not include emissions from fuel sold to any air or marine vessel engaged in international transport (international bunker fuels).*

Key EU policies and measures

- Bio-fuels Directive (2003);
- ACEA agreement (1999, 2000);
- Directives on Modal Shift (2001)
- Directive on labeling of cars (1999);
- Marco Polo Programme (environmental performance of freight transport) (2003).

Trends

- Between 1990 and 2006, GHG emissions from transport (all modes of transport) increased by 26%. They increased between 2000 and 2006 by 5%.
- Between 2005 and 2006, GHG emissions from transport increased by 0.4%.

Projections

- Emissions from transport are projected to increase from 1990 levels in all EU-15 Member States except in Germany. Ireland and Portugal even project an increase of more than 200%. In the EU-15, emissions in 2010 are projected to remain at 2006 levels with the existing

measures (Figure 3.1). Emissions could be reduced to +19% above 1990 levels with the implementation of additional measures.

- Five EU-12 Member States did not report projections for transport. The Czech Republic and Romania project increase of more than 200%. Lithuania is the only Member State in the EU-12 projecting emissions in 2010 to be lower than 1990.

Policies and measures targeting GHG emission from transport

The Community strategy to reduce CO_2 emissions from passenger cars and improve fuel economy aimed at delivering an average CO_2 emission value for new passenger cars equal to 120 g CO_2/km. It was meant to help the EU meet its commitments under the Kyoto Protocol, and reduce the EU dependency on imported oil supplies. In order to meet these targets, voluntary commitments by the European, Japanese and Korean automobile manufacturers' associations (ACEA, JAMA, KAMA) were made, where the automobile industry committed itself to reach average specific CO_2 emissions of 140 g CO_2/vehicle-km for new passenger cars by 2008 (ACEA) and 2009 (JAMA/KAMA).

According to the sixth annual report on the effectiveness of the strategy to reduce CO_2 emissions from cars, all three associations reduced the average specific CO_2 emissions of their cars registered for the first time on the EU market in 2004 compared to 2003 (ACEA and JAMA by approximately 1.2% and KAMA by approximately 6.1%). Overall, average specific CO_2 emissions from new cars were equal to 163 g CO_2/vehicle-km in 2004. This was 0.6% below the 2003 level and 12.4% below 1995 levels. In order to meet the EU final target of 120 g CO_2/km, additional efforts are necessary.

Manufacturers would need to cut CO_2 by 3.3% (ACEA and KAMA) and 3.5% (JAMA) every year for the years remaining until 2008/09 in order to meet the final target of 140 g CO_2/km. It was anticipated from the beginning that the average reduction rates would be greater in the later years. However, it is noted that the gaps to be closed, expressed in required annual performance, further increased in 2004, putting into serious doubt the attainment of the targeted 140 g CO_2/km. Figure 3.2 highlights five key CCPMs in the transport sector: the Bio-fuels Directive, the ACEA agreement, the Directives on modal shift, the Directive on labeling of cars and the Marco Polo Programme aimed at improving the environmental performance of freight transport. According to Member States reports, these CCPMs are projected to reduce emissions by 69 Mt in 2010 compared to a scenario where these measures did not exist.

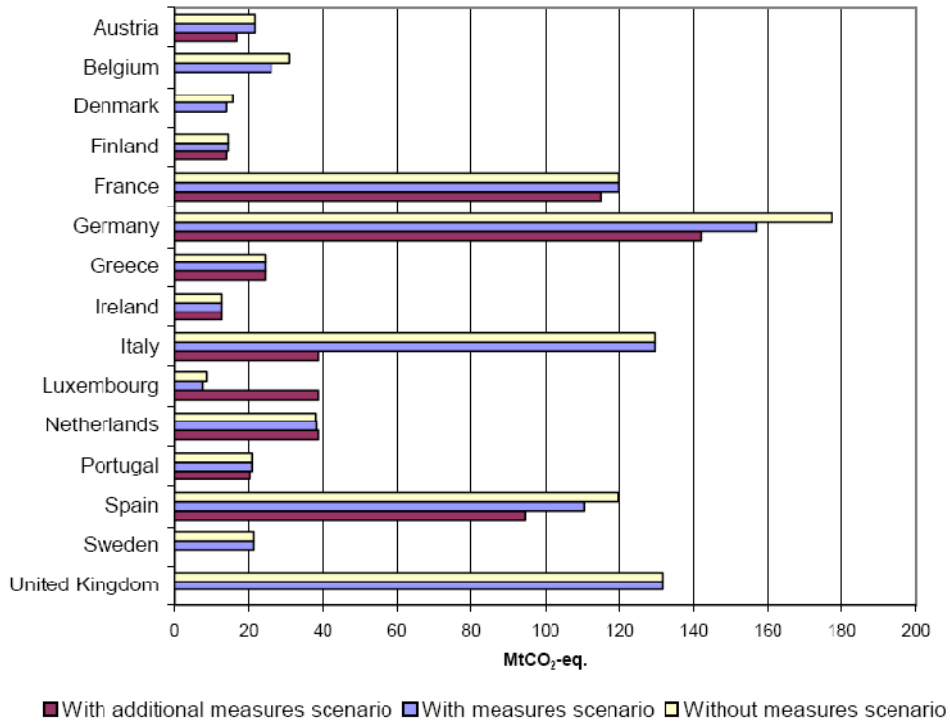

Figure 3.1 Contribution of policies and measures to emission reductions in the transport sector in 2010

