

# Energy Consumption and Energy Efficiency Trends in the EU-28 2000-2015

*Efficiency Trends of Energy-related Products and Energy Consumption in the EU-28*

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**Title** Energy Consumption and Energy Efficiency Trends in the EU-28 2000-2015

#### **Abstract**

This report aims at showing the present status of energy consumption in the EU-28, in the four main energy consuming sectors: residential, tertiary, transport and industry. During the last years, there have been efforts by the European Union to cut down on energy consumption and improve energy efficiency. From 2000 to 2014, there have been various initiatives that aim at reducing final energy consumption. Therefore, the report demonstrates the energy consumption progress from 2000 to 2015 in the mentioned four sectors.

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## ***Authors***

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## **Executive summary**

### ***Policy context***

The report is set in the context of the legislative framework which relates to energy efficiency in the EU-28. The main horizontal policy measures implemented at EU level that aim to directly or indirectly improve energy efficiency in the different covered economic sectors (i.e. residential sector, tertiary sector, transport sector and industry sector) are: the Energy Efficiency Directive (EED), the Energy Performance of Buildings Directive (EPBD), the Eco-design Directive (ED), the Energy Labelling Directive (ELD), the Directives establishing an Emissions Trading Scheme (ETS) in the European Union; the Effort Sharing Decision (ESD), the Renewable Energy Directive (RED), the Industrial Emissions Directive (IED), and the Regulation regarding CO<sub>2</sub> emissions of new passenger cars.

This report acquires its relevancy as it aims at analysing the EU energy consumption and identifying the energy efficiency trends in the framework of the EU energy consumption targets within the Europe 2020 strategy.

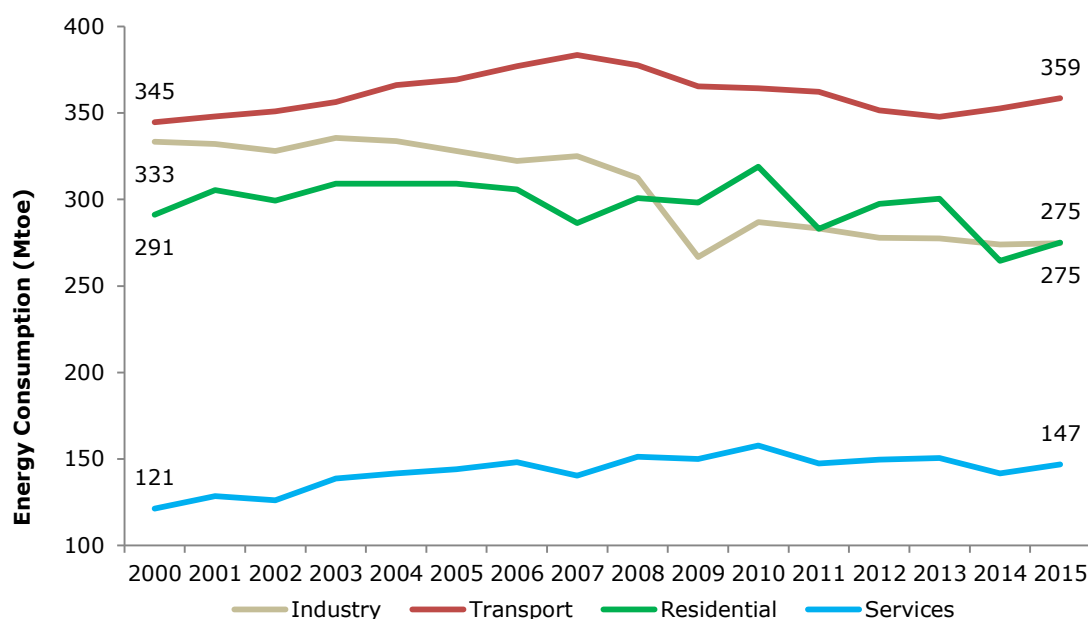
### ***Key conclusions***

The EU has decreased its energy consumption over period 2000-2015. The downward trend of energy consumption has influenced in the decrease of indicators such as energy intensity and energy consumption per capita, turning into a sign of higher competitiveness as global actor. In 2014, the EU already met in terms of final energy consumption the 2020 target set in the EED for 2020 (1 061 Mtoe in 2014 vs 1 086 Mtoe). In the same year the EU was 1.5% below the 2020 target for primary energy consumption (1 505 Mtoe in 2014 vs 1 483 Mtoe). In 2015 the EU final energy consumption increases by xx% compared with the previous year, remaining still under the 2020 target. Primary energy consumption reached at 1,530 Mtoe in 2015 increasing the gap from the 2020 target. Over this period, the financial and economic crisis has caused remarkable change in the dynamics and growth rates of the different economic sectors and in the EU Member States. It has contributed to get the energy consumption back on track towards its 2020 energy and environmental targets. Distinguishing by economic sectors, the transport and the tertiary sector have increased their final energy consumption over the analysed period. In the other sectors (i.e. residential and industry sectors) the final energy consumption has decreased. The increasing trend in the tertiary sector is expected to continue as per the on-going tertiarization process in the EU. On the other hand, the decreasing trend in industry sector has been highly influenced, among others, by the financial and economic crisis. Regarding the greenhouse gas emissions, the transport sector has increased its emissions from 1990-2015. In the residential sector, the energy demand depends also on weather and climate conditions, apart other affecting factors in the energy consumption such as building characteristics (i.e. building envelope, insulation level, location, etc.) or social and cultural reasons (lifestyle, habits, etc.) among others.

### ***Main findings***

In 2014 the EU final energy consumption reached the lowest level since 1990. In 2015 the EU final energy consumption start increasing. Nevertheless the level of consumption remained below the average of the last two decades. When analysing the overall EU energy consumption trends, the individual growth rates of the EU-28 MSs may not be representative as 4 Member States (i.e. Germany, France, the United Kingdom and Italy) consumed over 50% of the final energy consumption and 14 Member States (half of the European Union States) consumed less than 10% of the total final energy consumption in 2015. In 2015 all the sectors experienced an increase in their final energy consumption compared with 2014. Residential sector saw in 2015 the second (after 2014) lowest final energy consumption since 1990.

**Figure 1:** Final energy consumption in the EU-28, 2000-2015



Source: Eurostat

The tertiary sector is registering the highest energy consumption values for the period 1990-2015 from 2008 onwards; with the exception of year 2014. Transport sector start decreasing its final energy consumption after 2008, even that after 2014 the energy consumption in this sector start rising. The financial and economic crisis may have impacted the changes of final energy consumption in this sector over 2008-2013. Road transport (mainly cars) consumed the most among transport subsectors. The analysis shows that even the diesel and gasoline remained the main fuel types over period 2000 – 2005 the biofuels (especially biodiesels) have increased their share in the final energy consumed in the transport sector. After 2008 the final energy consumption in the industry sector saw three drops in its trend – 2009, 2014 and 2015. In 2009 the final energy consumption in this sector reached the lowest value over period 1990-2015. This reduction came mainly due to the decrease in production represented by the trends of the Industrial Production Indexes and the sector's added value to GDP

### **Related and future JRC work**

The report provides with an analysis of the energy consumption and energy efficiency trends with the latest available data. Therefore, future updates of this report are foreseen (e.g. analysis for the periods 2000-2016, 2000-2018 or 2000-2020). In addition, a more thorough analysis of each analysed economic sector and case studies of the EU28 Member States might be made, together with specific research topics on, for instance: EU District Heating Production or Energy-related Products (e.g. domestic/industrial appliances, electric motors and drives, etc.).

### **Quick guide**

This report presents the analysis of the energy consumption trends in the four main energy consuming sectors (i.e. residential, tertiary, transport and industry) in the EU for the period from 2000 to 2015. During the last years, there have been efforts by the European Union to cut down and reduce energy consumption, and improve energy efficiency. Thus, this analysis is needed in order to evaluate whether the different policy actions have influenced the energy consumption patterns. The results and findings of the report may be the starting point for further analysis such assumptions or projections on future energy consumption trends up to relevant dates (e.g. 2020, 2030 or 2050).

# 1 Introduction

One of the five ambitious objectives of the European Union regarding the strategy for *Europe 2020* focuses on climate and energy, and energy efficiency is at the heart of the EU's Europe 2020 Strategy for smart, sustainable and inclusive growth<sup>1</sup>.

The EU sets three key targets based on climate change and energy sustainability for 2020 which are the so-called '20-20-20' targets:

- 20% cut in greenhouse gas emissions from 1990 levels;
- 20% of EU energy consumption share produced from renewable resources;
- 20% improvement in energy efficiency on the EU primary energy consumption<sup>2</sup>.

Therefore, energy efficiency has become one of the main policy goals in the European Union and its objective of 20% reduction on primary energy consumption was identified in the Commission's Communication on *Energy 2020*<sup>3</sup> as a key step towards achieving our long-term energy and climate goals.

In order to achieve the EU energy targets set for 2020 and to continue the pathway to the EU energy targets for 2030<sup>4</sup> which are:

- 40% cut in greenhouse gas emissions compared to 1990 levels;
- at least a 27% share of renewable energy consumption;
- at least 30% energy savings compared with the business-as-usual scenario<sup>5</sup>.

Many important EU directives and regulations to promote energy efficiency have been implemented or are in the planning phase just before implementation. Furthermore, the EU Member States (MSs) have been very active in the area of energy efficiency at the national level by implementing many policies and measures.

The EU 20% energy saving target for 2020 was first introduced by the European Commission (EC) in its 2005 Green Paper on Energy Efficiency or Doing More With Less<sup>6</sup>, where it was indicated the cost-effective potential supported by several studies.

In 2006, the Action Plan for Energy Efficiency<sup>7</sup> proposed a set of energy efficiency policies at EU level to reach the 20% energy saving target by 2020. It was in March 2007 when the EU leaders committed themselves to transform Europe in a highly energy-efficient, low carbon economy and agreed on the above mentioned targets by 2020.

The Energy End-use Efficiency and Energy Services Directive<sup>8</sup> (ESD) introduced the indicative energy saving target of 9% over a 9 year period 2008-2016. Each MS had to adopt an indicative target for end-use efficiency of at least 9%. This target has been set and calculated in accordance with the method set out in Annex I to the Directive, i.e. it is based on the average final energy consumption of five past years (2001-2005). The target excludes some end-use sectors such as industry sector under ETS. A number of MSs introduced targets for 2016 higher than 9%. The target does not include efficiency improvements in the energy supply (e.g. generation), although some renewable energy sources and cogeneration were included.

The Directive introduced the framework of a National Energy Efficiency Action Plan (NEEAP) which each MS had to adopt in order to reach the 9% ESD energy saving target.

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<sup>1</sup> COM(2010) 2020

<sup>2</sup> 7224/1/07 REV 1: Presidency Conclusions of the European Council of 8/9 March 2007. This objective translates into a saving of 368 million tons of oil equivalent (Mtoe) of primary energy (gross inland consumption minus non-energy uses) by 2020 compared to projected consumption in that year of 1842 Mtoe. This objective was reconfirmed by the June 2010 European Council (17/6/2010 Nr: EUCO 13/10).

<sup>3</sup> COM(2010) 639

<sup>4</sup> COM(2014) 15

<sup>5</sup> Business as Usual scenario modelled with Primes in 2007.

<sup>6</sup> COM(2005) 265

<sup>7</sup> COM(2006) 545

<sup>8</sup> Directive 2006/32/EC



At the time of the ESD adoption only a few MSs had the experience to prepare and adopt NEEAPs. Three NEEAPs were foreseen by the ESD, one in 2008, one in 2011 and a final one in 2014. The NEEAP<sup>9</sup> should be a strategic document showing a coherent set of policies and measures needed in a specific MS to reach the 9% target. In addition, the second and third NEEAP should include a thorough analysis and evaluation of the preceding EEAP. Each MS had also to appoint at least one new or existing independent public sector authority or agency to ensure overall monitoring of the process set up to achieve these targets.

In order to meet the EU 2020 target and given the somewhat slow progress by MSs in implementing energy efficiency policies to meet the 2020 target, the Commission proposed on 22 June 2011 a new Directive to step up Member States efforts to use energy more efficiently at all stages of the energy chain – from the transformation of energy and its distribution to its final consumption. That was the Energy Efficiency Directive<sup>10</sup> (EED) which was adopted in December 2012 and repealed the previous ESD. The EED contains a set of binding measures such as: legal obligations to establish energy saving schemes in Member States, public sector to lead by example, energy audits, energy services, energy efficiency funds, efficient CHP, metering and billing information, consumer behaviour, etc.

One of the key articles of the Directive is Article 3, setting the target values for 2020 in terms of energy consumption: the Union's 2020 energy consumption has to be no more than 1,483 Mtoe of primary energy or no more than 1,086 Mtoe of final energy<sup>11</sup>. Targets which have been already met for final energy consumption (1,084 Mtoe of final energy consumption in 2015); while the EU is on the track to reach the primary energy consumption target, despite of the increase in 2015 (1,530 Mtoe of primary energy consumption; corresponding to a gap of 3.2%).

Another key article is Article 7, introducing Energy Efficiency Obligation schemes (EEOSs) mandating distributors and/or retail energy sales companies to reach energy savings targets or use alternative policy measures to deliver a targeted amount of energy savings amongst final energy consumers. The energy savings to be achieved by EEOs shall be at least equivalent to achieving new savings each year from 1 January 2014 to 31 December 2020 of 1.5% of the annual energy sales to final consumers of all energy distributors or all retail energy sales companies by volume, averaged over the most recent three-year period.

On November 2016 the Commission proposed an update to the Energy Efficiency Directive<sup>12</sup>, including a new 30% energy efficiency target for 2030, and measures to update the Directive to make sure the new target is met. The Energy Council on June 2017 agreed on a proposal for a revised directive on energy efficiency whose main elements will be an overall energy efficiency target of 30% and an energy savings obligation of 1.5%, decreasing to 1.0% for the period 2026-2030, unless the mid-term review in 2024 concludes that the EU is not on track to meet its targets.

Another important energy efficiency policy action at EU level has been the introduction of minimum efficiency requirements for products. The Eco-design Directive<sup>13</sup> is the EU framework legislation that allows the introduction of energy efficiency requirements for energy related products such as residential appliances, lamps, consumer electronics, ICT equipment, etc. Since the first Eco-design Directive<sup>14</sup> was introduced a number of implementing Regulations have been adopted introducing efficiency requirements for residential appliances (e.g. refrigerators, freezers, washing machines, dishwashers, etc.),

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<sup>9</sup> The evaluation of the quality of NEEAPs and the saving reported is not in the scope of the present report.

<sup>10</sup> Directive 2012/27/EU

<sup>11</sup> The indicated values refer to EU-28. When the EED was introduced the values were referred to EU-27 and were: 1,474 Mtoe of primary energy or no more than 1,078 Mtoe of final energy.

<sup>12</sup> <https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition>

<sup>13</sup> Directive 2009/125/EC

<sup>14</sup> Directive 2005/32/EC

lamps, televisions, air-conditioners, heaters and water heaters, power transformers and ventilation units among others<sup>15</sup>. Efficiency requirements have been complemented by mandatory energy labelling<sup>16</sup> use as established in the Energy Labelling Directive<sup>17</sup>. Energy labelling of residential equipment was first introduced in 1992<sup>18</sup>, with the first energy label introduced in 1994 for refrigerators. Energy label has contributed to enlarge the market for efficient appliances<sup>19</sup> [1]. The combination of Eco-design and energy labelling has been successful in substantially improving energy efficiency of residential equipment and this result in energy savings compared to a business as usual scenario [2].

The main EU policy for both residential and non-residential buildings is the Energy Performance of Building Directive<sup>20</sup> (EPBD) which was introduced firstly in 2002 and then recast in 2010<sup>21</sup>. Under this Directive, Member States shall implement at national level a set of measures regarding: energy performance certificates to be included in all advertisements for the sale or rental of buildings; regular inspections of heating and air-conditioning systems; all new buildings must be nearly zero-energy buildings by 31 December 2020 (new buildings occupied and owned by public authorities by 31 December 2018); introduce a set of minimum energy performance requirements for new buildings, for the major renovation of buildings and for the replacement or retrofit of building elements (i.e. heating and cooling systems, roofs, walls, etc.); Member States have also to implement measures and other instruments of national financial incentives to improve the energy efficiency of buildings.

