EUROPEAN
COMMISSION

Brussels, 10.1.2014
SWD(2014) 2 final

PART 1/2

COMMISSION STAFF WORKING DOCUMENT

Part 1 EU 6th National Communication

Accompanying the document

Commission Communication

SIXTH NATIONAL COMMUNICATION AND FIRST BIENNIAL REPORT FROM THE EUROPEAN UNION UNDER THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

{C(2014) 3 final}
{SWD(2014) 1 final}

TABLE OF CONTENTS

Part 1 EU 6th National Communication

Accompanying the document

Commission Communication

SIXTH NATIONAL COMMUNICATION AND FIRST BIENNIAL REPORT FROM THE EUROPEAN UNION UNDER THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

1. INTRODUCTION

This document represents the European Union's (EU) 6th National Communication (NC) required under the United Nations Framework Convention on Climate Change (UNFCCC), as reaffirmed by UNFCCC decision 9/CP.16 and UNFCCC decision 2/CP.17. It provides a comprehensive overview of climate change-related activity at the EU level.

As defined in the UNFCCC reporting guidelines for National Communications[1], the information is structured into:

- National circumstances relevant to greenhouse gas emissions and removals (section 2),
- Greenhouse gas inventory information (section 3),
- Policies and measures (section 4),
- Projections and the total effects of policies and measures (section 5),
- Vulnerability assessment, climate change impacts and adaptation measures (section 6),
- Financial resources and transfer of technology (section **Error! Reference source not found.**),
- Research and systemic observation (section **Error! Reference source not found.**) and
- Education, training and public awareness (section **Error! Reference source not found.**)

UNFCCC decision 2/CP.17 also requires the EU to submit its 1st Biennial Report (BR) by 1st January 2014. The UNFCCC reporting guidelines for National Communications content-wise overlap with the UNFCCC biennial reporting guidelines for developed country Parties (Annex I of decision 2/CP.17).

As endorsed in UNFCCC decision 2/CP.17, the EU has opted to submit its 1st Biennial Report as Annex 1 to this 6th National Communication. The tables as defined in the common tabular format (CTF) for the UNFCCC biennial reporting guidelines for developed country Parties (UNFCCC decision 19/CP.18) are enclosed as Appendix: CTF for EU 1st Biennial Report of Annex 1: EU 1st Biennial Report. For the CTF submission to the UNFCCC, the electronic reporting facility provided by the UNFCCC secretariat has been used as required by UNFCCC decision 19/CP.18.

1 FCCC/CP/1999/7 part II, in combination with UNFCCC decision 15/CMP.1

In order to avoid unnecessary duplication of information, overlapping contents were concentrated in the 1st Biennial Report: Those sections of the 6th National Communication's main body which content-wise would be identical to sections of the 1st Biennial report, do thus solely contain a reference to the corresponding section of Annex 1 (1st Biennial Report) and/or the CTF Appendix to Annex 1. To facilitate user-friendliness, whenever a reference is made to chapters in the Biennial Report text, these are clearly marked with [BR1] before the relevant chapter number in the Biennial Report.

The 28 Member States of the European Union submit separate NCs to the UNFCCC. However, in the EU's submission the chapters on greenhouse gas inventory information (see section 3) and projections (see section 5) reflect the sum of information compiled across the Member States.

A summary table outlining the location of supplementary information required under Article 7, paragraph 2, of the Kyoto Protocol within this National Communication is provided in the appendix to this document.

2. NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

Key developments

Population

- Croatia joined the European Union as 28th Member State on 1 July 2013. The EU-28 population has continued to grow, at around 0.3 % per annum, a similar trend to the NC5.

Economy

- EU-28 real GDP was 45 % higher in 2011 compared to 1990 although growth rates declined significantly in 2008-2011. Economic growth was mainly driven by growth in the service sector and in international trade. In 2009 the EU-28 faced a severe economic crisis in the aftermath of the financial crisis in 2008.

- The economic crisis was characterised by declines in international trade, industrial production, gross inland energy consumption, transport volumes and GHG emissions, to name but a few indicators. However, after the economic downturn in 2009, the European Union saw economic growth in 2010 and 2011 and many of these indicators increased again (although at a lower pace).

Energy

- Total gross inland and final energy consumption grew over the period from 1990-2006 (around 0.5 % per annum), and declined thereafter. In 2011 gross inland energy consumption was 3 % above the value of 1990.

- The economic trend in recent years is mirrored in the strong decline of energy consumption in 2009 and an increase in 2010; the decrease of energy consumption in 2011 is mainly due to milder winter conditions in that year.

- The trend reported in the NC5 of a shift in the primary fuel mix from coal to gas has slowed down in recent years. However, since 2000 a shift from oil to renewables can be observed.

- The rate of growth in renewables (driven largely by wind and biomass) has increased from 2002 onwards. The share of renewables in gross inland energy consumption increased from 6 % in 1990 to 13 % in 2011.

Transport

- Both freight and passenger transport grew strongly since 1995 up until the economic crisis in 2008. Freight transport showed a strong decline in 2008 and 2009, followed by a slow recovery in 2010, whereas passenger transport remained relatively stable.

Agriculture and forestry

- In 2009, agricultural use and forestry use accounted for 43 % and 30 % respectively of the land used in the EU.

- Overall the area of land under agricultural use decreased by approximately 3 % since 2000 whereas the forested area increased by 3 %.

2.1. Introduction

This chapter documents the national circumstances of the European Union. It illustrates a number of key characteristics that relate directly or indirectly to the greenhouse gas emissions and include energy, transport, land use, climatic conditions and trade patterns. The chapter analyses how these various factors have influenced greenhouse gas emissions to-date and how the historic trends observed might influence emissions going forward.

Data is reported as the aggregate of the Member States which comprise the European Union (EU), both the EU-15 and EU-28 (where data is available), as the former has a collective emissions reduction target under the Kyoto Protocol. Information is also reported at the Member State level where appropriate. In some cases, data was not available for Croatia, and EU-27 figures were considered instead.

The 5th National Communication focused primarily on the period from 1990 to 2007. This communication extends the analysis to the most recent years for which data is available (generally 2008 to 2011); changes in trends since 2007 are highlighted, where relevant.

This chapter includes the following improvements compared to the NC5:

- more detail on legislative arrangements and administrative procedures;
- a new map showing the population density in the EU-28;
- improved presentation of the distribution of land cover and land use types;
- more information on climatic conditions including annual precipitation and mean daily temperature;
- a comparison of purchasing power standards (PPS) per capita of all Member States;
- more detail on the impact of the global economic downturn;
- production data of energy intensive industries such as iron and steel and cement production;
- a time series showing the development of waste generation and treatment;
- a breakdown of types of housing;
- different types of energy sources used for space heating;
- development of the unit consumption of energy in households;
- information on fertilizer consumption and livestock in the EU;
- a comparison of the total forested area in 2000 and 2010;
- the chapter "Liberalisation and privatisation of energy markets" is no longer included.

2.2. Government Structure

The European Union's institutional system is unique in the world. The Member States, currently 28, confer competences upon the Union to attain objectives they have in common. The competences conferred upon the Union are set out in the Treaties[2], which

2 The last revision of the Treaties was signed in Lisbon and entered into force on 1 December 2009. The consolidated versions of the current Treaties can be found at: http://eur-lex.europa.eu/JOHtml.do?uri=OJ:C:2012:326:SOM:EN:HTML.

are international agreements serving as the founding core legal acts establishing the Union and regulating its relations with the Member States. Competences not conferred upon the Union in the Treaties remain with the Member States. The Treaties also create the Union's institutions, which are independent from Member State national authorities, and aim to promote the Union's values, advance its objectives, serve its interests, those of its citizens and those of the Member States, and ensure the consistency, effectiveness and continuity of its policies and actions. The Union institutions comprise:

- the European Parliament,
- the European Council,
- the Council,
- the European Commission,
- the Court of Justice of the European Union,
- the European Central Bank,
- the Court of Auditors.

The major policy-making bodies are the European Parliament, the Council and the Commission who drive the majority of policy initiatives, including on climate action.

The Members of the **European Parliament** are directly elected by citizens every five years. The European Parliament has four essential functions:

- It shares with the Council the power to legislate, i.e. to adopt European legislative acts (directives, regulations, decisions).
- It shares budgetary authority with the Council and can therefore influence EU spending.
- It has to be consulted, and in some specific instances it has to give its consent, before the conclusion of an international agreement with third countries or international organisations.
- It exercises democratic supervision over the European Commission. It elects the President of the Commission, approves the nomination of Commissioners and has the right to censure the European Commission.

The **Council of the European Union** consists of representatives of each national government at ministerial level. It is the main decision-making body and has a number of key responsibilities:

- It is the Union’s legislative body in co-decision with the European Parliament.

- It co-ordinates the broad economic policies of the Member States.

- It concludes, on behalf of the EU, international agreements with one or more third states or international organisations.

- It shares budgetary authority with the Parliament.

- It takes the decisions necessary for framing and implementing the common foreign and security policy, on the basis of general guidelines laid down by the European Council.

- It co-ordinates the activities of the Member States and adopts measures in the fields of police and judicial co-operation in criminal matters.

The **European Council** is the formation of the Heads of State or Government of the Member States, together with its President and the President of the Commission. The High Representative of the Union for Foreign Affairs and Security Policy participates in the work of the European Council. The European Council defines the general political directions and priorities of the European Union, but has no legislative powers.

The **European Commission** embodies and upholds the general interest of the Union. The President, the High Representative of the Union for Foreign Affairs and Security Policy and the other Members of the European Commission are appointed by the European Council after they have been approved by the European Parliament. In carrying out its responsibilities, the Commission is completely independent, i.e. it can neither seek nor take instructions from any government or other institution, body, office or entity. The **Commission** has the following main functions:

- It has the right to initiate draft legislation and present legislative proposals to the Parliament and the Council.

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

- It acts as guardian of the Treaties and, under the control of the Court of Justice, ensures that Union law is applied properly.

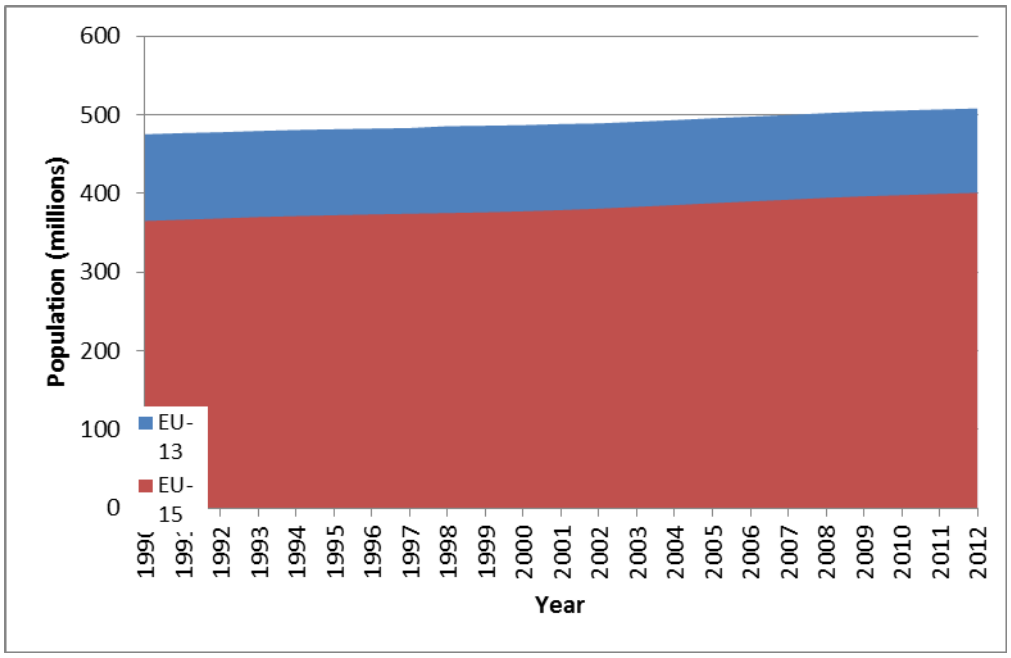
- It represents the Union on the international stage and negotiates international agreements with third countries and international organisations.

The remaining institutions cover the judiciary (Court of Justice), the central monetary authority (European Central Bank) and the external audit authority, responsible for carrying out the audit of EU finances (European Court of Auditors).

2.3. Population profile

While population growth is generally considered a driver for greenhouse gas emissions and for increasing energy consumption, the population trends in the EU do not seem to have played a major role in emission trends since 1990. Over the last 22 years the EU-28's population has increased by an average of 0.3 % annually. The total population increase in 2012 compared to 1990 was 6.9 %. In 2012, the EU-28 population amounted to 508 million people. A similar trend is observed in the EU-15 countries, with an annual average increase of around 0.4 % over the same period. The trend has not changed significantly since the publication of NC5. Trends in per capita primary energy consumption are shown in section 2.7.

Figure **Error! No text of specified style in document.**-1 Aggregate EU - 28 population 1990-2012

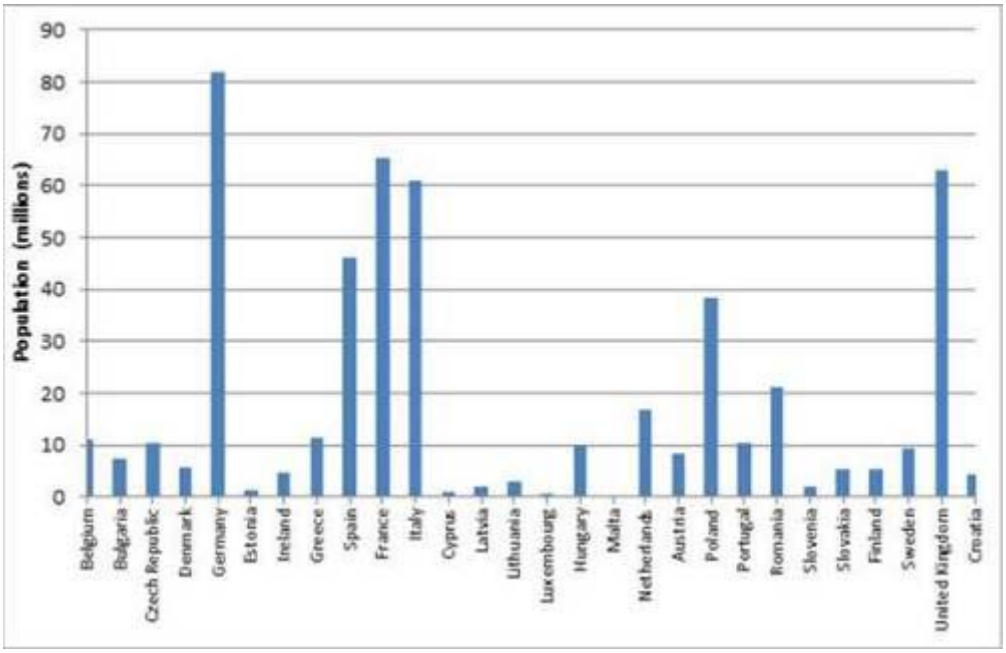


Source: Eurostat and INSEE

Note: Population on January 1st of each year. Data for population in French overseas territories in 1990 is based on data from the French statistical office INSEE.

The populations of Member States vary considerably, from 0.4 million for Malta to 81.1 million for Germany.

Figure **Error! No text of specified style in document.**-2 EU Member States populations, 2012



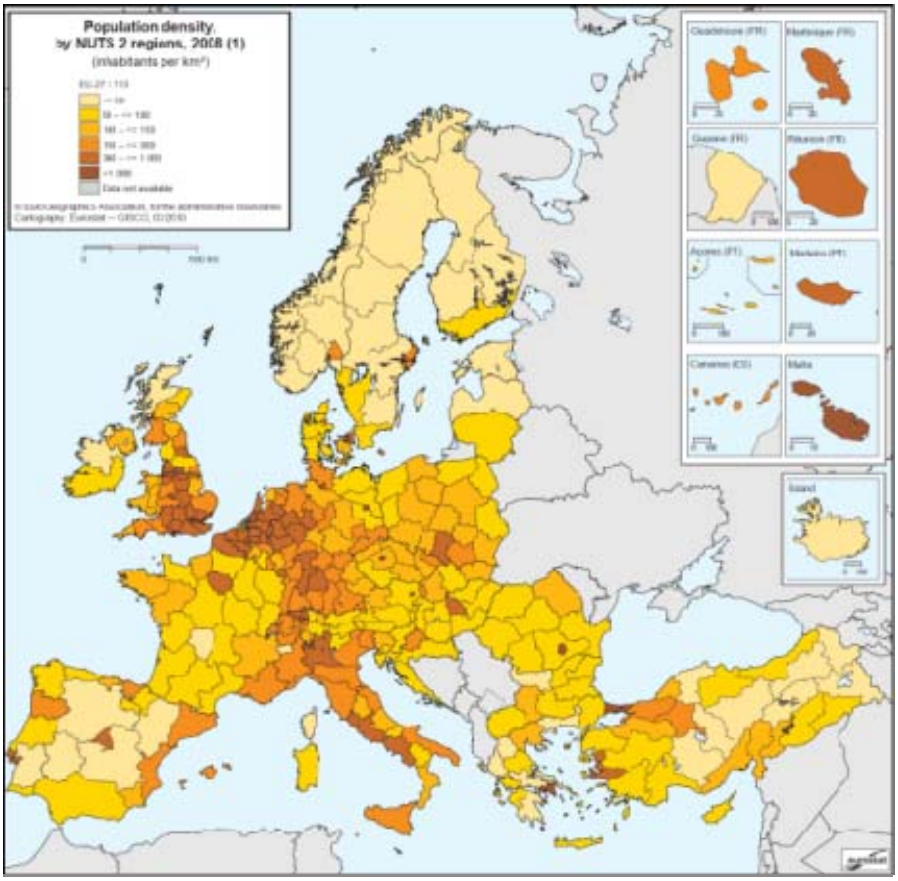
Source: Eurostat , INSEE

Note: Population on January 1st of each year. Data for population in French overseas territories in 1990 is based on data from the French statistical office INSEE.

In addition, population density varies between 17.7 inhabitants/km² in Finland and 1318.6 inhabitants/km² in Malta. The five states with the highest population density are Malta, the Netherlands, Belgium, the United Kingdom and Germany, with population densities of over 200 inhabitants/km².

Most EU Member States have relatively high population densities when compared to other Parties to the UN Convention. As higher population densities have implications on settlement and building patterns, this leads to changes in energy consumption and a tendency for shorter transport distances. However, shorter transport distances may facilitate economic integration among communities and regions, resulting in a tendency for higher transport intensity. In this respect, population density can have both a positive and negative impact on greenhouse gas emissions.

Figure **Error! No text of specified style in document.**-3 Population density of the EU-28 and selected neighbouring countries.



Source: Eurostat CISCO (2010)

Note: NUTS (Nomenclature of territorial units for statistics) regions on level 2 are basic regions for the application of regional policies, typically based on existing administrative divisions of Member States, with populations between 800 000 and 3 million people. Population density is based on the total area of the regions, including inland waters. Croatia and Scotland (UK), the density is based on land surface, excluding waters. The illustration also includes the non-EU countries Switzerland and Norway, FYR of Macedonia and Turkey.

2.4. Geographic profile

The European Union is situated primarily in Europe, with the exception of some French, Danish and British overseas territories. It spans a total area of 4 423 147 square kilometres, with a large coastline, which is 136 106 km long[3]. The EU topography is therefore diverse, including mountains, lakes, rivers, forests and plains. The EU is also

3 Eurostat, "Key figures for coastal regions and sea areas", Statistics in focus, 2009. http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-09-047/EN/KS-SF-09-047-EN.PDF. Accessed on: 24.07.2013.

highly urbanised, with 41 % of the population living in urban regions, 35 % in intermediate regions and 23 % in rural regions[4].

The distribution of land cover types varies widely across the EU. The most frequent land cover types in the EU are woodland, cropland and grassland. Forests cover 41.2% of the EU surface. The most forested country is Sweden with a forest area of 75.6 %, whilst the least forested country is Malta where forests represent only 5.1 % of the total area. In general, northern and alpine regions tend to have larger proportions of woodland.

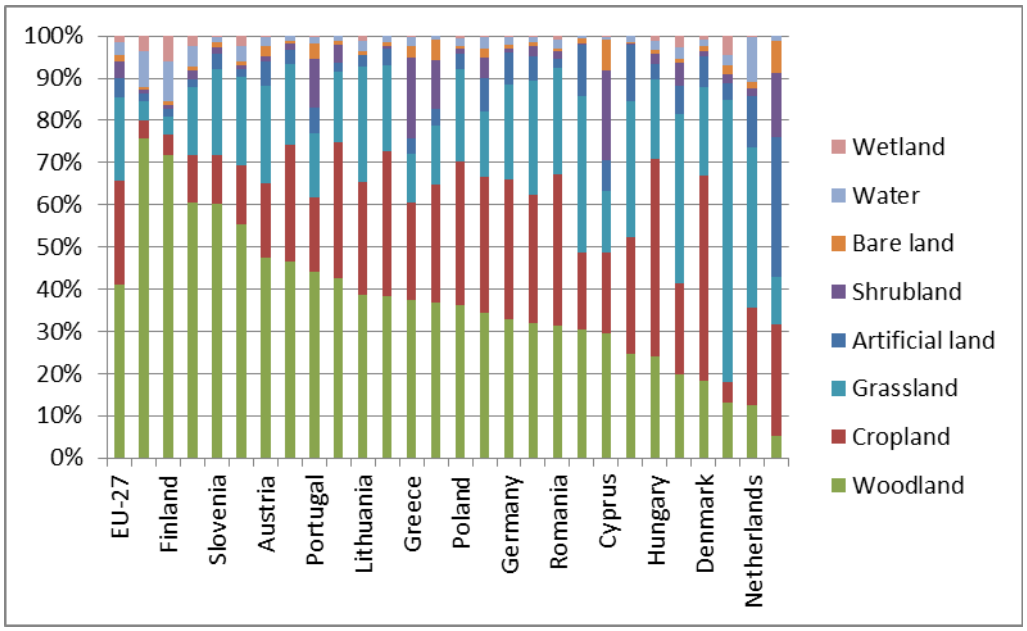
Concerning cropland, 24.7 % of the total EU area is covered by arable land or permanent crops. In Denmark and Hungary, more than 45 % of the country area is covered by cropland. The lowest proportion of cropland cover was recorded in Finland, Ireland and Sweden (less than 5 %).

Grasslands (including natural and agricultural grasslands) are the dominant land cover in Ireland (67.1 %), the United Kingdom (40.1 %) and the Netherlands (38.0 %). The EU average of grasslands amounts to 19.5%. Other land use types are shrubland, artificial land, water, bare land and wetland which contribute to 15.2 % of the total EU land cover.[5]

4 Eurostat, "Urban-intermediate-rural regions", News release, 30 March 2012, http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/1-30032012-BP/EN/1-30032012-BP-EN.PDF. Accessed on: 24.07.2013.

5 LUCAS 2012, Land cover overview, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lan_lcv_ovw&lang=en. Accessed on: 28.11.2013.

Figure **Error! No text of specified style in document.**-4 Main land cover by land cover type, 2012 (% of total area)



Source: Eurostat LUCAS

Note: No data available for Croatia.

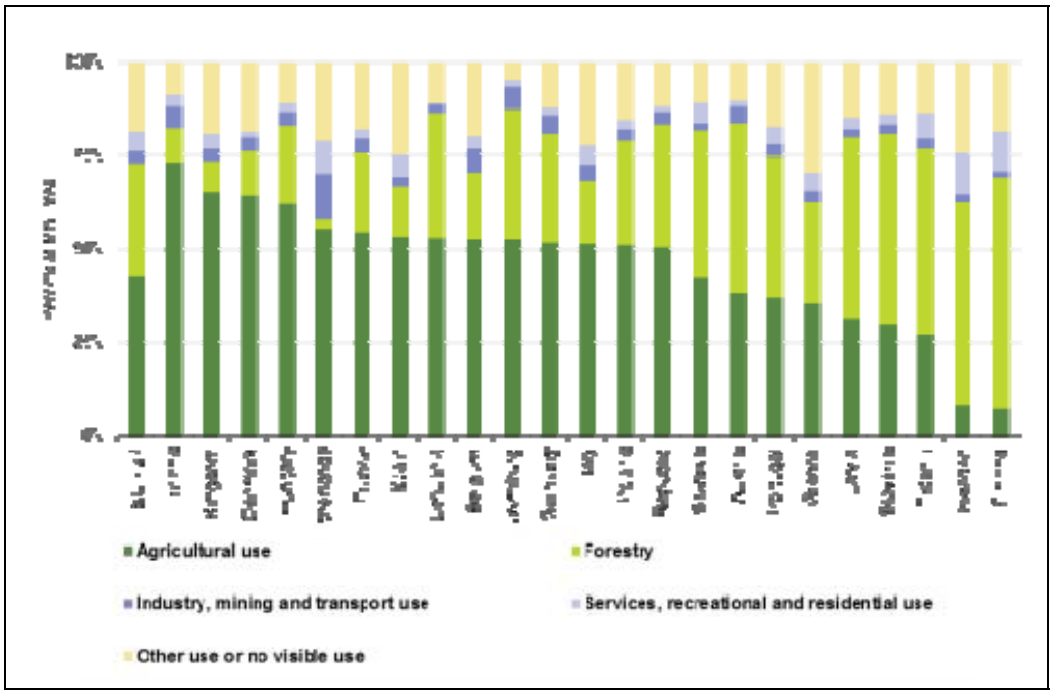
As a consequence, the highest proportion of agricultural land use was reported in Ireland, the United Kingdom, Denmark and Hungary (more than 60 % of total area). On the other hand, forestry is the predominant land use type in Finland, Sweden and Slovenia (more than 50 % of total area).

The EU-wide share of land use types is distributed as follows: 43 % agricultural use, 30 % forestry, 5 % services, recreational and residential use, 2.4 % industry, mining and transport use and 18.8 other or no visible use.[6]

Agriculture generates significant greenhouse gas emissions, this is discussed in more detail in section 2.12. Forest and other wooded areas however can be important carbon sinks (see section 2.13 for further details). Changes in land use will be driven to some extent via policy actions in the agricultural sector (see section 4.8), particularly the Common Agricultural Policy as well as those in the forestry sector (see section 4.9).

6 Eurostat, "Land cover, land use and landscape", Statistics Explained, data from September 2011, http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Land_cover,_land_use_and_landscape, accessed on: 08.07.2013

Figure **Error! No text of specified style in document.**-5 Primary land use by land use type, 2012 (% of total area)



Source: Eurostat LUCAS

Note: No data available for Bulgaria, Malta, Romania, Cyprus and Croatia.

2.5. Climate profile

The European Union covers climate zones ranging from dry summer sub-tropical in the Mediterranean over hemiboreal and boreal in the northeast to temperate maritime conditions along the Atlantic coast and the British Isles. High elevation patches of tundra climate can be found as well. The climate profile of a country can have strong impacts on its needs for heating during cold seasons or cooling during hot seasons, which triggers higher energy consumption and greenhouse gas emissions.

EU Member States close to the Atlantic Ocean or the North Sea generally experience relatively low temperature variations, both between summer and winter and between day and night. Figure Error! **No text of specified style in document.**-6 gives an overview of daily temperature variations. The northern Atlantic coast also experiences high rainfall (Figure Error! **No text of specified style in document.**-7). Scandinavian countries (i.e. Denmark, Finland and Sweden) tend to have mild summers and cold winters.

Figure **Error! No text of specified style in document.**-6 Mean of daily temperature range in the EU (1961-2010)

Source: E-OBS dataset from the EU-FP6 project ENSEMBLES[7] and the data providers in the European Climate Assessment and Dataset project[8].
Note: Each dot represents a measuring station.

The Mediterranean area tends to have higher temperature variations over the whole year. Generally this area has a hot, dry summer climate and mild, often rainy winters, although there are differences between regions. In the alpine region in central Europe annual precipitation is higher and temperatures are mild. The central European States have mild winters and mild summers, with more continental climatic conditions further east.

7 http://ensembles-eu.metoffice.com

8 http://www.ecad.eu

Figure **Error! No text of specified style in document.**-7 Annual precipitation sum in the EU (1961-2010)

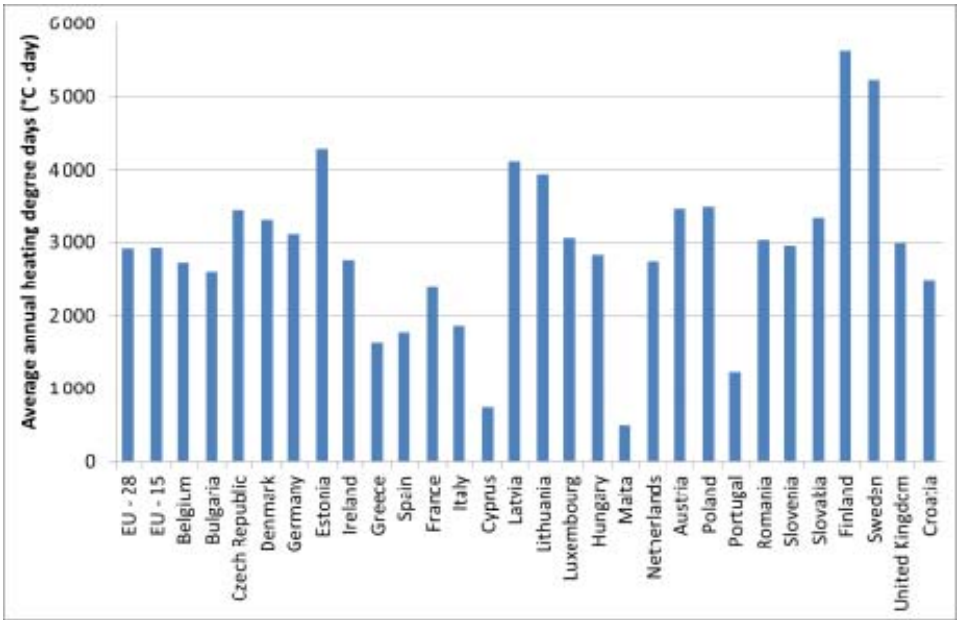
Source: E-OBS dataset from the EU-FP6 project ENSEMBLES[9] and the data providers in the European Climate Assessment and Dataset project[10].
Note: Each dot represents a measuring station.

The energy requirements and emissions in both winter months (for space heating) and summer months (for air conditioning) vary according to the temperature. The figure below shows the average annual number of heating degree days in each Member State. Requirements for space heating are particularly high in the northern and eastern Member States, whilst in summer months, southern and eastern countries will often experience average temperatures of more than 25 degrees Celsius. Tracking of cooling degree days will also become of increasing importance, particularly given the electricity demand for space cooling. In some countries, such as Greece, peak electricity demand tends to occur in summer months whereas for the majority of Member States it still occurs only during the winter period.

9 http://ensembles-eu.metoffice.com

10 http://www.ecad.eu

Figure ***Error! No text of specified style in document.****-8* Energy demand for heating, expressed as average annual heating degree days by Member State (1990-2009).



Source: Eurostat

Note: Heating degree-days are a measure of the demand for energy needed to heat a building in a certain climate. Eurostat uses the following method for the calculation of heating degree days: (18 °C - Tm) · d if Tm is lower than or equal to 15 °C (heating threshold) and are nil if Tm is greater than 15 °C where Tm is the mean (Tmin + Tmax / 2) outdoor temperature over a period of d days.

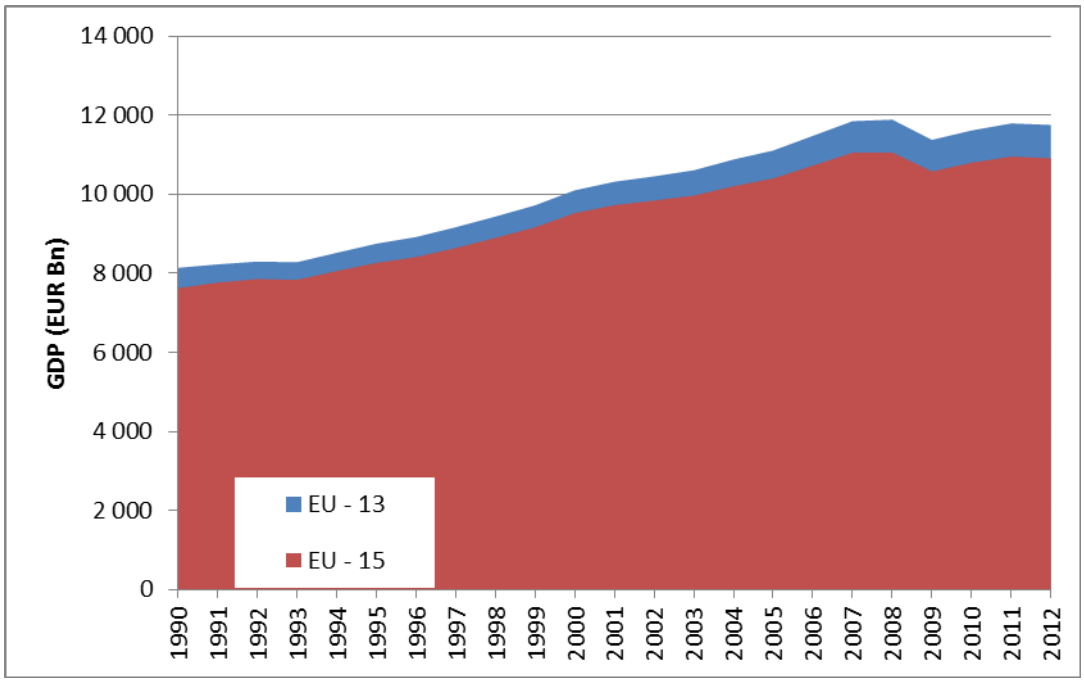
2.6. Economic profile

The economic profile of a country has a strong link to greenhouse gas emissions, with the overall level and types of economic activity strongly correlated to energy consumption. Greenhouse gas emissions also depend on factors such as energy efficiency and the structure of the economy. Trends in key economic factors are discussed below with the overall impact on energy intensity discussed in section 2.7.

2.6.1. Changes in overall Gross Domestic Product (GDP)

For the EU-28, GDP has increased by 44 % (in volume terms) from 1990 to 2012. When looking only at the EU-15 states, GDP has roughly followed the same pattern as the wider EU-28 with an overall increase in GDP of 43 %. The EU-15 countries account for around 92.7 % of all EU GDP.

Figure ***Error! No text of specified style in document.****-9* Development of GDP 1995-2012



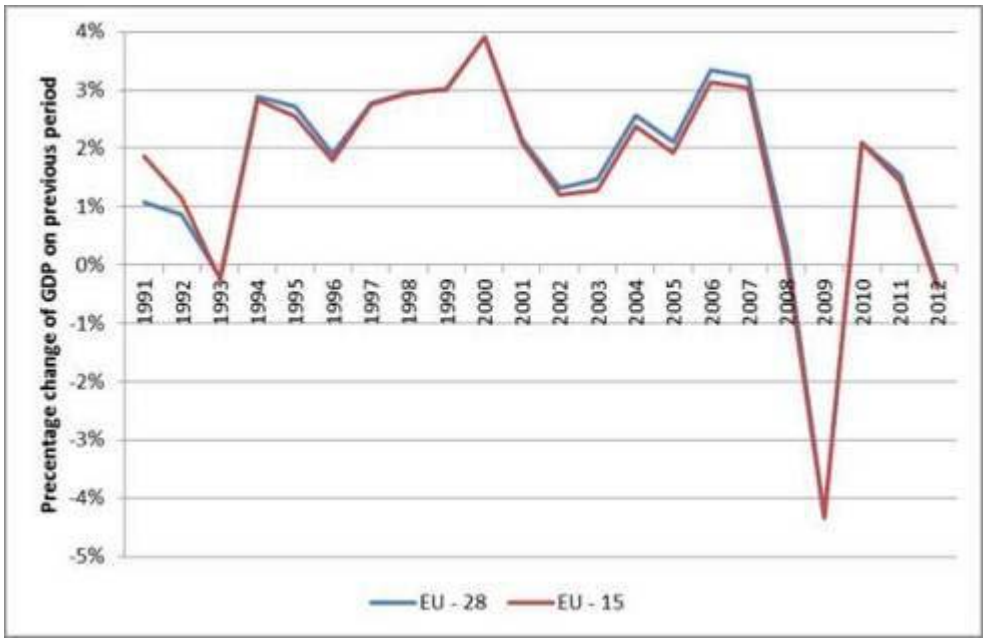
Source: Eurostat, European Commission, EEA

Note: GDP expressed as billions of euro, at 2005 market prices.

Economic growth in the EU slowed down in 2008 and declined in 2009 due to the global financial and economic crisis. Since 2010, the growth rate slowly increased and the GDP recovered. In 2012 positive growth rates were registered in 13 of the 28 EU Member States (average = -0.4 %), headed by Latvia (5.6 %), Estonia (3.9 %) and Lithuania (3.7 %). Nevertheless, in 2012 the Euro currency crisis in the Southern European countries contracted growth of the European economy again.[11]

11 Eurostat, National accounts – Real GDP, growth rate. ..http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tec00115&plugin=1 Accessed on:26.11.2013.

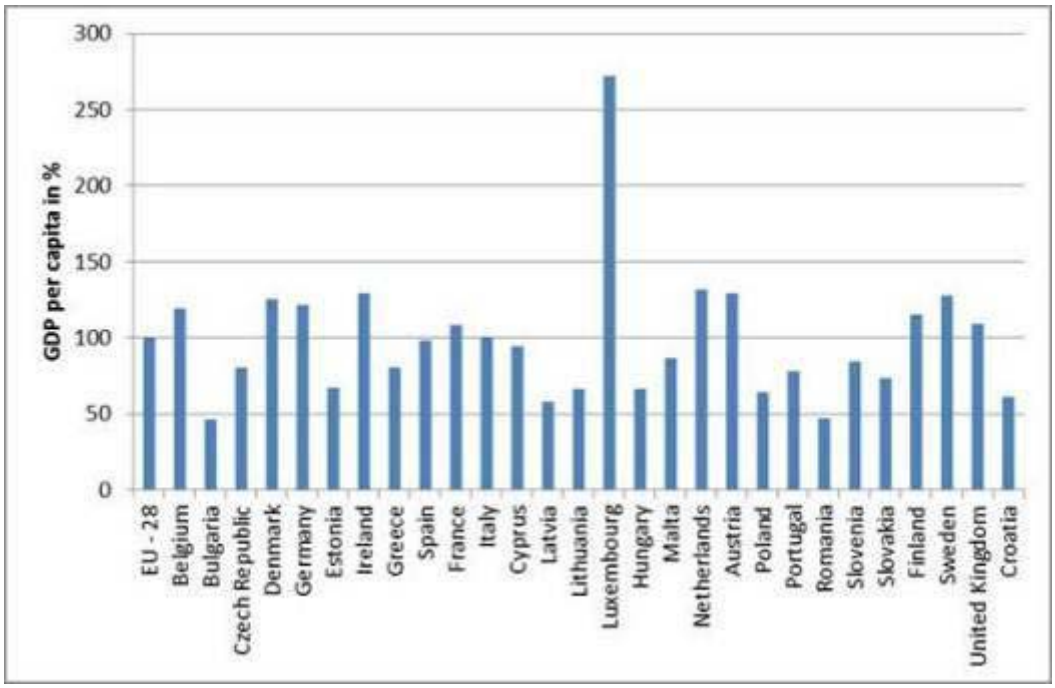
Figure ***Error! No text of specified style in document.****-10* GDP change on previous period (in %) – 1991-2012



Source: Eurostat

Figure Error! ***No text of specified style in document.****-11* shows GDP in purchasing power standards (PPS) per capita in 2011. This provides a better comparison of the potential for total consumption in each country (based on the purchasing power for a "representative" basket of goods and services). The countries' average GDP is compared relatively to the EU-28 average (set to 100). Among the EU Member States, Luxembourg is showing the highest relative value. For that country, GDP per capita in PPS is more than 2.7 times higher than the EU average which can partly be explained by the impact of cross-border workers from neighbouring countries. On the other end of the scale are Romania and Bulgaria whose GDP per capita accounts for less than 50 % of the EU average.

Figure ***Error! No text of specified style in document.****-11* Percentage of GDP per capita in relation to EU-28 average (2011)



Source: Eurostat

Note: Percentage of EU-28 total (based on PPS per inhabitant), Figure for Romania dated from 2010.

2.6.2. Development of economic sectors

Between 1995 and 2010 the Gross Value Added (GVA) increased by 73.9 % in the EU-28. Table Error! ***No text of specified style in document.****-1* shows the GVA of main economic sectors, where 73.6 % of the GVA is generated in the services sector. Services are of high importance in Malta, Cyprus, France, Greece, Belgium, Denmark and the United Kingdom where they contribute more than 75 % of the GVA.

At the same time, the share of the industry sector decreased from 23.8 % in 1995 to 18.7 % in 2010. Especially during the financial and economic crisis the industrial sector recorded heavy losses: - 13.8 % between 2007 and 2009. Construction also experienced substantial contraction; the output fell by 10.4 % between 2007 and 2010.

The breakdown of economic sectors shows that the largest contribution to the GVA originates from financial intermediation/real estate followed by public administration/community services/households. Both sectors experienced a growth of their share in overall GVA. Agriculture/fishing and construction are the smallest sectors regarding their GVA.

*Table **Error! No text of specified style in document.**-1* Gross-value added (at basic prices) of main economic sectors (NACE rev 1.1)

Unit = € billion	EU-15				EU-28			
Branch	1995	%	2010	%	1995	%	2010	%
Total - all NACE activities	6 064	100%	10 129	100%	6 324	100%	11 000	100%
Agriculture; fishing	159	2.6%	154	1.5%	181	2.9%	187	1.7%
Industry (except construction)	1 428	23.5%	1 839	18.2%	1 502	23.8%	2 062	18.7%
Construction	359	5.9%	595	5.9%	376	5.9%	658	6.0%
Wholesale and retail trade; hotels and restaurants; transport	1 263	20.8%	2 073	20.5%	1 323	20.9%	2 293	20.8%
Financial intermediation; real estate	1 501	24.7%	3 019	29.8%	1 543	24.4%	3 191	29.0%
Public administration and community services; activities of households	1 354	22.3%	2 448	24.2%	1 399	22.1%	2 611	23.7%

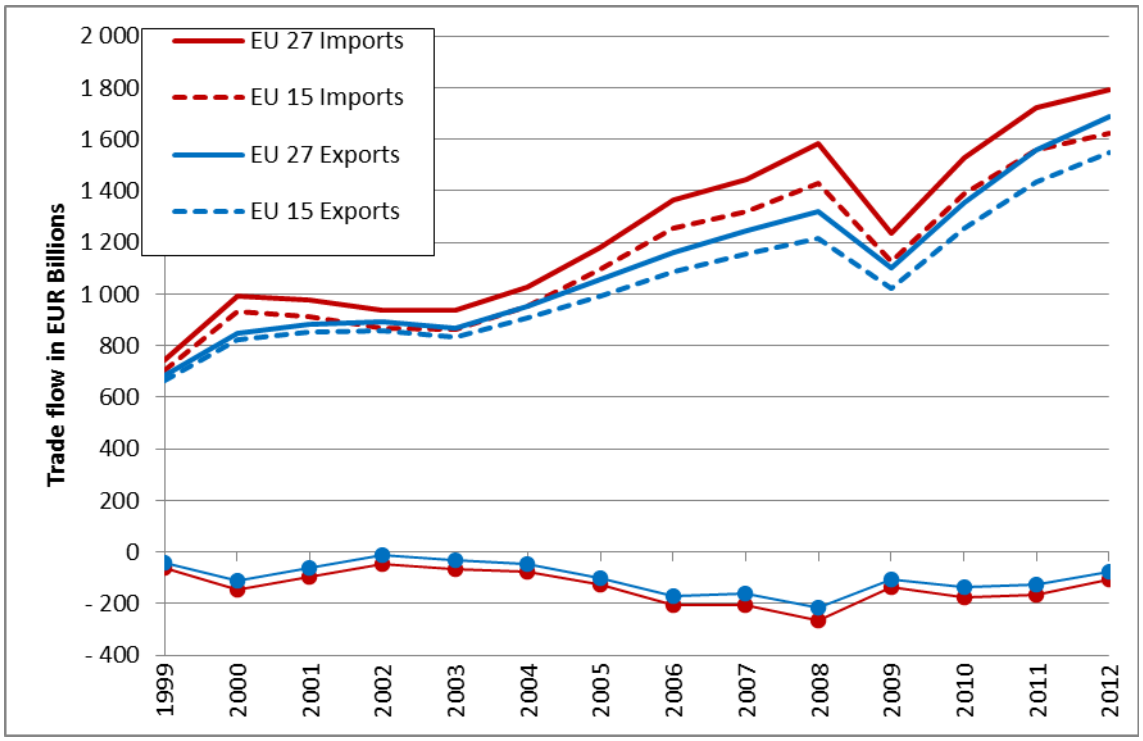
Source: Eurostat

Note: GVA expressed in billions of euro (from 1.1.1999)/Billions of ECU (up to 31.12.1998).

2.6.3. Trade patterns

Since the late 1990s, the EU has experienced a negative trade balance although the trend reversed slightly in the early part of the 2000s. The trade balance has ameliorated, compared to the 2006 – 2009 period but imports still exceed exports even though to a lower extent.

Figure ***Error! No text of specified style in document.****-12* Development of extra-EU-27 trade.

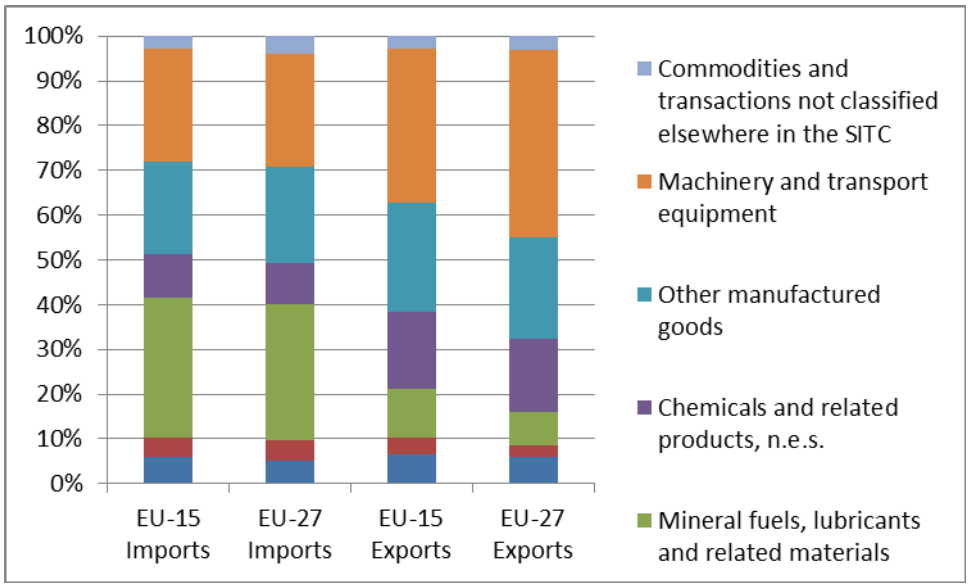


Source: Eurostat

Note: Croatia not included.

Figure Error! **No text of specified style in document.**-13 shows the percentage (as a proportion of total trade value) of extra- EU-27 trade by SITC (Standard International Trade Classification) category, for imports and separately for exports, in 2012. In comparison to the 5th National Communication, manufactured products such as machinery and transport equipment still present the largest share of EU exports but they no longer make up the highest proportion of EU imports. The leading imported product category currently is mineral fuels, lubricants and related materials.

Figure **Error! No text of specified style in document.**-13 Composition of extra-EU trade by value in 2012



Source: Eurostat

Note: Croatia not included.

With regard to GHG emissions, machinery and transport equipment as well as chemicals and related products tend to have lower emissions intensity, given the much higher value added of the products compared to energy use, mineral fuels and others, lubricants and related materials and other raw materials.

2.7. Energy profile

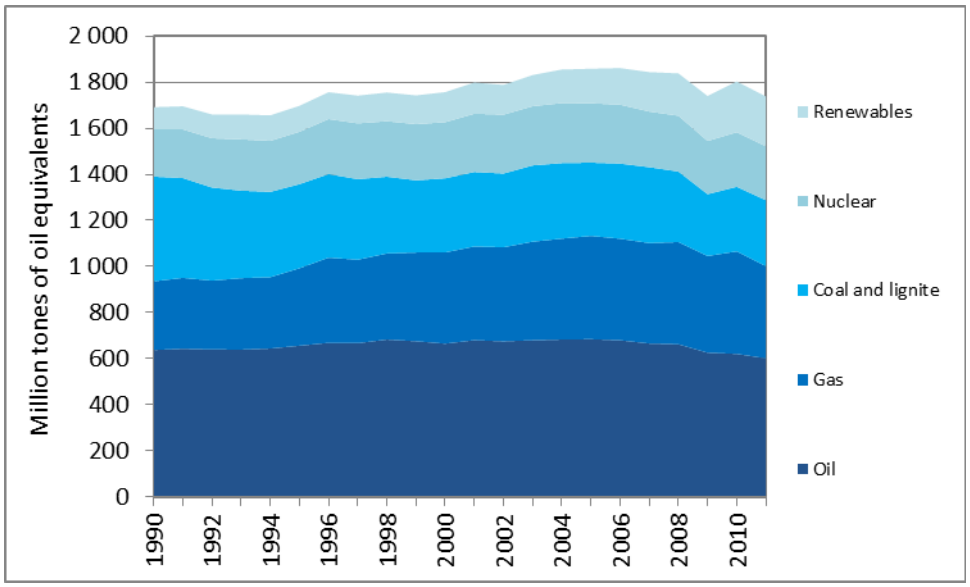
Energy use is the largest source of GHG emissions. The following sections provide a high-level overview of the most relevant factors concerning energy use in the European Union. The Eurostat Pocketbook "Energy, Transport and Environment Indicators – 2012 Edition"[12] provides more detail on the key drivers, environmental pressures and impacts from the production and consumption of energy. Climate policy drivers have had some impact on changes in the EU energy system to date (e.g. leading to improvements in energy efficiency or increases in the share of renewables), although to a large extent these have been driven by other factors (e.g. previous shift to gas as a result of price differentials). Historic trends in GHG emissions from energy-related activities are shown in section 3.2.3.

