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COMMISSION STAFF WORKING DOCUMENT

Seventh National Communication of the EU

Accompanying the document

Commission Report

Seventh national communication and third biennial report from the European Union under the UN Framework Convention on Climate Change (UNFCCC) (required under the UNFCCC and the Kyoto Protocol)

{C(2017) 8511 final} - {SWD(2017) 458 final}

Table of Contents

1. INTRODUCTION

This document represents the European Union's (EU) seventh National Communication (7NC) 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 7);
- Research and systemic observation (Section 8) and
- Education, training and public awareness (Section 9).

UNFCCC decision 2/CP.17 also requires the EU to submit its third Biennial Report (BR) by 1st January 2018. 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 third Biennial Report as Annex 1 to this 7th 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 to Annex I. 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.

To avoid unnecessary duplication of information, overlapping contents were concentrated in the third Biennial Report: Those sections of the seventh National Communication's main body which content-wise would be identical to sections of the third Biennial report, do thus solely contain a reference to the corresponding section of Annex 1 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 [3BR] before the relevant chapter number in the Biennial Report.

The 28 Member States of the European Union submit separate NCs to the UNFCCC.

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 Appendix I of this document.

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

2. NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

Key Developments

Population

- Population has continued to grow, at around 0.3 % per annum, a similar trend to the 6NC.

Economy

- EU-28 real GDP was 53 % higher in 2016 compared to 1990. This economic growth was mainly driven by growth in the service sector and in international trade.
- Growth rates declined significantly in 2008-2010 as the EU-28 faced a severe economic crisis in the aftermath of the financial crisis in 2008.
- Since 2010, the growth rate has slowly increased and GDP has recovered. Nevertheless, in 2012 the Euro currency crisis in the Southern European countries contracted growth of the European economy again. Growth has subsequently recovered again and in 2016 was 1.9 % per annum.

Energy

- Total gross inland and final energy consumption grew over the period from 1990-2006 (at around 0.5 % per annum), but has generally declined thereafter and in 2015 was very slightly less (by 0.03 %) than in 1990.
- The economic crisis in 2008 was mirrored by a strong decline in energy consumption in 2009 with a subsequent increase in 2010; energy consumption has subsequently declined.
- The trend observed since 1990 of a shift in the primary fuel mix from coal to gas has slowed down in recent years, but there has been an increasing shift to renewables. The share of renewables in gross inland energy consumption increased from 4 % in 1990 to 13 % in 2015, largely driven by growth in biomass. Production of energy from solar photovoltaics and wind has also increased very substantially over the period.

Transport

- Both freight and passenger transport grew strongly from 1995 until the economic crisis in 2008. Freight transport then showed a strong decline in 2008 and 2009; while it subsequently recovered, it is still below its 2007 level. Passenger transport was relatively stable from 2007, until 2014 when it began to rise again.

Agriculture and forestry

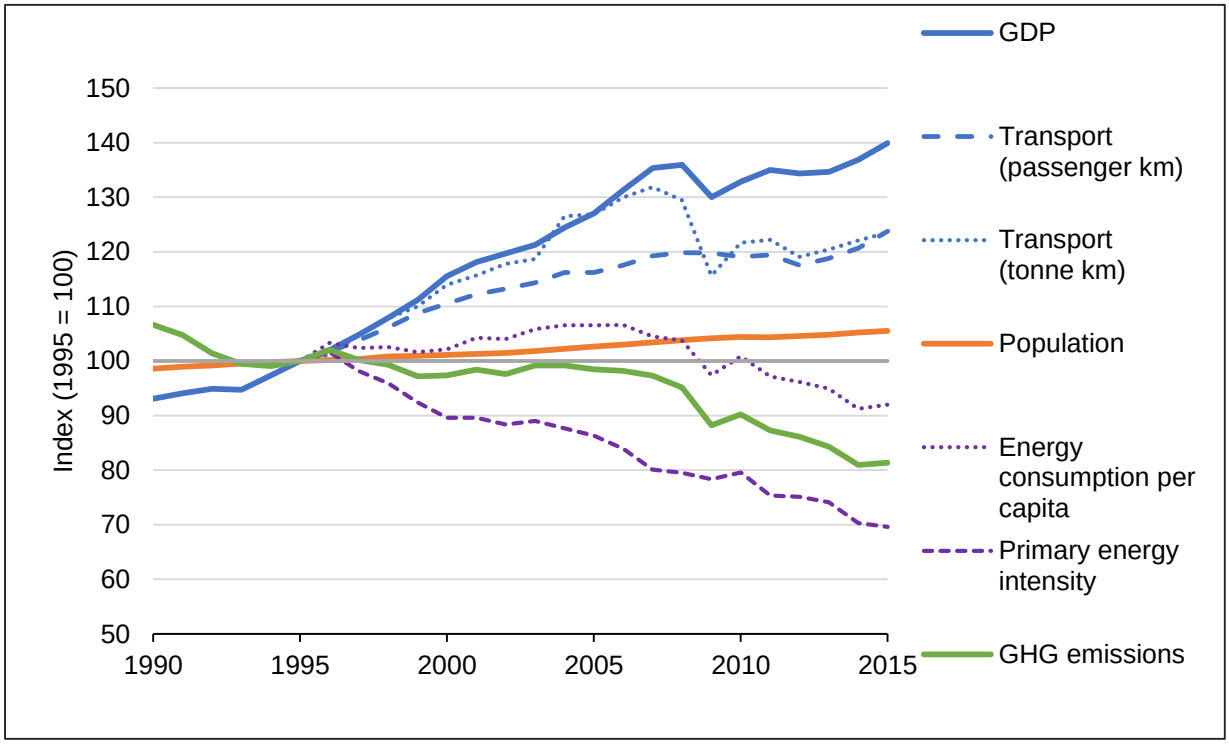
- In 2015, agricultural and forestry accounted for 41 % and 33 % respectively of land use.

Key trends

- Despite increases in population and GDP, GHG emissions for the EU-28 have fallen (Figure 2-1). Decomposition analysis of data from 1990 to 2012 shows that is due to

a decoupling of economic growth from GHG emissions[2]. This was mainly driven by technological improvements which reduced energy intensity (energy use per unit of GDP), and the deployment of low carbon technologies.

Figure 2-1 Trends in greenhouse gas emissions and key parameters for the EU-28



Source: Chapter 2 and 3 of this report
Note: GHG emissions are without emissions and removals from Land Use, Land-Use Change and Forestry (LULUCF).

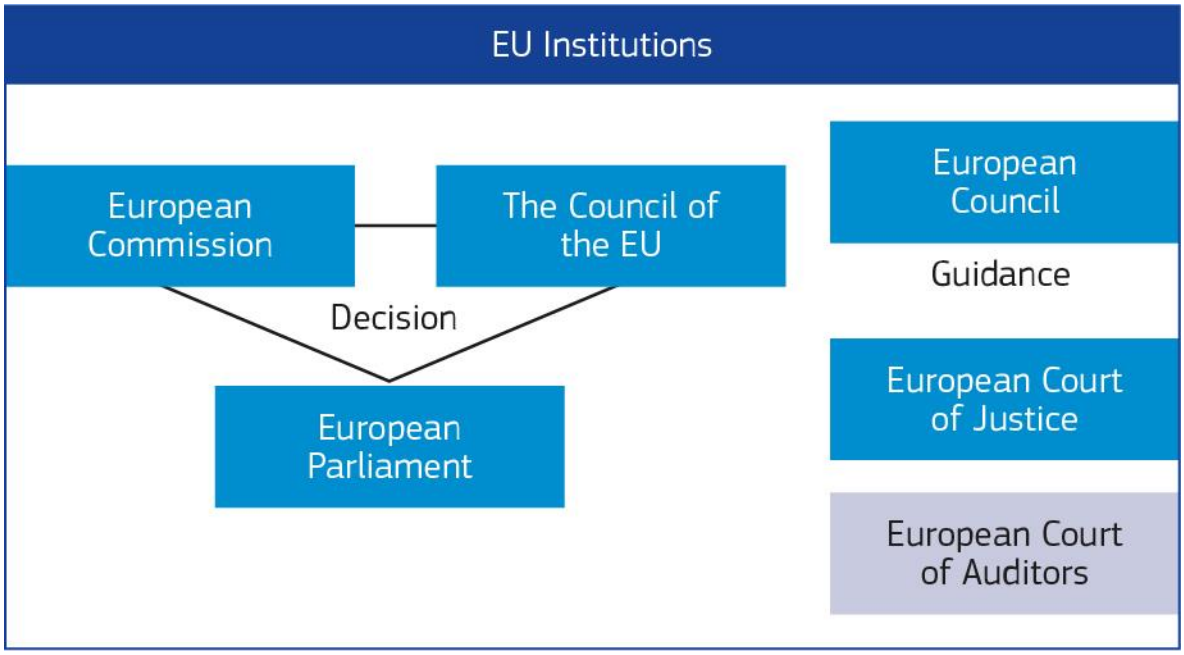
2.1. Government structure

The European Union's (EU) institutional system is unique in the world. The 28 Member States confer competences upon the Union to attain objectives they have in common. These competences are set out in a number of Treaties[3], which are international agreements serving as the founding core legal acts establishing the Union. The Treaties regulate the Union's relations with the Member States, and create the Union's institutions (see Figure 2-2).

2 ICF International, 2016.Decomposition analysis of the changes in GHG emissions in the EU and Member States. A report in association with ZEW Umweltbundesamt GmbH and Eclareon for DG CLIMA - https://ec.europa.eu/clima/sites/clima/files/strategies/progress/docs/dca_report_en.pdf .

3 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

Figure 2-2 Key EU institutions for governance



The major policy-making bodies in the EU are the European Parliament, the Council of the EU and the Commission, who together 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 Council of the European Union consists of representatives of each national government at ministerial level. It is the main decision-making body and as well as being the legislative body in co-decision with the European Parliament, co-ordinates the broad economic policies of the Member States. The European Commission represents the interests of the Union as a whole. It proposes and enforces legislation, and implements policies and the EU budget. The President of the Commission and its other Members are appointed by the European Council after they have been approved by the European Parliament.

The European Council is made up of the Heads of State or Government of the Member States, and the European Commission President, together with its President and the President of the Commission. It defines the general political directions and priorities of the European Union, but has no legislative powers. Other key institutions are 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).

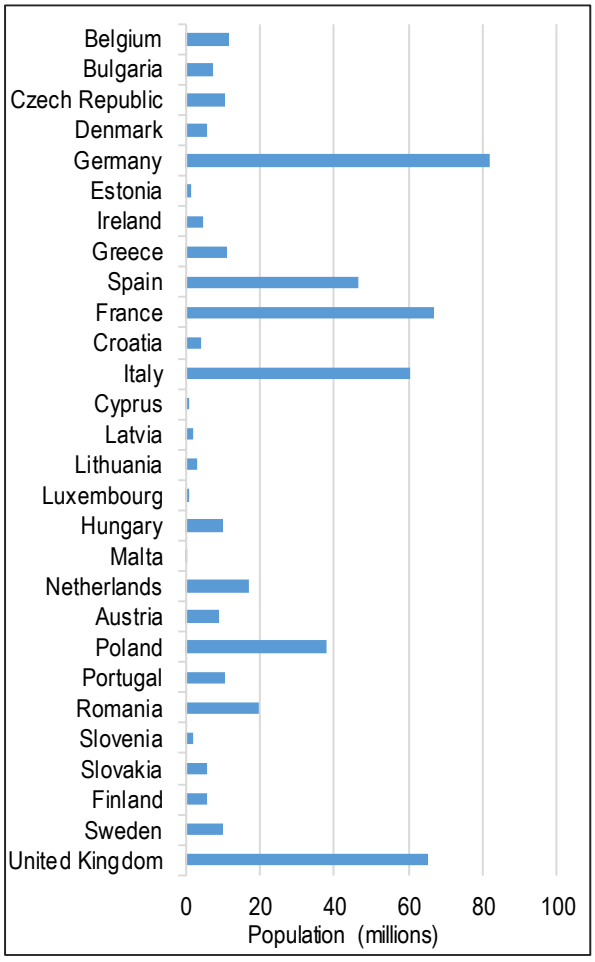
2.2. Population profile

Over the last 26 years the EU-28's population has grown on average by 0.3 % per annum, reaching 510 million people in 2016, an overall increase of 7.4 % since 1990. While population growth is generally considered a driver for greenhouse gas emissions and for increasing energy consumption, this trend of increasing population has not played a major

role in emission trends since 1990[4]. Trends in per capita primary energy consumption are shown in Section 2.5.1.

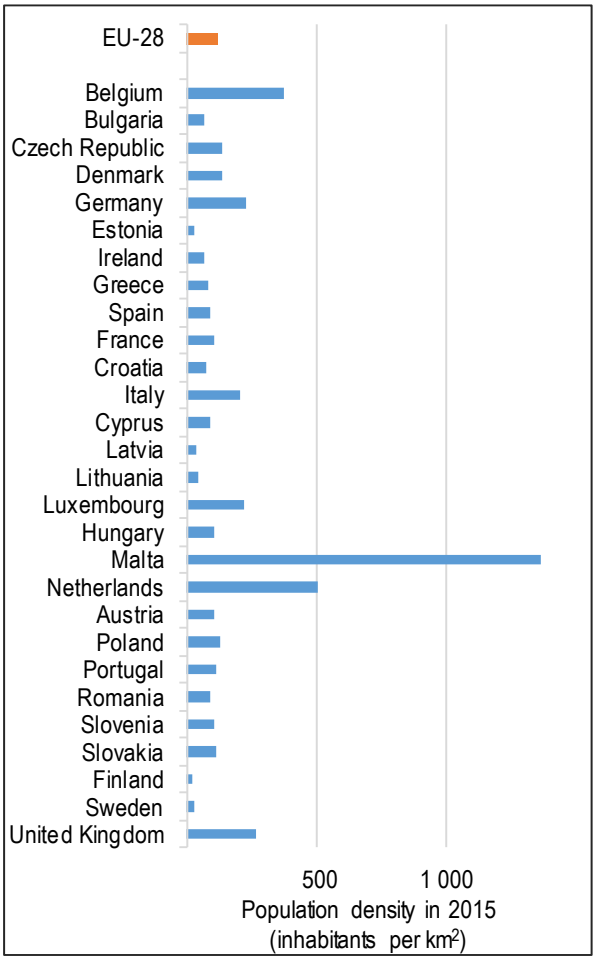
The populations of Member States vary considerably, from 0.43 million for Malta to 82.2 million for Germany (see Figure 2-3), as does population density (see Figure 2-4). The most densely populated Member State, Malta, has 1 370 inhabitants/km², which is more than70 times that of the most sparsely populated, Finland with 18 inhabitants/km². Most EU Member States have relatively high population densities compared to other Parties to the UN Convention. Higher population densities can have both a positive and negative impact on greenhouse gas emissions. For example they can mean shorter transport distances, which might be expected to lower greenhouse gas emissions, but shorter transport distances may facilitate economic integration among communities and regions, resulting in a tendency for higher transport intensity.

Figure 2-3 EU Member States populations on 1 January 2016



Source: Eurostat

Figure 2-4 Population density of the EU Member States in 2015



Source: Eurostat

4 ICF International, 2016.Decomposition analysis of the changes in GHG emissions in the EU and Member States. A report in association with ZEW Umweltbundesamt GmbH and Eclareon for DG CLIMA https://ec.europa.eu/clima/sites/clima/files/strategies/progress/docs/dca_report_en.pdf ..

2.3. **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 4 464 thousand square kilometres[5], with a large coastline of 141 941 km[6] and a diverse topography including mountains, lakes, rivers, forests and plains. The EU is also highly urbanised, with 40 % of the population living in urban regions, and a further 32 % in intermediate regions[7].

The most common type of land cover in the EU is woodland, which covers 38 % of the EU's surface (see Figure 2-5). Northern and alpine regions tend to have larger proportions of woodland, and in the most forested country, Finland, forests cover 68 % of the country. However the distribution of land cover types varies widely across the EU, and in the least forested country, Malta, forests cover only 5 % of the total area. The next most common land cover is crop land. 22 % of the total EU area is covered by arable land or permanent crops, but again this varies significantly between Member States. In Denmark and Hungary, more than 44 % of land is cropland, while in Finland, Ireland and Sweden it is less than 6 %. Grasslands (including natural and agricultural grasslands) are the dominant land cover in Ireland (56 %), and the Netherlands and the United Kingdom (36 %), although on average in the EU they account for only 21 %. Other land use types are shrubland, artificial land, water, bare land and wetland which together account for 19 % of the total EU land cover.[8]

Figure 2-6 shows that agriculture is the main use for land in the EU, accounting for 41 % of land use. Agriculture is the predominant land use in 19 of the Member States and in Denmark, Ireland, Hungary and Romania, agricultural is the primary land use and accounts for more than 58 % of land use. For other countries, forestry is the predominant land use, accounting for over 50 % of land area in Finland, Sweden, Estonia, Slovenia, and Latvia. For the EU as a whole, use for forestry accounts for 33 % of land area. Agriculture generates significant greenhouse gas emissions, and this is discussed in more detail in Section 2.11. Forest and other wooded areas however can be important carbon sinks (see Section 2.12 for further details). Changes in land use will be driven to some extent via policy actions in the agricultural sector (see Section 4.4.1.5), particularly the Common Agricultural Policy as well as those in the forestry sector (see Section 4.4.1.6).

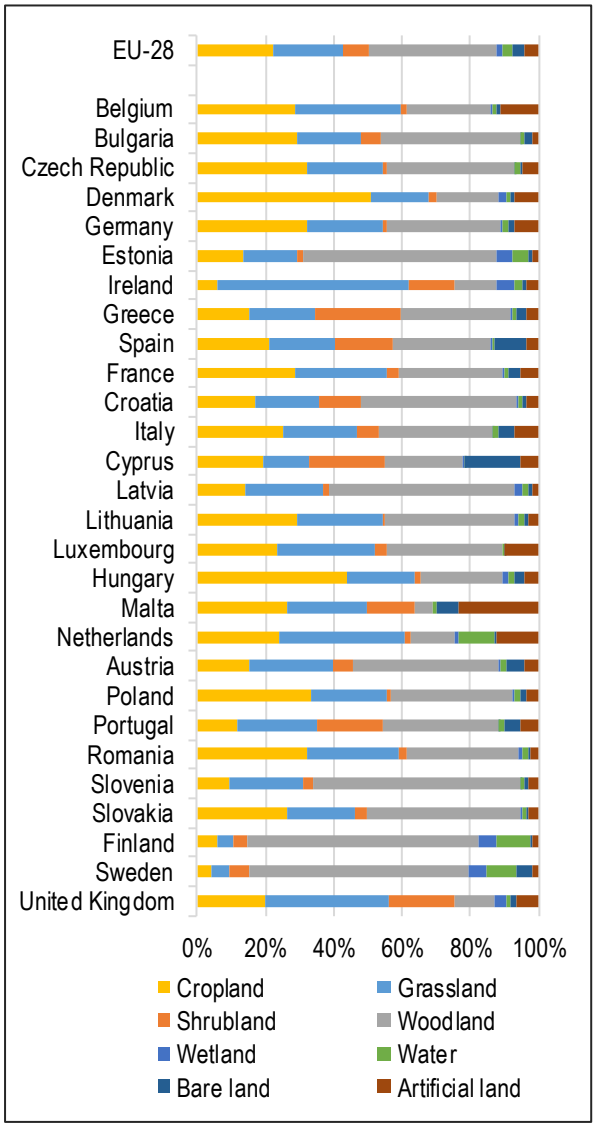
5 Eurostat, "Size and population", Living in the EU, 2017, https://europa.eu/european-union/about-eu/figures/living_en, Accessed on: 1.08.2017

6 Coastline length for EU27 of 136 106 km from: 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: 1.08.2017. Coastline length of 5 835 km for Croatia from the World Factbook https://www.cia.gov/library/publications/the-world-factbook/geos/hr.html, accessed on 19.06.2017

7 Eurostat, "Distribution of population by degree of urbanisation, dwelling type and income group - EU-SILC survey [ilc_lvho01]", Eurostat dataset, Extracted on: 05.05.17

8 Eurostat, "Land cover overview [lan_lcv_ovw]", Eurostat dataset, Extracted on: 02.05.17

Figure 2-5 Main land cover in 2015 (% of total area)



Source: Eurostat LUCAS

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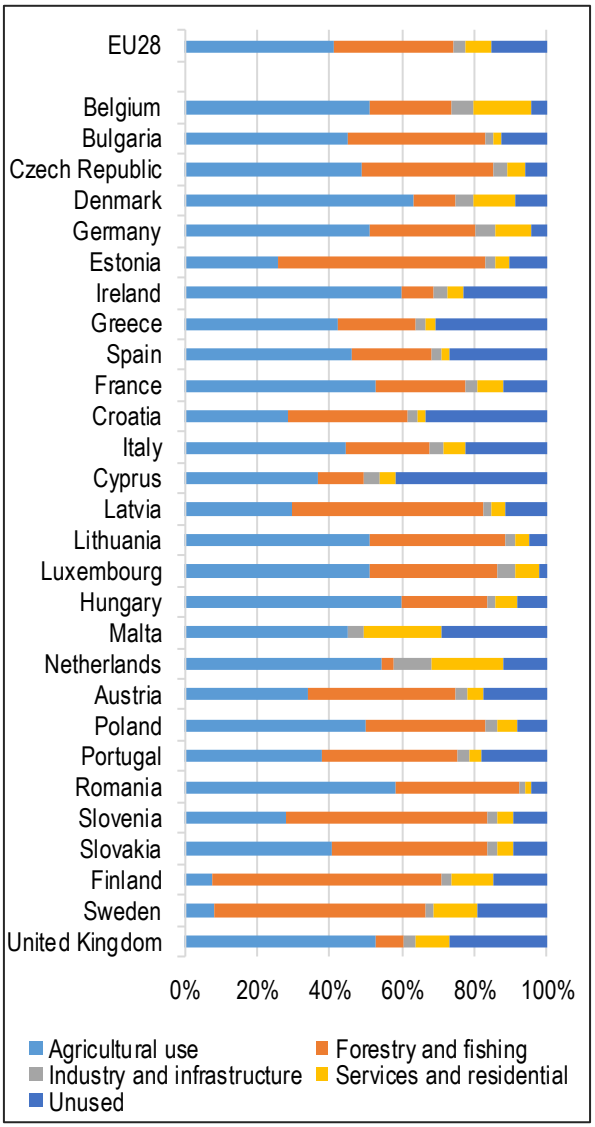
Figure 2-6 Primary land use in 2015 (% of total area)



Source: Eurostat LUCAS

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2.4. Climate profile

The European Union covers climate zones ranging from dry summer sub-tropical in the Mediterranean to 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 strongly influence 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 2-7 gives an overview of daily temperature

variations. The northern Atlantic coast also experiences high rainfall (see Figure 2-8). Scandinavian countries (Denmark, Finland and Sweden) tend to have mild summers and cold winters.

Figure 2-7 Mean of daily temperature range 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.

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

10 http://www.ecad.eu

Figure 2-8 Annual precipitation sum in the EU (1961-2010)

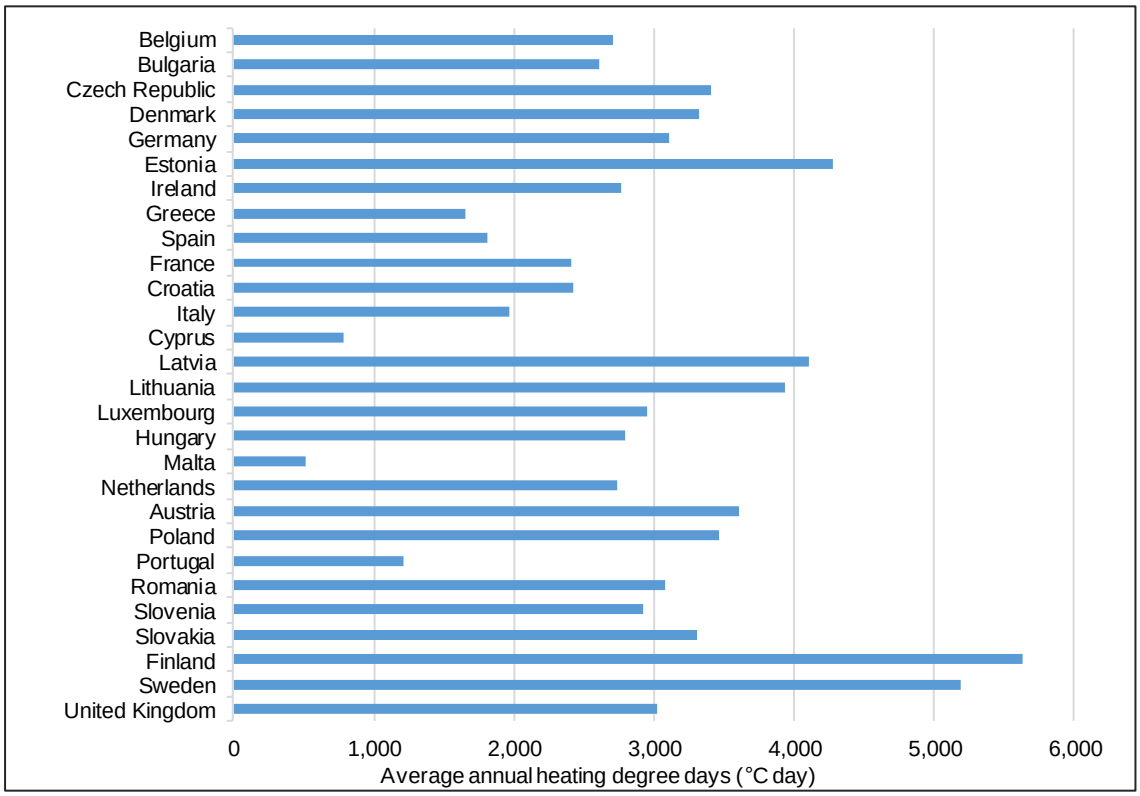
Source: E-OBS dataset from the EU-FP6 project ENSEMBLES[9]and the data providers in the European Climate Assessment and Dataset project[10].

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.

Figure 2-9 below shows the average annual number of heating degree days in each Member State. Space heating requirements 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 °C, leading to electricity demand for space cooling. This means that 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 during the winter period.

Figure 2-9. Average annual heating degree days by Member State (1990-2016)

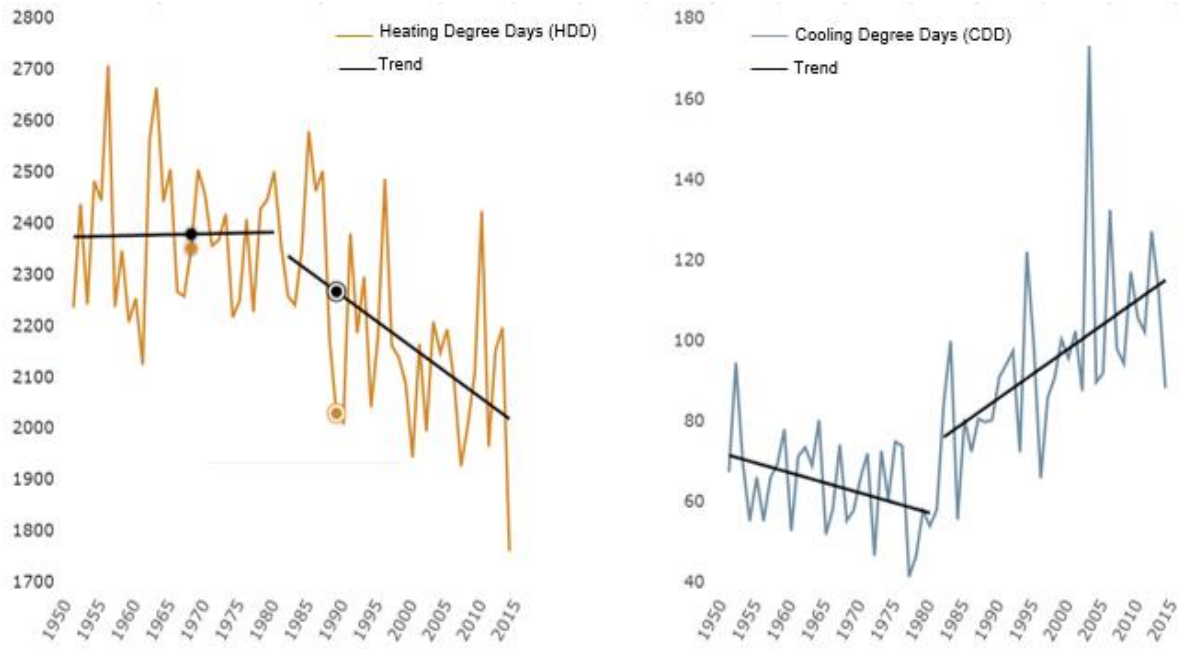


Source: JRC Agri4Cast

Note: Heating degree-days are a measure of the demand for energy needed to heat a building in a certain climate. JRC calculates heating degree days as: (18 °C - $T_{m)}$ if T_m is lower than or equal to 15 °C (heating threshold) and as nil if T_m is greater than 15 °C where T_m is the daily mean air temperature.

Figure 2-10 shows population-weighted heating degree days and cooling degree days for Europe since 1951. These vary substantially year by year depending on weather during the year, however some long-term trends can also be seen. The number of population-weighted heating degree days decreased by 8.2 % between the 1951–1980 and 1981–2014 periods, with the largest absolute decrease occurring in northern and north-western Europe. The number of population-weighted cooling degree days increased by 49.1 % between the 1951–1980 and 1981–2014 periods; the largest absolute increase occurred in southern Europe.

Figure 2-10 Population-weighted heating and cooling degree days averaged over Europe (1951 to2014)



Source: EEA

Note: This figure shows time series of heating degree days (left) and cooling degree days (right) averaged over Europe (EU-28 without Cyprus but including Liechtenstein, Norway and Switzerland) over the period 1951-2014, including linear trends for 1951-1980 and 1981-2014. Population weighting based on the GEOSTAT2011 dataset by Eurostat was applied during spatial aggregation.