It is within this legislative framework where the present report acquires its importance, as it aims at showing the present status and existing trends in energy consumption along the EU-28 Member States, in the four main energy consuming sectors: residential, tertiary, transport and industry. In the residential sector, a special focus on the electricity consumption of main household appliances and equipment is carried out. Also, in the industry sector, an analysis of electricity consumption by electric motors and drives is provided. During the last years, there have been efforts by the European Union to cut down and reduce on energy consumption and improve energy efficiency.

From 2000-2015, there have been various policies that aim at reducing final energy consumption. Therefore, the present report demonstrates the energy consumption progress from 2000-2015 in the mentioned sectors. Besides the final energy consumption, electricity and gas consumption are analysed.

The report consists of seven chapters. The second chapter provides with data for gross, primary and final energy consumption such as energy supply composition and energy drivers as energy intensity and energy per capita across the EU-28 Member States. This comparison gives insights about energy consumption and efficiency level that take place throughout the delivery and transformation of the energy for the final end use. Chapter 3 analyses the final energy consumption in the residential sector. The analysis includes consumption drivers such as economic growth, population, heating demand, household's characteristics and energy prices with the aim of analysing their influences in the consumption trends qualitatively. Chapter 4 focuses on the tertiary sector and provides with an overview of the energy consumption changes. Chapter 5 analyses the energy consumption trends in the transport sector with a focus on the road sector and the CO<sub>2</sub> emissions produced by the sector. Chapter 6 provides an overview of the main changes

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<sup>15</sup> For the updated list of the Regulations adopted and the products covered by efficiency requirements under the Eco-design see:

[https://ec.europa.eu/energy/sites/ener/files/documents/list\\_of\\_ecodesign\\_measures.pdf](https://ec.europa.eu/energy/sites/ener/files/documents/list_of_ecodesign_measures.pdf)

<sup>16</sup> For the updated list of the Regulations adopted and the products covered by energy labelling see: [https://ec.europa.eu/energy/sites/ener/files/documents/list\\_of\\_energy\\_labelling\\_measures.pdf](https://ec.europa.eu/energy/sites/ener/files/documents/list_of_energy_labelling_measures.pdf)

<sup>17</sup> Directive 2010/30/EU

<sup>18</sup> Council Directive 92/75/EEC

<sup>19</sup> There is an on-going energy labelling directive revision process (see COM (2015) 341 final).

<sup>20</sup> Directive 2002/91/EC

<sup>21</sup> Directive 2010/31/EU

in the industry sector and subsectors regarding the energy consumption and production output. Chapter 7 corresponds to the conclusions and findings of the report.

## 2 Gross, Primary and Final Energy Consumption in EU-28

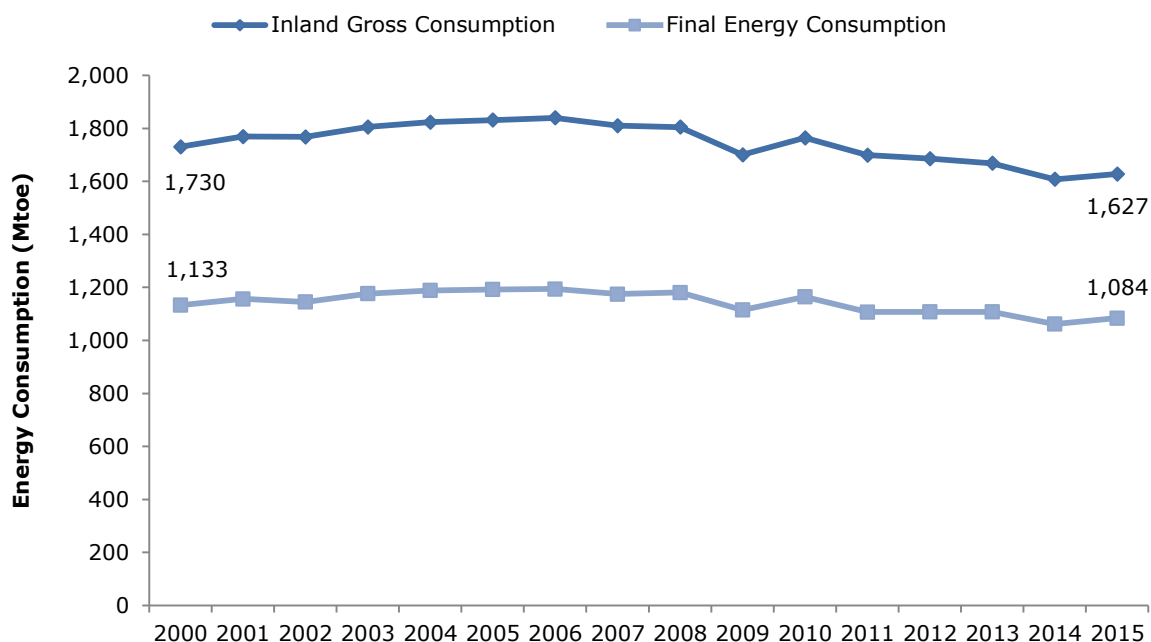
Gross inland energy consumption, also known as total primary energy supply, represents the quantity of energy necessary to satisfy inland consumption of a geographical entity under consideration [3]. It is composed by the final energy consumption and the energy that is consumed in the stages before the delivery to the final destination. Final energy consumption is the amount of energy that is actually consumed in the different sectors. This report is focused mainly on the final energy consumption. However, gross inland consumption is also important in order to have an indication of the losses that occur throughout the transport, distribution and transformation stages in the delivery of the energy for final consumption.

This chapter covers the gross inland energy consumption and the final energy consumption in the EU-28 Member States. The share of the different sectors in the energy consumption and the contribution of the different fuel types are analysed, together with the growth rates in the EU-28 along the covered period.

### 2.1 Gross inland energy consumption

Gross inland energy consumption in the EU-28 declined from 1,730 Mtoe in 2000 to 1,627 Mtoe in 2015. **Figure 2** shows how gross inland consumption and final energy consumption have evolved from 2000 onwards. It can be seen that both have declined. Final energy consumption (1,084 Mtoe) represented the 66.6% of the gross inland consumption in 2015. That means that a large share equal to 33.4% of energy is consumed during the process of the energy delivery to end-users. Looking at this data is important for understanding the efficiency of the entire energy system.

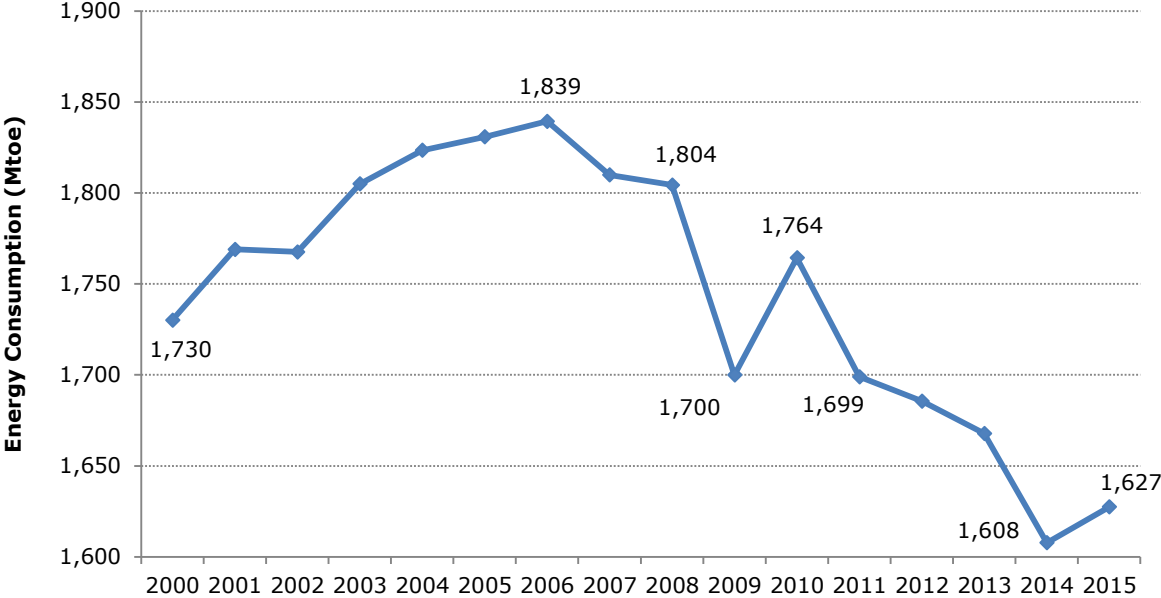
**Figure 2:** Gross inland energy consumption – Final energy consumption in the EU-28, 2000-2015



Source: Eurostat

The gross inland consumption in the EU-28 reached a maximum of almost 1,840 Mtoe in year 2006. A significant drop by 5.8% took place in 2009 rising then in 2010 by 3.8%. After 2010 a decreasing trend has been undergone (**Figure 3**). In 2015, the gross inland consumption was 1,627 Mtoe which establishes the second lowest value over the period from 1990 to 2015.

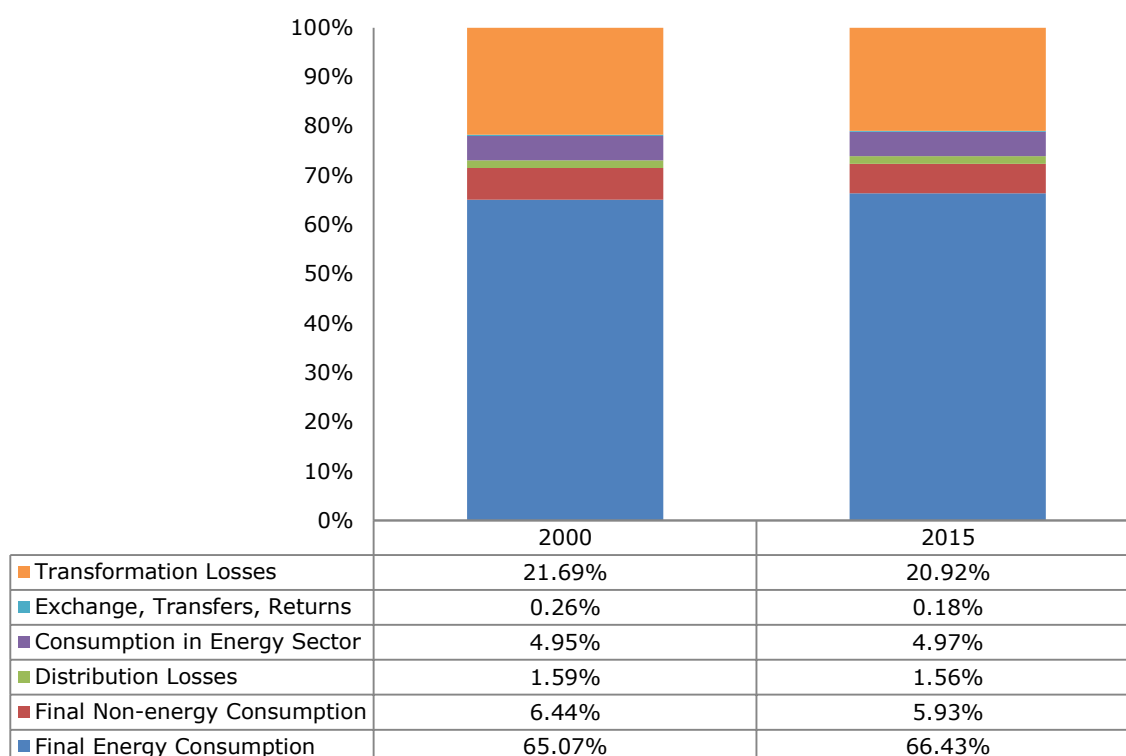
**Figure 3:** Gross inland consumption in the EU-28, 2000-2015



Source: Eurostat

The difference between gross inland and final energy consumption is due to transformation losses (20.9%), consumption in the energy sector (5.0%), final non-energy consumption (5.9%), distribution losses (1.6%) and other exchanges, transfers and returns (0.2%) - **Figure 4**. Compared to 2000, there has been a slight increase (+1.36%) of the share of the final energy to gross inland consumption. This is the result of the reduction of the share of the other components, with the only exception of the consumption in energy sector. However, these changes are very small and the main consumption patterns have remained the same.

**Figure 4:** Gross inland energy consumption breakdown in the EU-28, 2000 and 2015



Source: Eurostat

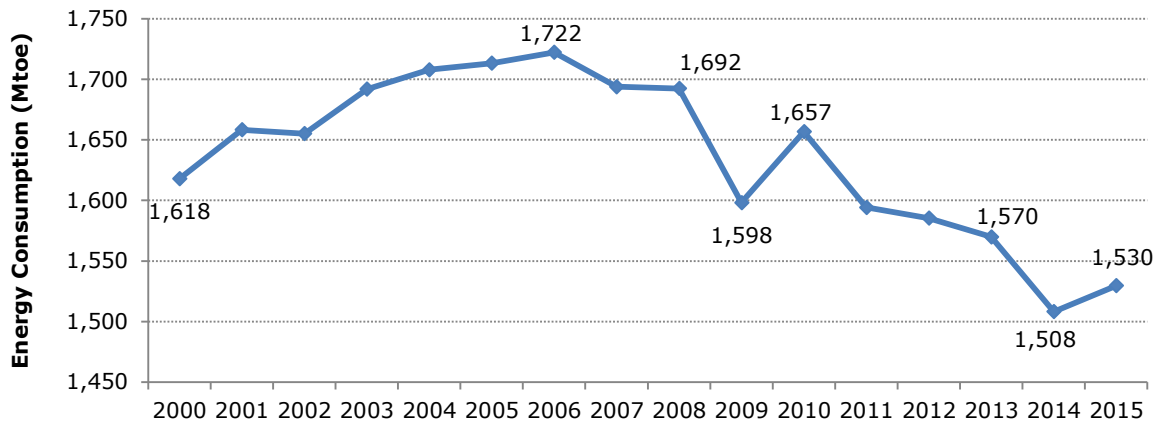
## 2.2 Primary energy consumption

Primary energy consumption<sup>22</sup> in the EU-28 declined from 1,618 Mtoe in 2000 to 1,530 Mtoe in 2015; representing a drop by 5.4% over the period. Primary energy consumption experienced an increasing trend from 2000 to 2006, reaching the maximum value over the analysed period in 2006 (1,722 Mtoe). The series show two minimum over period 2000-2015, in 2009 and 2014 respectively. In 2009 the primary energy consumption dropped by 1.2% in comparison to year 2000. In 2014 we can observe a further decrease of 5.6% compared to 2009. In 2014, the EU primary energy consumption registered the lowest value since 2000 (1,508 Mtoe) with a fall of 3.9% in comparison to 2013. In 2015 the consumption increased again with a growth rate of 1.5% compared to the previous year.

As already mentioned, the EU target values for 2020 for the primary energy are set in 1,483 Mtoe. Before the increase registered in 2015, the analysed data indicate that the EU was on track to achieve its goal in terms of primary energy consumption. The actual gap to accomplish the target is 3.2% as per the data corresponding to 2015.

<sup>22</sup> Primary energy consumption covers the consumption of the energy sector, losses during transformation and distribution of energy, and the final consumption by end users. It excludes energy used for non-energy purposes.