The impacts of climate policy in the energy sector (see section 4.5 for further details) are expected to be far more significant in future years than what statistics show up to now, particularly as a result of the new climate and energy package. It is expected to

12 Eurostat Pocketbook: Energy, transport and environment indicators — 2012 edition http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-DK-12-001/EN/KS-DK-12-001-EN.PDF.. Accessed on 09.09.2013

lead to more sizeable shifts in energy use towards renewables (and also gas) as well as an overall impact on primary and final energy consumption due to improvements in energy efficiency; these effects should become more noticeable within these indicators in coming years.

Figure **Error! No text of specified style in document.**-14 Gross inland energy consumption[13] by fuel for the EU-28



Source: Eurostat

Gross inland energy consumption (see section 2.7.2 for details of final energy consumption) in the EU-28 increased over the period from 1990 until 2006 despite continued efforts to improve energy efficiency; since 2006 it was decreasing. This trend was interrupted by a large increase in 2010 caused by the recovery from the economic crisis which itself had led to a significant drop of primary energy supply in 2009.

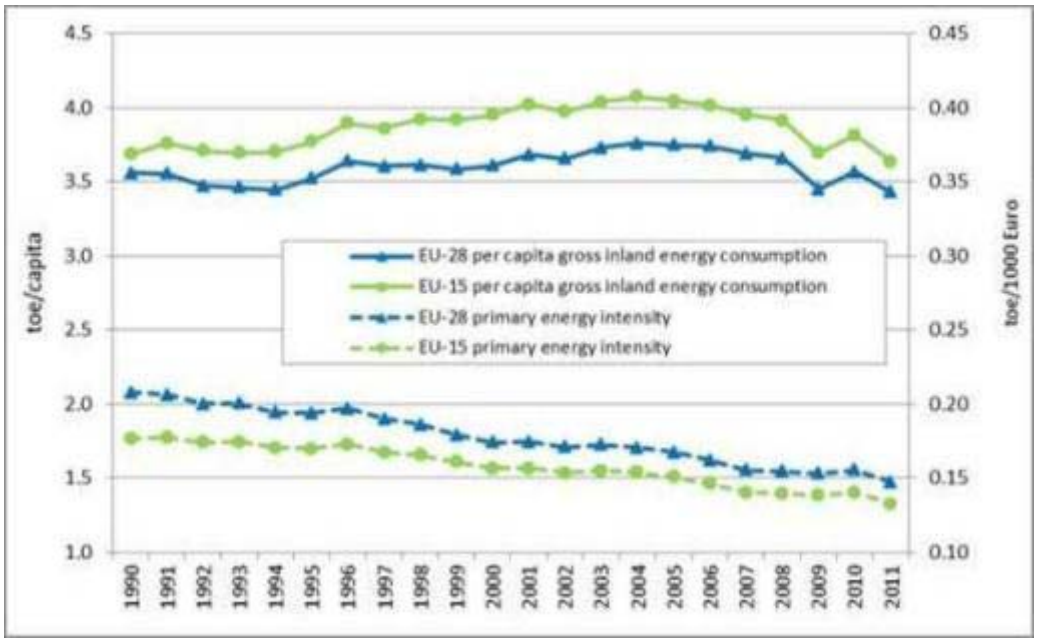
Trends in the consumption of different energy carriers within the total have changed significantly since 1990 and the trends reported in the 5th National Communication have broadly continued. Since 1990 there has been a decrease of 37 % in the consumption of carbon-intensive coal and lignite. Meanwhile there has been an increase of over 30 % in gas consumption which, in comparison to other fossil fuels, produces less greenhouse gas emissions. The consumption of oil decreased slightly by 6 % between 1990 and 2011. Consumption of energy generated from nuclear power has also increased by 14 % on 1990 levels. Renewables have seen the most marked increase with consumption increasing by over 120 % from 1990 levels.

13 Gross inland energy consumption is the total energy demand of a country or region. It represents the quantity of energy necessary to satisfy inland consumption of the geographical entity under consideration.

These increases have had a positive effect on the EU's GHG emissions as shown in section 3.2.3. Nevertheless, fossil fuels continue to dominate total energy consumption, making up 74 % of total primary energy consumption in total. The share of renewable energy sources remains small despite the increase in use (13 % gross final energy consumption).

Figure Error! ***No text of specified style in document.****-15* below shows primary energy intensity (toe/unit GDP) and per capita primary energy consumption for both the EU-15 and EU-28 Member States from 1990-2011. Since NC5, per capita energy use has continued to decrease even more strongly with a short interruption in 2010, which again demonstrates the recovery from the global economic crisis. In addition, energy intensity has decreased steadily since 2006 for both the EU-28 and EU-15, except for 2010 (see the reason mentioned above). Both these trends are having a positive impact in reducing GHG emissions. More information on the GHG emission intensity of the EU economy can be found in section 3.2.5.

Figure ***Error! No text of specified style in document.****-15* Per capita gross inland energy consumption and primary energy intensity (ratio between gross inland energy consumption and gross domestic product).

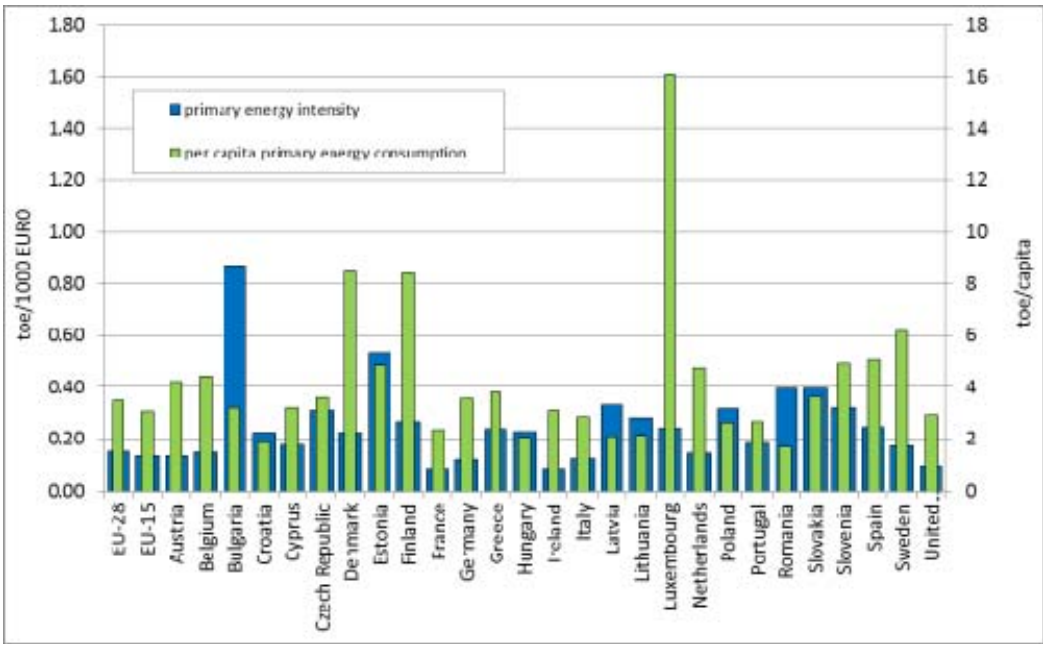


Source: Eurostat, European Commission, EEA

Note: Estimate of GDP as billions of Euro at 2005 market prices

Figure ***Error! No text of specified style in document.****-16* shows primary energy intensity (toe/unit GDP at purchasing power standards) for each Member State and for the EU-15 and EU-28 in 2011.

Figure ***Error! No text of specified style in document.****-16* Primary energy intensity and per capita consumption by Member State in 2011



Source: Eurostat

Note: Data for Malta not available

The final energy needs of the EU economy represent less than two thirds of the EU's primary energy consumption. There are very significant energy losses linked to the transformation and distribution of useful energy (e.g. as heat and electricity) to the end-users. Energy losses broadly depend on the average efficiency of conventional thermal power stations and combined heat and power (CHP) plants, the use of nuclear power for electricity production, and the penetration of non-thermal renewables.

Countries with lower energy intensity may also have an economy structured less around heavy industry and more around the service industries. In addition or alternatively, they may have a higher degree of energy efficiency (both in energy generation and end-use) throughout the economy.

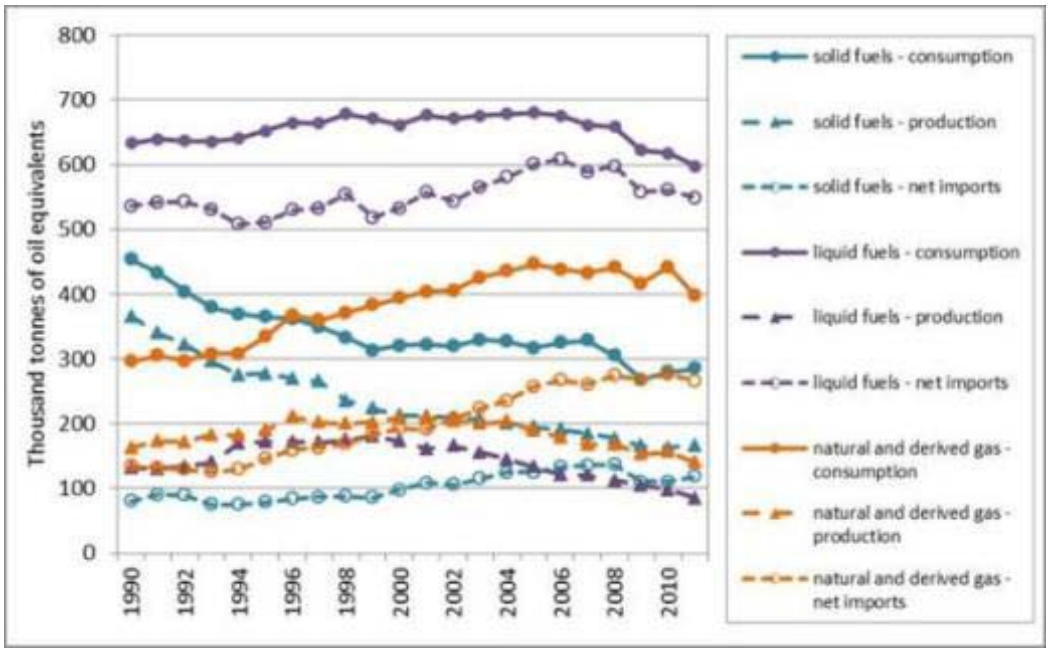
New Member States generally have higher energy intensities (e.g. Bulgaria, Estonia, Slovakia). However, five new Member States (namely Croatia, Hungary, Latvia, Lithuania, and Romania) have particularly low per capita energy consumption – less than 2.5 toe/capita – compared with the EU-28 average of 4.3 toe/capita. In the EU-15, France has the lowest per capita energy consumption (2.4 toe/capita), while it is particularly high in Luxembourg (16.1 toe/capita) due to road fuel exports.[14]

14 Purchase of road transport fuels by non-residents, which are allocated to Luxembourg's energy consumption, but consumed in other Member States.

2.7.1. Energy Supply

Figure Error! ***No text of specified style in document.****-17* shows primary production, gross inland consumption and net imports of solid fuels, oil and gas in the EU-28 as a whole from 1990 to 2011. The vast majority of oil consumed is from imports and the trend had been an upward one until 2006; since then it has been declining. Overall oil consumption has stayed relatively constant over this period, declining more significantly after 2006. In the meantime there has also been a decline in production at an average rate of 1.9% annually. The same applies to gas consumption, with imports exceeding production for the first time in 2002. Imports now make up approximately two thirds of EU gas consumption. In the case of solid fuels, overall consumption is decreasing. Although imports have risen in recent years, with a short decline in 2009, production volumes still exceed imports. If current trends continue, however, it is likely that imports will exceed production volumes in the next few years.

Figure ***Error! No text of specified style in document.****-17* Supply of fossil fuels, EU-27

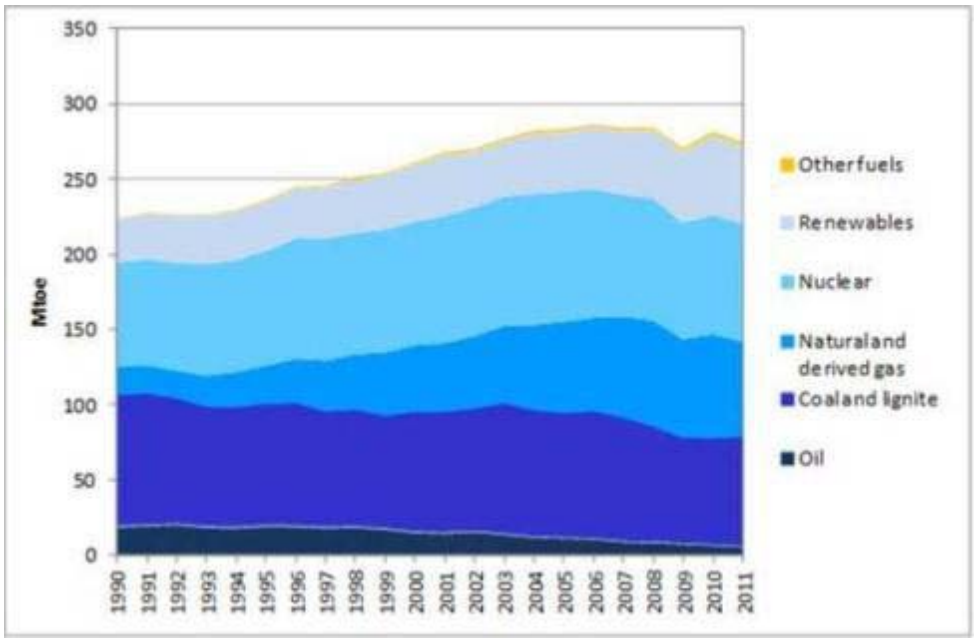


Source: Eurostat

Note: Data for Croatia not available.

In general, since the NC5, the EU-28 has seen a more rapid increase in its dependence on all imported fossil fuels (around 47 % of primary energy), which has led to growing concerns over security of supply. As in the 5th National Communication, oil still accounts for the largest share (47 %) of the EU's fossil fuel consumption. The next largest share is gas (31 %) and then solid fuels (22 % of the fossil fuels consumed in the EU).

Figure ***Error! No text of specified style in document.-18*** Gross electricity production by fuel for EU-28

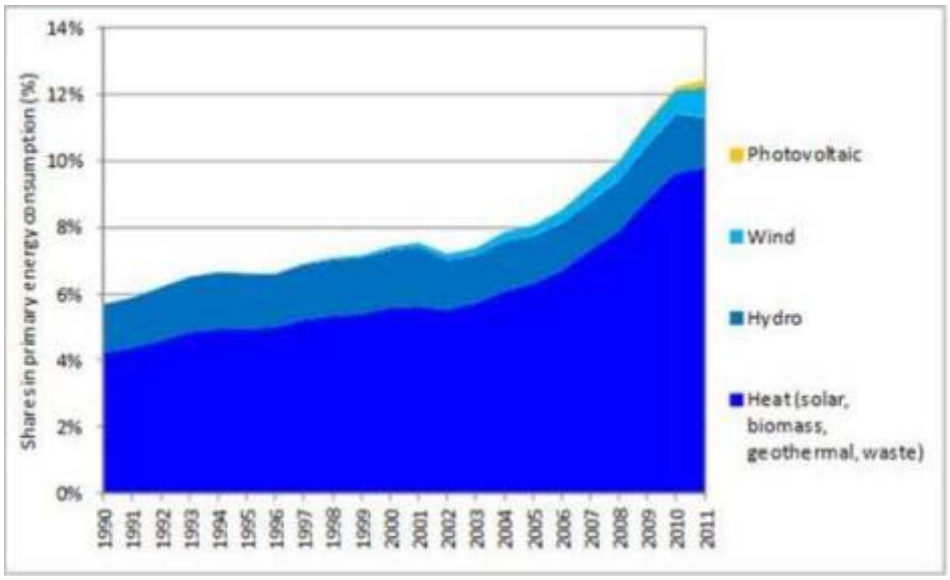


Source: Eurostat

Although the absolute amount of electricity production from renewables has increased by over 80 % since 1990, renewable electricity still makes only a 19 % contribution to total generation. The proportion produced by nuclear has remained fairly constant and in 2011 it was approximately 28 % of total electricity production. There have been large decreases in both oil and coal and lignite production; together they accounted for 29 % of total production in 2011 (down from 48 % in 1990).

Production from gas has increased from 9 % of the overall mix in 1990 to 23 % in 2011. Overall, the generation mix of electricity in the EU-28 has become less carbon intensive since the beginning of the 1990s, with the trends seen in NC4 and NC5 broadly continuing. However, the lower carbon intensity has been somewhat counterbalanced by the overall rise in total electricity production – an increase of 23 % from 1990 to 2011.

Figure ***Error! No text of specified style in document.****-19* Share of renewable energy in gross inland energy consumption, EU-28.

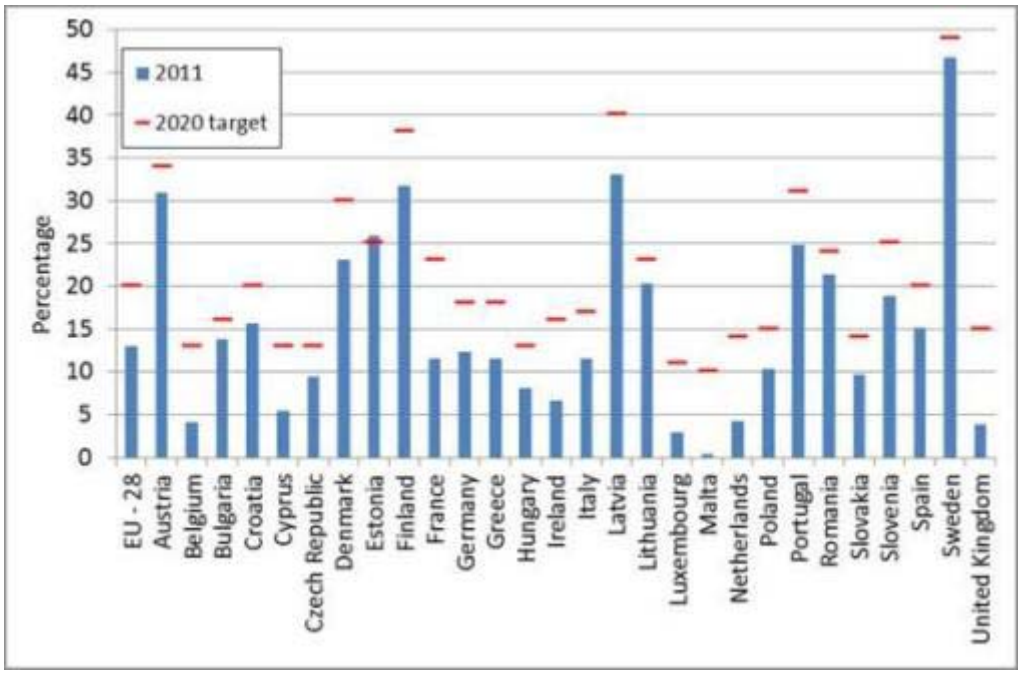


Source: Eurostat

The share of gross final energy consumption met by renewables has increased substantially over the last ten years to around 13 % in 2011. A substantial increase can be seen from renewable heat production, wind power generation and photovoltaics whereas hydro power production is relatively constant.

The bulk of renewable energy consumed, over two thirds, comes from heat (solar, biomass, geothermal and waste). Hydropower is the second biggest contributor, providing about 12 % of total renewable energy in 2011; however hydropower's relative contribution to overall renewables has decreased significantly (from about 26 % in 1990). Wind power has seen the largest increase - from less than 0.1 % in 1990 to contributing around 7 % of total renewable energy in 2011. During the last years, renewable energy from photovoltaic recorded the largest relative increase, of over 1000 %, from 324 toe in 2007 to 3 867 toe in 2011.

Figure ***Error! No text of specified style in document.-20*** Share of renewable energy in gross final energy consumption in 2011



Source: Eurostat

Note: Gross final energy consumption is defined in Directive 2009/28/EC on the promotion of the use of energy from renewable sources as "the energy commodities delivered for energy purposes to industry, transport, households, services including public services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission".

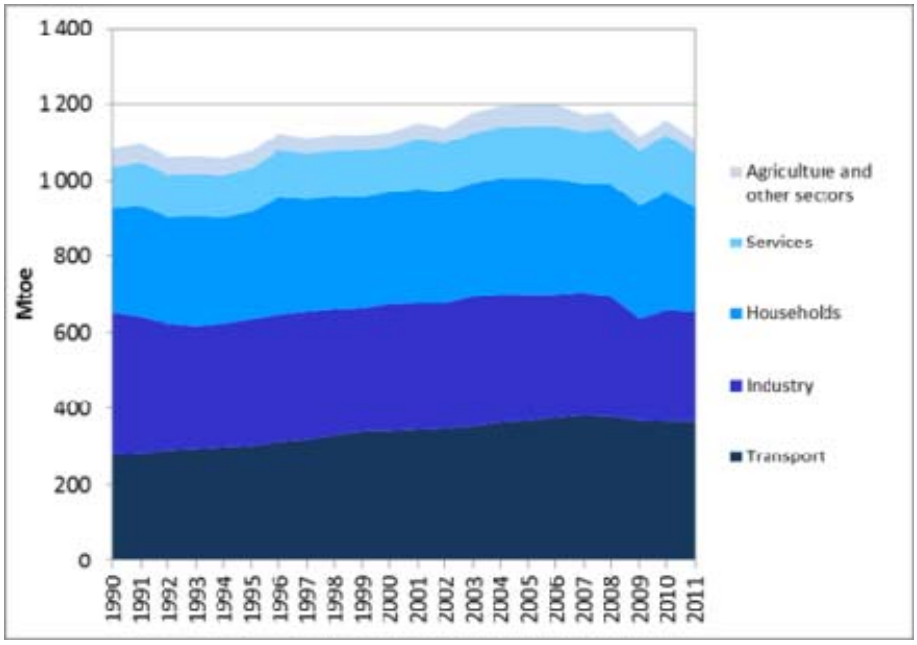
Based on 2011 figures all EU countries with the exception of Estonia still need to take additional actions to fulfil the new Renewable Energy Sources (RES) targets for 2020 (see section [BR1] 4.3.3 in Annex 1: EU 1st Biennial Report). The RES targets include all sources of electricity, heat and transport fuel, aiming at a 20% of RES to gross final energy consumption for the EU as a whole by 2020 (see also section 2.7 on the EU energy policy). The country with the highest target is also one of the closest to meeting it; in 2011 46.8 % of Sweden's final energy consumption was from renewable sources close to its 2020 target of 49 %. Denmark, Portugal, Austria, Finland and Latvia also have renewable energy targets of at least 30 %, with Austria being closest in 2011 to meeting this target.

Conversely, the United Kingdom, the Netherlands and Belgium have 2020 targets of 15 %, 14 % and 13 % respectively but in 2011 were sourcing 4.3 % or less of final energy from renewable sources. In absolute terms France needs to make the biggest increase followed by the United Kingdom – a further 11.5 % and 11.2 % respectively must come from renewable sources to meet their RES targets.

The most recent progress report (2013)[15] from the Commission states that there still exist barriers preventing the planned expansion of renewable sources, namely with regard to administrative simplification and permitting procedures for infrastructure development and operation, but also because of the consequences of the economic crisis.

2.7.2. Energy consumption in different sectors

Figure ***Error! No text of specified style in document.****-21* Final energy consumption by sector in the EU-28



Source: Eurostat

Final energy consumption in the EU-28 increased by approx. 2 % between 1990 and 2011. The services sector and the transport sector have both seen the largest increase in overall energy consumption since 1990 – by over 31 % and 29 % respectively. This is further explored in section 2.7. The relatively small proportion of low carbon transport in the EU is having a significant impact on GHG emissions (see section 3.2.3). The increase in energy consumption in the services sector correlates with an increasing share of GVA coming from this sector. Households are also one of the largest consumers of final energy in the EU. Space heating and cooling are the most significant components of household energy demand, and can vary substantially from year to year depending on climatic conditions. In 2011 household energy consumption equalled the 1990 level. Final energy consumption in industry has fallen by over 20 % since 1990, largely as a result of a shift towards less energy-intensive manufacturing industries, as well as the continuing transition to a more service-oriented economy.

15 Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Renewable Energy Progress Report COM(2013) 175 final.

2.7.3. Liberalisation and privatisation of energy markets

The creation of a genuine internal market for energy is one of the EU's priority objectives. The existence of a competitive internal energy market is a strategic instrument both in terms of giving European consumers a choice between different companies supplying gas and electricity at reasonable prices, and of making the market accessible for all suppliers. To this end, the Commission put forward the Third Energy Package[16] in 2007. The Third Energy Package includes two Directives (distinguishing electricity market and gas market) and three Regulations. More details on these changes are described in section 4.5.

2.7.4. Energy prices

Figure Error! ***No text of specified style in document.****-22* illustrates how the average end-user prices of both electricity and gas have varied since 2001 for industry and households in the EU. In addition, it illustrates how disposable income has varied over this period, as this provides a very broad indication of how expenditure on energy varies as a share of income.

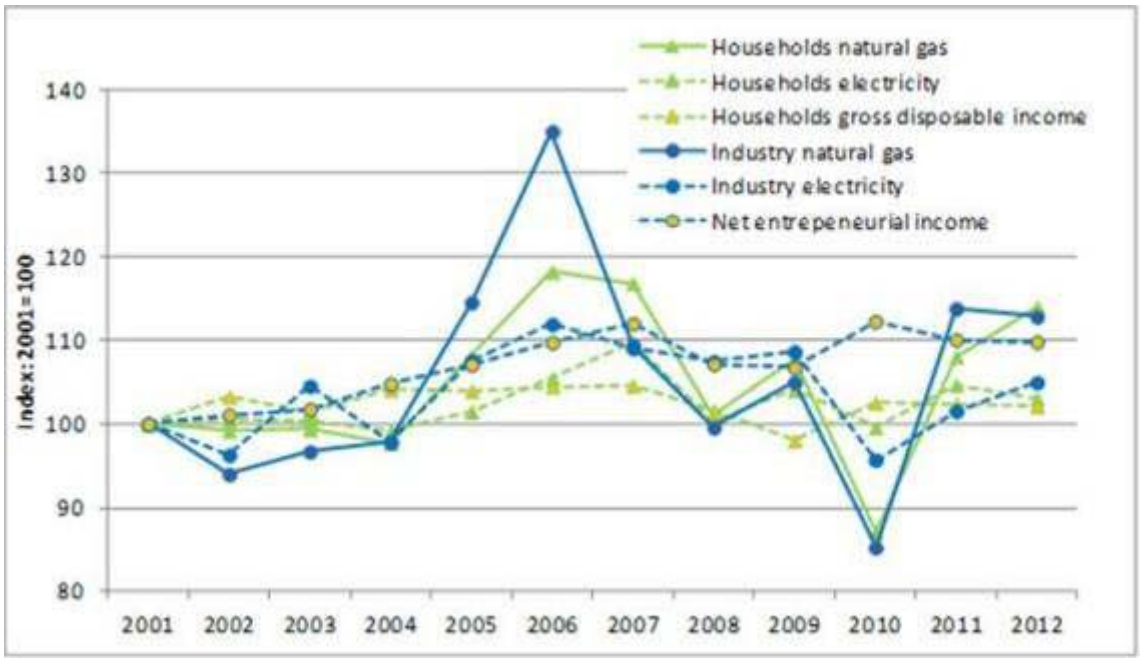
The price of natural gas has generally increased over the period with large fluctuations in 2006 and 2010. The peak and troughs are more pronounced in the case of industry compared to households.

The price of electricity shows a small increase of the period with smaller fluctuations than the gas price. The fluctuations follow to some degree the fluctuations of the gas price illustrating that gas is an important fuel for the electricity production.

Increasing gas and electricity prices should have a positive impact on the EU's GHG emissions as both industry and households make efforts to conserve energy and improve their level of energy efficiency. This should be the case for households as the disposable income of households hardly increased between 2001 and 2012. On the other hand, substitution effects may play a negative role, whereby consumers opt for cheaper fuels such as coal, which is more carbon-intensive.

16 http://ec.europa.eu/energy/gas_electricity/legislation/third_legislative_package_en.htm

Figure ***Error! No text of specified style in document.****-22* Change in average end-user energy prices in the EU, 2001-2012



Source: Eurostat

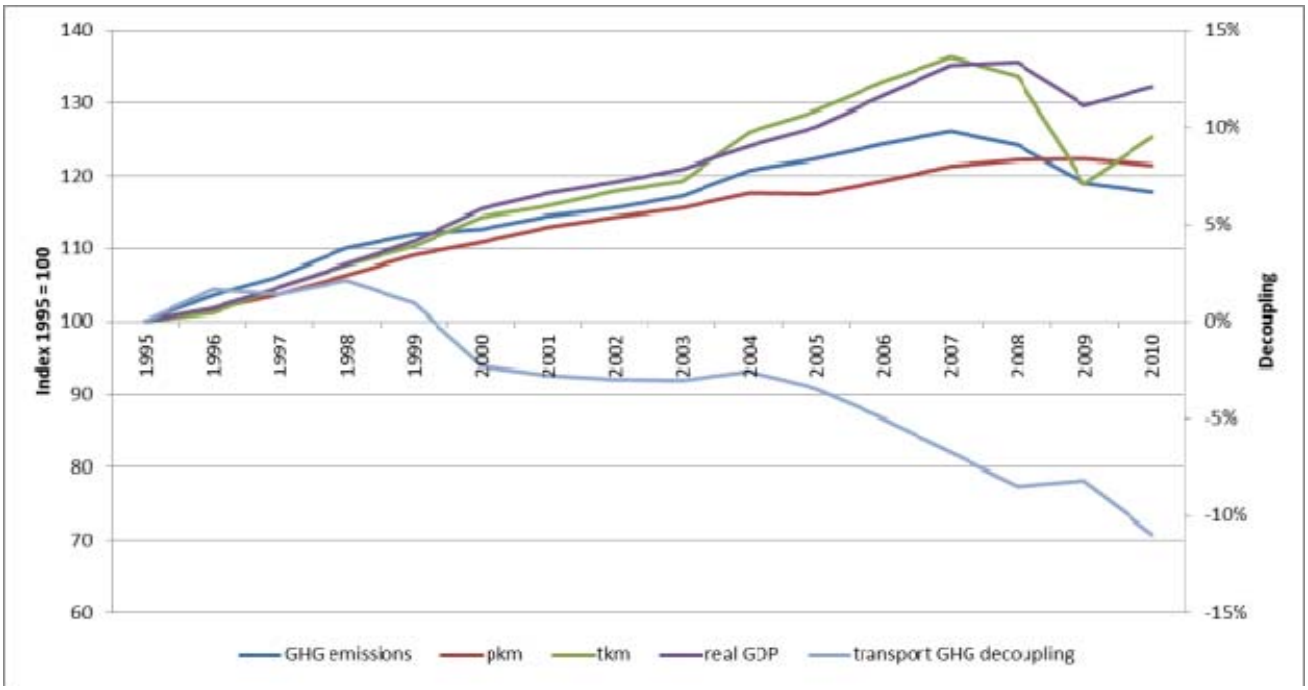
Note: Data until 2005 only included EU-15, from 2006 onwards prices for EU-27 were considered

2.8. Transport profile

The following sections provide a high-level overview of the most relevant factors related to transport.

As reported in the 5th National Communication, both freight and passenger transport have continued to grow strongly since 1995 up until the economic crisis in 2008. Freight transport growth was largely in line with real GDP growth until the economic crisis, followed by a strong decline in 2008 and 2009 and a recovery in 2010. Passenger transport has grown slower than real GDP since 1995. As a result, the GHG emissions and energy use of transport have grown until 2007, making it the sector with the largest energy consumption within the EU-27.

Figure ***Error! No text of specified style in document.****-23* Growth in transport volumes and emissions and GDP in EU-27



Source: European Commission, DG Mobility and Transport and Eurostat

Note: Estimate of GDP as billions of Euro at 2005 market prices. Freight transport data from DG Mobility and Transport: Air and sea: only domestic and intra-EU-27 transport; provisional estimates. Road: national and international haulage by vehicles registered in the EU-27. Passenger transport (pkm = passenger kilometres) includes passenger cars, powered two-wheelers, buses & coaches, tram & metro, railways, intra-EU air, intra-EU sea. Decoupling is calculated as the percentage change in GHG intensity (ton CO2 per unit of GDP) compared to the 1995 baseline.

2.8.1. Freight transport

The table below shows the modal split for freight transport in 1995 and 2010. The major part of freight is transported via road (45.8 %), followed by sea transport (36,9%). Overall freight transport volume has increased by 25.2%, with volume increases along all individual modes as well. Overall the modal split did not change significantly between 1995 and 2010. Road transport is still the dominant mode, and has shown the largest relative and absolute increases. As a result the modal shares of most other transport modes (particular rail and oil pipelines) have decreased from 1995 to 2010. The increase in the modal share of road transport has to be noted as it is more carbon-intensive than most alternative modes.

Table ***Error! No text of specified style in document.****-2* Modal split of freight transport in EU - 27

Modal split	Tkm		Share of the sector (%)		Transport increase (%)
	1995	2010	1995	2010	1995 – 2010
Road	1 288.7	1 755.6	42.1	45.8	36.2
Sea	1 146.0	1 414.8	37.5	36.9	23.5
Rail	386.1	389.9	12.6	10.2	1.0
Inland Waterway	122.1	147.4	4.0	3.8	20.8
Oil Pipeline	114.9	120.6	3.8	3.1	4.9
Air	2.0	2.5	0.1	0.1	27.4
Total	3 059.8	3 830.9	100.0	100.0	25.2

Source: DG Mobility and Transport

Note: Air and Sea: only domestic and intra-EU-27 transport; provisional estimates. Road: national and international haulage by vehicles registered in the EU-27.

2.8.2. Passenger transport

Between 1995 and 2007, passenger transport in the EU has increased at a relatively lower rate than GDP. The effect of the financial and economic crisis is less distinct than for freight transport.

A reduction in absolute carbon emissions in the passenger transport sector will need to come primarily via improved vehicle efficiency, shift from individual to collective transport or soft modes, the shift to less carbon-intensive transport fuels (e.g. sustainably produced biofuels or low carbon electricity) and a reduction in congestion.

The table below shows the total distance travelled by passengers– comparing 1995 with 2010. Overall passenger transport has increased by 21 %, largely as a consequence of the 22 % increase in car transport. Regarding the modal split the importance of passenger cars becomes clearly visible: 73.3 % of the total passenger kilometres are travelled by car. Air travel, which comes second in the modal split, accounts for only 8.2%. However, it has shown the largest increase and has grown by 51.5 % since 1995. This is important as growth in air transport has exceeded the improvements in efficiency, leading to significant increases in emissions. In general, the modal split does not differ substantially from the NC5.

*Table **Error! No text of specified style in document.**-3* Modal split of passenger transport in EU - 27

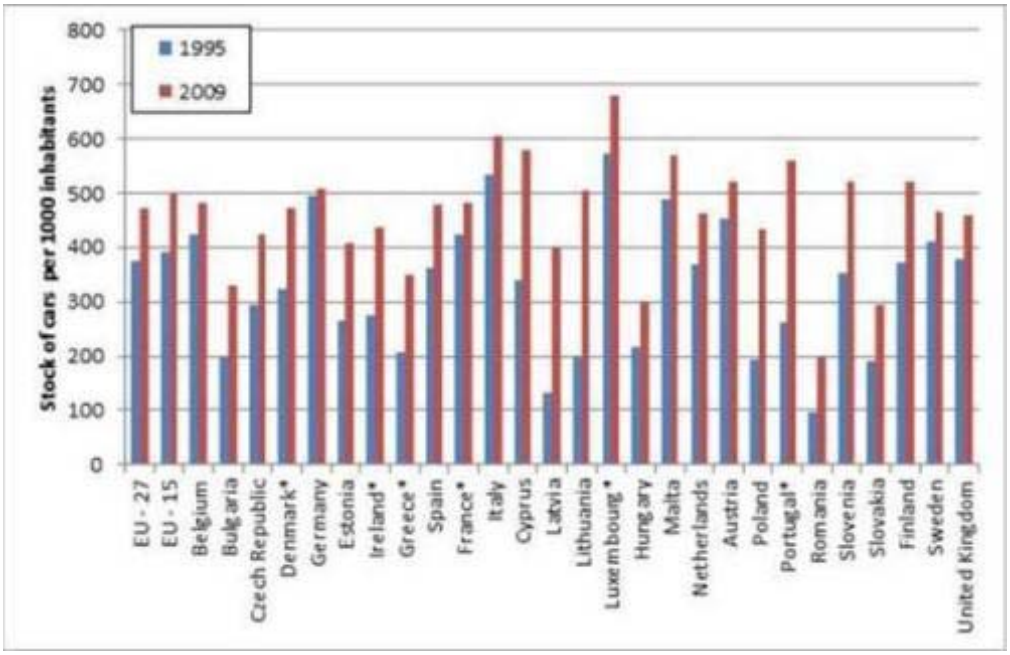
Modal split	Pkm		Share of the sector (%)		Transport change (%)
	1995	2010	1995	2010	1995-2010
Passenger cars	3 879.2	4 737.6	73.0	73.7	22.1
Powered 2-wheelers	122.2	120.0	2.3	1.9	-1.8
Buses & coaches	497.4	510.1	9.4	7.9	2.6
Railways	350.5	403.8	6.6	6.3	15.2
Tram & metro	71.0	90.1	1.3	1.4	26.9
Air	346.0	524.2	6.5	8.2	51.5
Sea	44.4	38.1	0.8	0.6	-14.2
Total	**5 310.7**	**6 423.9**	**100.0**	**100.0**	**21.0**

Source: Eurostat, DG MOVE

Note: Air and Sea: only domestic and intra-EU-27 transport; provisional estimates. Road: national and international haulage by vehicles registered in the EU-27.

The next graph shows that in each of the EU-27 Member States the level of car ownership has increased; overall ownership in the EU-27 increased by 26 % between 1995 and 2009. In Romania, Latvia and Lithuania car ownership levels have more than doubled, whereas Germany experienced the smallest increase at 2.6 %. Nevertheless, this still leaves Romania with the lowest level of ownership in the EU-27 (197 per 1 000 inhabitants). Luxembourg has the highest level of ownership with 678 per 1 000 inhabitants, followed by Italy with 606 cars.

*Figure **Error! No text of specified style in document.**-24 Level of car ownership*



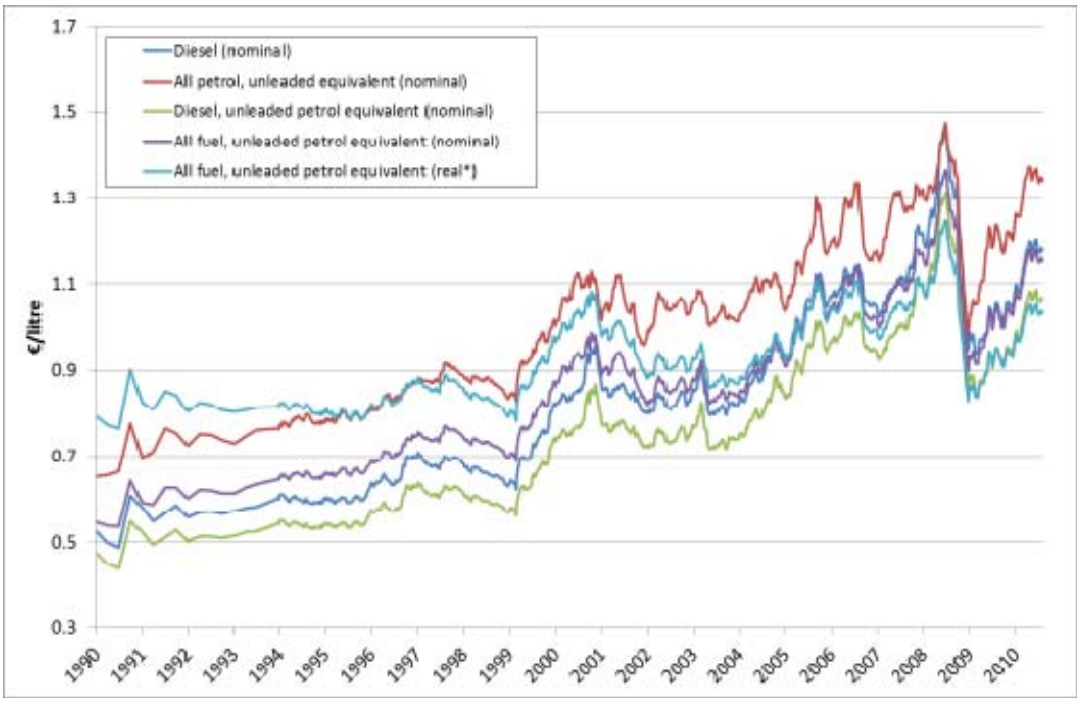
Source: Eurostat

Note: Croatia not included. Passenger car stock at end of year n divided by the population on 1st January of year n+1. Countries with * did not provide data for 2009, therefore latest figures reported were taken (Denmark: 2008, Ireland: 2007, Greece: 2003, France: 2007, Luxembourg: 2008, Portugal: 2002).

2.8.3. Prices of transport fuels

The line graph below shows how average diesel and petrol prices have evolved in the EU Member States since 1990. Overall, the prices for both fuels more than doubled between 1990 and 2011 due to substantial increases in oil prices; real prices (when adjusting for inflation) increased by around a third over the same period.

*Figure **Error! No text of specified style in document.**-25 Average EU road transport fuel prices*



Source: EEA

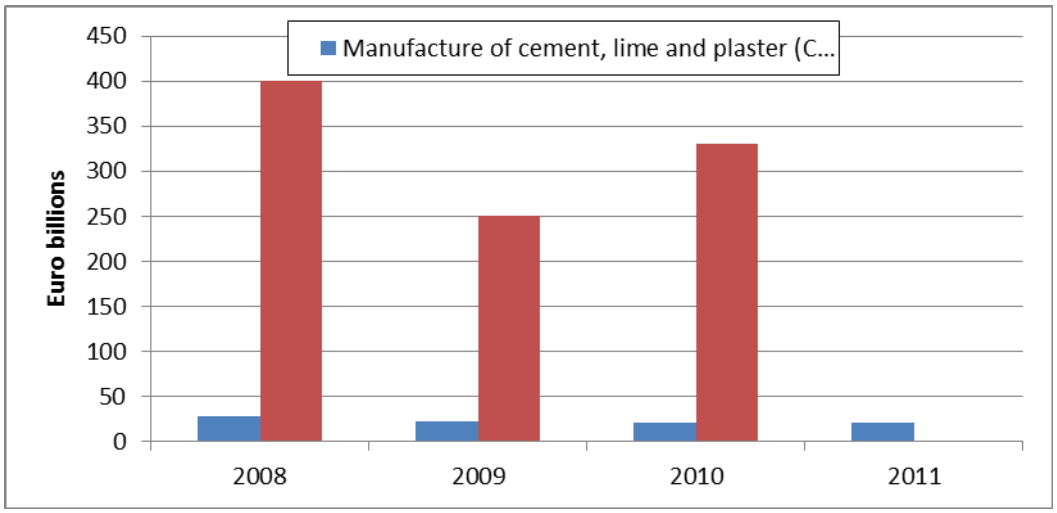
Note: * 'Real' is the price corrected for inflation, using 2005 as the baseline year.

2.9. Industry

The largest share of gross value added in the industry sector is contributed by subsectors electricity, gas, steam and air conditioning (11.0 %); food, beverages and tobacco products (10.4 %); and machinery and equipment (8.2 %).

The following illustration shows the production value of two very energy-intensive industry sectors in recent years. The decrease of production during the economic crisis in 2009 is clearly visible, in particular for iron and steel.

Figure ***Error! No text of specified style in document.****-26 Production value of iron, steel and cement industry*



Note: Production value measures the amount actually produced by the unit, based on sales, including changes in stocks and the resale of goods and services. The production value is defined as turnover, plus or minus the changes in stocks of finished products, work in progress and goods and services purchased for resale, minus the purchases of goods and services for resale, plus capitalised production, plus other operating income (excluding subsidies). Income and expenditure classified as financial or extraordinary in company accounts is excluded from production value. Annual average exchange rates vis-à-vis the euro in EUR millions (reference year 2005). Data for iron and steel not available for 2011.

2.10. Waste

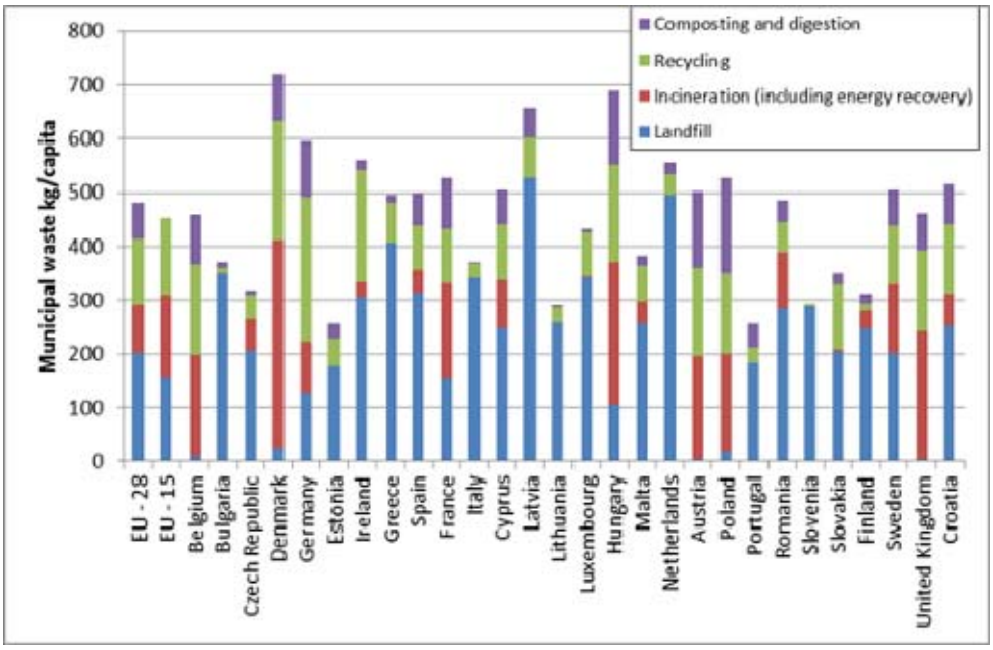
Greenhouse gas emissions from waste depend on the quantity of waste and how it is disposed of (including recycling, landfill and incineration). All types of waste treatment have an impact on emissions, including the consumption of energy in the collection, treatment and production of waste. The trends in emissions from waste can be seen in section 3.2.3. Waste to landfill produces large methane emissions if not managed correctly (e.g. via methane recovery and diversion of biodegradable municipal waste from landfill).

Recycling and incineration of waste with energy recovery generally result in lower greenhouse gas emissions than disposing of the waste to landfill, and these types of waste treatment are increasingly being used, in part as a result of the policy drivers discussed in section 4.10.

The figure below shows the amount of municipal waste generated for each Member State in 2011, broken down by type of treatment. For the EU-28 on average 42 % of waste per capita is recycled, 36 % is sent to landfill and 22 % is incinerated. The lowest recycling rates are in Bulgaria and Croatia – at less than 10 %, whereas the remaining 90 % are landfilled. In contrast, Germany, the Netherlands and Sweden do send only

less than 1 % of the municipal waste to landfill. In Denmark, more than half of the municipal waste is incinerated. In terms of recycling, the Netherlands, Austria and Germany are the leaders with recycling rates of over 60 %.