2.5. **Economic profile**

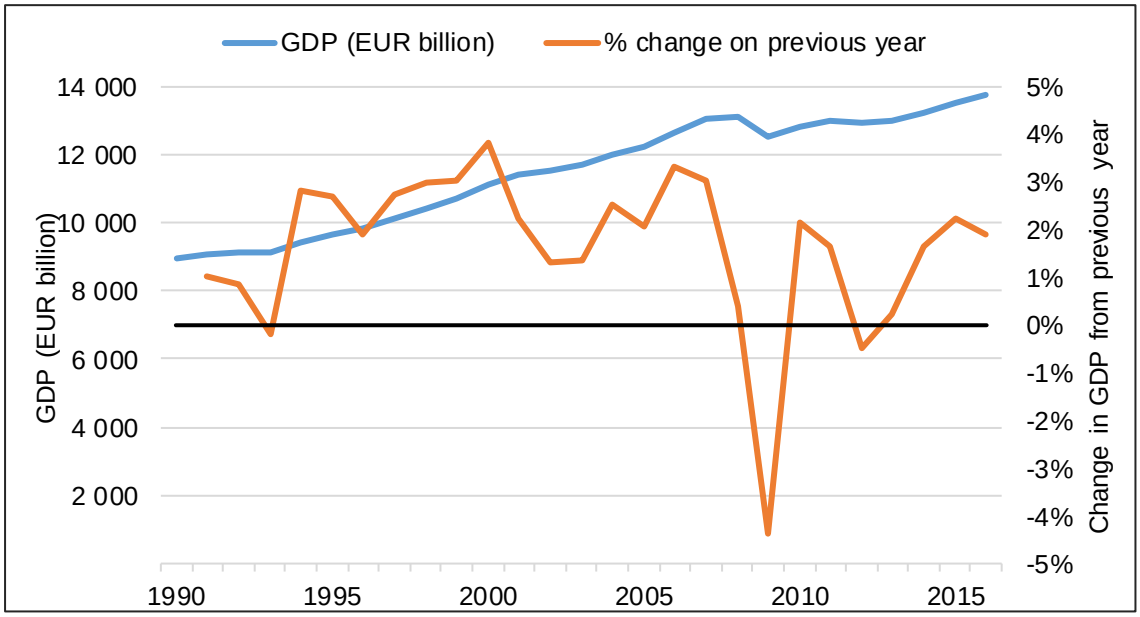
The economic profile of a country has a strong link to greenhouse gas emissions, with the overall level and types of economic activity strongly correlated to energy consumption. Greenhouse gas emissions also depend on factors such as energy efficiency and the structure of the economy. Trends in key economic factors are discussed below with the overall impact on energy intensity discussed in Section 2.6.

2.5.1. *Changes in overall Gross Domestic Product (GDP)*

For the EU-28, GDP has increased by 53 % (in volume terms) from 1990 to 2016 (see Figure 2-11). 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 has slowly increased and the GDP has recovered. Nevertheless, in 2012 the Euro currency crisis in the Southern European countries contracted growth of the European economy again, and this continued in 2013[11], although the EU economy overall began to grow again in 2013. In 2016 all of the EU Member States showed positive growth, headed by Ireland (5.2 %), Malta (5.0 %) and Romania (4.8 %), and with an average increase across the EU of 1.9 % from 2015.

11 Eurostat, "National accounts and GDP", Eurostat Statistics Explained, 2017, http://ec.europa.eu/eurostat/statistics-explained/index.php/National_accounts_and_GDP, Accessed on: 10.05.2017

Figure 2-11 Development of GDP 1990-2016



Source: EEA and AMECO database, European Commission
Note: GDP expressed at market prices with a reference year of 2010.

Figure **2-12** (below) shows GDP in purchasing power standards (PPS) per capita in 2015. This provides a better comparison of the potential for total consumption in each country, as it is based on the purchasing power for a "representative" basket of goods and services. The countries' GDP per capita is compared relative to the EU-28 average, which is set to 100. The highest relative GDP per capita on a purchasing power basis is in Luxembourg, where it is more than 2.6 times higher than the EU average. This can partly be explained by the impact of cross-border workers from neighbouring countries. At the other end of the scale are Bulgaria, Romania and Croatia where GDP per capita is less than 60 % of the EU average.

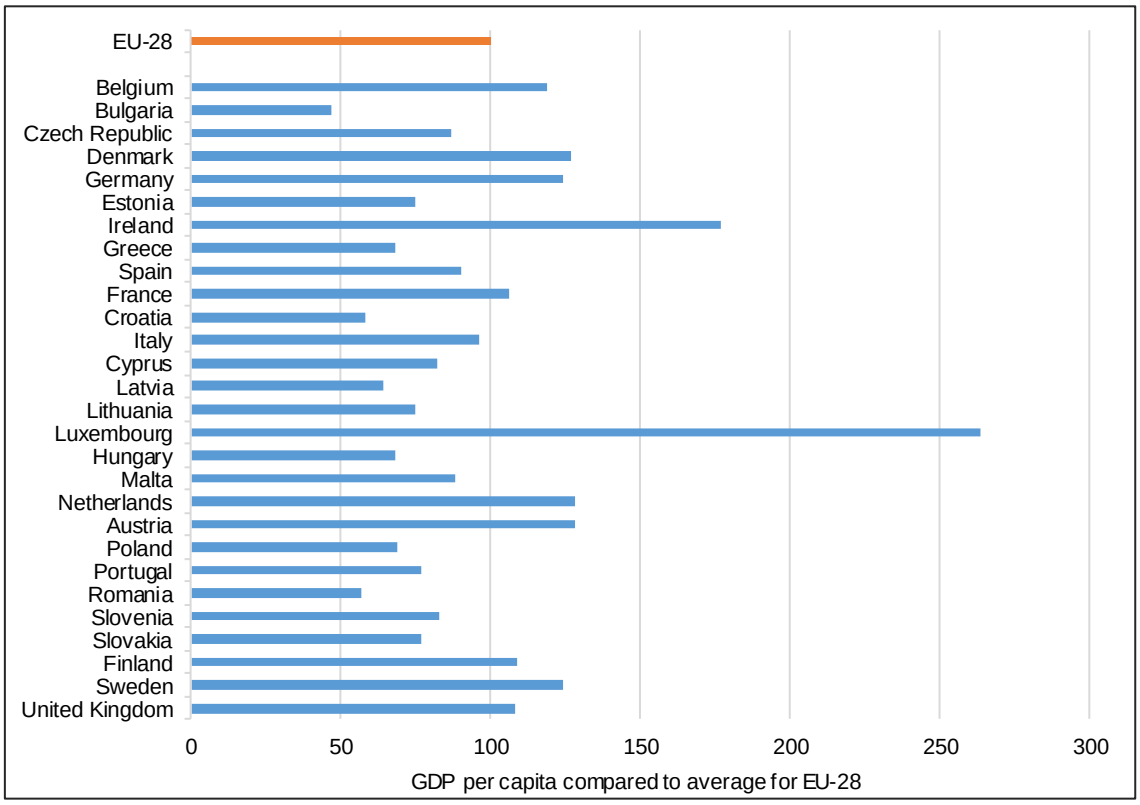
2.5.2. *Development of economic sectors*

Between 1995 and 2016 the Gross Value Added (GVA) in the EU-28 almost doubled (see Table 2-1). Almost three-quarters (74 %) of GVA is generated by the services sector, which is of particularly high importance in Cyprus, Luxembourg, Malta, Greece, United Kingdom and France, where it contributes more than 80 % of the GVA.

During the same period, the share of the industry sector decreased from 23 % in 1995 to 19 % in 2016, with output falling substantially (by 13.8 %) during the financial and economic crisis of 2007 to 2009. Construction output also contracted significantly; falling by 10.4 % between 2007 and 2010.

Within the services sector, 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 have the smallest contributions to GVA (1 % and 5 % respectively in 2016).

Figure 2-12 Percentage of GDP per capita in relation to EU-28 average (2015)



Source: Eurostat
Note: Percentage of EU-28 total (based on PPS per inhabitant).

Table 2-1 Gross-value added (at basic prices) of economic sectors in EU-28 (€ billion)

Economic Sector	1995	%	2016	%
Agriculture; fishing	172	3 %	195	1 %
Industry (except construction)	1 546	23 %	2 560	19 %
Construction	405	6 %	705	5 %
Wholesale and retail trade; hotels and restaurants; transport	1 260	19 %	2 526	19 %
Financial intermediation; real estate[12]	1 836	28 %	4 280	32 %
Public administration, community services, activities of households	1 405	21 %	2 982	23 %
Total -	6 624	100 %	13 246	100 %

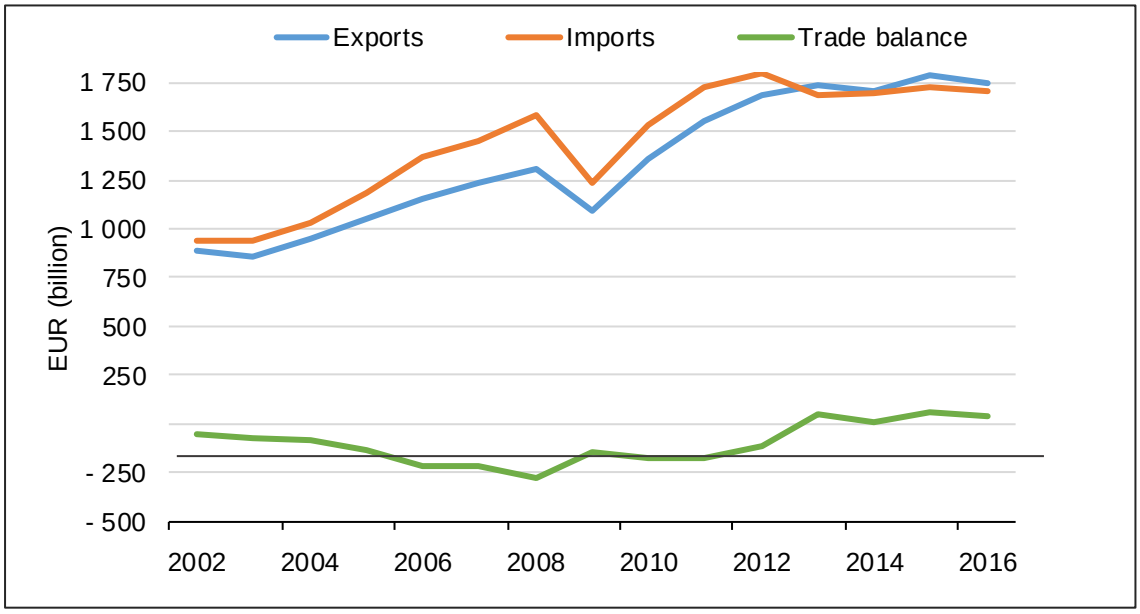
Source: Eurostat
Note: GVA expressed in billions of euro in 2016 and billions of ECU in 1995.

12 Information, Financial, Real estate, Scientific

2.5.3. *Trade patterns*

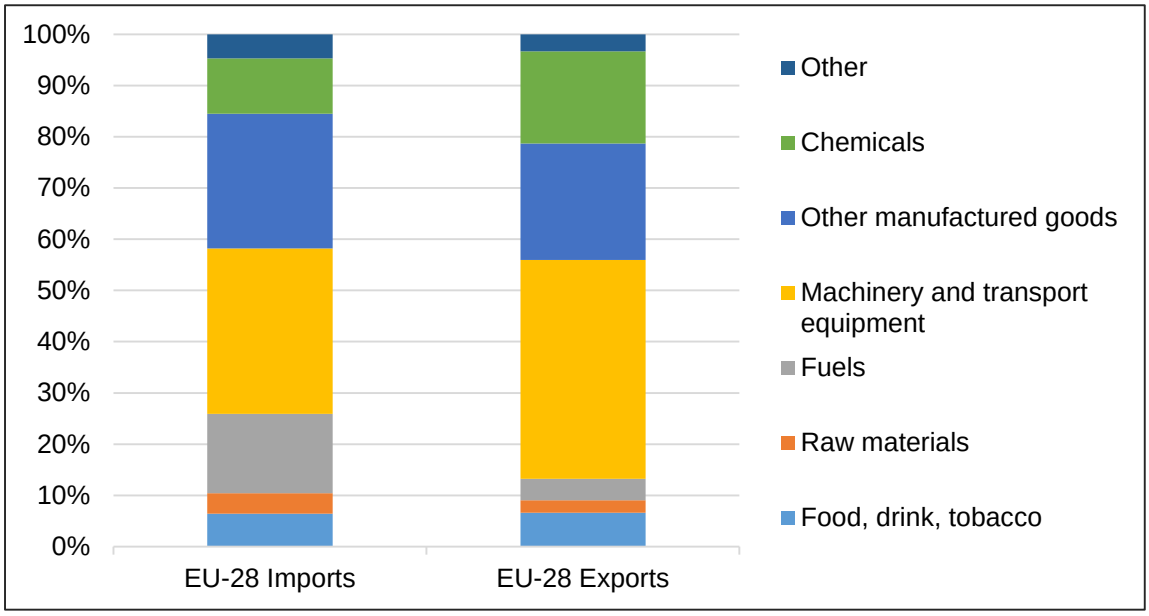
From 2002 to 2008, the EU experienced an increasingly negative trade balance, but since then this trend has reversed and since 2013, exports have exceed imports (Figure 2-13). Figure 2-14 shows the percentage (as a proportion of total trade value) of extra- EU-28 trade for imports and exports in 2016 by SITC (Standard International Trade Classification) category. In comparison to the 6NC , mineral fuels, lubricants and related materials no longer make up the highest proportion of EU imports. The leading imported product category is now manufactured products such as machinery and transport equipment at 32.3 %. This category, as at the time of the 6NC, also accounts for the largest share of exports at 42.7 %. 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.

Figure 2-13 Development of extra-EU-28 trade



Source: Eurostat

Figure 2-14 Composition of extra-EU trade by value in 2016



Source: Eurostat. Fuels = Mineral fuels, lubricants and related materials

2.6. Energy profile

This section provides a high-level overview of the most relevant factors concerning energy use, which is the largest source of GHG emissions in the EU. The Eurostat Pocketbook "Energy, Transport and Environment Indicators – 2016 Edition"[13] provides more detail on the key drivers, environmental pressures and impacts from the production and consumption of energy.

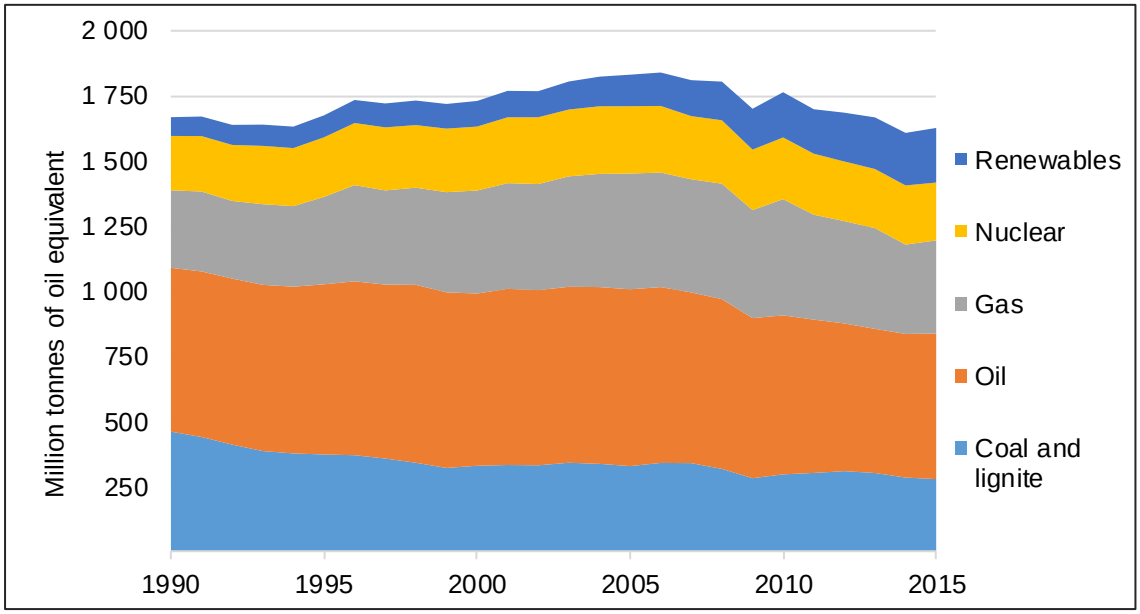
Climate policy drivers have had a clear impact in the EU energy system. The drivers have played a significant role in the increased share of renewables, with the EU ETS's contribution to reductions in emissions and national climate and energy policies, often linked to the implementation of EU Directives, helping to improve energy efficiency[14]. Other factors such as the shift to gas as a result of price differentials have also helped to reduce emissions historically. Historical 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 4.4.1.2 for further details) are expected to become more significant in the future, particularly as a result of the new climate and energy package. This is expected to lead to an even greater increase in the use of renewables (as well as gas) as well as impacts on primary and final energy consumption due to improvements in energy efficiency.

Gross inland energy consumption in the EU-28 increased over the period from 1990 until 2006 despite continued efforts to improve energy efficiency, but subsequently began to decrease (see Figure 2-15). This downward 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, but has since continued, apart from a small increase in 2015.

13 Eurostat Pocketbook: Energy, transport and environment indicators — 2016 edition, http://ec.europa.eu/eurostat/documents/3217494/7731525/KS-DK-16-001-EN-N.pdf/cc2b4de7-146c-4254-9521-dcbd6e6fafa6. Accessed on 11.05.2017

14 Decomposition analysis of the changes in GHG emissions in the EU and Member States. ICF international, 201

Figure 2-15 Gross inland energy consumption[15] by fuel for the EU-28



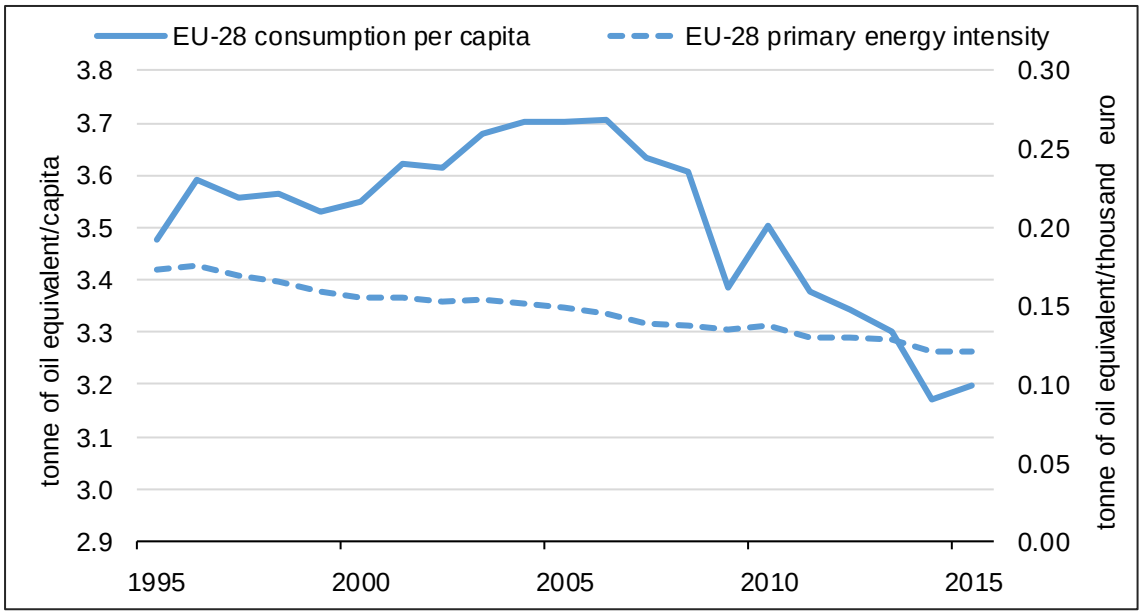
Source: Eurostat

Trends in the consumption of different energy carriers within the total have changed significantly in the period 1990 to 2015, with a decrease of 40 % in the consumption of carbon-intensive coal and lignite, and of 11 % in the consumption of oil. Meanwhile there has been an increase of over 20 % in the consumption of gas, which, in comparison to other fossil fuels, produces less greenhouse gas emissions. Renewables have seen the most marked increase with consumption increasing by over 190 % from 1990 levels. Consumption of energy generated from nuclear power increased by 6 %. 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 73 % of total primary energy consumption in total. The share of renewable energy sources has increased to 13 % of gross final energy consumption.

Figure 2-16 shows primary energy intensity (toe/unit GDP) and per capita primary energy consumption for the EU-28 Member States from 1990- 2015. Since 2006 per capita energy use has continued to decrease even more strongly with a short interruption in 2010, where it increased due to the recovery from the global economic crisis, and a small rise in consumption in 2015. In addition, energy intensity has decreased steadily since 2006, except for 2010; see for the reasons mentioned above. Both these trends are having a positive impact in reducing GHG emissions. More information on GHG emission intensity can be found in Section 3.2.3.

15 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.

Figure 2-16 Per capita gross inland energy consumption and primary energy intensity

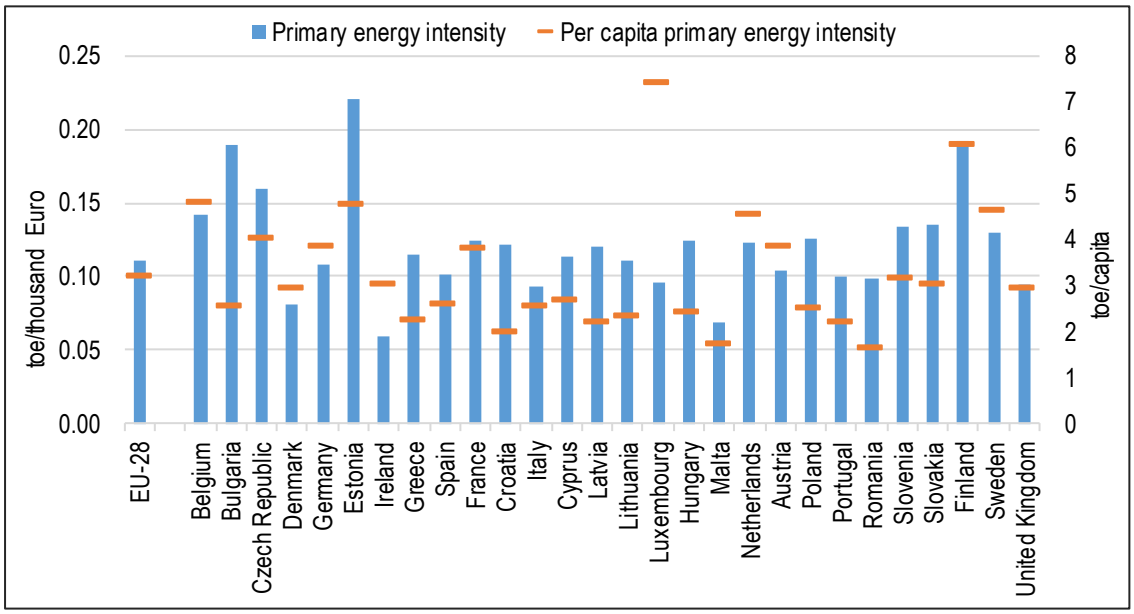


Source: Eurostat, European Commission, EEA
Note: Estimate of GDP as billions of Euro at 2005 market prices. Primary energy intensity is the ratio between gross inland energy consumption and gross domestic product

Figure 2-17 shows primary energy intensity (toe/unit GDP at purchasing power standards) and per capita energy intensity by Member State in 2015. Countries with lower energy intensity such as Ireland, Malta and Denmark may 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. Member States with higher energy intensities include Estonia, Finland and Bulgaria.

Per capita energy consumption is particularly low in Romania, Malta and Croatia – over a third below the EU-28 average of 3.2 toe/capita. In contrast, per capita consumption in Luxembourg at 7.4 toe/capita is more than double the EU average.

Figure 2-17 Primary energy intensity and per capita consumption in 2015



Source: Eurostat

2.6.1. *Energy Supply*

Figure 2-18 shows the supply of fossil fuels in the EU-28 from 1990 to 2015, split into fuels produced in the EU and net imports of fuels from 1990 to 2015. There is a trend of increasing dependence on imported fossil fuels, which now account for around 76 % of fossil fuel supply and 55 % of total primary energy supply. This has led to growing concerns over security of supply. Oil accounts for the largest share (47 %) of fossil fuel consumption, followed by gas (30 %) and then solid fuels (22 %).

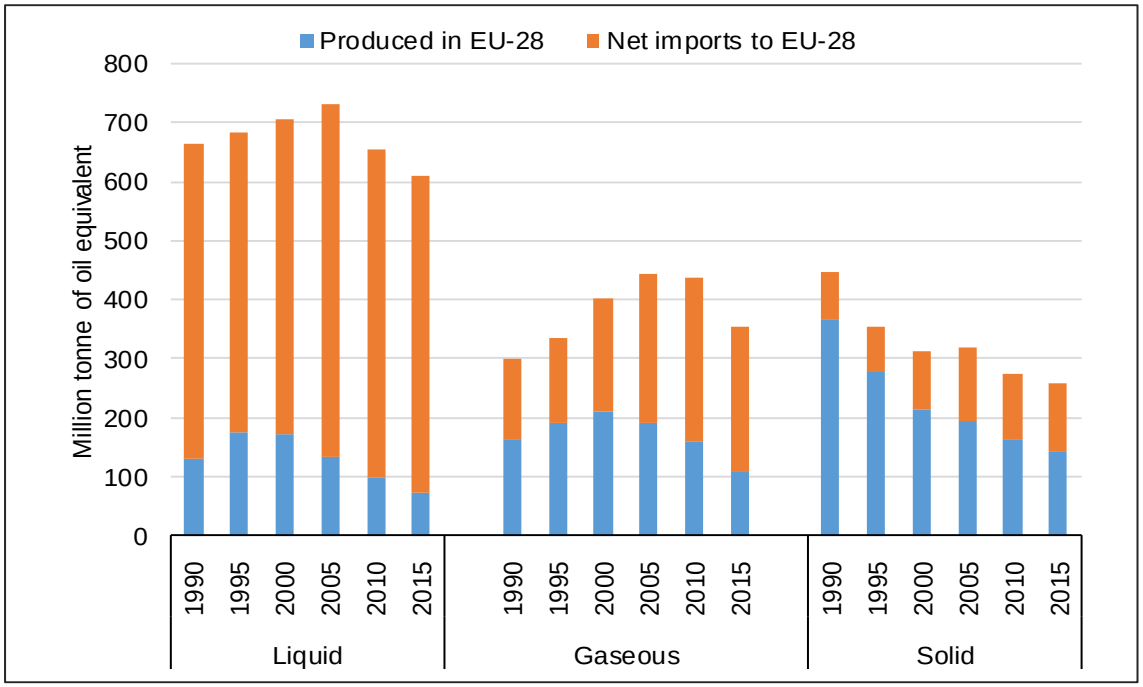
The vast majority of oil consumed is from imports and the trend had been an upward one until 2006; since then net imports declined until 2015, when there was a slight increase. Oil consumption rose in the period to 1998, but then remained relatively constant until 2005, when it began to decline significantly, falling by 18 % in the period 2005 to 2015. Production in the EU during this period declined even more significantly (by 44 %) and imports now account for 88 % of consumption compared to 80 % in 1990. A similar trend is seen in gas consumption, with imports exceeding production for the first time in 2002. Imports now make up over two thirds (69 %) of EU gas consumption. In the case of solid fuels, overall consumption is decreasing, with slight increases from 2010 to 2012. Although imports have risen in recent years, with a short decline in 2009 and more recently in 2015, production volumes still exceed imports. If current trends continue, however, it is likely that imports will exceed production volumes in the next few years.

Overall electricity generation has risen by 25 % between 1990 and 2015 (see

Figure 2-19). Electricity production from renewables has almost tripled in that period and now accounts for 30 % of generation compared to 13 % in 1990. The proportion produced by nuclear has slightly increased and was 31 % of total electricity production in 2015. There have been large decreases in both oil and coal and lignite production; together they accounted for 26 % of total production in 2015 (down from 48 % in 1990).

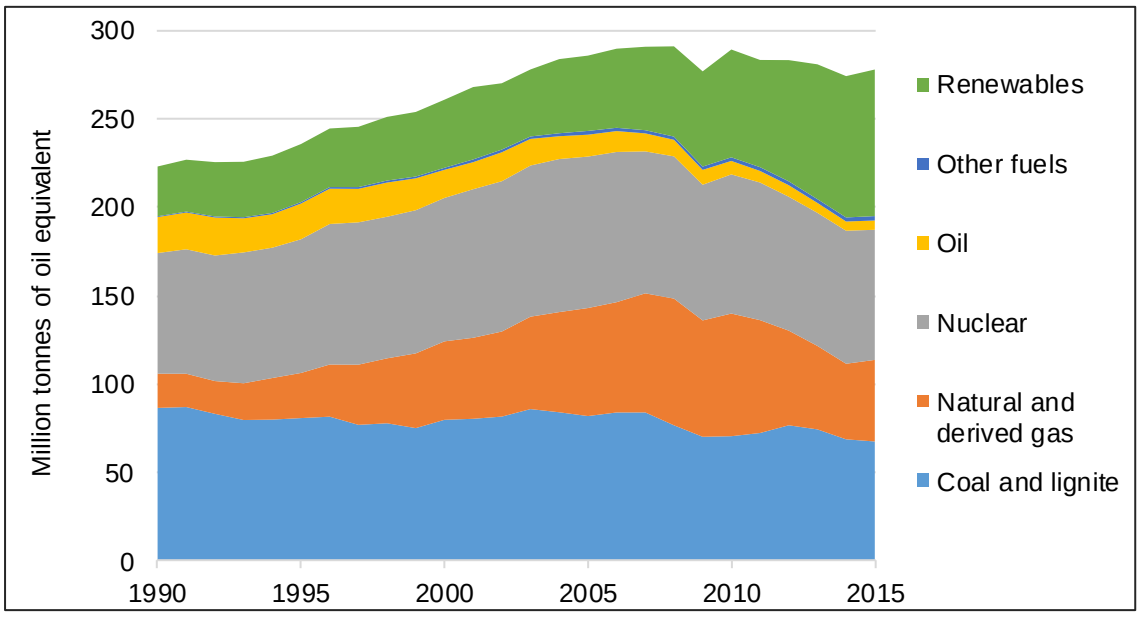
Production from gas has increased from 9 % of the overall mix in 1990 to 17 % in 2015. Overall, the generation mix of electricity in the EU-28 has become less carbon intensive since the beginning of the 1990s. However, the lower carbon intensity has been somewhat counterbalanced by the overall rise in total electricity production.