**Figure 5:** Primary energy consumption in the EU-28, 2000-2015



Source: Eurostat

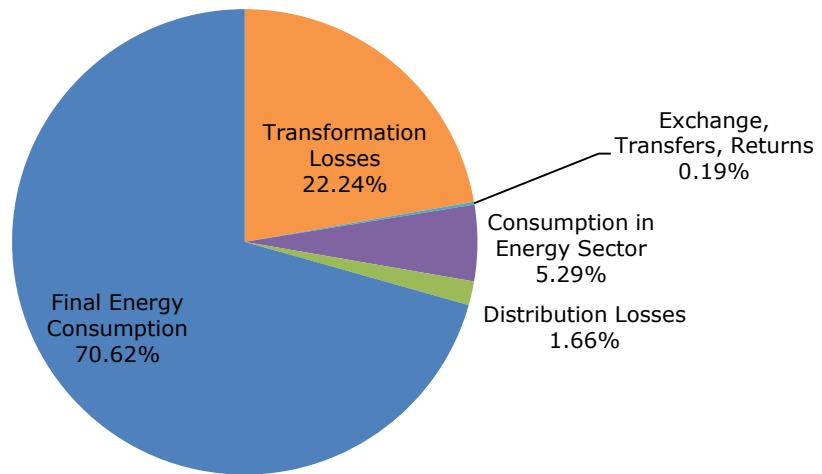
Looking at the composition of primary energy (**Figure 6**) it is possible to observe that final energy consumption accounts for 70.62% of primary energy; followed by transformation losses (22.24%) and consumption in energy sector (5.29%).

The EU energy intensity<sup>23</sup> declined from 0.15 to 0.12 toe/thousand Euro over period 2000-2015. Since 2000 this indicator has followed a downward trend, with the exception of year 2003 and the period 2007-2010, when this indicator remained almost-constant at approximately 0.14 toe/thousand Euro (Figure 6). This reduction is due to several factors such as structural changes in recent years in the overall economy and technological improvements, together with the positive impact of energy efficiency policies both at the EU and national level.

Energy per capita in the EU, has decreased in total by 0.4 toe/cap over period 2000-2015. It reached a maximum in 2006 (3.7 toe/cap). Both, the EU's population growth and the gross inland energy consumption decrease have influenced in the decrease of this indicator.

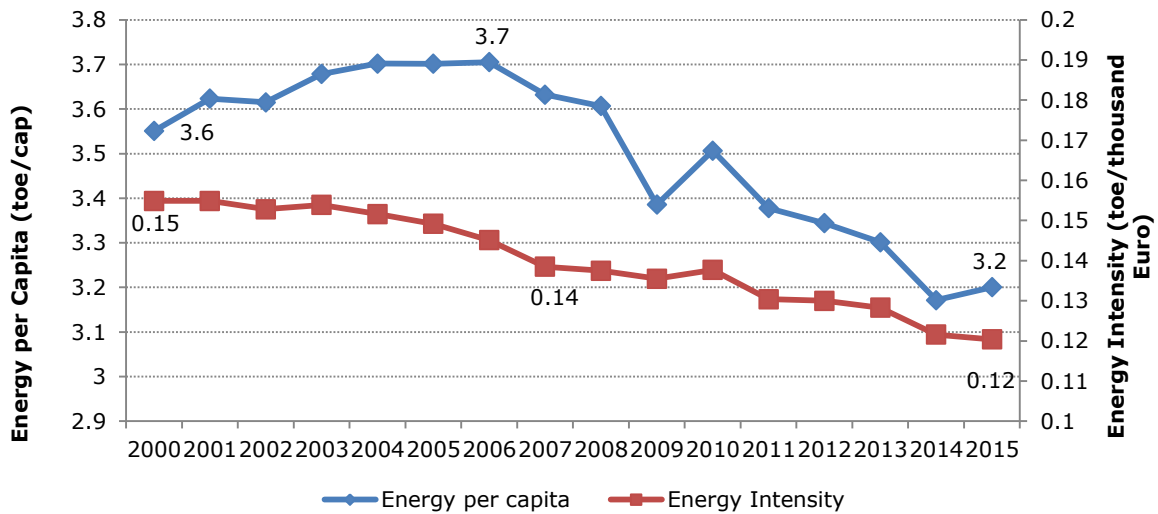
<sup>23</sup> Energy intensity is defined as the ratio between the primary energy consumption and Gross Domestic Product (GDP) calculated for a calendar year. Generally, the lower energy intensity, the higher competitiveness of the region or country analysed.

**Figure 6:** Primary energy consumption breakdown in the EU-28, 2015



Source: Eurostat

**Figure 7:** Energy indicators for primary energy consumption: energy per capita and energy intensity<sup>24</sup> in the EU-28, 2000-2015



Source: Eurostat

### 2.3 Final energy consumption in different sectors

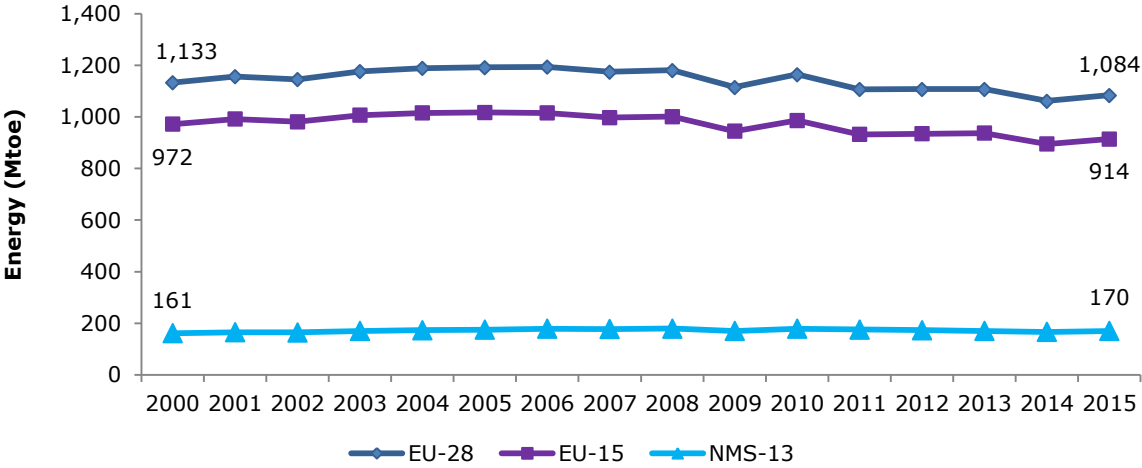
In 2015 the EU total final energy consumption in EU-28 was 1,084 Mtoe (**Figure 8**). It can be observed a decrease of 4.32% in comparison to year 2000, when the consumption was 1,133 Mtoe. In order to capture potential differences between European countries it is interesting to consider separately countries that were in the EU prior of May 2004 and countries entered in the EU after this date. Differentiating by MS

<sup>24</sup> GDP values at market prices have been considered to calculate the energy intensity values reported in the graph.



groups 84.3% (914 Mtoe) was consumed in EU-15 and 15.7% (170 Mtoe) in NMS-13<sup>25</sup>. The EU-15 shows a decrease of 6% for the period 2000-2015. In contrast, NMS-13 increased their consumption by 6%, from 161 Mtoe to 170 Mtoe.

**Figure 8:** Final energy consumption in the EU-28, 2000-2015.

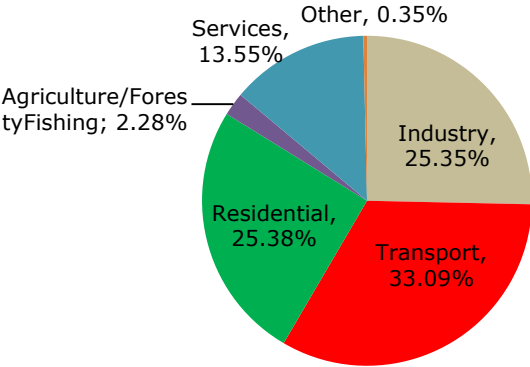


Source: Eurostat

This energy was mainly consumed by four sectors: industry, residential, services and transport (**Figure 9**). In 2015, the sector with the largest share of final energy consumption was the transport sector, which consumed 33.1 % of the total amount of final energy consumption. Residential sector follows with 25.4%. Industry was the third sector with a share of 25.4%. The contribution of the service sector, accounted for 13.6%.

Final energy consumption distribution by sector for five different years (i.e. 2000, 2004, 2007, 2010 and 2015) is shown in **Figure 10**. It can be observed that the shares have slightly changed during the period, and the ranking of the sectors regarding final energy consumption has been often maintained.

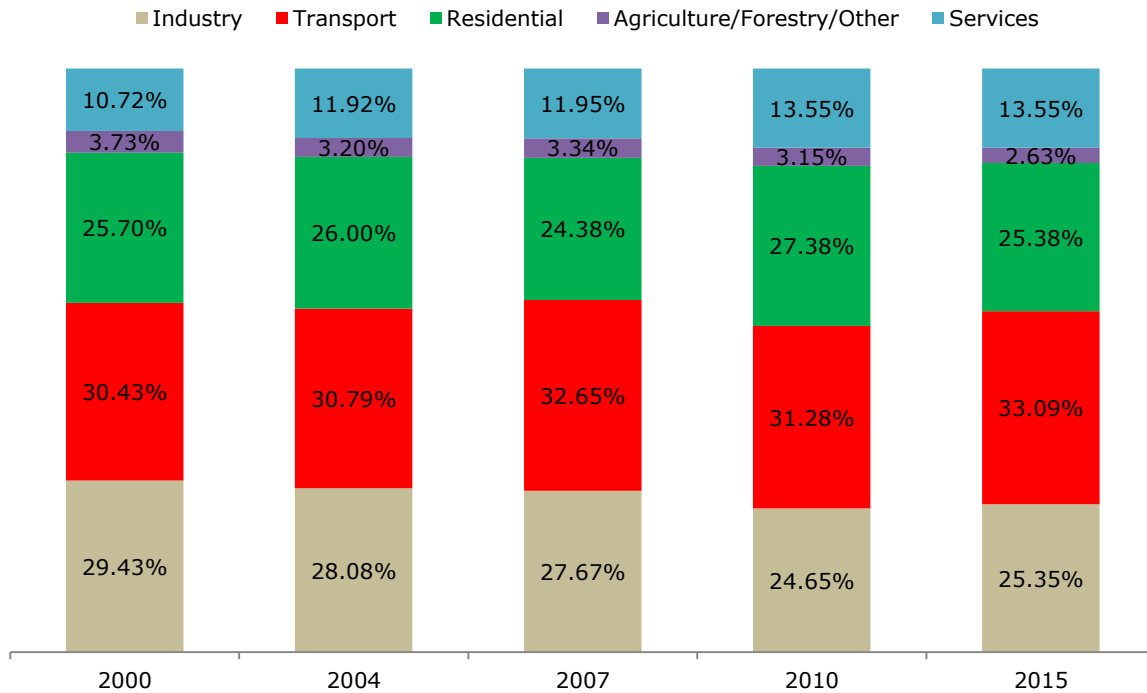
**Figure 9:** Final energy consumption breakdown into sectors in the EU-28, 2015.



Source: Eurostat

<sup>25</sup> The New Member States 13 (NMS-13) includes the following 13 countries: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.

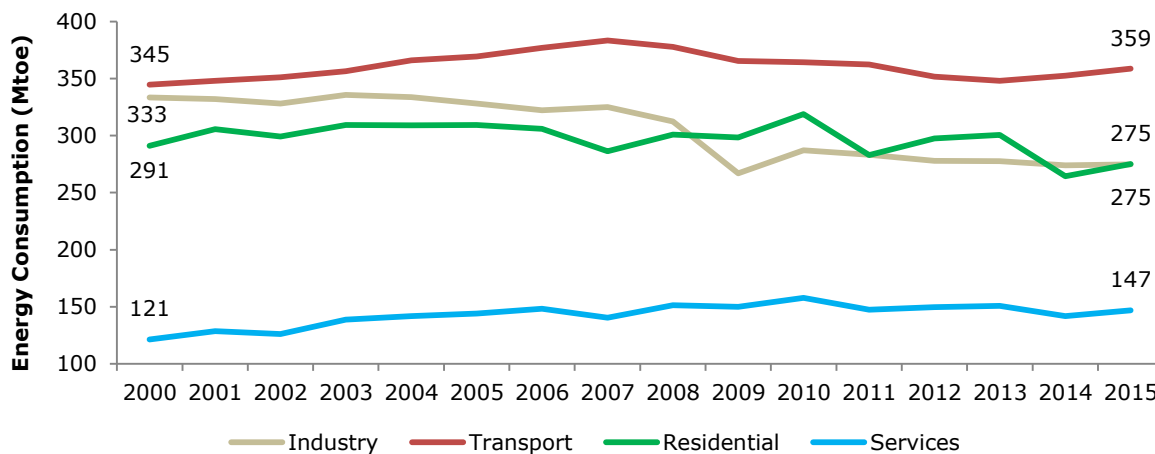
**Figure 10:** Final energy consumption shares by sector in the EU-28, 2000, 2004, 2007, 2010 and 2015



Source: Eurostat

**Figure 11** shows how the final energy consumption per sector changed from 2000 to 2015. It can be seen that the final energy in industry and residential sector has notably varied throughout the different years (e.g. between 2008 and 2009 for the industry sector and between 2013 and 2014 for the residential one), while energy consumption of the transport and services sector has changed more gradually. The increase of final energy consumption in transport and services sectors combined with the decrease in the industry sector might be representative of an on-going tertiarization process in the EU. In 2015, however, the final energy consumption has increased in all the sectors compared to year 2014.

**Figure 11:** Final energy consumption dynamics through main sectors in the EU-28, 2000-2015

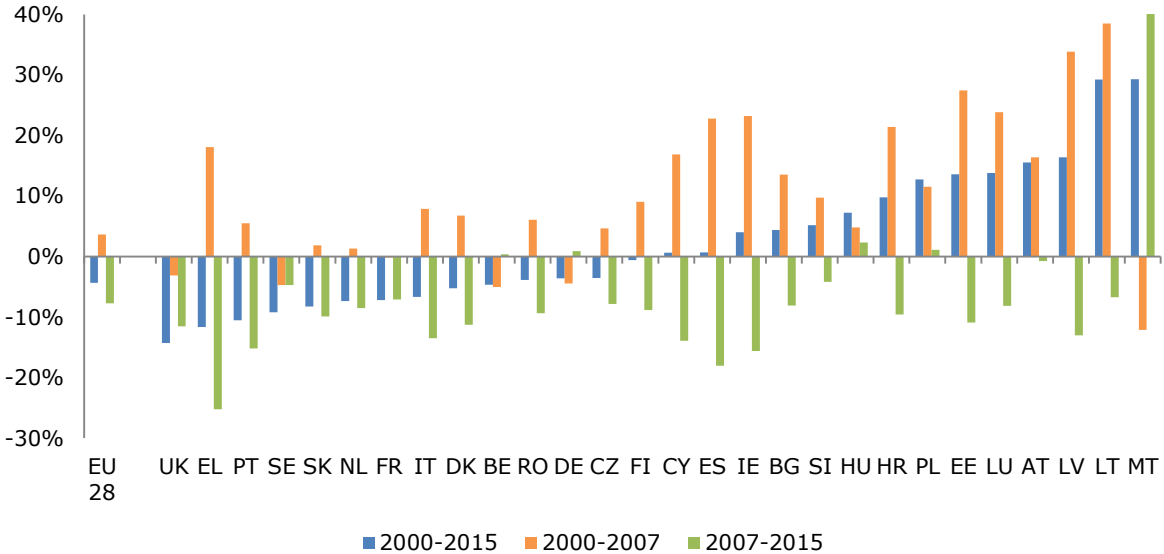


Source: Eurostat

**Figure 12** shows the final energy consumption changed in each EU Member States. For the analysed period, final energy consumption growth rate varies considerably among the EU Member States.