Figure ***Error! No text of specified style in document.****-27* Treatment of municipal waste per capita in 2011

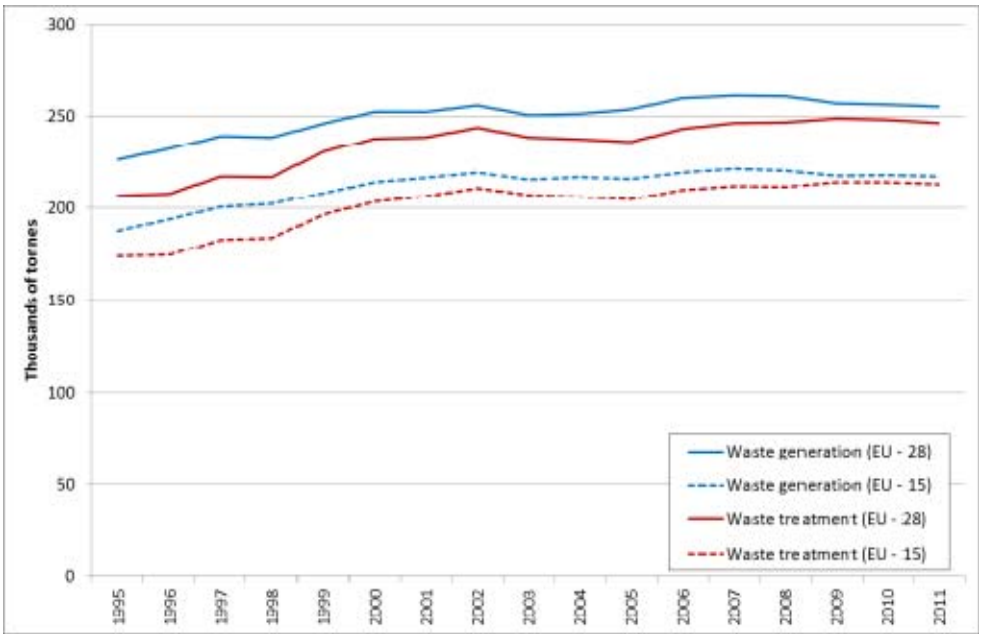


Source: Eurostat

Note: Composting and digestion aggregate not available for EU-15

As can be seen in the next figure, municipal waste generation increased markedly in the 1990s but showed a slight decrease during the financial and economic crisis in 2009. The amount of waste treated roughly follows the trend of waste generated. It can be seen that the gap between the two has been reduced in recent years.

Figure ***Error! No text of specified style in document.****-28* Development of municipal waste generation and treatment since 1995.



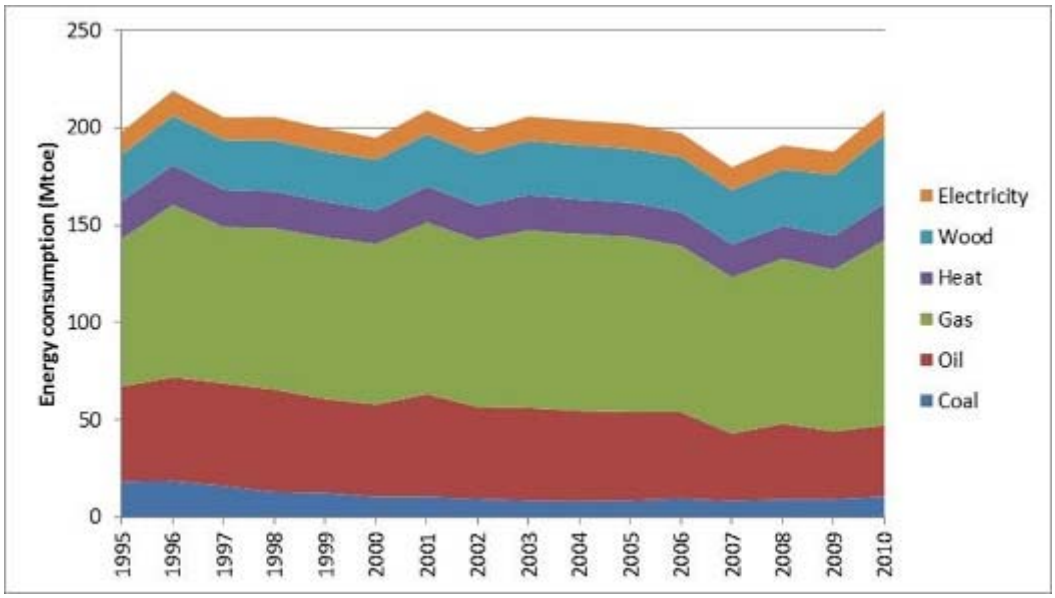
Source: Eurostat

Note: Data before 2006 not available for Croatia.

2.11. Building stock and urban structure

Energy consumption for space heating within buildings constitutes a significant component of all EU energy consumption. As a wide range of fuels is available for heating, the mix of these various fuels is crucial for the overall GHG emissions of this sector. The following figure shows the energy consumption of residential space heating in the EU, divided into fuel types.

Figure ***Error! No text of specified style in document.****-29* Energy consumption of residential space heating in mega-tonnes of oil equivalents (Mtoe) in EU-28.



Source: Odyssee; Latvijas Statistica (for Latvia)

Note: data for Cyprus, Luxembourg, Malta, Portugal and Slovenia are not available for all years.

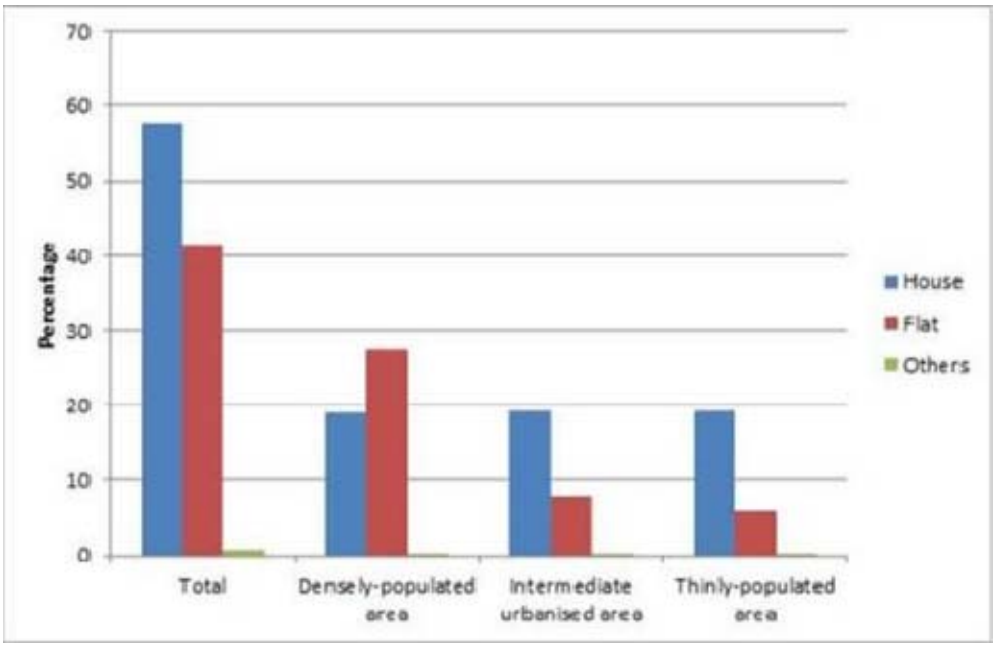
As can be seen in the figure above, coal consumption has decreased since 1996, but showed a slight increase in recent years. Its share in overall energy consumption currently amounts to 5 %, down from 9 % in 1995. Likewise, oil consumption has decreased from 25 % in 1995 to 17 % in 2010. At the same time, the share of gas consumption in residential space heating has increased from 37 % in 1995 to 46 % in 2010. This has important implications on overall GHG emissions from residential heating, as the CO_2 emission intensity is much lower for natural gas than for oil or coal.

Concerning the remaining categories of energy consumption, the past 15 years saw a slight decrease in (district) heat and an increase in wood and electricity used for residential heating.

The overall energy consumption of residential heating has not changed significantly over the past 15 years. Factors that affect overall energy consumption include increased energy efficiency, type of housing, residential area per capita and overall population. Annual fluctuations in the figure above can be explained by weather patterns such as a mild winter in 2007.

The type of housing is important because generally the ratio of residential area to outer wall area is more advantageous in flats compared to houses, resulting in lower energy consumption for heating. Densely populated areas with their high share of flats (see the following figure) are in many cases characterised by lower energy consumption per square meter.

Figure ***Error! No text of specified style in document.****-30* Breakdown of types of housing in the EU-27 in 2011.

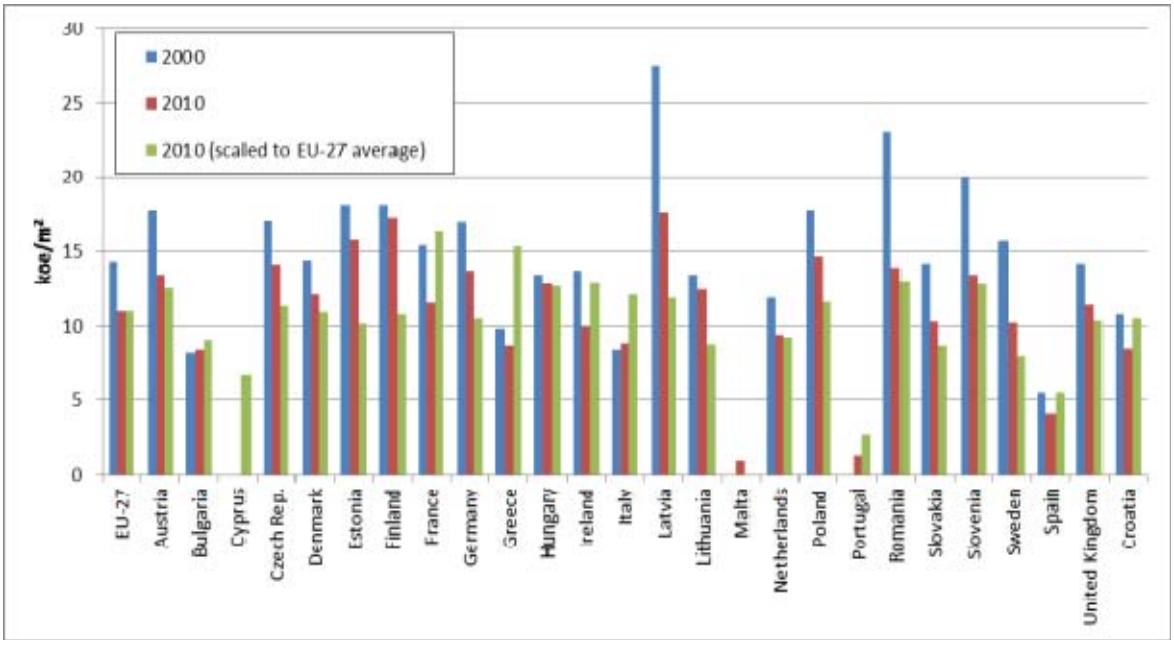


Source: Eurostat

Although overall energy consumption of residential heating has not changed significantly over the past decade, the energy consumption per unit area has decreased, as a result of higher energy efficiency. For example, the EU average energy consumption per square meter has decreased by 23 % from 14.3 to 11.0 kilogrammes of oil equivalents (see the following figure).

Climate-corrected energy consumption is also shown. It provides a good proxy for the thermal and heating system efficiency of households as it is corrected for the effect of size of building and average climate of the various Member States.

Figure ***Error! No text of specified style in document.****-31* Household energy consumption for space heating in kilograms of oil equivalents per square meter (koe/m²), 2000 and 2010.

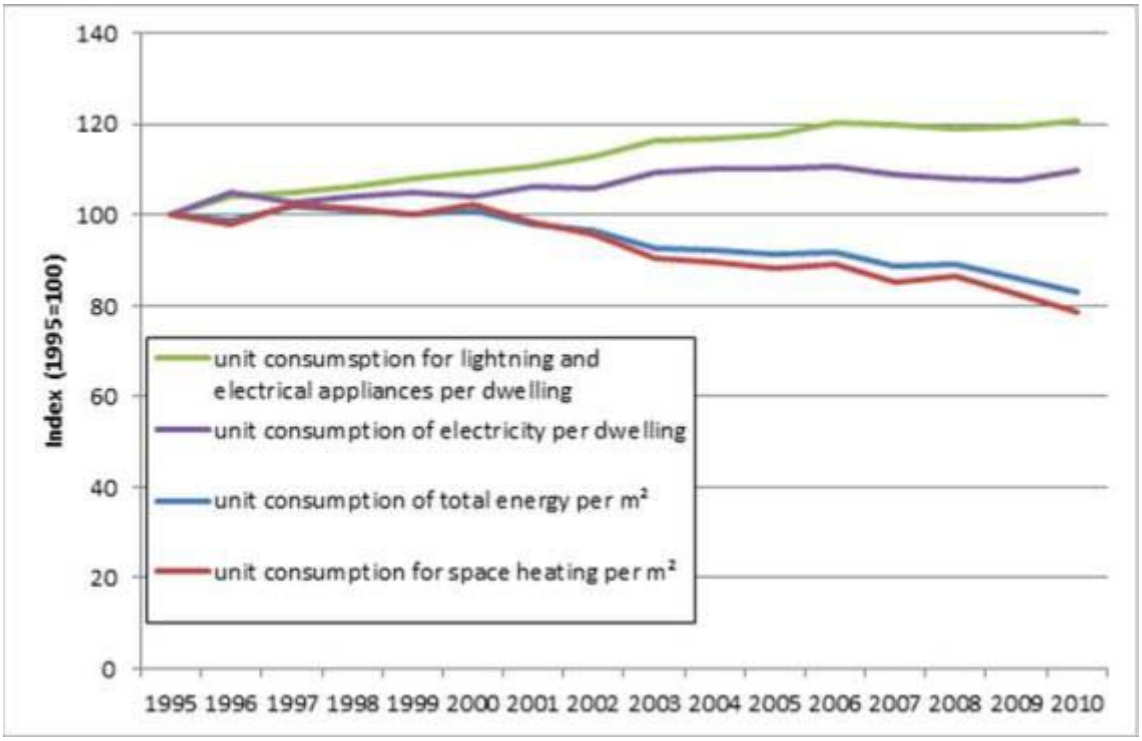


Source: Odyssee

Note: Data for 2000 and 2010 are climate corrected against each country's long-term average climate, whereas the last series is climate corrected and scale against the EU - 27 long-term average climate to account for temperature differences between countries. Data for Luxembourg, Belgium not available; for Malta, Netherlands and Portugal data is only partly available.

The buildings sector has one of the highest potentials for improved energy efficiency. Measures to reduce the space heating/cooling demand in buildings represent a significant part of this potential. Many of these measures (e.g. improved insulation) are highly cost-effective, but a number of barriers to their implementation exist, for example, high costs of initial investment. With regard to unit consumption of total energy and heating per square meter, it can be seen in the next figure that households reduced this energy consumption by almost 20 % since 1995. On the other hand, total electricity consumption per dwelling increased by 10 %, electricity consumption for lightning and appliances even increased by 20 % compared to 1995 levels, caused by the increasing stock of electrical appliances and larger homes.

Figure ***Error! No text of specified style in document.****-32* Unit consumption of energy in households



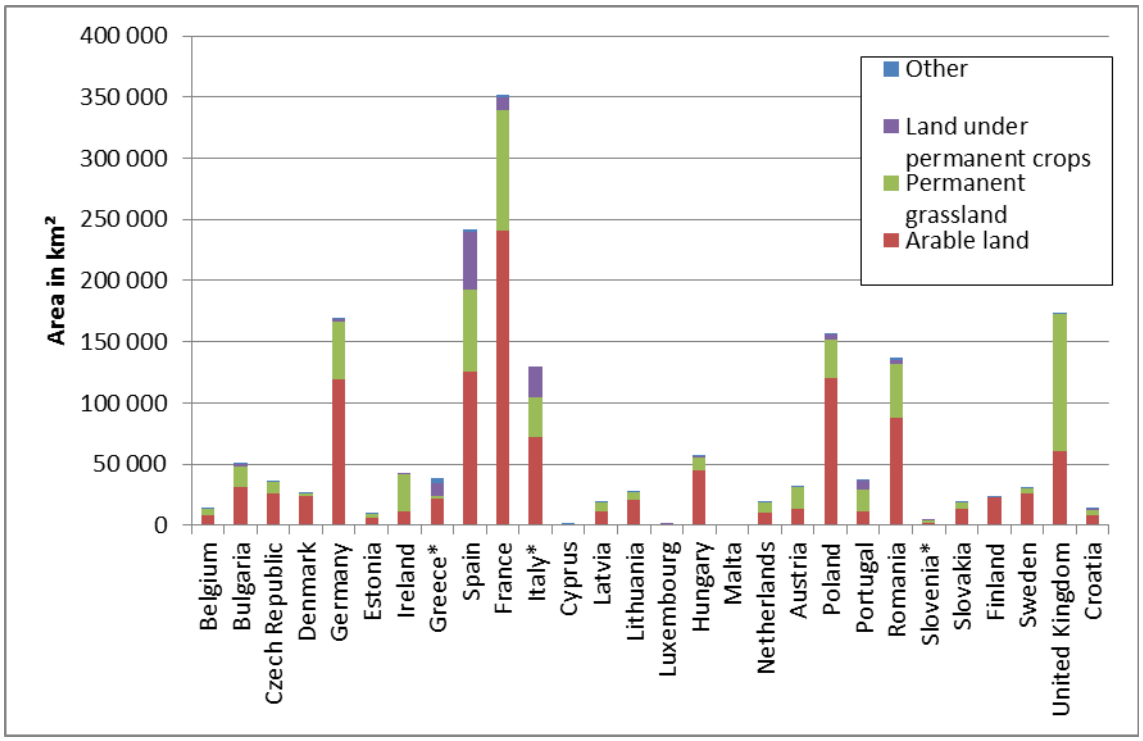
Source: Odyssee

2.12. Agriculture

In 2009 the total utilized agricultural area (UAA) in the EU amounts to 1.86 million km² which corresponds to 41.5 % of the total EU-28 area. On the overall EU-28 the area of land under agricultural use has been relatively stable revealing only a slight decrease of approximately 2.5 % between 2000 and 2009.The distribution of different land use types did not change either. Nevertheless, there are different trends among the Member States. In some Eastern countries of the EU (e.g. Slovakia, Latvia and Lithuania) a tendency of shrinking UAA can be observed. These countries face a deep restructuring process in their agricultural sectors. In other countries the UAA only slightly decreased (Austria, Portugal and Spain) and in some cases increased (France, United Kingdom, Malta, and Denmark).

Figure 2-34 shows the land use patterns of the Member States. France has the largest utilized agricultural area, followed by Spain, United Kingdom, Germany and Italy. Regarding the UAA categories, Spain, Greece and Italy are leading in terms of cropland (9 % of their total national surface area). Ireland has the largest share of permanent grasslands covering more than 40 % of its area.

*Figure **Error! No text of specified style in document.**-33 Total utilized agricultural land and usage patterns in 2009 in the EU-28.*



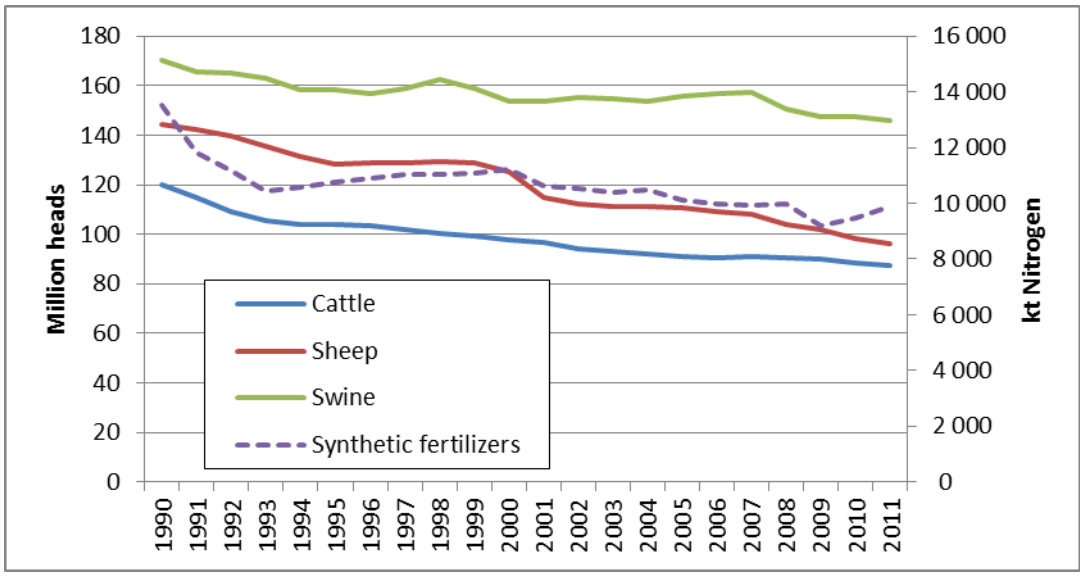
Source: Eurostat

Note: Incomplete data for Italy, Slovenia, and Greece. Missing figures were gap-filled with most recent data available.

Agriculture constitutes a significant source of GHG emissions, for example due to N_2O associated with fertilizer use and CH_4 emissions from livestock (as well as energy consumption in the sector itself). Related trends are highlighted in more detail in the figure below (trends in agriculture emissions are outlined in section3.2.3).

The use of nitrogenous fertilizers (in mineral and organic form) is an important factor driving agricultural emissions. The use of mineral nitrogenous fertilizer amounted to 9,.6 million tons in 2010, while was 30 % higher in 1990. The overall livestock in the EU-27 has substantially decreased since 1990, particularly ruminants which are emitters of enteric methane. The sheep herd amounts to around 95 million heads and the cattle herd counts approximately 87 million heads. Swine is the largest livestock sector with nearly 146 million heads.

*Figure **Error! No text of specified style in document.**-34 EU-27 Fertilizer consumption and livestock.*

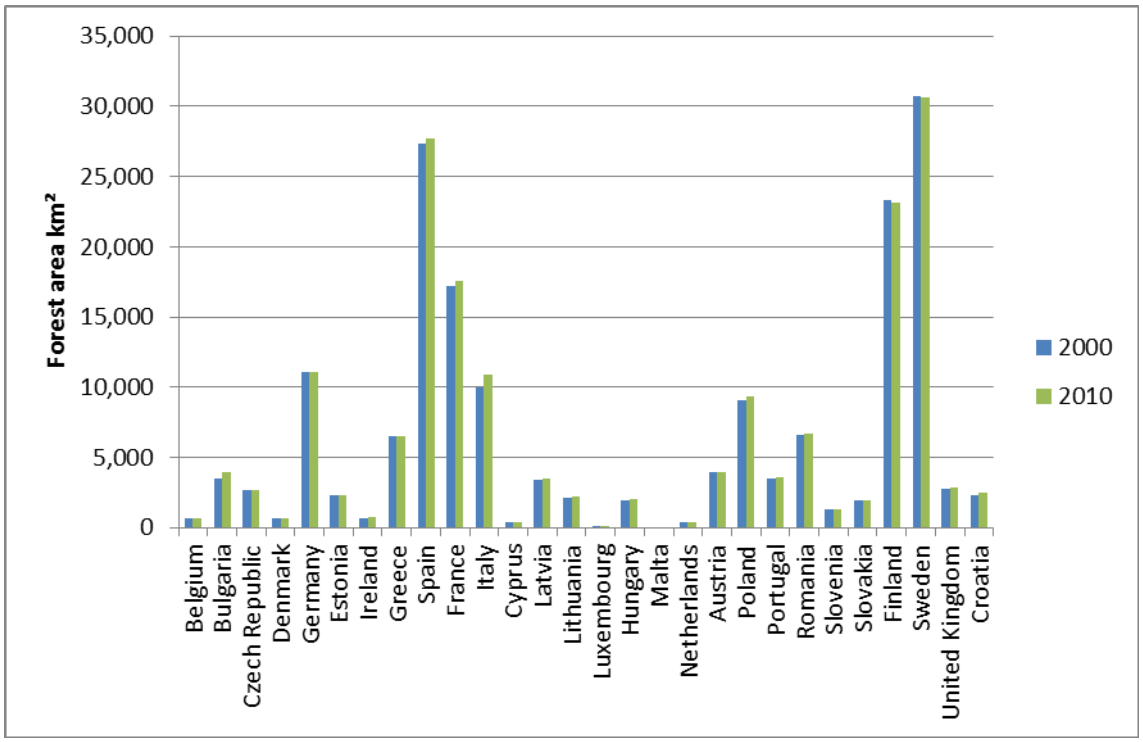


Source: Annual European Union greenhouse gas inventory 1990–2011

2.13. Forests

Overall, the total forested area across the EU-28 Member States increased by 3 % between 2000 and 2010. In 2010, the forested area amounted to approx. 1.8 million km² which is almost 40 % of the total EU-28 area. The forest area increased in all countries, with the exception of Sweden and Finland (showing a very slight decrease of -0.36 % and -0.71 % respectively between 2000 and 2010). Six countries make up two thirds of the total forested area: Sweden, Spain, Finland, France, Germany and Italy. The increase in forested and wooded areas throughout the EU is important for climate change mitigation, given their role as a carbon sink (trends in emissions related to Land-Use, Land-Use Change and Forestry are provided in section 3.2.3).

*Figure **Error! No text of specified style in document.**-35 Forested area in 2000 and 2010*



Source: Eurostat

Note: Total forested area including other wooded land.

3. GREENHOUSE GAS INVENTORY INFORMATION

Key developments

- Total GHG emissions in the EU-15 (without LULUCF) decreased by 14.7 % from 1990 to 2011. Over the same period, EU-28 GHG emissions decreased by 18.3 %. In both EU-15 and EU-28 the biggest relative change has been in the waste sector where the emissions of CH_4 from managed waste disposal on land decreased substantially.

- Averaged over the latest four years, EU-15 emissions (without LULUCF) were 11.2 % and EU-28 emissions (without LULUCF) were 15.6 %below the emission level of 1990.

- Emissions of total greenhouse gases decreased by 4.2 % in the EU-15 and 3.3 % in the EU-28 between 2010 and 2011. This was largely due to a strong

emission decrease in households and services. Milder winter conditions and the lower demand for heating can partly explain lower emissions in 2011 compared to 2010.

3.1. Introduction

This chapter presents greenhouse gas emission trends of the European Union (EU) for the EU-15 and EU-28 for the period 1990-2011. The EU submits an inventory for EU-15 under the Kyoto Protocol and for EU-28 under the UNFCCC. The legal basis of the compilation of the EU inventory and the inventory methodology and data availability are also described briefly. The greenhouse gas data presented in this chapter are consistent with the 2013 submission of the EU to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat[17], except for the EU-28 aggregates, where the data for Croatia was added to the data for EU-27 to reflect the enlargement of the Union to 28 Member States as of 1 July 2013. Thus, as the 2013 EU inventory was submitted prior to this enlargement, it covers the EU-27 only. However, at the date of submission of this National Communication, the EU now covers the 28 Member States, as will the inventory submission in 2014. The aggregates for the EU-15 with a collective arrangement for fulfilment of the Kyoto target under the first commitment period are not affected. The data for Croatia was taken from Croatia's GHG inventory resubmission to the UNFCCC.

Summary tables of GHG emissions for the EU-15 and the EU-28 in the common tabular format are presented in CTF Tables 1 (a) and 1 (b) in the CTF Appendix. These data and the complete submissions of the Member States under Decision 280/2004/EC are available on the EEA website (http://www.eea.europa.eu/).

The EU inventory has been compiled from data delivered by the 27 Member States by 15 March 2013 under Decision 280/2004/EC, and subsequent updates to these data received by 15 May 2013. The data presented in NC6 takes into account the resubmission of the EU inventory to the UNFCCC of 18 November 2013. The data for Croatia, which was added to compile the EU-28 aggregates, was taken from its UNFCCC resubmission made on 15 November 2013.

3.2. Descriptive Summary of GHG Emissions Trends

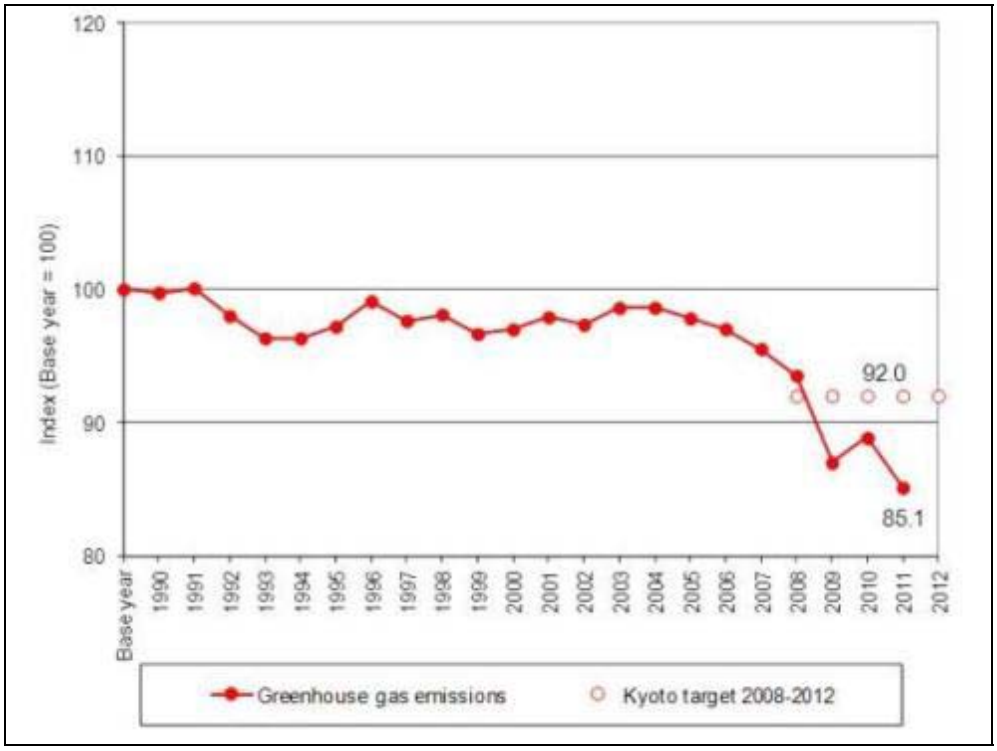
3.2.1. Overall greenhouse gas emissions trends

In 2011 total GHG emissions in the EU-15, without LULUCF, were 14.7 % (623 million tonnes CO_2 equivalents) below 1990, and 14.9 % (635 million tonnes CO_2 equivalents) below its Kyoto base year (Figure Error! **No text of specified style in document.**-36). Between 2010 and 2011 emissions decreased by 4.2 % (159.6 Mt of CO_2 equivalents).

17 European Environment Agency, Technical Report No 08/2013 Annual European Union greenhouse gas inventory 1990–2011 and inventory report 2013.

Under the Kyoto Protocol, the EU-15 (the 15 Member States of the Union at the time) agreed to reduce their GHG emissions collectively by 8 % over the 2008-2012 period compared to the 'base year'[18]. This can be achieved by a combination of existing and planned domestic policies and measures, the use of carbon sinks and the use of Kyoto mechanisms. Since 2009 total GHG emissions have been below the EU-15 Kyoto target (CTF Tables 1 (a) in the CTF Appendix).

Figure **Error! No text of specified style in document.**-36 EU-15 GHG emissions 1990-2011 compared with Kyoto target for 2008-2012 (excluding LULUCF)

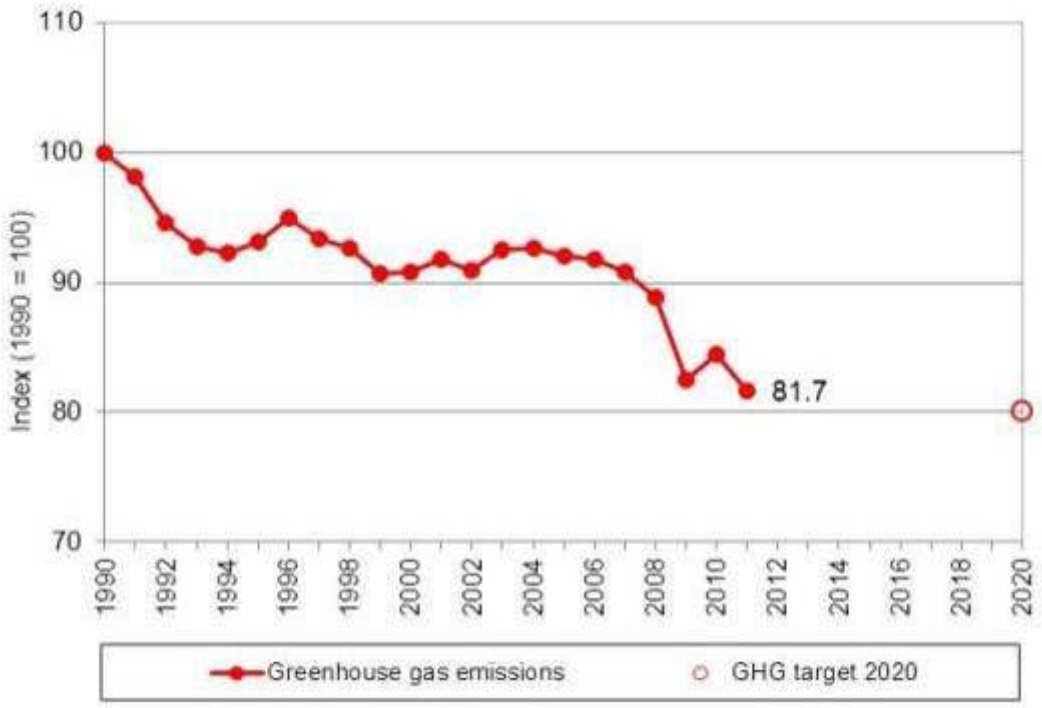


Source: EEA

Total GHG emissions, without LULUCF, in the EU-28 decreased by 18.3 % between 1990 and 2011 (-1028 Mt of CO_2 equivalent). Between 2010 and 2011, emissions decreased by 3.3 % (155.3 Mt CO_2 equivalent) (Figure Error! ***No text of specified style in document.****-37*).

18 Following the UNFCCC reviews of Member States' 'initial reports' during 2007 and 2008 and pursuant to Article 3, Paragraphs 7 and 8 of the Kyoto Protocol, the base-year emissions for the EU-15 have been fixed to 4 265.5 Mt CO2 equivalent.

*Figure **Error! No text of specified style in document.**-37 EU-28 GHG emissions 1990-2011 (excluding LULUCF)*



Source: EEA

3.2.2. Emission Trends by Gas

CTF Table 1 (a) in the CTF Appendix provides an overview on the main trends in the EU-15 GHG emissions and removals for 1990–2011. In the EU-15 the most important GHG is CO_2, accounting for 82.7 % of total EU-15 emissions in 2011. In 2011, EU-15 CO_2 emissions without LULUCF were 3 003 Tg, which was 10.8 % below 1990 levels. Compared to 2010, CO_2 emissions decreased by 4.8 %. CH_4 and N_2O emissions account for 8 % and 7 % of total GHG emissions respectively in 2011; both gases show falling trends. Fluorinated gases are increasing and account for the remaining 2 % of total GHG emissions.

CTF Table 1 (b) in the CTF Appendix provides an overview of the main trends in EU-28 GHG emissions and removals for 1990–2011. The most important GHG by far is CO_2, accounting for 82.2 % of total EU-28 emissions in 2011 excluding LULUCF. In 2011, EU-28 CO_2 emissions without LULUCF were 3 764 Tg, which was 15 % below 1990 levels. Compared to 2010, CO_2 emissions decreased by 3.8%. CH_4, N_2O and fluorinated gases account for 9 %, 7 % and 2 % of total GHG emissions respectively in 2011.

3.2.3. Emission Trends by Main Source Categories

CTF Table 1 (a) in the CTF Appendix provides an overview of EU-15 GHG emissions in the main source categories for 1990–2011. As emissions from international aviation and shipping are excluded from national totals they are not presented in the table.

The sector energy contributed 80 % to total GHG emissions being the largest source category in the EU-15. Total GHG emissions from this sector decreased by 11.7 % from 3 282 Tg in 1990 to 2 898 Tg in 2011. The main reasons for the falling emissions since 1990 are efficiency improvements and fuel shifts from coal to gas in electricity and heat production and in manufacturing industries. In addition, efficiency improvements, fuel shifts and better insulation of buidlings contributed to the falling trend.

The sector agriculture is the second largest source category in the EU-15 (10 % to total GHG emissions). Total GHG emissions from this sector decreased by 14.8 % from 434 Tg in 1990 to 370 Tg in 2011, reflecting falling cattle population and lower fertiliser and manure use on agricultural soils.

The sector industrial processes is the third largest source category (7 % to total EU-15 GHG emissions in 2011). Total GHG emissions from this sector decreased by 28.3 % from 353 Tg in 1990 to 253 Tg in 2011, mainly due to emission reduction measures in adipic acid production, nitric acid production and production of halocarbons.

The remaining emissions stem from the sectors waste and solvent and other product use with 2.8 % and 0.2 % of the EU-15 total emissions in 2011. In addition, the sector land use, land use change and forestry (LULUCF) was responsible for a net emission removal of 174 million tonnes of CO_2-equivalent in 2011, marking an increase of emission removals of 27.2 % since 1990. Overall, net emission removals from LULUCF accounted for 5 % of total GHG emissions in 2011. Forests are a significant net carbon sink, croplands are a source and grasslands are a small sink.

CTF Table 1 (b) in the CTF Appendix provides an overview of EU-28 GHG emissions in the main source categories for 1990–2011. The most important sector by far is Energy (i.e. combustion and fugitive emissions), accounting for 79.4 % of total EU-28 emissions in 2011. The second largest sector is Agriculture (10.1 %), followed by Industrial Processes (7.3 %). Waste and solvent and other product use accounted for 2.9 % and 0.2 % of the EU-28 total emissions, while LULUCF contributed over 297 million tonnes of net emission removals in 2011. Emissions from international aviation and shipping are excluded from the national totals and therefore not presented in the table.

International bunker emissions of the EU inventory are the sum of the aviation bunker and maritime bunker emissions of the Member States. These emissions are reported as memo items but excluded from national totals. Emissions of greenhouse gases from international aviation and shipping activities both increased constantly between 1992 and 2007. Between 2008 and 2010 international bunker emissions decreased in the EU-28, partly reflecting the economic recession, but have increased again in 2011. Total

GHG emissions from international transport reached 299 million of CO_2 equivalents in 2011. Emissions from these two categories are equivalent to 3.8 % for international aviation (136 Mt) and 4.5 % for international navigation (163 Mt) of total EU-28 GHG emissions in 2011. In 2011, emissions from aviation bunkers and maritime bunkers are still 95 % and respectively 48 % above 1990 levels.

3.2.4. Change in Emissions from Key Categories for EU-15 and EU-28

Key categories are defined as the sources or removals of emissions that have a significant influence on the inventory as a whole, in terms of the absolute level of the emissions, the trend, or both.

Carbon dioxide

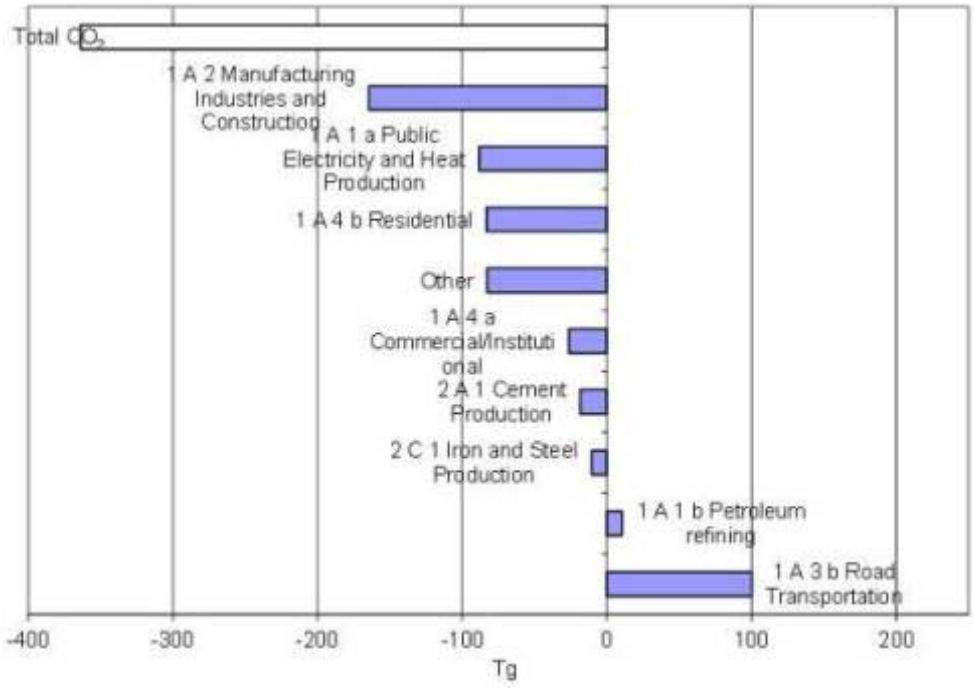
CO_2 emissions from 'electricity and heat production' are the largest key category in the EU-15, accounting for 24 % of total greenhouse gas emissions in 2011 and for 83 % of greenhouse gas emissions of the Energy Industries Sector. As can be seen in Figure Error! ***No text of specified style in document.****-38*, below, this category shows the second largest decrease between 1990 and 2011. Fuel used for 'public electricity and heat production' increased by 13 % in the EU-15 between 1990 and 2011, however, CO_2 emissions from 'public electricity and heat production' did not increase in line with fuel consumption. Between 1990 and 2011, CO_2 emissions from electricity and heat production decreased by 9 % in the EU-15. The main explanatory factors at EU-15 level have been improvements in energy efficiency and (fossil) fuel switching from coal to gas.

CO_2 emissions from 'road transportation' are the second largest key source of all categories in the EU-15 accounting for 20.4 % of total GHG emissions in 2011. Between 1990 and 2011, CO_2 emissions from road transportation increased by 16 % in the EU-15 due to an increase in fossil fuel consumption in this key category (Figure Error! ***No text of specified style in document.****-38*). Since 2007 the large increase in 'road transportation'-related CO_2 emissions was offset by reductions in energy-related emissions from manufacturing industries and construction and 'public electricity and heat production.

CO_2 emissions from 'manufacturing industries and construction' are the fourth largest key source in the EU-15, accounting for 13 % of total GHG emissions in 2011. Between 1990 and 2011, emissions from this category showed the largest decrease, as they declined by 26 % in the EU-15. The emissions from this key source are due to fossil fuel consumption in 'manufacturing industries and construction', which was 13 % below 1990 levels in 2011. A shift from solid and liquid fuels to mainly natural gas took place and an increase of biomass and other fuels has been recorded.

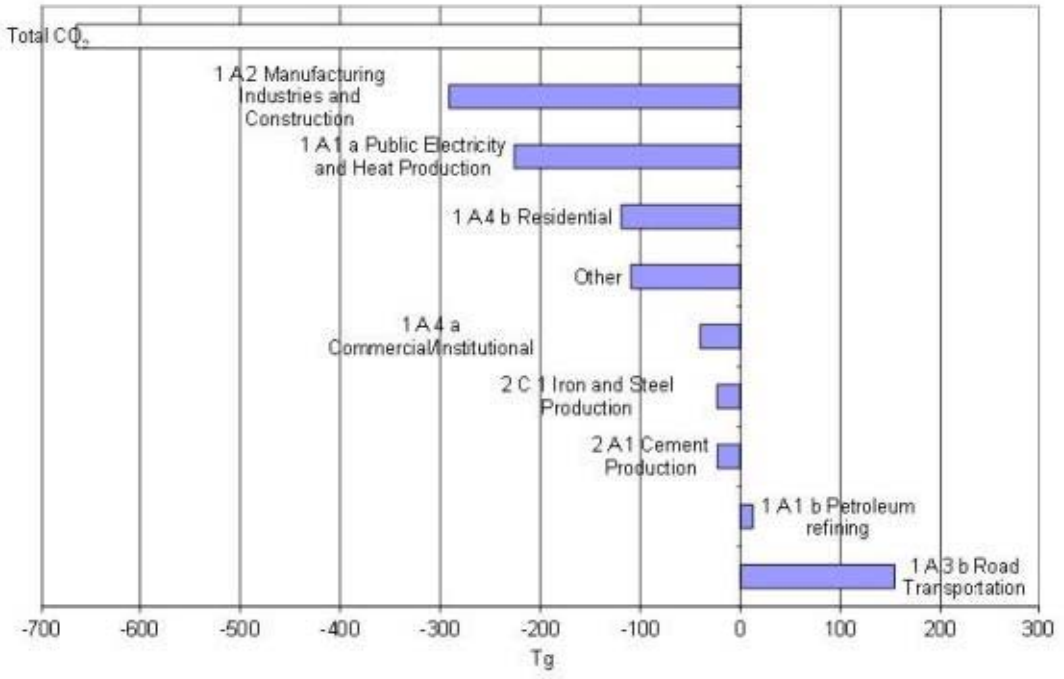
For EU-28 a similar trend in the change of CO_2 emissions from key categories can be observed (Figure Error! ***No text of specified style in document.****-39*).

Figure ***Error! No text of specified style in document.****-38* Absolute change of CO2 emissions by large key categories 1990 to 2011 in CO2 equivalents (Tg) for EU-15



Source: EEA

Figure ***Error! No text of specified style in document.****-39* Absolute change of CO2 emissions by large key categories 1990 to 2011 in CO2 equivalents (Tg) for EU-28

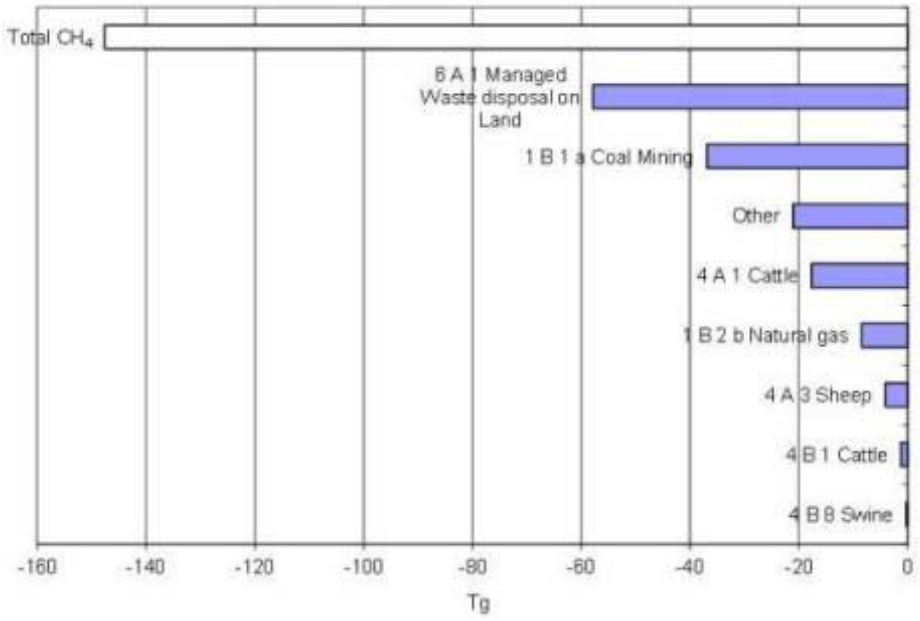


Source: EEA

Methane

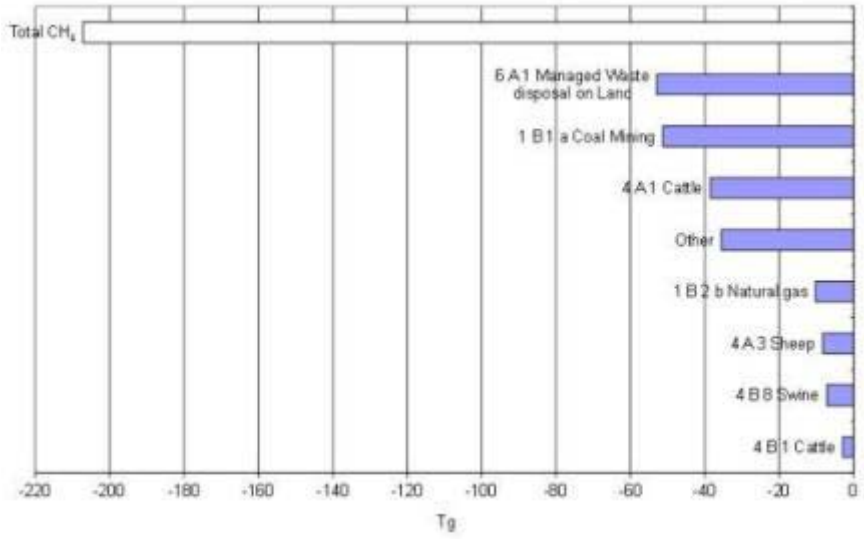
Methane emissions account for 8 % of total EU-15 GHG emissions in 2011 and decreased by 34 % since 1990 to 289 Tg CO_2 equivalents in 2011 (Figure Error! ***No text of specified style in document.****-40*). The two largest key sources (6 A 1 Managed Waste Disposal on Land at 23.1 % and 4 A 1 Cattle at 34.7 %) account for 57.8 % of CH_4 emissions in 2011. Figure Error! ***No text of specified style in document.****-40* shows that the main reasons for declining CH_4 emissions were reductions in 'managed waste disposal on land' mainly caused by the increased use of recycling and incineration of waste with energy recovery and reductions in 'coal mining'. Figure Error! ***No text of specified style in document.****-41* shows that the reduction of these two key categories were mostly due to developments in EU-15 while in EU-28 reductions in the CH_4 emissions from 'cattle' added significantly to the overall reduction of methane emissions.