Figure 2-18 Supply of fossil fuels in the EU-28



Source: Eurostat

Figure 2-19 Gross electricity production by fuel for EU-28

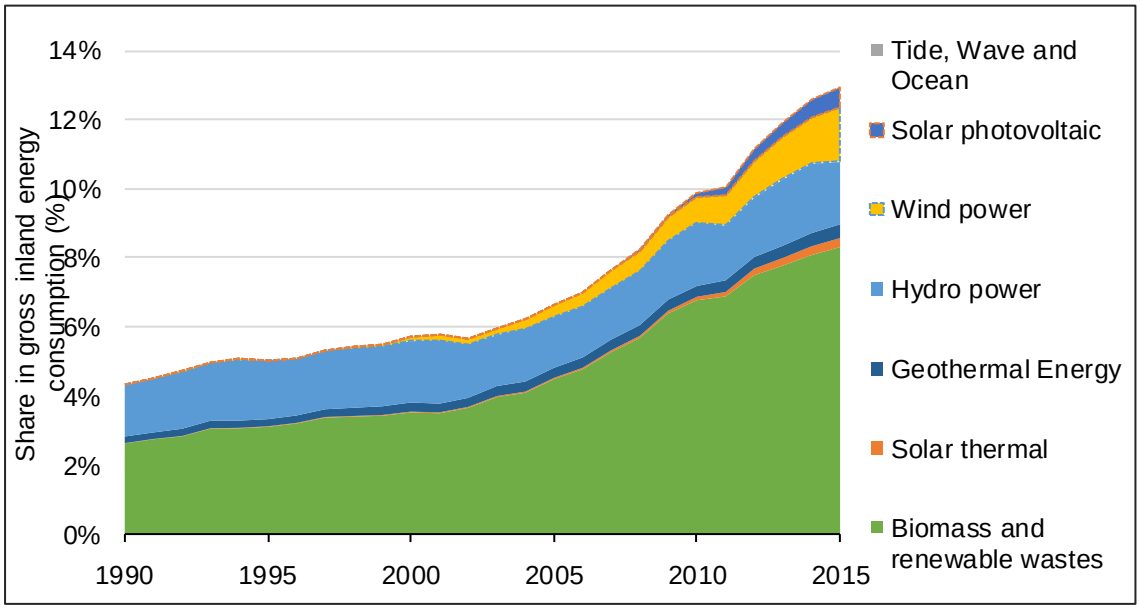


Source: Eurostat

The share of gross inland energy consumption from renewables has increased substantially over the last 25 years to around 13 % in 2015 (Figure 2-20). Very large increases have been seen in wind power generation and photovoltaics, with substantial but lesser growth in solar thermal, biomass and geothermal. Production from hydro, tidal, wave and ocean technologies has remained relatively constant.

The bulk of renewable energy consumed, over two thirds, is renewable heat (solar, biomass, geothermal and waste). Hydropower is the second biggest contributor, providing about 14 % of total renewable energy in 2015, with wind power the third largest, contributing 12 % - an enormous increase from its share in 1990 of 0.1 % of renewable energy consumed. Consumption from solar photovoltaics has also grown substantially, with output almost 8 000 times higher in 2015 than in 1990 and its share increasing from 0.002 % of renewable energy consumed in 1990 to 4.2 % in 2020.

Figure 2-20 Share of renewable energy in gross inland energy consumption, EU-28



Source: Eurostat

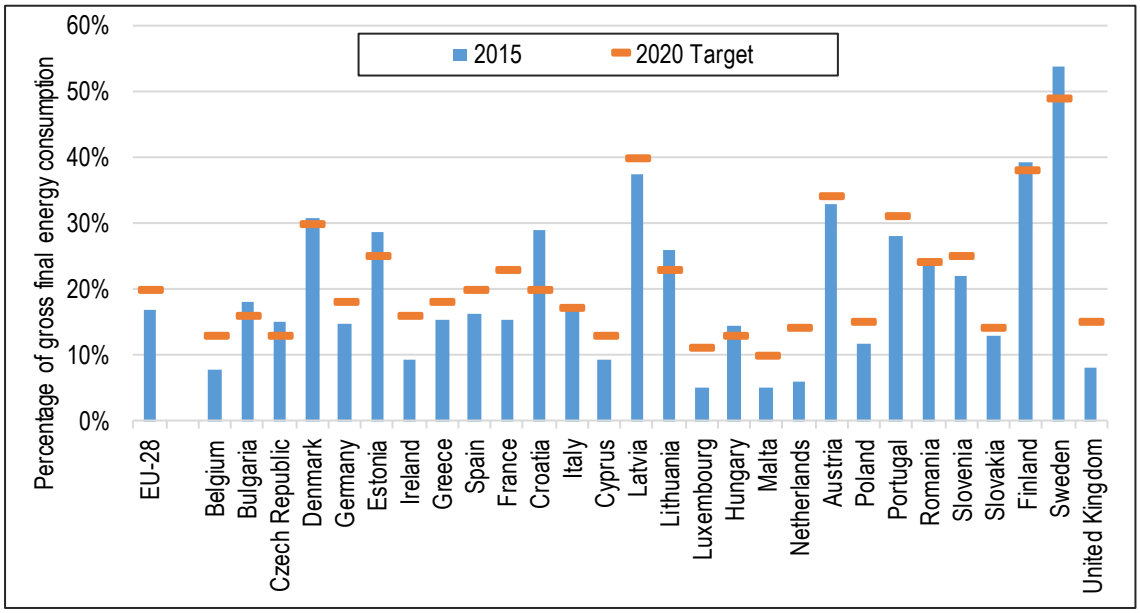
Based on data for 2015, eleven Member States (Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, Hungary, Italy, Lithuania, Romania, and Sweden) have already met their Renewable Energy Sources (RES) targets for 2020, but the remainder still need to take action to ensure that it is achieved (Figure 2-21). This shows significant progress since the time of the 6NC when no Member States had met their RES target. 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 4.4.1.2 on the EU energy policy).

The Commission' most recent progress report (2017)[16] states that the vast majority of Member States which have not yet met their targets are well on track in terms of renewable energy deployment, but will need to continue their efforts to meet their targets. Countries

16 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(2017) 57 final.

which still need to make significant progress to meet their targets include Netherlands, Luxembourg, Malta and the United Kingdom. The report also concludes that Member States have made progress on administrative barriers which may hinder deployment, but this progress has not been uniform across the Union and there is still ample room for improvement.

Figure 2-21 Share of renewable energy in gross final energy consumption in 2015 by Member State



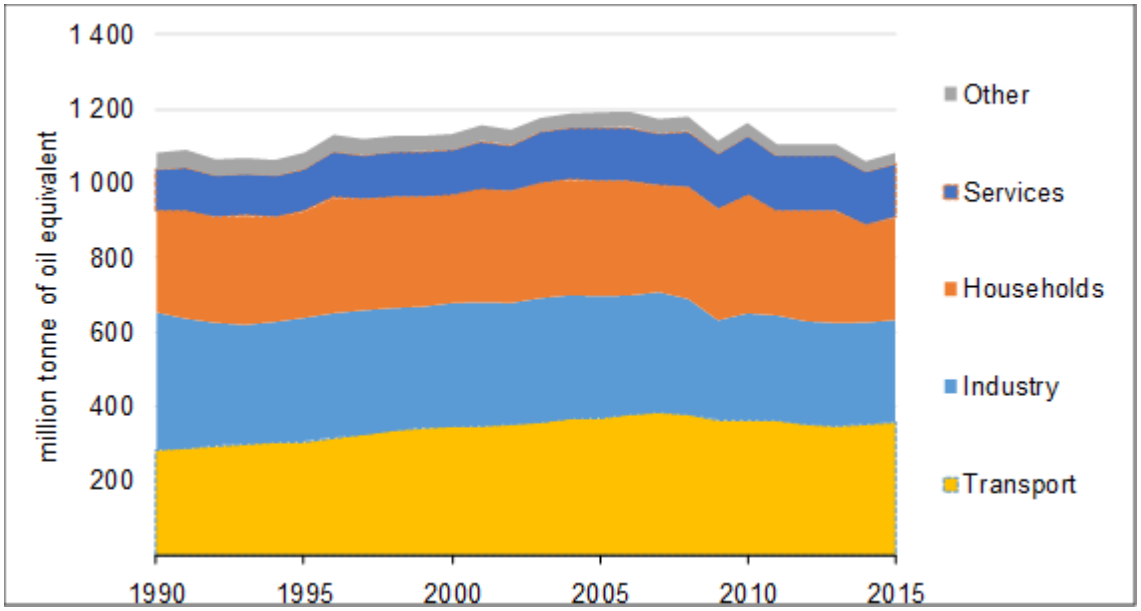
Source: Eurostat

2.6.2. *Energy consumption in different sectors*

Final energy consumption by sector is shown in Figure 2-22. This is less than two thirds of the EU's primary energy consumption, as 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. These 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.

Final energy consumption in the EU-28 increased from 1990 to 2006, but has since shown a general downward trend, so that in 2015, it was very slightly less (by 0.03 %) than consumption in 1990. A decline in consumption in the industry sector (of 26 %), 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, was offset by significant increases in consumption in the transport sector (of 26 %) and the services sector (of 35 %). Transport now accounts for the largest share (33 %) of final energy consumption. The developments in the transport sector are further explored in Section 2.7 and Section 3.2.3.. The increase in energy consumption in the services sector correlates with an increasing share of GVA from this sector.

Figure 2-22 Final energy consumption by sector in the EU-28



Source: Eurostat

Households are also one of the largest consumers of final energy in the EU, and in 2015, as in 1990, accounted for 25 % of total final energy consumption. 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.

2.6.3. *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[17] in 2007. The Third Energy Package includes two Directives, distinguishing electricity market and gas market, and three Regulations.

2.6.4. *Energy prices*

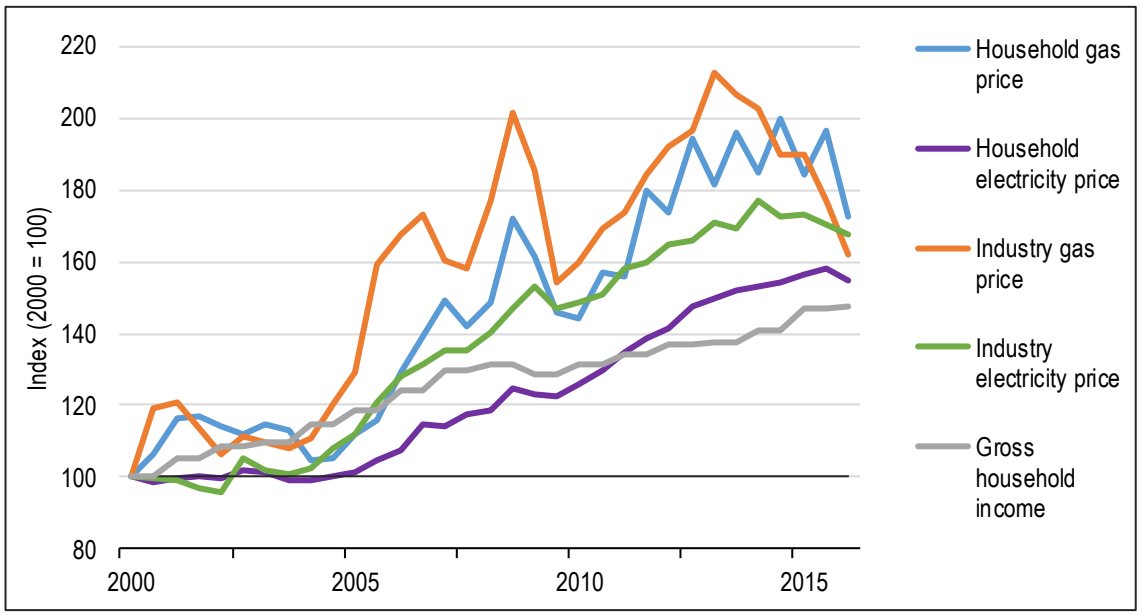
Figure 2-23 illustrates how the average end-user prices of both electricity and gas have varied since 2000 for industry and households in the EU. In addition, it illustrates how gross household disposable income has varied over this period, as this provides a very broad indication of how expenditure on energy varies as a share of income.

The price of natural gas has generally increased over the period, although it has fluctuated considerably. In the case of industrial gas prices there has been a drop in prices since 2013. The price of electricity rose less steeply over the period and has fluctuated much less than the gas price.

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

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 may particularly be the case for households as their disposable income has not risen as much as fuel prices. 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.

Figure 2-23 Change in average end-user energy prices in the EU, 2001-2016

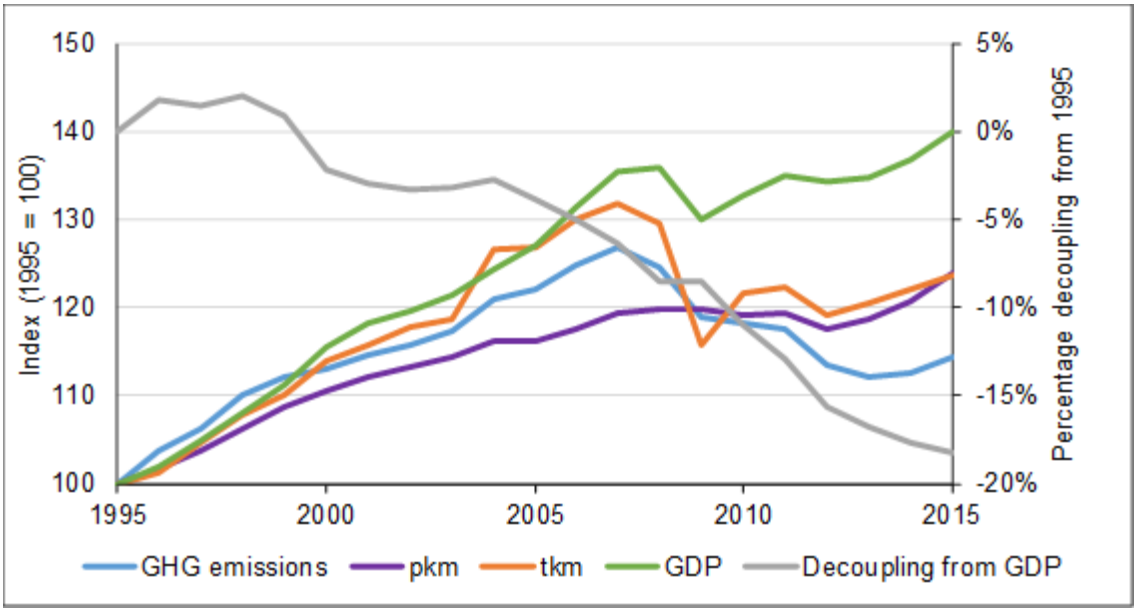


Source: Eurostat

2.7. Transport profile

Both freight and passenger transport grew strongly from 1995 until the economic crisis in 2008 (Figure 2-24). 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. While this growth has continued, it is still below levels seen in 2007 before the economic crisis. Passenger transport has shown a lower but more constant rate of growth than freight transport, with its overall growth since 1995 being less than the increase in real GDP. Overall these trends have resulted in GHG emissions from transport increasing from until 2007, when the trend was reversed due to the drop in freight transport demand caused by the economic crisis. Emissions then continued to fall until 2014, when an increase was observed, driven by rising transport energy use, caused by the low oil price environment.

Figure 2-24 Growth in transport volumes, GHG emissions and GDP in the EU-28



Source: European Commission, DG Mobility and Transport and Eurostat

Note: Estimate of GDP as billions of Euro at 2010 market prices. Freight transport data from DG Mobility and Transport. Air and sea: only domestic and intra-EU-28 transport; estimates for 1995-2004. Road: national and international haulage by vehicles registered in the EU-28. 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 transport GHG intensity (ton CO_2 per unit of GDP) compared to the 1995 baseline.

2.7.1. *Freight transport*

Figure 2-25 below shows the modal split for freight transport in 1995 and 2015. Overall freight transport volume has increased by 23.6 %, with volume increases in all modes. In 2015, the major part of freight was transported via road (49 %), followed by sea transport (31.6 %). Road slightly increased its share of freight transport (from 45.3 % in 1995 to 49 % in 2015) and as a result, the modal shares of other transport modes (particularly rail and sea transport) decreased. This is important as road transport is substantially more carbon intensive per tonne km than rail[18].

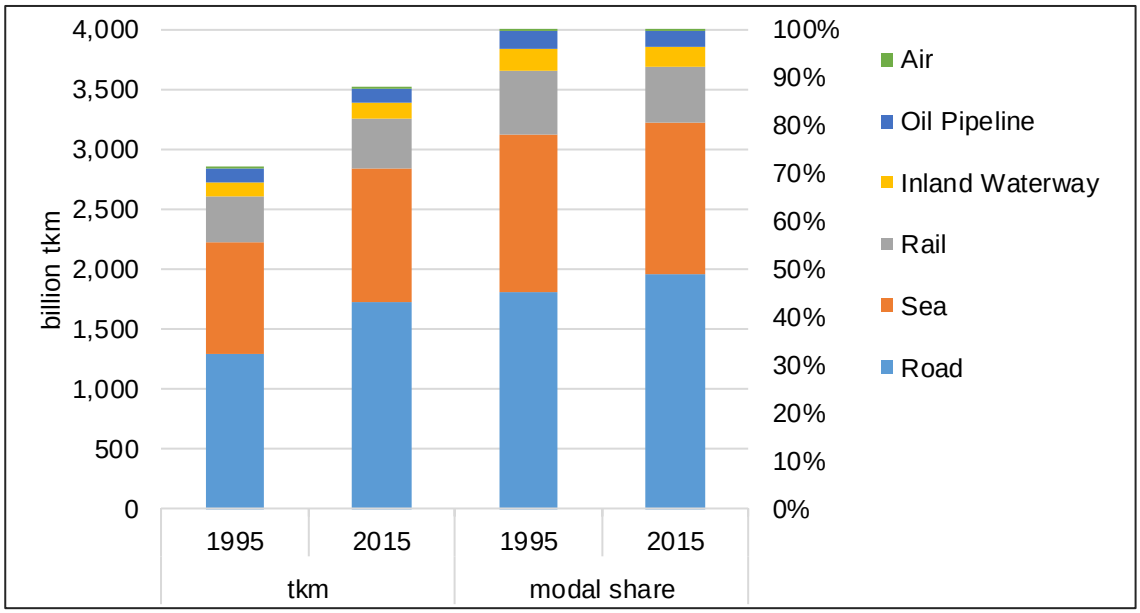
2.7.2. *Passenger transport*

Between 1995 and 2007, passenger transport in the EU increased at a lower rate than GDP. The effect of the financial and economic crisis is far less distinct than for freight transport, temporarily halting the increase in passenger transport, rather than leading to a significant decrease. Figure 2-26 shows the total distance travelled by passengers, comparing 1995 with 2015. Overall passenger transport has increased by 23.8 %, with car transport increasing by 20.9 %. Regarding the modal split, 71.5 % of the total passenger kilometres are travelled by passenger cars. Air travel (domestic and intra EU-28), comes second in the modal split,

18 European Environment Agency. Indicators: Energy efficiency and specific CO_2 emissions. https://www.eea.europa.eu/data-and-maps/indicators/energy-efficiency-and-specific-co2-emissions/energy-efficiency-and-specific-co2-9

accounting for 9.8 %. However, this is an increase from 1995 when it accounted for 6.5 % of the total passenger kilometres, thus registering the highest increase since 1995 (+86.5 %).This is important as growth in air transport has exceeded the improvements in aircraft fuel efficiency, leading to significant increases in emissions.

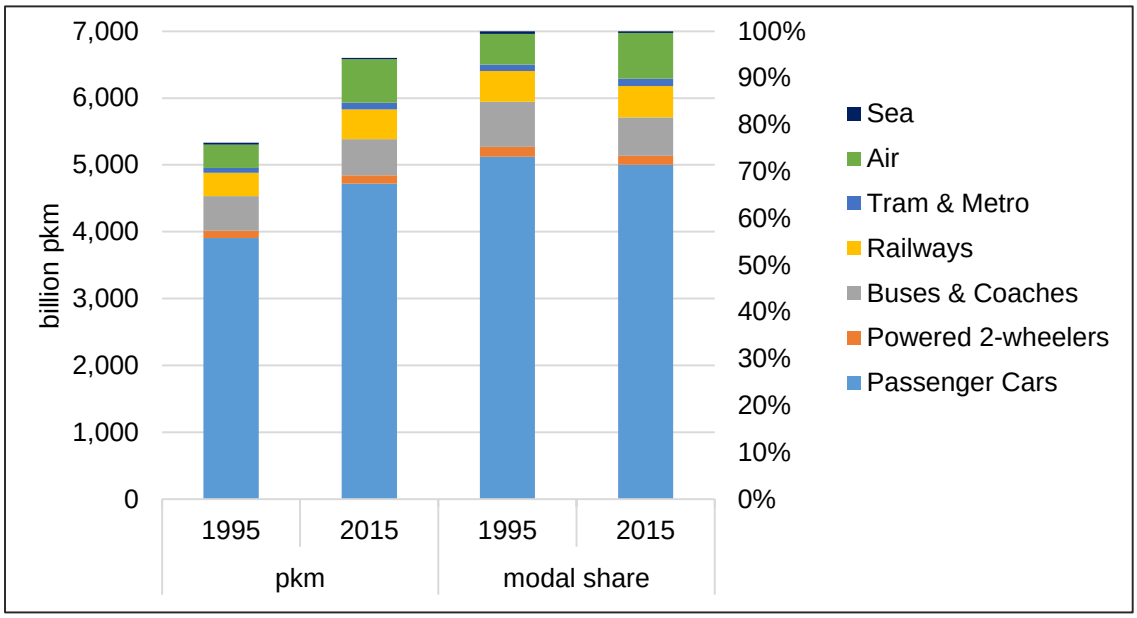
Figure 2-25 Modal split of freight transport in the EU-28



Source: DG Mobility and Transport

Note: Air and Sea: only domestic and intra-EU-28 transport, estimates for 2015. Road: national and international haulage by vehicles registered in the EU-28 in 1995, activity performed by European drivers within the EU territory in 2015.

Figure 2-26 Modal split of passenger transport in the EU-28

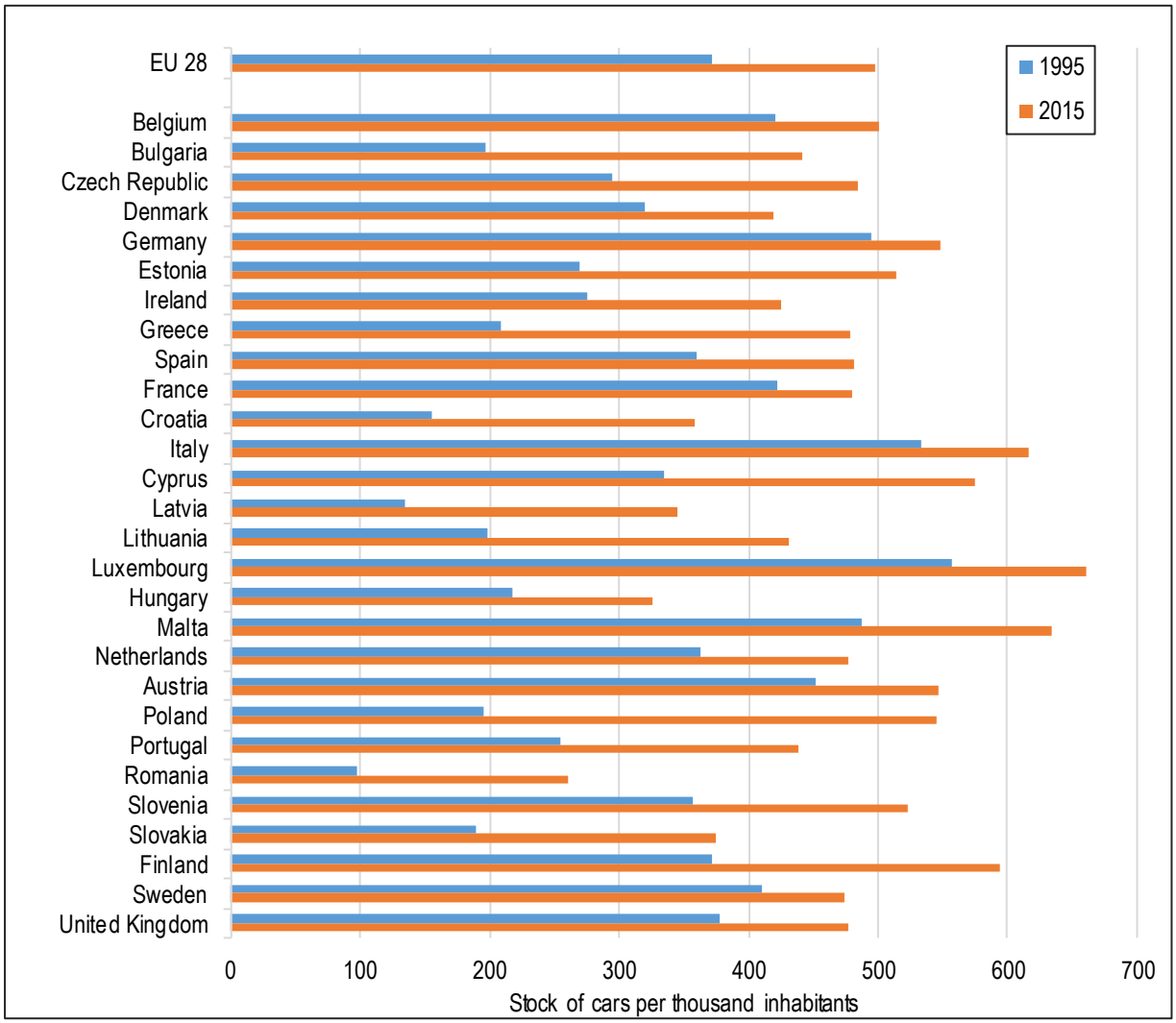


Source: Eurostat, DG MOVE

Note: Air and Sea: only domestic and intra-EU-28 transport; provisional estimates.

Figure 2-27 shows that in each of the EU-28 Member States the level of car ownership has increased between 1995 and 2015, with the overall level of ownership in the EU-28 increasing by 34 %. In Poland, Romania, Latvia, Croatia, Greece, Bulgaria and Lithuania car ownership levels have more than doubled, whereas Germany experienced the smallest increase at 11 %. Romania has the lowest level of ownership in the EU-28 (261 per 1 000 inhabitants). Luxembourg has the highest level of ownership with 661 cars per 1 000 inhabitants, followed by Malta with 634 cars per 1 000 inhabitants.

Figure 2-27 Level of car ownership



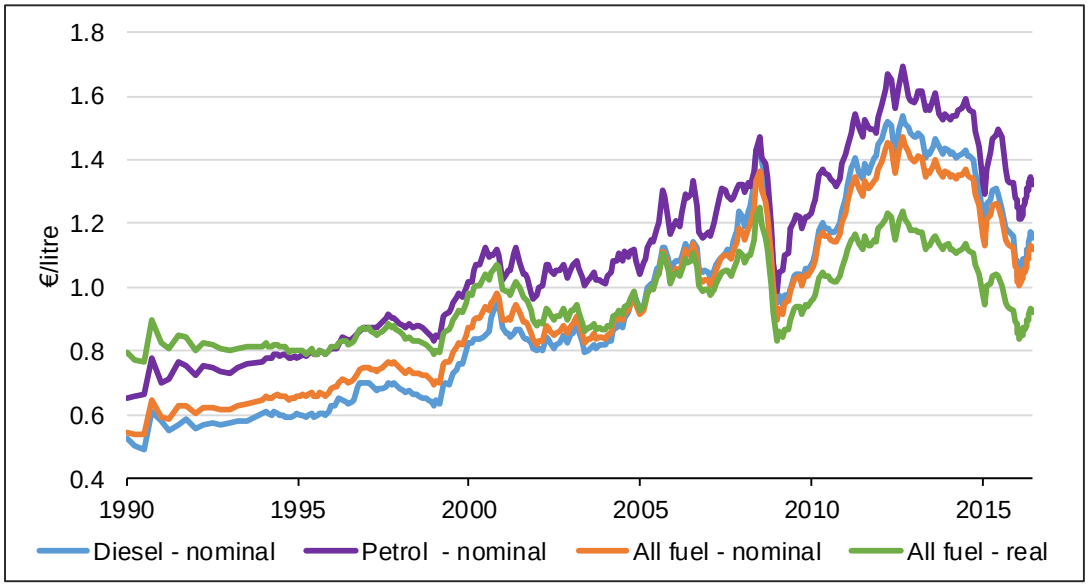
Source: Eurostat, DG Mobility and Transport

Note: Passenger car stock at end of year n divided by the population on 1st January of year n+1.

2.7.3. *Prices of transport fuels*

Figure 2-28 shows the trend in average diesel and petrol prices in the EU Member States since 1990. Overall, the prices for petrol increased by 8 % and diesel more than doubled between 1990 and 2016 due to substantial increases in oil prices; real prices (when adjusting for inflation) increased by around 9 % for all fuels.

Figure 2-28 Average EU road transport fuel prices

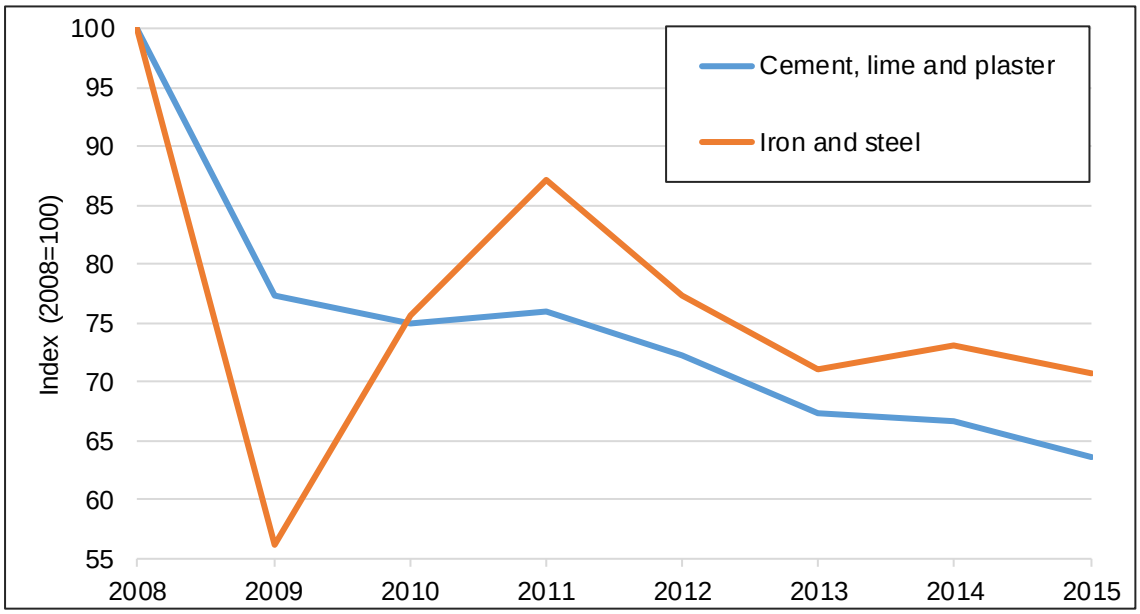


Source: EEA
Note: 'Real' is the price corrected for inflation, using 2005 as the baseline year.