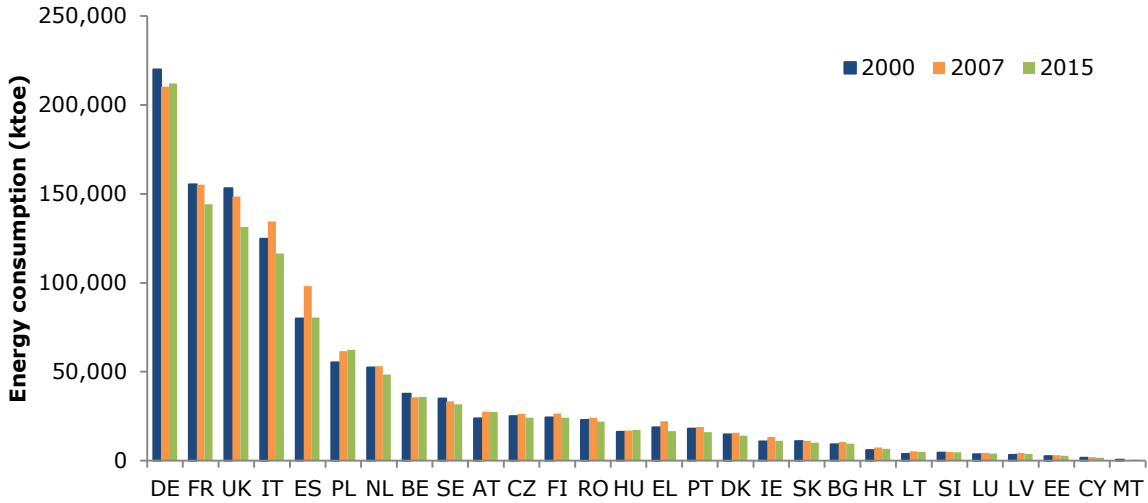
In the period 2000-2015, ten EU Member States experienced higher decreasing rates than the average decreasing rate for EU-28. The highest drop took place in UK (-14.3%), followed by Greece (-11.6%) and Portugal (-10.5%). In contrary, Malta (29.3%), Lithuania (29.2%) and Latvia (16.4%) were the EU MS where the final energy consumption rose the most in comparison to 2000. Fourteen MSs, ten of which NMS-13 and four of which EU-15, experimented an increasing of the final energy consumption. Slovakia, Romania and Czech Republic are the only New Member States where the final energy consumption decreased below the average European level.

**Figure 12:** Final energy consumption growth rate by EU-28 Member State; 2000-2015, 2000-2007 and 2007-2015



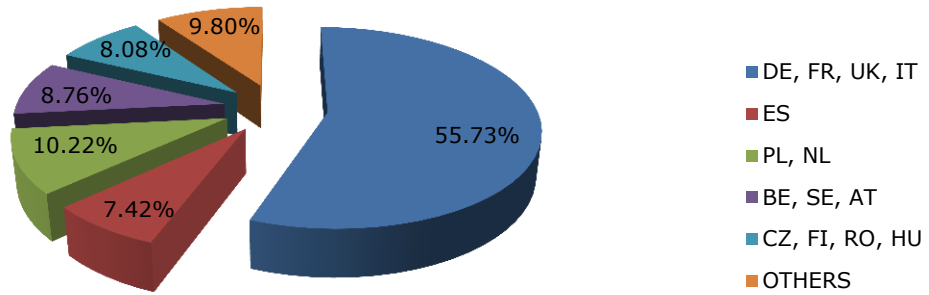
Source: Eurostat

**Figure 13:** Final energy consumption in the EU-28 Member States 2000, 2007 and 2015



Source: Eurostat

**Figure 14:** Share of EU-28 Member States final energy consumption in 2015

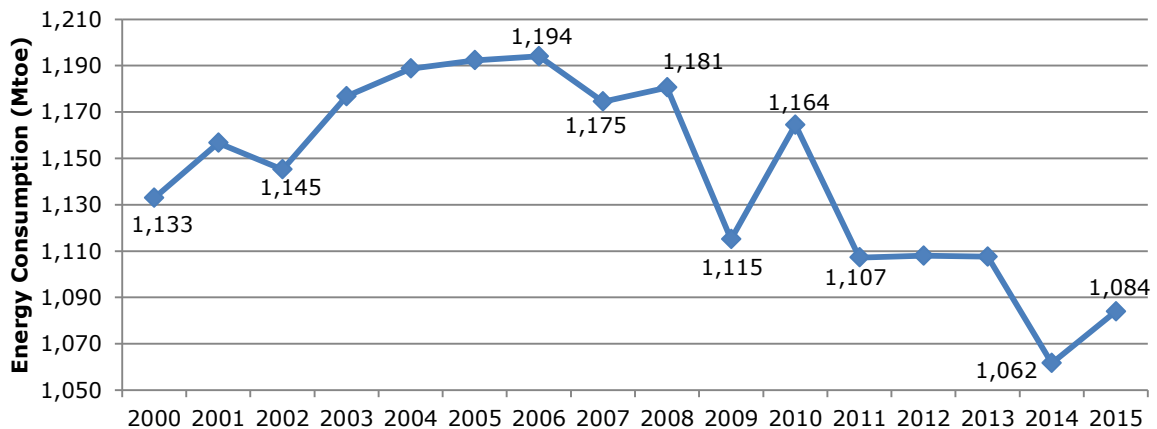


Source: Eurostat

In 2015, Germany was the EU Member State that consumed the most (212.1 Mtoe) reaching a contribution of 19.6% in the EU total final energy consumption. Together with France (144.1 Mtoe; 13.30%), the United Kingdom (131.4 Mtoe; 12.12%) and Italy (116.4 Mtoe; 10.74%) they covered more than 55% of the EU final energy consumption. **Figure 13** shows the ranking of the EU Member States as regard to the final energy consuming as well as share of each EU MS in the final energy consumption. It can be observed how fourteen Member States consumed less than 10% of the total energy consumption (**Figure 14**).

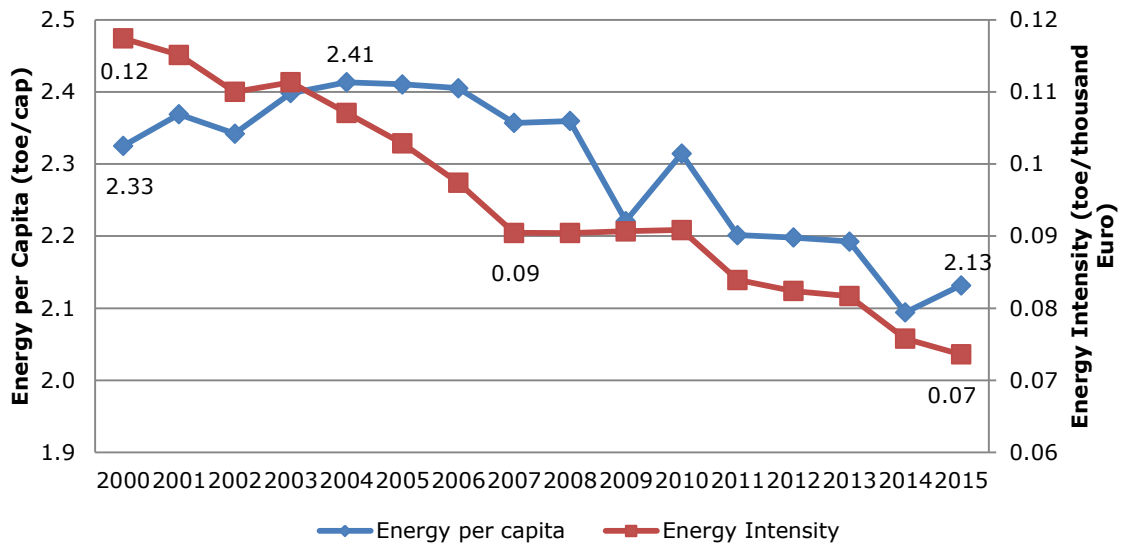
The decline of 4.32% in the European final energy consumption, for the period 2000-2015, has not been gradual. **Figure 15** shows that until 2010 the EU final energy consumption increases each year compared to 2000, except for 2009. From 2003 to 2006 there was a constant growth reaching a maximum in 2006 with 1,194 Mtoe. During the period 2011-2013, the final energy consumption has remained nearly constant. In 2014 the EU final energy consumption reached the lowest level since 2000. In 2015 the EU final energy consumption increased by 2% compared to 2014.

**Figure 15:** Final Energy Consumption in the EU-28, 2000-2015 (Detailed)



Source: Eurostat

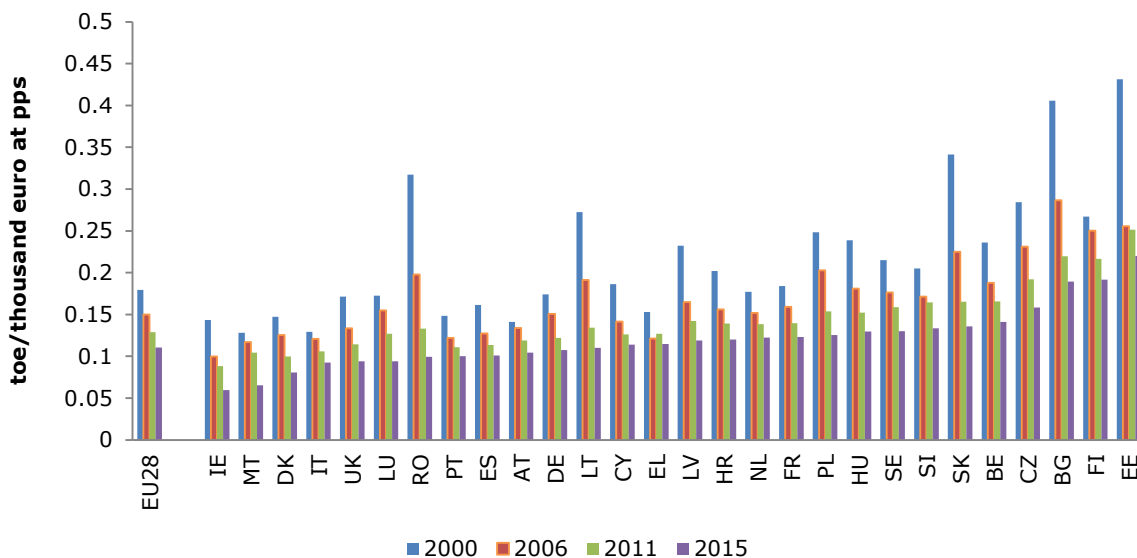
**Figure 16:** Energy indicators for final energy consumption: energy per capita and energy intensity<sup>26</sup> in the EU-28, 2000-2015



Source: Eurostat

Energy intensity (EI) and energy per capita are two indicators related to the final energy consumption analysed below. Between 2000 and 2015, the energy intensity in the EU dropped by 0.05 toe/thousand Euro, reaching 0.07 toe/thousand Euro. Over the same period the energy per capita indicator followed a different trend reaching in 2014 the lowest value (2.1 toe/capita) since 2000. In 2015 the energy per capita in the EU rose slightly at 2.13 toe/capita. Energy per capita indicator is mainly influenced by the final energy consumption. The growth rates between years reflect the dynamics of final energy consumption more than the changes in the population growth rate.

**Figure 17:** Final Energy intensity in the EU-28 (GDP at Current prices, Purchasing Power Standards), 2000, 2006, 2011 and 2015



Source: Eurostat

<sup>26</sup> GDP values at market prices have been considered to calculate the energy intensity values reported in the graph.

Ireland had the lowest energy intensity among the EU Member States in 2015, at 0.06 toe/thousand Euro at pps<sup>27</sup>. Malta and Denmark followed with 0.07 toe/thousand Euro at pps and 0.08 toe/thousand Euro at pps respectively. The EU MSs with the highest energy intensity in the same year were Estonia (0.22 toe/ thousand Euro at pps), Finland and Bulgaria (0.19 toe/ thousand Euro at pps). In 2015, twelve European countries registered energy intensity values below the European average (<0.11 toe/ thousand Euro at pps).

The highest reductions in the energy intensity values between 2000 and 2015 have been found in Romania (68.67%), Slovakia (60.27%) and Lithuania (59.53%). Greece, Finland and Italy are the countries where the energy intensity has reduced the least during this period (25.02%, 28.24% and 28.46% respectively). The trends in energy intensity can reflect the efforts made by the EU Member States in order to reach the target imposed by Europe 2020 strategy. The average reduction rate in energy intensity for EU-28 has been -38.8% over the period 2000-2015.

Table 1 presents an overview of the EU final energy consumption over period 2000-2005. It provides data the absolute level of energy consumed in the sectors, as well as the indexed final consumption versus 2000 and year-on-year growth rates. Comparing with 2000 it can be observed that, over period 2001-2008, the EU experienced positive final energy consumption's growth rates. In contrast, from 2009 onwards, only year 2010 shows a higher level of final energy consumption. Specific insights about the main consuming sectors are given in each of the subsequent chapters.

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<sup>27</sup> Purchasing power standard