Figure ***Error! No text of specified style in document.****-40* Absolute change of CH4 emissions by large key categories 1990 to 2011 in CO2 equivalents (Tg) for EU-15



Source: EEA

Figure ***Error! No text of specified style in document.****-41* Absolute change of CH4 emissions by large key categories 1990 to 2011 in CO2 equivalents (Tg) for EU-28

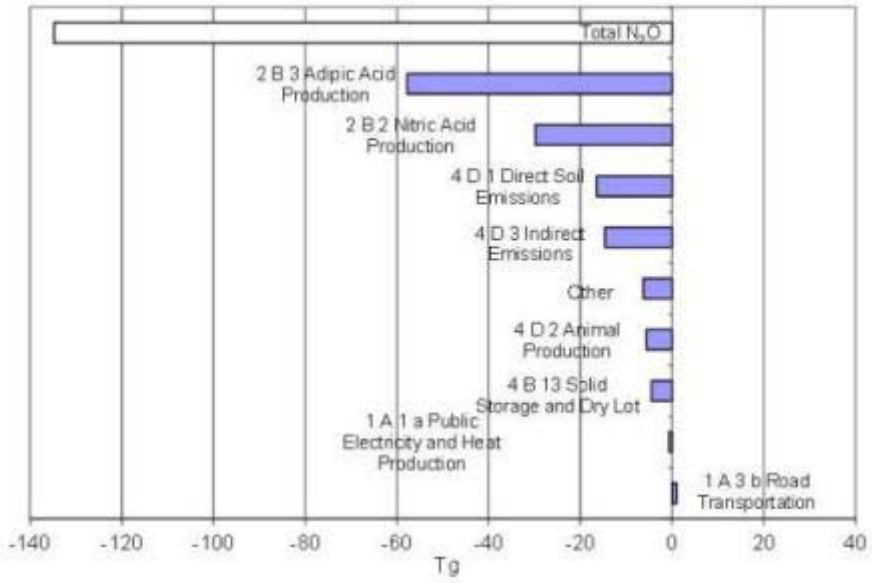


Source: EEA

Nitrous oxide

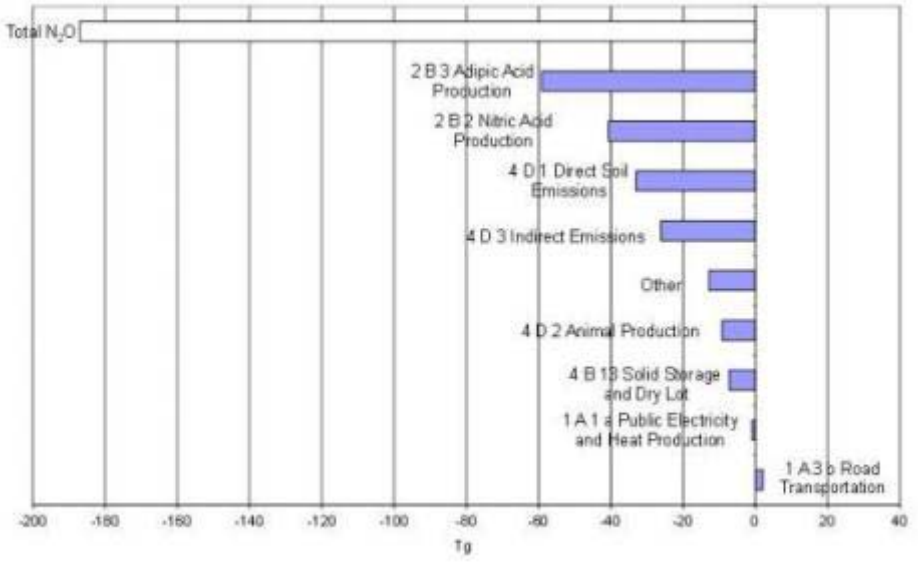
N_2O emissions are responsible for 7.3 % of total EU-15 GHG emissions and decreased by 34.1 % to 264 Tg CO_2 equivalents in 2011 (Figure Error! ***No text of specified style in document.****-42*). The two largest key sources causing this trend (4 D 1 Direct Soil Emissions at 36.6 % and 4 D 3 Indirect Emissions at 24.9 %) account for approx. 61.5 % of N_2O emissions in 2011. The main reason for large N_2O emission cuts were reduction measures in the 'adipic acid production'. When also considering the new Member States, emission cuts in the key categories 'direct soil emissions' and 'Indirect emissions' mostly added to this overall trend in reducing N_2O emisions in the EU-28 (Figure Error! ***No text of specified style in document.****-43*).

Figure ***Error! No text of specified style in document.****-42* Absolute change of N2O emissions by large key categories 1990 to 2011 in CO2 equivalents (Tg) for EU-15



Source: EEA

Figure ***Error! No text of specified style in document.****-43* Absolute change of N2O emissions by large key categories 1990 to 2011 in CO2 equivalents (Tg) for EU-28



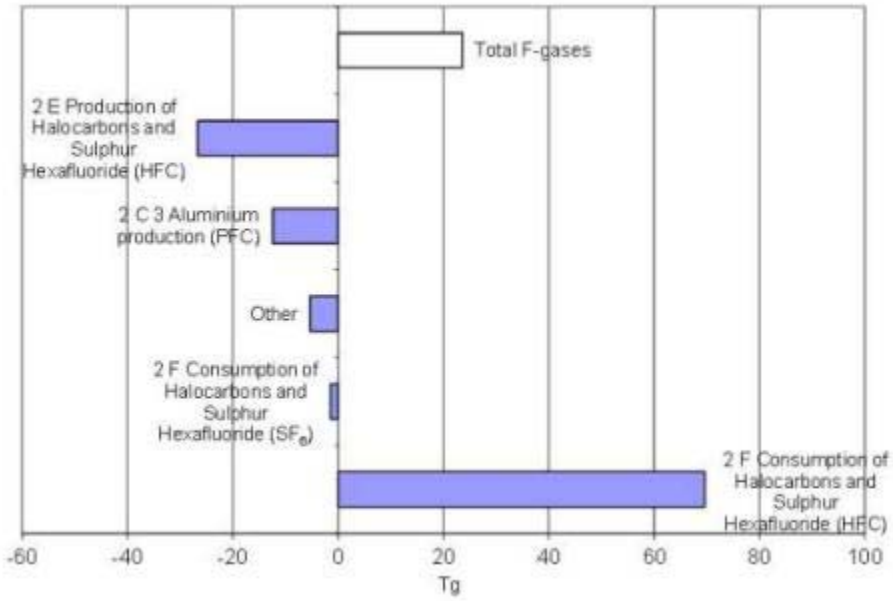
Source: EEA

Fluorinated gases

Fluorinated gas emissions account for 2.2 % of total EU-15 GHG emissions. In 2011, emissions were 80 Tg CO_2 equivalents, which was 42.9 % above 1990 levels (Figure Error! ***No text of specified style in document.****-44*). The two largest key categories (i.e. HFC from consumption of halocarbons and consumption of SF_6) account for 94 % of fluorinated gas emissions in 2011. HFC emissions from the 'consumption of halocarbons' showed large increases between 1990 and 2011. The main reason for this is the phase-out of ozone-depleting substances such as chlorofluorocarbons under the Montreal Protocol and the replacement of these substances with HFCs (mainly in refrigeration, air conditioning, foam production and as aerosol propellants). On the other hand, HFC emissions from the 'production of halocarbons' decreased substantially. The decrease started in 1998 and was strongest in 1999 and 2000. This is mostly the result of reducing HFC-23 by-production by destroying this substance as part of the process. From the remaining F-gases, both perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) showed overall decreases, both in the EU-15 and in the EU-28.

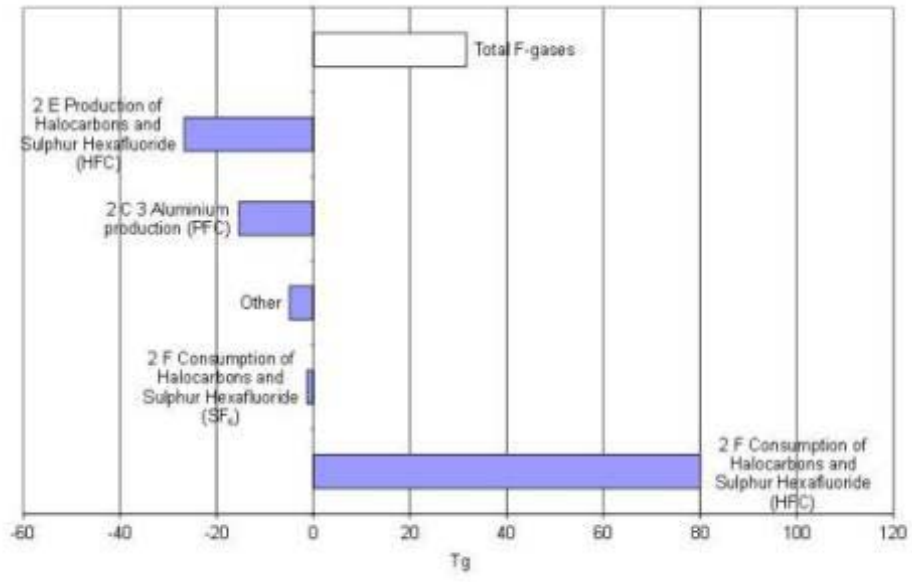
Figure Error! ***No text of specified style in document.****-45* shows that the trend in F-gases in EU-28 is very similar to the trend in EU-15.

*Figure **Error! No text of specified style in document.**-44 Absolute change of F-gas emissions by large key categories 1990 to 2011 in CO2 equivalents (Tg) for EU-15*



Source: EEA

*Figure **Error! No text of specified style in document.**-45* Absolute change of F-gas emissions by large key categories 1990 to 2011 in CO2 equivalents (Tg) for EU-28

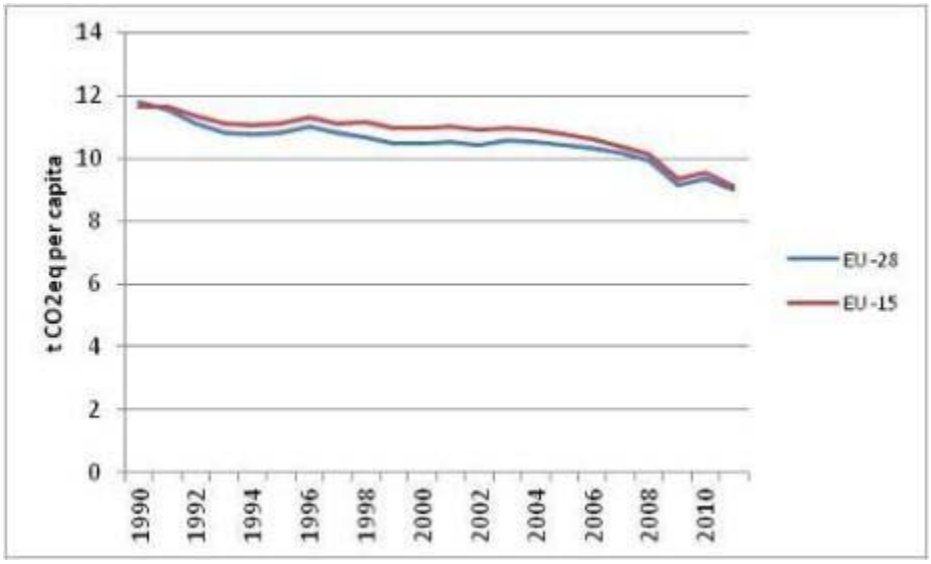


Source: EEA

3.2.5. Key Drivers Affecting Emission Trends

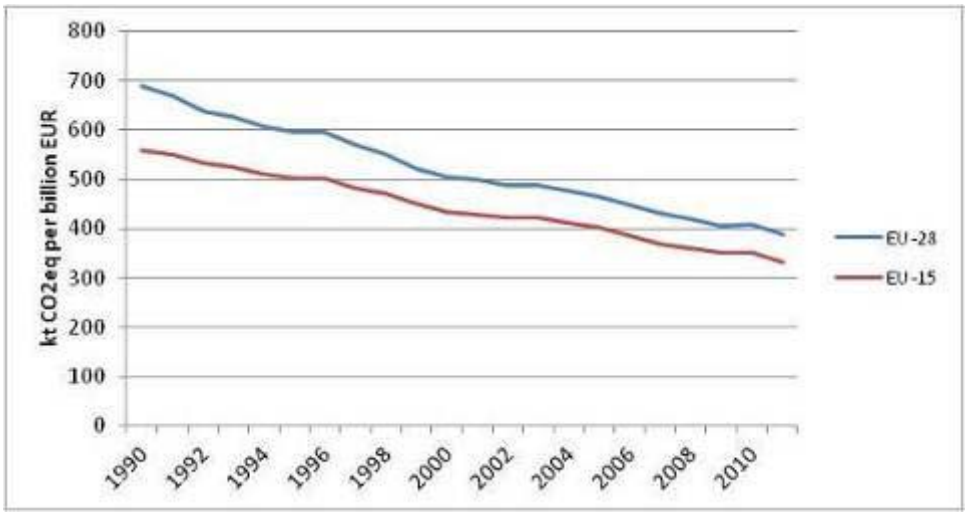
The main reasons for the changes during the period 1990-2011 are described in more detail in section 2 (National Circumstances). Two main drivers of greenhouse gas emissions are population and economic growth. As described in section 2, population grew by 9 % (EU-15) and 7 % (EU-28) and GDP increased by 44 % (EU-15) and 45 % (EU-28) between 1990 and 2011. As GHG emissions declined by 15 % (EU-15) and 18 % (EU-28) both GHG per capita and GHG emissions per GDP fell considerably.

*Figure **Error! No text of specified style in document.**-46 GHG emissions per capita 1990 to 2011 for EU-15 and EU-28*



Source: EEA, Eurostat

*Figure **Error! No text of specified style in document.**-47* GHG emissions per GDP 1990 to 2011 for EU-15 and EU-28



Source: EEA, Eurostat

Since NC4 in 2007, emissions decreased in the EU-28, with a sharp drop in 2009, when the economic downturn caused substantial emission reductions in all Member States. In 2010, emissions increased again, partly driven by the economic recovery from the 2009 recession in many European countries. In particular emissions from iron and steel production and other manufacturing industries increased significantly in 2010.

The sections below summarise the main reasons for the changes in emissions in the EU during the period 2010-2011.

Main reasons for changes in EU-15 emissions, 2010–2011

The 2011 winter was warmer than in the previous year, leading to decreased demand for heating and lower emissions from the residential and commercial sectors.

The 159.6 million tonnes (CO_2 equivalents) decrease in GHG emissions between 2010 and 2011 was mainly due to the following factors:

- A strong emission decrease in households and services (-93.9 million tonnes, or -15.3 %) in almost all EU-15 Member States. Milder winter conditions and the lower demand for heating can partly explain lower emissions in 2011 compared to 2010.

- Decreasing emissions in electricity and heat production (-28.9 million tonnes, or -3.2 %) in particular in the UK and France. In both countries, reductions in demand for electricity was accompanied by greater use of nuclear power and lower use of gas (UK) and coal (France) for electricity generation.

- Decreasing emissions in road transportation (-8.6 million tonnes, or -1.2 %), following a decreasing trend for the fourth consecutive year, which was driven by reductions in both passenger and freight transportation.

- Reduced emissions in the category 'manufacturing industries excluding iron and steel industry' (-10.5 million tonnes, or -2.8 %) in particular in Greece, Italy, Portugal, Spain and the UK. The main reasons were a decline in industrial production (Greece, Spain), a decline in cement production (Greece, Portugal, Spain, and Italy) and a fuel shift from oil to natural gas in the UK manufacturing industry.

- A slight decrease in emissions from iron and steel production (-4.4 million tonnes, or -3 %) following a substantial increase in emissions in 2010 (+29.6 million tonnes or +25.8 %) which was caused by a significant increase in crude steel production due to the recovery from the economic crisis.

- A substantial decrease in emissions from nitric acid production (-3.8 million tonnes, or -40 %) mainly driven by decreases in Belgium, France and the United Kingdom.

Main reasons for emission changes in the EU-28, 2010-2011

Between 2010 and 2011, emission decreases in the EU-28 were mainly due to:

- CO_2 from households and services (-104.5 million tonnes, or -14 %). This decrease was mainly caused by emission reductions in the EU-15. Among the new Member States Poland and the Czech Republic reported the highest decreases.

- CO_2 from public electricity and heat production (-19.5 million tonnes, or -1.6 %). This decrease was mainly caused by the EU-15, while Bulgaria, Romania and Poland had an opposing trend.

- CO_2 from manufacturing industries excl. iron and steel (-11.7 million tonnes, or -2. %). This decrease was mainly due to EU-15 Member States. Half of the new Member States also reported slightly decreasing emissions, while Poland's emission increased by 10 %.

- CO_2 emissions from road transport (-8.6 million tonnes, or -1 %). This decrease was mainly due to emission reductions in the EU-15. Most of the new Member States also contributed to this decreasing trend, while Estonia, Poland, Romania and Slovenia reported emission increases.

- Other major emission decreases occurred in nitric acid production, iron and steel production and solid waste disposal.

Substantial emission increases between 2010 and 2011 in the EU-28 were only reported for:

- N_2O from agricultural soils (+4.3 million tonnes, or +1.8 %).

3.2.6. Information on Indirect Greenhouse Gas Emissions for EU-15

Emissions of CO, NO_x, NMVOC and SO_2 have to be reported to the UNFCCC Secretariat because they influence climate change indirectly: CO, NO_x and NMVOC are precursor substances for ozone which itself is a greenhouse gas. Sulphur emissions produce microscopic particles (aerosols) that can reflect sunlight back out into space and also affect cloud formation. Table Error! **No text of specified style in document.**-4 shows the total indirect GHG and SO_2 emissions in the EU-15 between 1990 and 2011. All emissions were reduced significantly from 1990 levels: the largest reduction was achieved in SO_2 (-86 %), followed by CO (-67 %), NMVOC (-57 %) and NO_x (-49 %).

Table **Error! No text of specified style in document.**-4 Overview of EU-15 indirect GHG and SO_2 emissions for 1990–2011 (Gg)

INDIRECT GHG EMISSIONS	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
	(Gg)									
NO_x	13 673	12 023	10 490	9 482	9 175	8 866	8 140	7 453	7 246	6 966
CO	53 825	42 345	31 937	23 992	22 568	22 087	20 478	18 419	19 239	17 844
NMVOC	15 270	12 596	10 237	8 385	8 239	7 621	7 178	6 824	6 751	6 549
SO_2	16 459	9 986	6 144	4 572	4 353	4 142	3 090	2 668	2 451	2 390

Source: EEA

3.2.7. Information on Indirect Greenhouse Gas Emissions for EU-28

Emissions of CO, NO_x, NMVOC and SO_2 have to be reported to the UNFCCC Secretariat because they influence climate change indirectly. (See 3.2.6 for further explanation). In the EU-28, SO_2 emissions decreased by 78 %, followed by CO (-64 %), NMVOC (-55 %) and NO_x (-48 %) (Table Error! **No text of specified style in document.**-5).

Table **Error! No text of specified style in document.**-5 Overview of EU-28 indirect GHG and SO_2 emissions for 1990–2011 (Gg)

INDIRECT GHG EMISSIONS	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
	(Gg)									
NOx	17 090	14 741	12 748	11 646	11 365	11 015	10 200	9 352	9 209	8 882
CO	67 029	51 691	39 198	30 913	29 580	28 860	27 409	25 124	26 162	24 395
NMVOC	17 957	14 487	11 960	10 076	9 958	9 297	8 859	8 344	8 301	8 065
SO_2	25 378	16 815	10 462	8 307	8 134	7 810	6 432	5 675	5 476	5 654

Source: EEA

3.2.8. Accuracy/Uncertainty of the Data

Table Error! **No text of specified style in document.**-6 shows the main results of the uncertainty analysis for the EU-15. The lowest level uncertainty estimates are for fuel combustion activities (1.2 %) and the highest estimates are for agriculture (75.9 %). Overall level uncertainty estimates including LULUCF of all EU-15 GHG emissions is calculated at 8.3 % and excluding LULUCF slightly lower, at 7.9 %.

With regard to trend uncertainty estimates the lowest uncertainty estimates are for fuel combustion activities (+/- 0.4 percentage points) and the highest estimates are for LULUCF (25.2 percentage points). Overall trend uncertainty (including LULUCF) of all EU-15 GHG emissions is estimated to be 1.1 percentage points.

Table **Error! No text of specified style in document.**-6 Tier 1 uncertainty estimates of EU-15 GHG emissions for the main sectors

Source category	Gas	Emissions 1990	Emissions 2011	Emission trends 1990-2011	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A Fuel combustion activities	all	3 182 229	2 853 395	-10.3%	1.2%	0.4%
1.B Fugitive emissions	all	91 121	42 066	-53.8%	12.1%	7.1%
2. Industrial processes	all	347 030	250 674	-27.8%	9.0%	7.0%
3. Solvents and other product use	all	8 012	5 417	-32.4%	38.1%	5.5%
4. Agriculture	all	433 047	368 929	-14.8%	75.9%	7.4%
6. Waste	all	171 330	101 593	-40.7%	26.3%	12.7%
5. LULUCF	all	-128 679	-142 485	10.7%	31.7%	25.2%
Total (incl LULUCF)	**all**	**4 104 089**	**3 479 590**	**-15.2%**	**8.3%**	**1.4%**
Total (excl LULUCF)	**all**	**4 232 769**	**3 622 074**	**-14.4%**	**7.9%**	**1.1%**

Note: Emissions are in Gg CO_2 equivalents; they are slightly lower than the emissions included in CTF table 1 (a) because not all MS estimate uncertainties for all emissions and this table reflects the emissions for which uncertainty estimates are available.

Source: EEA

This is the second year in which an uncertainty analysis for Tier 2 (Monte-Carlo-Simulation) has been conducted for each sector. The analysis includes all uncertainty data which were reported for the Member States. In detail, these are nearly 1 500 individual data rows for all MS at subsector level and gas.

In all input and output parameters, uncertainty has been expressed as normal probability density function. Consistent with the IPCC requirements, the uncertainty range is presented as a range with 95% probability of a given value being within the boundaries. Thus the boundaries were given as the 2.5 and 97.5-percentiles from the mean value.

During the Monte-Carlo-Analysis the emissions and the combined uncertainty (uncertainty for emission factor and activity data) with normal distribution functions were simulated through 10 000 iterations. Therefore, for each individual level a standard derivation of emissions were generated. The results for this Tier 2 analysis can be found in the following tables (Table Error! ***No text of specified style in document.****-7*, Table Error! ***No text of specified style in document.****-8*).

*Table **Error! No text of specified style in document.**-7 Tier 2 uncertainty estimates of EU-15 GHG emissions per main sector*

Source category	Gas	**Base year emissions 1990** (average simulation value)	**Last Year 2011 emissions** (average simulation value)	**Level uncertainty estimates based on MS uncertainty estimates** medium (2.5 - 97.5 percentile)
1.A Fuel combustion activities	all	3 181 961	2 853 460	1% (0.99 - 0.99)
1.B Fugitive emissions	all	90 883	41 988	11.1% (10.8 – 11.4)
2. Industrial processes	all	346 737	250 547	4.8% (4.8 - 4.8)
3. Solvents and other product use	all	8 023	5 433	33.7% (32.8 – 34.6)
4. Agriculture	all	423 898	366 713	43.9% (43.01 - 44.8)
6. Waste	all	-129 034	-142 269	26.4% (25.996 – 26.9)
5. LULUCF	all	171 043	101 472	20.6% (20.6 - 20.6)

Note: Emissions are in Gg CO_2 equivalents and are mean values of the Monte-Carlo-Analysis

Source: EEA

*Table **Error! No text of specified style in document.**-8 Tier 2 uncertainty estimates of EU-15 GHG emissions per gases*

		CO_2	**CH_4**	**N_2O**	**PFC**	**HFC**	**SF_6**	**Total GHG**
1990	Mean value	3 232.35	427.85	381.80	30.00	10.02	11.50	4 093.51
	Standard deviation	32.17	17.65	97.09	1.46	0.39	0.37	104.84
	2s	2.0%	8.3%	50.9%	9.8%	7.8%	6.4%	**5.1%**
2011	Mean value	2 859.83	284.28	254.99	69.64	3.47	5.14	3 477.35
	Standard deviation	24.19	11.47	79.57	5.41	0.58	0.17	83.88
	2s	1.7%	8.1%	62.4%	15.5%	33.2%	6.5%	**4.8%**

Source: EEA

3.2.9. Changes since the 5th National Communication

Since the publication of the 5th National Communication, various updates and revisions to methodologies have been implemented in the EU GHG inventory, which have impacted on the time-series of emissions. Overall, recalculations for the EU-15 and EU-27[19] are insignificant (below 1 %). However, large recalculations in absolute terms were made in Germany, Spain and France (Table Error! ***No text of specified style in document.***-*9*).

19 At the time of the 5th National Communication, Croatia was not yet part of the European Union, so the comparison here is based on the EU-27 aggregate.

*Table **Error! No text of specified style in document.**-9 Major revisions to the EU GHG inventory since publication of the 5th National Communication*

Country (Year of Change)	Change
Germany (2010)	Change of data source - from the evaluation tables which were used for the last submission - to the Energy Balance which is now available. Correction of error. New activity data and changed emission factor in the Nitric Acid Production.
Spain (2010)	Correction of errors and actualization of basic information from thermal power station. Actualization of basic information about the fuel balance of the year 2007.
Germany (2011)	Reallocation of CO_2 emissions from blast furnace gas combustion in coke ovens, industrial power plants, sinter plants and rolling mills from source category 2C1 to source category 1A1, 1A2a and 1A2f. New available data from national statistics. Estimation procedure has been corrected in accordance with IPCC (1996b) procedure for agricultural soils (N_2O). Correction of error in the estimation of TAN-immobilization in solid manure systems. Correction of emission factors (1996 GL instead of 2006 GL) in agricultural soils (N_2O). Revision of method that considers N-losses due to emissions from N-species in agricultural soils (N_2O).
France (2011)	Actualization of the compilation of the content of biogas as a result of the UNFCCC survey.
France (2013)	Modified livestock rates in the agriculture sector as a result of the agricultural census of 2010. Method changes for the estimation of solid waste disposal as a result of the UNFCCC survey in 2010. The estimate 2013 now integrates generation and burning of biogas.

At the time of the 5th National Communication, the trend of overall EU-15 GHG emissions excluding LULUCF between 1990 and 2007 was -4.3 %. In the 2013 submission this trend between 1990 and 2007 has decreased to -4.2 %. In the EU-27, the trend of GHG excluding LULUCF between 1990 and 2007 changed from -9.3 % in the 2007 submission to -9.2 % in the latest submission.

3.3. National System

3.3.1. Institutional Arrangements

In the EU, the legal basis for the compilation of the Union greenhouse gas inventory is Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for

reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC (hereafter referred to as the Monitoring Mechanism Regulation or MMR). More details of the Regulation are given in section [BR1] 4.9.1 in Annex 1: EU's 1st Biennial Report. The EU national inventory system as well as the QA/QC programme is described in more detail in a Commission Staff Working Document[20].

The Directorate General for Climate Action of the European Commission is the overall body responsible for preparing the inventory of the European Union. Each Member State is responsible for the preparation of its own inventory and these inventories provide the necessary data for the inventory of the European Union, which is the sum of Member State inventories. As of 9 January 2013, all Member States of the EU are Annex I parties to the UNFCCC and have committed to preparing individual GHG inventories and submitting them to the UNFCCC Secretariat by 15 April each year.

The main institutions involved in the compilation of the EU GHG inventory are:

- Member States,
- European Commission Directorate General for Climate Action (DG Climate Action),
- European Environment Agency (EEA) and its European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM),
- Eurostat (also a Directorate General of the European Commission), and
- Joint Research Centre (JRC, also a Directorate General of the European Commission).

The roles and responsibilities of various agencies and entities in relation to the inventory development process, as well as the institutional, legal and procedural arrangements made to prepare the inventory are schematically shown in Figure Error! **No text of specified style in document.**-48 below. The entity with the overall responsibility for the Union inventory system is the European Commission, more specifically DG Climate Action.

DG Climate Action is assisted by the European Environment Agency (EEA), which is an agency of the European Union. Article 24 of the Monitoring Mechanism Regulation provides the legal basis for the cooperation between the European Commission and the EEA. The EEA's main task in the inventory process is the compilation of the Union inventory (CRF tables) and preparation of the Union inventory report. The EEA is assisted in its work by a European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM), which is an international consortium working with the EEA

20 Commission Staff Working Document SWD(2013)308 final on Elements of the Union greenhouse gas inventory system and the Quality Assurance and Control (QA/QC) programme.

under a framework partnership agreement. The Commission's DGs Eurostat and JRC are also involved in the process of inventory preparation, with their respective roles related to energy statistics for Eurostat and LULUCF and agriculture for JRC[21].

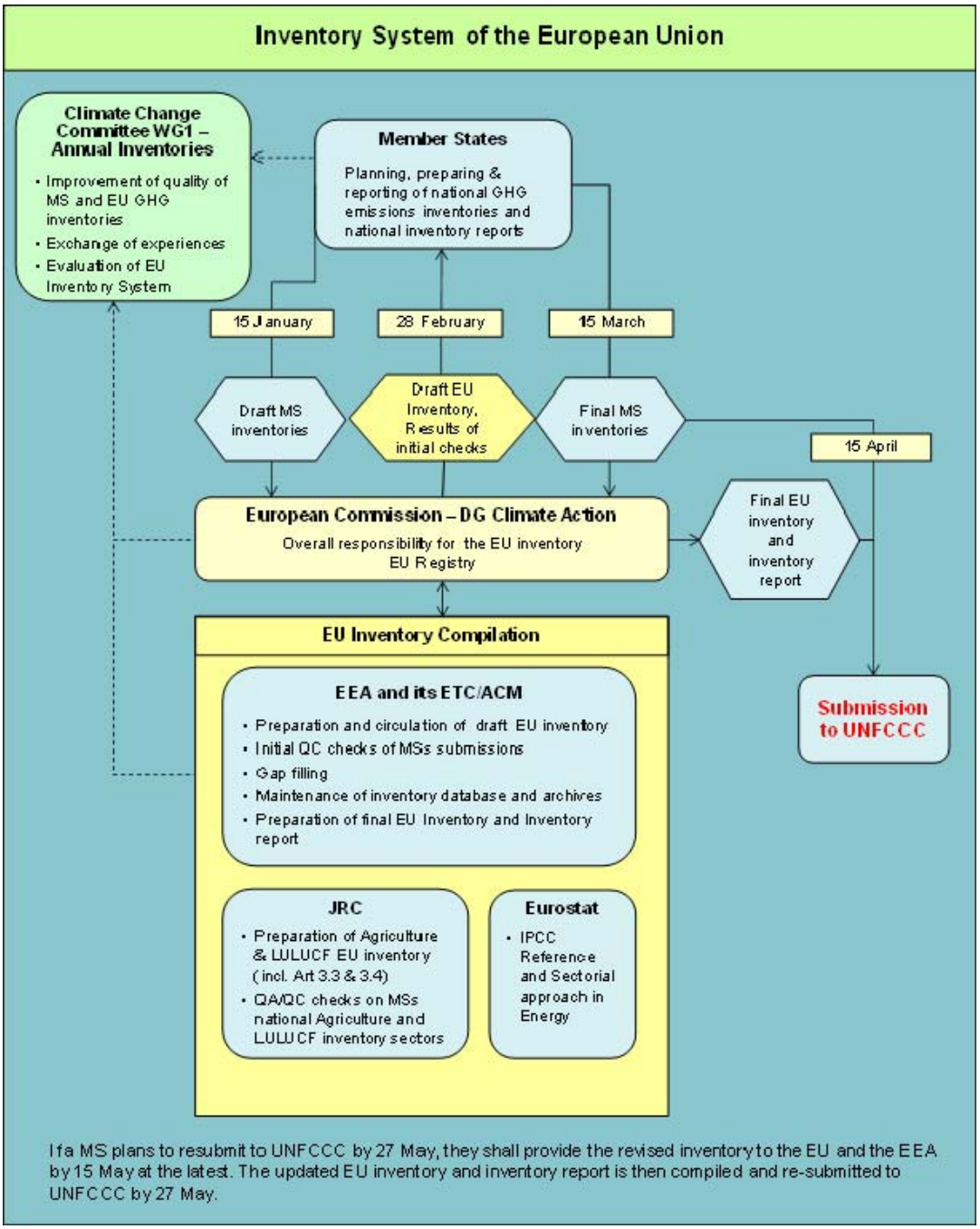
While the Union GHG inventory is the sum of the sectoral emissions data from the Member States, the only case where this is different is with regard to the CO_2 emissions for the Reference Approach based on Eurostat energy data. The Reference Approach is a top-down approach, using high-level energy supply data to calculate the CO_2 emissions from the combustion of mainly fossil fuels.

The Union inventory for the complete time series, including the base year and all other inventory years, is established on the basis of the inventories supplied by Member States. The total estimates in the Union GHG inventory should accurately reflect the sum of Member States' national GHG inventories. The quality of the Union inventory therefore depends on the quality of Member States' inventories. Member States are responsible for the quality of activity data, emission factors and other parameters used for their national inventories as well as the correct application of methodologies provided in the IPCC Guidelines, IPCC Good Practice Guidance and IPCC Good Practice Guidance for LULUCF. Member States are also responsible for establishing QA/QC programmes for their inventories. The QA/QC activities of each Member State are described in the respective national inventory reports and summarised in the Union inventory report. The detailed QA/QC activities of the Union inventory system are described in the EU national inventory report and also summarised in section 3.3.2, below.

The Monitoring Mechanism Regulation sets out the annual cycle of preparation of the EU inventory, as shown schematically by Figure Error! **No text of specified style in document.**-48, below. By 15 January each year, Member States submit draft national inventories to the European Commission. The EEA, assisted by it ETC/ACM, Eurostat and JRC, carries out quality checks and prepares a draft EU inventory by 28 February. Member States submit final inventories (CRF tables and national inventory reports) to the Commission by 15 March, which contain the same information as the submission on 15 April to the UNFCCC Secretariat. The EEA, assisted by the ETC/ACM, Eurostat and JRC, together with DG Climate Action then prepare the final EU inventory (CRF tables and EU national inventory report). Both the EU and Member States individually make their official submissions to the UNFCCC Secretariat on 15 April.

21 The Statistical Office of the European Communities (Eurostat) and the Joint Research Centre (JRC) are DGs of the European Commission. For simplicity reasons, these institutions are referred to as 'Eurostat' and the 'JRC' in this report.

Figure **Error! No text of specified style in document.**-48 Inventory system of the European Union



3.3.2. Quality Assurance/Quality Control (QA/QC) Procedures

The quality of the Union GHG inventory depends on the quality of the Member States' inventories, the QA/QC procedures of the Member States and the quality of the compilation process of the European Union inventory. The Member States and also the European Union as a whole have implemented QA/QC procedures in order to comply with the IPCC good practice guidance.

The EU QA/QC programme[22] describes the quality objectives and the inventory quality assurance and quality control plan for the Union GHG inventory including responsibilities and the time schedule for the performance of the QA/QC procedures. Definitions of quality assurance, quality control and related terms used are those provided in IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and Guidelines for National Systems under the Kyoto Protocol. The EU QA/QC programme is reviewed annually and modified or updated as appropriate.

The European Commission (DG Climate Action) is responsible for coordinating QA/QC activities for the Union inventory and ensures that the objectives of the QA/QC programme are implemented and the QA/QC plan is developed. The European Environment Agency (EEA) is responsible for the annual implementation of QA/QC procedures for the Union inventory.

The overall objectives of the EU QA/QC programme are:

- to establish quality objectives for the Union GHG inventory, taking into account the specific nature of this inventory as a compilation of Member States' GHG inventories;
- to implement the quality objectives in the design of the QA/QC plan, defining general and specific QC procedures for the EU GHG inventory submission
- to provide a Union inventory of GHG emissions and removals consistent with the sum of Member States' inventories and covering the EU's geographical area;
- to ensure the timeliness of Member States' GHG inventory submissions to the EU;
- to ensure the completeness of the Union GHG inventory, inter alia, by implementing procedures to estimate any data missing from the national inventories, in consultation with the Member State concerned;
- to contribute to the improvement of quality of Member States' inventories and

22 SWD(2013) 308 final.

- to provide assistance for the implementation of national QA/QC programmes.

A number of specific objectives have been elaborated in order to ensure that the Union GHG inventory complies with the UNFCCC inventory principles of transparency, completeness, consistency, comparability, accuracy and timeliness.

In the QA/QC plan, quality control procedures before and during the compilation of the Union GHG inventory are listed. In addition, QA procedures, procedures for documentation and archiving, the time schedules for QA/QC procedures and the provisions related to the inventory improvement plan are included.

QC procedures are performed at several different stages during the preparation of the Union inventory. Firstly, a range of checks are used to determine the consistency and completeness of Member States' data so that they may be compiled in a transparent manner at EU level. Secondly, checks are carried out to ensure that the data are compiled correctly at EU level to meet the overall reporting requirements. Thirdly, a number of checks are conducted with regard to data archiving and documentation to meet various other data quality objectives.

Further improvement of the QA/QC procedures

One of the most important activities for improving the quality of national and Union GHG inventories is the organisation of workshops and expert meetings under the EU GHG Monitoring Mechanism. Since 2004, a number of workshops and expert meetings on QA/QC in GHG inventories have been organised. Workshop reports are available at the website of the EEA/ETC-ACM[23].

In recent years, workshops mostly focused on quality improvements in the sector LULUCF. Information on these workshops are available at the Joint Research Centre's website[24].

3.3.3. The EU Inventory Methodology and Data

This National Communication has been compiled using the Union inventory and with regards to the UNFCCC guidance for parties preparing their National Communications. The Union inventory is compiled, in accordance with the UNFCCC guidelines[25], on the basis of the inventories of the 15 or 28 Member States (until 2013, only 27 Member States, prior to the accession of Croatia from 1 July 2013). The estimates of emissions in the Union inventory are, where appropriate and feasible, consistent with the IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories[26], the 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas

23 http://acm.eionet.europa.eu/meetings/past_html

24 http://afoludata.jrc.ec.europa.eu/index.php/public_area%5Cevents_policy

25 United Nations Framework Convention on Climate Change (UNFCCC), 2006. Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. Nairobi. http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf

26 Intergovernmental Panel on Climate Change (IPCC), 1997. Revised 1996 IPCC guidelines for national greenhouse gas inventories. Geneva.

Inventories[27] and the 2003 Good Practice Guidance for Land Use, Land-Use Change and Forestry[28]. In addition to the Monitoring Mechanism Regulation, Commission Decision 2005/166/EC provides the legal framework for the compilation of the Union GHG inventory. It forms the implementing legislation of the previous Decision 280/2004/EC, which was replaced by the Monitoring Mechanism Regulation. The MMR itself is to be complemented by so-called implementing and delegated acts, which further specify reporting provisions. Due to the nature of the legislative process, by the time of submission of this NC, these additional legal acts may not be yet in place. In the interim period, Commission Decision 2005/166/EC continues to apply, until repealed. Many of the provisions of the new implementing and delegated acts may not differ substantially from those in the Decision.

The emissions of each source and sink category are the sum of the emissions of the respective source and sink categories of the 15 or 28 Member States. This also applies for the base year estimate of the EU-15 GHG inventory. Currently, 12 Member States have selected 1995 as the base year for fluorinated gases, while Austria, France and Italy have chosen 1990 (Table Error! ***No text of specified style in document.****-10*).

Table ***Error! No text of specified style in document.****-10 Base year emissions for EU-15 Member States*

27 Intergovernmental Panel on Climate Change (IPCC), 2000. Good practice guidance and uncertainty management in national greenhouse gas inventories. Geneva.

28 Intergovernmental Panel on Climate Change (IPCC), 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. Geneva.

EU-15 MS	CO_2, CH_4, N_2O	HFC, PFC, SF_6	Base year emissions [1] (tonnes CO_2 equivalents)
Austria	1990	1990	79 049 657
Belgium	1990	1995	145 728 763
Denmark	1990	1995	69 323 336
Finland	1990	1995	71 003 509
France	1990	1990	563 925 328
Germany	1990	1995	1 232 429 543
Greece	1990	1995	106 987 169
Ireland	1990	1995	55 607 836
Italy	1990	1990	516 850 887
Luxembourg	1990	1995	13 167 499
Netherlands	1990	1995	213 034 498
Portugal	1990	1995	60 147 642
Spain	1990	1995	289 773 205
Sweden	1990	1995	72 151 646
United Kingdom [)]	1990	1995	776 337 201
EU-15	1990	1990 (AT, FR, IT) 1995 (other MS)	4 265 517 719

Source: Initial review reports of the EU-15 Member States (www.unfccc.int)
1 Base-year emissions exclude emissions and removals from the LULUCF sector but include emissions due to deforestation in the case of Member States for which LULUCF constituted a net source of emissions in 1990.
2 The base year emissions relate to the EU territory of Denmark and the UK.

*Table **Error! No text of specified style in document.**-11 Base year emissions for new Member States*

New MS	CO_2, CH_4, N_2O	HFC, PFC, SF_6	Base year emissions 1) (tonnes CO_2 equivalents)
Bulgaria	1988	1995	132 618 658
Croatia	1990	1990	31 321 790
Cyprus	Not relevant	Not relevant	
Czech Republic	1990	1995	194 248 218
Estonia	1990	1995	42 622 310
Hungary	1985-87	1995	115 397 149
Latvia	1990	1995	25 909 160
Lithuania	1990	1995	49 414 386
Malta	Not relevant	Not relevant	
Poland	1988	1995	563 442 774
Romania	1989	1989	278 225 022
Slovakia	1990	1990	72 050 764
Slovenia	1986	1995	20 354 042

Member States use different national methodologies, national activity data or country specific emission factors in accordance with IPCC and UNFCCC guidelines. The EU believes that this is consistent with the UNFCCC reporting guidelines and the IPCC good practice guidelines, provided each methodology is consistent with the IPCC good practice guidelines. In general, no separate methodological information is provided at EU level except summaries of methodologies used by Member States. Details can be found in the Annual European Union greenhouse gas inventory 1990-2011 and Inventory Report 2013 submission to the UNFCCC Secretariat. For some sectors quality improvement projects, including expert workshops, have been started with the aim of further improving estimates at Member State level. These sectors include energy background data, emissions from international bunkers, emissions and removals from LULUCF, emissions from agriculture, and waste.

Table Error! **No text of specified style in document.**-12 shows the geographical coverage of the EU-15 Member States' national inventories. The EU-15 inventory and the EU-28 inventory, respectively, are the sums of the Member States' inventories and cover the same geographical area as the inventories of the Member States, to the extent to which their territories are part of the Union (see some differences for Denmark, France and the United Kingdom).

Table **Error! No text of specified style in document.**-12 Geographical coverage of the EU-28 inventory

Member State	**Geographical coverage**	**EU-territory coverage (UNFCCC and Kyoto)**	**Party coverage (UNFCCC)**	**Party coverage (Kyoto Protocol)**
Austria	Austria	√	√	√
Belgium	Belgium consisting of Flemish Region, Walloon Region and Brussels Region	√	√	√
Denmark	Denmark (excluding Greenland and the Faeroe Islands)	√		
	Denmark, Faroe Islands and Greenland		√	
	Denmark and Greenland			√
Finland	Finland including Åland Islands	√	√	√
France	Metropolitan France, the overseas departments (Guadeloupe, Martinique, Guyana and Reunion) and the overseas communities (Saint-Barthelemy and Saint-Martin), excluding the French overseas communities (French Polynesia, Wallis and Futuna, Mayotte, Saint-Pierre and Miquelon) and overseas territories (the French Southern and Antarctic Lands) and New Caledonia.	√		√

Member State	Geographical coverage	EU-territory coverage (UNFCCC and Kyoto)	Party coverage (UNFCCC)	Party coverage (Kyoto Protocol)
	Metropolitan France, the overseas departments (Guadeloupe, Martinique, Guyana and Reunion), the overseas communities (French Polynesia, Saint-Barthelemy and Saint-Martin, Wallis and Futuna, Mayotte, Saint-Pierre and Miquelon) and overseas territories (the French Southern and Antarctic Lands) and New Caledonia.		√	
Germany	Germany	√	√	√
Greece	Greece	√	√	√
Ireland	Ireland	√	√	√
Italy	Italy	√	√	√
Luxembourg	Luxembourg	√	√	√
Netherlands	The reported emissions include those that have to be allocated to the legal territory of the Netherlands. This includes a 12-mile zone from the coastline and also inland water bodies. It excludes Aruba, Curaçao and Sint Maarten that are constituent countries within the Royal Kingdom of the Netherlands. It also excludes the isles Bonaire, Saba and Sint Eustatius that are since 10 October 2010 public bodies (openbare lichamen) with their own legislation that is not applicable to the European part of the Netherlands. Emissions from offshore oil and gas production on the Dutch part of the continental shelf are included.	√	√	√
Portugal	Mainland Portugal and the two Autonomous regions of Madeira and Azores Islands. Includes also emissions from air traffic and navigation bunkers realized between these areas.	√	√	√
Spain	Spanish part of Iberian mainland, Canary Islands, Balearic Islands, Ceuta and Melilla.	√	√	√
Sweden	Sweden	√	√	√
United Kingdom	England, Scotland, Wales and Northern Ireland, and Gibraltar, excluding the UK Crown Dependencies (Jersey, Guernsey and the Isle of Man) and the UK Overseas Territories (except Gibraltar).	√		
	England, Scotland, Wales and Northern Ireland, the UK Crown Dependencies (Jersey, Guernsey and the Isle of Man) and the UK Overseas Territories that have ratified the Kyoto Protocol (the Cayman Islands, the Falkland Islands, Bermuda, Montserrat and Gibraltar).		√	√
EU-15		√		
Bulgaria	Bulgaria	√	√	√
Croatia	Croatia	√	√	√
Cyprus	Area under the effective control of the Republic of Cyprus	√	√	√
Czech Republic	Czech Republic	√	√	√
Estonia	Estonia	√	√	√

Member State	Geographical coverage	EU-territory coverage (UNFCCC and Kyoto)	Party coverage (UNFCCC)	Party coverage (Kyoto Protocol)
Hungary	Hungary	√	√	√
Latvia	Latvia	√	√	√
Lithuania	Lithuania	√	√	√
Malta	Malta	√	√	√
Poland	Poland	√	√	√
Romania	Romania	√	√	√
Slovakia	Slovakia	√	√	√
Slovenia	Slovenia	√	√	√

3.3.4. Data Gap Filling Procedure

The Union GHG inventory is compiled by using the inventory submissions of the EU Member States. If a Member State does not submit all data required for the compilation of the Union inventory by 15 March of a reporting year, the Commission prepares estimates for data missing for that Member State. In the following cases gap filling is undertaken:

- to complete specific years in the GHG inventory time-series for a specific Member State;
- for the most recent inventory year(s);
- for the base year;
- for some years of the time series from 1990 to the most recent year;
- to complete individual source categories for individual Member States that did not estimate specific source categories for any year of the inventory time series and reported 'NE'. Gap filling methods are used for major gaps when it is highly certain that emissions from these source categories exist in the Member States concerned;
- to provide complete CRF background data tables for the European Union when some Member States only provided CRF sectoral and summary tables. (In this case, the gap filling methods are used to further disaggregate the emission estimates provided by Member States.)
- to enable the presentation of consistent trends for the EU.

For data gaps in the Member States' inventory submissions, the following procedure is applied by the ETC/ACM in accordance with the implementing provisions under the Monitoring Mechanism Regulation for missing emission data:

- If a consistent time series of reported estimates for the relevant source category is available from the Member State for previous years that has not been subject to adjustments under Article 5.2 of the Kyoto Protocol, extrapolation of this time series is used to obtain the emission estimate. As far as CO_2 emissions from the energy sector are concerned, extrapolation of emissions should be based on the percentage change of Eurostat CO_2 emission estimates if appropriate.

- If the estimate for the relevant source category was subject to adjustments under Article 5.2 of the Kyoto Protocol in previous years and the Member State has not submitted a revised estimate, the basic adjustment method used by the expert review team as provided in the 'Technical guidance on methodologies for adjustments under Article 5.2 of the Kyoto Protocol' is used without application of the conservativeness factor.

- If a consistent time series of reported estimates for the relevant source category is not available and if the source category has not been subject to adjustments under Article 5.2 of the Kyoto Protocol, the estimation should be based on the methodological guidance provided in the 'Technical guidance on methodologies for adjustments under Article 5.2 of the Kyoto Protocol' without application of the conservativeness factor.

The Commission prepares the estimates by 31 March of the reporting year, following consultation with the Member State concerned, and communicates the estimates to the other Member States. The Member State concerned shall use the estimates referred to for its national submission to the UNFCCC to ensure consistency between the EU inventory and Member States' inventories.

The methods used for gap filling include interpolation, extrapolation and clustering[29]. The methods are consistent with the adjustment methods described in UNFCCC Adjustment Guidelines (Table 1 of the Technical Guidance on methodologies for adjustments under Art. 5, para. 2 KP) and in the IPCC Good Practice Guidance. On the basis of the general approaches mentioned above, concrete methodologies were developed for each sector and GHG as required by the UNFCCC reporting guidelines.

Starting with the GHG inventory 2011, estimates have been available for all EU Member States and no gap filling was therefore needed.