2.8. Industry

The largest shares of gross value added in the industry sector in 2014 were contributed by construction (20 %), electricity, gas, steam and air conditioning (9 %); manufacture of machinery and equipment (8 %), and manufacture of motor vehicles (7 %). Figure 2-29 shows trends in the production value of two very energy-intensive industry sectors (iron and steel and cement). The decline in production during the economic crisis in 2009 is clearly visible, in particular for iron and steel.

Figure 2-29 Trends in production value of iron, steel and cement industry



Source: Eurostat

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).

2.9. **Waste**

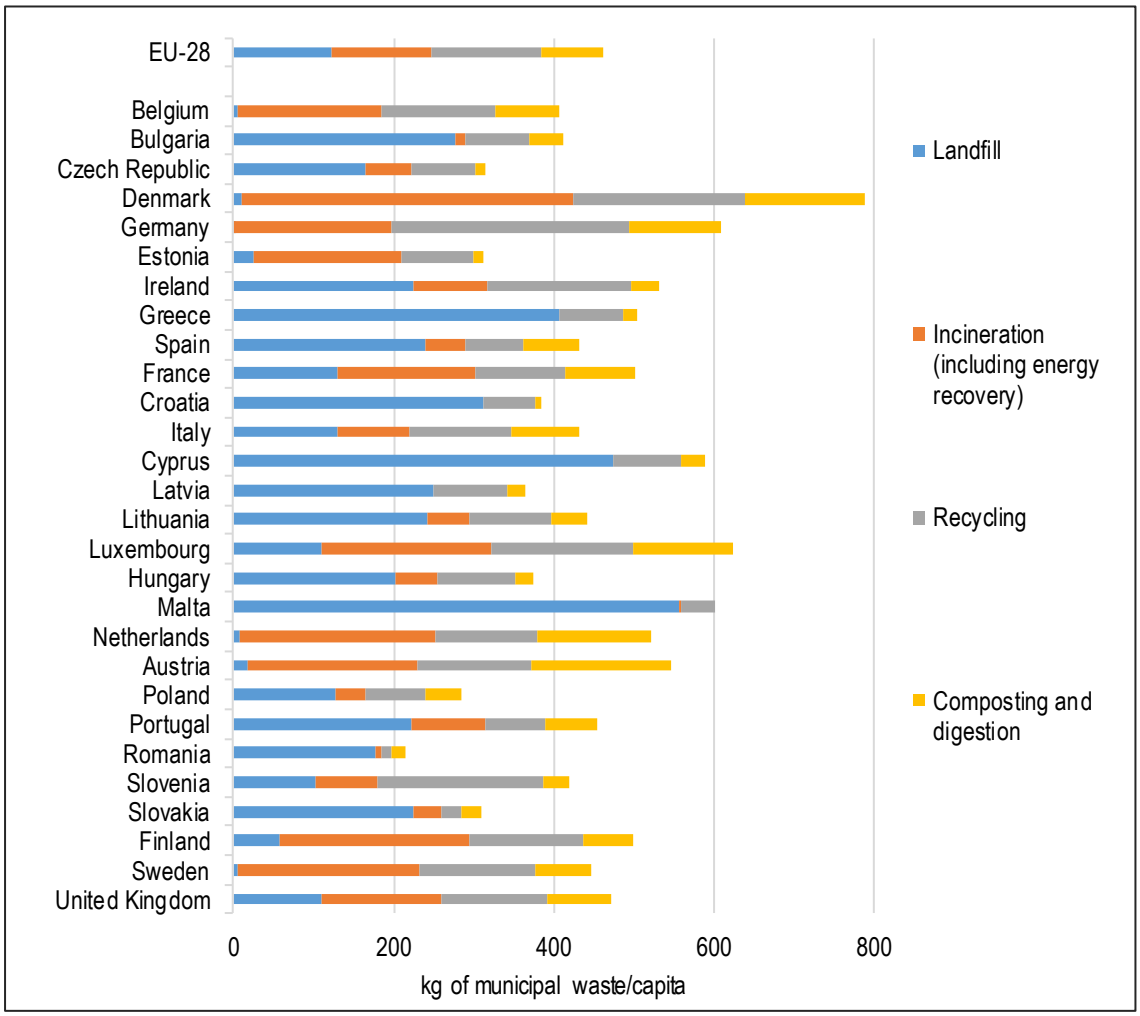
Greenhouse gas emissions from waste depend on the quantity of waste and how it is disposed of (including recycling, landfill and incineration). All types of waste treatment have an impact on emissions, including the consumption of energy in the collection, treatment and production of waste. The trends 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 4.4.1.7.

Figure 2-30 below shows the amount of municipal waste per capita in each Member State in 2015, which goes to each type of treatment. For the EU-28 on average 46 % of waste per capita is recycled, 26 % is sent to landfill and 27 % is incinerated. There has been a significant move away from disposal to landfill since the 6NC, when 36 % was sent to landfill. The lowest recycling rates are in Malta – at less than 7 %, with the remaining 93 % of waste landfilled. In contrast, Germany, Sweden and Belgium send less than 1 % of the municipal waste to landfill. In Estonia, Denmark and Sweden, more than half of the

municipal waste is incinerated. In terms of recycling, the Germany is the leader with over two-thirds (68 %) of waste recycled.

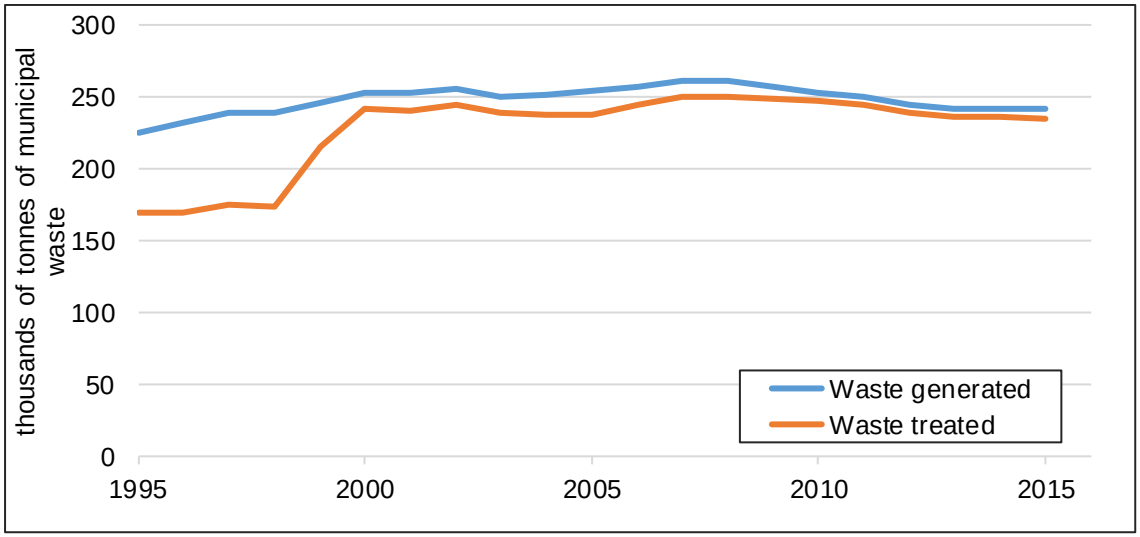
Figure 2-30 Treatment of municipal waste per capita in 2015



Source: Eurostat
Note: Data for Greece and Ireland is for 2012 and for Portugal 2014

As can be seen in Figure 2-31 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, as more of the waste generated has been treated.

Figure 2-31 Development of municipal waste generation and treatment since 1995

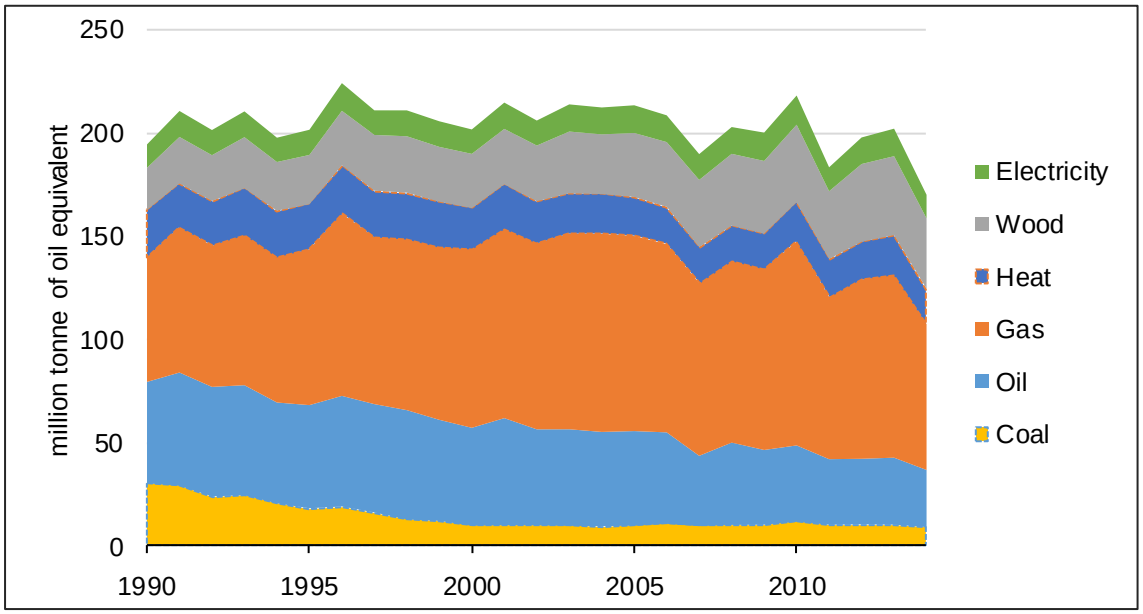


Source: Eurostat
Note: Data before 2006 not available for Croatia.

2.10. **Building stock and urban structure**

Energy consumption for space heating in buildings is a significant component of EU energy consumption. Figure 2-32 shows the energy consumption of residential space heating by fuel types. The main form of fuel for heating is gas, which has increased its share from 31 % in 1990 to 42 % in 2014. Wood has also increased its share – from 11 % to 20 %. The more carbon intensive oil and coal have seen their shares fall, to 16 % and 5 % respectively. This has important implications for overall GHG emissions from residential heating, as the CO_2 emission intensity of natural gas is much lower than for oil or coal.

Figure 2-32 Energy consumption of residential space heating in the EU-28 (1990 to 2014)



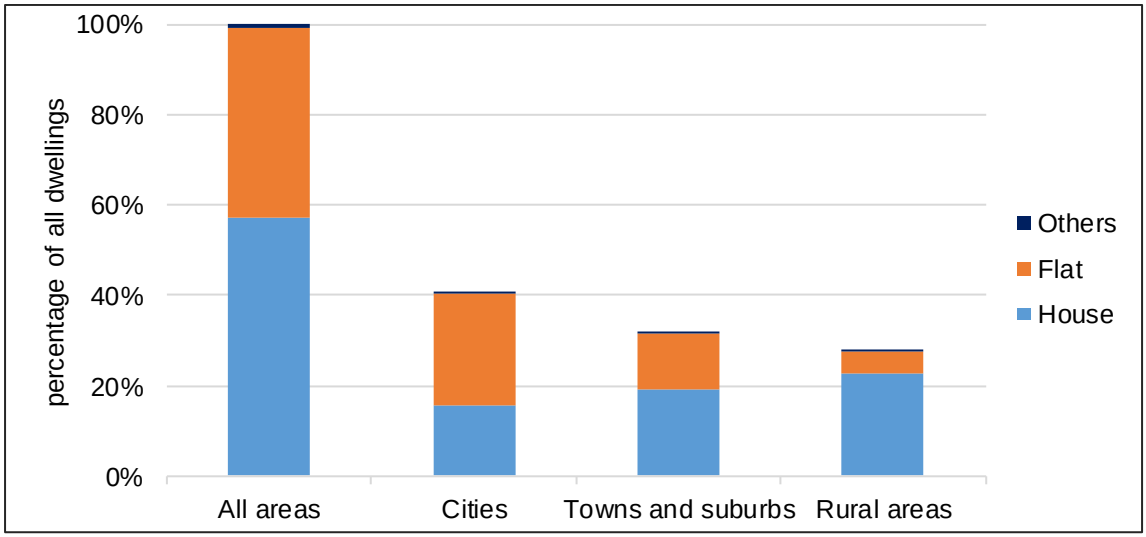
Source: Odyssee
Note: data for Cyprus, Luxembourg, Malta, Portugal and Slovenia are not available for all years.

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, 2011 and 2014.

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 Figure 2-33) are in many cases characterised by lower energy consumption per square metre. 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 metre has decreased by 28 % from 14.1 to 10.1 kilogrammes of oil equivalents (see Figure 2-34).

Climate-corrected energy consumption per square metre is also shown in Figure 2-34. 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.

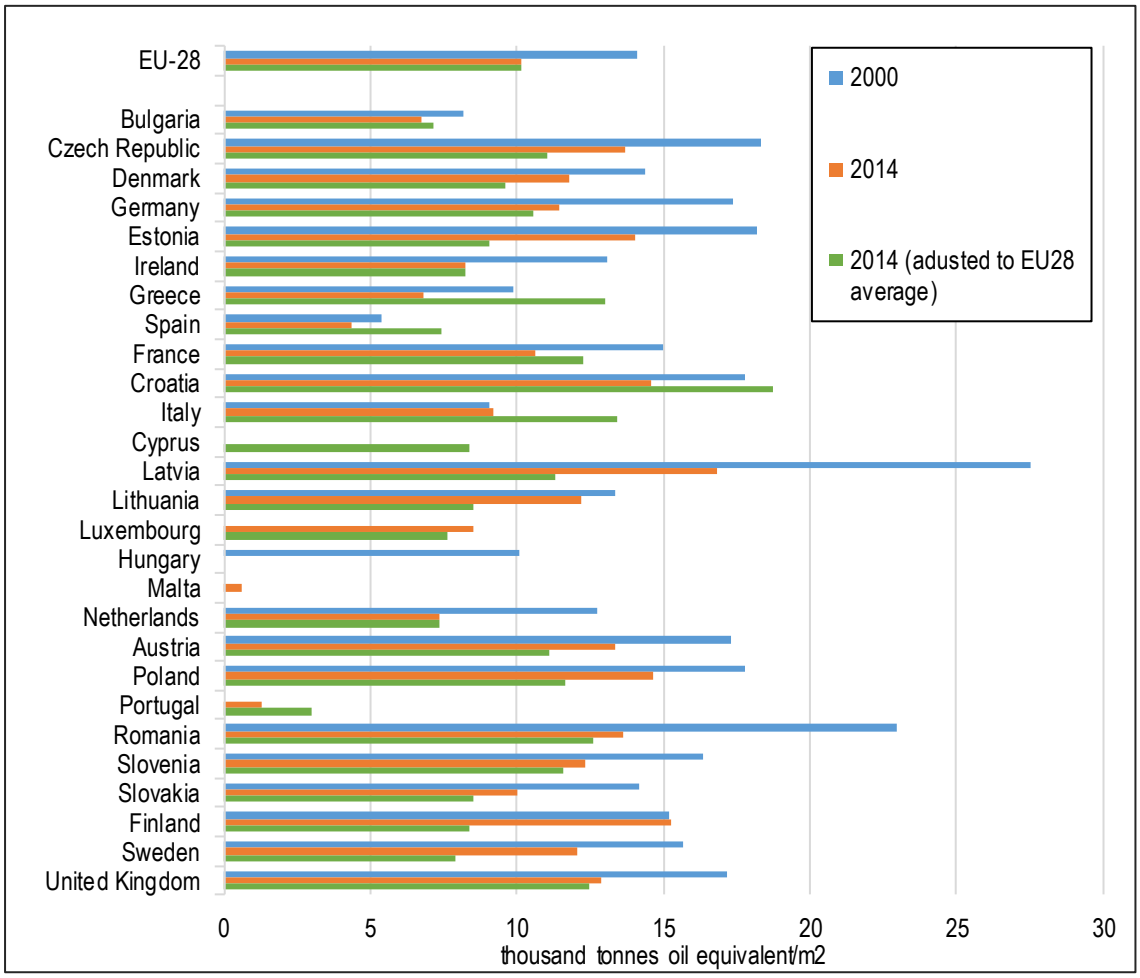
Figure 2-33 Breakdown of types of housing in the EU-28 in 2015



Source: Eurostat

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 metre, it can be seen in Figure 2-35 that households reduced this energy consumption by about 30 % since 1990. On the other hand, total electricity consumption per dwelling increased by 3 %, electricity consumption for lightning and appliances even increased by 12 % compared to 1990 levels, caused by the increasing stock of electrical appliances and larger homes. However the upward trend observed since 1990, has been reversed since 2010, with consumption falling between 2010 and 2014, due to the improved energy efficiency of lighting and appliances.

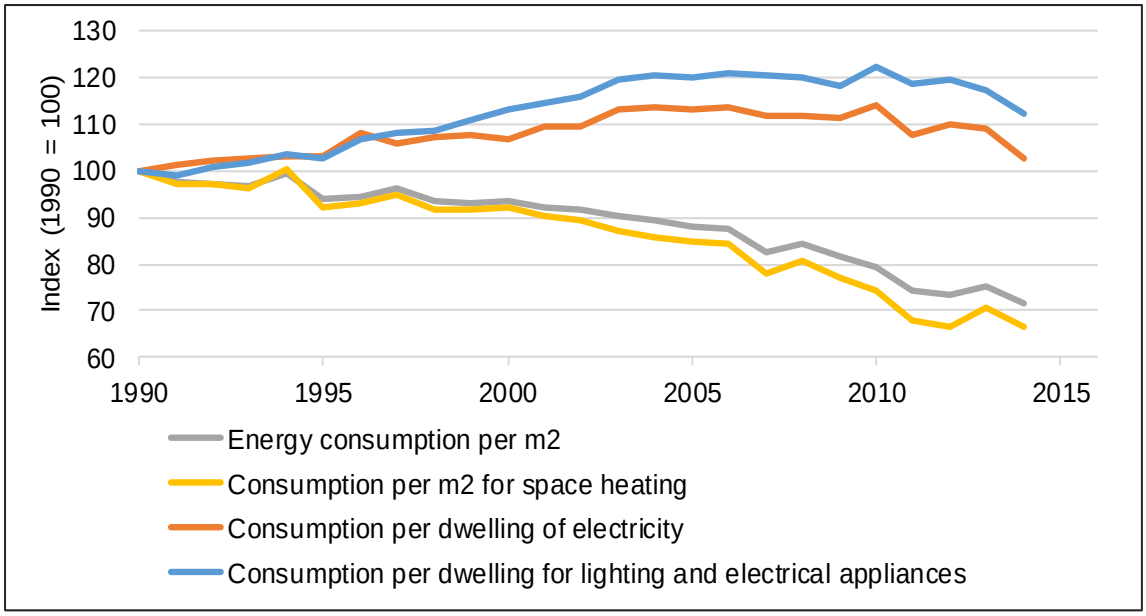
Figure 2-34 Household energy consumption per m^2 for space heating



Source: Odyssee

Note: Data for 2000 and 2014 are climate corrected against each country's long-term average climate, whereas the last series is climate corrected and scale against the EU - 28 long-term average climate to account for temperature differences between countries. Data not available for Belgium. Latest available data used where 2014 data not available (Romania, 2011; Lithuania and Malta 2012, Portugal and UK, 2013)

Figure 2-35 Unit consumption of energy in households



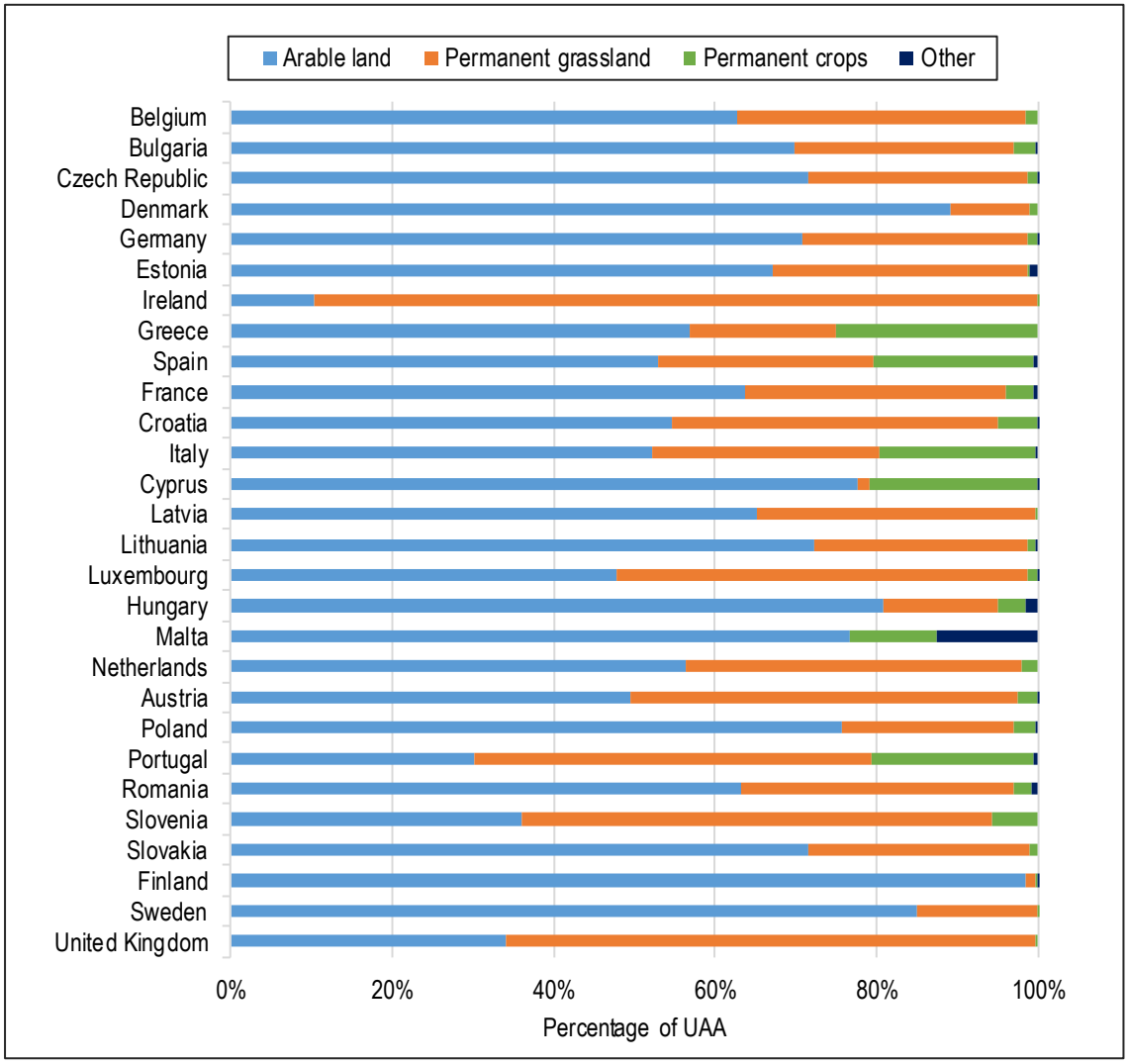
Source: Odyssee

2.11. **Agriculture**

In 2015 the total utilised agricultural area (UAA) in the EU-28 was 1.79 million km² which corresponds to 40 % of the total EU-28 area. The UAA declined slightly (by 4 %) between 2004 and 2015, but trends varied considerably between Member States. Significant increases were seen in Croatia, Estonia, Latvia and Lithuania, but were largely offset by decreases in countries such as Italy, Poland and Spain. Figure 2-36 shows the land use patterns of the Member States. Overall in the EU, about 60 % of the UAA is arable land, and 33 % is permanent grass land, but there is considerable variation between Member States. For example in Finland, where only 7% of land is used for agriculture, 99 % of the UAA is arable land, and only 1 % grass land. In contrast, in Ireland where 60% of land is used for agriculture, 90 % of the UAA is grassland and only 10 % arable land.

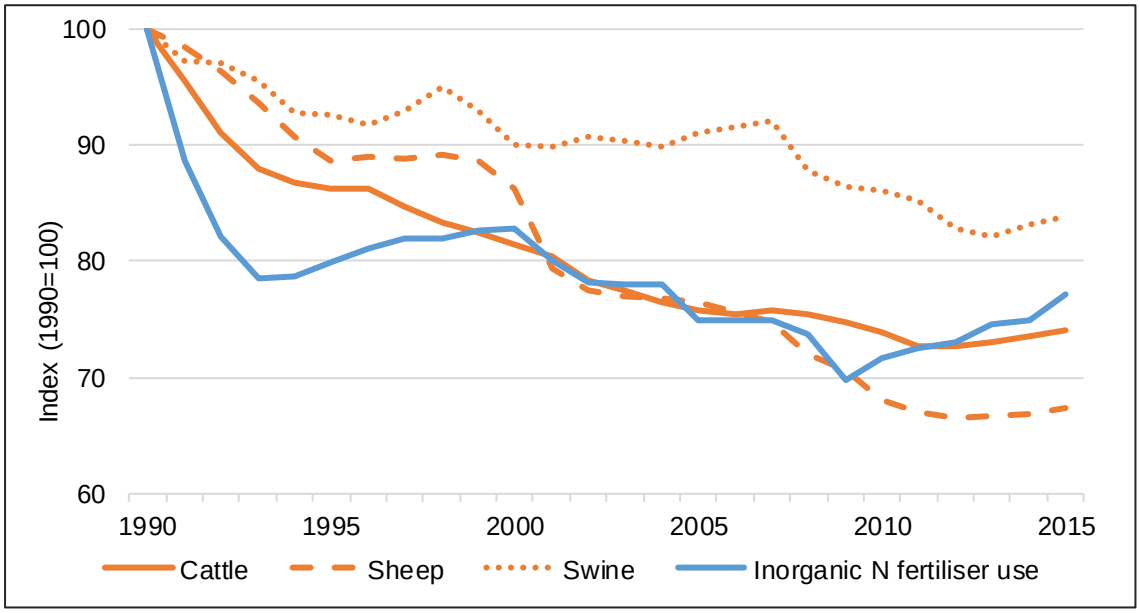
Agriculture constitutes a significant source of GHG emissions, for example due to nitrous oxide (N_2O) associated with fertilizer use and methane (CH_4) emissions from livestock (as well as energy consumption in the sector itself). Related trends are highlighted in more detail in **Figure 2-37**; trends in agriculture emissions are outlined in Section 3.2.3.

Figure 2-36 Total utilised agricultural land and usage patterns in 2015



Source: Eurostat

Figure 2-37 Trends in livestock populations and inorganic fertiliser use in EU-28



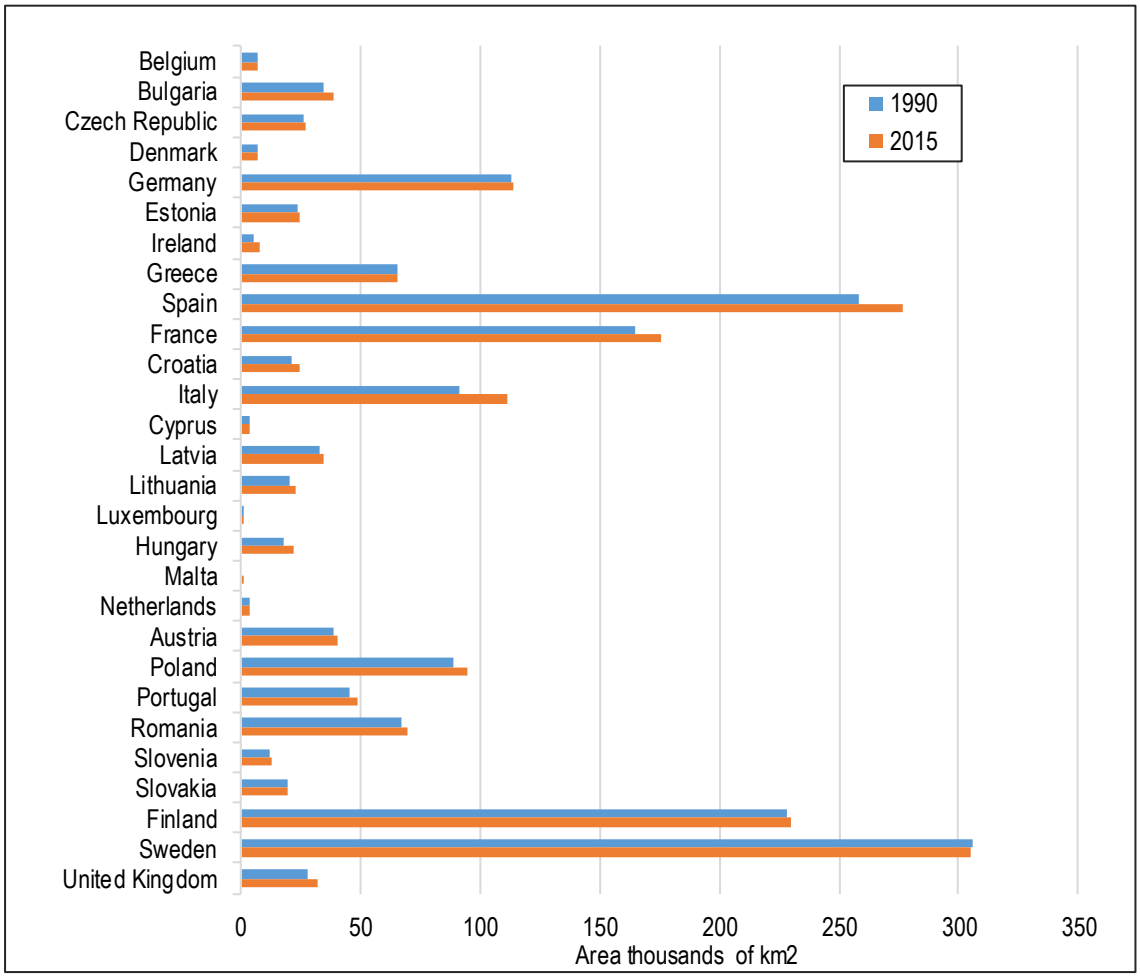
Source: Annual European Union greenhouse gas inventory 1990–2015

The use of nitrogenous fertilizers (in mineral and organic form) is an important factor driving agricultural emissions. The use of mineral nitrogenous fertilizer in the EU-28 fell substantially between 1990 and 2009, but has subsequently started to increase; in 2015 it was 23 % below 1990 levels. The number of livestock has substantially decreased since 1990, with cattle, which are emitters of enteric methane, falling by about a quarter.