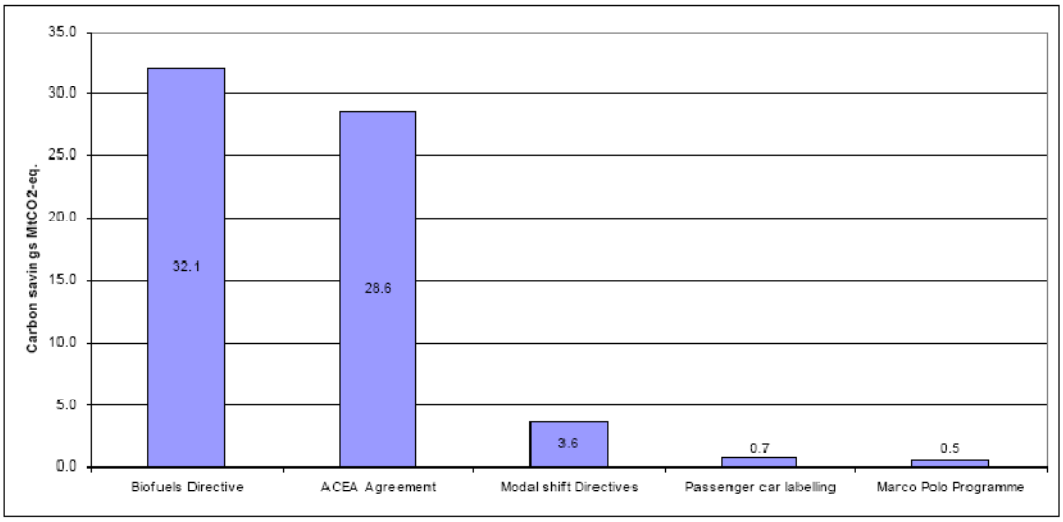

Figure 3.2 Emission reduction potential of CCPMs in the transport sector in 2010

3.1 CO_2 emissions from road transport

Definition (IPCC sector 1A3b): *all combustion and evaporative emissions arising from fuel use in road vehicles, including the use of agricultural vehicles on highways.*

- Between 1990 and 2006, CO_2 emissions from road transport increased by 25%. They increased by 4% between 2000 and 2006.
- Road transport represents 93% (in 1990 as well as in 2006) of total transport CO_2 emissions (international aviation excluded).

CO_2 emission from road transport is the second largest key category in EU-15 and contributes 19% to total GHG emissions in 2006. Final energy demand for transport, passenger kilometers in cars and CO_2 emissions show a very similar increasing trend of about 25–30%, while the increase of freight transport is much stronger, about 60% in the EU-15 (Figure 3.3).

CO_2 emissions and fuel combustion show changes in the same range, while N_2O increased by 20% or more in all Member States except Hungary. The increase in N_2O emissions is mainly due to the introduction of catalytic converters. Reductions of N_2O emissions are only reported by Estonia and Lithuania.

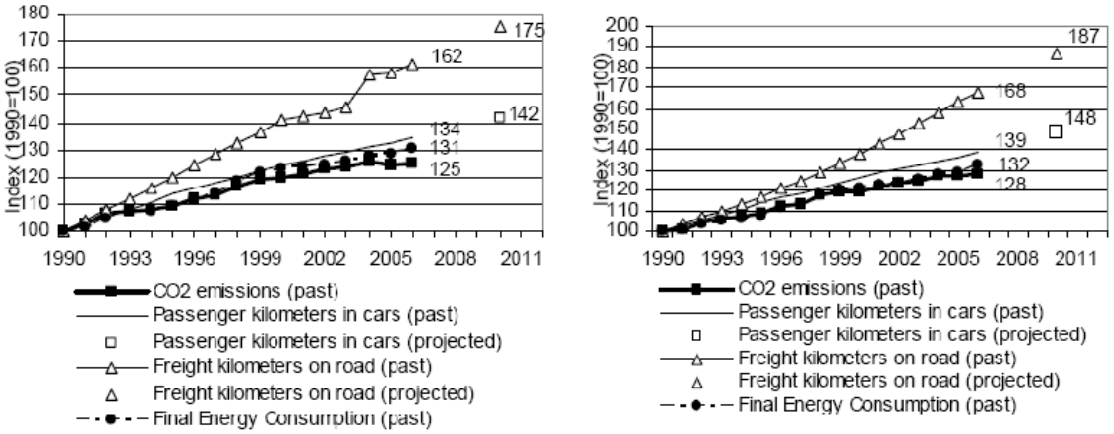

Figure 3.3 Trend of CO_2 emissions from transport and passenger and freight transport of the EU-15 (left) and the EU-27 (right)