29 ETC ACC technical note on gap filling procedures, December 2006.

3.4. National registry

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and Decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of the EU has undergone major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of the EU) is called the Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

- Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

- Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

- Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

- Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

- The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

- The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;

- All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to

ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

(a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);

(b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;

(c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;

(d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;

(e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. Croatia was migrated and consolidated as of 1 March 2013. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry have therefore occurred in 2012, as a consequence of the transition to the CSEUR platform:

*Table **Error! No text of specified style in document.**-13 Changes to the EU national registry in 2012*

Reporting Item	Description
15/CMP.1 Annex II.E paragraph 32.(a) Change of name or contact	N/A
15/CMP.1 Annex II.E paragraph 32.(b) Change regarding cooperation arrangement	The EU Member States who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went into production on 20 June 2012. Croatia was migrated and consolidated as of 1 March 2013. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidating national registries. This description includes: • Readiness questionnaire • Application logging • Change management procedure • Disaster recovery • Manual Intervention • Operational Plan • Roles and responsibilities • Security Plan • Time Validation Plan • Version change Management The documents above are provided as an appendix to the latest EU inventory submission. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.
15/CMP.1 Annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	In 2012, the EU registry has undergone major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR). The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to the latest EU inventory submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and led to successful certification on 1 June 2012.

Reporting Item	Description
15/CMP.1 Annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The overall change to a Consolidated System of EU Registries triggered changes the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to the latest EU inventory submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and led to successful certification on 1 June 2012.
15/CMP.1 Annex II.E paragraph 32.(e) Change to discrepancies procedures	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated manual intervention document and the operational plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to the latest EU inventory submission.
15/CMP.1 Annex II.E paragraph 32.(f) Change regarding security	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated security plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to the latest EU inventory submission.
15/CMP.1 Annex II.E paragraph 32.(g) Change to list of publicly available information	N/A
15/CMP.1 Annex II.E paragraph 32.(h) Change of Internet address	The new internet address of the European Community registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/EU/index.xhtml
15/CMP.1 Annex II.E paragraph 32.(i) Change regarding data integrity measures	The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated disaster recovery plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to the latest EU inventory submission.
15/CMP.1 Annex II.E paragraph 32.(j) Change regarding test results	On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.

Reporting Item	Description
The previous Annual Review recommendations	N/A

4. POLICIES AND MEASURES

Key developments

Cross-cutting policies and measures

- Many existing EU-level policies and measures are being strengthened to meet the targets for the year 2020 from the integrated Climate and Energy Package. This includes legislation put in place by the EU to reduce its greenhouse gas emissions by at least 20 % compared to 1990 by 2020, with a conditional offer to move to 30%, provided that other developed countries commit themselves to comparable emission reductions and developing countries contribute adequately according to their responsibilities and respective capabilities. Furthermore, the EU has committed to supplying 20 % of energy from renewable sources by 2020 (as a share of total EU gross final energy consumption), supplemented by a target to achieve a minimum of 10 % renewable transport fuel. Moreover, the EU has committed to a 20 % reduction of total primary energy consumption by 2020, compared to a Business as Usual baseline.

- The EU ETS has been revised and strengthened based on lessons learned. The third phase (2013-2020) has successfully started. The changes include a single, EU-wide emissions cap, auctioning of new allocations as default allocation method, harmonised allocation rules based on EU-wide performance benchmarks for free allocation, additional sectors and gases included. The EU ETS covered on average 41 % of total EU-28 GHG emissions during the 2008-2012 period.

- Member States have taken on binding annual targets (for each year from 2013 to 2020), reducing their greenhouse gas emissions from the sectors not covered by the EU ETS, such as housing, agriculture, waste and transport (excluding aviation), and a thorough annual compliance system has been established.

- The revised and strengthened Monitoring Mechanism Regulation (MMR) entered into force in 2013. It enhances current reporting rules on GHG emissions to implement the Climate and Energy package and to meet requirements arising from current and future international climate agreements.

- With regard to the EU's future climate strategy, the Commission adopted policy documents to promote the discussion on the long-term framework of climate and energy policies in Europe. It includes a roadmap on moving

towards a competitive low carbon economy in 2050, a White Paper on competitive and efficient transport systems, a roadmap on energy, and a bioeconomy strategy. Furthermore, the Commission adopted a Green Paper to launch a public debate on the preparation of the EU climate and energy framework for 2030.

Energy

- Significant progress has been made to meet the 20% renewables target by 2020 laid down in the Climate and Energy Package. The share of gross inland energy consumption met by renewables has increased substantially over the last ten years to around 13 % in 2011. A substantial increase can be seen from renewable heat production, wind power generation and photovoltaics whereas hydro power production has been relatively constant. At national level, EU Member States prepared National Renewable Energy Action Plans and most Member States experienced significant growth in renewable energy on the way towards meeting their national binding targets. At present, many Member States are reviewing their national support schemes to improve the overall cost efficiency of policies on renewables. The Strategic Energy Technology Plan is guiding Member States since 2007 in prioritising the development of innovative solutions which will respond to the needs of the European energy system by 2020, 2030 and beyond.

- A wide range of policies and measures were also introduced to promote energy efficiency, most recently the Energy Efficiency Directive. This Directive aims at keeping the EU's energy efficiency target on track and explicitly sets goals for primary and final energy consumption by 2020.

- Overall, a decarbonisation of the energy sector has been experienced, as highlighted by the following data: the consumption of carbon-intensive coal and lignite decreased by 37 % by 2011 compared to 1990, while gas consumption increased by more than 30 %. Renewables have seen the most marked increase with consumption increasing by over 120 % in 2011 from 1990 levels.

Transport

- CO_2 emissions of motor vehicles are targeted by recent regulations which aim at reducing emissions of the passenger car fleet by 40 % and emissions of light commercial vehicles by 28 % by 2020, compared to the 2007 fleet emission average. These efforts are supplemented by environmental performance requirements such as tyre pressure monitoring systems and gear shift indicators.

- Significant progress has been made to reduce the average CO_2 emissions of the new passenger car fleet and meet the binding targets set at 130 g CO_2/km by 2015 and 95 g CO_2/km by 2020. Average emissions decreased to 132.2 g CO_2/km in 2012, compared with the 2007 fleet average of 158.7 g CO_2/km.

- In order to reduce fossil fuel consumption, the Fuel Quality Directive also introduced a binding target for fuel suppliers to reduce life-cycle GHG emissions per unit of energy by up to 6 % by 2020 compared to 2010. In addition, in 2013 the Commission adopted the Clean Power for Transport Package which supports the broad deployment of alternative fuels vehicles and vessels and the relevant infrastructures in Europe. .

- The Commission also adopted a strategy for progressively including GHG from maritime transport. As a first step, a proposed legislation for the monitoring, reporting and verification of emissions from large ships is under consideration by the Parliament and the Council.

- Transport activity, in particular freight transport and transport in the new EU Member States, has steadily increased in the EU since 1990 until the economic crisis. As a result, GHG emissions from transport have grown until 2007, albeit at a slower pace than real GDP, and are decreasing since.

Industry

- Emissions from F-gases are regulated, leading to a cumulative reduction of 2 861 kt CO_2 eq by 2010, since the adoption of two legislative acts on F-gases in 2006. Furthermore, a proposal to strengthen this legislation is under consideration by the Council and the European Parliament. It aims at limiting the use of F-gases in new equipment and introducing a phase-down measure of HFCs combined with some bans of use.

- The new Industrial Emissions Directive (IED) also aims at achieving significant benefits to the environment and human health by reducing polluting emissions to the atmosphere, water and soil, as well as waste from industrial and agricultural installations, in particular through better application of Best Available Techniques (BAT).

Agriculture

- In recent years, environmental considerations including climate change mitigation have been integrated into the Common Agricultural Policy (CAP). The new CAP (covering the2014-2020 period) will further enhance the existing policy framework for sustainable management of natural resources, contributing to both climate change mitigation and enhancing the resilience of farming to the threats posed by climate change and variability.

- Furthermore, legislation is in place (the Nitrates Directive) to contribute to decreasing CH_4 and N_2O emissions from agricultural activities. The European Soil Thematic Strategy also aims at preventing soil degradation and preserving soil as an important carbon pool.

Forestry

- The new EU Forest Strategy provides a framework that coordinates and ensures coherence of forest-related policies and allows synergies with other sectors that influence forest management. Member States are asked to consider the principles and goals of this strategy when setting up and implementing their action plans and national forest programmes. The new EU legislation on GHG accounting rules for LULUCF activities (going beyond forestry) lays down rules for the robust accounting in this sector. It will support the mitigation potential of this sector by improving the visibility and tracking progress of mitigation efforts.

Waste

- Since the last National Communication, focus has been put on the full and timely implementation of the EU waste legislation, which contributes directly or indirectly to a reduction of GHG emissions.

4.1. Introduction

In the European Union, there are two distinct levels of policies and measures (PaMs) that have an impact on greenhouse gas emissions:

- European Union policies, which are proposed by the Commission and subsequently approved, amended or rejected by the Council of the European Union and the European Parliament. These common and coordinated policies and measures (CCPM) are applicable to all Member States, though Member States may implement Directives at different points in time. The EU's National Communication concentrates on these CCPMs

- National policies developed and implemented by Member States themselves. As such, these policies and measures are outside the scope of this National Communication.

The scope of this section comprises

- A description of the policy making process in the EU (section 4.2),

- 4.3. Additional Information Required Under the Kyoto Protocol (section 4.3),

- Descriptions of cross-sectoral PaMs and sectoral PaMs on energy, transport, industry, agriculture, forestry and waste (sections 4.4 to 4.10) and

- Descriptions of the interactions of policies and measures (section 4.12) and of the effects of PaMs on the modification of long-term trends (section 4.13).

Major parts of the contents of the PaMs chapter of the National Communication as required by the UNFCCC reporting guidelines for National Communications overlap with contents required for the Biennial Reports. Thus, in several sub-chapters of this section only a reference to the respective section in Annex 1: EU 1st Biennial Report is given.

Complementing the descriptions of policies and measures in the respective sectoral chapters, quantifications of the PaMs' impacts on GHG emission reduction are summarised in CTF table 3 in the Appendix: CTF for EU 1st Biennial Report of Annex 1: EU 1st Biennial Report. These (mostly) ex-ante estimates have been produced by the European Commission in individual policy impact assessments and assume full implementation of the CCPMs. However, estimates are not available for all CCPMs and all years covered in CTF Table 3. Some older estimates are also for the EU-15 while more recent estimates are for the EU-27 or the EU-28. In contrast, the estimates of expected GHG emission savings presented in the projections section 5 are uniquely derived from aggregating MS estimates.

4.2. The Policy Making Process

4.2.1. Introduction

Adoption of new legislation in Europe commonly follows the so-called co-decision procedure (ordinary legislative procedure), whereby both the Council of the European Union (Council of Ministers) and the directly elected European Parliament collectively amend, adopt or reject legislation proposed by the Commission. In this process the Parliament and the Council are given equal weighting.

With regards to the policy making process, there are four key stages:

- Policy demands are made and articulated. The impetus or demonstration of the need for a policy can come from a variety of sources, but only the Commission has the power of initiative to propose legislation.

- Once the proposal has been presented by the European Commission, the Council and the European Parliament, depending on procedure, can amend the proposal. This means that all three institutions can play an active role in shaping the final proposal.

- Policy proposals must then be formally agreed on by both the European Parliament and the Council. If no agreement can be reached the policy is not adopted and the procedure is ended.

- Policy proposals are then implemented. While the Commission takes the lead in implementation, it remains the responsibility of individual Member States to implement EU policies at the national level according to their own national systems and processes. Failure to meet agreed objectives can invoke infringement proceedings, which are dealt with by the European Court of Justice and can result in a fine for non-compliance with EU legislation.

A key step towards the formulation and implementation of any EU policy is to carry out an Impact Assessment[30] of the proposed policy or key policy changes. The Impact Assessment outlines a process that prepares evidence for political decision-makers on the advantages and disadvantages of possible policy options. The Impact Assessment is carried out by the Directorate General who takes the lead on a particular policy. The Impact Assessment process is an important element of implementing the EU's commitments under Article 4.2(e)(ii) of the UNFCCC to "identify and periodically review its own policies and practices which encourage activities that lead to greater levels of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol than would otherwise occur".

There are a number of legal instruments available to the European Union to reach its objectives, with due respect for the subsidiarity principle[31]: Regulations, Directives, Decisions and Recommendations (see NC4 and NC5 for more details).

This section of the National Communication introduces the overall policy context in the European Union describing strategies and practices that have been set-up or revised since the Fifth National Communication. Moreover, the chapter presents information on the way economic, social and environmental consequences are assessed for policies and measures, and provides a description of the EU-wide monitoring and evaluation of policies and measures. Changes in institutional arrangements concerning monitoring and evaluation of GHG mitigation policies are highlighted as are legislative arrangements and enforcement and administrative procedures relevant to the implementation of the Kyoto Protocol.

4.2.2. Monitoring and Evaluation

For a description of EU-wide monitoring and evaluation please refer to section [BR1] 4.9.1 in Annex 1: EU 1st Biennial Report.

30 SEC(2009) 92 Impact Assessment Guidelines: http://ec.europa.eu/governance/impact/docs/key_docs/iag_2009_en.pdf

31 The principle whereby the Union does not take action (except in the areas which fall within its exclusive competence) unless it is more effective than action taken at national, regional or local level, http://europa.eu/scadplus/glossary/subsidiarity_en.htm

4.2.3. Overall Policy Context

4.2.3.1. Europe 2020

Europe 2020 is a new ten year growth strategy and builds upon the lessons learnt from the Lisbon Strategy and also draws on the benefits that have arisen from the coordinated response to the financial crisis in the European Recovery Plan (refer to section 5.1.2 of NC 5). The main objective of Europe 2020 is to deliver "smart, sustainable, inclusive growth" as a result of greater coordination of both national and European policy. The three priorities of the Europe 2020 strategy are outlined in a 2010 communication[32] entitled "Europe 2020: A strategy for smart, sustainable, inclusive growth" and include:

- Smart growth: developing an economy based on knowledge and innovation;
- Sustainable growth: promoting a more resource-efficient, greener and more competitive economy;
- Inclusive growth: fostering a high employment economy delivering social and territorial cohesion.

An emphasis on sustainability is included in the Europe 2020 strategy and therefore attaining the EU's 20/20/20 climate and energy targets is one of the five headline targets. Seven flagship initiatives have been presented to address these targets. In relation to sustainable growth, these include the "Resource Efficient Europe Flagship"[33] which was launched in 2011. The flagship initiative provides a long-term framework for actions in many policy areas, supporting policy agendas for climate change, energy, transport, industry, raw materials, agriculture, fisheries, biodiversity and regional development. It provides for the series of coordinated roadmaps that are discussed in section 4.2.3.5.

The European Semester is a policy coordination exercise, which assesses the progress of each Member State towards meeting the targets set out in the Europe 2020 strategy. The progress towards attaining the EU's 20/20/20 climate and energy targets is assessed based on the National Reform Programmes of Member States and projections of future greenhouse gas emissions. Following the analysis the Commission can provide Member States with specific recommendations that can help to strengthen the mainstreaming of climate action into broader economic policies.

The results of the European Semester 2013 indicate that the EU-27 is on track to meet its 2020 GHG emissions target. However, it is evident from the assessments that the projected performance of Member States is highly variable and several Member States have been identified as requiring additional effort.[34] For example, 13 Member States will not reach their 2020 emission target set under the Effort Sharing Decision without

32 COM (2010) 2020 Final.

33 COM (2011) 21.

34 http://ec.europa.eu/clima/policies/g-gas/progress/docs/16_energy_and_ghg_en.pdf

additional efforts. Furthermore although all Member States are expected to meet their national targets for 2020 set by the Renewable Energy Directive, the European Semester 2013 suggests that additional measures may be necessary due to the economic crisis and various barriers to renewable energy development hindering progress.

In order to further assist Member States with progressing towards the 20/20/20 energy and climate change targets, the European Semester 2013 recommends the following policy initiatives[35]:

- Planning effective, growth-friendly use of the revenue from auctioning of EU ETS allowances to start in 2013,
- Realising the full potential for increasing energy efficiency, particularly in the buildings sector,
- Providing a stable, coherent and cost-efficient framework for investment in green technologies, in renewable energy sources and in energy infrastructure,
- Exploiting the emissions reduction potential of transport,
- Fully exploiting the possibility of shifting the tax burden away from labour to tax bases less detrimental to growth and jobs, in particular through environmental taxation,
- Removing environmentally harmful subsidies.

4.2.3.2. European Climate Change Programme

The European Climate Change Programme (ECCP) was established in June 2000 to provide a cohesive framework to identify and develop the necessary elements of an EU strategy to implement the Kyoto Protocol. In autumn 2005, the Commission launched ECCP II as a continued programme for policy preparation and development. This second phase investigated new policy areas such as adaptation, aviation and carbon capture and storage, as well as reviewing and further implementing policies and measures that were the focus of ECCP I. Further information was included in the EU's 4th National Communication.

4.2.3.3. Climate and Energy Package

In December 2008, the European Parliament and the European Council agreed on the EU Climate and Energy Package, which for the first time provided an integrated and ambitious package of policies and measures to tackle climate change. The Climate and

35 http://ec.europa.eu/clima/policies/g-gas/progress/index_en.htm

Energy Package was formally adopted in 2009. It includes the 20-20-20 targets, which set the following key objectives:

- To reduce greenhouse gas emissions by at least 20 % compared to 1990 by 2020, with a firm commitment to increase this target to 30 % in the event of a satisfactory international agreement being reached;

- To achieve 20 % of energy from renewable sources by 2020 (as a share of total EU gross final energy consumption), supplemented by a target to achieve a minimum of 10 % renewable transport fuel; and

- A commitment to save 20 % of total primary energy consumption by 2020 compared to a business as usual baseline.[36]

In order to meet these key objectives, the Climate and Energy Package comprises four pieces of complementary legislation[37]:

- A Directive revising the EU Emissions Trading Scheme (EU ETS), which covers some 40 % of EU greenhouse gas emissions (for a detailed description refer to Section 4.4);

- An "effort-sharing" Decision setting binding national targets for emissions from sectors not covered by the EU ETS (for a detailed description refer to Section 4.4);

- A Directive setting binding national targets for increasing the share of renewable energy sources in the energy mix (for a detailed description refer to sections 4.5 and 4.6);

- A Directive creating a legal framework for the safe and environmentally sound use of carbon capture and storage technologies. Carbon Capture and Storage Directive, detailed description in section 4.4).

The package is complemented by two further legislative acts that were agreed at the same time: A regulation requiring a reduction in CO_2 emissions from new cars (CO_2 regulation) and a revision of the Fuel Quality Directive (for details see section 4.6). Energy efficiency is not directly covered by the Climate and Energy Package; however the Energy Efficiency Directive was adopted in 2012 to help achieve the energy efficiency target. For more information on the Climate and Energy Package please refer to the 5th National Communication. Individual legislations are detailed in the relevant sectors.

36 The 20 % EU energy efficiency target was legally defined in the Energy Efficiency Directive as the 'Union's (at that time: EU-27) 2020 energy consumption of no more than 1474 Mtoe primary energy or no more than 1078 Mtoe of final energy.

37 http://europa.eu/rapid/press-release_IP-09-628_en.htm

The 20-20-20 targets have recently been adopted as one of the headline targets of the Europe 2020 strategy (see section 4.2.3.2) and progress towards achieving the three key objectives of the Climate and Energy Package includes:

- GHG emissions for the EU in 2011 have decreased by 17 % compared to 1990 levels.[38]

- The share of renewables in the final energy consumption of the EU-28 amounted to 13 % in 2011 – compared to 8.5 % in 2005.[39]

Primary energy consumption peaked in 2006 (approximately 1706 Mtoe) and has been decreasing since 2007, falling to 1583 Mtoe in 2011.[40]

4.2.3.4. The Energy 2020 Strategy

The achievement of Europe's ambitious goals will require substantial change in Europe's energy system, with public authorities, energy regulators, infrastructure operators, the energy industry and citizens all actively involved, and tough choices to be made. The European Commission therefore published a Second Strategic Energy Review[41] on 13th November 2008 as a further step towards achieving the core energy objectives of sustainability, competitiveness and security of supply. In response to the political agenda outlined by the Second Strategic Energy Review (please refer to the 5th National Communication), the communication "Energy 2020 – A strategy for competitive, sustainable and secure energy"[42] was adopted by the European Commission on the 10th of November 2010.

The Energy 2020 strategy aims to respond to the longer term challenges of decarbonising the EU's energy supply whilst also ensuring energy security and the competitiveness of the region. The Communication is the product of extensive debates within the EU institutions and wider stakeholders, which provides an ambitious policy framework that "consolidates existing measures and steps up activity in areas where new challenges are emerging"[43]. Five key energy priorities for the EU over the next ten years are identified within the Energy 2020 communication:

- Achieving an efficient Europe;

- Building a truly pan-European integrated energy market;

- Empowering consumers and achieving the highest level of safety and security;

38 The scope includes aviation. http://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends/greenhouse-gas-emission-trends-assessment-5

39 http://ec.europa.eu/clima/policies/g-gas/progress/docs/16_energy_and_ghg_en.pdf

40 http://ec.europa.eu/clima/policies/g-gas/progress/docs/16_energy_and_ghg_en.pdf

41 COM (2008) 781 final.

42 COM (2010) 639 final.

43 COM (2010) 639 final.

- Extending Europe's leadership in energy technology and innovation;
- Strengthening the external dimension of the EU energy market.

Each energy priority is accompanied by a series of actions to encourage the successful implementation of the Energy 2020 Strategy. Most importantly, these include legislation on energy efficiency (Energy Efficiency Directive, see section 4.5) and the Energy Infrastructure Regulation, entitled "Guidelines for trans-European Energy Infrastructure"[44] agreed upon in 2013.

The Energy 2020 Strategy acknowledges the importance of establishing a blueprint of the European Infrastructure for 2020-2030 and a subsequent proposal adopted by the European Commission in 2011[45] identified the priority infrastructure that needs to be constructed in order to facilitate a functioning internal market that can integrate a large scale production of renewables and guarantee security of supply. Further actions to support the building of a truly pan-European integrated energy market include the timely and accurate implementation of the internal market legislation, streamlining permit procedures and market rules for infrastructure developments and to provide the right financing framework.

In order to extend Europe's leadership in energy technology and innovation the Energy 2020 Strategy calls for the implementation of the Strategic Energy Technology (SET) plan[46], which establishes an energy technology policy for Europe – accelerating the development and deployment of cost-effective low carbon technologies. The importance of funding for 'frontier research' and strengthening external links is also emphasised within the Energy 2020 Strategy.

4.2.3.5. Roadmaps 2050

In 2011, the European Commission launched three roadmaps to promote the discussion on the long-term framework of climate and energy policies in Europe: a) the "Roadmap for Moving to a Competitive Low Carbon Economy in 2050"[47] b) the "Roadmap to a Single European Transport Area - Towards a Competitive and Resource Efficient Transport System"[48] and c) the "Energy Roadmap 2050"[49]. The European Council reconfirmed in February 2011 that the objective of the EU is to reduce Europe's GHG emissions by 80 to 95 % below 1990 levels by 2050 as part of efforts by developed countries as a group to reduce their emissions by a similar degree. Although the EU is already committed to GHG emission reductions of at least 20 % below 1990 levels by 2020 as part of the Climate and Energy Package, longer-term policies are now required to ensure that the ambitious reduction target for 2050 is achieved. The European

44 OJ L 115 25.04.2013, p.39.

45 COM (2011) 658 final.

46 http://ec.europa.eu/energy/publications/doc/2010_setplan_brochure.pdf

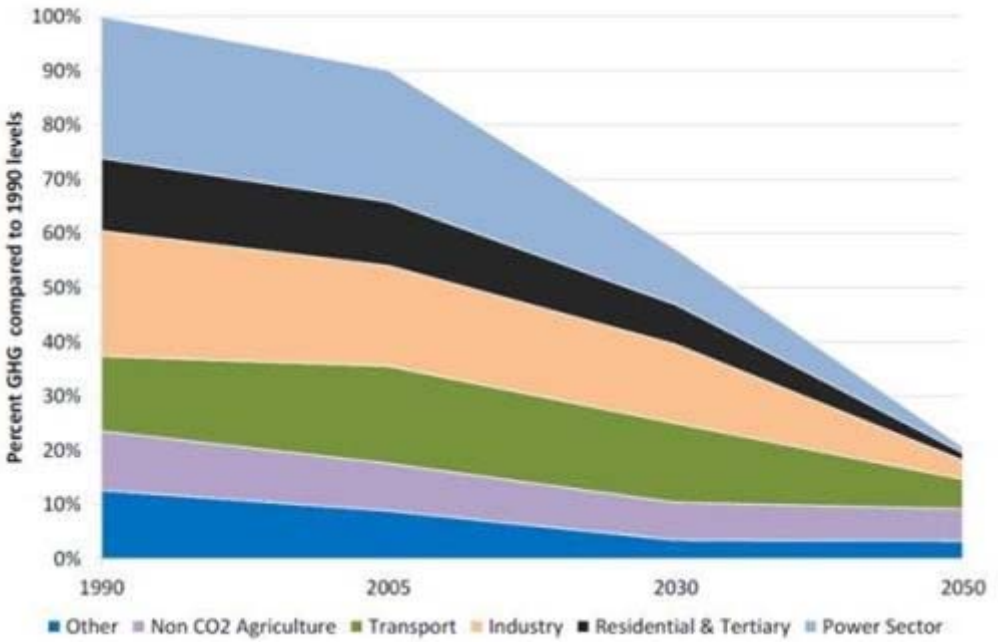
47 COM (2011) 112 final.

48 COM (2011) 144 final.

49 COM(2011) 885/2.

Commission has therefore published the communication entitled “Roadmap for moving to a competitive low-carbon economy in 2050”, providing guidance on how the EU can decarbonise its economy.

*Figure **Error! No text of specified style in document.**-49 EU Roadmap 2050 decarbonisation pathway*



Source: COM (2011) 112 Final

The Roadmap for moving to a competitive low-carbon economy in 2050 is based on economic modelling and scenario analysis, which considers how the EU can move towards a low carbon economy assuming continued global population growth, increasing global GDP and, by varying trends in terms of international climate action (i.e. global action / fragmented action), energy (i.e. fossil fuel prices) and technological development (i.e. effective technology scenarios / delayed CCS and delayed electrification scenarios). ‘The analysis of the projections of the different EU decarbonisation scenarios shows that by 2050, an 80 % EU internal reduction compared to 1990 is technically feasible with proven technologies if a sufficiently strong carbon price incentive is applied across all sectors (ranging from approx. €100 to €370 per ton of CO_2eq)’.[50] The cost-efficient pathway for achieving the 2050 target calls for domestic GHG reductions below 1990 levels of 25 % in 2020, 40 % in 2030 and 60 % in 2040 and this would require an additional annual investment of €270 billion[51] for all sectors over the next 40 years.

50 SEC(2011) 289 final.

51 This estimated annual investment is averaged out over a 40 year period and is based on the effective technology scenario for both the global and fragmented action case.

The extent and timing of these GHG reduction milestones are differentiated by sector reflecting the different abatement potentials that exist within the EU (*Figure Error! **No text of specified style in document.**-49*). It is assumed within the Roadmap strategy that electricity demand will significantly increase[52] (i.e. electrification of transport) and that in parallel GHG emissions from the power sector will need to reduce drastically by 93 to 99 % below 1990 levels by 2050.

The Energy Roadmap 2050[53] was therefore subsequently published by the European Commission to assess a range of scenarios (i.e. energy efficiency / high renewables / delayed CCS / low nuclear) for the region's future energy mix. The outcome of the assessment is that decarbonisation of the power sector is possible and that the total energy system may be less costly, as a percentage of European GDP, than current policies in the long run due in part to reduced exposure to fossil fuel price volatility in the future[54]. All scenarios for decarbonising the power sector result in higher capital expenditure and lower fuel costs.

The "Roadmap for Moving to a Competitive Low Carbon Economy in 2050" strategy envisages that GHG emissions associated with the transport sector need to be reduced by between 54 % and 67 % below 1990 levels by 2050. The European Commission has recently published a white paper entitled "Roadmap to a Single European Transport Area" to provide policy guidance on mitigation options which include:

- developing and deploying new and sustainable fuels and propulsion systems;
- optimising the performance of multimodal logistic chains, including making greater use of more energy-efficient modes;
- increasing the efficiency of transport and of infrastructure use with information systems (including SESAR and Galileo) and market-based incentives (such as the application of 'user pays' and 'polluter pays' principles)[55].

The Energy Roadmap and the Transport Roadmap are consistent with the emission reduction milestones. The European Commission expects Member States and stakeholders to take these Roadmaps - and any further sector specific Roadmaps - into account in the further development of EU and national policies for achieving a low carbon economy by 2050.

In addition to these roadmaps, a framework for transforming Europe's economy into a sustainable one by 2050 was set in 2001 with the "Roadmap to a Resource Efficient

52 Gross electricity consumption in 2050 in the Effective Technologies scenario than in the Delayed Electrification scenario and is around 850 TWh higher than in the reference scenario

53 COM (2011) 885/2.

54 Exposure to fossil fuel price volatility would drop in decarbonisation scenarios as import dependency falls to 35-45 % in 2050, compared to 58 % under current policies. This applies under the assumption of global carbon action.

55 COM (2011) 144 final.

Europe"[56] with emphasis on resource productivity and decoupling of economic growth and resource use.

The Roadmaps are part of the Resource Efficiency Flagship of the Europe 2020 Strategy (see section 4.2.3.1).

4.2.3.6. European Bioeconomy Strategy

The European Bioeconomy Strategy[57] that was adopted in February 2012 promotes the transition to a post-petroleum society. It covers all biomass producing and processing sectors, aiming to substitute the use of fossil resources by renewable ones in industrial processes and to improve the resource efficiency of production processes through innovative solutions based on the use of industrial biotechnology (e.g. to green conventional chemical processes) and other innovative technologies. The Bioeconomy Strategy will ensure that substantial EU, national and private funding is provided for bioeconomy research and innovation and will improve the co-ordination of funding to support established priorities of bioeconomy related policies.

4.2.3.7. 2030 Framework for Climate and Energy Policies

In March 2013 the Commission adopted a Green Paper entitled 'A 2030 Framework for climate and energy policies'[58]. The key objectives of the 2030 framework will include the reduction of greenhouse gas emissions, securing energy supply and supporting economic growth.

An early adoption of the 2030 framework for climate and energy policies is justified in the Green Paper on the basis that it will provide longer term certainty for investors and will also enable the EU to set its level of ambition in the ongoing UNFCCC negotiations in advance of the expected 2015 deadline for an international agreement.

The 2030 framework will build upon the experience and lessons learnt from the 2020 framework and will take into account the longer term perspective outlined previously by the Commission in the 2011 Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050 and the Transport White Paper. A stakeholder consultation allowed the Member States and other stakeholders to contribute their view on the type, nature and level of potential climate and energy targets for 2030. The outcome of both the stakeholder consultation and the Impact Assessment will feed into a proposal by the Commission for the 2030 Framework expected early in 2014.

4.2.3.8. 7th Environmental Action Programme

General environment action programmes have guided the development of EU environment policy since the early seventies. The Sixth EU Environment Action

56 COM (2011) 571 final.

57 COM (2012) 60 final.

58 COM (2013) 169 final.

Programme (EAP) covered the period 2002-2012. A Decision on a 7th EU Environment Action Programme, (entitled 'Living well, within the limits of our planet') was formally adopted in November 2013[59]. The 7th EAP- proposed by the European Commission in 2012 - provides an overarching framework for environmental policy (without specific set objectives for climate policy as this is now a separate policy area) up to 2020, identifying nine priority objectives for the EU and its Member States:

- protecting nature and strengthen ecological resilience
- boosting sustainable resource-efficient low-carbon growth
- effectively addressing environment-related threats to health,
- better promoting the implementation of EU environment law,
- ensuring that policies benefit from state of the art science,
- securing the necessary investments in support of environment and climate change policy,
- improving the way environmental concerns and requirements are reflected in other policies,
- enhancing the sustainability of EU cities, and
- improving the EU's effectiveness in addressing regional and global challenges related to the environment and climate change.

Based on these objectives the 7th EAP will 'create a shared understanding of the state of Europe's environment, the challenges we face and the opportunities we have'[60]. It is recognised within the Decision that most of the legislation for meeting these objectives are already in place; however additional efforts are required to improve implementation of current legislation, the evidence base for policy, the investment framework and integration on environment aspects into other policies and sectors.

4.2.4. Assessment of the economic and social consequences of response measures

For a description of the assessment procedures of the economic and social consequences of response measures in the EU, see section [BR1] 4.10 in Annex 1: EU 1st Biennial Report.

59 http://ec.europa.eu/environment/newprg/pdf/PE00064_en.pdf

60 http://europa.eu/rapid/press-release_MEMO-12-908_en.htm

4.2.5. Legislative Arrangements and Enforcement/ Administrative Procedures Relevant to Kyoto Protocol Implementation

For the EU-15 Member States, the Kyoto Protocol's compliance procedures will only apply if the EU-15 as a whole misses its 8% reduction target. Should this occur, then each Member State will be held to its target under the EU's burden-sharing agreement, and the EU as a whole will be in non-compliance with its obligation to meet the -8 % target. On top of that, the European Commission can decide to start infringement procedures against EU-15 Member States that miss their targets under the burden-sharing agreement.

The remaining Member States with Kyoto targets (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia) are bound to their individual targets as set out in the Kyoto Protocol, both under the Kyoto Protocol's non-compliance procedures and under EU law.

Article 258 of the Treaty on the Functioning of the European Union gives the Commission powers to take legal action against a Member State that is not respecting its obligations.

If the Commission considers that there may be an infringement of EU law that warrants the opening of an infringement procedure, it addresses a "Letter of Formal Notice" (first written warning) to the Member State concerned, requesting it to submit its observations by a specified date, usually two months.

In light of the reply or absence of a reply from the Member State concerned, the Commission may decide to address a "Reasoned Opinion" (second and final written warning) to the Member State. This clearly and definitively sets out the reasons why it considers there to have been an infringement of EU law, and calls upon the Member State to comply within a specified period, usually two months.

If the Member State fails to comply with the Reasoned Opinion, the Commission may decide to bring the case before the Court of Justice. Where the Court of Justice finds that the Treaty has been infringed, the offending Member State is required to take the measures necessary for compliance.

Article 260 of the Treaty gives the Commission power to act against a Member State that does not comply with a previous judgement of the European Court of Justice. The article also allows the Commission to ask the Court to impose a financial penalty on the Member State concerned.

Further information on infringement procedures, including recent decisions on breaches of EU law, can be found on the Commission's website[61].

61 http://ec.europa.eu/community_law/infringements/infringements_en.htm

In addition, the EU has implemented a thorough compliance system as part of the climate and energy package. In the EU ETS compliance is determined for all installations and aviation operators on an annual basis. The Effort Sharing Decision establishes emission reduction targets for the non-ETS sector for each Member States individually for each year of the 2013-2020 period and also includes an annual compliance mechanism at the end of each reporting year with clear consequences when Member States fail to meet their commitments.

4.2.6. Changes in institutional arrangements

For a description of the changes in institutional arrangements, please refer to section [BR1] 4.9 in Annex 1: EU 1st Biennial Report.

4.3. Additional Information Required Under the Kyoto Protocol

4.3.1. Introduction

The following section contains information in accordance with UNFCCC Decision 15/CMP.1, and contains supplementary information required under Article 7 paragraph 2 of the Kyoto Protocol regarding:

- 4.3.2. Member State use of Kyoto mechanisms (section 4.3.2),
- 4.3.3. Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17 (section 4.3.3),
- 4.3.4.1. Policies and Measures Promoting Sustainable Development (Art. 2 (1) Kyoto Protocol) (section 4.3.4.1),
- 4.3.4.2. Policies and Measures Related to Bunker Fuels (Art. 2 (2) Kyoto Protocol) (section 4.3.4.2) and
- 4.3.4.3. Minimisation of adverse impacts (Art. 2 (3) Kyoto Protocol) (section 4.3.4.3).

4.3.2. Member State use of Kyoto mechanisms

For a description of Member State use of Kyoto mechanisms, please refer to section [BR1] 4.12 in Annex 1: EU 1st Biennial Report.

4.3.3. Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17

Supplementarity obligations under the Kyoto Protocol require that any international credit purchases by Member States must be in addition to emission abatement action taken domestically. Within the EU the term has not been quantitatively defined.

Although the end of the first commitment period is reached, final information on compliance and on supplementarity for this period is not available before the end of the true-up period in 2015.

In general, for the EU the use of flexible mechanisms takes place on the one hand by operators in the EU ETS, on the other hand by governments for the achievement of Kyoto targets.

As part of the EU ETS, Member States were required to inform the European Commission in their Phase II NAPs on the maximum amount of JI and/or CDM credits that can be used. This limit was then assessed according to the principle of supplementarity, and where appropriate approved or revised by the European Commission. The percentages vary from 4 % of free allocation in Estonia to 22 % in Germany. In total, this adds up to 1.4 billion CERs or ERUs that could have been used in the second trading period[62]. The amended EU ETS Directive 2009/29/EC (Article 11a(8)) sets the upper limit for credit use for the period from 2008 to 2020 at a maximum of 50 % of the reduction effort below 2005 levels. This is further specified into installation-level limits in the Commission Regulation on international credit entitlements (RICE) [63]. The sum of the installation-level limits is expected to be lower than the upper limit, but higher than the 1.4 billion CERs and ERUs already allowed in the second period (see section [BR1] 4.2.2.4). Since some entitlements are expressed as a percentage of verified emissions, the overall maximum amount will only be known at the end of third trading period.

Information on the actual use of Kyoto mechanisms by governments cannot currently be estimated: Due to a change in the reporting of SEF tables, the separation between entities holding accounts (EHA) and operator holding accounts (OHA) is no longer reliable, making it impossible to distinguish between governmental use of flexible mechanisms and changes to the number of units induced by operators in the EU ETS. Information on the actual amounts of retired units by Member States for compliance in the first commitment period is shown in CTF Table 4b in the CTF Appendix. This information is too incomplete to discuss with regard to the percentage of flexible mechanisms used for compliance in the first commitment period.

In *Table Error! **No text of specified style in document.**-14* the initial Assigned Amount Units (AAU) for EU-15 and EU-28[64] are compared to actual emissions and the

62 EEA 2013 - Trends and Projections Report, http://www.eea.europa.eu/publications/trends-and-projections-2013

63 Commission regulation on determining international credit entitlements pursuant to Directive 2003/87/EC of the European Parliament and of the Council (OJ L 299, 9.11.2013, p.32-33)

64 EU-28 is calculated as the sum of all EU Member States, although Cyprus and Malta do not have an individual target under the Kyoto Protocol.

projected use of flexible mechanisms in the first commitment period (CP 1). The table bases on results from the EEA Trends and Projections Report 2013[65] and takes into account preliminary GHG emissions for the year 2012 and information on the planned governmental use of flexible mechanisms, as these have been reported by questionnaires under the biennial submission from Member States to the European Commission under the EU Monitoring Mechanism Decision[66].

With the issuance of EU ETS allowances (EUA) which are directly linked to AAU, a separation of the total assigned amount has indirectly been determined between ETS and non-ETS sector (see [BR1] section 4.2.2.2 in EU's 1st Biennial Report). In both sectors, emissions in the 2008-2012 period are below the designated targets for EU-15 and EU-28 aggregate. Nevertheless, 1 212 million units of flexible mechanisms are planned to be used in total in EU-15, of which 808 million units have already been surrendered in the EU ETS. In EU-28 the amount of units used in the EU ETS is 1 039 million units, whereas the net sum of the governmental units planned to be used is 17 million units. This is due to the fact that in most EU-13 Member States there are sales of units planned through the International Emission Trading (IET) and Joint Implementation, reducing the total amount from 403 million to 17 million units.

In total, the estimated effect of the use of flexible mechanisms in CP 1 (in the EU ETS and governmental) for EU-28 amounts to 1 056 Mt CO_{2eq} about 4 % of initial AAU. For more information by Member States please refer to section [BR1] 4.12 in Annex 1: EU 1st Biennial Report.

65 http://www.eea.europa.eu/publications/trends-and-projections-2013

66 Decision no 280/2004/EC.

*Table **Error! No text of specified style in document.**-14 Supplementarity: Use of flexible mechanisms 2008-2012 (preliminary results)*

		EU-15	EU-28*
Initial assigned Amounts (2008-2012)	Mt CO_2 eq.	19 621	26 712
AAU issued for ETS (2008-2012)		7 803	10 341
Non-ETS target (2008-2012)		11 818	16 371
Actual Emissions (2008-2012)		18 735	23 376
of which ETS		7 394	9 614
of which Non-ETS (2012= proxy)		11 341	13 762
Preliminary difference to Non-ETS target without use of flexible mechanisms and effect of carbon sinks		477	2 609
Planned governmental net use of flexible mechanisms	Million units	403	17
Use of flexible mechanisms in EU ETS		808	1 039
CDM		528	663
JI		281	376
Planned total use of flexible mechanisms		1 212	1 056
* Cyprus and Malta have no individual target under the Kyoto Protocol			

Source: Data from EEA Trends and Projections Report 2013

4.3.4. Policies and measures in accordance with Art 2 (KP)

4.3.4.1. Policies and Measures Promoting Sustainable Development (Art. 2 (1) Kyoto Protocol)

Sustainable development is an overarching objective of the European Union set out in the Treaty, governing all the Union's policies and activities. Information on the EU's Sustainable Development Strategy (SDS) was included in the EU's 5th National Communication.

In 2009, the Commission adopted the 2009 Review of EU SDS[67]. The review stresses that the EU has mainstreamed sustainable development into a broad range of its policies. In particular, the European Union has taken the lead in the fight against climate change and the promotion of a low-carbon economy[68]. At the same time, unsustainable trends persist in many areas and the efforts need to be intensified. The review takes

67 (COM (2009) 400 final, 24/07/2009, Mainstreaming sustainable development into EU policies: 2009 Review of the European Union Strategy for Sustainable Development. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0400:FIN:EN:PDF

68 http://ec.europa.eu/environment/eussd/

stock of European Union policy measures in the areas covered by the EU SDS and launches a reflection on the future of the EU SDS and its relation to the Lisbon strategy.

The review is complemented by Eurostat's bi-annual monitoring report on sustainable development (Eurostat, 2011[69]). The monitoring report aims to provide an objective, statistical picture of progress toward the goals and objectives of the EU SDS.

The European Council in December 2009 confirmed the review and emphasized that significant additional efforts are needed to curb and adapt to climate change, to decrease high energy consumption in the transport sector and to reverse the current loss of biodiversity and natural resources. It further states that the shift to a safe and sustainable low-carbon and low-input economy will require a stronger focus in the future. Priority actions should be more clearly specified in future reviews. Governance, including implementation, monitoring and follow-up mechanisms should be reinforced for example through clearer links to the future EU 2020 strategy and other cross-cutting strategies.

4.3.4.2. Policies and Measures Related to Bunker Fuels (Art. 2 (2) Kyoto Protocol)

Policies and measures relating to bunker fuels are described in Annex 1: EU's 1st Biennial Report, in section [BR1] 4.4.14 – "International marine transport" and for aviation in section in section [BR1] 4.2.2 – "EU Emissions Trading Scheme".

4.3.4.3. Minimisation of adverse impacts (Art. 2 (3) Kyoto Protocol)

Information on how the EU strives to implement policies and measures under Article 2 of the Kyoto Protocol in such a way as to minimize adverse effects

According to paragraph 36 of the Annex to the UNFCCC decision 15/CMP.1, each Party shall provide information not reported elsewhere under these guidelines on how it strives to implement policies and measures under Article 2 of the Kyoto Protocol in such a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9, of the Convention, taking into account Article 3 of the Convention.

The EU has reported on detailed activities on how it strives to minimize adverse effects on other Parties in its annual national inventory report in chapter 15.[70]

69 Eurostat (2011): Sustainable development in the European Union - 2011 monitoring report of the EU sustainable development strategy, http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-31-11-224/EN/KS-31-11-224-EN.PDF).

70 EEA (European Environment Agency) (2013): Annual European Union greenhouse gas inventory 1990-2011 and inventory report 2013. Technical report No 8/2013, http://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2013.

Section **Error! Reference source not found.** provides information on EU programmes which aim to minimize adverse effects of climate change on developing countries, in particular those that are particularly vulnerable to climate change.

Impacts on third countries are mostly indirect and can frequently neither be directly attributed to a specific EU policy, nor directly measured by the EU in developing countries. Therefore, the reported information covers potential adverse social, environmental and economic impacts (including trade impacts) that result from complex assessments of indirect influences and that are based on accessible data sources in developing countries.

The most important continuous activity in this respect is the EU's wide-ranging impact assessment system accompanying all new policy initiatives. This approach ensures that potential adverse social, environmental and economic impacts on various stakeholders and third Parties are identified and minimized within the legislative process. In general, impact assessments are required for all legislative proposals, but also for other important Commission initiatives which are likely to have far-reaching impacts. In chapter 15 of the EU's annual national inventory report, the impact assessment process is explained in more detail[71]. Consulting interested parties is an obligation for every impact assessment and all affected stakeholders should be engaged, using the most appropriate timing, format and tools to reach them. Existing international policy dialogues are also to be used to keep third countries fully informed of forthcoming initiatives, and as a means of exchanging information, data and results of preparatory studies with partner countries and other external stakeholders.

Major EU policies such as the Directive on the promotion of the use of renewable energy (Directive 2009/28/EC, the extension of the EU ETS to the aviation sector (Directive 2008/101/EC), updates of EU policies which should lead to a low carbon and energy efficient economy are also presented in more detail as examples in the 2013 submission of the EU's national inventory report.

Since the submission of the most recent national inventory report only two additional impact assessments have been completed and published that are related to the policies and measures covered in section 4 of this report:

Proposal for a Regulation of the European Parliament and of the Council on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport (see section [BR1] 4.4.14 in Annex 1: EU's 1st Biennial Report)

This proposal addresses ships above 5000 gross tons in respect of emissions released during their voyages from the last port of call to a port under the jurisdiction of a Member State and from a port under the jurisdiction of a Member State regardless of their flag. With regard to economic effects on third countries, the impact assessment of this proposal concludes that "based on the pass-through of costs and savings in maritime transport and on the price building mechanisms in different sectors, measurable

71 EEA Technical report No 8/2013

increases of commodity prices (with transport costs being only an insignificant element of the commodities' prices) are only expected for natural gas of up to 0.1-0.5% and for iron ore of up to 0.1-0.3%. Such price impacts are far below the usual price fluctuation for these products. In conclusion, no impacts deriving from possible increases of commodity prices are expected for third countries.[72]

Commission regulation implementing Directive 2009/125/EC with regard to ecodesign requirements for computers, servers and displays.

Experts from third countries were involved in the stakeholder consultation process and the initiative was discussed in meetings of Commission staff with third country government representatives as e.g. USA, China, India, etc.

The impact assessment found no significant impacts on the competitiveness of industry of the EU or third countries and in particular in the SMEs sector due to the small absolute costs related to product re-design and re-assessment.

With regard to impacts on trade, the process for establishing ecodesign requirements for computers, servers and displays has been fully transparent, and a notification under WTO-TBT was issued 60 days prior to the vote by the Regulatory Committee.

4.4. Cross-sectoral policies and measures

Cross-sectoral policies and measures comprise:

- The EU Emissions Trading Scheme
- The Effort Sharing Decision
- The CCS Directive
- Taxation of Energy Products and Electricity
- Research and Innovation in Climate and Energy
- Structural and Cohesion Funds
- The National Emissions Ceiling Directive

For a description of these policies and measures and a quantification of their impacts, please refer to section [BR1] 4.2 in Annex 1: EU 1st Biennial Report.

72 Impact Assessment – Part 1 Accompanying the document Proposal for a Regulation of the European Parliament and of the Council on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport and amending Regulation (EU) No 525/2013. Commission staff working document SWD(2013) 237 final/2.

4.5. Sectoral policies and measures: Energy

EU policies and measures targeted on energy comprise:

- Renewable Energy Roadmap
- Renewable Energy Directive (2009/28/EC)
- Biomass Action Plan
- Cogeneration Directive (2004/8/EC)
- Directive on Energy End-use Efficiency and Energy Services (2006/32/EC)
- Energy Performance of Buildings (Directive 2010/31/EU)
- Energy Efficiency Plan 2011 (COM/2011/109)
- Energy Efficiency Directive (2012/27/EC)
- Internal Market in Electricity Directive (2009/72/EC)
- Ecodesign Framework Directive (Directive 2009/125/EC)
- Energy Labelling Directive (Directive 2010/30/EU)
- Green public procurement
- Energy star programme
- Motor Challenge Programme
- Strategic Energy Technology Plan (SET plan)
- Intelligent Energy Europe II Programme
- The Covenant of Mayors

For a description of these policies and measures and a quantification of their impacts, please refer to section [BR1] 4.3 in Annex 1: EU 1st Biennial Report.

4.6. Sectoral policies and measures: Transport

EU policies and measures targeted on transport comprise:

- Renewable Energy Directive (2009/28/EC)

- Strategy to reduce CO_2 from passenger cars and light-commercial vehicles (COM/2007/19)
- Regulation on CO_2 emissions from cars (443/2009)
- Regulation CO_2 emissions from light-commercial vehicles (510/2011)
- Biofuels Directive (repealed by Renewable Energy Directive)
- Fuel Quality Directive (2009/30/EC)
- Infrastructure charges for heavy goods vehicles (Directive 1999/62/EC as amended by Directives 2006/38/EC and 2011/76/EU)
- Proposal for an amendment of the Fuel Quality Directive and the Renewable Energy Directive
- Euro 5 and 6 Standards (Regulation (EC) No 692/2008)
- Euro VI Standard for heavy duty vehicles (Regulation (EC) No 595/2009)
- Environmental performance requirements for motor vehicles and tyres (Regulations (EC) 661/2009, (EC) 1222/2009 and (EU) 65/2012)
- Clean Power for Transport package including the deployment of alternative fuel infrastructure
- Clean Vehicles Directive (2009/33/EC)
- Roadmap to a Single European Transport Area
- International maritime transport.