2.12. **Forests**

Overall, the total forested area across the EU-28 Member States increased by 5 % between 1990 and 2015 (see Figure 2-38). In 2015, the forested area amounted to approx. 1.8 million km² which is 41 % of the total EU-28 area. The forest area increased in all countries, with the exception of Denmark, Luxembourg and Sweden (showing decreases of -3 %, -0.5 % and -0.3 % respectively between 1990 and 2015). 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 2-38 Forested area in 1990 and 2015



Source: Eurostat
Note: Total forested area including other wooded land.

3. GREENHOUSE GAS INVENTORY INFORMATION

Key Developments

- Total greenhouse gas (GHG) emissions in the EU-28 plus Iceland (ISL) (without LULUCF and without international aviation, with indirect CO_2 emissions, and with NF_3 emissions) were 4 317 million tonnes CO_2 equivalent in 2015. Total GHG emissions decreased by 23.6 % from 1990 to 2015. In the EU-28 plus ISL the biggest relative change has been in the waste sector where the emissions of CH_4 from managed waste disposal on land decreased substantially.
- In 2015, total GHG emissions in the EU-28 plus ISL (without LULUCF and without international aviation, with indirect CO_2 emissions, and with NF_3 emissions) increased by 23.1 million tonnes, or 0.54 % compared to 2014. The increase in emissions was triggered by the higher heat demand by households and services due to slightly colder winter conditions in Europe, as well as by higher road transport demand.
- Total energy consumption increased overall, with fossil emissions increasing, particularly for natural gas and crude oil. The consumption and emissions of solid fuels decreased in 2015 for the third consecutive year. The sustained increase in renewables, particularly biomass, wind and solar, offset otherwise higher emissions in 2015. Electricity production from hydro and nuclear electricity production declined in 2015. The decline in hydro was due to low rainfall[19].
- In spite of the 2015 increase in emissions, there were further improvements in the carbon intensity of the EU energy system because of the increased shares of renewables and gas relative to coal in the fuel mix. The energy intensity of GDP also improved as total energy consumption increased less rapidly than economic growth. The improvement in energy intensity was largely driven by lower energy-transformation losses and better energy efficiency of the overall EU economy[20].

3.1. Introduction

This chapter provides the key points about the EU GHG inventory. Further detail is provided in the 3BR.

Under the Kyoto Protocol, for its second commitment period, the EU, its Member States and Iceland have agreed to fulfil their quantified emission limitation and reduction commitments jointly. The Union, its Member States and Iceland agreed to a quantified emission reduction commitment that limits their average annual emissions of greenhouse gases during the second commitment period to 80 % of the sum of their base year emissions, which is reflected in the Doha Amendment[21].

19 Analysis of key trends and drivers in greenhouse gas emissions in the EU between 1990 and 2015, Available at https://www.eea.europa.eu/publications/analysis-of-key-trends-and

20 See reference above

21 See https://ec.europa.eu/clima/policies/strategies/progress/kyoto_2_en

The GHG data presented in this chapter are consistent with the 2017 submission of the EU to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), under the Convention and the Kyoto Protocol[22]. In this Communication, the EU plus ISL is referred to EU-28+ISL.

The GHG inventory data presented in this chapter of the National Communication refers to the GHG inventory of the EU-28+ISL, as submitted by the EU in 2017 under the Kyoto Protocol. The third biennial report contains the GHG inventory information pertaining to the EU-28 alone and is consistent with the annual inventory submission made by the EU under the Convention in 2017. Emissions in 2015 from the EU-28 were 4 310 million tonnes CO_2 eq., and 4 317 million tonnes CO_2 eq. from the EU-28+ISL.

The GHG inventory data presented in this chapter of the National Communication refers to the GHG inventory of the EU-28+ISL, as submitted in 2017 under the Kyoto Protocol. As the EU inventory is the sum of the Member States' inventories, the EU-28 inventory covers the same geographical area as the inventories of the 28 Member States. For complete information on the geographical coverage, please refer to Table 1.17 of the EU national inventory report, as submitted to the UNFCCC in 2017 (EU NIR 2017).

The sectoral scope of the emissions presented in this chapter aligns with the reporting requirements of the second commitment period (CP2). Indirect emissions of CO_2 are included in all the emission data quoted in the National Communication. Emissions from international aviation are excluded in this chapter.

The legal basis of the compilation of the EU inventory and the inventory methodology and data availability are described in Chapter 1 of the EU NIR 2017 "*Introduction to the EU GHG inventory*".

The legal basis for the compilation of the EU 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 GHG emissions and for reporting other information at national and EU level relevant to climate change and repealing Decision No 280/2004/EC (MMR)[23]. The EU inventory has been compiled from data delivered by the 28 Member States and Iceland by 15 March 2017 under Regulation (EU) No 525/2013, and subsequent updates to these data received by 15 May 2017.

Summary tables of GHG emissions for EU-28+ISL in the common reporting format are presented in Appendix II. These data and the complete submissions of the Member States (Member States) under Regulation (EU) No 525/2013 are available on the EEA website (http://www.eea.europa.eu/).

3.2. **Descriptive Summary of GHG Emissions Trends**

This section only has a brief description of the trends in GHG emissions. For a full description of the trends, please see relevant sections in the EU National Inventory Report (NIR) and [3BR] Section 2.3.

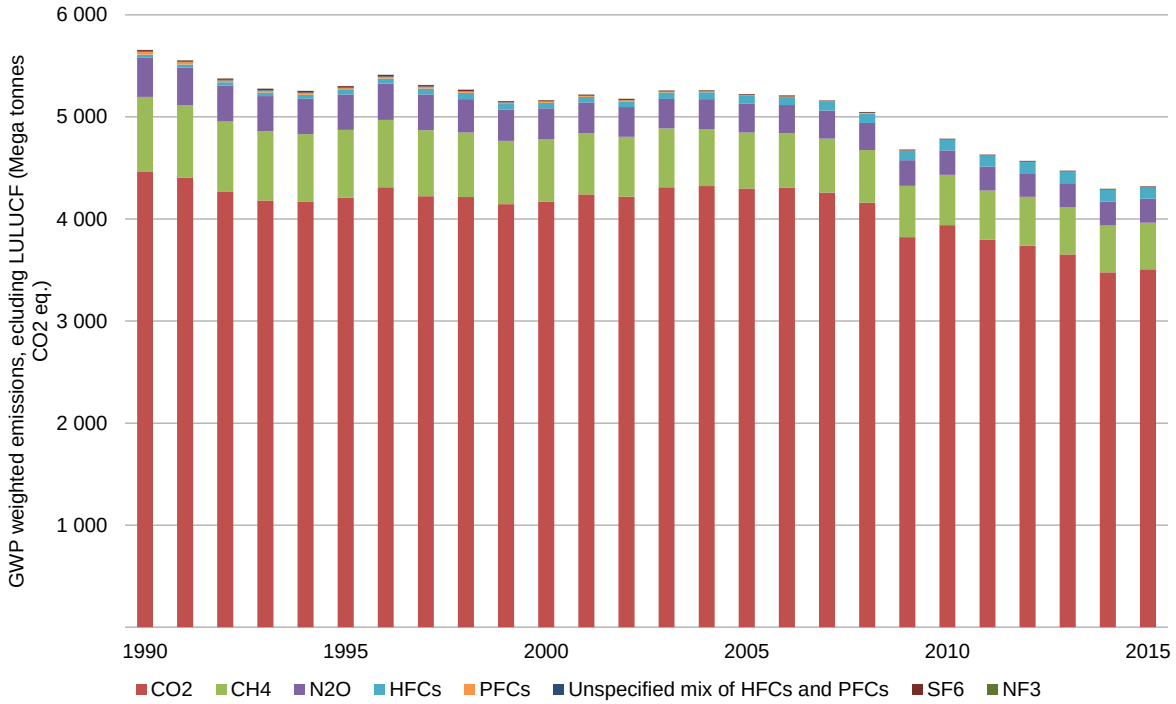
22 Available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php

23 Available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0525&from=EN

3.2.1. *Trends in total GHG emissions*

In 2015 total GHG emissions in the EU-28+ISL, without LULUCF, were 23.6 % (1 336 million tonnes CO_2 equivalents) below 1990, (see Figure 3-1). Between 2014 and 2015 emissions increased by 0.5 % (23 million tonnes of CO_2 equivalents).

Figure 3-1 EU-28+ISL GHG emissions 1990 to 2015, excluding LULUCF.



Source: EEA

3.2.2. *Trends in emissions by GHG*

Table 1 in Appendix II provides an overview on the main trends in the EU-28+ISL GHG emissions and removals for 1990–2015. In the EU-28+ISL the most important GHG is CO_2, accounting for 81.2 % of total EU-28+ISL emissions in 2015. In 2015, EU-28+ISL CO_2 emissions without LULUCF were 3 506 million tonnes, which was 21.5 % below 1990 levels. CH_4 and N_2O emissions account for 10.6 % and 5.5 % of total GHG emissions respectively in 2015; both gases show falling trends. As a group of gases, fluorinated gases (HFCs, PFCs, SF_6 and NF_3) are increasing and account for the remaining 2.7 % of total GHG emissions.

3.2.3. *Trends in emissions by main source and sink categories*

Table 1 Appendix II provides an overview of EU-28+ISL GHG emissions in the main source categories for 1990 to 2015. Emissions from international aviation and shipping are excluded from national totals and are presented in the table as memo items.

The energy sector contributed 77.9 % to total GHG emissions in 2015. This sector is the largest source of emissions in the EU-28+ISL. Total GHG emissions from this sector decreased by 22.5 % from 4 341 in 1990 to 3 362 million tonnes in 2015. 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 also, in manufacturing industries. In addition, efficiency improvements, fuel shifts and better insulation of buildings contributed to the decline. The use of renewables is an important factor also.

The agriculture sector is the second largest source of emissions in the EU-28+ISL, and contributed 10.1 % to total GHG emissions in 2015. Total GHG emissions from this sector decreased by 23.3 % from 549 million tonnes CO_2 equivalent in 1990 to 438 million tonnes CO_2 equivalent in 2015, reflecting falling cattle population and lower fertiliser and manure use on agricultural soils.

The industrial processes and product use sector is the third largest source of emissions, and contributed 8.7 % to total EU-28+ISL GHG emissions in 2015. Total GHG emissions from this sector decreased by 27.4 % from 518 million tonnes CO_2 equivalent in 1990 to 376 million tonnes CO_2 equivalent in 2015, mainly due to emission reduction measures in adipic acid production, nitric acid production and production of halocarbons.

The remaining emissions arise from the waste sector, contributing 3.2 % to total EU-28+ISL GHG emissions in 2015. Total GHG emissions from this sector decreased by 42.1 % from 241 million tonnes CO_2 equivalent in 1990 to 140 million tonnes CO_2 equivalent in 2015. Key EU polices such as the Landfill Waste Directive have been successful in reducing greenhouse gas emissions from the waste sector.

In addition, net removals from land use, land use change and forestry (LULUCF) increased in the EU over the same 25-year period. Based on the 2017 EU GHG inventory, net removals increased by 32.9 % in the EU 28 between 1990 and 2015 and the net sink has increased from 4.1 % of total net GHG emissions in 1990 to 7.3 % in 2015. In 2015, net removals from the LULUCF sector in the EU 28 amounted to 295 million tonnes of CO_2 equivalent. The key driver for the increase in net removals is a significant build-up of carbon stocks in forests. Environmental policies have also resulted in less intensive agricultural practices and an increase in forest and woodland conservation areas for the purpose of preserving biodiversity and landscapes. In 2015, cropland and grassland were sources of emissions.

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 and excluded from national totals. Emissions of greenhouse gases from international aviation increased between 1990 and 2008, with some inter-annual fluctuations. In 2009 there was a clear decline in emissions, mainly due to the global financial crisis of 2007 to 2009. From 2010 onwards emissions steadily rose, approximately returning to their 2008 levels by 2015. Emissions of greenhouse gases from international navigation increased between 1990 and 2008, with some inter-annual fluctuations. In 2009 there was a clear decline in emissions, mainly due to the global financial crisis of 2007 to 2009. From 2011 onwards emissions have steadily declined. In 2015, emissions were similar to those in 2000.

Total GHG emissions from international transport reached 278 million tonnes of CO_2 equivalents in 2015. Emissions from these two categories are equivalent to 3.5 % for international aviation (143 million tonnes of CO_2 equivalents) and 3.4 % for international navigation (135 million tonnes of CO_2 equivalents) of total EU-28+ISL GHG emissions in

2015. In 2015, emissions from aviation bunkers and maritime bunkers were 106 % and 23 %, respectively, above 1990 levels.

3.2.4. *Further details about the GHG inventory and interpretation of results*

Sections in the 3BR provide further details about the following points:

- Changes in emissions from Key Categories (see [3BR] Section 2.3.4);
- Key drivers affecting emission trends (see [3BR] Section 2.3.5);
- Information on indirect GHG emissions (see [3BR] Section 2.3.6);
- Accuracy and uncertainty of the data (see [3BR] Section 2.3.7);
- Details of the gap filling procedure (see [3BR] Section 2.5.1).

3.2.5. *Changes since the 6th National Communication*

Since the publication of the 6NC, various updates and revisions to methodologies have been implemented in the EU GHG inventory, which have impacted on the time-series of emissions. The 2013 EU GHG inventory was used in the 6NC. This means changes to the GHG inventory used in this Communication are a result of four GHG inventory updates.

Cross cutting changes that affect the GHG inventories of all the Member States since 6NC include:

- Implementation of the IPCC 2006 guidelines (moving from the 1996 GLs, the 2000 Good Practice Guidelines and the 2003 LULUCF Good Practice Guidance);
- Changes to the Global Warming Potentials that are used;
- The KP scope of the EU GHG inventory is now the EU-28 and ISL.

Because of these cross cutting changes, direct comparisons of the changes in the magnitude of emissions between the 6NC and 7NC are not valid.

3.3. **National system**

In accordance with the MMR Article 6(1), the EU has established a Union Inventory System to ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of Member State national inventories. Commission delegated regulation (EU) 666/2014 establishes the substantive requirements for the EU national system[24]. This in turn ensures the integrity and coherence of the Union greenhouse gas inventory.

The Commission's Staff Working Document, SWD (2013) 308 final[25] outlines the main elements of the Union inventory system. This Communication presents a summary of the EU's system. Complete details of the system can be found in the EU NIR 2017 in Section 1.2 "*A description of the institutional arrangements"*.

24 Commission Delegated Regulation (EU) No 666/2014 of 12 March 2014 establishing substantive requirements for a Union inventory system and taking into account changes in the global warming potentials and internationally agreed inventory guidelines pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council; http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2014.179.01.0026.01.ENG

25 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 http://ec.europa.eu/clima/policies/strategies/progress/monitoring/docs/swd_2013_308_en.pdf

3.3.1. *Institutional, legal and procedural arrangements*

This section summarises the legal, institutional, and procedural arrangements of the EU for preparing, reporting and checking its GHG inventory.

Legal 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 GHG emissions and for reporting other information at national and EU level relevant to climate change and repealing Decision No 280/2004/EC (MMR). Commission delegated regulation (EU) 666/2014 establishes the substantive requirements for the EU national system. The EU national inventory system as well as the QA/QC programme is described in more detail in Commission Staff Working Document SWD (2013) 308 final [26].

Institutional and procedural arrangements

The European Commission's DG Climate Action in consultation with the Member States has the overall responsibility for the EU inventory. Member States are required to submit their national inventories and inventory reports under the Monitoring Mechanism Regulation to the European Commission, DG Climate Action; and the European Commission. DG Climate Action itself submits the inventory and inventory report of the EU to the UNFCCC Secretariat, on behalf of the European Union. In the actual compilation of the EU inventory and inventory report, the European Commission, DG Climate Action, is assisted by the European Environment Agency (EEA) including the EEA's ETC/ACM and by Eurostat and the Joint Research Centre (JRC)[27].

The Directorate General for Climate Action of the European Commission is the overall body responsible for preparing the inventory of the EU. Each Member State (MS) is responsible for the preparation of its own inventory and these inventories provide the necessary data for the inventory of the EU, which is the sum of MS inventories. 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,
- JRC (also a Directorate General of the European Commission).

26 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. http://ec.europa.eu/clima/policies/strategies/progress/monitoring/docs/swd_2013_308_en.pdf

27 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

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 3-2 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 EU. 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 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[28].

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. 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.

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. Member States are also responsible for establishing QA/QC programmes for their inventories. The QA/QC activities of each MS 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 3.3.3, below.

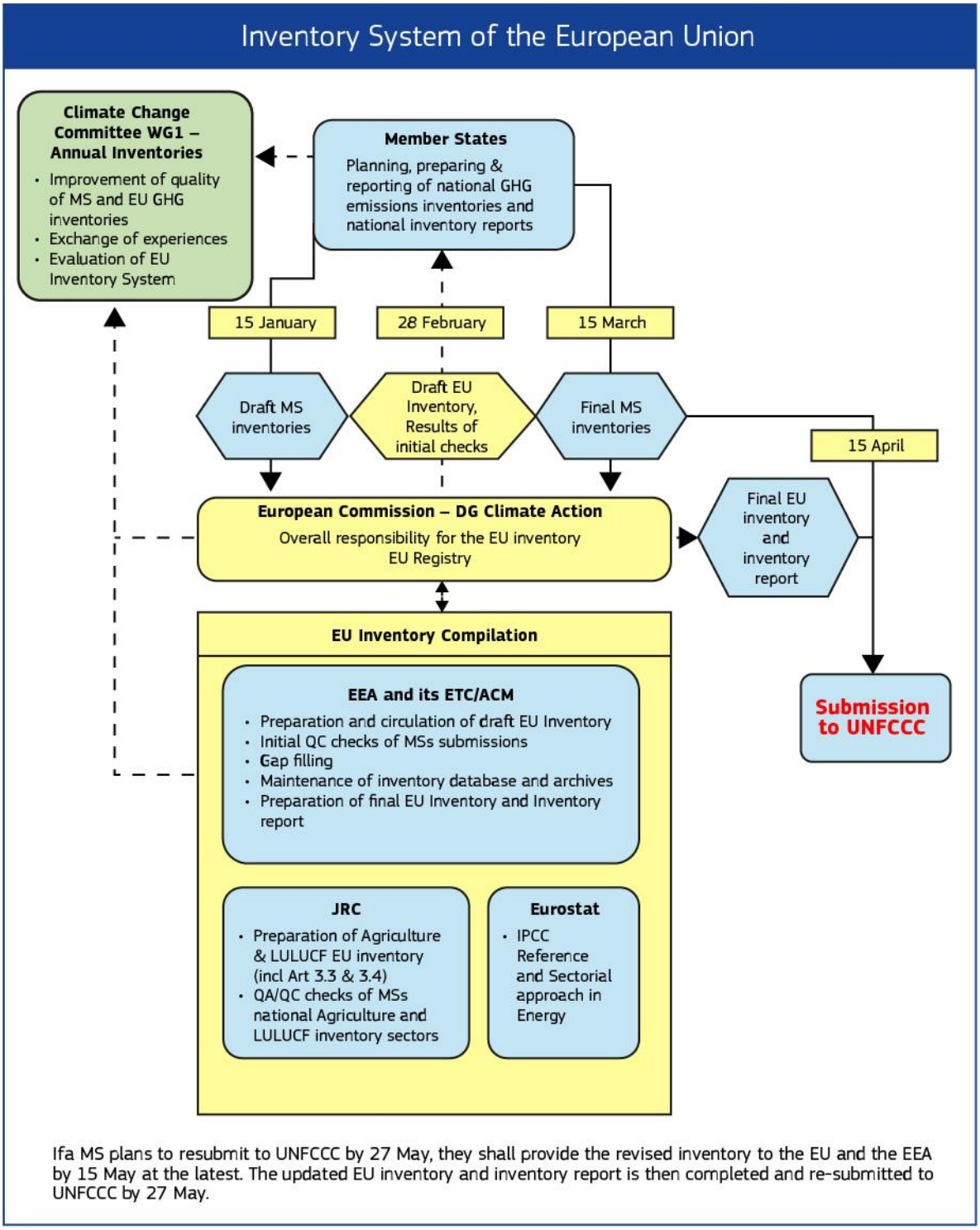
The consultation between the DG Climate Action and the Member States takes place in the Climate Change Committee established under Article 26 of the MMR. The Committee is composed of the representatives of the Member States and chaired by the representative of the DG Climate Action. Procedures within the Committee for decision-making, adoption of measures and voting are outlined in the rules of procedure, adopted in November 2003. In

28 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

order to facilitate decision-making in the Committee, working groups have been established, one of which is Working Group 1 on ‘Annual inventories’.

The MMR sets out the annual cycle of preparation of the EU inventory, as shown schematically by Figure 3-2 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.

Figure 3-2. Inventory system of the EU



3.3.2. *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[29], on the basis of the inventories of the 28 Member States and Iceland. The estimates of emissions in the Union inventory are, where appropriate and feasible, consistent with the IPCC 2006 Guidelines for National Greenhouse Gas Inventories[30]. In addition to the Monitoring Mechanism Regulation, Commission Delegated Regulation (EU) No 666/2014 and Commission Implementing Regulation (EU) No 749/2014[31] provide the legal framework for the compilation of the Union GHG inventory.

The emissions of each source and sink category are the sum of the emissions of the respective source and sink categories of the 28 Member States and Iceland. This also applies for the base year estimate of the EU-28 GHG inventory.

Table 3-1 Base year emissions for EU-28+ISL Member States under KP CP2

Source: EEA[32]

[Considering that the numbers are not final as the numbers reflect MS data before their individual reviews and that the review of the EU's initial report is not completed at the time the report was written, detailed numbers would only be presented after calculations are completed.]

The EU, its Member States and Iceland have agreed to fulfil their quantified emission limitation and reduction commitments under Article 3 of the Kyoto Protocol for the second commitment period to the Kyoto Protocol jointly, in accordance with the provisions of Article 4 thereof. The Union, its Member States and Iceland agreed to a quantified emission reduction commitment that limits their average annual emissions of greenhouse gases during the second commitment period to 80 % of the sum of their base year emissions, which is reflected in the Doha Amendment.

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 EU greenhouse gas inventory 1990 to 2015 and Inventory Report 2017 submission to the UNFCCC Secretariat[33]. For some sectors quality improvement projects, including expert workshops, have been started with the aim of further improving estimates at MS level. These sectors

29 UNFCCC, 2013 http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf#page=2: The Kyoto Protocol's monitoring procedures are based on existing reporting and review procedures under the Convention (decisions 24/CP.19 and 13/CP.20), building on experience gained in the climate change process over the past decades. They also involve additional accounting procedures that are needed to track and record Parties' holdings and transactions of Kyoto Protocol units: assigned amount units (AAUs), certified emission reductions (CERs), emission reduction units (ERUs) and removal units (RMUs).

30 http://www.ipcc-nggip.iges.or.jp/public/2006gl/

31 Commission Implementing Regulation (EU) No 749/2014 of 30 June 2014 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council

32 Report from the Commission. Report to facilitate the calculation of the assigned amount of the European Union, and the report to facilitate the calculation of the joint assigned amount of the Union, its Member States and Iceland pursuant to Article 3(7bis), (8) and (8bis) of the Kyoto Protocol for the second commitment period, as required under Article 3(2) of Council Decision (EU) 2015/1339 {SWD(2016) 316 final} http://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-618-F1-EN-MAIN.PDF

33 http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php

include energy background data, emissions from international bunkers, emissions and removals from LULUCF, emissions from agriculture, and waste.

Table 3-2 shows the geographical coverage of the EU-28+ISL Member States' national inventories. The EU-28+ISL 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 3-2 Geographical coverage of the EU-28+ISL inventory[34]

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second commitment period)	EU-territory coverage (UNFCCC)	Party Coverage (UNFCCC)	Country code
Austria	Austria	√	√	√	AUT
Belgium	Belgium consisting of Flemish Region, Walloon Region and Brussels Region	√	√	√	BEL
Bulgaria	Bulgaria	√	√	√	BGR
Croatia	Croatia	√	√	√	HVR
Cyprus	Area under the effective control of the Republic of Cyprus	√	√	√	CYP
Czech Republic	Czech Republic	√	√	√	CZE
Denmark	Denmark (excluding Greenland and the Faeroe Islands)	√	√		DNM
Estonia	Estonia	√	√	√	EST
Finland	Finland including Åland Islands	√	√	√	FIN
France	Metropolitan France, the overseas departments (Guadeloupe, Martinique, Guyana and Reunion) and the overseas communities (Saint-Barthelemy, Saint-Martin and Mayotte), excluding the French overseas communities (French Polynesia, Wallis and Futuna, Saint-Pierre and Miquelon) and overseas territories (the French Southern	√	√		FRK

34 Commission Staff Working Document. Report to facilitate the calculation of the assigned amount of the European Union, and the report to facilitate the calculation of the joint assigned amount of the Union, its Member States and Iceland pursuant to Article 3(7bis), (8) and (8bis) of the Kyoto Protocol for the second commitment period, as required under Article 3(2) of Council Decision (EU) 2015/1339. {SWD(2016) 316 final}. Brussels, 23.9.2016. COM(2016) 618 final. http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52016DC0618

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second commitment period)	EU-territory coverage (UNFCCC)	Party Coverage (UNFCCC)	Country code
	and Antarctic Lands)and New Caledonia.				
France	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.			√	FRA
Germany	Germany	√	√	√	DEU
Greece	Greece	√	√	√	GRC
Hungary	Hungary	√	√	√	HUN
Ireland	Ireland	√	√	√	IRE
Italy	Italy	√	√	√	ITA
Latvia	Latvia	√	√	√	LVA
Lithuania	Lithuania	√	√	√	LTU
Luxembourg	Luxembourg	√	√	√	LUX
Malta	Malta	√	√	√	MLT
Netherlands	The reported emissions 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 and The Netherlands Antilles, which are self-governing dependencies of the Royal Kingdom of The Netherlands. Emissions from offshore oil and gas production on the Dutch part of the continental shelf are included.	√	√	√	NLD
Poland	Poland	√	√	√	POL

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second commitment period)	EU-territory coverage (UNFCCC)	Party Coverage (UNFCCC)	Country code
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.	√	√	√	PRT
Romania	Romania	√	√	√	ROU
Slovakia	Slovakia	√	√	√	SVK
Slovenia	Slovenia	√	√	√	SVN
Spain	Spanish part of Iberian mainland, Canary Islands, Balearic Islands, Ceuta and Melilla.	√	√	√	ESP
Sweden	Sweden	√	√	√	SWE
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).		√		GBE
United Kingdom	England, Scotland, Wales and Northern Ireland and the UK Overseas Territories and UK Crown Dependencies to whom the UK's ratification of the Kyoto Protocol has been extended and whose emissions are included for the second commitment period (the Cayman Islands, the Falkland Islands, Gibraltar, Jersey, Guernsey and the Isle of Man).	√			GBK
United Kingdom	England, Scotland, Wales and Northern Ireland and the UK Overseas Territories and UK Crown Dependencies for whom the UK's ratification of the UN Framework Convention on Climate Change is			√	GBR

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second commitment period)	EU-territory coverage (UNFCCC)	Party Coverage (UNFCCC)	Country code
	extended (the Cayman Islands, the Falkland Islands, Gibraltar, Bermuda, Jersey, Guernsey and the Isle of Man).				
European Union	EU-28		√	√	EUA
Iceland	Iceland	√		√	ISL
European Union and Iceland	EU-28, Iceland and the UK's Overseas Territories and Crown Dependencies that have ratified the Kyoto Protocol	√			EUC

3.3.3. *Quality Assurance/Quality Control (QA/QC) procedures*

Section 2.5 of the EU Third Biennial Report provides a summary of the QA/QC procedures that are applied to the EU GHG inventory. Section 3.4 of the EU NIR 2017 "*Sector-specific quality assurance and quality control*" provides further details.

3.3.4. *Accuracy/Uncertainty of the data*

This section of the Communication provides a summary of the uncertainty associated with the EU-28+ISL inventory. Full details of the uncertainty analysis are provided in the EU NIR; see Section 1.6 "*General uncertainty evaluation*".

The EU uncertainty analysis was made on basis of the Tier 1 uncertainty estimates, which were submitted from the Member States, using a more sophisticated approach than required under the IPCC guidelines. Uncertainties were estimated at detailed level and aggregated to six main sectors 'Energy', 'Fugitive emissions', Industrial processes and product use', 'Agriculture', 'LULUCF' and 'Waste'.

For the total GHG net emissions (including LULUCF), the uncertainty estimate in the level was 6.1 %, and the estimate uncertainty in the trend was 1.1 %.

3.4. **National registry**

This section of the National Communication summarises the national registry of the EU. Further details can be found in Chapter 14 of the EU NIR, and in the NIRs of the Member States.

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.

The consolidated platform which implements the national registries in a consolidated manner (including the registry of the EU) is called the Union registry 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 is fulfilled by each Party through a publicly available web page hosted by the Union registry;
- 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 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 Union registry, 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 Union registry platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry have occurred since the last NC report.

Table 3-3 Changes to the EU national registry in 2015

Reporting item	Description
15/CMP.1 Annex II.E paragraph 32.(a) Change of name or contact	None
15/CMP.1 Annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	In 2016 new tables were added to the database for the implementation of the CP2 functionality. Versions of the Union registry released after 6.1.6 (the production version at the time of the last NC submission) introduced other minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to each release of a new version in Production. Annex H testing is carried out every year. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 Annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(f) Change regarding security	The mandatory use of hardware tokens for authentication and signature was introduced for registry administrators.
15/CMP.1 Annex II.E paragraph 32.(g) Change to list of publicly available information	Publicly available information is provided via the Union registry homepage for each registry e.g. https://ets-registry.webgate.ec.europa.eu/euregistry/XX/public/reports/publicReports.xhtml
15/CMP.1 Annex II.E paragraph 32.(h)	No change of the registry internet address occurred during the

Reporting item	Description
Change of Internet address	reporting period.
15/CMP.1 Annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 Annex II.E paragraph 32.(j) Change regarding test results	Both regression testing and tests on the new functionality are carried out prior to release of the new versions in Production. The site acceptance tests are carried out by quality assurance consultants on behalf of and assisted by the European Commission. Annex H testing is carried out on an annual basis.