3.2 CO_2 emissions from domestic civil aviation

Definition (IPCC sector 1A3a): *emissions from domestic air transport including all civil passenger and freight traffic inside a country (commercial, private, agricultural, etc.), including take-offs and landings for these flight stages. This category does not include emissions from fuel use at airports for ground transport, fuel for stationary combustion at airports and fuel sold to any air or marine vessel engaged in international transport (international bunker fuels).*

- Between 1990 and 2006, CO_2 emissions from domestic civil aviation increased by 56%, which represents an annual average growth of +2.8%. This was due to increased demand for air traffic, despite efficiency increases through technological improvements and operative measures.
- International aviation is not included; its contribution to GHG emissions is EU wide much higher than the domestic aviation.

CO_2 emissions from domestic civil aviation contribute 0.6% to total EU-15 greenhouse gas emissions in 2006. For EU-15, the number of air passengers increased by about 114% compared to 1990 (+4.9% annual growth) and a further increase to about 148% compared to 1990 is projected for 2010 (Figure 3.4). Compared to 2007's submission, Greece revised the time series now showing an emission increase between 1990 and 2006. This increase is also reflected in the EU-15 and the EU-27 CO_2 emissions from domestic civil aviation.

CO_2 emissions from aviation represent approximately 2.5% of global greenhouse gas emissions. The total impact of aviation on climate change is estimated to be two to five times higher than the effect of CO_2 alone, due to emissions of NO_X and cloud formation.

Emissions from international aviation are not covered by quantified emissions reduction commitment under the Kyoto Protocol, but according to the data included in national GHG inventory reports, international flights are responsible for about 80% of total fuel consumption from aviation for the EU as a whole. The share is lowest in larger countries whereas international aviation is responsible for over 95% of the emission in most small Member States with no or very little domestic flights.

Air transport is steadily increasing although the attack on the World Trade Centre in New York City in September 2001 had clear impact on international traffic and related CO_2 emissions during two years. Projections show that CO_2 emissions will further increase for domestic as well as for international transport. For the EU-15 Member States, projected increases in CO_2 emission from domestic aviation range from 144% to 309%.

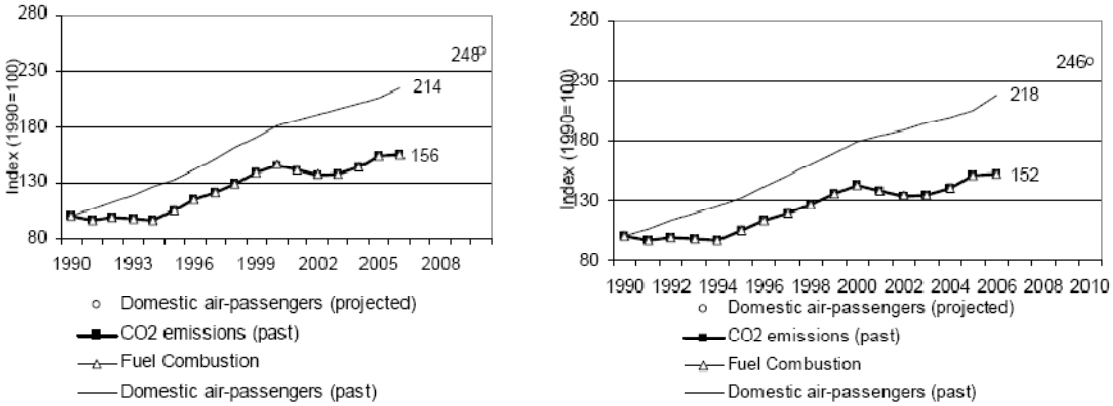

Figure 3.4 CO_2 emissions and fuel combustion from domestic civil aviation
And projected value for air passengers in the EU-15 (left) and EU-27 (right)

4 The contribution of construction to GHG—Category and Trends

4.1 Energy supply (energy industries)

Definition (IPCC sector 1A1): *emissions from fuels combusted by the fuel extraction or energy-producing industries.*

Key EU policies and measures

- Directive on the EU emission trading scheme (ETS) (2003)
- Directive on electricity production from renewable energy sources (2001)
- Cogeneration Directive (2004)
- Directive on energy taxation (2003)
- Directive on the energy performance of buildings (2002).

Trends

- Between 1990 and 2006, GHG emissions from energy industries increased by 4% in the EU-15. They increased by 7% between 2000 and 2006 in the EU-15.

Projections targeting energy supply and use

- Belgium, Denmark, Germany, Sweden and the United Kingdom are the EU-15 Member States that project that with the existing measures in place, 2010 emissions from energy supply and use will be lower than in 1990. The other EU-15 Member States project

increasing emissions compared to 1990. Austria project being below 1990 levels with the implementation of additional domestic measures.

- Except Slovenia all EU-12 Member States project decreases in GHG emissions from energy supply and use by 2010 compared to 1990 emissions, due to the reductions that took place in the 1990s.