For a description of these policies and measures and a quantification of their impacts, please refer to section [BR1] 4.4 in Annex 1: EU 1st Biennial Report.

4.7. Sectoral policies and measures: Industry

EU policies and measures targeted on industry comprise:

- Regulation on certain fluorinated greenhouse gases (EU F gas Regulation No. 842/2006)
- Proposed revision of the F-Gas Regulation

- Emissions from air conditioning systems in motor vehicles (MAC-Directive 2006/40/EC)
- Industrial Emission Directive (2010/75/EU)
- Ecodesign Framework Directive (Directive 2009/125/EC).

For a description of these policies and measures and a quantification of their impacts, please refer to section [BR1] 4.5 in Annex 1: EU 1st Biennial Report.

4.8. Sectoral policies and measures: Agriculture

EU policies and measures targeted on agriculture comprise:

- Agricultural Market and Income support (1st pillar of Common Agricultural Policy / CAP)
- Rural Development Policy (2nd pillar of CAP)
- Soil Thematic Strategy
- Nitrates Directive.

For a description of these policies and measures and a quantification of their impacts, please refer to section [BR1] 4.6 in Annex 1: EU 1st Biennial Report.

4.9. Sectoral policies and measures: Forestry

Major EU policies and measures targeted on forestry comprise:

- EU Forest Strategy
- Forestry measures within Rural Development Plan
- EU biodiversity strategy
- EU timber regulation
- EU Action Plan for Forest Law Enforcement, Governance and Trade (FLEGT)
- European Forest Fire Information System (EFFIS).

For a description of these policies and measures and a quantification of their impacts, please refer to section [BR1] 4.7 in Annex 1: EU 1st Biennial Report.

Please note that (according to the BR guidelines[73]) section [BR1] 4.7 is on "Land use, land use Change and Forestry" (LULUCF) policies and measures and thus has a broader scope than the present section which (according to the NC guidelines[74]) focuses on forestry only. Thus, in section [BR1] 4.7, LULUCF Accounting is covered in addition to the above mentioned policies and measures.

4.10. Sectoral policies and measures: Waste

EU policies and measures targeted on waste comprise:

- Waste Framework Directive
- Landfill Directive
- Waste Incineration Directive
- EU policies targeting waste streams
- Management of Biodegradable Waste
- Urban Waste Water Directive.

For a description of these policies and measures and a quantification of their impacts, please refer to section [BR1] 4.8 in Annex 1: EU 1st Biennial Report.

4.11. Policies and measures no longer in place

For policies and measures that are no longer in place, please refer to the respective sub-sections of section [BR1] 4.2 to section [BR1] 4.8 in Annex 1: EU 1st Biennial Report.

4.12. Interaction of policies and measures

The EU Emission Trading Scheme (ETS) is one of the overarching and key policy instruments implemented in the EU to achieve its climate policy objectives (for more information on EU ETS, see section [BR1] 4.2.2 in Annex 1: EU 1st Biennial Report). It covered 39 % of EU-15 GHG emissions (41 % of EU-28 GHG emissions) in the 2008-2012 period and interacts as a structural measure with many other policies and measures by giving a price to GHG emissions.

73 UNFCCC biennial reporting guidelines for developed country Parties: Annex I to Decision 1/CP.17; FCCC/CP/2011/9/Add.1.

74 Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications: Decision 4/CP.5; FCCC/CP/1999/7.

A particularly complex interaction can be observed for end-use energy efficiency policies and the EU ETS. For example, a measure to increase the efficiency of specific household goods could be examined: Such a measure might be set up by governments to raise attention on electricity consumption of households, but also by power plant operators. Plant operators in particular might have an incentive to increase efficiency for several reasons: i) as a marketing activity, ii) as a reaction to a governmental measure requiring to undertake energy efficiency measures for final users to reduce end-use energy consumption by a specific percentage (white certificates) or iii) to reduce electricity consumption in order to avoid the installation of additional generating capacities or to operate a plant more efficiently to reduce the need of ETS allowances. If the efficiency improvement saves electricity that is generated in fossil fuelled power plants, the induced reduction is reflected in the ETS, as power generators above 20 MW are generally included there. The reduction of electricity consumption might have no effect at all on ETS emissions (in case of complete autarky of households from electrical grid) or an effect on ETS emissions, depending on the share of renewables in the electrical grid. Such an example therefore demonstrates why it is difficult to quantify emission reductions resulting from the ETS.

In addition, the separation of emission reductions into ETS and non-ETS sectors is not always explicit, as especially the use of electricity is an interlinkage between all sectors (even the transport sector if electric vehicles are taken into account).

In general the interaction of market-based instruments and regulation need to be examined closely. While a market-based instrument, such as the ETS, sets an emissions reduction and provides flexibility as to where exactly the reduction might be achieved, a regulation might set a limit on emissions for a specific sector, technology or activity. If these activities are simultaneously covered under the ETS, the regulation would impact upon the efficiency of the ETS. This might particularly be the case where high-cost mitigation options need to be employed more under the regulation than they would under the ETS.

4.13. Effect of policies and measures on the modification of long-term trends

The precise impact of policies and measures on the EU-28's long-term emission trends, outlined in section 5, is difficult to isolate. In part as the information presented in Chapter 5 is based on the sum of MS projections (with somewhat different approaches and assumptions, see section 5.6) as well as the impact of other factors (e.g. energy prices), which also drive changes in longer-term trends.

However, looking at the historic trends from 1990 to 2011 in national circumstances (see section 2) and historic and projected emissions (1990–2020) across different sectors (see section 5.2) some high-level effects can be discerned:

In relation to energy use (excluding transport) primary and final energy consumption grew over the period to 2006, but from the early part of the 2000s, consumption appears to have started to plateau. After 2006, a declining trend in energy use is observed (with

a dip in the 'economic crisis' year 2009). Electricity consumption has been following a similar pattern, however with a stronger increase rates up to the early 2000s. Over time generation has shifted towards a lower carbon intensity fuel mix. The EU-28 primary energy intensity has fallen from 1990 to 2011 by more than 25% (see section 2.7.1). As a result, EU-28 emissions from energy use have declined gradually from 1990 to 2011 (as well, with a dip in the year 2009 due to the economic crisis). Taking into account the existing measures these are projected to fall further to 30% below 1990 levels by 2020, whilst with additional measures they are expected to decline even more (30% below 1990 levels by 2020, see section **5.2.3.1**). This indicates that policies have a sizeable impact on (particularly end-use) energy efficiency and hence overall consumption itself, and are also strongly driving the shift towards low carbon electricity generation, particularly as a result of new renewables policies.

Transport activity, in particular freight transport and transport in the new EU Member States, has steadily increased in the EU since 1990 until the economic crisis. As a result, GHG emissions from transport have grown until 2007, albeit at a slower pace than real GDP, and are decreasing since. With existing measures, emissions are expected to remain stable and with additional measures expected to continue to decline. However, 2020 emission levels would still be 12% above 1990 levels (see section 5.2.3.2). This indicates that additional measures, e.g. driving improved vehicle efficiency (particularly the strategy for CO_2 in cars – see section 4.6), and to a lesser extent the introduction of biofuels, are expected to more than offset the increase in emissions from the expected continued increase in demand for transport.

Emissions from industrial processes show a strongly fluctuating trend for the past since 1990 (see section 5.2.3.3): After a sharp decrease since 2007, emissions appear to have stabilised since 2009 with a slightly increasing trend. In the projections emissions are estimated to remain static with additional measures and with a slightly increasing trend with existing measures.

Policies and measures in agriculture, coupled with a decrease in activity already appear to have had a significant effect on historic emissions; driving increased productivity, reduced nitrogen fertiliser production, reductions in livestock numbers, improved manure management, etc. In the projections (see section 5.2.3.4) emissions are estimated to remain broadly static both with existing and with additional, indicating a more limited impact from policies on longer term trends.

Similarly, in the waste sector emissions have declined strongly from the mid-1990s to 2011, in particular, as a result of policies such as the Landfill Directive (see section 4.10). Emissions are expected to decrease further, although the rate of decrease slows down slightly under both the existing and with additional measure scenarios (see section 5.2.3.5), indicating that the impact of policies on longer-term trends is also gradually declining.

The impact of policies on long-term emission trends in other key sectors, such as marine and aviation (see section 5.2.3.7), is more difficult to discern. The underlying trend is a

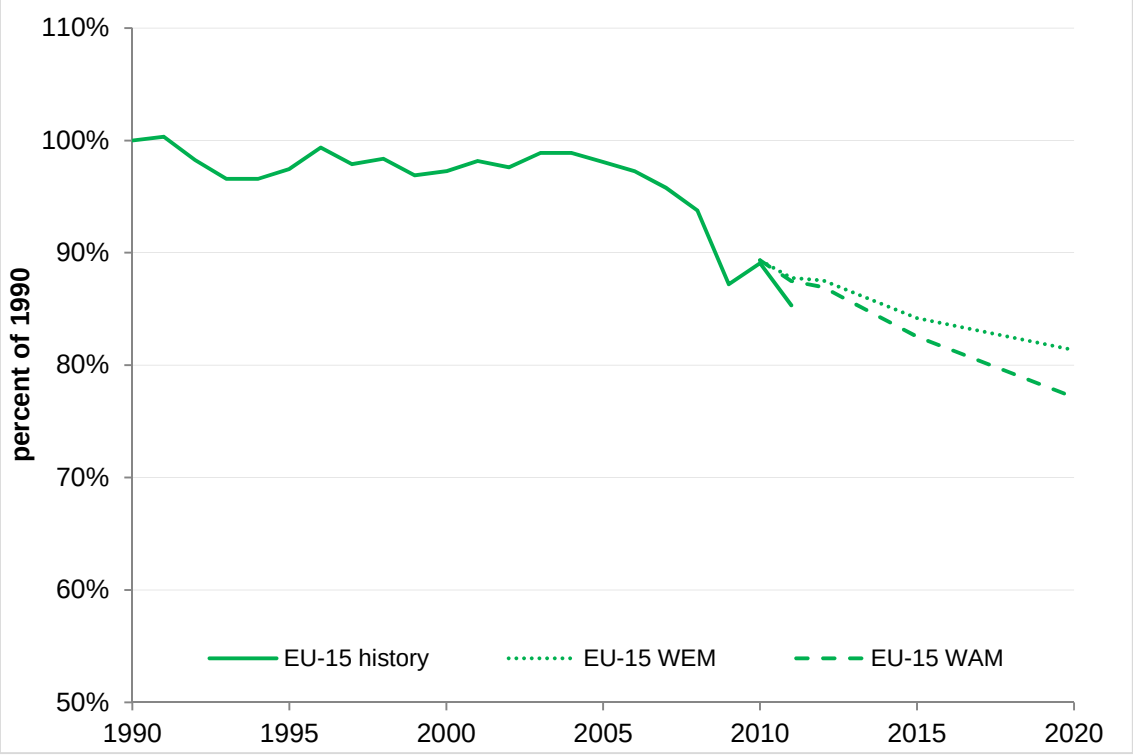
continued and rapid increase in emissions from these sectors, but new policy action such as the incorporation of aviation into the EU ETS will likely reduce the rate of this increase. However, not all MS have reported projections in these sectors and where they have done so, they do not necessarily include the impact of the latest policy changes.

5. PROJECTIONS AND THE TOTAL EFFECTS OF POLICIES AND MEASURES

Key developments

In 2020, emissions of GHG in the EU-15 as a result of implemented measures (WEM scenario) are projected to be 18.7 % below 1990 levels. Considering also planned measures (WAM scenario), the projected GHG emission reductions increases to 22.9 % below 1990 levels (see Figure Error! **No text of specified style in document.**-50).

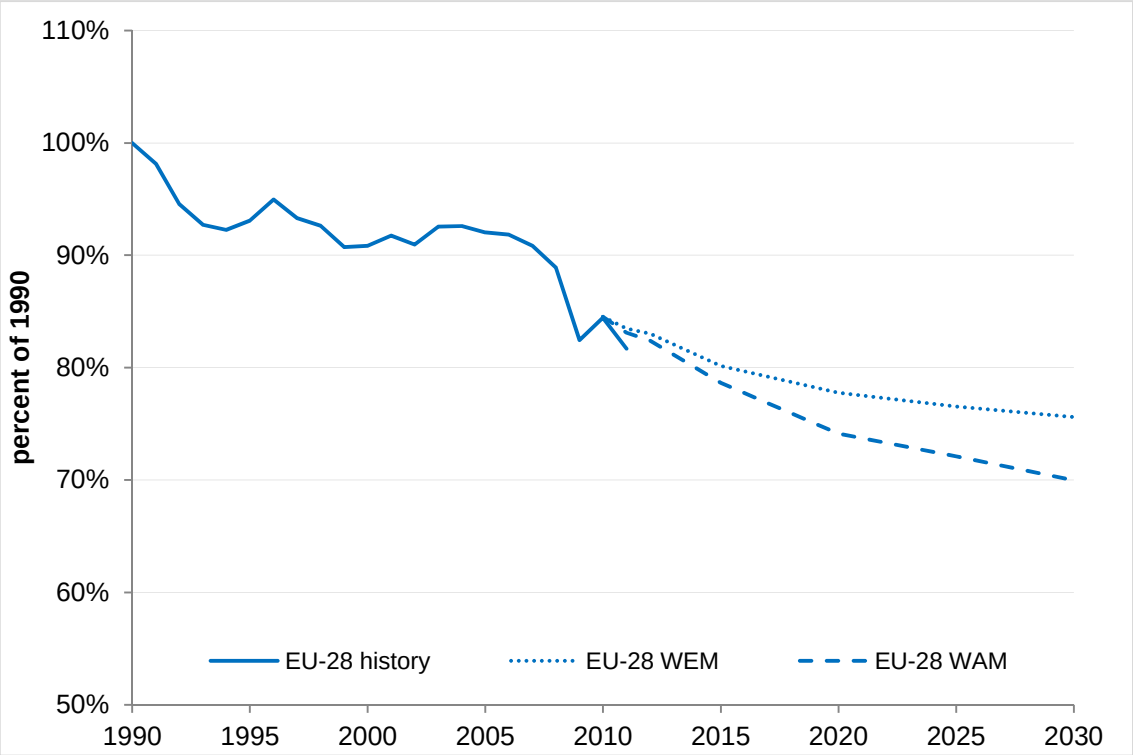
*Figure **Error! No text of specified style in document.**-50 Total aggregate GHG emission projection for EU-15, including historic values, relative to 1990*



In 2020, in the EU-28, total GHG emissions as a result of implemented measures (WEM scenario) are projected at 22 % below 1990 levels. Considering also planned measures

(WAM scenario) the projected GHG emission reductions would be 26 % below 1990 levels (see Figure Error! **No text of specified style in document.**-51).

*Figure **Error! No text of specified style in document.**-51 Total aggregate GHG emission projection for EU-28, including historic values, relative to 1990*



The most significant sectoral contribution in absolute GHG emission reductions in the EU-28 WEM scenario from 1990 to 2020 is projected to stem from the energy sector (1 051 Mt CO_2eq), followed by agriculture, industry and the waste sector. GHG emissions in the transport sector are projected to increase by 18% compared to 1990 levels. If also additional measures are considered (WAM scenario), the pattern of sectoral shares in emission reductions remains the same, while the emissions growth in the transport sector in EU-28 is less prominent (12% increase by 2020 compared to 1990 levels).

Reductions in CO_2 emissions are expected to contribute most to overall emission reductions in the EU-28. Under the WEM scenario, CO_2 contributes to 70% of the aggregate GHG emission reductions in 2020 compared to 1990, followed by CH_4, and N_2O.

5.1. Introduction

5.1.1. Context

Please refer to Section [BR1] 5.1.1 in Annex 1: EU 1st Biennial Report for information on the context. Here, and in the following, solid lines refer to historic values, dotted and dashed lined refer to scenarios.

5.1.2. Scenarios

For an introduction of the scenarios presented in the National Communication, please refer to section [BR1] 5.1.2 in Annex 1: EU 1st Biennial Report.

5.1.3. Key parameters and assumptions

The key parameters and assumptions underlying the EU-15 are aggregated from data reported by individual Member State projections and are summarised in Table Error! **No text of specified style in document.**-15 below.

*Table **Error! No text of specified style in document.**-15 Key parameters and assumptions EU-15 projections*[75]

Parameter	2015	2020
CO2-price (Euro (2010)/tCO2_eq)	12	17
GDP (Bio. Euro (2005))	12	13
International coal price (Euro (2010)/boe)	18	20
International gas price (Euro (2010)/boe)	50	54
International oil price (Euro (2010)/boe)	87	95
Population (Mio.)	398	404

For an introduction of the key parameters and assumptions that underlie each of the scenarios for the **EU-28**, please refer to section [BR1] 5.1.3 in Annex 1: EU 1st Biennial Report.

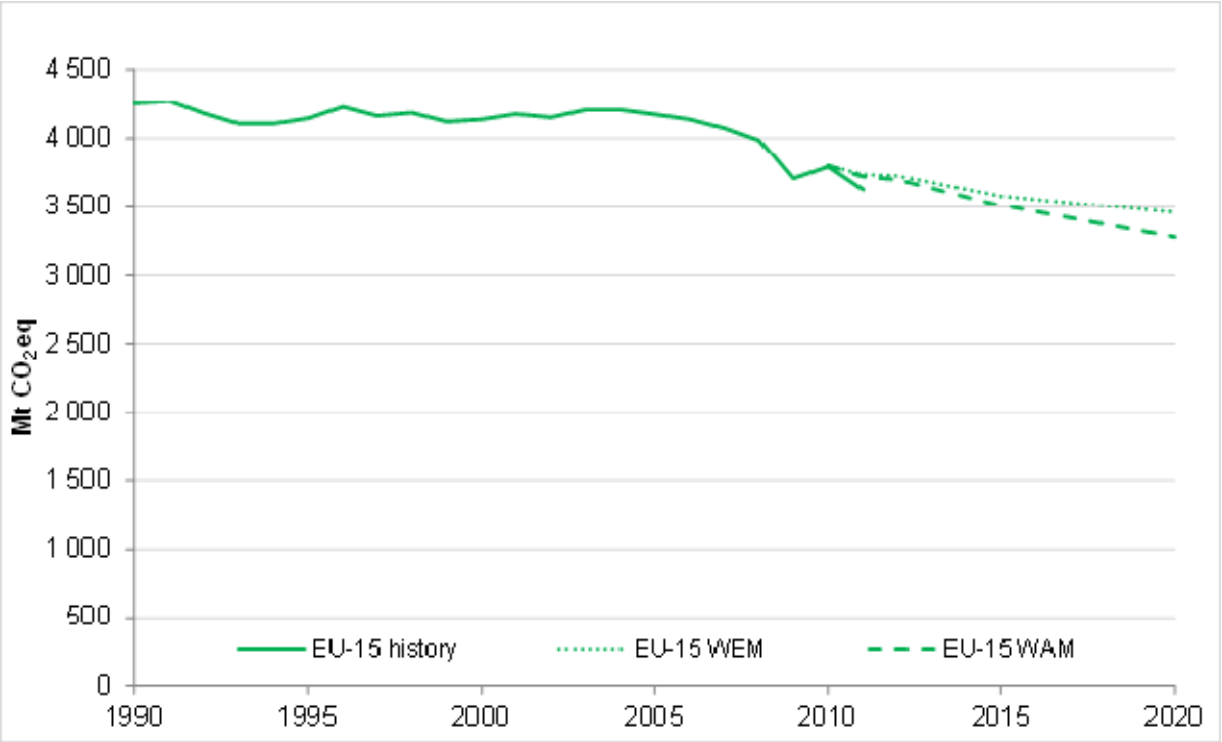
5.2. Projections

This section and its subsections present the GHG projections for EU-15 only. For the presentation of the GHG emission projections of the EU-28, please refer to Section [BR1] 5.3 in Annex 1: EU 1st Biennial Report.

75 Gap filling: GDP: Missing GDP values on Member State level in 2010 gap-filled with AMECO data obtained via EEA in constant Euro (2005). Missing projected values gap-filled with EUCLIMIT average annual growth rate of EU-28 GDP. Prices: projected data gap-filled with weighted average (based on GDP). Population: Missing 2010 data gap-filled with Eurostat data, missing projected values gap-filled with linear extrapolation of trend. In case all values were missing, 2010 values were gap filled with Eurostat data and projected values were held constant.

Figure Error! **No text of specified style in document.**-52 demonstrates the development of total greenhouse gas (GHG) emissions for the **EU-15** aggregate in Mt CO_2eq, calculated as the sum of projections by Member States (see methodology documentation in Section [BR1] 5.6.1). Historic and projected GHG emissions are shown. The data reported in later sections is indexed to the year 1990, as it is the base year for CO_2, CH_4 and N_2O emissions.

*Figure **Error! No text of specified style in document.**-52 Total aggregate EU-15 GHG projections relative to 1990 GHG emissions; WEM and WAM scenario*



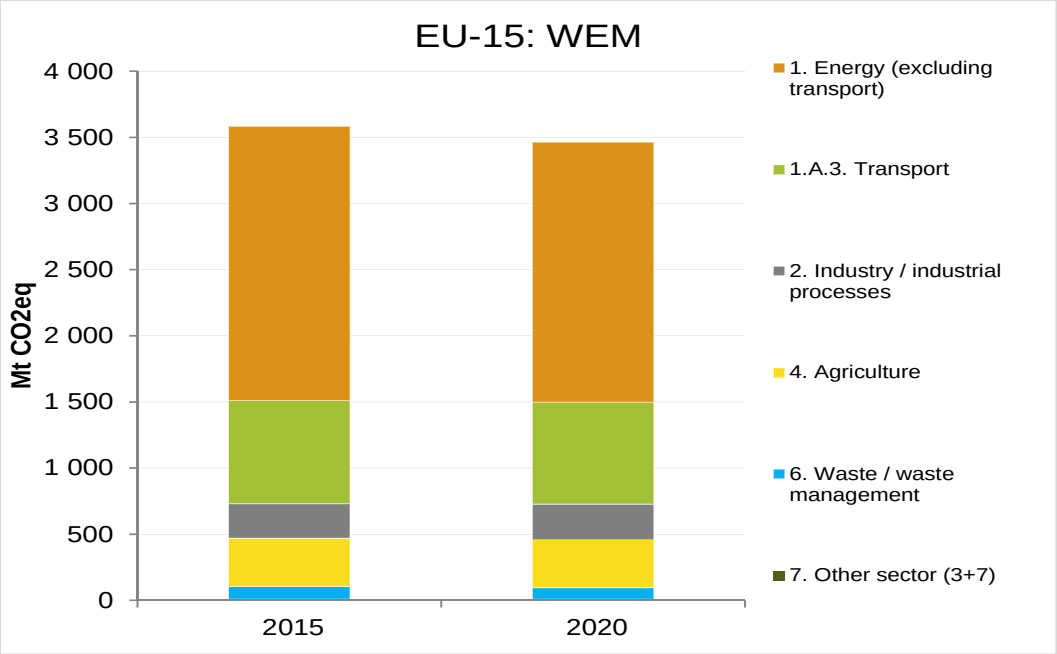
In 2020, emissions of GHG in the **EU-15** as a result of implemented measures (WEM scenario) are projected to be 18.7 % below 1990 levels. Considering also planned measures (WAM scenario) increases the projected GHG emission reductions to 22.9 % below 1990 levels.

Section 5.2.5 provides all information reported in Sections 5.2.1 through 5.2.3.7 in tabular format.

5.2.1. Total aggregate GHG emission projections per sector

Figure Error! **No text of specified style in document.-**53 provides a qualitative impression of sector shares on projected total aggregate GHG emissions for EU-15.

*Figure **Error! No text of specified style in document.**-53 Sector breakdown of projected total aggregate EU-15 GHG emissions; WEM and WAM scenario*



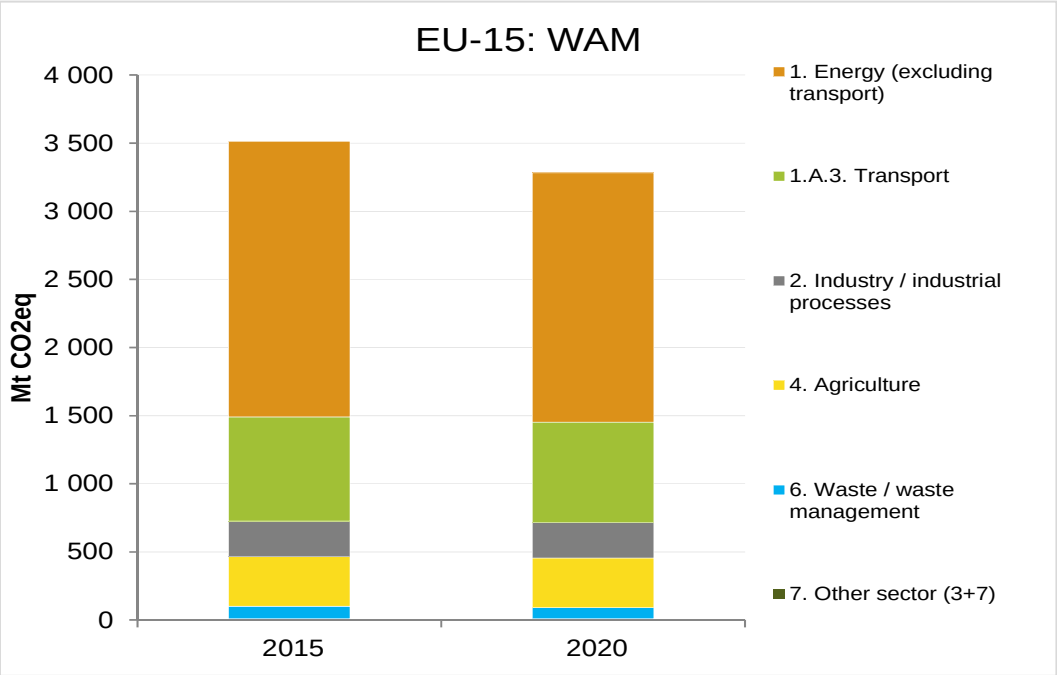


Figure Error! **No text of specified style in document.**-54 provides information on total aggregate GHG emissions on sector level relative to 1990. EU-15 projections are displayed for 2015 and 2020, excluding carbon sinks and governmental use of Kyoto Mechanisms for each sector.

In the **WEM** scenario, emissions of total aggregate GHG in the **EU-15** are projected to be 794 Mt CO_2eq (18.7 %) below 1990 levels in 2020. The most significant contribution of absolute GHG emission reductions in the EU-15 from 1990 to 2020 is projected to stem from the energy sector (625 Mt CO_2eq) followed by the waste sector (86 Mt CO_2eq) and the industrial sector (85 Mt). Projected GHG emissions in the transport sector increase by 75 Mt CO_2eq by 2020.

In the **WAM** scenario, emissions of total aggregate GHG in the **EU-15** are projected to be 973 Mt CO_2eq (22.9 %) below 1990 levels in 2020. The most significant share of absolute GHG emission reductions from 1990 to 2020 is projected to stem from the energy sector (757 Mt CO_2eq), followed by the industrial sector (91 Mt CO_2eq) and the waste sector (90 Mt CO_2eq). GHG emissions in the transport sector are projected to increase by 38 Mt CO_2eq until 2020. Figure Error! **No text of specified style in document.**-54 visualizes the above paragraphs relative to 1990. Figure Error! **No text of specified style in document.**-55 visualizes total GHG emission changes for WEM and WAM scenarios for the EU-15.

*Figure **Error! No text of specified style in document.**-54 Total aggregate EU-15 GHG emissions per sector relative to 1990; WEM and WAM scenario*

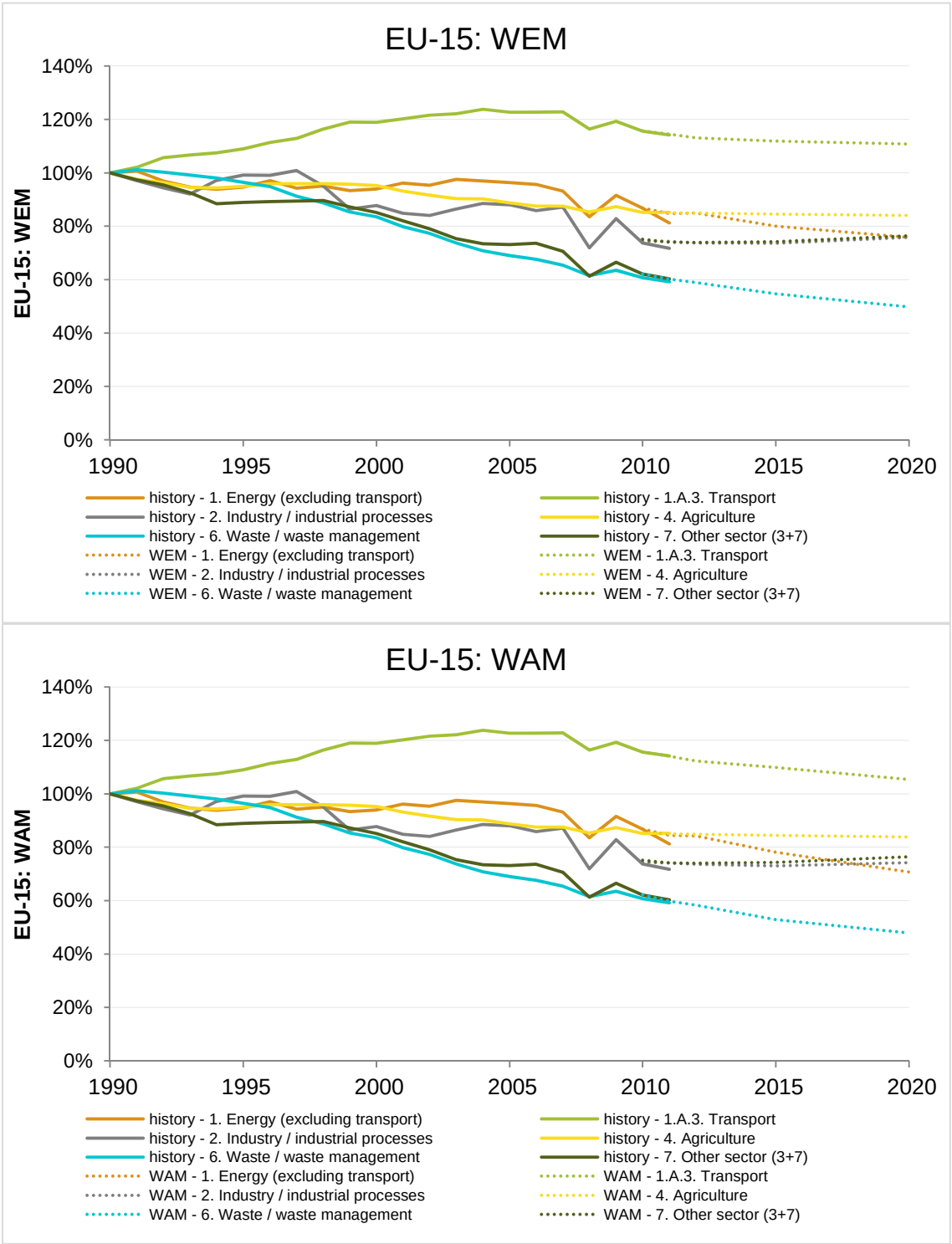
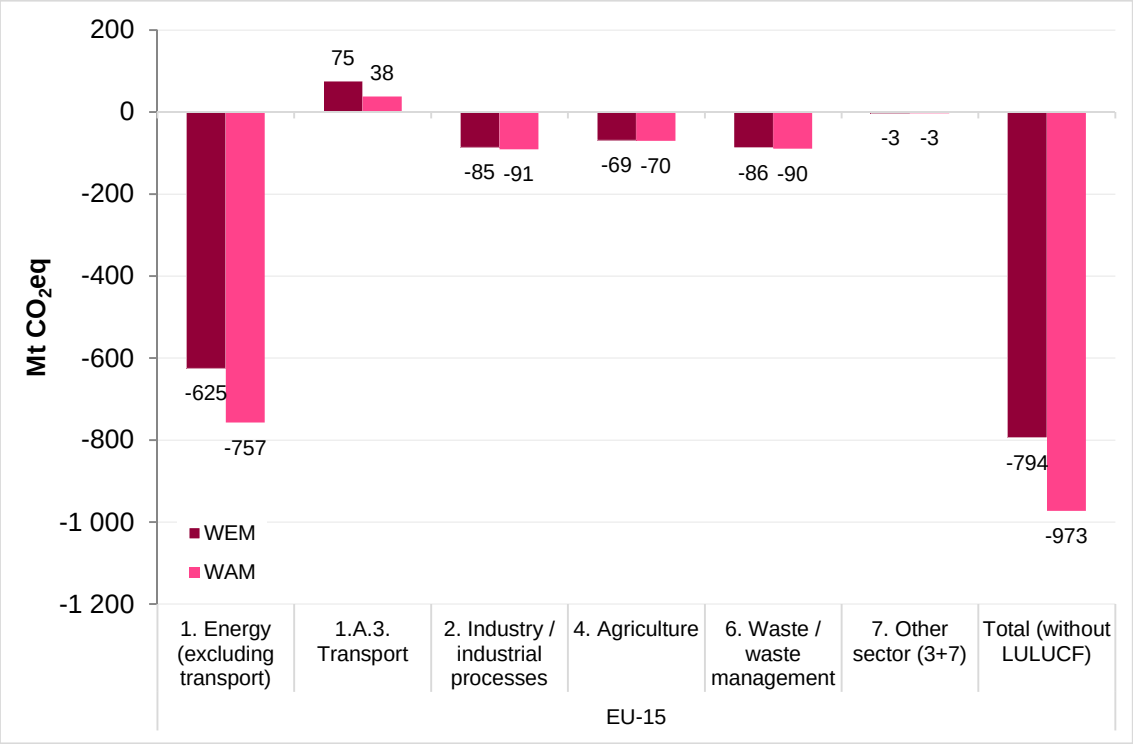


Figure ***Error! No text of specified style in document.****-55 Absolute projected EU-15 GHG emission changes per sector between 1990 and 2020; WEM and WAM scenario*



The common factors which drive historic trends and projections are discussed in more detail in section 2 and in the national inventory and projection reports of individual Member States. Policies and measures which influence GHG emissions in each sector are discussed in more detail in section 4.

5.2.2. Total aggregate GHG emission projections per gas

Figure Error! ***No text of specified style in document.****-56* below illustrates the expected change in emissions from individual greenhouse gases between 1990 and 2020 under the "with existing measures" and "with additional measures" scenarios.

The projected overall reduction of **EU-15** GHG emissions (excluding LULUCF) in the **WEM** scenario from **1990-2020** is 794 Mt CO_2eq.

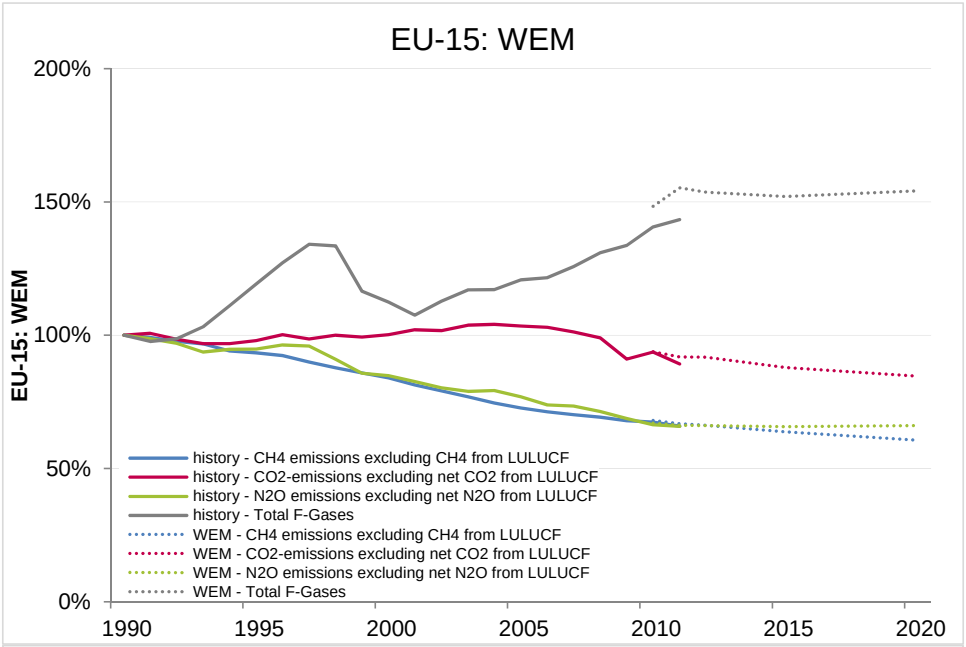
Reductions in CO_2 emissions are expected to contribute most to overall emission reductions, the absolute reduction of CO_2 emissions under the WEM scenario from 1990-2020 are projected to be 518 Mt CO_2eq in the EU-15. Reductions in CH_4 emissions are projected to be 172 Mt CO_2eq. N_2O emissions are projected to be reduced by 134 Mt CO_2eq by 2020. F-gases are the only gases projected to increase relative to

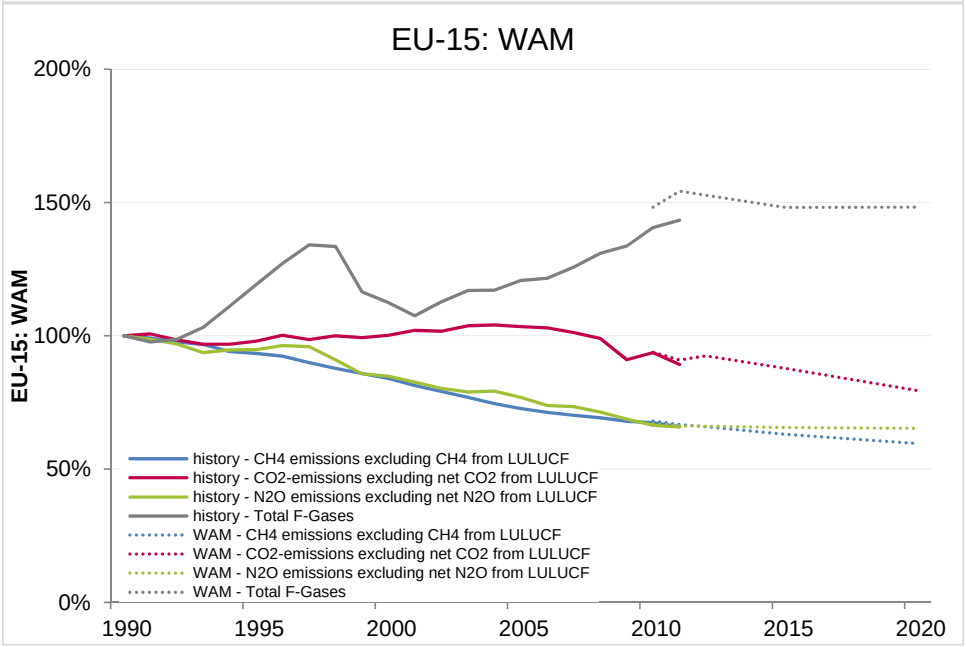
1990 levels. However, the absolute contribution of F-gases to overall emissions is less significant: the projected additional F-gas emissions in 2020 compared to 1990 levels are 30 Mt CO_2eq in the EU-15 under the WEM scenario.

The projected overall reduction of **EU-15** GHG emissions (excluding LULUCF) from **1990-2020** under the **WAM** scenario is 973 Mt CO_2eq.

Reductions in CO_2 emissions are expected to contribute most: the absolute reduction of CO_2 emissions from 1990-2020 is projected to be 687 Mt CO_2eq. Reductions in CH_4 emissions are projected to be 176 Mt CO_2eq and N_2O emissions are projected to decrease by 138 Mt CO_2eq. F-gases are the only gases projected to increase relative to 1990 levels. However, the absolute contribution of F-gases to overall projected emissions is less significant: the projected additional F-gas emissions in 2020 compared to 1990 levels are 27 Mt CO_2eq in the EU-15 when considering also additional measures of the WAM scenario.

Figure ***Error! No text of specified style in document.****-56 Total EU-15 GHG emissions per gas relative to 1990; WEM and WAM scenario*





5.2.3. GHG emission projections per UNFCCC sector (level 1) and separately for bunker fuels

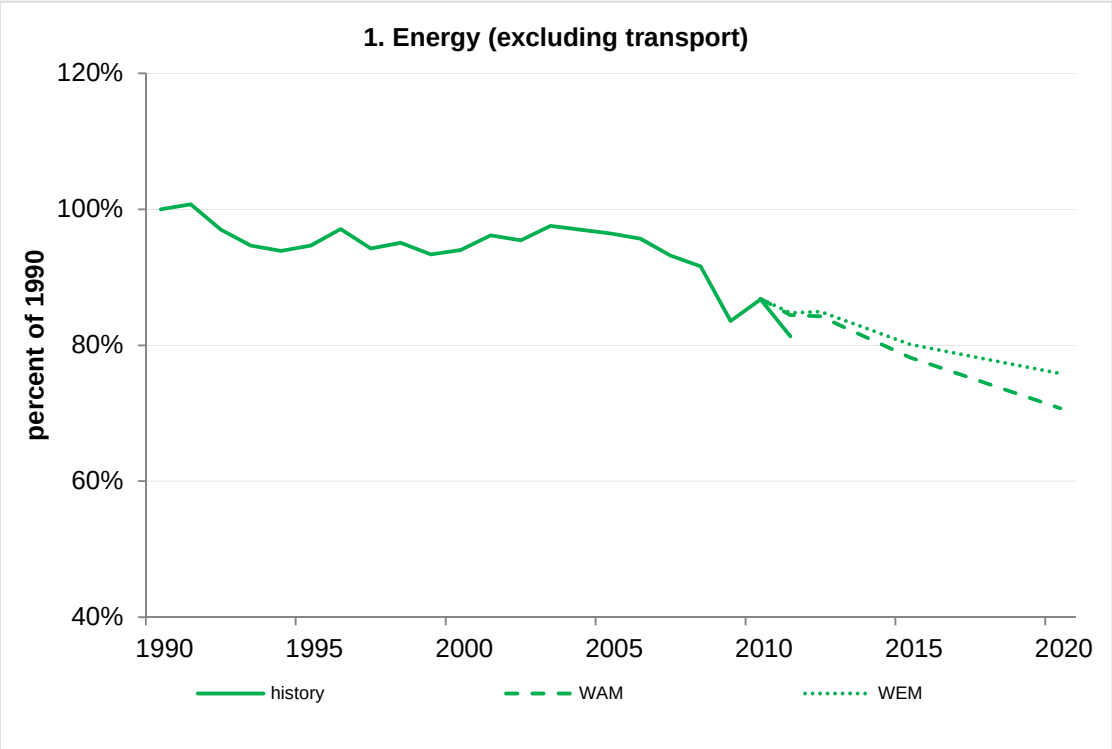
5.2.3.1. Energy

Figure Error! **No text of specified style in document.**-57 shows the EU-15 GHG emissions and projections from the energy sector excluding transport. For the EU-15 emissions from the energy sector (excluding transport) have fallen since 1990 mainly due to fuel switching to gas (also reducing CH_4 emissions from coal mining), increased energy and technical efficiency, decreases in fuel combustion in manufacturing industries and construction and restructuring of industry in the new Member States. In part, such reductions have been counteracted by increased housing stock and growth in the services sector, resulting in increased demand for energy services in buildings and homes, and in particular strong growth in demand for electricity to provide these. In addition, recent economic growth in the new Member States has begun to increase demand for energy services. In general, EU-15 emissions from the energy sector show a gradual downward trend from 1990 to the present day, with a short and steep decrease during the economic crisis, after which they increased again to pre-crisis levels and continue with the downward trend also in projections.

Projections for the sector demonstrate Member States expectations that emissions from the sector will decrease as the result of existing policies and measures in the EU-15. The actual magnitude of the decreases in GHG emissions from the energy sector that can be achieved up to 2020 is also dependent on the successful implementation of planned additional measures.

Figure Error! **No text of specified style in document.**-57 shows that under the **WEM** scenario, **EU-15** GHG emissions from the energy sector are projected to decrease, reaching 24.2 % below 1990 levels by 2020. Considering also additional policies and measures (**WAM** scenario), decreases of emissions could reach 29.3 % below 1990 levels by 2020.

*Figure **Error! No text of specified style in document.**-57 Projected EU-15 GHG emissions relative to 1990 in the energy sector (excluding transport)*



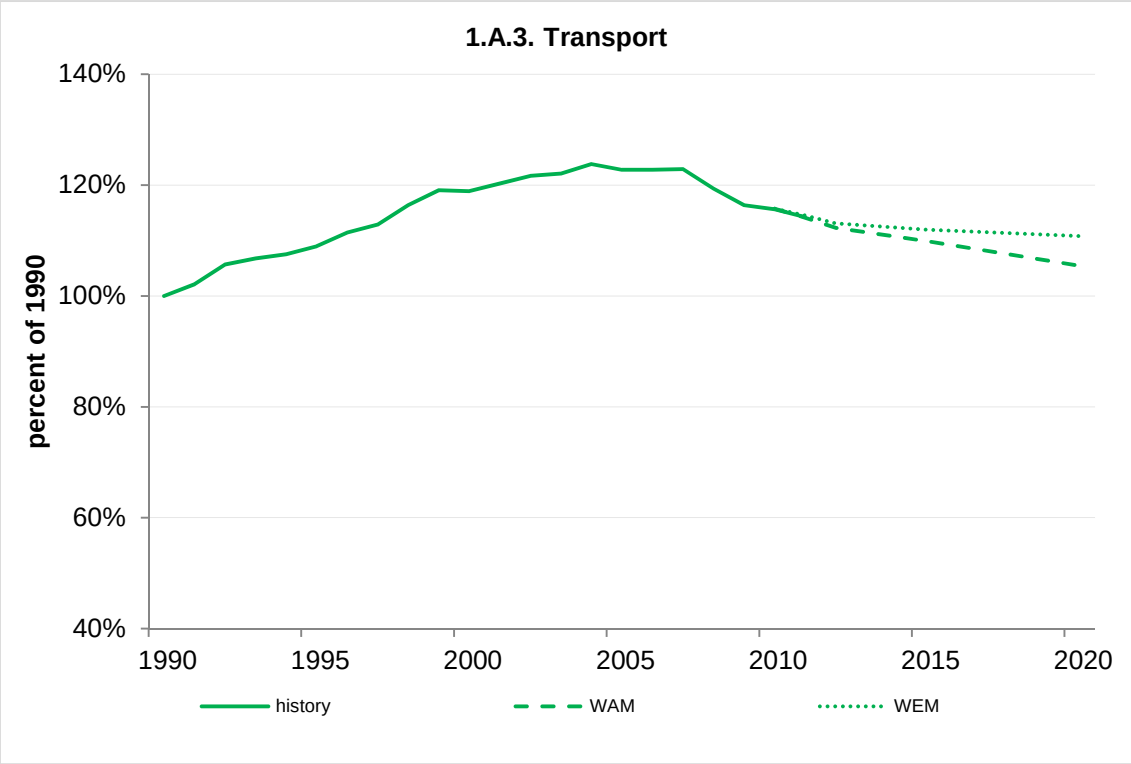
5.2.3.2. Transport

The transport sector caused the largest increase in greenhouse gas emissions between 1990 and 2011 (14.2 %) and is the only sector expected to experience an increase in emissions between 1990 and 2020 under the WEM scenario.

Figure Error! **No text of specified style in document.**-58 below shows projected GHG emissions relative to 1990 in the transport sector for EU-15. Generally it can be observed that GHG emissions from transport remain above 1990 levels until 2020. **EU-15** emissions in the sector are projected to be 10.8 % above 1990 levels in 2020 under the **WEM** scenario.

Considering additional policies and measures of the **WAM** scenario results in a further decline of emissions in the transport sector, so that these are projected to be 5.4 % above 1990 levels in 2020.