**Table 1:** Overview of final energy consumption changes for different sub-sectors, EU-28

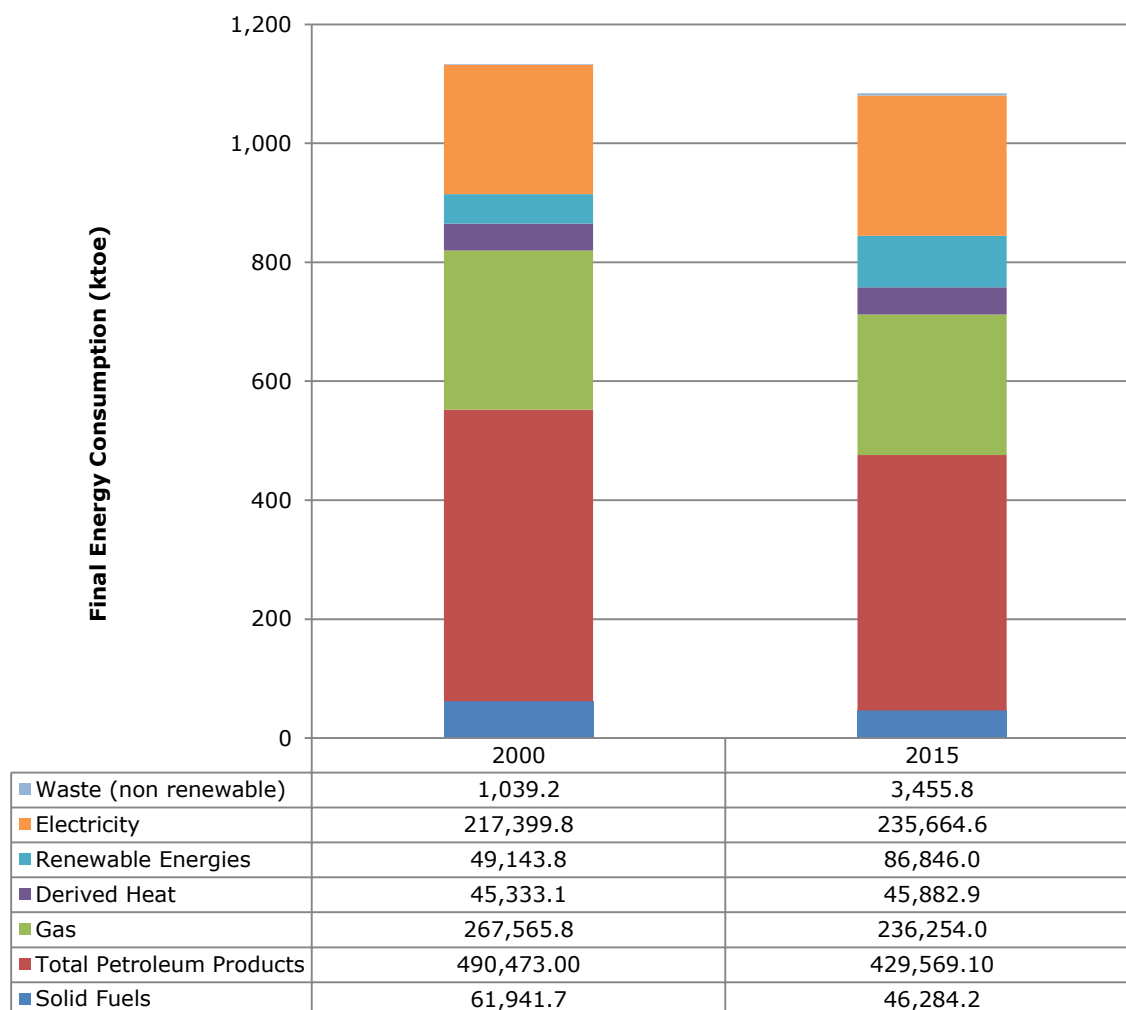
<b>Final Energy Consumption per Sector, EU-28</b>								
<b>(Mtoe)</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
<b>Total</b>	1132.897	1156.655	1145.207	1176.793	1188.704	1192.280	1194.056	1174.514
<b>Industry</b>	333.372	332.099	328.023	335.558	333.747	328.063	322.293	324.975
<b>Transport</b>	344.691	348.019	350.962	356.412	366.061	369.275	377.030	383.484
<b>Residential</b>	291.201	305.521	299.257	309.170	309.091	309.224	305.848	286.382
<b>Services</b>	121.420	128.551	126.093	138.730	141.723	144.160	148.268	140.386
<b>(Mtoe)</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
<b>Total</b>	1180.578	1115.119	1164.493	1107.250	1107.965	1107.567	1061.668	1083.957
<b>Industry</b>	312.454	266.805	287.009	283.223	277.949	277.600	273.965	274.737
<b>Transport</b>	377.669	365.457	364.206	362.256	351.555	347.907	352.580	358.629
<b>Residential</b>	300.753	298.303	318.864	283.001	297.527	300.489	264.515	275.155
<b>Services</b>	151.357	150.026	157.770	147.425	149.759	150.674	141.784	146.924
<b>% Growth rate to year 2000</b>								
<b>(%)</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
<b>Total</b>		2.10%	1.09%	3.87%	4.93%	5.24%	5.40%	3.67%
<b>Industry</b>		-0.38%	-1.60%	0.66%	0.11%	-1.59%	-3.32%	-2.52%
<b>Transport</b>		0.97%	1.82%	3.40%	6.20%	7.13%	9.38%	11.25%
<b>Residential</b>		4.92%	2.77%	6.17%	6.14%	6.19%	5.03%	-1.66%
<b>Services</b>		5.87%	3.85%	14.26%	16.72%	18.73%	22.11%	15.62%
<b>(%)</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
<b>Total</b>	4.21%	-1.57%	2.79%	-2.26%	-2.20%	-2.24%	-6.29%	-4.32%
<b>Industry</b>	-6.27%	-19.97%	-13.91%	-15.04%	-16.62%	-16.73%	-17.82%	-17.59%
<b>Transport</b>	9.57%	6.02%	5.66%	5.10%	1.99%	0.93%	2.29%	4.04%
<b>Residential</b>	3.28%	2.44%	9.50%	-2.82%	2.17%	3.19%	-9.16%	-5.51%
<b>Services</b>	24.66%	23.56%	29.94%	21.42%	23.34%	24.09%	16.77%	21.01%
<b>% Growth rate to previous year</b>								
<b>(%)</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
<b>Total</b>		2.10%	-0.99%	2.76%	1.01%	0.30%	0.15%	-1.64%
<b>Industry</b>		-0.38%	-1.23%	2.30%	-0.54%	-1.70%	-1.76%	0.83%
<b>Transport</b>		0.97%	0.85%	1.55%	2.71%	0.88%	2.10%	1.71%
<b>Residential</b>		4.92%	-2.05%	3.31%	-0.03%	0.04%	-1.09%	-6.36%
<b>Services</b>		5.87%	-1.91%	10.02%	2.16%	1.72%	2.85%	-5.32%
<b>(%)</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
<b>Total</b>	0.52%	-5.54%	4.43%	-4.92%	0.06%	-0.04%	-4.14%	2.10%
<b>Industry</b>	-3.85%	-14.61%	7.57%	-1.32%	-1.86%	-0.13%	-1.31%	0.28%
<b>Transport</b>	-1.52%	-3.23%	-0.34%	-0.54%	-2.95%	-1.04%	1.34%	1.72%
<b>Residential</b>	5.02%	-0.81%	6.89%	-11.25%	5.13%	1.00%	-11.97%	4.02%
<b>Services</b>	7.81%	-0.88%	5.16%	-6.56%	1.58%	0.61%	-5.90%	3.63%

Source: Eurostat

## 2.4 Final energy consumption per fuel types

The main energy fuels of final energy consumption are petroleum products, gas, and electricity that provide respectively the 39.6%, 21.8% and 21.7% of the EU final energy consumption in 2015. Renewables (geothermal energy, solar thermal energy, biofuels, and renewable municipal waste)<sup>28</sup>, solid fuels and derived heat, have a total share of around 16.5%. Over the period there has been a reduction of 108 Mtoe in solid fuels, petroleum products and gas, and an increase of 59 Mtoe in renewables, electricity and waste. This shows that the drop of 49 Mtoe in final energy consumption from 2000 to 2015 is the combined result of diverse changes in the energy type mixture. For instance the energy gap due to a decline of 31 Mtoe in gas has been covered by the increase of other energy types such as renewables, electricity and heat. In this perspective an increase in electricity can be explained not only as a direct increase of electricity consumption for the same type of service, but also as a substitute for gas or other energy sources. Furthermore, in the specific case of electricity, the consumption share is expected to grow in the future as renewable energy sources are integrated into electrical grids once generated in renewable power plants such as hydroelectric power plants, wind farms or PV power stations.

**Figure 18:** Final energy consumption by energy types in the EU-28, 2000 and 2015

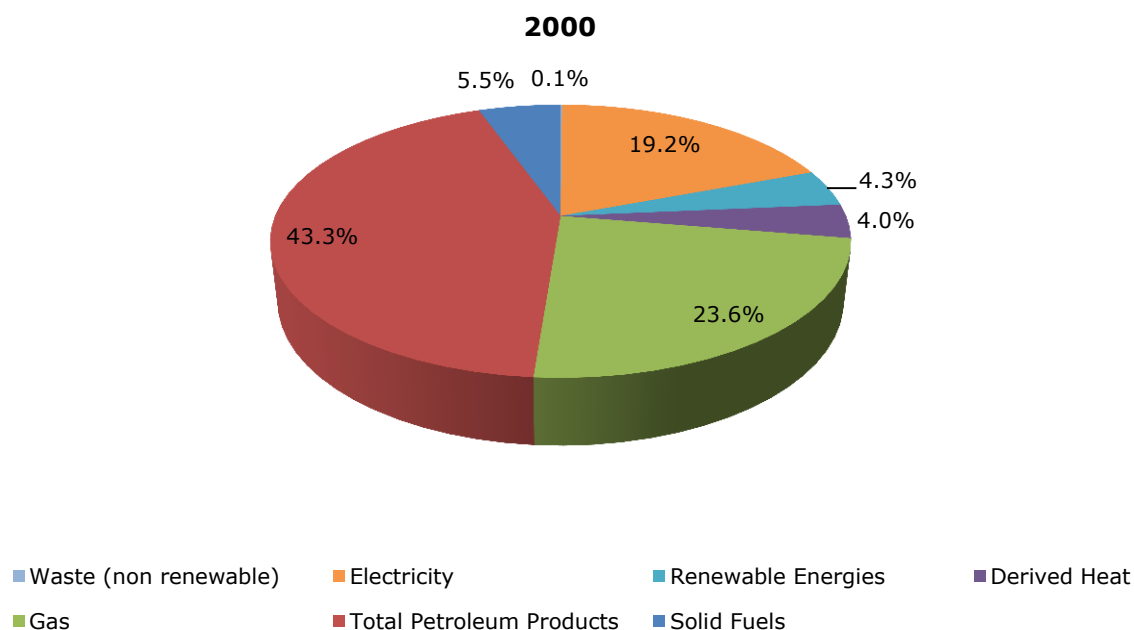


Source: Eurostat

<sup>28</sup>Renewable energy sources other than hydro power, wind power, tide, wave and ocean energy, and solar photovoltaic. These sources are accounted under the contribution generated by electricity consumption.



**Figure 19:** Share of energy source to final energy consumption in the EU-28, 2000 and 2015



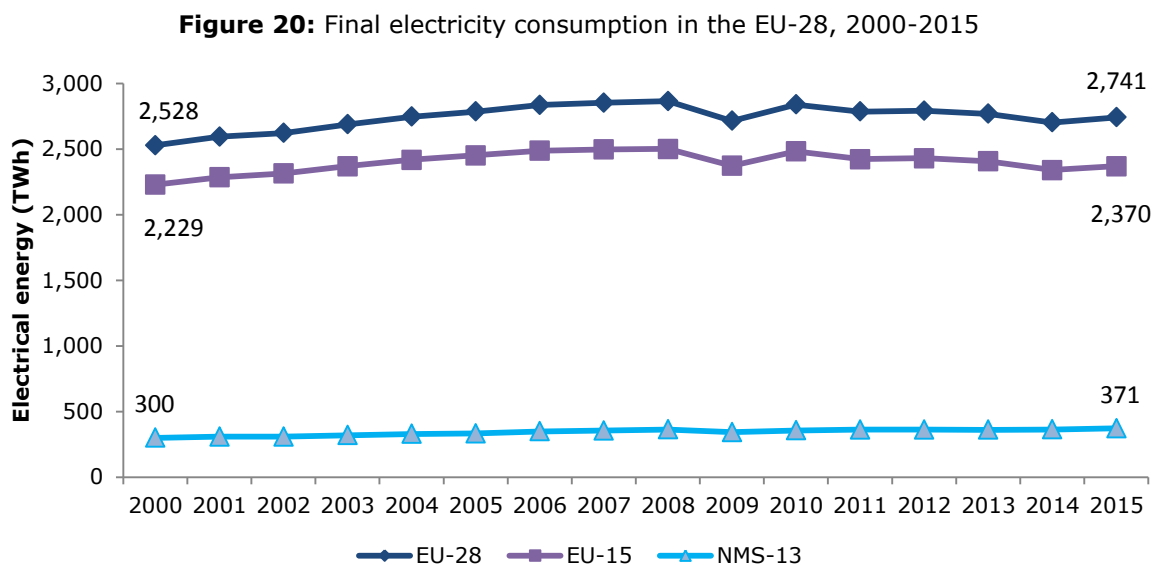
With regard to the shares of the different energy sources, from 2000 to 2015 electricity has raised its share (by 2.5%), renewable energy sources' share has notably augmented (nearly doubled), derived heat's share has remained almost stable, while the shares of solid fuels, gas, petroleum and oil product have decreased by 1.2%, 1.8% and 3.7% respectively.

## 2.5 Final electricity and gas consumption in different sectors

This subchapter covers the analysis of electricity and gas consumptions in different sectors over the period 2000-2015 in the 28 countries of the European Union.

### Final Electricity consumption

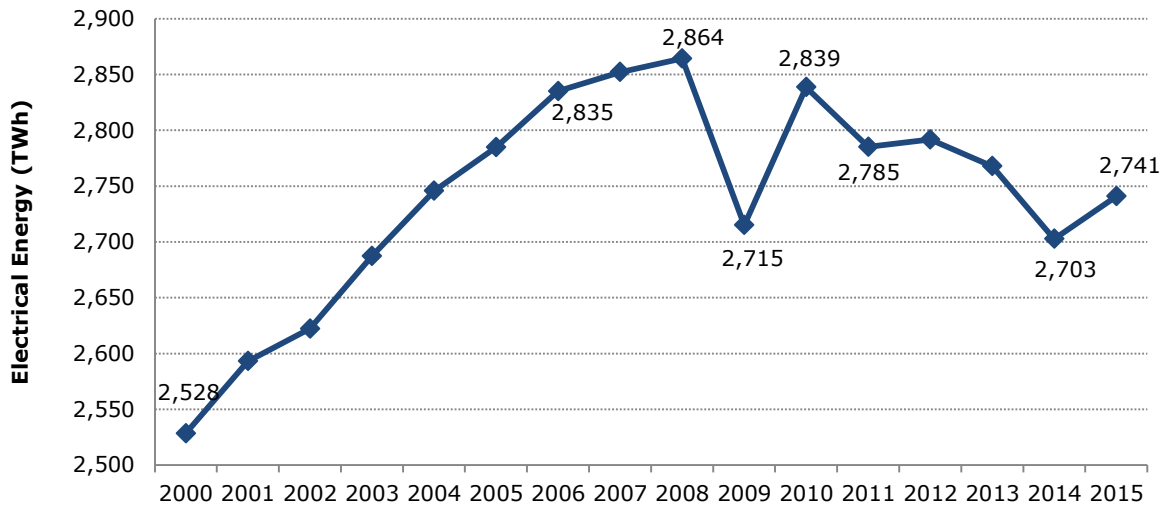
In 2015, total electricity consumption across the EU-28 countries was 2,741 TWh. It corresponds to an increase of 8.4% in comparison to year 2000, when the electricity consumption was 2,528 TWh (**Figure 20**). 86.5% of the total electricity consumption was made by EU-15 (2,370 TWh), while NMS-13 consumed 13.5% (371 TWh) of electricity.



Source: Eurostat

**Figure 21** provides a detailed picture of the electricity consumption trend at the EU level. From 2000 to 2006 the EU region experienced a positive steady annual growth rate from 1% to 2.5%. In 2008 the electricity consumption reached its maximum level (2,864 TWh). A fall by 5.2% occurred in 2009, followed by an increase of 4.57% in 2010. From 2011 to 2014 it is possible to observe a decrease in the electricity consumption, followed by a new increase in 2015. In the period 2010-2015, electricity has undergone a drop by 3.5%.

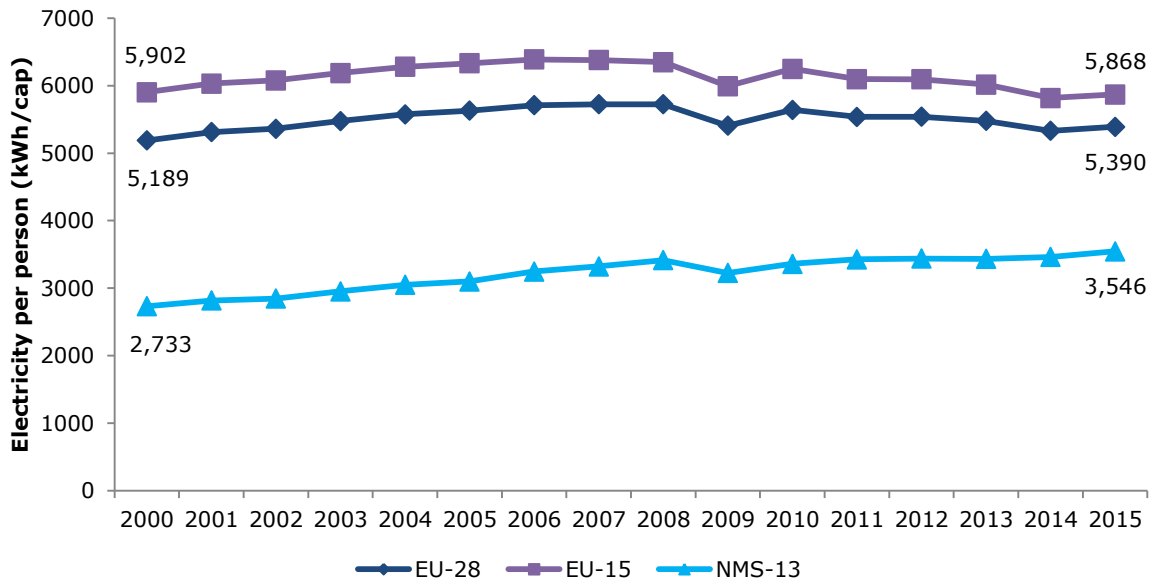
**Figure 21:** Electricity consumption in the EU-28, 2000-2015



Source: Eurostat

In 2015, final electricity per capita consumption was 5,390 kWh, a rise by 3.9% in comparison to 2000. There is a sharp difference within the EU-28 on average terms a person living in NMS-13 consumes 1.65 times less energy than a person living in EU-15. Despite of this, the final electricity consumption per capita in NMS-13 has grown by 29.7% in the analysed 16-year period, while EU-15 has reduced its consumption by -0.6% (Figure 22).