4.1.1 CO_2 emissions from electricity and heat production

Definition (IPCC sector 1A1a): *emissions from public electricity generation, public combined heat and power generation, and public heat plants. Public utilities are defined as those undertakings whose primary activity is to supply the public. They may be in public or private ownership. This category includes emissions from own on-site use of fuel but not emissions from auto producers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity which supports their primary activity).*

- In 2006, CO_2 emissions from public electricity and heat production in the EU-15 were 7% higher than in 1990.
- A continuous decoupling between CO_2 emissions and electricity and heat production has been observed since 1990. It is mainly due to fuel switching (coal to gas) and efficiency improvements. However, there have been signs of further decoupling of emissions from production since 2003, as emissions have been relatively stable despite increasing electricity production and consumption.
- Electricity consumption and production are projected to keep strongly increasing.

4.1.2 CO_2 emissions from petroleum refining

Definition (IPCC sector 1A1b): *emissions from all combustion activities supporting the refining of petroleum products. This category does not include evaporative emissions.*

- Between 1990 and 2006, CO_2 emissions from petroleum refining increased significantly, closely following the trend of fuel combustion in this sector.
- No decoupling between emissions and activity has occurred since the fuel mix, still largely dominated by liquid fuels, did not change significantly.
- Except in Bulgaria, Czech Republic, Hungary, the Netherlands, Slovenia and the United

- Kingdom, CO emissions increased in all EU Member States.

4.1.3 CO_2 emissions from the manufacture of solid fuels and other energy industries

Definition (IPCC sector 1A1c): *combustion emissions from fuel use during the manufacture of secondary and tertiary products from solid fuels including production of charcoal. This category includes emissions from own on-site fuel use.*

- Between 1990 and 2006, CO_2 emissions from the manufacture of solid fuels and other energy industries were significantly reduced, following the trend in fuel combustion in this sector.
- The decreasing trend in CO_2 emissions stopped in 2000. Emissions have been stable since, at a level 40% below 1990 levels.
- Fuel switching from solid to gaseous fuels led to further reduction in CO_2 emissions.
- Ten EU-27 Member States show a decrease between 1990 and 2006, but emissions increased by more than 150% in Denmark and the Slovak Republic.

4.2 Energy use (excluding transport)

4.2.1 CO_2 emissions from energy use in manufacturing industries and construction

Definition (IPCC sector 1A2): *emissions from combustion of fuels in industry including combustion for the generation of electricity and heat. This category does not include emissions from the energy used for transport by industry, but include emissions arising from off-road and other mobile machinery in industry.*

Key EU policies and measures

- Cogeneration Directive (2004)

Trends

- Between 1990 and 2006, GHG emissions from energy use in manufacturing industries decreased by 12%. They decreased by 2% between 2000 and 2006.
- Energy intensity (4) in industry decreased by approximately 1.8% per year over the period 1990–2004. This was due to structural changes in favour of higher value-added products, changes in some industries to less energy-intensive processes, improvements in the energy efficiency of processes and import substitution.
- CO_2 emissions increased between 1990 and 2006 in only six EU-27 Member States.

- Data for gross value added in manufacturing industries were provided by only six EU-27 Member States. All these data show that CO_2 emissions were decoupled from gross value added.

4.2.2 CO_2 emissions from energy use and processes for iron and steel production

Definition (IPCC sector 1A2a): *emissions from combustion of fuels in the iron and steel industry including combustion for the generation of electricity and heat.*
Definition (IPCC sector 2C1): *by-product or fugitive greenhouse gas emissions from industrial processing of iron and steel products*

- EU-15 CO_2 emissions from iron and steel production decreased by 13% between 1990 and 2006 and by 2% between 2000 and 2006.
- This was mainly due the increasing share of electric processing in steel production, while the share of integrated steelworks has been decreasing.
- Emissions and gross value added have been decoupling since the late 1990s.

4.2.3 CO_2 emissions from energy use in the chemical industry

Definition (IPCC sector 1A2c): *emissions from combustion of fuels in the chemical industry (production of ammonia, nitric acid, adipic acid, carbides, etc.) including combustion for the generation of electricity and heat.*

- Between 1990 and 2006, EU-15 CO_2 emissions from chemical industry (combustion and process) decreased by 2%, but have increased recently (+3% between 2000 and 2006).
- While gross value added has been constantly increasing since 1990 (except in 2003), the amount of fuel combusted by the chemical industry and the related CO_2 emissions have decreased during the same period.
- The emission trend is closely linked to the amount of fuel combusted, which indicates that overall in the EU, this industry is reducing its energy intensity.

4.2.4 CO_2 emissions from energy use in the pulp, paper and print industry

Definition (IPCC sector 1A2d): *emissions from combustion of fuels in the pulp, paper and print industry including combustion for the generation of electricity and heat.*

- Between 1990 and 2006, CO_2 emissions from pulp, paper and print increased by 8%, but they have decreased remarkably in the EU-15 since 2003 (– 5% between 2000 and 2006).
- A shift from solid and liquid fuels to gas and biomass led to partial decoupling of CO_2 emissions from fuel combustion in the pulp, paper and print industry.