Figure **Error! No text of specified style in document.**-58 *Projected EU-15 GHG emissions relative to 1990 in the transport sector*



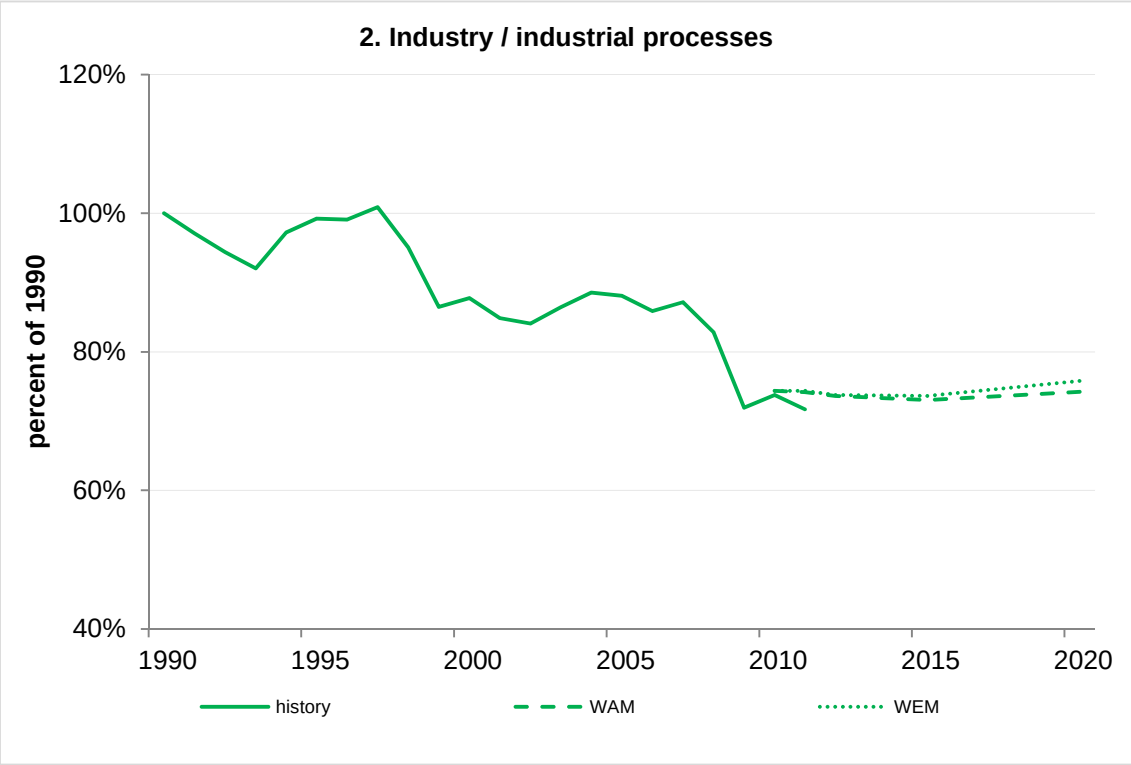
5.2.3.3. Industry / industrial processes

EU-15 emissions from the industry/industrial processes sector have decreased considerably since their peak in 1997. They have sharply declined between 2007 and 2009, then continued slightly upwards and after 2011 a slight upward trend is projected; specifically in the WEM scenario. Their fluctuating nature is driven by economic conditions (affecting activity levels) but also by EU and national regulation (affecting efficiency).

Projected **EU-15** GHG emissions from industrial processes under the **WEM** scenario are expected to reach 24.2 % below 1990 levels by 2020.

Under the assumption of the implementation of **additional measures**, GHG emissions from industrial processes in the EU-15 could reach levels of and 25.8 % below 1990 levels by 2020 (see Figure Error! **No text of specified style in document.**-59 below).

*Figure **Error! No text of specified style in document.**-59 Projected EU-15 GHG emissions relative to 1990 in the industry / industrial processes sector*



5.2.3.4. Agriculture

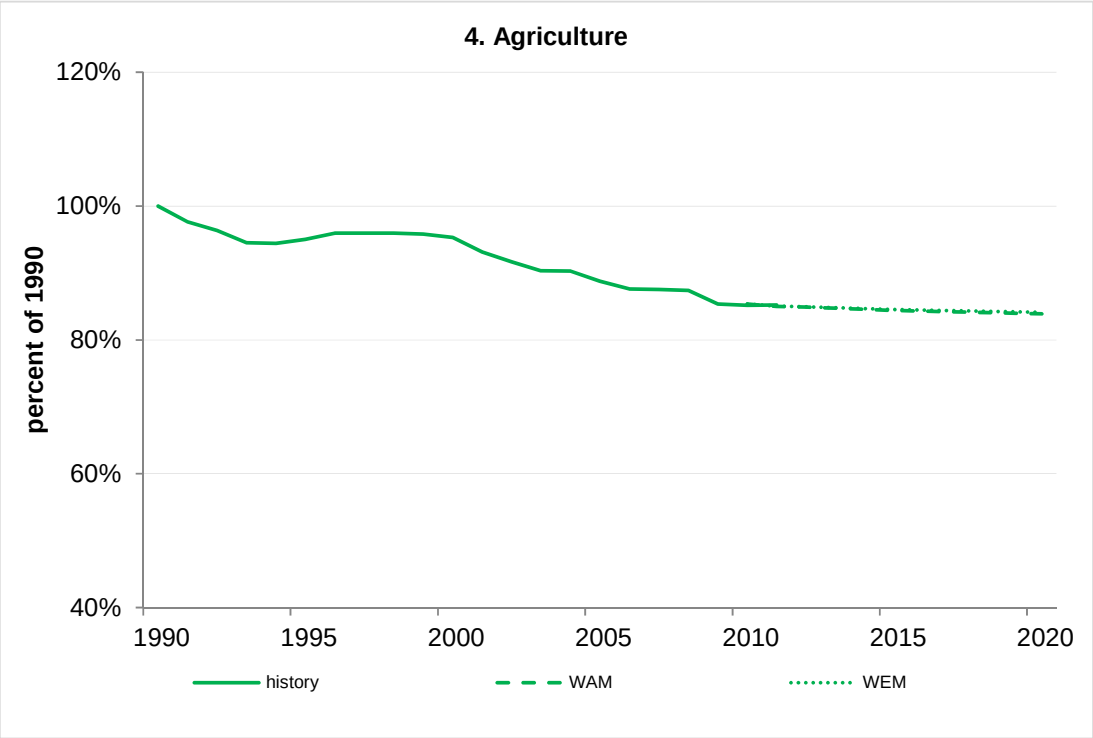
EU-15 GHG emissions from the agricultural sector have shown a steady decrease over the past years.

Changes in agricultural policy and farming subsidies as well as increased productivity have driven reduced animal numbers, reduced nitrogen fertiliser production and use and improved manure management resulting which have resulted in reduced emissions from agricultural soils and livestock.

EU-15 GHG emissions from the agricultural sector are expected to continue decreasing up to 2020 in both WEM and WAM projections but at a slower pace than in previous decades.

Figure Error! **No text of specified style in document.**-60 shows that GHG emissions from the agricultural sector are projected to reach 15.9 % below 1990 levels by 2020 under the **WEM** scenario. Considering **additional measures** would slightly increase GHG emission reductions in the EU-15 to 16.1 % below 1990 levels.

*Figure **Error! No text of specified style in document.**-60 Projected EU-15 GHG emissions relative to 1990 in the agriculture sector*



5.2.3.5. Waste

EU-15 GHG emissions from the waste sector have shown a steady and sharp decrease over the past 23 years. EU-15 emissions from the sector are projected to continue to decrease sharply up to 2020. Planned additional measures of the WAM scenario are projected to have a modest impact on further emission reductions.

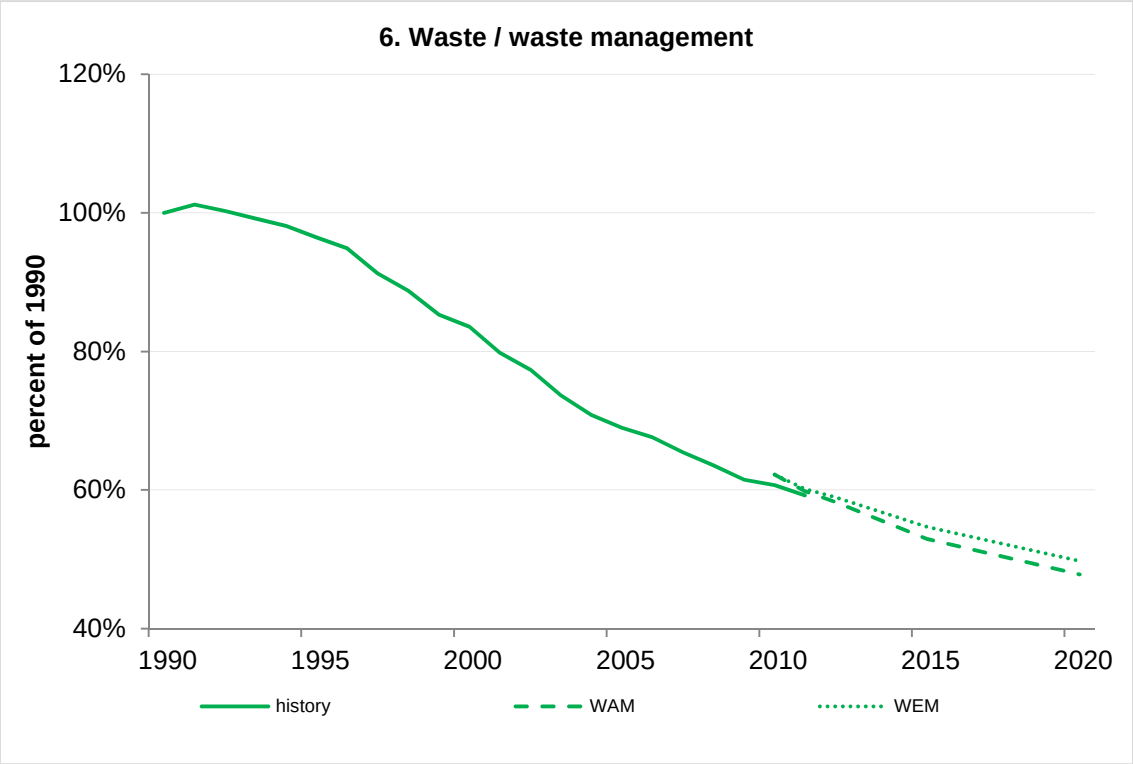
GHG emissions from the waste sector in the **EU-15** and under **existing measures** are projected to continue to decrease, reaching 50.2 % below 1990 levels by 2020.

The additional measures considered in the **WAM** scenario would contribute to further GHG emission reductions, which are projected to 52.1 % below 1990 levels in 2020 (see Figure Error! **No text of specified style in document.**-61 below).

Past and future emission decreases can largely be attributed to successful waste legislation, e.g. increased recycling, bans on landfill deposit, landfill taxes and methane recovery from treated wastewater and landfill. In particular, the Landfill Directive (see section [BR1] 4.8.3 in Annex 1: EU 1st Biennial Report) has established objectives for the progressive reduction of biodegradable waste to landfill by 25 % within five years of

Member State implementation of the Directive, 50 % within eight years, and by 65 % within fifteen years, compared to 1995 levels.

*Figure **Error! No text of specified style in document.**-61 Projected EU-15 GHG emissions relative to 1990 in the waste sector*



5.2.3.6. Other Sector (3+7)

The 'Other sector' is the sum of emissions from Common Reporting Format (CRF) sectors 3 (Solvent and Other Product Use) and 7 (Other).

The contribution to the overall emissions from this sector has historically[76] been very small (0.2 % in 2011 for EU-15). EU-15 GHG emissions from 'other' sources have shown a steady and sharp decrease in the past.

Member State projections however indicate a rather stable (slightly increasing) trend after 2015 in both, WEM and WAM scenarios.

76 The inventories list a zero value for the "Other Sector", so historically speaking, only the share from the "Solvents and Other Product Use"is listed here .

In the **EU-15**, there is very little difference between the **WEM and WAM** projections. Figure Error! **No text of specified style in document.**-62 shows that emissions are projected to slowly increase, reaching 23.6 % below 1990 levels by 2020.

*Figure **Error! No text of specified style in document.**-62 Projected EU-15 GHG emissions relative to 1990 in the other sector (solvent and other product use, other sector)*

5.2.3.7. Aviation and maritime bunker fuels

WEM projections of emissions from international bunker fuels sold to aircrafts are reported by 26 Member States. WAM projections of emissions from international bunker fuels sold to aircrafts are reported by 22 Member States. Missing values were gap-filled by WEM values. With this broad coverage nearly all emissions from international aviation are covered in the projections. The same holds for emissions from international bunker fuels sold to ships. Figure Error! **No text of specified style in document.**-63 below shows the projected emissions for the aviation sector for the EU-15 for the WEM (dotted line) and WAM (dashed line) scenarios.

The figure shows that the rapid increase which was dampened by the economic crisis is projected to continue up to 2020, but at a slightly slower pace.

In the **EU-15** under the **WEM** scenario, emissions from international aviation are projected to continue to increase, reaching 107.3 % above 1990 levels by 2020.

If additional measures from the **WAM** scenario are also considered, this increase is slightly slowed down and is projected to reach 102.3 % above 1990 levels by 2020.

*Figure **Error! No text of specified style in document.**-63 Projected EU-15 GHG emissions relative to 1990 in the international bunkers – aviation sector*

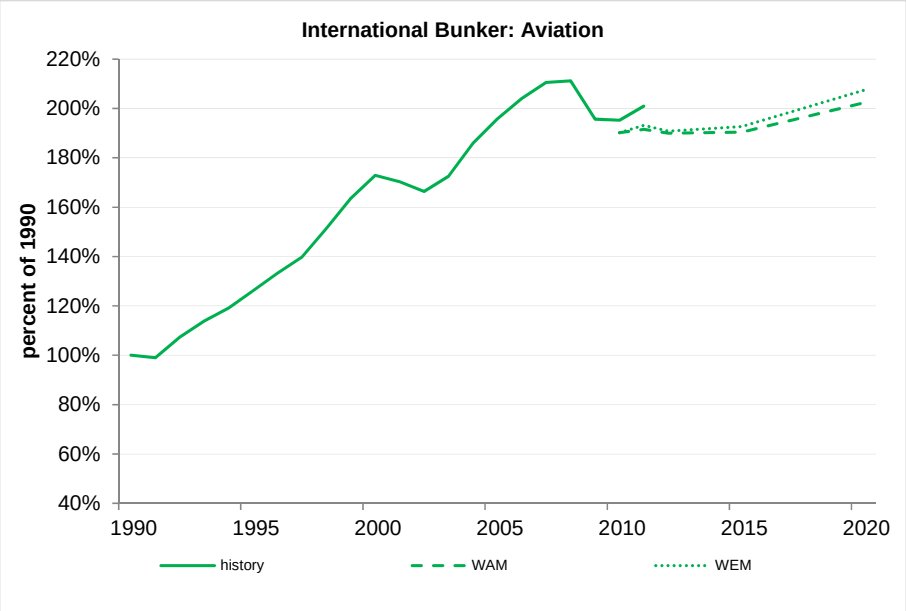
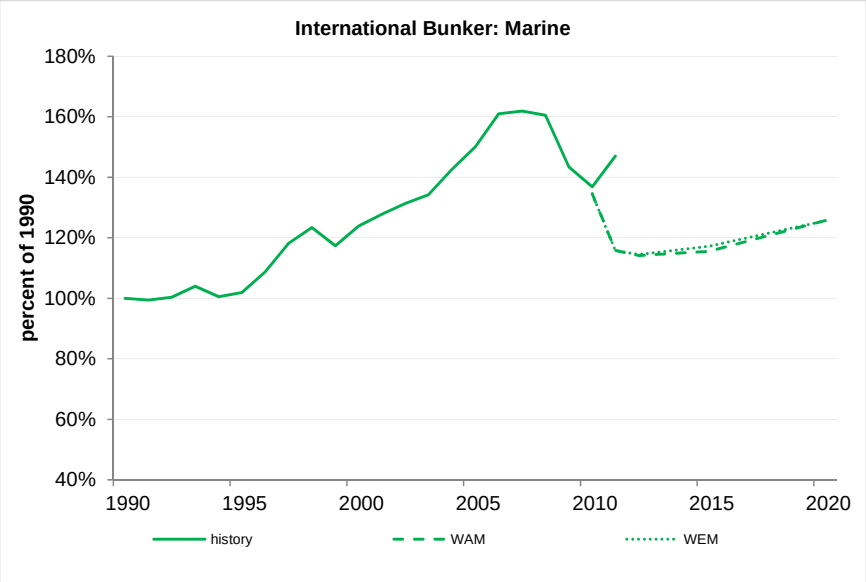


Figure Error! **No text of specified style in document.**-64 below shows the projected emissions for the marine sector for the EU-15, and both reported scenarios. The increase in emissions from the marine sector was broken by the economic crisis but is projected to continue up to 2020, but at a lower level and pace. In the **EU-15** under the **WEM** scenario, emissions from the marine sector are projected to continue to increase, reaching 25.7 % above 1990 levels by 2020. If additional measures from the **WAM** scenario are also considered, there are no significant changes in the projected emissions.

Figure ***Error! No text of specified style in document.****-64 Projected EU-15 GHG emissions relative to 1990 in the international bunkers – marine sector*



5.2.4. Projections of indirect GHG

It is not possible to present indirect GHG emission projections.

5.2.5. Tabular representation of EU-15 GHG emission projections

Table Error! **No text of specified style in document.**-16 shows detailed information on GHG emission projections for the EU-15 in tabular format.

*Table **Error! No text of specified style in document.**-16[77] Tabular representation of EU-15 GHG emissions, historic and projected*

Sector/Gas	1990	1995	2000	2005	2010	2011	2015	2020
history (Gg CO2eq)								
1. Energy (excluding transport)	2585574	2447189	2430835	2493046	2242219	2101994		
1.A.3. Transport	696628	758964	828335	855188	805309	795734		
2. Industry / industrial processes	353202	350331	309929	311069	260581	253234		
4. Agriculture	433868	412156	413446	385133	369491	369785		
6. Waste / waste management	172019	165928	143744	118674	104420	101941		
7. Other sector (3+7)	13212	11749	11254	9667	8205	7969		
CH4 emissions excluding CH4 from LULUCF	435572	406653	366015	316737	293459	287160		
CO2-emissions excluding net CO2 from LULUCF	3367101	3297510	3372961	3484095	3155308	3002815		
N2O emissions excluding net N2O from LULUCF	395852	460796	416334	388578	336115	334839		
Total F-Gases	55979	66722	62912	67629	78687	80279		
Memo Item: International Bunker: Marine	*105542*	*107537*	*130733*	*158352*	*144430*	*155136*		
Memo Item: International Bunker: Aviation	*64854*	*81822*	*112102*	*126985*	*126636*	*130295*		
WEM (Gg CO2eq)								
1. Energy (excluding transport)					2244569	2192111	2070903	1960753
1.A.3. Transport					806287	797684	779736	771671
2. Industry / industrial processes					262738	262591	260139	267760
4. Agriculture					370348	368928	366737	364884
6. Waste / waste management					107009	103495	94050	85605
7. Other sector (3+7)					9922	9788	9806	10095
CH4 emissions excluding CH4 from LULUCF					296230	291181	277593	263960
CO2-emissions excluding net CO2 from LULUCF					3156375	3094313	2958661	2848862
N2O emissions excluding net N2O from LULUCF					265195	262159	260049	261717
Total F-Gases					83074	86906	85118	86279
Memo Item: International Bunker: Marine					*141933*	*122145*	*123668*	*132618*
Memo Item: International Bunker: Aviation					*123348*	*125267*	*124954*	*134441*
WAM (gg CO2eq)								
1. Energy (excluding transport)					2244569	2183066	2020981	1828891
1.A.3. Transport					806287	794804	765479	734527
2. Industry / industrial processes					262738	262022	257926	262108
4. Agriculture					370348	368830	366250	363948
6. Waste / waste management					107009	102924	91082	82313
7. Other sector (3+7)					9922	9792	9827	10095
CH4 emissions excluding CH4 from LULUCF					296230	290577	274427	259721
CO2-emissions excluding net CO2 from LULUCF					3156375	3082435	2894773	2680928
N2O emissions excluding net N2O from LULUCF					265195	262058	259530	258282
Total F-Gases					82972	86332	82918	83000
Memo Item: International Bunker: Marine					*141933*	*122257*	*121945*	*132676*
Memo Item: International Bunker: Aviation					*123348*	*124205*	*123489*	*131195*

5.3. Assessment of aggregate effects of policies and measures

Please refer to Section [BR1] 5.6.2 for details on the methodology.

For the EU-15, the assessment of the aggregate effects of policies and measures is accomplished for the periods to 2015 and 2020. The effects of policies and measures in

77 Historic GHG emissions are presented up to 2011. Projections are represented starting 2010. Thus, there is an overlap of historic and projected values. Note that if 2010 and 2011 GHG emission trajectories do not match this is due to the fact that projected GHG emissions were aggregated from individual Member State projections, which may not have taken into account the latest inventory values as the base year in the preparation of their projections.

Figure Error! **No text of specified style in document.**-65 are displayed in total, distinguishing between WEM and WAM scenario. The disaggregation of the total effects of policies and measures into sectors and gases is provided in Table Error! **No text of specified style in document.**-17 and Table Error! **No text of specified style in document.**-18.

For the aggregate effects of policies and measures in the WEM scenario, a bottom-up approach was used whereas a top-down approach was used to assess the aggregate effects of policies and measures in the WAM scenario. The effects were disaggregated into sectors in both scenarios, WEM and WAM. However, the sector split differs between the approaches (see Table Error! **No text of specified style in document.**-17) and the sector policy effects in WEM and WAM are therefore not fully comparable.

*Figure **Error! No text of specified style in document.**-65 Total effects of policies and measures for EU-15, in Mt CO_2eq avoided GHG emissions*

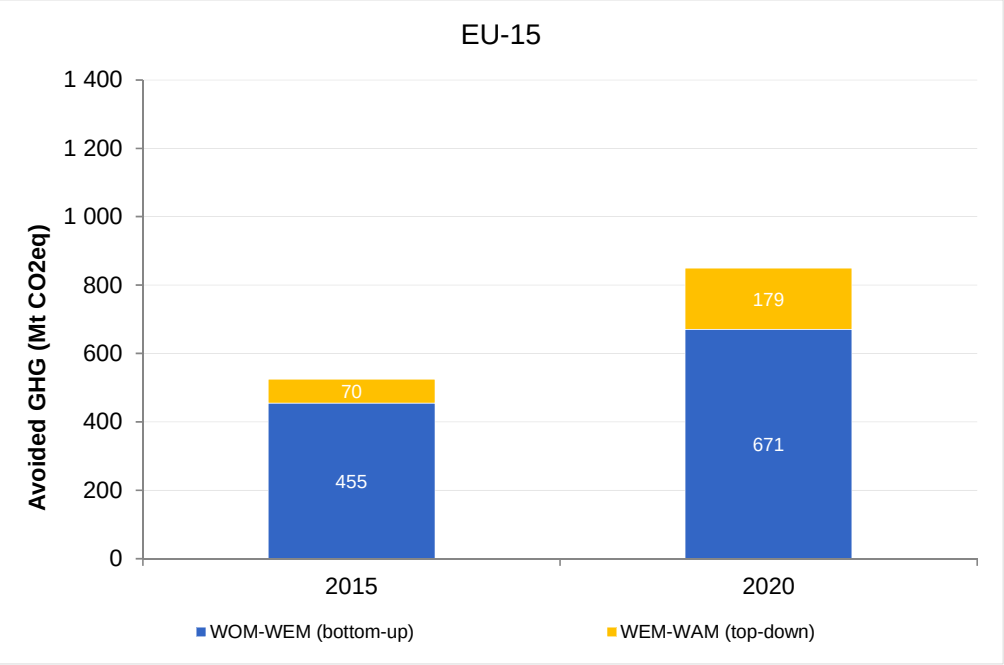


*Table **Error! No text of specified style in document.**-17 Total effects of policies and measures EU-15, by sectors in Mt CO_2eq avoided GHG emissions*

EU-15	2015	2020
	Mt CO_2 eq.	
WOM-WEM (bottom-up)	**455**	**671**
Energy consumption + supply	284	448
Transport	57	102
Industrial Processes	13	16
Agriculture	18	26
Waste	54	46
Cross-cutting	29	32
WEM-WAM (top-down)	**70**	**179**
1. Energy (excluding transport)	50	132
1.A.3. Transport	14	37
2. Industry / industrial processes	2	6
4. Agriculture	0	1
6. Waste / waste management	3	3
7. Other Sector (3+7)	0	0
Total effects of policies and measures	**525**	**850**

*Table **Error! No text of specified style in document.**-18 Effects of polices and measures as avoided GHG emission by gas for EU-15 in Mt CO_2eq avoided GHG emissions*

	2015	2020
EU-15	*Mt CO_2 eq.*	
WOM-WEM (bottom-up)	**520**	**748**
CO_2	382	594
CH_4	77	74
N_2O	34	39
HFC, PFC, SF_6	27	41
WEM-WAM (top-down)	**70**	**179**
CO_2	64	168
CH_4	3	4
N_2O	1	3
HFC, PFC, SF_6	2	3

5.4. Sensitivity Analysis

For the sensitivity analysis of EU-28 projections, please refer to section [BR1] 5.4.

5.5. Supplementarity

To meet international greenhouse gas targets, Annex I Parties can use Kyoto Protocol mechanisms. Information on the intended use in the first commitment period is given in Section 4.3.3 and in Section [BR1] 4.12 in Annex 1: EU 1st Biennial Report.

As this current chapter on projections only focuses on the development of GHG emissions up to 2020, the question of supplementarity cannot be raised for this time horizon, as no targets have been set and no final decisions taken with regard to the (supplementary) use of Kyoto mechanisms. In addition the group of EU-15 Member States will no longer have a common greenhouse gas reduction target in the second commitment period.

5.6. Methodology

The methodology applied for the EU-15 aggregate is analogous to the one applied to the EU-28 aggregate. All methodological aspects to be considered are documented in detail in Section [BR1] 5.6.

6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

Key developments

While reducing GHG emissions is of paramount importance to avoid dangerous climate change, the EU also recognises that some climate change impacts are unavoidable because of past emissions. The EU has therefore undertaken research and taken action to understand these impacts, develop adaptation responses and assist developing countries in strengthening their capacity to cope with climate change.

Since the 5th National Communication, progress has been made on assessing the impacts of climate change and developing adaptation policies across Europe. Comprehensive information on past and projected climate change and related impacts has been published for Europe, in particular as part of the European climate adaptation platform (Climate-ADAPT).

Action has been strengthened since the 5th National Communication in particular through the EU Strategy on adaptation to climate change, which was adopted in 2013. The strategy promotes and supports actions by Member States, by promoting adaptation in key vulnerable sectors at EU level and by ensuring better-informed decision-making.

6.1. Introduction

Both public and political recognition of the need to take urgent action to combat climate change has emerged in recent years. The European Commission has shown global leadership on climate change and is committed to maintain this role. The target of the European Union is to stabilize the global mean temperature to 2°C above pre-industrial levels.

However, significant changes in climate and its impacts are already visible in Europe today. Increasing temperatures, rising sea level, melting of glaciers and ice sheets as well as more intense and frequent extreme weather events are among the challenges for Europe already triggered by climate change (see section 6.2). Further climate change impacts are projected for the future which can increase existing vulnerabilities and deepen socio-economic imbalances in Europe[78] (see section 6.3).

Thus, in view of the specific and wide-ranging nature of climate change impacts across the EU's territory, the European Union has recognised its important role in developing an EU-wide framework for adaptation supplementing mitigation efforts. The European Commission has recognised that planning for adaptation requires a strategic approach to ensure timely, efficient and effective adaptation actions coherently across different sectors and levels of governance. The development process for an adaptation framework for Europe first led to the adoption of a Green Paper on adapting to climate change in Europe[79], recognising that all parts of Europe will increasingly feel the adverse effects of climate change. In 2009 a White Paper "Adapting to climate change: Towards a European framework for action"[80] set out concrete steps to be taken in preparing the 2013 EU strategy on adaptation to climate change, adopted on 16 April 2013[81]. As stated in the White Paper and further strengthened by the EU Adaptation Strategy, the EU sees its key role to support the public and private sector at national, regional or local levels by providing comprehensive information on adaptation (mainly through the European information platform Climate-ADAPT), by giving directions and advice to ensure coherent adaptation approaches (e.g. through guidelines) and by allocating funding (e.g. through the LIFE programme) for adaptation action. In addition, the EU has a strong role in supporting EU Member States in the case of transboundary issues and further strengthening and institutionalising mainstreaming of adaptation into certain sectors that are closely integrated at EU level through the single market and common policies (see section 6.4).

Emerging policy fields such as climate change adaptation are particularly dependent on research results as the knowledge base for better-informed decisions. Thus, since the 5th National Communication, research on the impacts of climate change, vulnerability and adaptation options has become a high priority for Europe. New research results within the EU's Sixth and Seventh Framework Programme for Research and Technological

78 http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012

79 http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0354en01.pdf

80 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF

81 http://ec.europa.eu/clima/policies/adaptation/what/docs/com_2013_216_en.pdf

Development (FP6, FP7) and many other programmes at transnational and national levels have provided improved insights into the impacts and vulnerabilities of climate change to Europe and potential adaptation responses (see section 6.5).

Adaptation is already taking place across the EU. Since the publication of the NC5 in 2009, not only the European Union but also its Member States have significantly increased the number of actions for coping with the impacts of climate change at international, national and local levels as well as across sectors. In April 2013, 15 EU Member States had adopted a National Adaptation Strategy (NAS)[82]. Most of the existing strategies include only little information on implementation (e.g. monitoring, financing of adaptation action) and therefore, some countries have set out concrete action plans (NAP). These strategies and action plans are undoubtedly a good starting point for adaptation action but the 2013 EU strategy recommends that all 28 EU Member States should have their own adaptation policies adopted. *Figure Error! **No text of specified style in document.**-66* shows an overview of the status of National Adaptation Strategies in the EU. Further information on adaptation activities in all EU Member States can be accessed via the country pages on Climate-ADAPT[83] and more detailed updates are expected to be delivered in the respective 6th National Communications to the UNFCCC.

82 http://ec.europa.eu/clima/policies/adaptation/what/docs/com_2013_216_en.pdf (with reference to Climate-ADAPT)

83 http://climate-adapt.eea.europa.eu/web/guest/countries

*Figure **Error! No text of specified style in document.**-66 Overview of National Adaptation Strategies in the EU*

Source: Environment Agency Austria, December 2013 (adjusted from Climate-ADAPT)

The following sections outline some of the main findings on impacts, vulnerability and adaptation and some of the key current and planned activities that have been developed since the 5th National Communication.

6.2. Observed patterns of climate change across the EU and projections for the future

Significant changes in climate and its impacts such as increase in mean temperature, changes in precipitation, sea level rise, etc. are already visible globally and in Europe. Observed impacts of climate change are projected to continue due to further climate change.

In 2012, a report by the European Environment Agency[84] (EEA) has been published providing a recent compilation on observed and projected climate change impacts across Europe. Its main findings are briefly summarized in this section.

6.2.1. Observed and projected change in temperature

Observed changes

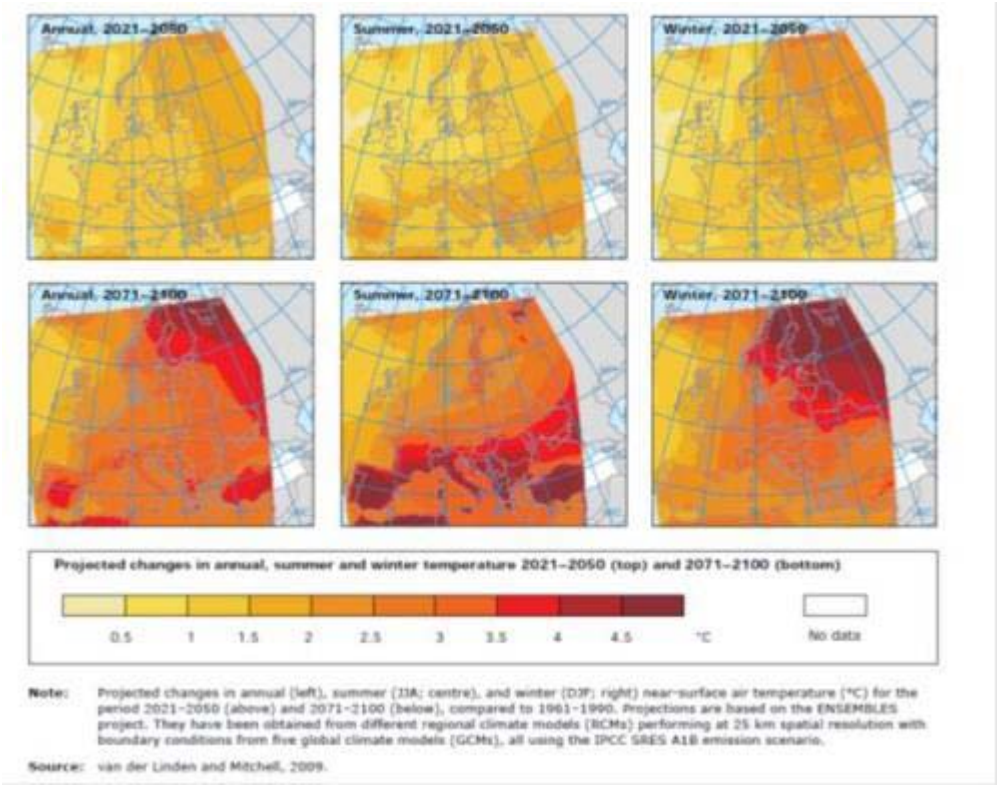
Regarding observed temperature change, the average temperature over land in Europe in the last decade was 1.3 °C warmer than the preindustrial level, which makes it the warmest decade on record. The average temperature for Europe has increased significantly more than the global average, which was 0.77 to 0.80 °C. High-temperature extremes (hot days, tropical nights, and heat waves) have become more frequent. Since 1880, the average length of summer heat waves over Europe has doubled and the frequency of hot days has almost tripled. In addition, the five warmest summers in Europe in the last 500 years all occurred between 2002-2011 (in 2002, 2003, 2006, 2007 and 2010). In comparison, low temperature extremes (cold spells, frost days) have become less frequent in Europe.

Projected changes

During the 21st century annual average land temperature over Europe is projected to continue increasing by more than the global temperature (Figure *Error! **No text of specified style in document.**-67*). The largest temperature increase is projected over eastern and northern Europe in winter and over southern Europe in summer. Increases in land temperature in Europe for the SRES A1B emission scenario are projected between 1.0 and 2.5 °C by 2021–2050, and between 2.5 and 4.0°C by 2071–2100. Extreme high temperatures and heat waves are projected to become more frequent and last longer across Europe over the 21st century. The most severe increases in hot summer days and tropical nights are projected in low-altitude river basins and along the Mediterranean coasts.

84 .http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012

*Figure **Error! No text of specified style in document.**-67 Projected changes in annual, summer and winter temperature across Europe*



Note: Projected changes in annual (left), summer (JJA; centre), and winter (DJF; right) near-surface air temperature (°C) for the 2021–2050 period (above) and 2071–2100 (below), compared to 1961–1990. Projections are based on the ENSEMBLES project. They have been obtained from different regional climate models (RCMs) performing at 25 km spatial resolution with boundary conditions from five global climate models (GCMs), all using the IPCC SRES A1B emission scenario.

Source: van der Linden and Mitchell 2009 in EEA 2012[85]

6.2.2. Observed and projected change in precipitation

Observed changes

Precipitation changes across Europe show more spatial and temporal variability than temperature. Since the mid-20th century, annual precipitation has been generally increasing across most of northern Europe by 10-40%, most notably in winter, but decreasing in parts of southern Europe by up to 20% in average annual precipitation (IPCC 2007[86]). More precisely, annual precipitation trends since 1950 show an increase of up to 70 mm per decade in north-eastern and north-western Europe and a decrease of up to 70 mm in some parts of southern Europe. The SREX report published by the IPCC

85 .http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012

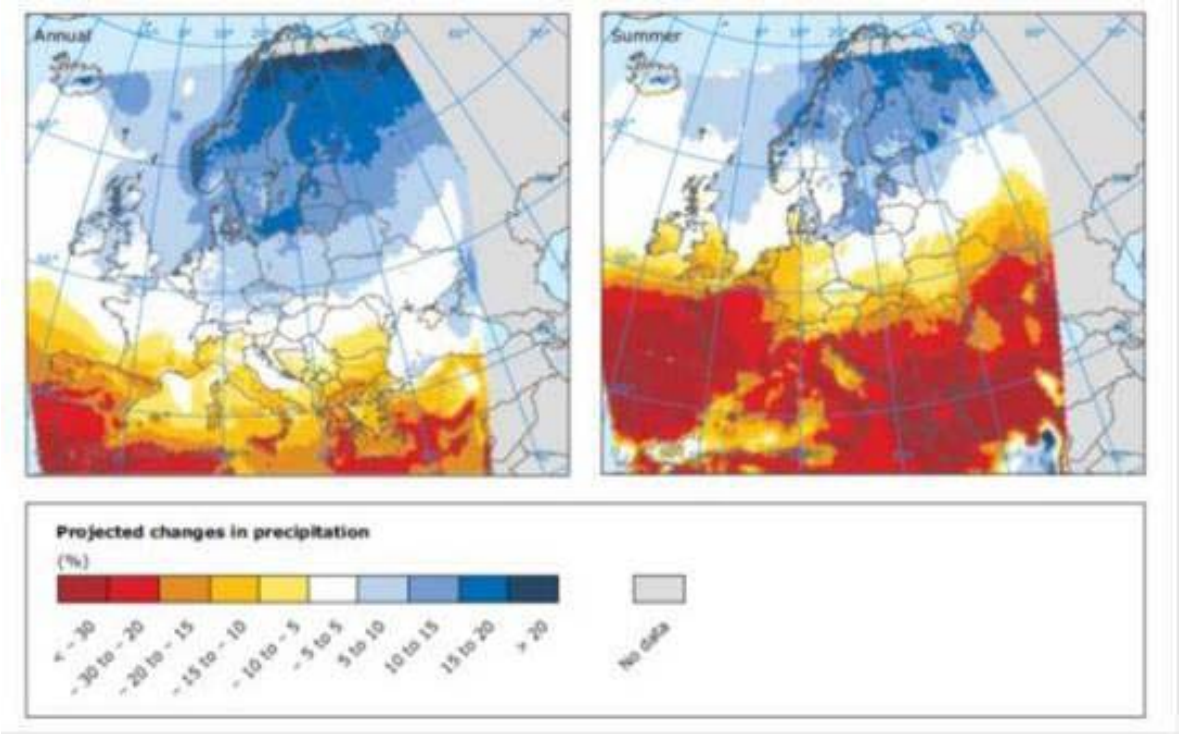
86 http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4_wg1_full_report.pdf

in 2012[87] identifies a likely increase in the frequency of heavy precipitation events or proportion of the total rainfall. In addition, snow mass in Europe has decreased by 7 % in the month of March from 1982 to 2009.

Projected changes

Most climate model projections show continued precipitation increases in northern Europe (most notably during winter) and decreases in southern Europe (most notably during summer). The change in annual mean precipitation between 1961–1990 and 2071–2100 would increase between 10% and 20 % in northern Europe and decrease between 5 and 20 % in southern Europe and the Mediterranean (Figure Error! ***No text of specified style in document.****-68*, left). Projections for summer precipitation show a decrease over southern (up to 60 %), central and northwest Europe Mediterranean (Figure Error! ***No text of specified style in document.****-68*, right). Heavy precipitation events are projected to become more frequent for most parts of Europe. The changes are strongest in Scandinavia in winter and in northern and eastern central Europe in summer.

Figure ***Error! No text of specified style in document.****-68 Projected changes in annual (left) and summer (right) precipitation (%) between 1961–1990 and 2071–2100*



87 IPCC – Intergovernmental Panel on Climate Change (2012): Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change.

Note: Projections are based on the ENSEMBLES project. They have been obtained from different regional climate models (RCMs) performing at 25 km spatial resolution with boundary conditions from five global climate models (GCMs), all using the IPCC SRES A1B emission scenario.

Source: van der Linden and Mitchell 2009 in EEA (2012), corrigendum[88]

6.2.3. Observed and projected change in freshwater

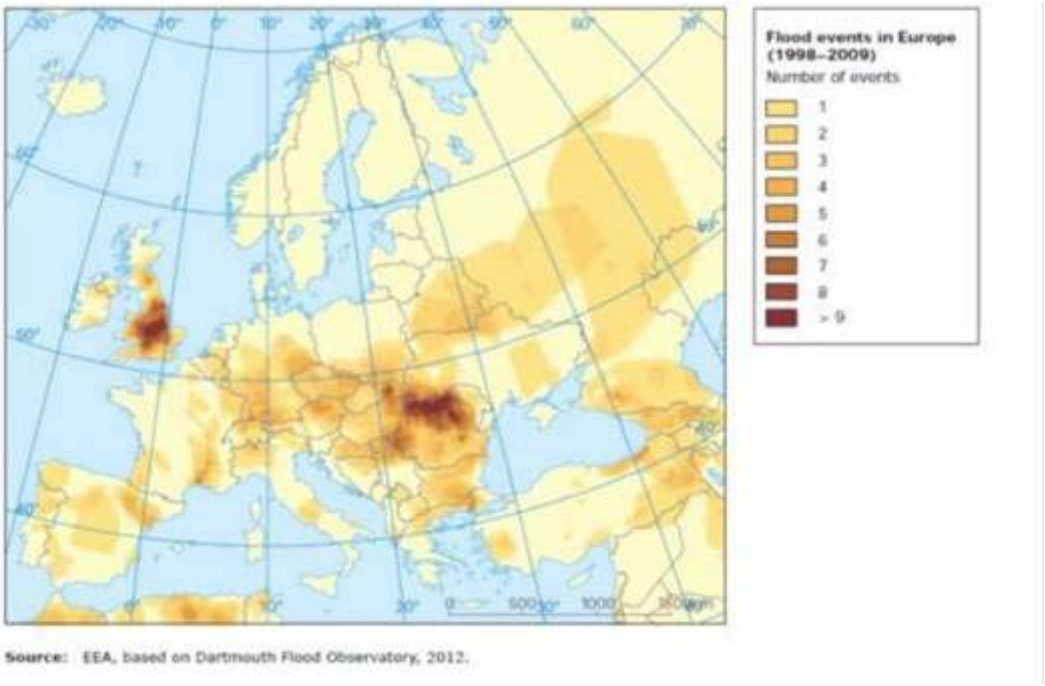
Observed changes

Climate change has already affected river flow but other factors (e.g. soil sealing, spatial development) also have a strong influence, which makes attribution difficult. Overall, annual river flow has decreased in southern and Eastern Europe, and increased elsewhere. In general, river flows have increased in winter and decreased in summer, but with substantial regional and seasonal variation. The impact of river flow droughts is currently largest in southern and south-eastern Europe. In comparison, large areas throughout Europe have been affected by flooding over the last decade (Figure Error! ***No text of specified style in document.****-69*). Flood losses in Europe have increased substantially over recent decades but the influence of climate change remains inconclusive up to now.

Regarding water temperature in major European rivers and lakes, an increase by 1-3°C has been recorded over the last century. The combination of increased temperatures and altered river flows are already affecting freshwater ecosystem and water quality.

*Figure **Error! No text of specified style in document.**-69 Occurrence of major floods in Europe (1998-2009)*

88 http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012



Source: EEA 2012, based on Dartmouth Flood Observatory[89]

Projected changes

Climate change is projected to result in strong changes in the seasonality of river flows across Europe. Summer flows are projected to decrease in most of Europe, including in regions where annual flows are projected to increase. River flow droughts are projected to increase in frequency and severity in southern and south-eastern Europe, Benelux, France, western parts of Germany and the United Kingdom over the coming decades. Regarding river flood hazards, an increase is projected for several of Europe`s major rivers.

6.2.4. Observed and projected change in oceans including sea level rise

Observed changes

Impacts of climate change are observed in all European seas, although the extent to which impacts have been documented in time and space varies among the seas. For example, surface ocean pH has declined from 8.2 to 8.1 over the industrial era which corresponds to a 30 % increase in oceanic acidity. In addition, the heat content of the World Ocean has increased since around 1970. Sea surface temperature in European seas increased in the past more rapidly than in the global oceans.

Measured trends have shown that sea-level rise is not constant over Europe but varies regionally due to physical processes (e.g. salinity, wind patterns). Since 1992 the following trends were recorded in selected regions across Europe (based on satellite

89 http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012

observation): The Baltic Sea shows an increase of between around 2 mm/year and 5 mm/year, Mediterranean Sea shows regions with increases of more than 6 mm/year and with decreases of more than – 4 mm/year, the Black Sea has seen an increase in sea level of between zero and around 5 mm/year.

Projected changes

Average surface water pH is projected to decline further to 7.7 or 7.8 by the year 2100 which represents a 100 to 150 % increase in acidity. These may affect many marine organisms and could alter ecosystems substantially. In addition, a further warming of the oceans is expected with projected climate change, although quantitative projections of ocean heat content are not available yet. Sea surface temperature is projected to rise more slowly than atmospheric temperature.

Projections of global mean sea-level rise in the 21st century range between 20 cm and about 2 m, showing that the level of uncertainty is high. Current projections suggests that sea-level rise is more likely to be less than 1 m than more than 1 m. Future projections of the spatial pattern of sea-level rise remain highly uncertain too. For example, a study estimates sea-level rise around the United Kingdom for the 21st century in the range of 12 cm to about 76 cm (depending on the emission scenario used). Another study estimated the plausible high-end scenario for 21st century sea-level rise on the North Sea coast of the Netherlands in the range of 40 to 105 cm[90].

6.2.5. Observed and projected change in the cryosphere

Observed changes

The extent and volume of the Arctic Sea ice and the Greenland ice sheet have declined rapidly since a couple of decades. Record low sea ice cover in the Arctic in September 2007, 2011 and 2012 was roughly half the size of the normal minimum extent in the 1980s. Regarding the Greenland ice sheet, the contribution of ice loss to global sea-level rise is estimated at 0.14–0.28 mm/year for the 1993–2003 period and has since increased.

Regarding glaciers, the vast majority in the European glacial regions are in retreat. Glaciers in the European Alps have lost approximately two thirds of their volume since 1850, with clear acceleration since the 1980s.

In the past 10–20 years European permafrost has shown a warming trend and the active layer thickness (i.e. thawing depth) has generally increased at some European permafrost sites.

Projected changes

90 .http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012

Arctic Sea ice is projected to continue to shrink in extent and thickness and may even disappear at the end of the summer melt season in the coming decades. For the Greenland ice sheet model projections suggest further declines in the future but the processes determining the rate of change are still poorly understood.

It can be expected that the volume of European glaciers will further decline between 22 % and 66 % compared to the current situation by 2100 under a business-as-usual emission scenario.

Permafrost areas are affected by the rate of warming and will very likely continue to thaw across Europe[91].

6.3. Expected impacts and vulnerabilities of climate change in the EU

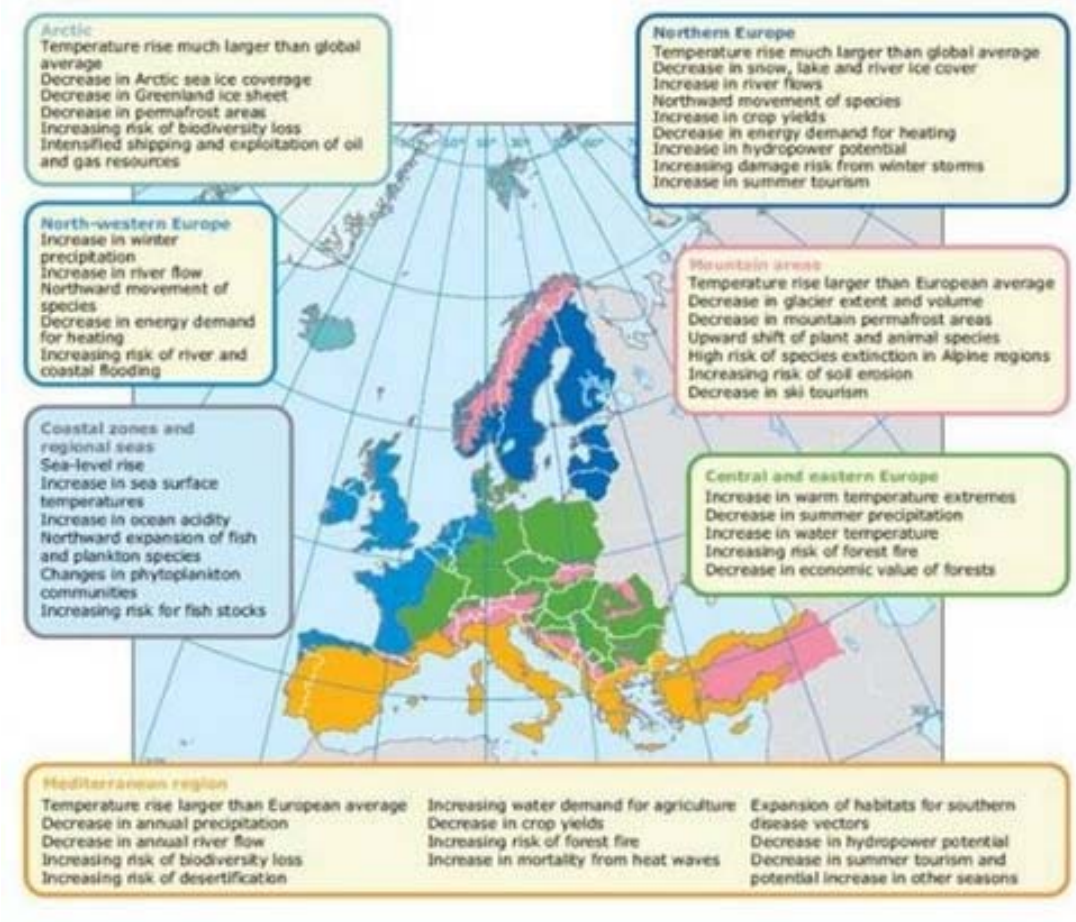
Climate change is expected to have far-reaching consequences for Europe. Current and projected impacts in Europe, together with their related costs, suggest that climate change will — either directly or indirectly — test the vulnerability of European society with economic, environmental, societal, geopolitical and technological risks. The security, health and quality of life of European citizens are at the core of the matter and climate change constitutes an additional pressure that challenges most of the components of human and natural systems[92].