4. POLICIES AND MEASURES

Key developments

Cross-cutting policies and measures

The EU Emission Trading System (EU ETS) is based on the 'cap and trade' principle, and has been operational since 2005. The EU ETS has undergone several revisions to strengthen its implementation in the course of its three trading periods, or phases, (2005-2007, 2008-2012, and the current one 2013-2020).

In July 2015, the Commission presented a legislative proposal to reform the EU ETS for Phase 4 which aims at achieving a 43 % reduction of emissions of installations in energy production and industry by 2030 compared to 2005 levels. In November 2017, the European Parliament and the Council agreed on a common position, and the legislation would be adopted before end 2017.

The **Effort Sharing Decision** has been effective in helping stimulate new national policies and measures, it has resulted in Member States becoming more active in considering new measures, as well as improved coordination between national, regional and local governments. This positive progress informed a new legislative proposal "Effort Sharing Regulation", which was presented by the Commission in July 2016. The regulation sets out binding annual greenhouse gas emission targets for Member States for the period 2021–2030, maintaining binding annual greenhouse gas emission limits for each Member State after 2020. Emissions limit will be set for each year in the 10 year period up to 2030 according to a decreasing linear trajectory. The main changes proposed from the current Decision are as follows:

- Existing flexibilities under the Effort Sharing Decision are retained, and two new flexibilities are added. These are:
    - A one-off flexibility to transfer a limited amount of allowances from the EU ETS: covering some emissions in the non-ETS sectors with EU ETS allowances which would normally have been auctioned.
    - A new flexibility to transfer a limited amount of credits from the land use (LULUCF) sector: to stimulate additional action in the land use sector.

The European Parliament adopted its position with respect to the proposed regulation on 14 June 2017, and the European Council had adopted its position later in 2017, enabling the start of trilogue negotiations.

The EU has agreed that at least 20 % of its **budget** for 2014-2020 – as much as € 180 billion − should be spent on climate change-related action. To achieve this increase, mitigation and adaptation actions are integrated into all major EU spending programmes. By current estimates, this target has been exceeded in 2016 and spending will remain close to it over 2017-2020. Key areas of climate related expenditure include:

- Climate change mitigation and adaptation support from European Structural and Investment Funds (ESIF) totals more than EUR 114 billion, of which almost half – about EUR 56 billion – comes from the European Agricultural Fund for Rural

Development (EAFRD). The European Regional Development Fund (ERDF) and the Cohesion Fund contribute EUR 55 billion collectively.

- Horizon 2020, the EU research and innovation (R&I) framework programme, provides nearly € 80 billion of funding over 7 years (2014 to 2020), in addition to private and national domestic investment. The EU aims to spend 35 % of the overall Horizon 2020 budget on climate relevant R&I, including physical and socio-economic sciences, Earth observations, technology research and innovation and climate policy analysis.

Energy

The Commission adopted the Clean Energy for All Europeans Package[35] on 30 November 2016 to keep the European Union competitive as the clean energy transition is changing global energy markets. The Package comprised eight legislative proposals, including proposals to amend three directives, respectively, the directives on energy efficiency, the Directive on the energy performance of buildings and the Directive on renewable energy. On the same day, the Commission adopted measures in relation to eco-design and energy labelling.

The EU has renewable energy targets for 2020 (20 % share of energy) and 2030 (at least a 27 % share of energy). Progress has been made towards achieving the 2020 target with a 16 % share of renewable energy in 2014 and an estimated 16.4 % share in 2015. Moreover, the vast majority of EU countries are well on track to reach their 2020 binding targets for renewable energy, but efforts should be continued to meet the 2020 target and to lay the foundations for achieving the 2030 target.

The Commission has made progress towards ensuring that the 2030 target is met, through the proposition of an amended Renewable Energy Directive. The proposal includes reforms across the three renewable energy sectors of electricity, heating and cooling and transport, including: the introduction of coordinated regional approaches, targeted financial instruments, administrative simplification, renewable heat and cooling obligations for fuel suppliers, facilitation of uptake of district heating and cooling system, finally the promotion of low carbon and energy diverse transport fuels whilst addressing land use change challenges of these fuels. These reforms have been supported through the introduction of an EU heating and cooling strategy.

The EU is on track to meet its 20 % 2020 energy efficiency target, provided that Member States continue to successfully implement their energy efficiency policies. In 2014, primary energy consumption was already only 1.6 % above its 2020 primary energy consumption target and 2.2 % below the 2020 final energy consumption target.

As regards 2030, the Commission proposed a 30 % energy efficiency target for 2030 in the Clean Energy for All Europeans Package. In order to ensure the 2030 target is met, the legislative framework needs to be adapted. Therefore the European Commission put forward proposals for amending the Energy Efficiency Directive and the Energy Performance of Buildings Directive.

35 https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition; http://eur-lex.europa.eu/resource.html?uri=cellar:fa6ea15b-b7b0-11e6-9e3c-01aa75ed71a1.0001.02/DOC_1&format=PDF

The proposal for an amended Energy Efficiency Directive include provisions to align energy efficiency targets with the EU 2030 climate and energy framework, to extend beyond 2020 the energy saving obligation requiring energy suppliers and distributors to save 1.5 % of energy each year from 2021 to 2030 with a view to attracting private investment and supporting the emergence of new market actors and to improve metering and billing of energy consumption for heating and cooling consumers.

The proposal for an amended Energy Performance of Buildings Directive includes provisions to help achieve a decarbonised building stock by 2050, clarify feasibility study and inspection requirements and promote electric vehicle uptake through infrastructure provision. It includes the provision of a smartness indicator for buildings, it enhances flexibility of funding mechanisms and it increases building data availability and quality.

Progress is being made with the energy efficiency of products through a new Ecodesign Working Plan for 2016-2019, setting out existing and new product measures that have the potential to deliver more than 600 TWh of annual primary energy savings in 2030.

Transport

EU-level transport policies that can support climate action are a key element of the 2020, 2030 and 2050 GHG targets set out in Section 4.3. The 2011 White Paper on Transport put forward a goal of reducing EU transport GHG emissions by at least 60 % by 2050 relative to 1990. This target was reiterated by the EU low-emission mobility strategy, adopted in 2016, which additionally set the ambition of drastically reducing without delay the emissions of air pollutants from transport. The analytical work underpinning the strategy showed that cost-effective CO_2 emissions reductions of 18-19 % are needed by 2030 for transport, relative to 2005.

To optimise the transport system and improving its efficiency, the Commission has adopted a European Strategy for Low-emission mobility and an agenda for a socially fair transition towards clean, competitive and connected mobility for all. The Commission also adopted a European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility.

The proposed revision of the regulatory framework for road charging includes adjustments that will broaden the scope to include coaches and light vehicles including cars, support the shift to applying the "user and polluter pays" principles for all vehicles, and modernise road charging methods. The proposed revision for EU rules on buses and coaches targets a level playing field for all operators and better travel options for consumers. The proposed revision on combined transport will promote cleaner freight transport.

The proposed revision to the Renewable Energy Directive will support the development of advanced alternative fuels for transport. The Commission’s favoured approach to achieve this is the incorporation of an obligation for advanced renewable transport fuels (including advanced biofuels), alongside a reduction of food-based biofuels. The Commission has adopted an Alternative Fuels Infrastructure Action Plan to support the deployment of an EU backbone charging infrastructure,

In order to further curb emissions from road transport, the Commission has proposed new CO_2 emissions standards for cars and vans for the period post 2020. Provisional data published by the European Environment Agency showed that good progress continues to be made on fuel efficiency of new cars, with the average emissions level of a new car sold in 2016 at 118.1 grams of CO_2 per kilometre, significantly below the 2015 target of 130 g (the 2020 target is 95 g CO_2/km). The Commission has made proposals for certifying, monitoring and reporting data on fuel consumption from heavy duty vehicles.

The proposed revision of the Clean Vehicle Directive will better promote the use of public procurement to incentivise the creation of markets for innovative and low-emitting vehicles.

Industry

Regulation of fluorinated greenhouse gases (F-gases), including hydrofluorocarbons (HFCs), at an EU level is through the adoption of two legislative acts: the 'MAC Directive', and the 'F-gas Regulation'. For the first time in 13 years of growing emissions of F-gases, the latter have declined in 2015 compared to the previous year, a clear signal that the policy measures are being effective. The quota system for companies trading in HFCs, put in place by the 2014 update of the F-gas Regulation, is producing scarcity of HFCs on the EU market and strongly incentivising end-users to move to more climate-friendly alternatives. These pieces of legislation have enabled the EU to show leadership in this area and have facilitated the negotiations towards agreeing on the Kigali amendment of the Montreal Protocol in 2016. The policy measures are projected to lead to cumulative emission savings of 1.5 Gt CO_2eq by 2030 and 5 Gt CO_2eq by 2050.

Agriculture

Implementation of the new Common Agricultural Policy (CAP) regulations started only in 2015 (with 2014 being a transitional year). For direct payments, implementation choices by Member States were finalised and notified to the European Commission during 2014, with the rules coming into force on 1 January 2015. An initial analysis of implementation choices taken by Member States suggests that in most cases the choices made are relevant to the GHG emission reduction/ climate needs and priorities identified. Contribution to climate action will be achieved through the combined effects of a number of different CAP measures, encompassing cross-compliance Good Agriculture and Environmental Condition (GAEC) standards, direct payments under the EAGF and rural development policy under the European Agricultural Fund for Rural Development (EAFRD) and accompanied by support from the Farm Advisory Service, and the activities of the European Innovation Partnership for Agriculture and the national Operational Groups.

In relation to direct payments, the 'greening' rules within CAP mean that 30 % of the payments going directly to farmers are linked to improving the environmental performance, for example to adopt practices beneficial for the climate. Some 30 % of rural development funds are also aimed at specific regional environmental priorities. In 2015, € 13.6bn of the

committed allocations under the CAP budget were climate relevant; this value rose to € 18.7bn[36] in 2016.

Forestry

The European Commission presented in July 2016 a legislative proposal to integrate greenhouse gas emissions and removals from land use, land use-change and forestry (LULUCF) into the 2030 climate and energy framework. This marked significant progress towards the goal agreed by EU leaders that all sectors, including the land use sector, should contribute to the EU's 2030 emission reduction target as well as to the Paris Agreement objectives.

The proposal contains several provisions laying down the rules to account emissions and removals in the LULUCF sector. The proposal maintains the "no debit rule" from the Kyoto Protocol, ensures that emissions from the use of biomass for energy are accounted towards Member States' 2030 climate commitments, streamlines accounting methodologies, and introduces flexibilities to support Member States in adhering to the "no debit" commitment.

Waste

Implementation of the EU's Circular Economy Action Package has been key in progressing efforts to reduce emissions from waste. It provides a clear, systematic and holistic approach that focusses on a number of priority issues, including plastics, food waste, critical raw materials and construction and demolition and clearly delineates actions, commitments and timetables.

A collection of legislative proposals published by the Commission under various directives, (Waste, Packaging Waste, Landfill, End of Life vehicles, Batteries and Accumulators and Waste Batteries and Accumulators, and Waste Electrical and Electronic Equipment) offer targets (recycling 65 % municipal waste and 75 % packaging waste by 2030, reduce landfill to 10 % of municipal waste by 2030), commitments (ban on landfilling separately collected waste), and clarification of methods as well as introducing incentives for producers to produce greener products and offering measures to facilitate industrial material reuse.

Key developments in the implementation of the Circular Economy Action Package include the development of legislative proposals on the online sale of goods, and fertilisers, the launch of the Innovation Deals for a circular economy, the development of an Ecodesign working plan as part of the Clean Energy for All Europeans package (as described in the Energy key developments section, previous), the establishment of the EU Platform on Food Losses and Food Waste, the publication of a Communication on waste-to-energy processes and their role in the circular economy, the development of a proposal to amend the Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment and the launch of a platform to support the financing of circular economy.

Furthermore, several policies have been developed across various waste streams. Policies to reduce consumption of plastic bags and to raise the recycling target for plastic packaging and

36 SWD(2016) 299 final. Commission Working Document Accompanying the document Communication from the Commission to the European Parliament and the Council. Mid-term review/revision of the multiannual financial framework 2014-2020: An EU budget focused on results.

reduce landfilling. A new dedicated plastics strategy is being developed that covers recycling, marine litter and dangerous chemicals.

Regarding the implementation of the Urban Waste Water Directive, a report published in 2016 found high compliance rates in the EU-15 and that implementation of the Directive had significantly reduced organic and nutrient pollution load discharges in the EU. However, full compliance was not achieved as gaps were found particularly on treatment.

Other local action

In 2015, Commissioner Miguel Arias Cañete launched the integrated Covenant of Mayors for Climate and Energy, extending the initiative to 2030 and incorporating adaptation into existing climate change and energy requirements. Since 2015, Covenant signatories have voluntarily pledged action to support the implementation of the EU's 40 % greenhouse gas reduction target by 2030 and have adopted a joint approach to tackling climate change mitigation and adaptation. More than 800 cities have committed to the new targets.

4.1. **Introduction**

This chapter of the European Union's 7NC should be read in conjunction with Chapter 4 of the accompanying EU 3BR. Together, these chapters provide an overview of the EU policy response designed to contribute to meeting the EU emission reduction targets as outlined in Section 3.

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 EU policies and measures are applicable to all Member States, though Member States may implement Directives at different points in time;
- National policies and measures developed and implemented by Member States themselves.

The reporting in the EU NC and BR concentrates on the EU policies and measures; national policies and measures are outside the scope of the reports.

In the following sections of the NC information is provided on the:

- Policy-making process in the EU (4.2);
- Key strategies and programmes with respect to climate change (4.3);
- An overview of EU-level policies and measures, including a reference list (with more detail in the 3BR), and information on PaMs no longer in place, on interactions between PaMs and on the effect of PaMs on long-term emissions trends;
- Other relevant information on EU-level climate change policies and measures, including:

- Monitoring and evaluation of EU-level policies and measures (4.5.1);
- Assessments of their economic and social consequences (4.5.2);
- Compliance mechanisms (4.5.3);
- Information on the use of Kyoto Mechanisms (4.5.3).

The BR provides a more detailed breakdown of EU-level policies and measures, including those which are cross-cutting across more than one sector, and those that are specific to an individual sector. The BR focuses in particular on changes and updates to these policies and measures since the submission of the EU's 2BR in December 2015.

As outlined above, 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 the 3BR is given.

Complementing the qualitative descriptions of policies and measures in the respective sectoral chapters, quantitative information on GHG emission reductions associated with the PaMs are summarised in CTF Table 3 in the Appendix: CTF for EU third Biennial Report. These (mostly) ex-ante estimates have been produced by the European Commission as part of the impact assessments of the individual policies. The estimates are for the EU as a whole, and assume full implementation of the PaMs. However, quantitative estimates are not available for all PaMs 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 to the estimates presented in CTF Table 3, the estimates of expected GHG emission savings presented in Section 5 (projections) are derived from the aggregation of Member States' estimates at an EU level.

4.2. **The EU policy-making process**

The EU policy-making process is outlined in Section 4.2.1 of the EU's 6NC, which explains the four key stages of the policy-making process under the co-decision procedure[37];

1. Initiation by the European Commission and articulation of policy demands;
2. Possible amendment by the Council and European Parliament;
3. Formal agreement by the Council and the European Parliament; and,
4. Implementation of the policy.

A key element of this process is better regulation and the use of Impact Assessments of the proposed policies or change to the policies. Since the 6NC and under its new President, the European Commission has redoubled its efforts to improve the quality of EU policy-making, with the launch of a communication on better regulation[38]. This includes the appointment of a First Vice-President, to coordinate better regulation in the European Commission, to ensure that no EU intervention is proposed where the outcome could be more effectively dealt with

37 See pages 79 and 80 of the Sixth NC - http://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/eu_6NC.pdf

38 https://ec.europa.eu/info/law/law-making-process/better-regulation-why-and-how_en#documents

by EU countries (subsidiarity) and that EU action must not exceed what is necessary to achieve the objectives (proportionality)[39].

The aim of the better regulation agenda is to ensure that:

- Decision-making is open and transparent;
- Citizens and stakeholders can contribute throughout the policy and law−making process;
- EU actions are based on evidence and understanding of the impacts;
- Regulatory burdens on businesses, citizens or public administrations are kept to a minimum.

There a number of key stages of the policy-making process and these include extensive planning and analysis at the policy preparation stage, improving consultation with stakeholders on proposed policies or changes to policies, making sure policies are 'fit for purpose', ensuring quality of impact assessments, increasing cooperation between EU institutions and improving regulatory cooperation with international partners. Some examples of activities relating to the above stages of the policy-making process are outlined below.

- Improving consultation with stakeholders – in July 2016, the Commission launched a new online feedback tool for stakeholders to provide input to the policy-making process;
- Making sure EU laws are fit for purpose – as part of the Regulatory Fitness and Performance (REFIT) programme established in 2012, the REFIT Platform was set up by the May 2015 Better Regulation Communication, and launched in January 2016, to advise the Commission on how to make EU regulation more efficient and effective while reducing burden and without undermining policy objectives[40];
- Ensuring quality – the Regulatory Scrutiny Board was set up in 2015 to review draft impact assessments and PaM evaluation reports (and fitness checks of multiple policies and laws). It replaces the Impact Assessment Board but has wider responsibilities than its predecessor. It is chaired by a Commission director-general and consists of three high-level Commission officials and three experts from outside the Commission. More information can be found on the Commission's better regulation website[41];
- Increasing cooperation between EU institutions – in April 2016, an agreement on better law-making between the Commission, Parliament and the Council entered into force[42];
- International regulatory cooperation – this is key element of bilateral free trade agreements, such as the EU-Canada Comprehensive Economic and Trade Agreement

39 https://ec.europa.eu/commission/priorities/democratic-change/better-regulation_en

40 https://ec.europa.eu/info/law/law-making-process/overview-law-making-process/evaluating-and-improving-existing-laws/reducing-burdens-and-simplifying-law/refit-platform_en

41 https://ec.europa.eu/info/law/law-making-process/regulatory-scrutiny-board_en

42 The text of the agreement can be found here - http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.123.01.0001.01.ENG&toc=OJ:L:2016:123:TOC

(CETA)[43] which the European Parliament voted in favour on 15 February 2017 (EU Member State parliaments must now approve CETA before it can come into effect).

4.3. The overall climate change policy context in the EU

This section describes some of the key over-arching strategies and programmes that guide the EU policy-making process on climate change.

4.3.1. *European Climate Change Programme*

The Second European Climate Change Programme (ECCP II) was launched in October 2005 to provide the framework for EU implementation of the Kyoto Protocol. Further information was included in the EU 4th National Communication.

4.3.2. *2020 Climate and Energy Package*

The 2020 Climate and Energy Package was formally adopted in 2009 and for the first time provided an integrated and ambitious package of policies and measures to tackle climate change. 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;
- To save 20 % of total primary energy consumption by 2020 compared to a business as usual baseline.

These are also headline targets of the Europe 2020 strategy for smart, sustainable and inclusive growth[44]. In order to meet these key objectives, the Climate and Energy Package comprises four pieces of complementary legislation:

- A Directive revising the EU Emissions Trading System (see Section 4.2.2 of the 1BR);
- An Effort-Sharing Decision setting binding national targets for emissions from sectors not covered by the EU ETS (see Section 4.2.3 of the 1BR);
- A Directive setting binding national targets for increasing the share of renewable energy sources in the energy mix (see Section 4.3.2 of the 1BR);
- A Directive creating a legal framework for the safe and environmentally sound use of carbon capture and storage technologies (see Section 4.2.4 of the 1BR).

The package was 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 (see Section 4.4.3 of the 1BR for more details) and a revision of the Fuel Quality Directive (see Section 4.4.6 of

43 More information on CETA can be found here - http://ec.europa.eu/trade/policy/in-focus/ceta/

44 http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A52010DC2020

the 1BR for more details). The Energy Efficiency Directive was adopted in 2012 to help achieve the energy efficiency target.

For information on progress towards the 20-20-20 targets, see [BR] Section 5.4.

4.3.3. *2030 Climate and Energy Framework*[45]

This framework[46] was agreed by EU leaders in October 2014 and builds on the 2020 climate and energy package mentioned above. It sets three key targets for the year 2030:

- At least 40 % reduction in greenhouse gas emissions (from 1990 levels). To achieve this, EU ETS sectors would have to cut emissions by 43 % (compared to 2005), and the ETS will be reformed and strengthened to achieve this. Non-ETS sectors would need to cut emissions by 30 % (compared to 2005), and this will need to be translated into individual binding targets for Member States;
- At least 27 % share of EU energy consumption for renewable energy;
- At least 27 % improvement in energy efficiency.

The European Council asked the Commission to review the energy efficiency target by 2020 having in mind an EU level of 30 %. With the Clean Energy for All Europeans package from November 2016, the Commission has already proposed to set a binding EU-wide target of 30 % for energy efficiency by 2030.

The framework is in line with the longer-term perspective set out in the Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050 and the Transport White Paper.

The framework will be underpinned by a new and transparent governance process that will the targets outlined above to be met in an effective and coherent manner. This governance process will be based on national plans for competitive, secure, and sustainable energy but will follow a common EU approach.

The European Commission has proposed a number of actions to help deliver the framework and the 2030 targets, including a reformed EU ETS (with a proposal for legislation being presented in parallel to the Communication on the 2030 framework – see 4.2.1 in the 3BR on the EU ETS for more details), a new Effort Sharing Regulation (see [3BR] 4.2.2), a proposal to integrate greenhouse gas emissions and removals from land use, land use-change and forestry (LULUCF) into the 2030 climate and energy framework (see [3BR] Section 4.3.5) a proposal for amending the Energy Efficiency Directive and the Energy Performance of Buildings Directive (see [3BR] Section 4.3.1) and a new set of indicators for the competitiveness and security of the energy system, such as price differences with major trading partners, diversification of supply, and interconnection capacity between EU countries.

An impact assessment for the framework was published in January 2014 and considers the costs and benefits of the proposed framework for 2030. It found that average annual

45 https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2030-energy-strategy

46 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0015&from=EN

additional investments are projected to be in the order of € 38 billion for the EU as a whole over the period 2011-2030, with more than half of the investments needed in the residential and tertiary sectors. However it should also be noted that fuel savings will to a large extent compensate for these investments. Crucially, costs do not differ substantially from the costs of renewing an ageing energy system, which would be necessary in any case.

The European Commission adopted "A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy" in February 2015. This strategy is made up of five closely related and mutually reinforcing dimensions – 'security, solidarity and trust', 'a fully-integrated internal energy market', 'energy efficiency', 'climate action – decarbonising the economy' and 'research, innovation and competitiveness'. Every year a State of the Energy Union review is conducted to assess progress and consider areas for further strengthening. The second State of the Energy Union report was published in February 2017, noting that 2016 had been a year of delivery, translating the overall vision into "concrete legislative and non-legislative initiatives". It also looked forward to the low emission mobility strategy due to be published in late 2017.

4.3.4. *The 2020 Energy Strategy*[47]

The communication 'Energy 2020 – A strategy for competitive, sustainable and secure energy' was published in November 2010. More information on the strategy can be found in Section 4.2.3.4 of the EU's 6NC. In March 2017, data was published which showed that the share of energy from renewable sources in gross final consumption of energy in the EU reached 16.7 %, nearly double the figure for 2004 (8.5 %), the first year for which the data are available[48]. Alongside this, information on the performance of each Member State was published, which showed that 11 Member States had already reached their individual renewable energy 2020 targets by 2015[49].

4.3.5. *European Bioeconomy Strategy*

The Bioeconomy Strategy (launched in February 2012) addresses the production of renewable biological resources and their conversion into vital products and bio-energy. It is structured around three pillars:

- Investments in research, innovation and skills;
- Reinforced policy interaction and stakeholder engagement;
- Enhancement of markets and competitiveness.

There is a currently planned review and update of the Strategy which will consider the need for new political impetus and orientation.

47 https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2020-energy-strategy

48 http://ec.europa.eu/eurostat/documents/2995521/7905983/8-14032017-BP-EN.pdf/af8b4671-fb2a-477b-b7cf-d9a28cb8beea

49 Bulgaria, the Czech Republic, Denmark, Estonia, Croatia, Italy, Lithuania, Hungary, Romania, Finland and Sweden.

4.3.6. *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" b) the "Roadmap to a Single European Transport Area - Towards a Competitive and Resource Efficient Transport System" and c) the "Energy Roadmap 2050". Further information was included in the EU's 6NC.

4.3.7. *7th Environmental Action Programme*

The 7th Environmental Action Programme (EAP) - proposed by the European Commission in 2012 - provides an overarching framework for environmental policy up to 2020. It does not include specific objectives for climate policy as this is now a separate policy area. More details can be found in Section 4.2.3.8 of the 6NC.

4.4. **Information on EU-level policies and measures**

4.4.1. *Reference list of cross-sectoral and sectoral policies and measures*

This section lists for ease of reference the various cross-sectoral and sectoral policies and measures at the EU-level. More information on the key updates to each of these can be found in the EU's 3BR.

4.4.1.1. Cross Cutting Polices and Measures

- The EU Emissions Trading System (2003/87/EC amended by 2009/29/EC);
- The Effort Sharing Decision (Decision No 406/2009/EC);
- Carbon Capture and Storage Directive (2009/31/EC);
- Monitoring Mechanism Regulation (Regulation No 525/2013);
- Energy Taxation Directive (2003/96/EC);
- Horizon 2020;
- European Structural and Investment Funds (ESIF)[50];
- National Emissions Ceilings Directive (2016/2284/EU) ;
- Covenant of Mayors for climate and energy;
- Proposal for a revision to Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments (COM (2015) 337 final);
- Proposed Regulation on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 for a resilient Energy Union (COM(2016) 482 final).

50 The five ESI Funds are the European Regional Development Fund, the Cohesion Fund, the European Social Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund.

4.4.1.2. Sectoral policies and measures: Energy

- Directive 2009/28/EC on the promotion of the use of energy from renewable sources;
- Directive 2010/31/EU on the Energy Performance of Buildings;
- Directive 2012/27/EU on Energy Efficiency;
- Directive 2009/125/EC establishing a framework for the setting of eco-design requirements for energy- related products;
- Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy- related products;
- Proposal for a Regulation setting a framework for energy efficiency labelling and repealing Directive 2010/30/EU;
- Green Public Procurement;
- Energy Star Programme;
- EU Project Development Assistance (PDA) Facilities;
- European Energy Efficiency Fund (EEEF);
- Motor Challenge Programme;
- Strategic Energy Technology Plan (COM(2007) 723);
- Energy Union Strategy (COM(2015) 80 final);
- Biomass Action Plan;
- Communication on Accelerating Clean Energy Innovation (COM(2016) 763 final);
- Communication on Ecodesign Working Plan (COM(2016) 773 final);
- Proposals for revised Energy Efficiency Directive (COM/2016/0761 final);
- Proposal for revised Energy Performance of Buildings Directive (COM/2016/0765 final);
- Proposal for revised Renewable Energy Directive (COM(2016) 767 final/2);
- Commission Implementing Decision on energy labelling, in support of and as regards: Commission Delegated Regulation (EU) 2015/1186, Commission Regulation (EU) 2015/1188, Commission Regulation (EU) 2015/1185;
- Commission Regulation (EU) 2016/2281 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air heating products, cooling products and high temperature process chillers
- Commission Regulation (EU) 2015/1189 of 28 April 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for solid fuel boilers
- Commission Regulation (EU) 2015/1188 of 28 April 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for local space heaters

- Commission Regulation (EU) 2015/1095 of 5 May 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for professional refrigerated storage cabinets, blast cabinets, condensing units and process chillers
- EU heating and cooling strategy (COM(2016) 51 final).
- Voluntary Industry Agreement to improve the energy consumption of games consoles within the EU (version 1.0)
- Proposal for a Directive of the European Parliament and of the Council on common rules for the internal market in electricity (recast)
- Proposal for a Regulation of the European Parliament and of the Council on the electricity market (recast)
- Proposal for a Regulation of the European Parliament and of the Council establishing a European Union Agency for the Cooperation of Energy Regulators (recast)
- Proposal for a Regulation of the European Parliament and of the Council on risk preparedness in the electricity sector

4.4.1.3. Sectoral policies and measures: Transport

- CO_2 and Cars Regulation (EC 443/2009)
- CO_2 and Vans Regulation (EC 510/2011)
- Strategy for reducing Heavy-Duty Vehicles' fuel consumption and CO_2 emissions
- Car and tyre labelling Directives (1999/94/EC and EC 1222/2009 respectively)
- Regulation of Safe motor vehicles and trailers (EC 661/2009)
- Renewable Energy Directive (2009/28/EC)
- Fuel Quality Directive (2009/30/EC)
- Infrastructure charging for heavy goods vehicles (1999/62//EC, amended by 2006/38/EC and 2011/76/EU)
- Directive 2014/94/EU on Deployment of Alternative Fuels Infrastructure
- Clean Vehicles Directive (2009/33/EC)
- Integrating maritime transport emissions in the EU's greenhouse gas reduction policies (COM(2013) 479 final and Regulation (EU) 2015/757)
- White Paper: Roadmap to a Single European Transport Area COM(2011) 144 final
- A European Strategy for Low-Emission Mobility (COM(2016) 501 final)
- European strategy on Cooperative Intelligent Transport Systems (COM(2016)766 final)
- Europe on the move: An agenda for a socially fair transition towards clean, competitive and connected mobility for all (COM(2017)283 final)
- Action Plan on Alternative Fuels Infrastructure

- Fuel Cells and Hydrogen Joint Undertaking (JU)
- Proposal for revised Eurovignette Directive (COM(2017)275 final)
- Proposal for revised European Electronic Tolling Services Directive (COM(2017)280 final)
- Proposal for monitoring and reporting systems for heavy duty vehicles (COM(2017)279 final)
- Proposal for revision of the Clean Vehicles Directive
- Proposal for revised Combined Transport Directive
- Proposal for revised market access rules for coach and bus services
- Proposal for revision of cars and vans CO_2 performance standards

4.4.1.4. Sectoral policies and measures: Industry / industrial processes

- Mobile Air Conditioning Systems (MAC) Directive (Directive 2006/40/EC);
- Fluorinated greenhouse gases regulation (Regulation (EU) No 517/2014);
- Industrial Emissions Directive 2010/75/EU (IED).