4.2.5 CO_2 emissions from energy use in the food-processing, beverages and tobacco industry

Definition (IPCC sector 1A2e): *emissions from combustion of fuels in the food-processing, beverages and tobacco industry including combustion for the generation of electricity and heat.*

- Between 1990 and 2006, CO_2 emissions increased by 6%, but they decreased by 11% between 2000 and 2006.
- A decoupling between activity in the food processing, beverages and tobacco industry and related CO_2 emissions can be observed in the EU-15 and the EU-27.

4.2.6 CO_2 emissions from energy use in other industries

Definition (IPCC sector 1A2f): *emissions from combustion of fuels in all industries other than iron, steel, non-ferrous metals, chemicals, pulp, paper, print, food processing, beverage and tobacco and other than agriculture, forestry and fisheries.*

- In the EU-15, CO_2 emissions and fuel combustion from this source category have been relatively stable since 1998. Some decoupling between emissions and combustion can be observed since 2000.

4.2.7 CO_2 emissions from energy use in agriculture, forestry, fisheries

Definition (IPCC sector 1A4c): *emissions from fuel combustion in agriculture, forestry, or domestic inland, coastal and deep-sea fishing. This includes traction vehicles, pump fuel use, grain drying, horticultural greenhouses and other agriculture, forestry or fishing related fuel use.*

- Between 1990 and 2006, EU-15 CO_2 emissions from energy use in agriculture, forestry and fisheries decreased by 11%, due to decreasing fuel use.

4.2.8 CO_2 emissions from energy use in services

Definition (IPCC sector 1A4a): *emission from fuel combustion in commercial and institutional buildings.*

- Between 1990 and 2006, CO_2 emissions from energy use in services in the EU-15 decreased by 1%.
- In all Member States that reported increasing emissions except Slovenia, emissions increased less than fuel combustion, which indicates that fuel switching has occurred.

4.2.9 CO_2 emissions from energy use in households

Definition (IPCC sector 1A4b): *all emissions from fuel combustion in households.*

Key EU policies and measures

- Directive on the energy performance of buildings (2002)
- Appliances labelling schemes (several Directives 1996–2003)
- Schemes for energy efficiency standards

Trends

- Between 1990 and 2006, CO_2 emissions from energy use in households have remained relatively stable, with an overall change of –1%.
- Short-term variations of CO_2 emission from households are closely linked to climatic conditions, reflected in the annual variations of heating degree days. Long-term trends show a decoupling between emissions and the number of households.

4.3 Industrial processes

Definition (IPCC sector 2): *by-product or fugitive emissions of greenhouse gases from industrial processes. Emissions from fuel combustion in industry are reported under the source category Energy.*

Trends

- Between 1990 and 2006, greenhouse gas emissions from industrial processes decreased by 12%. They remained stable between 2000 and 2006.

Projections

- Emissions from industrial process in the EU-15 are projected to remain at constant level with existing measures. Belgium, Germany, the Netherlands and the United Kingdom project that greenhouse gas emissions from industrial processes in 2010 will be lower than 1990 emissions with existing measures.
- Seven EU-12 Member States (Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Poland and Romania) project decreases in GHG emissions from industrial processes compared to 1990 emissions. Estonia even projects a 73% decrease by 2010 with existing measures.
- Austria, Finland, Germany, Italy and Spain defined additional measures, whereas the other EU-15 Member States only provide projections for already existing measures. The highest relative reductions are projected the United Kingdom.

4.3.1 CO_2 emissions from cement production

- Between 1990 and 2006, EU-15 CO2 emissions from cement production increased by 6%. Between 2000 and 2006 EU-15 emissions increased by 4%.

4.2.2 N_2O emissions from nitric acid production

- Between 1990 and 2006, N_2O emissions from nitric acid production decreased by 24%. Between 2000 and 2006 emissions decreased by 18%.

4.2.3 HFC emissions from refrigeration and air conditioning equipment

- Between 1990 and 2006, HFC emissions from refrigeration and air conditioning equipment increased from almost zero to almost 38 Mt CO_2-eq. in EU-15. Between 2000 and 2006 EU-15 emissions increased by 123%.

4.4 Agriculture

Trends

- Between 1990 and 2006, GHG emissions from agriculture decreased by 11%. The decrease was –7% between 2000 and 2006.

Projections

- With the existing measures, EU-15 emissions from agriculture are projected to decrease from current levels to 13% below 1990 levels. Portugal and Spain project that their greenhouse gas emissions from agriculture in 2010 will be higher than in 1990.
- All EU-12 Member States except Cyprus project decreases in greenhouse gas emissions from agriculture compared to 1990 emissions.
- Only Austria, Italy, Portugal and Spain defined additional measures, whereas the other EU-15 Member States only provide projections for already existing measures. The highest relative reductions with all measures considered (more than 20%) are projected by Austria, Denmark, Finland, Germany, the Netherlands and the United Kingdom.

4.4.1 CH_4 emissions from enteric fermentation

- Between 1990 and 2006, CH_4 emissions from enteric fermentation decreased by 11%. Between 2000 and 2006 emissions decreased by 5%.