The impacts of and vulnerabilities to climate change vary considerably across Europe, in terms of the regions, territories and sectors affected. The EEA 2012 report summarises the main observed as well as projected climate change impacts for the main regions in Europe in an overview map (Figure Error! ***No text of specified style in document.****-70*).

91 http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012

92 http://ec.europa.eu/clima/policies/adaptation/what/docs/background_report_part1_en.pdf

*Figure **Error! No text of specified style in document.**-70: Key observed and projected climate change impacts for the main regions in Europe*



Source: EEA 2012[93]

Regarding projected climate change impacts and vulnerabilities for sectors of relevance across Europe, some conclusions that can be drawn are presented below (based on McCallum et al. 2013, please refer to the report for the sources and literature used[94]).

6.3.1. Agriculture

Agriculture is the main user of land and water and still plays a dominant economic role in many rural areas of Europe. The stress imposed by climate change on agriculture is likely to intensify the regional disparities between European countries. In northern Europe increases in productivity and expansion of suitable cropping areas are expected to dominate. These are related to a lengthened growing season and an extension of the frost-free period. In southern Europe however, the benefits of projected climate change will be limited, while the disadvantages will be prevalent. Disadvantages include

93 http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012

94 http://ec.europa.eu/clima/policies/adaptation/what/docs/background_report_part1_en.pdf

increased water demand and periods of water deficit, extreme weather events (heat, drought, storms), loss of soil carbon content, erosion, lower harvestable yield and higher yield variability, new pests and plant diseases and crop damages, and reduction in suitable areas of traditional crops (also CION 2009[95]). Positive effects on agriculture in the whole of Europe include a potential increase in CO_2 fertilization of plants.

Rising sea levels may lead to a loss of farmland as a result of inundation and increasing salinity of soils and fresh water supplies, particularly in low-lying areas such as the Netherlands. Warming and extreme events, such as heat spells, will also have direct impacts on animal health, growth and output, as well as on reproduction. There will also be indirect effects through changes in the productivity of pastures and forage crops, and in the distribution of animal diseases.

Socio-economic characteristics also influence the vulnerability and adaptive capacity of the European agriculture. Impacts of climate change and variability largely depend on farm characteristics (e.g. intensity, size, land use). Farm characteristics influence management types and adaptation. As different farm types adapt differently, a large diversity in farm types reduces impacts of climate variability at regional level. Certain farm types may remain vulnerable while others are resilient to climatic changes. Farmers continuously adapt to changes, which affects the current situation as well as future impacts.

6.3.2. Forestry

The impacts of climate change will vary throughout the different geographic regions of Europe, with forest fires likely to dominate in southern Europe and the limited diversity of tree species in boreal forests enhancing the risk of significant pest and disease impacts. Next to negative climate change impacts, especially in the long term, opportunities arise as well in the forestry sector. Evidence to date suggests that productivity in northern and central Europe has increased and is likely to continue to increase. Further, northward expansion of potential distribution of some tree species is expected and potentially more favorable conditions for summer recreation in mountainous regions will exist. However, with more drastic changes in climate towards the end of the 21th century, severe and wide ranging negative climate change impacts have to be expected in most European regions, with the Mediterranean region being the most vulnerable to climate change based on potential impact assessment and adaptive capacity.

95 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF

6.3.3. Water resources and fisheries

Floods, droughts and water scarcity have already affected large parts of the European Union and have an important impact on our water resources and socio-economic developments. In the future, climate change is likely to change water availability and global warming will probably increase both the number and magnitude of hydrological extremes.

Water stress is spreading in Europe, affecting one third of the territory all year round. During summer months water scarcity is more pronounced in southern European basins but is also becoming increasingly important in Northern basins, including UK and Germany (CION 2012[96]).

The frequency and intensity of floods and droughts and their environmental and economic damage appear to have increased over the past thirty years. South-eastern Europe is increasingly facing extended periods of droughts, and both northern and Western Europe have been affected in more recent years (EEA 2012[97]).

The ClimWatAdapt project[98] investigated the future water situation and developments in the water sector in Europe until 2050 in terms of "vulnerability to water scarcity", "vulnerability to droughts", and "vulnerability to floods". The ClimWatAdapt project concludes that changes in future water scarcity are mainly driven by changes in water withdrawals. Under the EcF (Economy First) scenario, the percentage of area under severe water stress is expected to increase in all regions until 2050, with major changes in particular in eastern, western, and southern Europe. Increasing water withdrawals are the main cause in eastern and Western Europe. In southern Europe a decrease in water availability due to climate change exacerbate the situation with agriculture as the major water use sector potentially suffering significant economic losses. Mostly, water stress will not occur in northern Europe. In river basins under severe water stress, there will be strong competition for scarce water resources between households, industry, agriculture, and nature. Overall, this situation is most severe during summer when river flows are low and are becoming lower due to climate change. Additionally, the water demands are highest during the summer due to irrigation demands and tourism water use.

An analysis of the impacts of climate change on fisheries and aquaculture of the EU research project CLAMER[99] shows clear evidence from all European seas that "rising temperatures, along with overfishing, are causing substantial changes to fish stocks such as herring, sand eels and cod, as well as to their ranges and migration routes. Warmer

96 European Commission (2012): Commission Staff Working Document Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Social and Economic Committee and the Committee of the Regions: A Blueprint to Safeguard Europe's Water Resources. SWD(2012) 382 final. Brussels.

97 EEA – European Environment Agency (2012): Climate change, impacts and vulnerability in Europe 2012. An indicator-based report. EEA Report No 12/2012, Copenhagen.
http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012

98 http://climwatadapt.eu/

99 http://www.clamer.eu/

water fish species are gradually moving north so that unfamiliar fish species are now appearing on fish market stalls". For the future CLAMER expects "Northerly extension of warmer-water fish is expected to continue, with development of new exploitable populations. Stocks of cold-adapted species are projected to decline in, for instance, the North Sea, but to benefit from higher temperatures in areas such as the Barents Sea. Fish production is sensitive to the combined effects of climate, ocean acidification and plankton community changes, and heavily exploited fish stocks are likely to be especially vulnerable." Warmer waters may increase the growth rate for aquaculture species but can also place some species outside their comfort zone. Rising acidity may affect the ability of shellfish to construct their shells.

6.3.4. Energy

Climate threats for the European energy system do already exist and are projected to increase. Impacts of climate change, such as an increased frequency of extreme weather events or changing water and air temperatures have effects on all three major parts of the system: transmission and distribution, supply/generation and demand. Transmission and distribution of energy (mainly electricity) is challenged by new demand patterns as well as direct physical destruction due to a higher magnitude and frequency of extreme weather events (explicitly under threat are overhead transmission/distribution facilities, but also other infrastructure – e.g. substations, transformers or fragile supply infrastructure). Supply/generation of electrical energy is affected by efficiency decreases due to climate change and the more complex vulnerability setting of renewable energy (as compared to fossil fuel based energy supply) to changing climate parameters. Demand of energy is already triggered particularly by extreme periods (heat waves, floods/mass movements, droughts) causing demand-driven overstress of energy infrastructure, their direct destruction and consequent interruptions in energy supply. In particular, more intense and frequent heat waves can shift demand patterns to critical constellations at times where energy supply is low, e.g. as a result of decreased efficiency of thermal plants due to temperature increases of ambient and cooling water. This coincides with increased demand for cooling for private households, offices and storage of for example food and pharmaceutical products.

These impacts will be aggravated due to i) increasing interconnection of grid-dependent European internal energy market and thus increasing amounts of transmitted energy/less domestic supply in many regions; ii) projected further shift towards increasing electricity demands and according shifts in primary energy consumption and iii) increasing share of renewable energy generation that will entail a more complex picture of climate threats (e.g. increasing dependency from solar irradiation, wind velocities, river run-off regimes). Threats to the energy system might increase regional disparities with the EU with southern countries suffering from i) high electricity import dependency and thus relying on transmission infrastructure that is not yet resilient and ii) projected impacts from gradual temperature increase, heat wave and drought frequency further threats to domestic supply aggravating import dependency. Meanwhile, northern countries show a more complex and uncertain picture of potential gains and losses for energy supply and security.

6.3.5. Transport infrastructure

In the past, precipitation in its various forms caused the most damage to transport. This is true for all parts of Europe and all forms of transport such as rail, road, shipping and aviation. For example, heavy snowfall complicates road traffic, rail transport and airport operations regardless of where in Europe it occurs. Heavy rain causes flash flooding, which disrupts transport connections, inhibits inland waterway traffic and damages earth structures such as road, bridge and rail embankments.

Consequences of future climate change will both be negative and positive for transportation infrastructure, but will differ from region to region. In particular, the projected increase in frequency and intensity of weather and climate extremes, such as heavy rain (e.g. causing floods), heavy snowfall, extreme heat and cold, drought and reduced visibility can enhance negative impacts on the transport infrastructure, causing injuries and damages as well as economic losses. But also some beneficial impacts on transport due to climate change can be expected, such as reduced snow fall for most European regions improving traffic conditions. However, the vulnerability of the transport sector is also influenced by human behaviour and societal changes as the kind of mobility chosen by individuals also influences the vulnerability of the sector.

In terms of cost estimates for future climate change impacts on the transport sector, the Weather project[100] concludes that from 2010 to 2050, due to weather extremes, rail transport would experience the most substantial increase in all cost categories (i.e. comprising direct costs to the transport sector and indirect costs to its users and to other sectors). Aviation and road transport would also be affected, with varying levels of impacts for different EU regions.

6.3.6. Construction and buildings

The impact of climate change is particularly pertinent to the construction sector given the life expectancy of buildings, both in terms of new developments and the existing built environment to climatic changes to withstand a potentially very varied and uncertain climatic impact. The vulnerability of buildings and constructions is mainly influenced by the design (low resistance to storms) and location (e.g. in flood-prone areas, landslides, avalanches).

In the past, precipitation in its various forms caused the most damage to buildings and infrastructure. This is true for all parts of Europe and all forms of buildings and civil engineering works. For example, heavy snowfall caused building collapses, heavy rain and storm waters causing flash flooding lead to infiltration of water into buildings, damage or destruction. Additional salt water intrusion can cause deterioration of facades, statues and monuments. Heavy snowfall and landslides can seriously affect not only the day to day functioning of infrastructure (i.e. railways, roads) but also fast and efficient relief activities. With more intense extreme precipitation events expected, there

100 http://www.weather-project.eu/weather/inhalte/deliverables.php

is also a significant risk of drains and foul sewers flooding and failing to function. Recurring flooding and changes in ground water levels will require investment in flood resistance and resilience, while urban flash flooding must also be considered during extreme rainfall events. In coastal areas, coastal protection (e.g. sea walls, barriers) might lead to increased maintenance costs and higher frequency of updating works. Urban areas are particularly at risk due to higher sealing rates related to construction and buildings (e.g. higher water run-off, heat island effect during summertime, and lack of fresh water during droughts).

Major threats to construction and buildings requiring short-term action can be aggregated to: i) extreme precipitation which can be expected European wide (e.g. leading to water intrusion, damage to foundations and basements, destruction of buildings); ii) summer heat, especially in southern Europe (e.g. leading to material fatigue, decreased comfort and health, high energy use for cooling); iii) exposure of constructions to heavy snowfall and iv) rising sea levels that increase the risk of flooding in particular as many European cities are located next to the shore or rivers.

6.3.7. Biodiversity

Climate change is also leading to indirect impacts on biodiversity through changes in socio-economic drivers, working practices, cultural values, and policies. These have the potential to exacerbate many of the main pressures driving biodiversity loss, including habitat fragmentation and loss, over-exploitation, pollution of air, water and soil, and spread of invasive species (EEA 2010[101]). Due to their scale, scope and speed many could be more damaging than direct impacts, with knock-on implications for ecosystem services on which our society and economy rely. Further, human consumption and production patterns are causing ecosystems to degrade and depriving them of their capacity to withstand climate change and deliver essential services, such as crop pollination, clean air and water, and control of floods or erosion (RUBICODE project 2006–2009[102]).

The vulnerability of habitats to climate change is also likely to be a problem for species, particularly those that are habitat specialists and are already constrained by habitat availability and/or condition. Climate change is likely to exacerbate such threats, rather than create new opportunities[103].

101 http://www.eea.europa.eu/publications/10-messages-for-2010
http://www.eea.europa.eu/soer/europe/biodiversity
http://www.eea.europa.eu/publications/assessing-biodiversity-in-europe-84
http://www.eea.europa.eu/publications/eu-2010-biodiversity-baseline/

102 http://www.rubicode.net/rubicode/index.html

103 http://acm.eionet.europa.eu/reports/docs/ETCACC_TP_2010_14_Habitat_vulnerability_assessment.pdf

6.3.8. Health

Climate change will impact Europe citizens' health, animal (livestock) and plant (food security) health as well as cause (damage) costs related to direct and indirect health impacts.

The relation between human health and climate change are complex and interact with several other factors. Important factors are the population health status, population demographics and the health infrastructure. Vulnerable groups among others are children, elderly, pregnant women, low income groups and people with health issues (WHO 2010[104]). In many parts of Europe population is aging. Communicable diseases continue to emerge in Europe and elsewhere, and it is by now widely understood that myriad social and environmental risk factors influence their emergence. Major drivers of emerging infectious diseases that could threaten control efforts in Europe include globalization and environmental change (including climate change, travel, migration, global trade); social and demographic drivers (including population ageing, social inequality, lifestyles); and public health system drivers (including antimicrobial resistance, health care capacity, animal health, food safety). These factors, alongside many others, interact in dynamic and stochastic ways to drive the emergence and re-emergence of new diseases.

Besides its effects on infectious diseases, climate change impacts human health also through air quality, with negative consequences for respiratory and cardiovascular diseases. Changes in weather patterns may also change the seasonality of allergies, while changing ultraviolet radiation may increase the incidence of skin cancer and cataract.

Climate change may also impact animals' living conditions and bring forth pathologies such as parasitic diseases, nutritional disorders, sunstroke or dehydration which can be very important for the farmers' economic situation.

Regarding plant health an expansion of a range of pests that so far could not establish in Europe can be expected due to increased temperatures allowing them to survive wintertime and to have multiple generation cycles per year, and by increasing the susceptibility of crops and trees to new dangerous pests of plants from other continents.

6.3.9. Food security

Altered food supply and potential price increases could have potential impacts on the 'EU's food imports. For many years the EU has been a net food importer. Today the 'EU's overall trade is in fairly close balance (livestock and cereals), for many product groups the EU still remains a substantial importer (fruit, vegetables, cotton, tobacco, oilseeds and oils).

104 http://www.euro.who.int/__data/assets/pdf_file/0005/95882/Parma_EH_Conf_edoc06rev1.pdf

However, EU food production per capita has constantly increased in the past while simultaneously the share of income that households spend on food has steadily declined. Forecasts predict roughly stable or increasing production quantities for the EU – even in the case of subsidy and tariff cuts. The expected main effect of climate change in the coming decades will be to shift production from southern to northern Europe without significantly curtailing overall production.

If food prices rise dramatically, the EU could increase the agricultural area used for growing cereals; in particular, by cultivating abandoned land or shifting from biofuel and livestock production to more cereals. Furthermore, agricultural labour and capital input could be multiplied. An additional measure would be to enhance investments into agricultural productivity.

6.3.10. Economic activity and employment

Climate change is expected to cause a mix of positive and negative impacts on economic activity and employment, with substantial disparities among regions in Europe. In general, modest changes in climatic conditions are expected to have a relatively minor impact at macro level in Europe due to redistribution effects (between economic sectors, as well as between countries/regions) and adaptation capability. However, and even under optimistic scenarios, climate change could have significant adverse impacts at local level in terms of economic activity and employment.

The impact of temperatures increase, changes in precipitation regimes and sea-level rise will affect – directly or indirectly – productivity and viability of nearly all economic sectors across the EU, although some sectors are more weather-sensitive than others and will have more impact on people's lives and income possibilities. Rising temperatures and erratic weather pattern will reduce the land and natural capital productivity in many places. More frequent and intense heat waves, and altered transmission seasons and geographic range of important vector-borne diseases will lower labour productivity. As a result of sea level rise and increased intensity of climate extremes, physical capital assets will be more frequently impaired and important lifelines disrupted with wide reaching economic and social consequences. For the private sector (defined as privately owned or controlled companies, organisations and entities) impacts are expected to fall disproportionately on SMEs (CION 2013[105]) including disrupting business operations, property damage, disruption to supply chains and infrastructure leading to increasing costs of maintenance and materials, and raising prices. In other cases, climate change may also offer new business opportunities for products and services that would help people to adapt in the form of expanding market share and creating wealth in communities (innovation and job creation) and accessing new finance streams (increased public funding and financial products and services).

105 European Commission (2013): Commission Staff Working Document – Accompanying document to the EU Strategy on adaptation to climate change. Impact Assessment - Part 2. SWD(2013) 132 final. European Commission, Brussels. http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_132_2_en.pdf

Tourism is another major economic sector affected by climate change. The effects of climate change on the tourism sector vary widely, depending on the location and the season. The biggest adverse impacts would appear to be from changes in summer tourism flows (in the Mediterranean region) and winter skiing (in the Central region). Thus, the attraction of tourist destinations will change with the variation of tourist flows affecting regional economies. Conversely, some benefits are to be expected in other areas, which may benefit from a shift in tourist flows.

6.3.11. Social issues

Climate change impacts might affect people's daily lives in terms of employment, housing, health, water and energy access as well as the implementation of gender equality and other human rights. However these impacts are not too well understood at the EU level.

Main potential impacts on social issues that are expected to be most relevant for the EU level with regard to climate change impacts relate to **migration**, **gender**, and **ageing population.** The areas of **social protection** dealing with reduction of poverty and social exclusion, access to healthcare, pensions, long-term care, social security, employment and training services, social housing, child care and social assistance are facing climate change related negative impacts and at the same time directly influence the capacity of societies to adapt to all types of climate change impacts.

6.4. EU-level actions for adaptation to climate change

In view of the specific and wide-ranging nature of climate change impacts across the EU's territory, the European Union has long assumed its important role in developing an EU-wide framework for adaptation. Thus, the European Commission started in 2007 by adopting a Green Paper "Adapting to climate change in Europe – options for EU action"[106], followed by the White Paper "Adapting to climate change: Towards a European framework for action"[107]. Both documents started a process that has recently been brought to a new level through the adoption of the EU strategy on adaptation to climate change on 16 April 2013[108].

6.4.1. Towards a European Framework for adaptation: the Green and White Papers

In 2007, the European Commission adopted a **Green Paper on adapting to climate change in Europe**, recognising that all parts of Europe will increasingly feel the adverse effects of climate change. Responding to the feedback gathered from the broad stakeholder involvement for the Green Paper, the EU adopted an **Adaptation White Paper** in 2009. This White Paper set out the steps to be taken in preparing the 2013 EU strategy on adaptation to climate change. The White Paper highlighted five main reasons for the EU to take action on climate change adaptation:

106 http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0354en01.pdf

107 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF.

108 http://ec.europa.eu/clima/policies/adaptation/what/docs/com_2013_216_en.pdf

- Many climate change impacts and adaptation measures have cross-border dimensions;
- Climate change and adaptation affect EU policies;
- Solidarity mechanisms between European countries and regions might need to be strengthened because of climate change vulnerabilities and adaptation needs;
- EU programmes could complement Member State resources for adaptation;
- Economies of scale can be significant for research, information and data gathering, knowledge sharing, and capacity building.

The White Paper was framed to complement and ensure synergies with actions by Member States. It adopted a phased approach. Phase 1 (2009-2012) laid the ground work for preparing a comprehensive EU Adaptation Strategy to be implemented during phase 2, commencing in 2013. The first phase comprised a total of 33 actions arranged across four 'pillars'. The outcomes of these activities informed the elaboration of the EU Adaptation Strategy adopted in 2013.

Main achievements under the four pillars of the White Paper are summarised in the following[109].

Pillar 1: Develop and improve the knowledge base at regional level on climate change impacts, vulnerabilities mapping, costs and benefits of adaptation

Noting that information on climate change impacts, vulnerability and adaptation is available, but not sufficiently shared across EU Member States, the Commission started a process, to develop a Clearing House mechanism that would establish a comprehensive European information platform, which was launched on 23 March 2012 as the 'European Climate Adaptation Platform' (Climate-ADAPT[110]).

Hosted by the European Environment Agency (EEA), Climate‑ADAPT contains information on impacts, vulnerability and adaptation policy across Europe, and also includes adaptation case studies as well as a number of software tools to facilitate accessing this information. Climate-ADAPT is the EU entry point to information on

109 More detailed information on each of the 33 actions announced in the White Paper is available in: European Commission (2013): Commission Staff Working Document – Accompanying document to the EU Strategy on adaptation to climate change. Impact Assessment - Part 2. SWD(2013) 132 final. European Commission, Brussels. pp.96-106. http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_132_2_en.pdf

110 http://climate-adapt.eea.europa.eu

adaptation, and it complements other initiatives implemented or planned at national and sub‑national levels[111].

The platform Climate-ADAPT organises information under the following main entry points:

- adaptation information (observations and scenarios, vulnerabilities and risks, adaptation measures, national adaptation strategies, research projects);
- EU sectoral policies (agriculture and forestry, biodiversity, coastal areas, disaster risk reduction, financing, health, infrastructure, marine issues and fisheries, water management);
- transnational regions, countries and urban areas and
- tools (Adaptation Support Tool, Case Study Search Tool, Map Viewer).

To support the implementation of this pillar, the European Commission was assisted by a Working Group on Knowledge Base on Climate Change Impacts, Vulnerability and Adaptation (WG-KB), made up of representatives of Member States, research institutions and other stakeholders.

Pillar 2: Integrate adaptation into EU policies (mainstreaming)

This pillar aimed at ensuring that climate change impacts and adaptation are taken into consideration in all relevant EU policy sectors. The key policy initiatives subject to mainstreaming concentrate on the following nine sectors: water management, marine and fisheries, coastal areas, agriculture and forestry, biodiversity, infrastructure, finance and insurance, disaster risk reduction, and health (EEA 2013).

The EU's Seventh Framework Programme for Research and Technological Development (FP7), as well as several European Commission service contracts, played an important role in informing mainstreaming activities and potential policy intervention. The European Commission also supports mainstreaming efforts by providing sectoral guidelines for several EU policy areas to ensure that climate change impacts are taken into account (e.g. for Environmental Impact Assessment (EIA) and Strategic Environment Assessment (SEA)).

Work on mainstreaming has expanded to include strategic financial planning. The 2011 Commission proposal for the next Multiannual Financial Framework[112] (MFF) 2014-

111 EEA - European Environment Agency (2013): Adaptation in Europe. Addressing risks and opportunities from climate change in the context of socio-economic developments, EEA Report 3/2013, Copenhagen.
http://www.eea.europa.eu/publications/adaptation-in-europe

112 The Multiannual Financial Framework (MFF) shall ensure that European Union expenditure develops in an orderly manner and within the limits of its own resources. It shall be established for a period of at least five years. The annual budget of the Union shall comply with the multiannual financial framework (European Commission, 2008). The MFF de facto sets political priorities for future years and constitutes therefore a political as well as budgetary framework ('in which areas should the EU invest more or less in the future?').

2020 recognises this approach and includes a minimum contribution of 20 % for climate related expenditure, stipulating that all EU funds will need to take climate change into account in their funding allocation decisions[113].

Pillar 3: Use a combination of policy instruments – market-based instruments, guidelines, and public-private partnerships – to ensure effective delivery of adaptation

The European Commission carried out several studies to identify policy instruments suited for adaptation purposes and to develop specific guidelines (e.g. for CAP[114] and Cohesion[115] under the next financing period). Further, stakeholder involvement has taken place with the private sector on specific issues, such as standards and insurance. For example, a mandate has been adopted which would require standardisation organisations to consider, in the context of their work, updating Eurocodes[116], developing a technical report analysing and providing guidance for potential amendments for Eurocodes with regard to relevant impacts of future climate change[113].

Pillar 4: Work in partnership with the Member States and strengthen international co-operation on adaptation by mainstreaming adaptation into the EU's external policies.

To develop this pillar, the Commission created an Adaptation Steering Group (ASG) in September 2010. The ASG brought together Member States and a diverse range of stakeholders, including business organisations and NGOs and was to support the European Commission in implementing the White 'Paper's actions in preparation of the EU Adaptation Strategy. The Group met7 times in total between September 2010 and January 2013.

For strengthening the international co-operation on adaptation the EU has been taking an active role in the negotiations under the UNFCCC to ensure adaptation issues are adequately dealt within a post-2012 agreement and will continue to do so. In addition, adaptation to climate change has been mainstreamed into EU development cooperation. For the 2007 to 2013 financial perspective, the EU has adopted a package of new instruments for the implementation of external assistance which is mainly based on three "geographical" instruments: Development Cooperation Instrument (DCI), European Neighbourhood and Partnership Instrument (ENPI), and European Development Fund (EDF).

Across the 4 pillars of the 2009 White Paper, most of the 33 actions announced have been implemented.

113 http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_132_en.pdf

114 http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_139_en.pdf

115 http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_135_en.pdf

116 The EN Eurocodes are a series of 10 European Standards, EN 1990 - EN 1999, providing a common approach for the design of buildings and other civil engineering works and construction products.
http://eurocodes.jrc.ec.europa.eu/

6.4.2. The EU Strategy on Adaptation to Climate Change

Building on the results of the above-mentioned initiatives carried out under the 2009 White Paper and in-depth assessments of policy areas concerned, an **EU strategy on adaptation to climate change** was adopted by the European Commission on 16 April 2013. The overall aim of the EU Adaptation Strategy is to contribute to a more climate-resilient Europe. This means enhancing the preparedness and capacity to respond to the impacts of climate change at local, regional, national and EU levels, developing a coherent approach and improving coordination.

The Communication "An EU Strategy on adaptation to climate change"[117] is the main political document adopted. It sets out eight actions to be taken to meet the Strategy's three specific objectives:

(1) Promoting action by Member States,

(2) Better informed decision-making, and

(3) Climate-proofing EU action: promoting adaptation in key vulnerable sectors.

The European Commission also adopted a Green Paper on insurance in the context of natural and man-made disasters, launching a wide debate on the adequacy and availability of existing insurance options.

The Communication is complemented by a set of accompanying documents[118] reflecting the broad scope of climate change and adaptation to be considered:

- A first group of documents aims at facilitating adaptation processes across the EU by offering non-binding concrete suggestions to Member States and other stakeholders as a result of analyses and consultation. These include Guidelines on developing adaptation strategies, and other guidance documents for the integration of climate change adaptation into different key EU programmes and investments, such as the Cohesion Policy, the 2014-2020 rural development programmes under the Common Agricultural Policy (CAP);

- A second group of documents focuses on adaptation in specific sectors and policy areas. They illustrate some of the sectoral or territorial impacts of climate change (for coastal and marine issues; human, animal and plant health; and infrastructure) highlighting some of the measures currently being proposed by the European Commission to address these issues and bring about a complementary perspective on some particular issues (e.g. environmental degradation and migration).

117 http://ec.europa.eu/clima/policies/adaptation/what/docs/com_2013_216_en.pdf

118 http://ec.europa.eu/clima/policies/adaptation/what/documentation_en.htm

In addition, some Guidelines for Project Managers on making vulnerable investments climate resilient were released.

In the following, the three objectives with their proposed actions set out in the EU Adaptation Strategy are described in detail[119]:

Objective 1: Promoting action by Member States

Action 1: Encourage all Member States to adopt comprehensive adaptation strategies

One of the greatest challenges for cost-effective adaptation in Europe is to achieve coordination and coherence at the various levels of planning and management. As National Adaptation Strategies (NASs) are widely accepted as key tools to guarantee consistent action at country level, the EU Adaptation Strategy encourages all Member States to adopt a comprehensive NAS.

In 2017, the Commission will assess whether action being taken in the Member States is sufficient, to eventually consider further action, including the possibility to propose a legally binding tool.

Action 2: Provide LIFE funding to support capacity building and step up adaptation action in Europe (2013-2020)

The EU will provide financial support for adaptation through the proposed EU financial instrument for the Environment (LIFE), which for the first time includes a climate action sub-programme with a budgetary allocation dedicated specifically to climate change adaptation[120]. The Commission will use multi-annual work programmes to define strategic goals and thematic priorities to ensure alignment with the EU Adaptation Strategy.

Action 3: Introduce adaptation in the Covenant of Mayors framework (2013/2014)

Active engagement on the part of local and regional authorities will be essential, given the importance of adaptation action at local level. Building upon the success of an initial

119 http://ec.europa.eu/clima/policies/adaptation/what/docs/com_2013_216_en.pdf

120 The LIFE programme is the EU Financial instrument for the environment with the general objective to contribute to the implementation, updating and development of EU environmental policy and legislation by co-financing pilot or demonstration projects with European added value. Different LIFE projects have been actively working on ways to both mitigate the effects of climate change and to help the EU adapt to its impacts. These projects represented a total investment of approximately €24 million in EU co-financing in the period of 2007-2013. An overview on recent adaptation to climate change related LIFE projects can be found in the internet.
The Commission proposes to allocate in total EUR 3.2 billion over 2014-2020 to a new LIFE Programme for the Environment and Climate Action.

For more details on the proposal see: http://ec.europa.eu/environment/life/about/beyond2013.htm.

EU initiative[121] adaptation action by cities will be further developed in coordination with other EU policies following the model of the Covenant of Mayors[122].

Objective 2: Better informed decision-making

Action 4: Bridge the knowledge gap

The Strategy, recognizing that substantial knowledge gaps need to be filled, identifies the need for the European Commission to work with Member States and stakeholders in refining these knowledge gaps and identifying the relevant tools and methodologies to address them. Therefore, it establishes a solid link to feed the EU Framework Programme for Research and Innovation 2014-2020 – Horizon 2020 – with its finding, which will be addressed through specific programmes and mainstreaming climate action across the full programme (35 % of the budget).

Action 5: Further develop Climate-ADAPT as the 'one-stop shop' for adaptation information in Europe

The European Commission aims to continuously improve the Web platform Climate-ADAPT, to fulfil the need to facilitate access to sound adaptation information in Europe for all the relevant stakeholders, within and outside the EU territory. In this regard, since the launch of the Strategy the Commission and the EEA have continued developing the platform and disseminating its contents, and these efforts will be maintained and reinforced as an essential element of implementing the EU Adaptation Strategy.

Objective 3: Climate-proofing EU action: promoting adaptation in key vulnerable sectors

Action 6: Facilitate the climate-proofing of the Common Agricultural Policy (CAP), the Cohesion Policy and the Common Fisheries Policy (CFP)

The European Commission remains strongly committed to mainstreaming adaptation into key EU funds, policies and programmes. Together with the mainstreaming efforts referred above (indicate section), the Commission intends to ensure improved access to funding as a critical factor in building a climate-resilient Europe and supporting Member States' adaptation activities. As mentioned above, the objectives for all relevant EU finance programmes for 2014-2020 includes a minimum contribution of 20% for climate related expenditure.

Action 7: Ensuring more resilient infrastructure

121 http://eucities-adapt.eu/cms/

122 The Covenant of Mayors was officially launched in January 2008. Since then, this initiative has met large international success: 2.108 European cities had signed political commitments by November 2012. The initiative addresses local and regional authorities, voluntarily committing to increasing energy efficiency and use of renewable energy sources on their territories.

Infrastructure projects, which are characterised by a long life span and high costs, need to withstand the current and future impacts of climate change. The European Commission will explore all the potential ways at its hand to enhance the adaptation capacity of European infrastructures, from mainstreaming to standardisation, or providing further guidance to project developers. It will also explore ecosystem-based approaches to adaptation and the potential for developing green infrastructure as a climate change adaptation resource.

Action 8: Promote insurance and other financial products for resilient investment and business decisions

The European Commission's aim is to improve the market penetration of natural disaster insurance and to unleash the full potential of insurance pricing and other financial products for risk awareness prevention and mitigation and for long-term resilience in investment and business decisions.

The Green Paper on the insurance of natural and man-made disasters (CION 2013[123]), adopted together with the Strategy, is a first step in encouraging insurers to improve the way they help to manage climate change risks. Stakeholder discussions with the insurance and bank sectors on the basis of the Green Paper have been initiated.

Governance and review

The European Commission will cooperate with Member States through the relevant *fora*, including the Climate Change Committee and appointed adaptation national focal points, and continue to engage with stakeholders for proper and timely **implementation** of the EU Adaptation Strategy.

In 2017, the Commission will report to the European Parliament and the Council on the state of implementation of the Strategy and propose its review if needed.

6.5. Other EU research and assessment activities

Research is key for effective adaptation, as practical adaptation actions and measures must be based on sound, scientific, technical and socio-economic information. This has been recognised by the European Commission and the level of spending on impacts and vulnerability assessment and adaptation has increased significantly since NC5.

European research has been supported mainly through the Framework Programmes for Research and Technological Development[124]. The European Commission is funding research on the scientific, technical and socio-economic aspects of human-induced

123 European Commission (2013): Green Paper on the insurance of natural and man-made disasters. COM(2013) 213 final. European Commission. Strasbourg.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0213:FIN:EN:PDF

124 http://cordis.europa.eu/fp7/home_en.html

climate change, its potential impacts and options for adaptation and mitigation not only in Europe, but also in cooperation with third countries, including developing countries.

Under the EU's 7th Framework Programme for Research and Technological Development - FP7 (2007- 2013) climate change was a key priority including research on climate change adaptation[125].

A number of projects funded under FP7 have and will continue to contribute to the improvement of the assessment framework by advancing of the understanding of the climate system and its processes, the quantification of climate change impacts on human and natural systems (including extreme events), and the identification and assessment of mitigation and adaptation options including their costs. Results from research projects serve as a knowledge basis for the development and support of climate policies as well as policies on, for example, disaster risk reduction.

Some examples of projects on impacts, vulnerability and adaptation for various themes funded over the last few years under the European Commission 6th and the 7th Framework Programmes are summarised in Table Error! ***No text of specified style in document.****-19*.

Table ***Error! No text of specified style in document.****-19 Selected research project financed by FP6 and FP7*

Acronym and Link	Project title	General aim	Duration
ENSEMBLES	ENSEMBLES – A changing climate in Europe	An ensemble prediction system giving the first probabilistic climate projections of temperature and rainfall changes for Europe this century	2004-2009
IMPACT2C	Quantifying projected impacts under 2°C warming	IMPACT2C enhances knowledge, quantifies climate change impacts, and adopts a clear and logical structure, with climate and impacts modelling, vulnerabilities, risks and economic costs, as well as potential responses, within a pan-European sector based analysis. IMPACT2C utilises a range of models within a multi-disciplinary international expert team and assesses effects on water, energy, infrastructure, coasts, tourism, forestry, agriculture, ecosystems services, and health and air quality-climate interactions.	2011-2015
ClimateCost	the Full Costs of Climate Change	Advance the knowledge in long-term targets and mitigation policies; costs of inaction (the economic effects of climate change) and costs and benefits of adaptation	2008-2011
ADAM	ADaptation And Mitigation Strategies: supporting European climate policy	ADAM supports the EU in the development of post-2012 global climate policies, the definition of European mitigation policies to reach its 2020 goals, and the emergence of new adaptation policies for Europe with special attention to the role of extreme weather events	2006-2009

125 http://ec.europa.eu/research/infocentre/theme_en.cfm?item=Environment&subitem=Climate%20%26%20global%20change&start=1

Acronym and Link	Project title	General aim	Duration
RESPONSES	European responses to climate change: deep emission reductions and mainstreaming of mitigation and adaptation	Its objective is to identify and assess integrated EU climate-change policy responses that achieve ambitious mitigation and environmental targets and, at the same time, reduce the Union's vulnerability to inevitable climate-change impacts.	2011-2013
MEDIATION	Methodology for effective decision-making on impacts and adaptation	MEDIATION will: • integrate, consolidate and enhance access to the existing knowledge in the proper context of local, regional and sectoral application, methods and data. • further develop and improve methods in selected priority areas, such as cost-effectiveness analysis and vulnerability. • bring available knowledge beyond the current fragmented stage, and provide links between common, generically available knowledge about methods to assess climate change impacts, vulnerability and adaptation options, and the needs of regional or sectoral decision-making. • apply a systematic approach to developing a common methodological framework that integrates policy needs and the diversity in assessment approaches, both top-down and bottom-up. • increase the understanding, management and communication of pertinent uncertainties to allow for more harmonized approaches in European research to support robust decision-making.	2010-2013
CIRCLE CIRCLE-2	Climate Impact Research & Response Coordination for a Larger Europe	Coordinate European transnational research funding on Climate Change Impacts, Vulnerability and Adaptation (CCIVA) and facilitate the transfer of research outcomes that European and national decision makers need to design effective yet economically efficient Adaptation initiatives and strategies; Share experiences and lessons learnt on CCIVA research funding and management and on the development of national and regional Adaptation practices; Encourage international cooperation with non-European countries and organisations as well as the involvement of countries with less diverse CCIVA research programmes.	2005-2009 2010-2014
ClimateWater	Bridging the gap between adaptation strategies of climate change impacts and European water	The overall objective of the ClimateWater project is to study European and international adaptation measures and strategies related to climate change impacts and how these are taken into account in water policies. The project is formulating a coherent	2008-2011

Acronym and Link	Project title	General aim	Duration
	policies	framework on adaptation strategies of climate change impacts on water resources, water cycling and water uses of the society and nature with special regard to those that water policy has to take into account when considering climate change impacts.	
ESPON Climate	Climate Change and Territorial Effects on Regions and Local Economies in Europe	The ESPON project aims to develop a pan-European vulnerability assessment as a basis for identifying regional typologies of climate change exposure, sensitivity, impact and vulnerability. On this basis, tailor-made adaptation options can be derived which are able to cope with regionally specific patterns of climate change.	2009-2011
ACQWA	Assessing climatic change and impacts on the quality and quantity of water	The project uses advanced modelling techniques to quantify the influence of climatic change on the major determinants of river discharge at various time and space scales, and analyse their impact on society and economy, also accounting for feedback mechanisms. The focus will be on continuous transient scenarios from the 1960s up to 2050.	2008-2012
CIRCE	Climate Change and Impact Research: the Mediterranean Environment	The CIRCE project aimed at reducing vulnerability to climate change in the Mediterranean region. Its comprehensive assessment of climate change impacts in this region, the first ever produced, provides policy-makers and the public with information on current and potential impacts, including health, and with ways to modify services and infrastructure to respond to the climate change challenge.	2006-2011
Viroclime	Impact of Climate Change on the Transport, Fate and Risk Management of Viral Pathogens in Water	The use of hydrological models to determine the effects of climate change on the variation in viral flux, and therefore in risk associated with viral disease comprises a novel approach to the management of water-related disease. Tools developed in previous EU Projects will be used to conduct case studies on five selected sites (in Sweden, Spain, Hungary, Greece and Brazil) vulnerable to climate change (principally rainfall events), and the empirical baseline data accrued will be used in mathematical models constructed to estimate changes in exposure under defined conditions.	2011-2013
EDENext	Biology and control of vector-borne diseases in Europe	EDENext builds on the concepts, methods, tools and results of the earlier EDEN project (Emerging diseases in a changing European environment). It is using the same general approach of understanding and explaining biological, ecological and epidemiological processes in order to develop a set of state-of-the-art methods and tools to improve prevention, surveillance and control of vector populations and VBD.	2011-2014
WEATHER	Weather Extremes –	The WEATHER project aims at analysing the	2010-2012

Acronym and Link	Project title	General aim	Duration
	Impacts on Transport Systems and Hazards for European Regions	economic costs of climate change on transport systems in Europe and explores ways for reducing them in the context of sustainable policy design.	
EWENT	Extreme weather events on EU networks of transport	The objective of the EWENT project is to assess the impacts and consequences of extreme weather events on EU transport system.	2010-2012
KULTURISK	Knowledge-based approach to develop a culture of risk prevention	Project objectives are a critical and comprehensive review of static and dynamic measures to prevent water-related hazards with special focus on the importance of risk communication techniques; the development of a risk-based methodology for the evaluation and accounting of risk prevention measures; the demonstration that prevention measures are more effective from a social and economic point of view than post-disaster recovery for different types of water-related risks characterised by different temporal and spatial scales and different socio-economic contexts within Europe and promotion of a culture of risk prevention by using the KULTURisk outcomes as examples.	2011-2013
BIOFRESH	Biodiversity of freshwater ecosystems: Status, trends, pressures, and conservation priorities	Biofresh aims to build a global information platform for scientists and ecosystem managers with access to all available databases describing the distribution, status and trends of global freshwater biodiversity.	2009-2014
CLIMSAVE	Climate change integrated assessment methodology for cross-sectoral adaptation and vulnerability in Europe	CLIMSAVE will develop and apply an integrated methodology for stakeholder-led, climate change impact and vulnerability assessment that explicitly evaluates regional and continental scale adaptation options, and cross-sectoral interactions between the key sectors driving landscape change in Europe (agriculture, forests, biodiversity, coasts/floodplains, water resources, urban development and transport).	2010-2013
CCTAME	Climate change - terrestrial adaption and mitigation in Europe	The project will assess the impacts of agricultural, climate, energy, forestry and other associated land-use policies, considering the resulting feed-backs on the climate system. Geographically explicit biophysical models together with an integrated cluster of economic land-use models will be coupled with regional climate models to assess and identify mitigation and adaptation strategies in European agriculture and forestry. The role of distribution and pressures from socio-economic drivers will be assessed in a geographically nested fashion.	2008-2011
IMPRINTS	Improving preparedness and risk management for flash floods and debris flow events	The aim of IMPRINTS is to contribute to reduce loss of life and economic damage through the improvement of the preparedness and the operational risk management for Flash Flood and Debris Flow [FF/DF] generating events, as well as to contribute to sustainable development through reducing damages to the environment. To achieve this ultimate objective the project is oriented to produce	2009-2012

Acronym and Link	Project title	General aim	Duration
		methods and tools to be used by emergency agencies and utility companies responsible for the management of FF/DF risks and associated effects.	
CLIWASEC	Cluster - Climate-Water-Security	The CLIWASEC Cluster, “Climate Change Impacts on Water and Security (in Southern Europe and neighbouring regions)” has been established among three FP7 Research Projects which were selected for funding through the 2009 FP7 Call for proposals: CLIMB and WASSERMed, which address Theme 6 (“Environment, including Climate Change), and CLICO, addressing Theme 8 (“Socioeconomic Sciences and Humanities”). The main objective of the Cluster, which brings together a critical mass of scientists from 44 partner institutions, is to identify and foster scientific synergies and to establish a more efficient policy outreach strategy, also forming a comprehensive representation of issues faced in the Mediterranean region.	since 2010
ArcRisk	Arctic health risks: Impacts on health in the Arctic and Europe owing to climate-induced changes in contaminant cycling	ArcRisk is looking at the linkages between environmental contaminants, climate change and human health – aimed at supporting European policy development in these areas. The Arctic setting provides unique opportunities for research in these fields.	2009-2013
CLEAR	Climate change, environmental contaminants and reproductive health	The key questions to be addressed are, firstly, how may climate change influence human exposure to widespread environmental contaminants and, secondly, how may contaminants impact occurrence of reproductive disorders as sensitive indicators of health? To provide affirmative answers to these questions the proposal will as a first step identify and describe mechanisms by which a changing climate may affect the exposure of Arctic and other human populations to contaminants through change in chemical use and emissions, delivery to the arctic ecosystem as well as processing within the arctic physical environment and human food chain..	2009-2013
DROUGHT-R&SPI	Fostering European Drought Research and Science-Policy Interfacing	Drought-R&SPI will enhance the understanding of the: 1.Drought as a natural hazard, incl. climate drivers, drought generating processes and occurrences 2.Environmental and socio-economic impacts, and 3. Vulnerabilities, risks and policy responses, incl. the further development of drought management plans in support of EU and other international policies, e.g. UN/ISDR-HFA. The project will address the past and future climate, link science and science policy dialogue across scales and across a range of affected sectors.	2011-2014

Acronym and Link	Project title	General aim	Duration
SOILSERVICE	Conflicting demands of land use, soil biodiversity and the sustainable delivery of ecosystem goods and services in Europe	European soil biodiversity is pivotal for delivering food, fibre and bio-fuels and carbon storage. However, the demand is greater than the amount of soil available, as production of bio-fuels competes with areas for food production and nature. Moreover, intensified land use reduces soil biodiversity and the resulting ecosystem services. SOILSERVICE will value soil biodiversity through the impact on ecosystem services and propose how these values can be granted through payments.	2008-2012
RAMSES	Reconciling Adaptation, Mitigation and Sustainable Development for Cities	RAMSES aims to develop methods, tools and case studies to design strategies, quantify costs and evaluate the impacts of adaptation to climate change in cities. In detail, it aims to (i) develop a high level climate risk assessment for European cities, (ii) extend existing urban integrated assessment modelling to include pluvial flooding, evaluation of impacts on the urban economy of extreme events, and air quality and health issues, (iii) apply (and adapt) our integrated assessment facility for new city case studies – including one international location, and (iv) test a range of adaptation strategies to identify how best to reduce risks in cities and inform the design of transitions to more sustainable urban environments.	2012-2017
TOPDAD	Tool-supported policy-development for regional adaptation	TOPDAD focuses on the development of state-of-the-art socio-economic methods and tools to support the integrated assessment of climate change impacts and adaptation decision-making. Emphasis is placed on the energy, transport, tourism sectors, but also on the health, environment and the socioeconomic domains. The toolset to be developed by the project will support the estimation of the multiplier effect of initial damage throughout an economy and the rate of recovery of that economy following a climate event or long term changes.	2012-2016
BASE	Bottom-up Climate Adaptation Strategies towards a Sustainable Europe	BASE focuses on reconciling the bottom-up nature of adaptation with top-down strategic policy making through novel combinations of models and qualitative analyses. Through the analysis of over 20 cases, the project will aim at improving adaptation knowledge availability, integration and utilisation, at the promotion and strengthening of stakeholder participation in adaptation decisions and policies, and at supporting coherent, multi-level and multi-sector adaptation policy development.	2012-2016

As of 2014 the new EU Framework Programme for Research and Innovation “Horizon 2020“ will tackle 'societal challenges' – i.e. concerns of society/EU policy objectives (climate, environment, energy, transport, etc.) that cannot be addressed without innovation. It aims at bridging the gap between science and the market by coupling research to innovation. Climate-related expenditure, including adaptation and

mitigation, should exceed 35 % of the overall Horizon 2020 budget (over € 70 billion). To achieve this, climate action will be integrated across the whole of Horizon 2020. Furthermore, two out of eight challenges identified will specifically address the needs emerging from climate challenges, from observation and modelling to climate services and adaptation tools and solutions.

The Joint Research Centre (JRC) is the scientific and technical arm of the European Commission. It is providing scientific advice and technical know-how to support a wide range of EU policies such as climate change adaptation. JRC has presented an overview on research carried out in order to support the EU climate change policy, taking into account support for mitigation and adaptation[126]. These include:

- Studies on the economic impacts of climate change in the EU (PESETA I and PESETA II[127]). The main purpose of the PESETA I study was to make a consistent physical and economic assessment of the impacts of climate change in Europe at the end of the 21st century for various sectors.

- Support to Climate-ADAPT by providing data and content from in-house sources such as the European Forest Data Centre, European Database of Vulnerabilities, etc.

- Report on Environment and human health with one chapter on climate change (joint JRC-EEA report)[128]

Finally, the European Environment Agency (EEA) also had a significant role in advancing the knowledge base on climate change impacts, vulnerability and adaptation in recent years. The EEA does not fund research projects but produces integrated environmental data and indicator sets, assessments and thematic analyses in order to provide a sound decision basis for environmental and climate change policies in the EU and Member States and for cooperation with candidate and potential candidate countries. Recent reports on the topic of climate change impacts, vulnerability and adaptation published by the EEA include, in chronological order:

- Regional climate change and adaptation: The Alps facing the challenge of changing water resources (2009)[129],

- SOER report 2010: Adapting to climate change (2010)[130],

- SOER report 2010: Understanding climate change (2010)[131],

126 JRC – Joint research Centre (2011): Research at JRC in support of EU Climate change policy making. Luxembourg, 46pp.

127 http://ec.europa.eu/dgs/jrc/downloads/events/20120306-copenhagen/leen-hordjik.pdf

128 http://ies.jrc.ec.europa.eu/uploads/Environment%20and%20human%20health%20-%20joint%20EEA-JRC%20report.pdf

129 http://www.eea.europa.eu/publications/alps-climate-change-and-adaptation-2009

130 http://www.eea.europa.eu/soer/europe/adapting-to-climate-change

- 10 messages for 2010: Climate change and biodiversity (2010)[132];
- Urban adaptation to climate change in Europe (2012)[133];
- Climate change, impacts and vulnerability in Europe (2012)[134];
- Adaptation in Europe: Addressing risks and opportunities from climate change in the context of socio-economic developments (2013)[135].

131 http://www.eea.europa.eu/soer/europe/understanding-climate-change

132 http://www.eea.europa.eu/publications/10-messages-for-2010-climate-change

133 http://www.eea.europa.eu/publications/urban-adaptation-to-climate-change

134 http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012

135 http://www.eea.europa.eu/publications/adaptation-in-europe