4.4.1.5. Sectoral policies and measures: Agriculture

- Agricultural Market and Income support (1st pillar of Common Agricultural Policy / CAP);
- Rural Development Policy (2nd pillar of CAP);
- Soil Thematic Strategy (COM(2006) 231);
- Nitrates Directive (91/676/EEC).

4.4.1.6. Sectoral policies and measures: Forestry / LULUCF

- LULUCF accounting (Decision 529/2013/EU);
- Proposal to integrated greenhouse gas emissions and removals from land use, land use-change and forestry (LULUCF) into the 2030 climate and energy framework (COM/2016/0479).

4.4.1.7. Sectoral policies and measures: Waste

- Directive on Waste (2008/98/EC);
- Landfill Directive (1999/31/EC);
- Management of biodegradable waste (COM/2008/0811 final);
- Urban Waste Water Directive (91/271/EEC);
- Directives on end-of-life vehicles (2000/53/EC);
- EU action plan for the Circular Economy (COM(2015) 614 final);

- Motor Vehicles Directive (2005/64/EC);
- Directive on batteries and accumulators and waste batteries and accumulators (2006/66/EC);
- Directive on waste electrical and electronic equipment (2012/19/EU);
- Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (Directive 2011/65/EU);
- Packaging and Packaging Waste Directive ((EU) 2015/720 regarding 94/62/EC);
- A legislative proposal on online sales of goods (December 2015);
- A legislative proposal on fertilisers (March 2016);
- Launch of the Innovation Deals for a circular economy (May 2016);
- Ecodesign Working Plan 2016-2019 (COM(2016) 773 final);
- Establishment of the EU Platform on Food Losses and Food Waste (August 2016);
- A Communication on waste-to-energy processes and their role in the circular economy (January 2017).

4.4.2. *Policies and measures no longer in place*

There are no policies and measures that are no longer in place, although various regulatory proposals have been made to amend Directives.

4.4.3. *Interaction of policies and measures*

Broadly speaking there are interactions between the three core elements of the 2020 and 2030 climate and energy frameworks – GHG emissions, renewable energy and energy efficiency[51]. One of the most noticeable interactions is between the EU Emissions Trading System (EU ETS) and other climate-related policies and measures. Energy efficiency measures which lead to reductions in electricity demand, will not result in GHG reductions in the power sector, as the capped nature of the EU ETS (which covers power generation), will mean that GHG emissions will rise by a similar amount elsewhere within the EU ETS. This is not to say that GHG reduction and energy efficiency measures in the 'traded sector' are not important – they can help meet the GHG reductions set by the cap in the EU ETS more efficiently.

Interactions are also important between policies and measures that target the same outcome, and in many cases it may be easier to group such PaMs together for the purpose of measuring GHG impacts, rather than trying to assign GHG reductions to the different measures by taking account of interactions. One clear example is with transport, where a number of measures, such as the new car CO_2 regulations, vehicle labelling and CO_2-based vehicle taxation, will all be seeking the same outcome (greater sales of fuel efficient vehicles) and the interactions between the different policies may make assessment of individual contributions to GHG reductions difficult to make.

51 http://climatepolicyinfohub.eu/interactions-between-climate-policies-examples-europe

It should be noted that there are different types of interaction between PaMs and it is important to understand the nature of any interaction that is being assessed. As described in the WRI Policy and Action Standard[52], interactions could be:

- Overlapping (where the combined effect of implementing the policies together is less than the sum of the individual effects of implementing them separately);
- Reinforcing (where the combined effect of implementing the policies together is greater than the sum of the individual effects of implementing them separately);
- Overlapping and reinforcing (where multiple policies interact, with some overlapping and some reinforcing, with the net effect being with an overlapping or reinforcing effect).

A hierarchical approach to PaMs interactions can be taken to minimise risk of double-counting. For example, savings might only be counted if they are additional to the policies placed higher in the policy hierarchy.

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

Information on the effects of policies and measures on long-term GHG emissions trends can be found in Section 4.13 of the EU's 6NC.

4.5. **Other information**

This section contains other information relevant to the implementation of climate change policies and measures at the EU level.

4.5.1. *Monitoring and evaluation*

The monitoring and evaluation of progress towards the GHG targets outlined in [3BR] Section 3 is driven by the Monitoring Mechanism Regulation (MMR)[53], adopted in 2013. More information on the (MMR) can be found in Section 4.9.1 of the EU's First BR. Under the MMR, Member States are required to report on, inter alia:

- A greenhouse gas inventory from all sectors: energy, industrial processes, agriculture, land use, land use change & forestry (LULUCF) and waste
- GHG projections, and information on policies & measures to reduce greenhouse emissions;
- Information on national adaptation actions
- Information on low-carbon development strategies
- Information on financial & technology support to developing countries
- Information on national governments' use of revenues from the auctioning of allowances in the EU emissions trading system.

52 https://www.wri.org/sites/default/files/Policy_and_Action_Standard.pdf

53 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R0525

Under the MMR, the Commission is also required to produce an annual report on progress to Kyoto and EU targets for the EU, covering actual (historical) emissions and projected future emissions. It also includes information on EU policies and measures, climate finance and adaptation. The most recent report was published in November 2017[54], which assessed progress towards the EU's 2030 GHG reduction target as well as considering future GHG projections.

The monitoring and reporting of GHG emissions under the EU ETS prescribed in two Commission Regulations, which were introduced for Phase III of the system starting on 1st January 2013. The scope, purpose and legal status of these Regulations is described in Section 2.2.2 of the EU's 2BR, which explains that one relates to the monitoring and reporting of GHG emissions (EU No 601/2012), while the other concerns verification and accreditation activities (EU No 600/2012).

4.5.2. *Assessment of the economic and social consequences of response measures*

An assessment of the economic and social consequences of response measures is important to ensure the maximum wider benefits to the EU of its climate and energy policy framework[55]. This is done through the impact assessment process, described in more detail in Section 4.10 of the EU's 1BR and 2BR and the EU's National Inventory Report, as well as in Section 4.2 above. Also see chapter 4.4 of the [3BR].

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

Section 4.2.5 of the EU's 6NC gives more details of the compliance procedures for Member States, both under the Kyoto Protocol and directly to the EUwith respect the Effort Sharing Decision.

4.5.4. *Additional information required under the Kyoto Protocol*

Article 7, Paragraph 2 of the Kyoto Protocol, and UNFCCC Decision 15/CMP.1 and 3/CMP.11, set out additional reporting requirements that Parties to the Kyoto Protocol must meet. This information is summarised here for ease of reference, and includes:

- Member State use of Kyoto mechanisms;
- Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17;
- Policies and Measures Promoting Sustainable Development (Art. 2 (1) Kyoto Protocol) (Section 4.5.4.1);
- Policies and Measures Related to Bunker Fuels (Art. 2 (2) Kyoto Protocol) (Section 4.5.4.4);
- Minimisation of adverse impacts (Art. 2 (3) Kyoto Protocol) (Section 4.5.4.5).

54 https://ec.europa.eu/clima/policies/strategies/progress/monitoring_en

55 Response measures is understood to mean climate change mitigation activities and therefore the phrases is seen as analogous to 'policies and measures'. http://unfccc.int/cooperation_support/response_measures/items/4294.php

4.5.4.1. Member State use of Kyoto mechanisms

Under the second commitment period of the Kyoto Protocol, the EU, its Member States and Iceland jointly committed to a quantified emission reduction to 80% of the base year levels over the period 2013-2020.

The final use of mechanisms for CP2 shall be available upon completion of CP2.

The use of units from market-based mechanisms and land use, land-use change and forestry activities (LULUCF) from 2008 to 2012 counted towards achievement of the Kyoto Protocol targets for the first commitment period (CP1).

The Final Compilation and Accounting Report for the European Union[56], published on 2 August 2016, provided a breakdown of the total number of each Kyoto unit used for CP1 compliance for the EU15, as shown in Table 4-1.

Table 4-1 EU use of Kyoto units for first commitment period

Units	Quantity
AAUs	17 368 888 639
ERUs	445 838 157
RMUs	302 009 951
CERs	725 166 210
tCERs	1 615 811
lCERs	0
Total quantity	18 843 518 768

Abbreviations: AAU = assigned amount unit, CER = certified emission reduction, ERU = emission reduction unit, lCER = long-term certified emission reduction, RMU = removal unit, tCER = temporary certified emission reduction

The use of Kyoto units for CP1 for each of the EU15 that comprised the EU at the time of ratification of the Protocol is reported within the EU's True-up report[57], shown below in Table 4-2.

56 Final compilation and accounting report for the European Union for the first commitment period of the Kyoto Protocol. CC/ERT/2016/CAR/EU.

57 Technical information to the Report on the additional period for fulfilling commitments under the Kyoto Protocol. SWD(2015) 288 final

Table 4-2 Use of Kyoto Units for CP1

	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	Total
Austria	362 501 669	11 975 750	6 786 726	33 393 909			414 658 054
Belgium	590 701 837	9 451 546		26 162 846			626 316 229
Denmark	257 813 160	14 510 576	8 654 523	17 005 884			297 984 143
Finland	304 541 813	4 088 755	17 449 492	12 273 471			338 353 531
France	2 425 839 655	24 706 979	23 648 026	64 661 871			2 538 856 531
Germany	4 245 979 938	194 764 982	39 728 163	226 101 588			4 706 574 671
Greece	568 566 201	11 322 449	2 052 032	16 563 409			598 504 091
Ireland	280 189 478	4 294 121	16 291 152	6 512 114	1 221 981		308 508 846
Italy	2 258 521 514	46 715 521	75 276 599	98 993 939	131 267		2 479 638 840
Luxembourg	53 190 972	395 536	373 279	5 893 782	262 563		60 116 132
Netherlands	928 949 317	29 763 371		38 406 579			997 119 267
Portugal	302 650 818	4 567 634	44 760 045	10 119 578			362 098 075
Spain	1 568 312 827	65 062 121	52 780 585	105 824 516			1 791 980 049
Sweden	295 466 371	2 113 323		7 994 055			305 573 749
United Kingdom	2 925 663 069	22 105 493	14 209 329	55 258 669			3 017 236 560

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

As explained in Section 4.3.3 of the EU's 6NC, 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.

As was explained in the 6NC, use of flexible mechanisms within the EU takes place by operators in the EU ETS and by governments in their achievement of Kyoto targets. Within 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.

As explained in the EU's 6NC, under current reporting of SEF tables, it is impossible to distinguish between governmental use of flexible mechanisms and changes to the number of units induced by operators in the EU ETS. For the first commitment period the use of flexible mechanisms by the EU-15 towards CP1 is described in Section 4.5.4.1 above. A total of 1 474 630 129 flexible units were used out of a total of 18 843 518 768 units, which equates to 7.8 %. The total CP emission reduction against the EU-15 baseline was 8.0 %. Thus the EU-15 use of flexible mechanisms was similar to the level of emission reductions against the Kyoto baseline.

There is no clear picture on the likely use of flexible mechanisms for CP2. The European Environment Agency Trends and projections in Europe 2017 notes that the latest projections from Member States indicate that the EU seems on track to reach its target for the second commitment period of the Kyoto Protocol. Unlike previous EEA reports cited in earlier BRs, there is no detailed analysis of the potential use of flexible mechanisms by the EU or Member States.

4.5.4.3. Policies and measures promoting sustainable development

As explained in the EU's 6NC, sustainable development is an overarching objective of the European Union set out in the Treaty, governing all the Union's policies and activities. It has been effectively mainstreamed in all that the EU does, through the EU Sustainable Development Strategy (SDS), but also though other key strategies and programmes such as the EU 2020 Strategy and the 7th Environment Action Programme[58]. Information on the EU's Sustainable Development Strategy (SDS) was included in the EU's 5NC and information on the 2009 review of the SDS was included in Section 4.3.4.1 of the EU's 6NC.

The UN's 2030 Agenda for Sustainable Development[59], and the 17 Sustainable Development Goals (SDGs) within it, were agreed by world leaders in September 2015. In November

58 http://ec.europa.eu/environment/sustainable-development/index_en.htm

59 https://sustainabledevelopment.un.org/post2015/transformingourworld

2016, the EU presented its response to the 2030 Agenda and the SDGs by publishing a sustainable development package[60] that included the following:

- An overarching Communication on next steps for a sustainable European future accompanied by a Staff Working Document that describes in broad terms the contribution of the various EU policies and legislation to the SDGs;
- A proposal for a revision of the European Consensus on Development that will serve as the basis for further discussions with the Council and the European Parliament;
- A post-Cotonou framework[61] on the future relations with the African, Caribbean and Pacific Group of States.

The work outlined in the Communication has two broad elements. Firstly, it commits the Commission to mainstreaming the SDGs into EU policies and initiatives. It will provide regular reporting of the EU's progress as of 2017 (including in the context of the UN High Level Political Forum), and promote sustainable development globally in cooperation with external partners. The second element involves developing further the EU's longer term vision and the focus of sectoral policies after 2020, and reorient the EU budget's contributions towards the achievement of the EU's long-term objectives through the new Multiannual Financial Framework beyond 2020.

4.5.4.4. Policies and measures related to bunker fuels

Policies and measures relating to bunker fuels are described in the EU's 3BR, in [3BR] Section 4.3.2 for international marine transport and 4.2.1 for the EU Emissions Trading System.

4.5.4.5. Minimisation of adverse impacts

For 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, see Section 4.3.4.3 of the EU's 6NC, chapter 15 of the EU NIR 2017, and section 4.4. of 3BR.

60 http://europa.eu/rapid/press-release_IP-16-3883_en.htm

61 The framework for EU relations with the Africa, Caribbean and Pacific Group of States (ACP) post 2020, when the Cotonou Framework expires.

5. PROJECTIONS AND THE TOTAL EFFECTS OF POLICIES AND MEASURES

Key developments

- The GHG projections prepared by EU Member States and aggregated at EU-level (which take into account the implementation of the 2020 Climate and Energy Package) show that the EU-28 is on track to achieve its 2020 target. Under the "With Existing Measures" (WEM) scenario, total GHG emissions (including international aviation, excluding LULUCF) are projected to be 26.2 % lower in 2020 than in 1990 and 30.2 % lower in 2030 compared to 1990.

- Under the "With Additional Measures" (WAM) scenario, as reported by Member States, the projected GHG emissions compared to 1990 would decrease by 26.8 % in 2020, and 32.2 % in 2030.

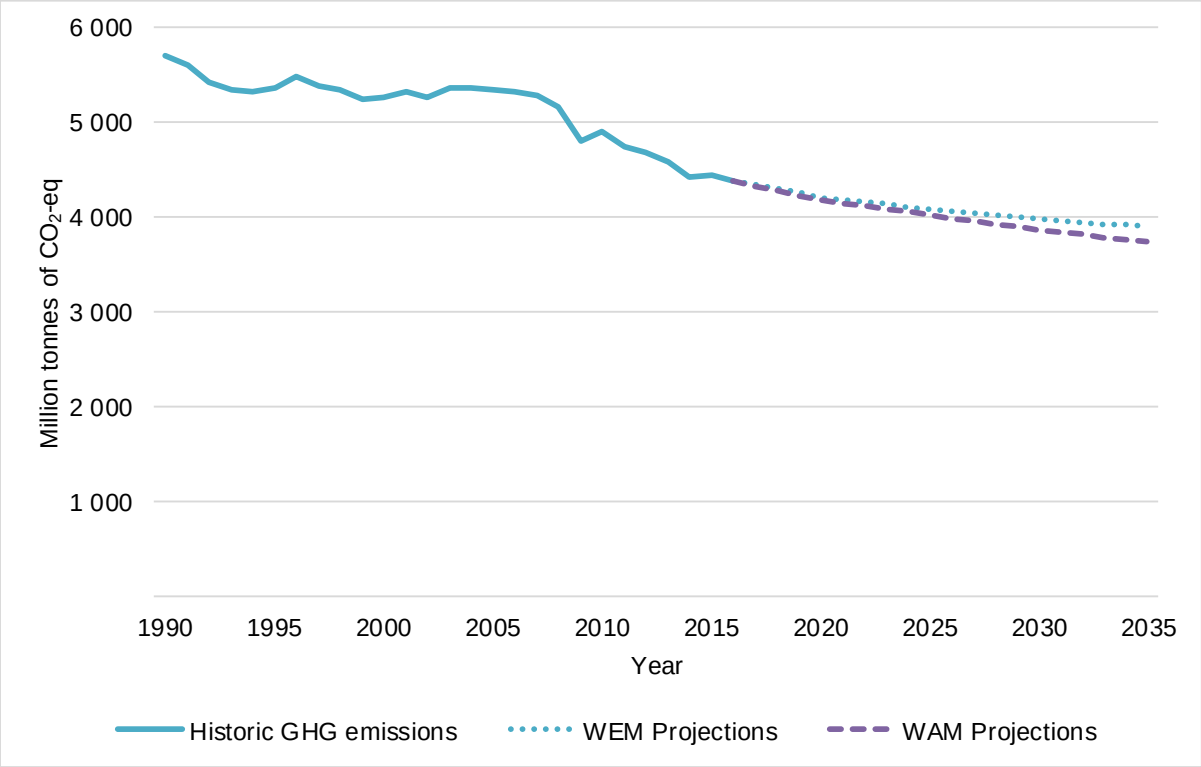
- The most significant sectoral contribution in absolute GHG emission reductions in the EU-28 WEM scenario from 1990 to 2020 is projected to stem from the energy sector (without transport) where emissions are projected to decrease by 36.5 % compared to 1990 in 2020 and by 41.8 % up to 2030 under the WEM, and 37.1 % in 2020 and 44.0 % in 2030 under the WAM scenario. The energy sector is followed by agriculture, industry and the waste sector.

- The transport sector is the only sector where emissions would still be higher by 2030 relative to 1990, due to high emissions growth during the '90s. Under the WEM scenario GHG emissions from the transport sector are projected to be 13.8 % higher than 1990 levels in 2020 and 13.4 % higher in 2030, under the WAM scenario 12.7 % higher in 2020 and 9.9 % higher in 2030.

- Reductions in CO_2 emissions are expected to contribute most to overall emission reductions in the EU-28. Throughout the two scenarios and the timeline from 2020-2025, CO_2 contributes between 85-90 % to total emissions, followed by N_2O with roughly 4-8 % and CH_4 with roughly 4-6 %.
- Total estimated GHG reductions amount to 562 Mt CO_2-eq in 2020 under the WEM and 596 Mt CO_2-eq under the WAM scenario.

Figure 5-1 presents total aggregate GHG emission trends for EU-28. The figure includes historical values (solid lines) and projected values (dotted lines) for the WEM and WAM scenario. In the WEM scenario, total EU-28 GHG in 2020 are projected to be 26.2 % below 1990 GHG emissions (including international aviation, excluding LULUCF). Up to 2030 GHG emissions are projected to decrease further. Considering also planned measures (WAM scenario), the projected GHG emission reductions decline further to 26.8 % below 1990 levels in 2020 and 32.2 % below 1990 levels in 2030.

Figure 5-1 Total, aggregate, absolute historic and projected EU-28 GHG emissions



For information about the aggregate emissions of specific sectors including trends, see [3BR] section 5.1.2.

5.1. Introduction

Please refer to [3BR] Section 4.1.1 for information on the context and scenarios presented in the seventh National Communication.

5.2. Projections

See [3BR] section 5.1.1 for information on the total, aggregate, absolute historic and projected total greenhouse gas (GHG) emissions for the EU-28. [3BR] Section 5.3 provides all information reported in Sections 5.2 through 5.3 in tabular format.

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 4.4.1.

Projections by sector. For detailed sectoral developments see [3BR] Section 5.1.2.

Projections by gas. For information on how projected GHG emissions will change disaggregated by gas see [3BR] Section 5.1.3.

Projections of indirect GHGs. It is not possible to present indirect GHG emission projections as the EU Monitoring Mechanism does not require the reporting of projections of indirect GHG emissions.

5.3. Assessment of aggregate effects of policies and measures

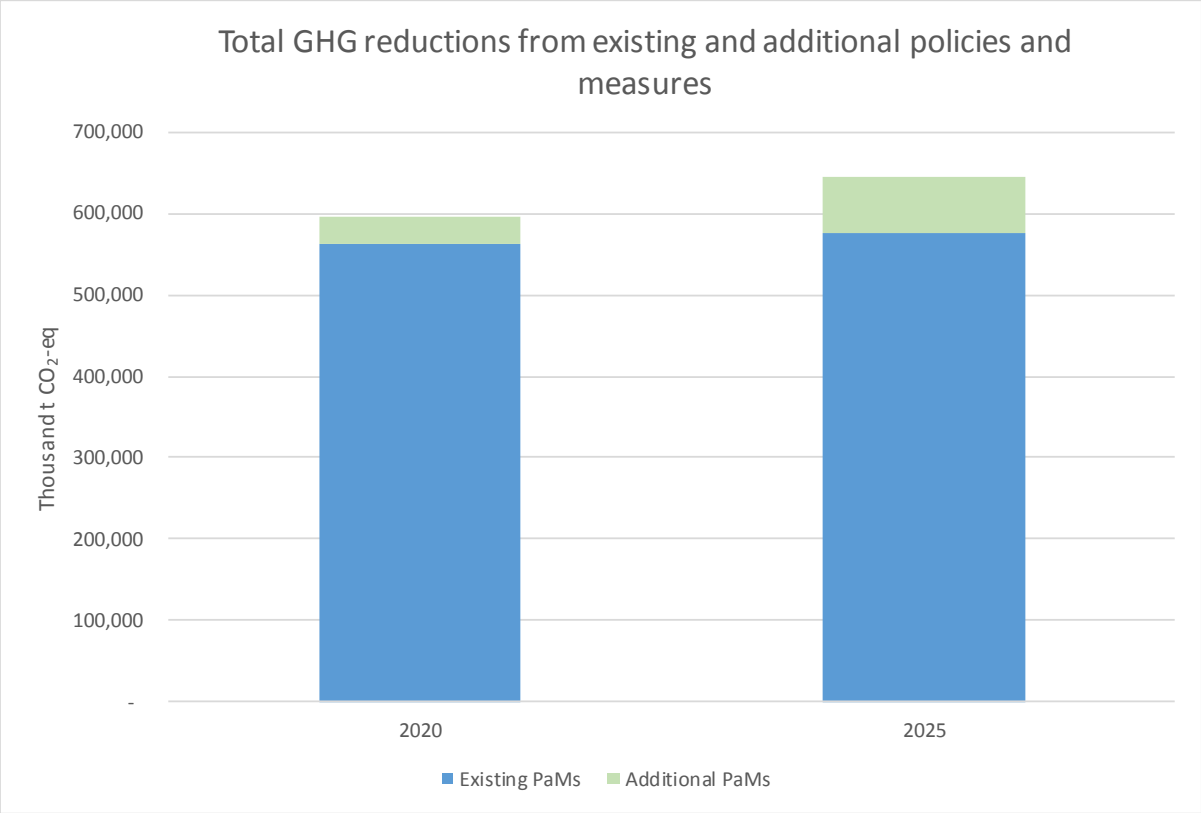
For the EU-28, the assessment of the aggregate effects of policies and measures is accomplished for the years 2020 and 2025. Effects are presented separately for existing – i.e. included under the WEM scenario - and for additional policies and measures – i.e. included under the WAM scenario additionally to the policies and measures also included under the WEM scenario.

Information on aggregate effects of policies and measures in earlier historic years (e.g. 1990-2015) cannot be provided as no EU-wide Without Measures (WOM) scenario is compiled[62]. The compilation of such a WOM scenario would require high costs. At the same time, the value provided would be limited as this backwards-looking exercise would not provide value in steering forward-looking policy decisions.

62 The impacts of mitigation measures presented in figures 5-2 with regards to the WEM have been calculated with the help of data from the EEA PaMs database (see http://pam.apps.eea.europa.eu; data from the version 2016 was used). The most recent version of this database offers data for 2020-2035. While information for 2015 is available from previous reporting cycles to the database, it is not methodologically consistent with the 2020-2035 data reported by EU MS in 2016 and has thus not been included.

Figure 5-2 displays total GHG reductions from existing and from additional policies and measures.

Figure 5-2 Total GHG reductions from existing and additional policies and measures



The disaggregation of the total effects of existing and additional policies and measures into sectors and gases is provided in Table 5-1 and Table 5-2.

For the aggregate effects of existing policies and measures, a bottom-up approach based on the EEA's PaMs database was used whereas a top-down approach comparing GHG emissions under the WEM and the WAM scenario was used to assess the aggregate effects of additional policies and measures. The PaMs database does not offer the same sectoral breakdown as the IPCC 2006 Guidelines for national GHG inventories on which the WEM and WAM projections are based. The GHG reduction impacts of existing PaMs are therefore presented according to the sectoral categorisation available from the EEA's PaMs database, while the impacts of additional PaMs are generally presented according to sectors as foreseen under the IPCC 2006 Guidelines (for reasons of transparency, the transport sector is presented separately and not as part of the energy sector).

Table 5-1 GHG reductions from existing and additional PaMs by sector[63]

Scenario	2020 Reductions in kt CO_2-eq	2025 Reductions in kt CO_2-eq
Existing PaMs		
Total	**562 240**	**575 892**
Cross cutting	31 225	12 971
Energy consumption, Energy supply	392 161	432 573
Transport	75 321	66 134
Industry	39 566	47 567
Agriculture	8 607	7 780
Waste	15 360	8 866
Additional PaMs		
Total	**33 879**	**69 276**
Energy without transport	19 861	44 219
Transport	8 691	15 533
Industrial Processes and other product use	957	3 518
Agriculture	3 718	4 292
Waste	652	1 713

63 Effects from existing and additional PaMs related to international aviation are not presented. Thie EEA PaMs database does not include PaMs related to international aviation, so no information related to existing measures for this subsector is available. Additional measures are not reported as only 2 out of the 28 EU Member States reported GHG reductions related to international aviation under the WAM scenario.

Table 5-2 GHG reductions from existing and additional PaMs by gas

Scenario	2020 Reductions in kt CO_2-eq	2025 Reductions in kt CO_2-eq
Existing PaMs		
Total	**562 240**	**575 892**
CO_2	473 575	499 708
CH_4	35 094	27 220
N_2O	45 379	25 117
F-gases	8 192	23 847
Additional PaMs		
Total	**33 879**	**69 276**
CO_2	28 221	59 789
CH_4	2 091	3 257
N_2O	2 704	3 005
F-gases	488	2 853

5.4. Sensitivity Analysis

For the sensitivity analysis of EU-28 projections, please refer to [3BR] Section 5.3.6.

5.5. Supplementarity

Please see [3BR] Section 5.2.

5.6. Methodology

All methodological aspects, including parameters used and strengths and weaknesses of the modelling approach used are documented in detail in [3BR] Section 5.6.

6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACT AND ADAPTATION MEASURES

Key developments

The EU recognises that some climate change impacts are unavoidable due to past emissions. The EU is investing in efforts to understand climate change impacts and is taking action to reduce vulnerability and adapt to a changing climate.

Since the 6NC was published in 2014, the EU has continued to strengthen the evidence base that supports climate change adaptation decision-making and has enhanced efforts to increase climate resilience. The EU is also strengthening cooperation with developing countries on adaptation. More information can be found in the related chapters.

Key developments include:

- Since 2014, yearly calls for proposals with adaptation-relevant priorities have been launched by The LIFE Programme, which is the EU's financial instrument supporting environmental, nature conservation and climate action projects in the EU Member States. Funding can be used for adaptation activities in vulnerable areas in Europe[64].
- In 2014, the Commission developed an 'adaptation preparedness scoreboard', identifying key indicators for measuring Member States' level of readiness[65].
- In 2014, the EEA published a report on national adaptation policy processes in European countries[66].
- In 2015, Member States provided reports on their adaptation activities within the EU climate monitoring and reporting system, MMR[67]. These included information on Member States' national adaptation planning and strategies, outlining their implemented or planned actions to facilitate adaptation to climate change. The information reported has been incorporated into the country pages of Climate−ADAPT[68].
- In 2016, the EEA published the fourth 'Climate change, impacts and vulnerability in Europe report'[69]. It is an indicator-based assessment of past and projected climate change and its impacts on ecosystems and society. It also looks at society's vulnerability to these impacts, at the development of adaptation policies, and at the underlying knowledge base.

64 EEA (2017) Climate change impacts and vulnerability in Europe 2016, European Environment Agency. https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016

65 http://climate-adapt.eea.europa.eu/eu-adaptation-policy/strategy

66 https://www.eea.europa.eu/publications/national-adaptation-policy-processes

67 The climate Monitoring Mechanism Regulation (MMR) establishes a mechanism for reporting by the Union and its Member States on its climate commitments, including those made in the Paris Agreement. Monitoring and reporting on climate change adaptations actions is included in the MMR.

68 EEA (2017) Climate change impacts and vulnerability in Europe 2016, European Environment Agency. https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016

69 EEA (2017) Climate change impacts and vulnerability in Europe 2016, European Environment Agency. https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016

- In 2016, the fourth macro-regional strategy (MRS) in the EU was published for the Alpine region, building on the experiences of the existing strategies. The emergence of MRS has been driven by several EU countries and regions as a complement to traditional country policies on territorial management. They are designed to tackle common challenges such as climate change, using a bottom-up approach involving national, regional and local actors.
- By 2017, 24 Member States had adaptation strategies compared to 15 in 2013. This progress has been catalysed by the implementation of the 'EU Strategy on adaptation to climate change' adopted in 2013. The strategy takes a coherent approach by complementing the activities of Member States, promoting adaptation action across the EU, ensuring that adaptation considerations are addressed in all relevant EU policies (mainstreaming), bridging knowledge gaps and promoting greater coordination, coherence and information-sharing.
- By 2017, the former Mayors Adapt signatories and the integrated Covenant of Mayors for Climate and Energy brings together almost 900 cities committed to adaptation planning and action. It is expected that by the end of 2017 around 100 European cities will have submitted a climate risk and vulnerability assessment as well as indicative adaptation actions.
- An evaluation of the adaptation strategy is currently underway and will be completed in 2018. It examines the implementation of the strategy action and the achievements of its objectives.

6.1. Introduction

Both public and political recognition of the need to take urgent action on climate change has continued to build momentum since the 6NC. The European Commission is a global climate change leader and is committed to maintaining this role. The European Union has a binding target to jointly reduce greenhouse gas emissions by at least 40 % in 2030 compared to 1990[70], and to stabilise global mean temperatures below 2°C above pre-industrial levels. This commitment was reflected in the Union's Nationally Determined Contribution (NDC)[71].