4.4.2 N_2O emissions from agricultural soils

- Between 1990 and 2006, EU-15 N_2O emissions from agricultural soils decreased by 15%. Between 2000 and 2006 emissions decreased by 10%.

4.5 Waste

Trends

- Between 1990 and 2006, greenhouse gas emissions from sector waste decreased by 39%. Between 2000 and 2006 they decreased by 23%.

Projections

- Emissions from waste sector are projected to decrease more than in any other sector by 2010
- (–44% with existing measures). Only Ireland, Portugal and Spain project that their greenhouse gas emissions from waste in 2010 will be higher than in 1990.
- Only three EU-12 Member States (Bulgaria, Cyprus and Lithuania) project decreases in greenhouse gas emissions from waste compared to 1990 emissions.
- Only Austria and Spain defined additional measures, whereas the other EU-15 Member States only provide projections for already existing measures. The highest reductions (more than 50%) are projected by Belgium, Germany, the Netherlands, Sweden and the United Kingdom.

5 Research project funded under the 7th Research Program

The EU has complementary policies in place to support research, innovation and entrepreneurship in Europe's regions and Member States. Providing the basis of excellent research and innovation in Europe is the precondition for maintaining the EU model of sustainable development. Cohesion policy can help all regions to build up research and innovation capacity, to stimulate and support innovations in the social area, and to exchange good practice through trans-national and inter-regional co-operation.

The *7th Framework Program for Research and Technological Development* (FP7) is the European Union's main instrument for funding research in Europe between 2007 and 2013. The program has a total budget of over € 50 billion. This represents a substantial increase compared with the previous Framework Program FP6 (41% at 2004 prices, 63% at 2007 prices), a reflection of the high priority of research in Europe.

This money is (for the most part) spent on grants to research actors all over Europe and beyond, in order to co-finance research, technological development and demonstration projects. Grants are determined on the basis of calls for proposals and a peer review process, which are highly competitive.

Projects which are related to Greenhouse Gas Emission issues are listed in Table 5.1, with the comparison of their duration, start and end date, project cost and project funding. These greenhouse gas emission related projects are mainly focus on transport policy issues, land-use topics, and clean fuel and energy. Each project is described briefly as follows. All the information reported is from http://cordis.europa.eu/.

Table 5.1 Comparison of GHG related projects and their funding situations

Project name	Project code	Duration (months)	Start date	End date	Project cost (million euro)	Project funding (million euro)	Funding ratio	Cost per year (million euro)
Reducing greenhouse-gas emissions of transport beyond 2020: linking R&D, transport policies and reduction targets	GHG-TRANSPORD	24	2009-10-1	2011-9-30	1.42	0.94	66.20%	0.71
Reducing emissions from deforestation and degradation through alternative landuses in rainforests of the Tropics	REDD-ALERT	36	2009-5-1	2012-4-30	4.52	3.49	77.21%	1.51
Technology Opportunities and Strategies towards Climate-friendly trAnsport	TOSCA	18	2009-8-1	2011-1-31	0.743	0.743	100.00%	0.50
Carbon aware travel choices in the climate-friendly world of tomorrow	CATCH	30	2009-8-1	2012-1-31	1.94	1.48	76.29%	0.78
Thermal systems integration for fuel economy	TIFFE	42	2009-6-1	2012-11-30	3.62	2.04	56.35%	1.03
Development of a clean and energy self-sustained building in the vision of integrating H2 economy with renewable energy sources	H2SUSBUILD	48	2008-10-1	2012-9-30	9.92	6.7	67.54%	2.48
High effiency biodiesel plant with minimum ghg emissions for improved fame production from various raw materials	ECODIESEL	48	2008-1-1	2011-12-31	8.99	4.97	55.28%	2.25
Application of biofuel by-products to the soil: implications for carbon sequestration and GHG Emissions	BEST	24	2008-11-1	2010-10-31	0.16	0.16	100.00%	0.08

- *Reducing greenhouse-gas emissions of transport beyond 2020: linking R&D, transport policies and reduction targets (GHG-TRANSPORD)*

The existing GHG reduction targets do not force reductions of the transport sector, though for specific modes like air transport the planned inclusion into the European emissions trading scheme (EU-ETS) will indirectly impose targets for these modes in a few years. Thus it is obvious that in the future (1) the transport sector will have to contribute to GHG emission reductions such that (2) reduction targets for the different transport modes have to be anticipated and (3) aligned R&D strategies and transport policies have to be developed to efficiently and effectively meet these reduction targets for the medium to long-term.

The GhG-TransPoRD proposal aims to contribute to the development of a R&D strategy for the EU to reduce the GHG emissions of the different transport modes (road, rail, air and shipping) linking this R&D strategy with the available policy measures.

- *Reducing emissions from deforestation and degradation through alternative land-uses in rainforests of the Tropics (REDD-ALERT)*

The overall goal of the project is to contribute to the development and evaluation of mechanisms and the institutions needed at multiple levels for changing stakeholder behavior to slow tropical deforestation rates and hence reduce GHG emissions. This will be achieved through enhancing our understanding of the social, cultural, economic and ecological drivers of forest transition in selected case study areas in Southeast Asia, Africa and South America.