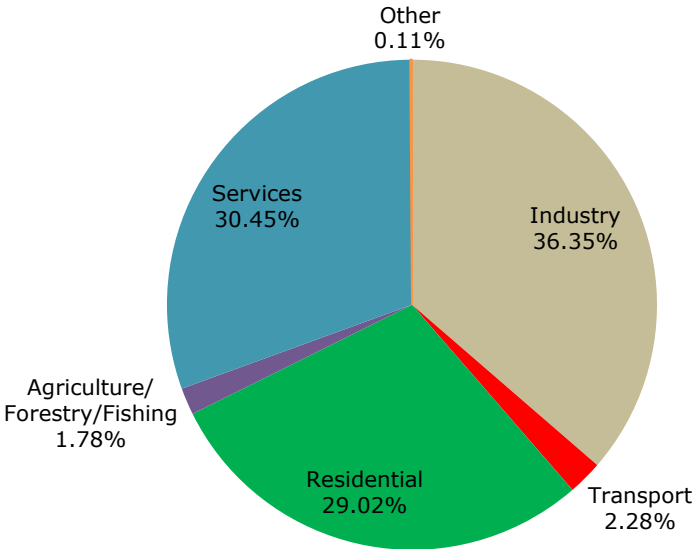
**Figure 22:** Final electricity per capita consumption in the EU-28, 2000-2015



Source: Eurostat

Three sectors account for 95% of the electricity consumption in EU-28. 36.4% of the electricity is consumed in the industry sector, 30.5% in the service sector and 29.0% in the residential (Figure 23).

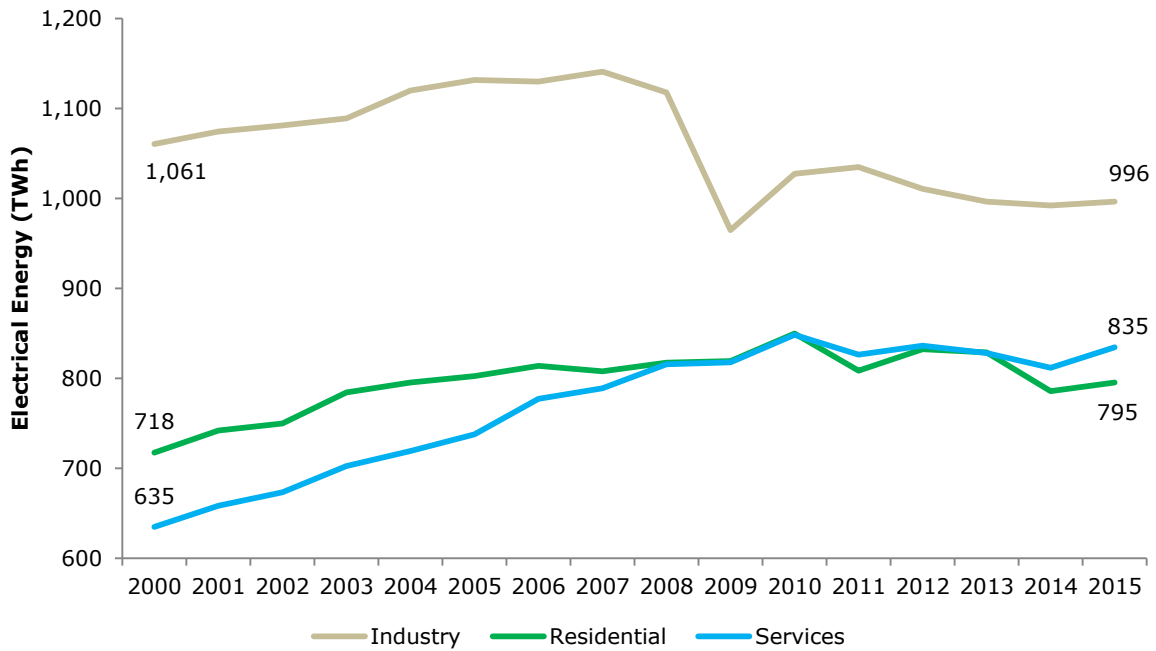
Figure 23: Electricity consumption breakdown into sectors in the EU-28, 2015



Source: Eurostat

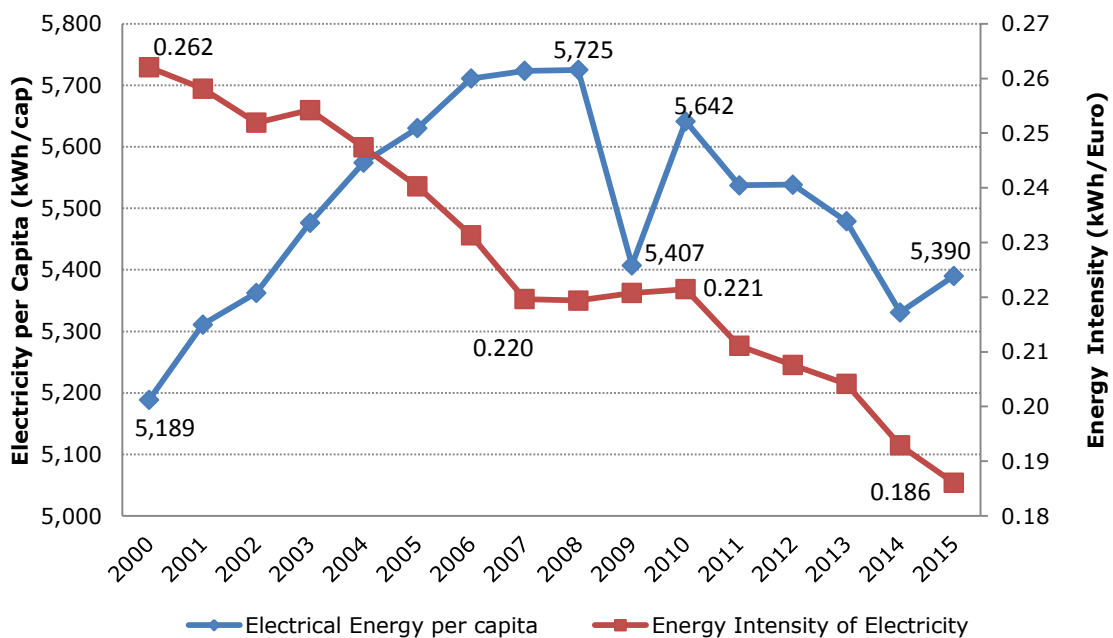
In the period 2000-2015, the industry sector has always been the sector with the highest electricity consumption, reaching a maximum of 1,141,034 TWh in 2007. For the same sector, a dramatically drop of 14% in the electric consumption took place between 2008 and 2009, as a result of the impact of the financial crisis. Since 2011, it can be observed a slight lowering trend in the electricity consumption at European level, interrupted by a small increase in 2015. Residential and Service sectors had different growth rates from 2000 to 2008. Since then these sectors have undergone similar trends as illustrated in Figure 24.

**Figure 24:** Final electricity consumption dynamics through main consuming sectors in the EU-28, 2000-2015



Source: Eurostat

**Figure 25:** Energy indicators for final electricity consumption: electricity per capita and electrical energy intensity<sup>29</sup> in the EU-28, 2000-2015



Source: Eurostat

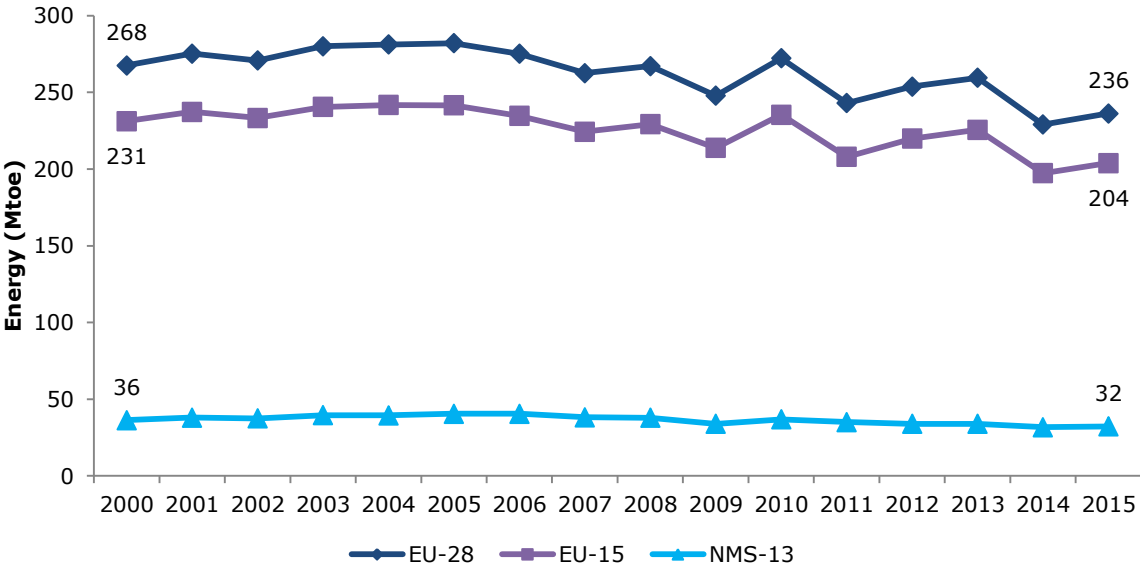
<sup>29</sup> GDP values at market prices have been considered to calculate the energy intensity values reported in the graph.

**Figure 25** describes the trend of the energy intensity of the final electricity consumption and the trend of final electricity consumption per capita. In 2015 the energy intensity of the final electricity consumption was 0.186 kWh/Euro, the lowest value over the analysed 16-years period. In the period from 2000 to 2015, the energy intensity of the final electricity has gradually dropped by 0.076 kWh/Euro. Between 2007 and 2010, the value remained stable around 0.22 kWh/Euro. In the period 2000-2015, the final electrical energy consumption per capita has grown by 201 kWh/cap. This indicator reached a maximum in 2008 with 5,725 kWh/cap, followed by a fall of 318 kWh/cap in 2009. From 2010 to 2014, this indicator has continuously dropped with the exception of year 2012 in which remained quite stable. It increased in 2015, however staying below the level of 2013.

**Final Gas Consumption**

In 2015, the total gas consumption of the EU-28 countries reached 236.25 Mtoe (**Figure 26**). This established a drop of 11.9% in comparison to the level of year 2000 when the consumed gas was equal to 267.68 Mtoe. EU-15 was responsible for 86.3% of the total gas consumption, while NMS-13 consumed 13.6% (32.32 Mtoe) of gas.

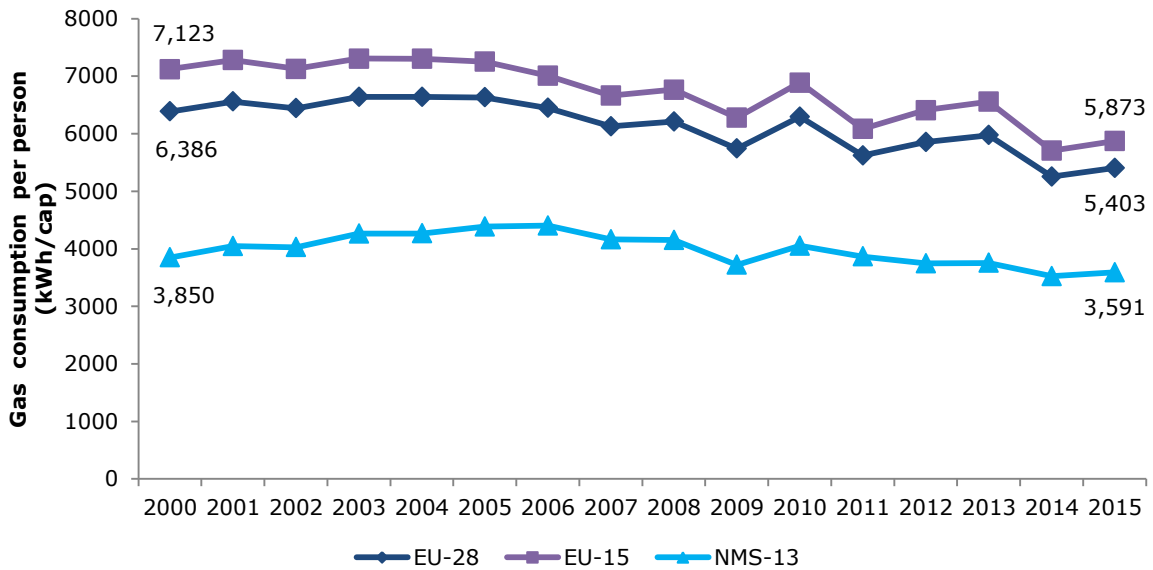
**Figure 26:** Final gas consumption trends in the EU-28, 2000-2015



Source: Eurostat

In 2015, the final gas consumption per capita in the EU-28 was 5,403 kWh/cap. This value represents a drop by 15.4% in comparison to year 2000. The overall trend shows a decrease in the gas consumption; this decrease has been more representative in the EU-15 where the gas consumption per capita has been reduced by 17.5% as shown in **Figure 27**. As in the case of final electricity consumption per capita, there is a remarkable heterogeneity across the EU-28 Member States as on average terms a person in EU-15 consumes 1.6 times more than a person in NMS-13.

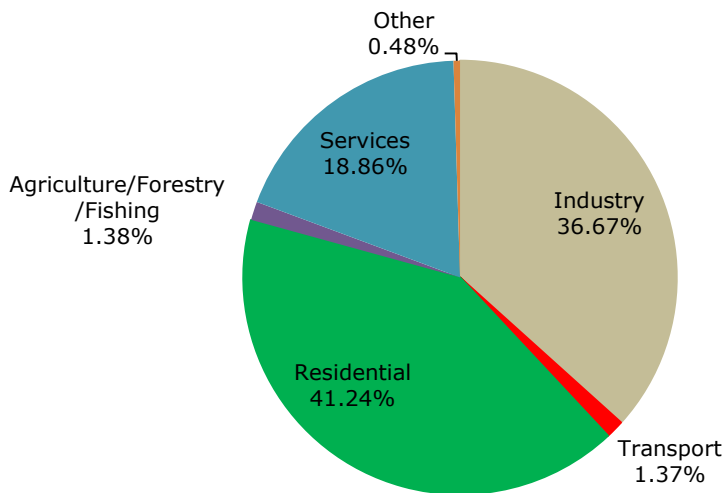
**Figure 27:** Final gas per capita consumption trend in the EU-28, 2000-2015



Source: Eurostat

As in the case of final electricity consumption, the gas consumption is located primarily in three sectors. Residential sector is the highest consumer of gas with 41.2%, followed by industry sector with 36.7% and service sector which accounts for 18.8% of total final gas consumption. The three sectors together cover the 96% of the gas consumption of the European Union, as illustrated in **Figure 28**.