Increasing temperatures, rising sea levels, 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). Significant changes in climate and its impacts are already visible in Europe today. Further climate change impacts are projected and are likely to increase existing vulnerabilities, in addition to deepening socio-economic imbalances in Europe.[72]

In view of the wide-ranging nature of climate change impacts across the EU's territory, the European Union has recognised the need to develop an EU-wide framework for adaptation that supplements national adaptation efforts. The European Commission has recognised that planning for adaptation requires a strategic approach to ensure timely,

70 More information about the EU 2030 Climate & Energy Framework can be found at: https://ec.europa.eu/clima/policies/strategies/2030_en#tab-0-1

71 http://www4.unfccc.int/ndcregistry/PublishedDocuments/European%20Union%20First/LV-03-06-EU%20INDC.pdf

72 http://ec.europa.eu/clima/policies/adaptation/what/docs/com_2013_216_en.pd

efficient and effective adaptation actions coherently across different sectors and levels of governance.

The EU Adaptation Strategy defines the EU's main role as supporting the public and private sector at the national, regional and local levels by providing comprehensive information on adaptation. Information is mainly provided through the European information platform, Climate-ADAPT[73], as well as the Covenant of Mayors for Climate and Energy[74], which now includes adaptation. The EU also provides guidance on coherent adaptation approaches (e.g. through guidelines), in addition to concretely allocating funding (e.g. through the LIFE programme) to adaptation actions. In addition, the EU is supporting its Member States in the case of transboundary issues. It is further strengthening and mainstreaming adaptation into those sectors that are closely integrated at the EU level through the single market and common policies.

Emerging policy fields such as climate change adaptation are particularly dependent on new and increasingly precise research results for decision making. Thus, since the 6th NC, research on the impacts of climate change, vulnerability and adaptation options has become a high priority for Europe. Of particular note are outputs from the EU's Seventh Framework Programme for Research and Technological Development (FP7) and its successor, Horizon 2020, together with many other programmes at the transnational and national levels. Disaster Risk Reduction (DRR) and new insurance products are two adaptation-related research areas that have been prioritised since the 6NC, to address the impacts of more frequent extreme weather events.

The following sections outline observed and projected changes to the climate across the EU as well as anticipated impacts. The current and planned EU adaptation actions to reduce climate change vulnerability that have been developed since the 6th NC are described.

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, among others) are already being felt globally and in Europe. Observed impacts of climate change are projected to increase due to further climate change. In 2017 the European Environment Agency (EEA) published a report[75] providing an updated compilation of observed and projected climate change impacts across Europe's regions. Its findings are summarised in this section.

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

74 http://www.covenantofmayors.eu/about/covenant-of-mayors_en.html

75 EEA (2017) Climate change impacts and vulnerability in Europe 2016, European Environment Agency. https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016

6.2.1. *Observed and projected change in temperature*

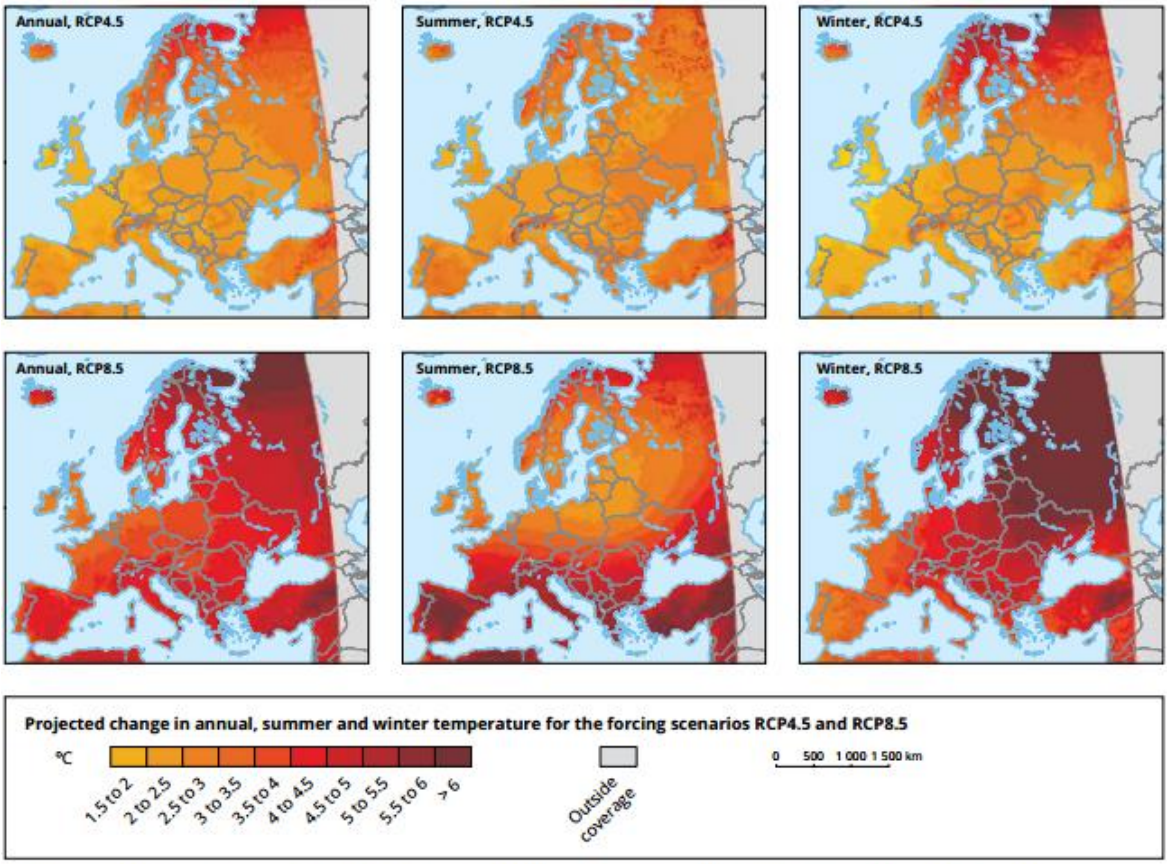
Observed changes

The average annual temperature for the European land area for the last decade (2006–2015) was around 1.5 °C above pre-industrial levels, making it the warmest decade on record. 2014 and 2015 were the warmest years in Europe since instrumental records began. 500-year-old temperature records were broken in over 65 % of Europe in the period 2003–2010. Climate reconstructions show that summer temperatures in Europe in the last three decades (1986–2015) have been the warmest for at least 2 000 years, and were outside the range of natural variability. The strongest warming has been observed over the Iberian Peninsula, particularly in summer, and across central and north-eastern Europe. Winter warming has been strongest over Scandinavia.

Projected changes

Temperatures across Europe are projected to continue increasing throughout this century. Annual average land temperature over Europe is likely to increase in the range of 1 to 4.5 °C under a medium emissions scenario (RCP4.5), and 2.5 to 5.5 °C under a high emissions scenario (RCP8.5) (Figure 6-1) by the end of this century (2071–2100 relative to 1971–2000) - more than the projected global average increase. The strongest warming is projected across north-eastern Europe and Scandinavia in winter and southern Europe in summer, and the projected increase in the frequency of heat waves is greatest in southern and south-eastern Europe.

Figure 6-1 Projected changes in mean annual, summer, and winter temperature for the forcing scenarios RCP4.5 and RCP8.5[76]



Note: This map shows projected changes in mean annual (left), summer (middle) and winter (right) near-surface air temperature (°C) in the period 2071–2100 compared with the baseline period 1971–2000 for the forcing scenarios RCP4.5 (top) and RCP8.5 (bottom). Model simulations are based on the multi-model ensemble average of many different combined GCM–RCM simulations from the EURO-CORDEX initiative.

Source: EURO-CORDEX (Jacob et al., 2014).

6.2.2. *Observed and projected change in precipitation*

Observed changes

Average annual precipitation for all of Europe has not changed significantly since 1960, but significant changes have been observed at sub-continental scales. North-eastern and north−western Europe show an increasing trend of up to 70 mm per decade (in Western Norway) since 1960, whereas some parts of southern Europe show a decrease of up to 90 mm per decade, in central Portugal. At mid-latitudes, no significant changes in annual precipitation have been observed. Mean summer (June to August) precipitation has decreased by up to 20 mm per decade in most of southern Europe, while increases of up to 18 mm per decade have been recorded in parts of northern Europe.

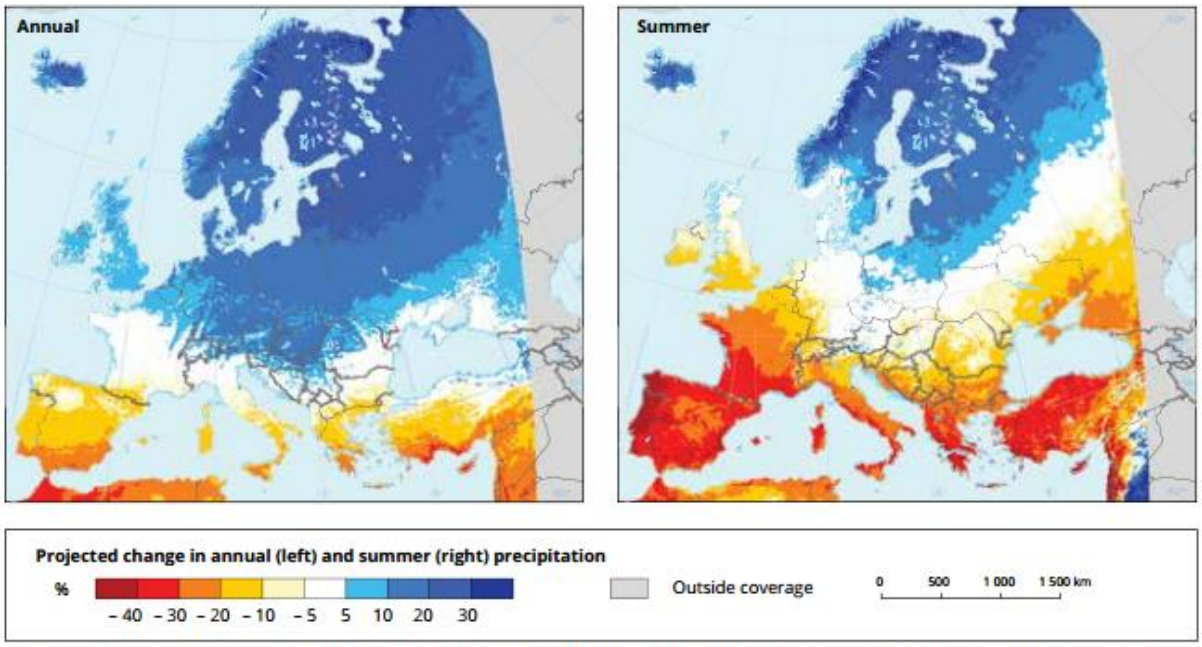
76 EEA (2016), Climate impacts, vulnerability and adaptation in Europe 2016. Map 3.4, pg. 76. http://www.eea.europa.eu//publications/climate-change-impacts-and-vulnerability-2016

Projected changes

Projected changes in precipitation vary substantially across regions and seasons. Annual precipitation is projected to decrease in southern Europe and to increase in northern Europe. For a high emissions scenario, the models project a statistically significant increase in annual precipitation in large parts of central and northern Europe (of up to about 30 %) and a decrease in southern Europe (of up to 40 %) from 1971–2000 to 2071–2100 (Figure 6-2, left hand map); in summer, the precipitation decrease extends northwards (Figure 6-2, right hand map). Future projections are regionally and seasonally different in Southern Europe, but the projected decrease in southern Europe is strongest in the summer. Precipitation is projected to decrease in the summer months up to southern Sweden, and increase in winter with more rain than snow in mountainous regions[77].

Climate projections in the IPPC AR5 indicate high confidence of increased extreme precipitation in Northern Europe (all seasons) and continental Europe (except summer)[78]. Even in regions where summer precipitation is expected to increase, soil moisture and hydrological droughts may become more severe as a result of increasing evapotranspiration[79].

Figure 6-2 Projected changes in annual and summer precipitation[80]



Note: This map shows projected changes in annual (left) and summer (right) precipitation (%) in the period 2071–2100 compared with the baseline period 1971–2000 for the forcing scenario RCP8.5. Model simulations are based on the multi-model ensemble average of many different RCM simulations from the EURO-CORDEX initiative.

Source: EURO-CORDEX (Jacob et al., 2014).

77 https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap23_FINAL.pdf

78 https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap23_FINAL.pdf

79 https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap23_FINAL.pdf

80 EEA (2017), Climate impacts, vulnerability and adaptation in Europe 2016. Map 3.8, pg. 81. http://www.eea.europa.eu//publications/climate-change-impacts-and-vulnerability-2016

6.2.3. *Observed and projected change in freshwater*

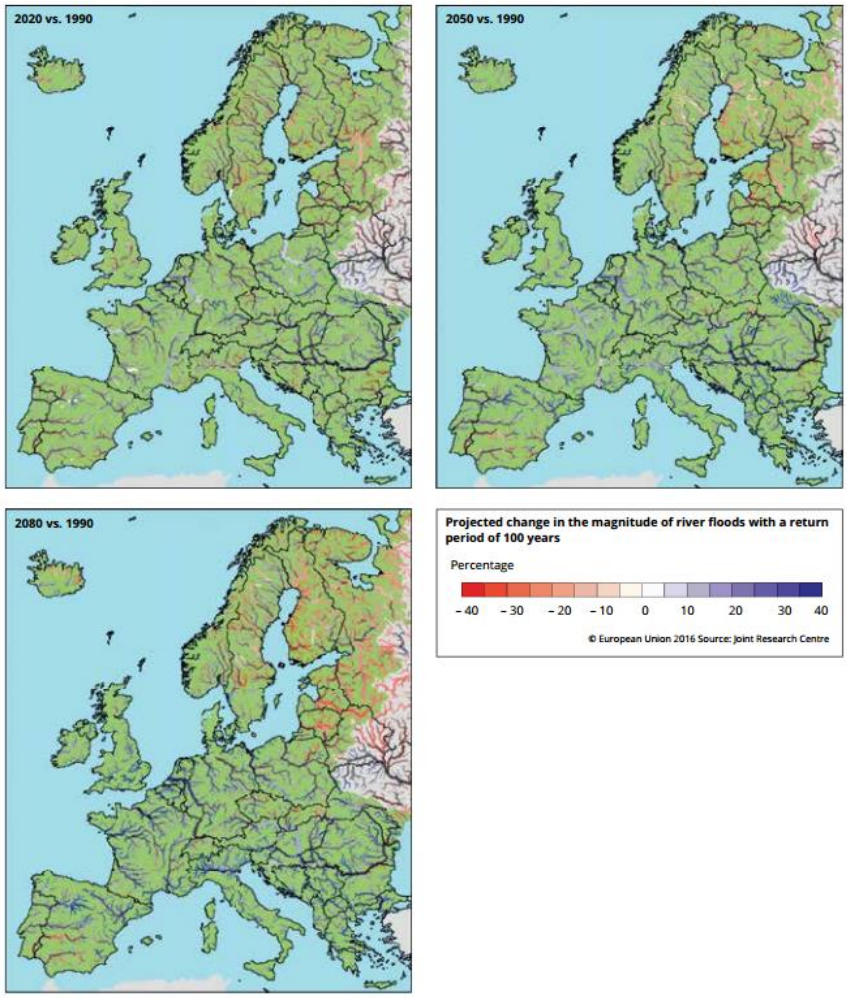
Observed changes

In general, river flows in Europe have increased in winter and decreased in summer since the 1960s, but with substantial regional and seasonal variation. Water flows have generally increased in western and northern Europe, while decreasing in southern and parts of Eastern Europe, particularly in summer. These trends have led to an increase in the number of floods since 2000, and an increase in the severity and frequency of droughts in south-western and central Europe in particular, impacting water quality and freshwater ecosystems. Note that river engineering and other factors also influence these observations.

Projected changes

Detecting long-term trends in hydrological variables is difficult owing to substantial inter-annual and decadal variability. Projections nonetheless suggest an intensifying hydrological cycle and increased seasonality of river flows, resulting in more frequent and intense flood events and droughts. Reduced snow accumulation during winter is projected to reduce the risk of early spring flooding. Figure 6-3 highlights the projected changes in river floods.

Figure 6-3 Projected changes in river floods with a return period of 100 years[81]



Note: This map shows the projected change in the level of one-in-a-century river floods (Q100). The relative changes for the time slices 2006–2035 (2020), 2036–2065 (2050) and 2066–2095 (2080) are compared with the ensemble mean of the baseline (1976–2005), based on an ensemble of seven EURO-CORDEX simulations forced by the RCP8.5 scenario and the LISFLOOD hydrological model. The consistency of the model projections is evaluated through the use of the coefficient of variation (CV) of the relative change. Smaller CVs indicate better model agreement of the projected mean change. Data points with CV > 1 are greyed out.

Source: Adapted from Alfieri, Burek et al., 2015.

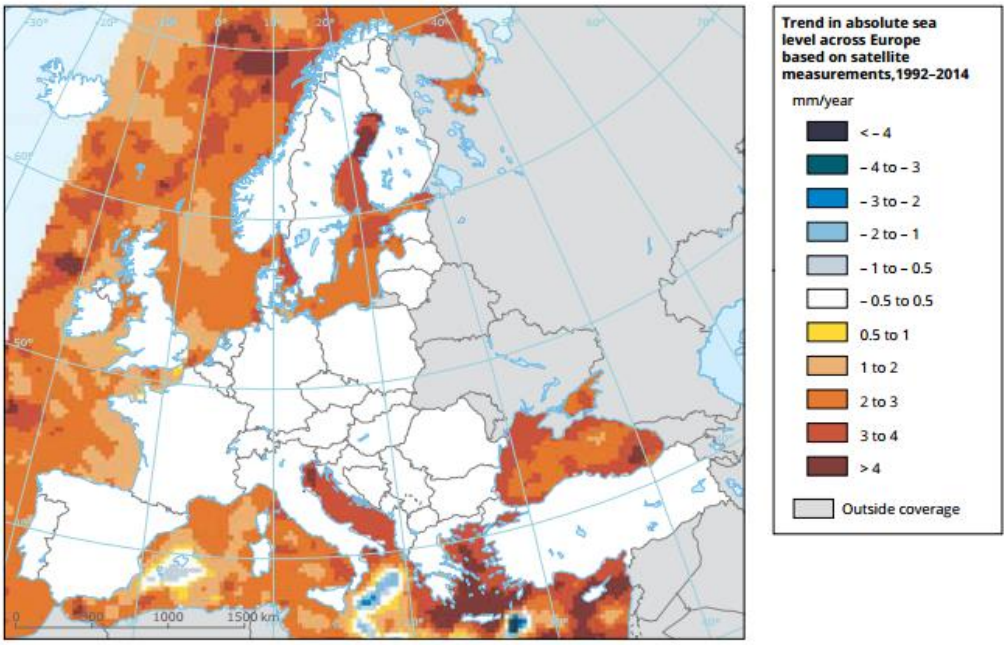
6.2.4. *Observed and projected change in oceans including sea level rise*

Observed changes

Sea level measurements for the European region are available from satellite altimeter observations (Figure 6-4) and from tide gauges. All coastal regions in Europe have experienced an increase in absolute sea level, and most of them have experienced an increase in sea level relative to land but with significant regional variation.

81 EEA (2017), Climate impacts, vulnerability and adaptation in Europe 2016. Map 4.8, pg. 143. http://www.eea.europa.eu//publications/climate-change-impacts-and-vulnerability-2016

Figure 6-4 Trend in absolute sea level across Europe based on satellite measurements[82]



Note: The map shows the linear trend in sea level change over the period 1992–2014. Data uncertainty is higher along coastal zones than in areas further away from the coast. In some regions of the Mediterranean Sea, the depicted trends reflect long-term variability in gyres (i.e. rotating ocean currents) rather than the effects of climate change.

Source: Data supplied by CLS/CNES/LEGOS group (also available through CMEMS).

As well as SLR (sea level rise), other primary climate change impacts observed in European seas are acidification, increased ocean heat content and increased sea surface temperature. For example, in the North-east Atlantic Ocean, sea surface temperatures and ocean heat content are increasing, at different rates across all regions.

Projected changes

Relative sea level change along most of the European coastline is expected to be similar to the global average, except for the northern Baltic Sea and the northern Atlantic coast, which are rising as a consequence of post-glacial rebound. In these regions, relative sea levels are rising slower and may even decrease.

A recent study found that by the end of this century, the 100-year extreme sea levels (ESL) along Europe's coastlines is on average projected to increase by 57 cm for Representative Concentration Pathways (RCP) 4.5 and 81 cm for RCP8.5. The North Sea region is projected to face the highest increase in ESLs, amounting to nearly 1m under RCP8.5 by 2100, followed by the Baltic Sea and Atlantic coasts of the UK and Ireland. Relative sea level rise (RSLR) is shown to be the main driver of the projected rise in ESL, with increasing dominance toward the end of the century and for the high-concentration pathway. Changes in storm surges and waves enhance the effects of RSLR along the majority of northern European coasts, locally with contributions up to 40 %. In southern Europe, episodic extreme events tend to stay stable, except along the Portuguese coast and

82 EEA (2017), Climate impacts, vulnerability and adaptation in Europe 2016. Map 4.3, pg. 127. http://www.eea.europa.eu//publications/climate-change-impacts-and-vulnerability-2016

the Gulf of Cadiz where reductions in surge and wave extremes offset RSLR by 20–30 %. By the end of this century, 5 million Europeans currently under threat of a 100-year ESL could be annually at risk from coastal flooding under high-end warming.[83]

Other projected changes in oceans are projected to have predominantly negative effects on oceans and their ecosystems in Europe. Future climate change is projected to warm the Baltic Sea, to decrease its salinity, to decrease sea ice extent by 50–80 % during the 21st century, and to further expand oxygen depleted 'dead zones'.

In the Mediterranean, temperature is projected to increase, and run-off is projected to decrease, thereby increasing salinity. Stratification is projected to remain largely constant because of the compensating effects of increasing temperature and increasing salinity on the density of sea water. The observed invasion and survival of alien species has been correlated with the warming trend in sea surface temperature.

6.2.5. *Observed and projected change in the cryosphere*

Observed changes

A general loss of glacier mass since the beginning of the measurements has occurred in all glacier regions in the EU. The Alps have lost roughly 50 % of their ice mass since 1900 (Zemp et al., 2008, 2015; Huss, 2012).

Projected changes

Projections of Baltic Sea ice extent under different emissions scenarios suggest that the maximal ice cover and ice thickness will continue to shrink significantly over the 21st century. The best estimate of the decrease in maximum ice extent from a model ensemble is 6 400 km^2/decade for a medium emissions scenario (RCP4.5) and 10 900 km^2/decade for a high emissions scenario (RCP8.5). For the latter scenario, largely ice-free conditions are projected by the end of the century (Luomaranta et al., 2014).

The retreat of European glaciers is projected to continue throughout the 21st century. One study estimates that their volume for all European regions combined will decline between 22 and 84 % relative to 2006 under a moderate greenhouse gas forcing scenario (RCP4.5), and between 38 and 89 % under a high forcing scenario (RCP8.5) (Radić et al., 2014).

6.2.6. *Extreme weather and disaster prevention*

Observed changes in extremes

Attribution of the observed changes in the number of disaster events and the associated losses to specific causes is hampered by large inter-annual variability, changes in reporting, and the implementation of measures to reduce impacts. Observations from the EEA report (2017) indicate that several weather patterns are becoming more extreme with more intense and frequent events. Large parts of Europe have experienced intense and

83 Vousdoukas, M.I., Mentaschi, L., Voukouvalas, E., Verlaan, M., Feyen, L. Extreme sea levels on the rise along Europe's coasts (2017) Earth's Future, 5 (3), pp. 304-323.

long heat waves since the 1950s, most of which occurred since 2000 (2003, 2006, 2007, 2010, 2014 and 2015) with notable impacts on society. Heavy precipitation events have increased in northern and north-eastern Europe since the 1960s. Observations for south-western and southern Europe are inconclusive. Frequency and intensity of observed wind storms have shown considerable decadal variability across Europe and as such are also inconclusive. However, hail storms have increased in frequency since 1951, in particular across mountainous and Alpine regions, including southern France and Austria.

An analysis of the timing of river floods in Europe over the past 50 years found clear patterns of changes in flood timing that can be ascribed to climate effects[84]. These variations include earlier spring snowmelt floods in northeastern Europe, later winter floods around the North Sea and parts of the Mediterranean coast owing to delayed winter storms, and earlier winter floods in western Europe caused by earlier soil moisture maxima. The number of very severe flood events, in terms of socio-economic impact, in Europe increased over the period 1980–2010, but with large inter-annual variability. This increase has been attributed to better reporting, land-use changes and increased heavy precipitation in parts of Europe, but it is not currently possible to quantify the importance of these factors.

A recent review of extreme sea levels during major storms along European coasts observed that storm surge heights along the Estonian coast of the Baltic Sea have increased significantly during the 20th century. The trend is associated with increasing mean sea levels.

Projected changes

Future climate change is projected to increase the frequency and intensity of climate-related extremes and the associated losses. Heat waves are expected to increase across Europe and droughts to increase across southern Europe. Under a high emissions scenario (RCP8.5), very extreme heat waves as strong as those already felt or even stronger are projected to occur as often as every two years in the second half of the 21st century. The impacts will be particularly strong in southern Europe. Projections are inconclusive for short-term meteorological extremes such as wind and hailstorms. Recent studies on changes in winter storm tracks generally project an extension eastwards of the North Atlantic storm track towards central Europe and the British Isles. Model projections show a likely increase in overall flood risk, i.e. coastal and inland floods (Figure 6-3).

Projected increases in extreme high coastal water levels are likely to result from increases in local relative mean sea level in most locations. However, recent studies suggest that increases in the meteorologically driven surge component can also play a substantial role, in particular along the northern European coastline. Extreme sea level events will increase (high confidence; WGIAR5 Section 13.7; SREX Section 3.5.3), mainly dominated by the global mean sea level increase. Storm surges are expected to vary along the European coasts. Significant increases are projected in the eastern North Sea[85].

84 Blöschl et al., Changing climate shifts timing of European floods (2017) Science, 357 (6351), pp. 588-590.

85 https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap23_FINAL.pdf

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

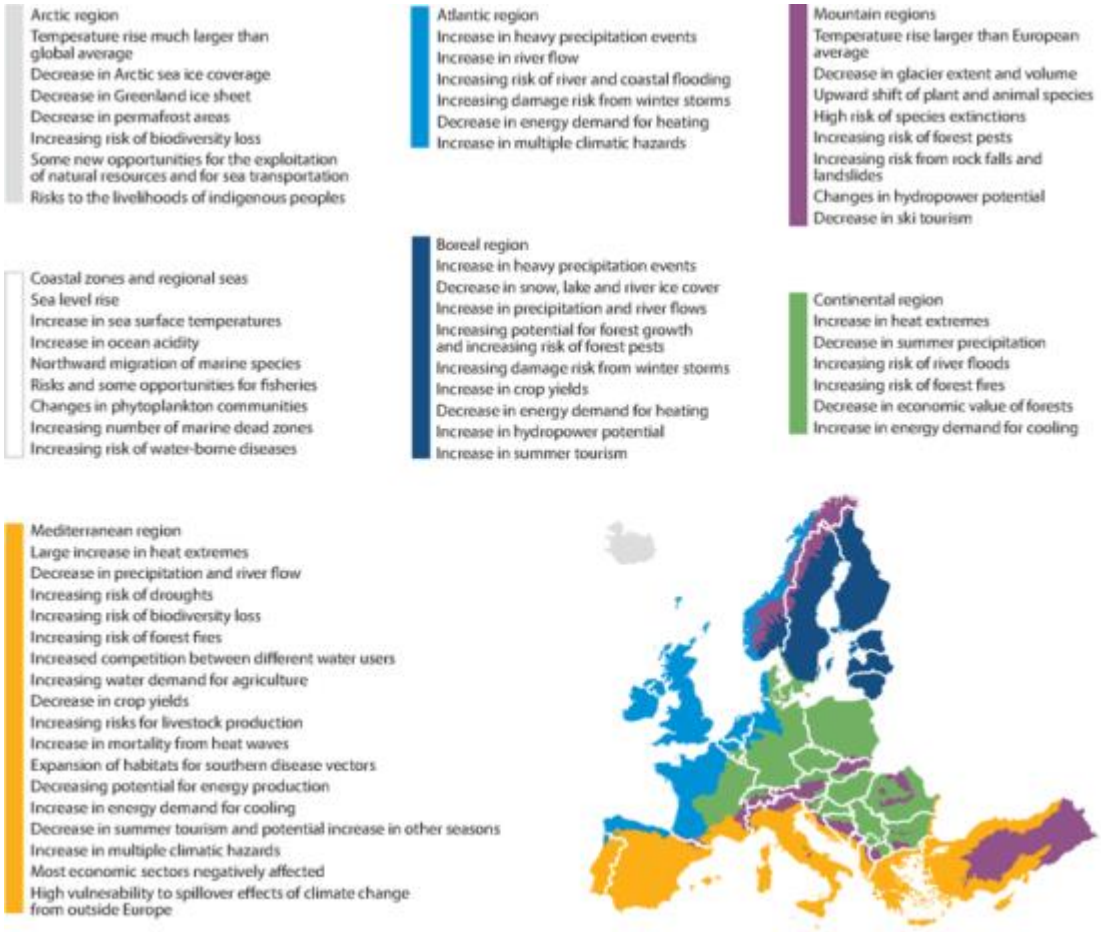
Climate change is already occurring globally and across Europe.[86] While it is clear that all regions of Europe are vulnerable to climate change, certain hotspots, in particular the southern and south-eastern regions, are expected to experience the most acute adverse impacts.

The recent report 'Climate change impacts and vulnerability in Europe 2016'[87] provides a detailed, indicator−based assessment of past and projected climate change impacts, together with the associated vulnerabilities of and risks to ecosystems, human health and society in Europe, based on a wide range of observations and model simulations. The main findings from this recent research are summarised in the sections below. An overview is provided for the main regions in Europe in the overview map (Figure 6-5).

86 Kovats, R.S., R. Valentini, L.M. Bouwer, E. Georgopoulou, D. Jacob, E. Martin, M. Rounsevell, and J.-F. Soussana, 2014: Europe. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1267-1326.

87 EEA (2017) Climate impacts, vulnerability and adaptation in Europe 2016., European Environment Agency, http://www.eea.europa.eu//publications/climate-change-impacts-and-vulnerability-2016

Figure 6-5 Key observed and projected climate change impacts for the main bio-geographical regions in Europe



Source: EEA (2016)