This understanding will facilitate the identification and assessment of viable policy options addressing the drivers of deforestation and their consistency with policy approaches on avoided deforestation, such as Reduced Emissions from Deforestation and degradation (REDD), currently being discussed in UNFCCC and other relevant international fora.

At the same time, ways of improving the spatial quantification of land use change and the associated changes in GHG fluxes will be developed, thereby improving the accounting of GHG emissions resulting from land use change in tropical forest margins and peatlands. This will allow the analysis of scenarios of the local impacts of potential international climate change policies on GHG emission reductions, land use, and livelihoods in selected case study areas, the results of

which will be used to develop new negotiation support tools for use with stakeholders at international, national and local scales to explore a basket of options for incorporating REDD into post-2012 climate agreements.

The project will provide a unique link between international policy-makers and stakeholders on the ground who will be required to change their behavior regarding deforestation, thereby contributing to well-informed policy-making at the international level.

- *Technology Opportunities and Strategies towards Climate-friendly trAnsport (TOSCA)*

The project presented here assesses the technical feasibility, economic affordability, and social acceptability of technology policies that would lead toward a lower climate-impact transport system within the EU under different scenario conditions. The project is organized around three major workshops, which include important stakeholders from academia, industry, government, NGOs, and key participants from relevant existing and former EU projects. In order to enable informed and focused discussions at each workshop, participants are provided with supporting studies well before each workshop.

The workshops and supporting studies cover:
(1) a techno-economic assessment of major transport modes (automobiles, buses, trucks, aircraft and railways) and of alternative transportation fuels for reducing GHG emissions;
(2) an integration of these technologies in scenarios of European transportation futures; and
(3) an estimate of the penetration of future low-GHG emission technologies and fuels for promising policies under the different scenario conditions, along with an assessment of the societal implications of these policies.

- *Carbon aware travel choices in the climate-friendly world of tomorrow (CATCH)*

The CATCH Project aims to develop a knowledge platform which will become a public information system for mobility related greenhouse gas (GHG) emissions reduction advice. The holistic Platform will provide travelers, businesses, planners and other mobility stakeholders with the tools to play their part in creating a new mobility culture promoting timely and informed climate-friendly travel choice and policies. The Platform will enable travelers to understand the

climate change impacts of their choices, and take effective actions to reduce them, and enable policy decision makers to include carbon constraints into their actions.

The Platform will include a range of CATCH tools, including a virtual environmental travel assistant, and be driven by the CATCH mobility knowledge engine. The main project activities to achieve this aim are:

- Strong user understanding and user-based design;
- Review of the results in previous research, and engagement with existing EU funded projects WISETRIP and i-Travel projects, and the CIVITAS initiative;
- Realization of a database of GHG and transportation performance, which interfaces with appropriate emissions-related systems;
- Identification and assessment of climate-friendly travel scenarios;
- Development, testing and validation of the mobility knowledge engine;
- Defined exploitation path and wide dissemination of results through a dedicated internet web site, publications, conferences and workshops.

CATCH will involve 40 cities and global carbon constraint professionals from mobility and related fields. Each city and professional has different experiences and brings new understanding. CATCH s expected results meet the following work program objectives:

- To guarantee at least neutral impacts on climate change
- To cover the critical gaps in existing emission information systems
- To apply large scale demonstrations of integrated solutions for cities in Europe, regional and interregional mobility.

- *Thermal systems integration for fuel economy (TIFFE)*

The project is devoted to the development of an innovative Integrated Vehicle Thermal System based on the integration of vehicle thermal systems to improve the on board thermal management and the energy efficiency.

The major project contents are:

- Dual loop air conditioning: one loop to transfer the cooling power and one loop to reject the heat;

- Two-levels temperature heat rejection system: one temperature to reject the high temperature heat (e,g. engine waste heat) and one temperature to cool locally the vehicle auxiliary systems;
- Innovative heat exchangers: new generation of compact fluid-to fluid heat exchangers and application of innovative technologies for fluid-to-air heat rejection;
- Use of innovative coolants (e.g. Nano-fluids): to improve the heat rejection and redesign the heat exchangers TIFFE benefits can be summarized in a Cost Reduction (due to resize of the systems and their integration) and Fuel Economy increase of 15% on real use thanks to the: improvement of the aerodynamics due the new front end design and increase of auxiliary systems efficiency thanks to the local cooling;
- Engine overall efficiency thanks to a fine control of heat exchange, local cooling (turbo-charge, fuel, ...) and improvement of the engine intake
- The reduction of engine re-starts on Hybrid or Stop and Start vehicle due to cabin thermal comfort: the dual loop air conditioning with a designed thermal inertia guarantees thermal comfort when the thermal engine is off;
- Compact Refrigeration Unit compliant with Low GWP refrigerants R744 or flammables (e.g. R152a, R1234yf) Two prototypes will be realized and validated:
- A gasoline passenger car with Stop and Start function;
- A diesel Light Commercial Vehicle with hybrid power train Both will undergo to a complete series of road and climatic chamber tests and a long range road test;
- To verify the reliability and effectiveness of the system and to promote its exploitation.