**Figure 28:** Gas consumption breakdown into sectors in the EU-28, 2015

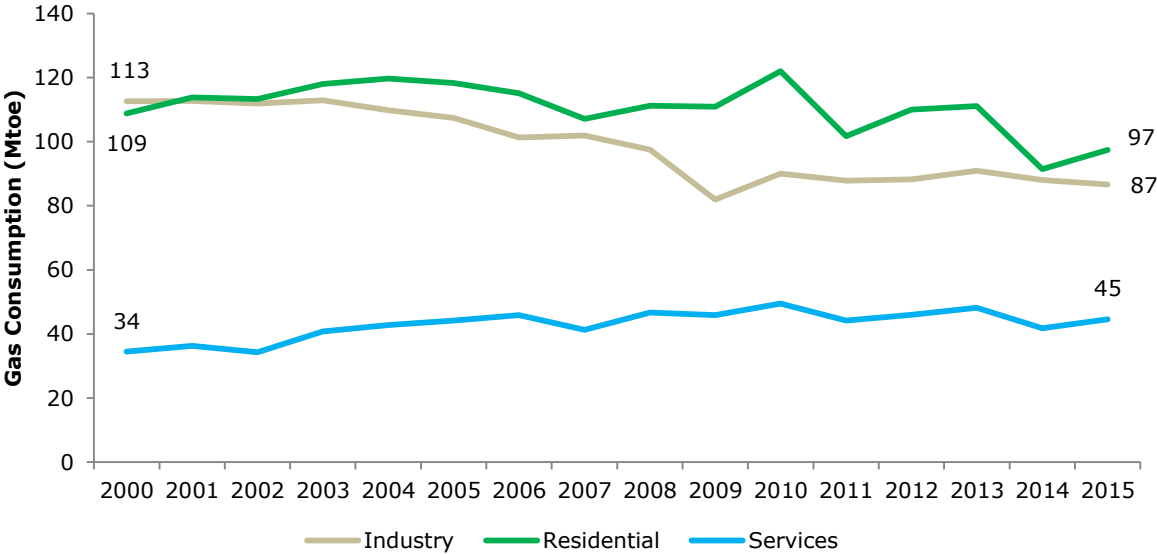


Source: Eurostat

**Figure 29** shows the gas consumption trend for the period 2000-2015 in three above mentioned sectors. In 2000, industry and residential sectors had the highest shares of

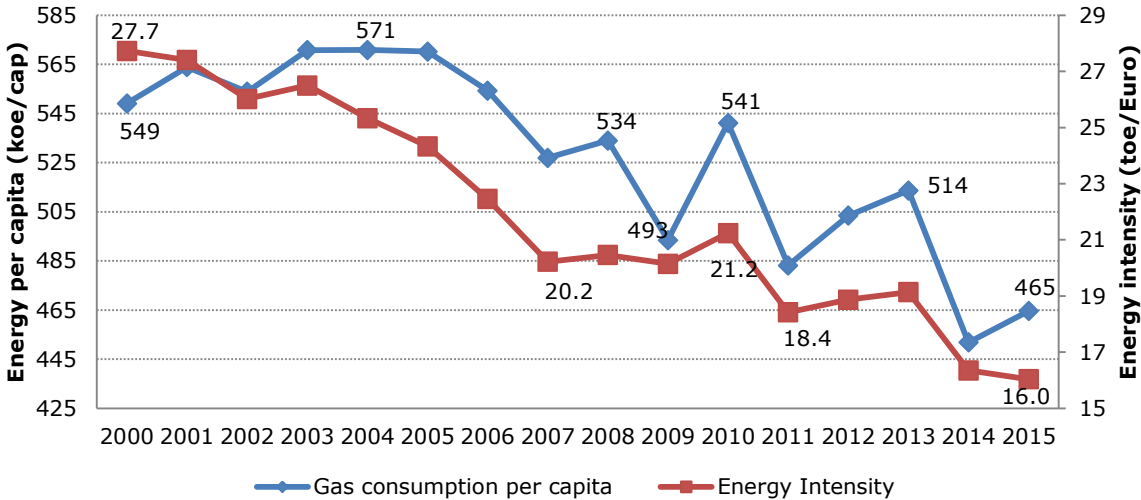
consumption of gas, 112.64 Mtoe (42.1%) and 108,80 Mtoe (40.7%) respectively. Over the period, the trends have reversed and their ranking has changed. Both sectors have occasionally experienced high changes in comparison to previous year, e.g. between 2008 and 2009 the consumption of gas in industry sector declined by 15.9% or between 2010 and 2011 it dropped by 16.6% in the residential sector. Overall both sectors have undergone a reduction of the gas consumption, while service sector has experienced a gradually increasing trend for the same period. To be noted that, from 2014 to 2015, gas consumption has increased in residential and services sector and has decreased in industry.

**Figure 29:** Final gas consumption dynamics through main consuming sectors in the EU-28, 2000-2015



Source: Eurostat

**Figure 30:** Energy indicators for final gas consumption: gas consumption per capita and gas energy intensity<sup>30</sup> in the EU-28, 2000-2015



Source: Eurostat

<sup>30</sup> GDP values at market prices have been considered to calculate the energy intensity values reported in the graph.



In 2015, the energy intensity of the final gas consumption was 16 toe/Euro; this value represents the lowest level during the analysed period. From 2000 to 2015, the energy intensity of the final gas has gradually dropped by 11.7 toe/Euro. Between 2007 and 2010, the value remained stable at 20.2 toe/Euro. In the period 2000-2015, gas consumption per capita decreased by 84 koe/cap. This indicator reached a maximum in 2004 with 571 koe/cap. Since 2007 it has registered continuous fluctuations. In 2014, the per capita gas consumption registered the lowest level over the analysed period. In 2015 it increased up to 465 koe/cap.

### 3 Energy Consumption and Energy Efficiency Trends in the Residential Sector

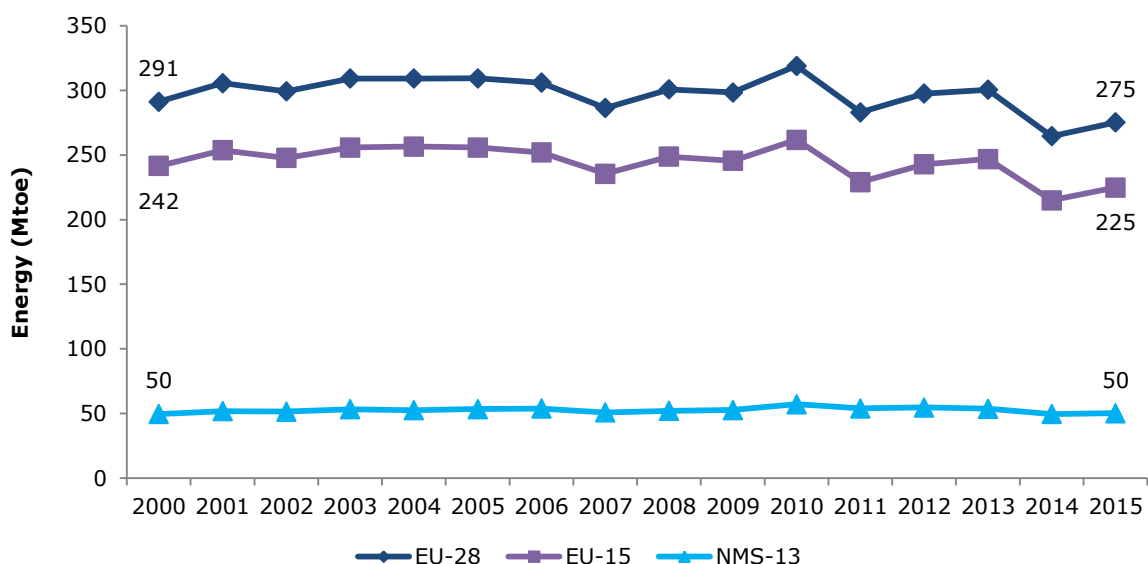
This chapter covers energy efficiency and energy consumption trends in the residential sector, with a focus on electricity and gas consumption. Consumption-related data are presented together with data regarding some main energy consumption drivers such as economic growth, population growth, weather conditions, and household characteristics.

#### 3.1 Final energy consumption trends in the residential sector

This section shows the final residential energy consumption trends for the period 2000-2015. Influencing factors in the energy consumption such as economic development and weather conditions are also qualitatively analysed. In 2015, the residential sector represented 25.38% of the final energy consumption in the European Union, being the third consuming sector after transport (33.09%), and industry sector (25.35%). By analysing the data concerning the residential consumption, it is possible to observe that the final energy consumption in the residential sector followed a fluctuating dynamics, with a significant decrease of 11.25% and 11.97% in 2011 and 2014 respectively.

**Figure 31** shows the final residential energy consumption trend at European level over the period 2000-2015. It can be observed that, after a peak in 2010 (319 Mtoe), the energy consumption has reached its minimum in 2014 (265 Mtoe). These two values represent the maximum and minimum respectively for the 26-years period from 1990 to 2015. During the period 2000-2015, the final residential energy consumption in the EU-28 has dropped overall by 5.5%, from 291 Mtoe to 275 Mtoe. In 2015, 81.8% (225 Mtoe) of the final energy consumption in the residential sector has been consumed in EU-15, whereas NMS-13 have accounted for the remaining 18.2% (50 Mtoe). During the analysed period the group of EU-15 has undergone a reduction of 7% of its residential consumption; the group of NMS-13, instead, has maintained its consumption around the level of year 2000.

**Figure 31:** Final residential energy consumption in the EU-28, 2000-2015.

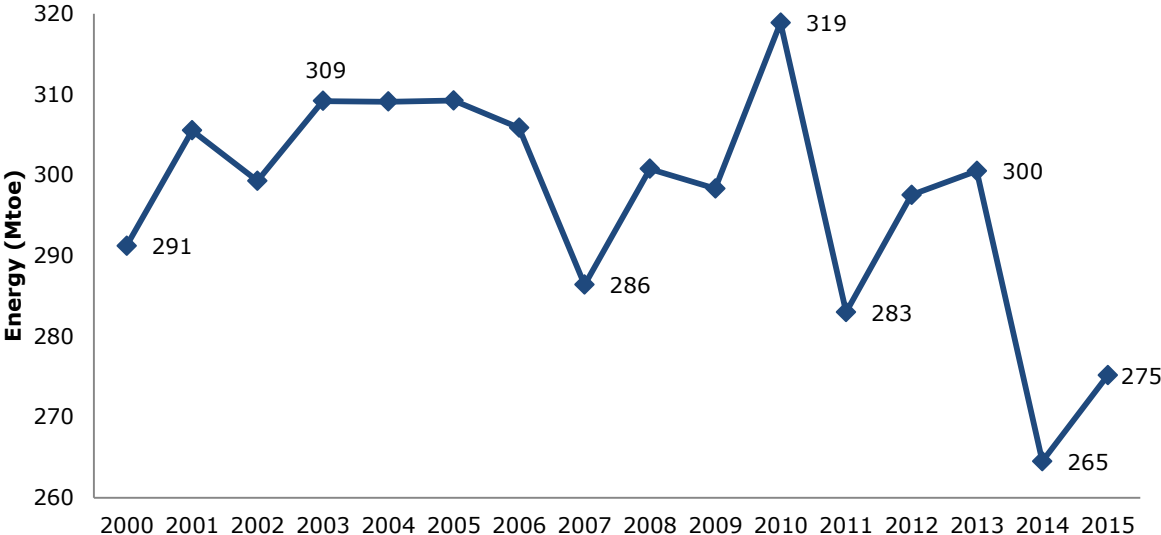


Source: Eurostat

**Figure 32** and **Figure 33** complement the previous figure by providing a more fine-grain visualisation of the evolution of the final residential energy consumption and a visualisation of the yearly growth rates over the period 2000-2015. In this way it is

possible to have an idea about the magnitude of the variation across years, both in absolute and relative terms. It can be observed that from 2003 to 2006 the consumption remained quasi-constant with the highest change of -1.09% between 2005 and 2006. Since 2007 onwards, the final residential energy consumption has registered a continuous fluctuation. To be noted that annual decrease rates are generally higher in absolute value compared to annual increase rates observed in this period. In 2015, there has been an increase of 4.02% in final residential energy consumption.

**Figure 32:** Final residential energy consumption in the EU-28 (detailed), 2000-2015



Source: Eurostat

**Figure 33:** Final residential energy consumption annual growth rates in the EU-28, 2000-2015

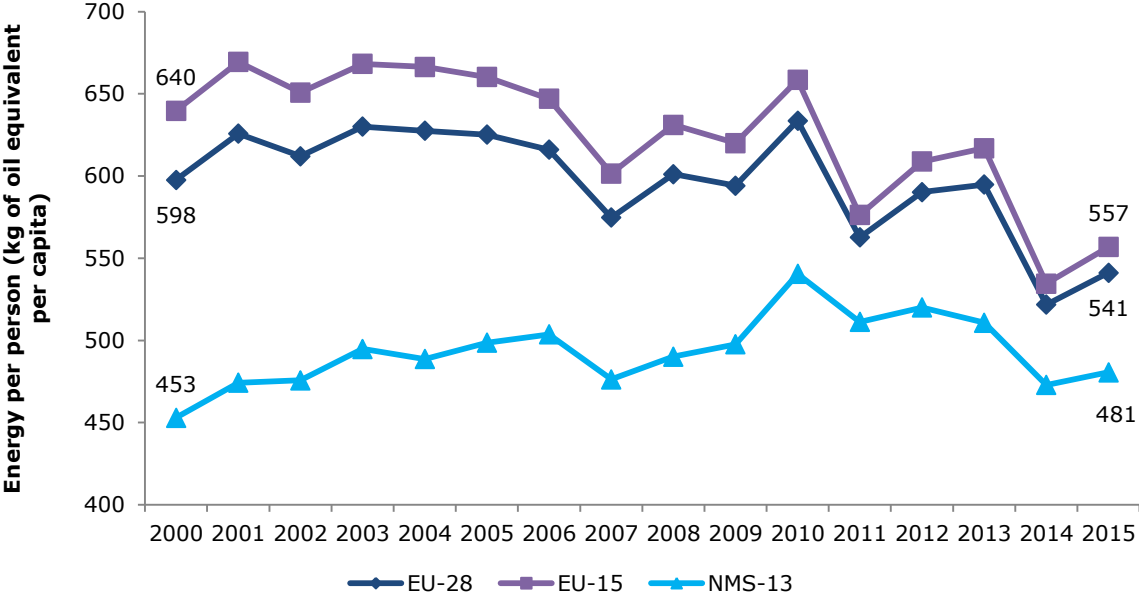


Source: Eurostat

Per capita final energy consumption in the residential sector has lowered by 57 koe at European level from 2000 to 2015, this lowering representing a drop of 9.5%. The trend

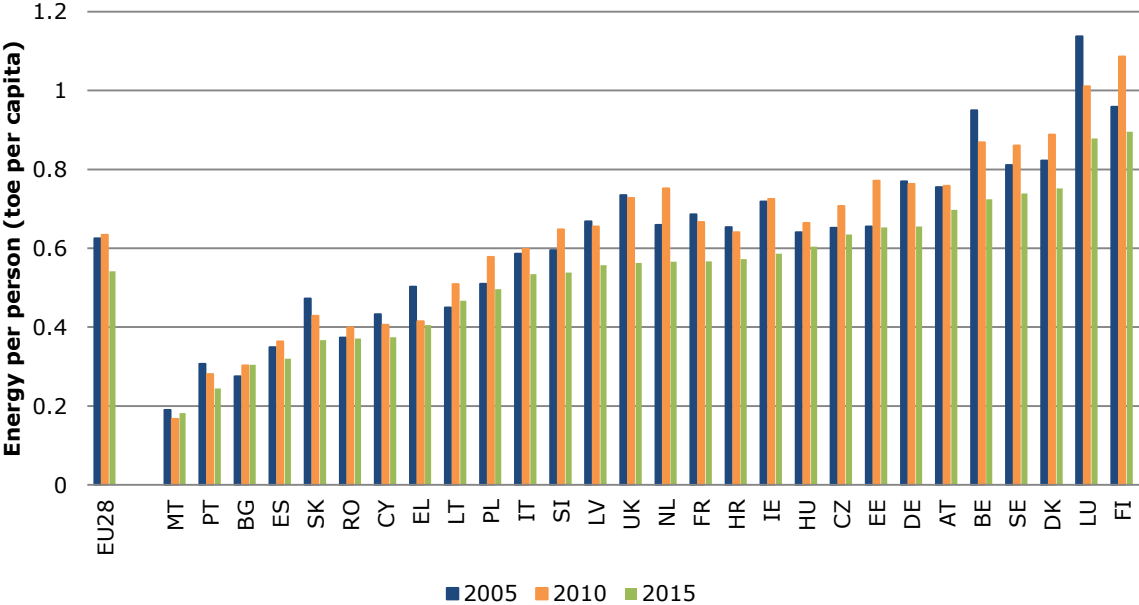
of this indicator mainly follows that of the final residential energy consumption, as the changes in the population growth rates have been much less sharp than the energy consumption changes. Therefore, despite the fact that the EU-28 population has been continuously growing, its influence on the final residential energy consumption annual changes is quite limited.