- *Development of a clean and energy self-sustained building in the vision of integrating H2 economy with renewable energy sources (H2SUSBUILD)*

More than 40% of the total energy consumed in the EU is used to cover the needs for heating, cooling and electricity of buildings. As the major part of this energy is produced from combustion of oil and natural gas, both the EU and the EU Building Sector are highly depended on imported fossil fuels. Moreover, the Sector is also a major contributor to Green-House Gas (GHG) emissions. To address issues concerning EU security of energy supply, EU contribution to climate change and in line with the Kyoto protocol and ongoing discussions in the European and International community, the EC has set the objectives of 30% reduction of its GHG emissions by 2020 and 20% increase of the share of renewable energy.

The Building Sector, as a major industrial sector, has to significantly contribute to the realization of these objectives. Thus, the trend for the Building Sector is to move from fossil fuels based energy production to the use of renewable energy sources (RES) and clean fuels to produce the required energy to cover the building energy needs. However, in order to ensure continuous operation of energy systems based on RES it is necessary to find a proper way to balance the intermittent nature of RES.

- *High effiency biodiesel plant with minimum ghg emissions for improved fame production from various raw materials (ECODIESEL)*

The project will demonstrate a 200.000 t/year capacity flexible FAME production plant, starting from different kinds of raw material oils, with the aim of reducing 40% of the CO_2 balance compared to the well to wheel emissions of a conventional fossil diesel plant, through the following measures: to develop an integrated transesterification process, linked to the neighboring crushing process through pipeline connections for raw material and energy steam supply to the process, and creating a whole pipeline system for transport of all raw materials and final products, thus critically reducing transport costs and emissions, and boosting drastically the environmental performance of the plant in order to obtain higher energy and CO_2 balances from the production process to develop a Sustainability Due Diligence Model for Jatropha oil production, well above the current state of the art, able to be applied to the production of this biodiesel crop outside and inside the EU.

- *Application of biofuel by-products to the soil: implications for carbon sequestration and GHG Emissions (BEST)*

Biofuel production is considered a promising strategy for reducing the net emissions of CO_2 into the atmosphere and decreasing dependence on fossil fuels. Hence interest in energy production from renewable biomass is increasing worldwide. However, biofuel production also implies a decrease in the return of carbon (C) rich crop residues to the soil, which is replaced with nitrogen (N) rich by-products of biofuel production (BBPs).

This may profoundly affect the greenhouse gas (GHG) balance of the soil, both through a decrease in the soil organic carbon content (CO_2 emission), and through an increase in N_2O emission from mineralized N. However, no scientific data is available to quantify this effect.

Research on the effects of biofuel production on the GHG balance of the soil is therefore needed to complete the life cycle analysis (LCA) of biofuel production. The aim of this proposal is to quantify the effect of BBPs applied to the soil on GHG emissions and related N and C dynamics in the soil.

6 Conclusion

Greenhouse gas emissions in the EU-27 account for approximately 10.5% of global anthropogenic greenhouse gas emissions. The largest greenhouse gas emitting activities in the EU-27 are the production of electricity and heat, road transportation, fossil fuel combustion from households, agriculture, and iron and steel production. Carbon dioxide (CO_2) emissions account for 83% of total greenhouse gas emissions, while methane (CH_4) and nitrous oxide (N_2O) each represent approximately 8% of total emissions. Between 1990 and 2006, greenhouse gas emissions decreased by 7.7% in the EU-27 and by 2.2% in the EU-15.

The European Climate Change Program (ECCP), launched in 2000, provides a cohesive framework to identify and develop all the necessary elements of an EU strategy to implement the Kyoto Protocol. In addition to domestic measures, Member States are allowed to make use of the flexible mechanisms defined by Kyoto Protocol (Kyoto mechanisms) in order to achieve the targets. Under this program, Member States can contribute to and/or benefit from emission reductions taking place abroad.

Based on information provided by 22 Member States, 57% of the policies and measures implemented at national level to reduce greenhouse gas emissions were introduced in response to EU policies (CCPMs) and 24% more have been reinforced by them. With the existing measures in place, EU-27 greenhouse gas emissions are projected to increase by 1% between 2006 and 2010. With the implementation of additional measures, EU-27 emissions are projected to decrease continuously between 2006 and 2020.

This report mainly uses the information provided by European Environment Agency (EEA). EEA is an agency which provides sound, independent information on the environment. EEA's mandate is to help the Community and member countries make informed decisions about improving the environment, integrating environmental considerations into economic policies and moving towards sustainability. EEA coordinates the European environment information and observation network; EEA is a major information source for developing, adopting, implementing and evaluating environmental policy. Currently, the EEA has 32 member countries.

Reference

EEA (2008), *Greenhouse gas emission trends and projections in Europe 2008*
EEA (2009), *Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009*