**Figure 34:** Final residential energy consumption per capita in the EU-28, 2000-2015



Source: Eurostat

**Figure 35:** Final residential energy consumption per capita by EU-28 Member State, in 2005, 2010 and 2015



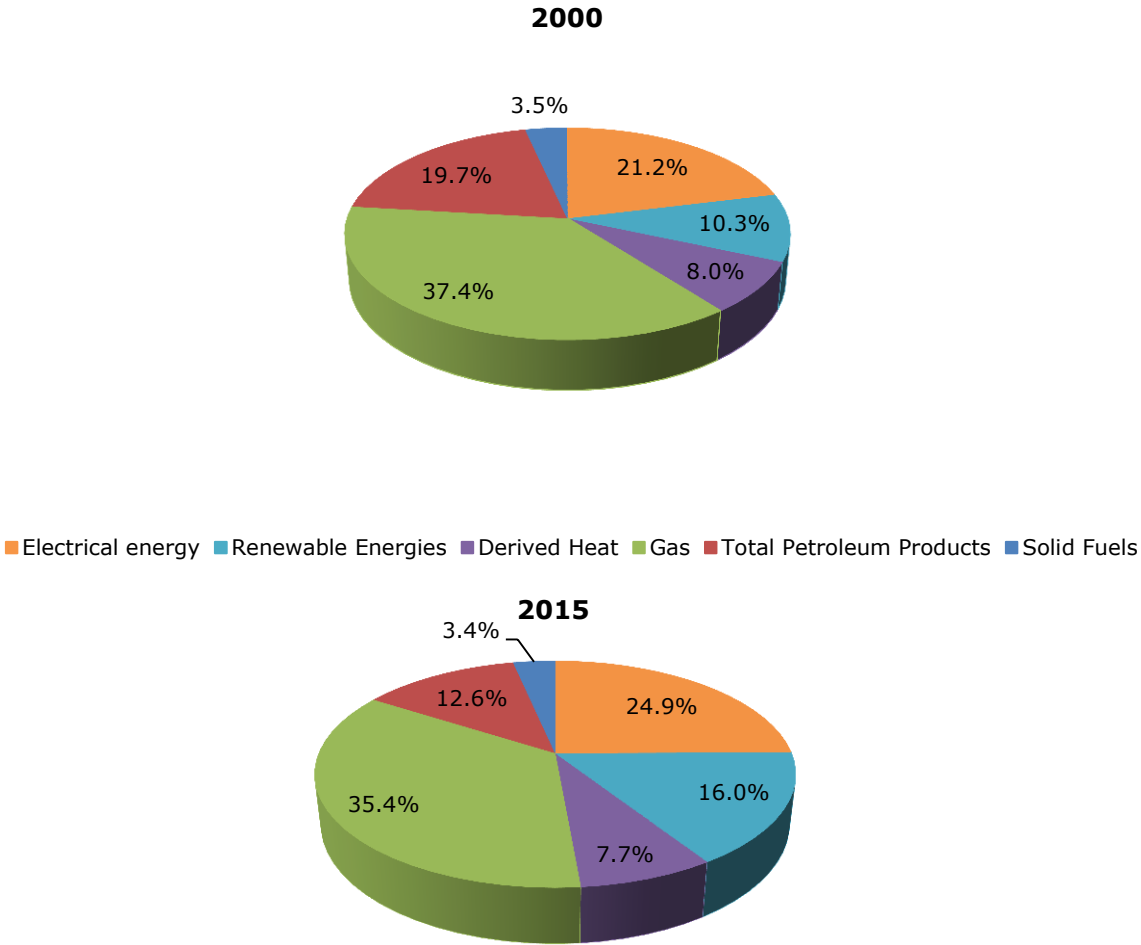
Source: Eurostat

When analysing the final residential energy per capita by Member State (**Figure 35**), it is observed that in 2015 the countries with highest consumption are Finland with 0.90 toe/cap, followed by Luxembourg (0.88 toe/cap) and Denmark (0.75 toe/cap). In

contrast, Malta, Portugal and Bulgaria have the lowest values with 0.18, 0.24 and 0.30 toe/cap respectively. The average EU-28 value has dropped by 13.44% in the period between 2005 and 2015 (from 0.625 toe/cap to 0.541 toe/cap).

Almost half of the Member States, i.e. twelve countries, have registered a final energy consumption per capita below the average of EU-28 (< 0.541 toe/cap) in 2015. Out of these countries, six have mainly or solely Mediterranean climate. These countries are: Malta, Portugal, Spain, Cyprus, Greece, and Italy. This result may indicate that climate is an important driver of residential energy consumption as mild winters lead generally to lower energy consumption. To be noted that the remaining 6 countries belong to the group of NMS-13. Rather than by energy efficiency policies in force, this might be caused by factors such as cultural habits, economic development, or availability of energy resources in comparison to other EU-28 countries.

**Figure 36:** Share of fuel types to final residential energy consumption in the EU-28, 2000 and 2015



Source: Eurostat

**Figure 36** shows the share of each energy type to final residential energy consumption. In 2015, gas has accounted for 35.4% of the consumption, followed by electrical energy (24.9%) and renewable energies (16.0%). The share of electricity includes electricity generated from renewable energy sources which are integrated into the electrical network (i.e. wind power, photovoltaic power, hydro power and tide, wave and ocean

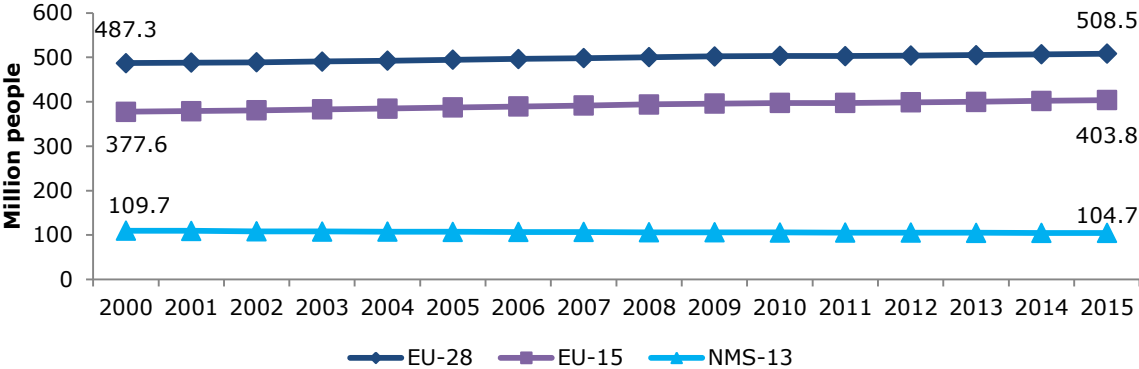
energy). Therefore, the share of renewables mainly focuses on production of heat from renewable resources.

As gas and electricity are the main energy sources for the residential sector, their consumption trends have been analysed independently later in this chapter.

**Factors influencing residential energy consumption**

When analysing energy consumption, it is important to consider influencing factors such as population growth, economic development and weather conditions. No quantitative analysis aiming to assess the influence of these factors is presented in this report. Nevertheless, possible explanations for the registered consumption patterns are proposed, by simply comparing energy consumption trends with the trends registered for the following variables in the period 2000-2015: population, GDP per capita, weather conditions (actual heating degree days), number of dwellings per country, average number of persons per household. Considering the influence of these factors can provide a better understanding of the relation between energy consumption and efficiency trends in the residential sector.

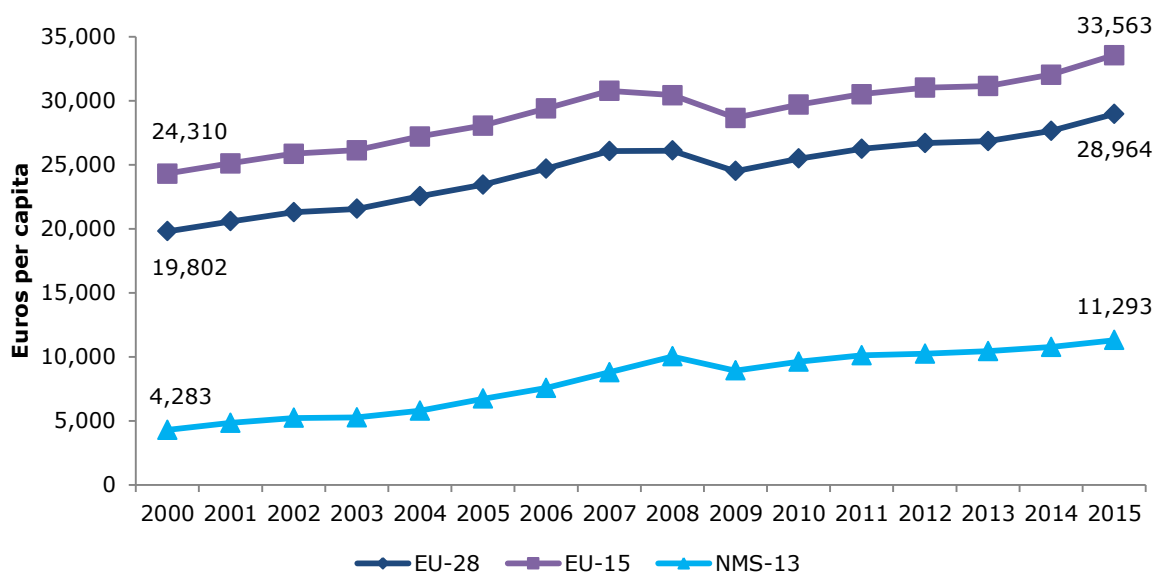
**Figure 37:** Population in the EU-28, 2000-2015



Source: Eurostat

Between 2000 and 2015 the population in the EU-28 grew by 4.35%. In the same period the residential final energy consumption dropped by 5.5%. In the EU-15, the population grew by 6.94% between 2000 and 2015. On the other hand the population in the NMS-13 decreased by 4.56% in the same period. This means that the constant level of the total residential energy consumption observed in the NMS-13 turns into an increase in the energy consumption per capita, due to the population’s decrease for the period 2000-2015, as it is possible to understand looking at the same time at **Figure 31**, **Figure 34** and **Figure 37**.

**Figure 38:** Gross Domestic Product per capita at current market prices in the EU-28



Source: Eurostat

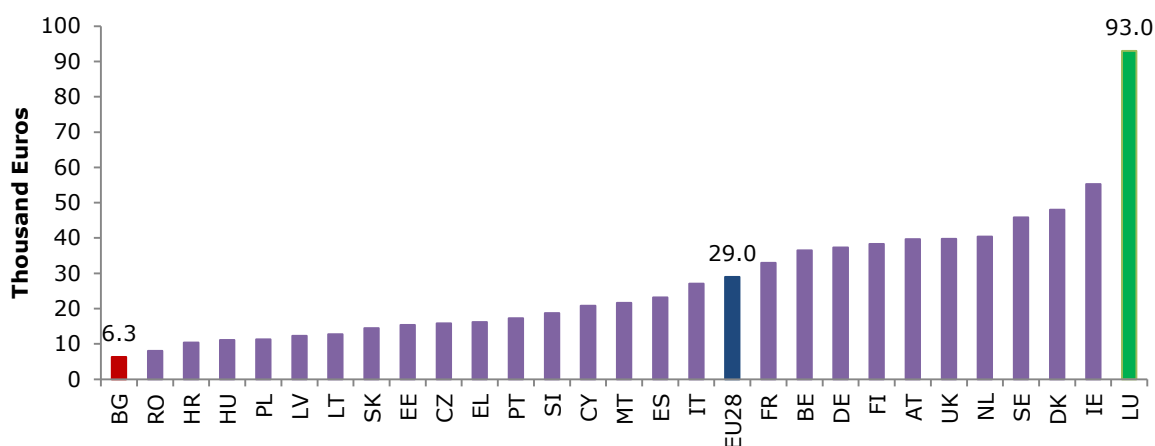
Other factors that can influence energy consumption are the economic development and the economic situation of the countries. GDP per capita<sup>31</sup> in the EU-28 (**Figure 38**) has been continuously increasing between 2000 and 2015 with a single fall in 2009 due to the economic and financial crisis worldwide. Between 2009 and 2010 the GDP per capita increased again by 4% in the EU-28. The GDP per capita across countries in the EU-28 for the year 2015 results very largely dispersed as illustrated in **Figure 39**. The GDP per capita in Bulgaria was EUR 6,288 whereas GDP in Luxembourg was EUR 92,973 in 2015. The average GDP per capita in the EU-28 was EUR 28,964. While GDP per capita over the period 2000-2015 increased by 46.27%, final residential energy consumption per capita fell by 9.5% in the same period. Given the large dispersion in GDP per capita in the EU-28 it is of interest to look at the disaggregated data per country for what regards final residential consumption (**Figure 35**). Finland, Luxembourg and Denmark which are the countries with highest consumption per capita also have above average GDP per capita. This could suggest that higher GDP levels may indeed lead to buy more energy, by using equipment at home resulting in higher energy consumption.

The growth in GDP per capita, despite the population's increase, can be attributed to important economic developments during these years. A comparison between economic growth and energy consumption growth indicates that the observed significant economic growth has not been accompanied by an increase of the same magnitude in energy consumption.

It is clear that economic development is positively correlated with total final energy consumption. However, especially in the residential sector, economic growth in the EU might have been accompanied by a more efficient usage of energy, due to the adoption of more energy efficient equipment. In the household sector a development in this sense can result from more efficient appliances and systems and better insulated buildings in general.

<sup>31</sup> All GDP numbers are given in current prices as of the year 2015 (source: Eurostat).

**Figure 39:** GDP per capita at current market prices in the EU-28, year 2015



Source: Eurostat

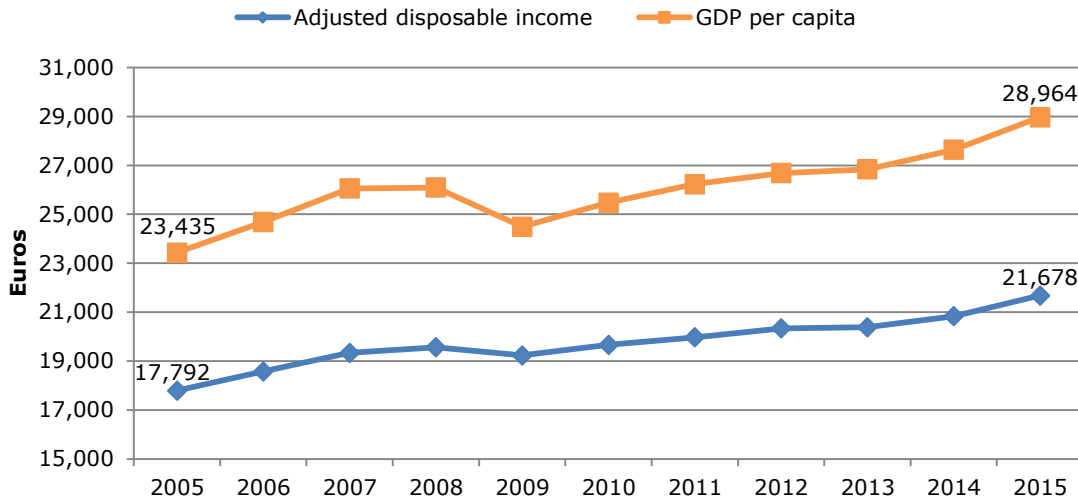
Although Gross Domestic Product is largely and traditionally used in energy statistics for obtaining key indicators such as energy intensity, the disposable income of households, or adjusted gross disposable income, can represent a more interesting economic indicator for the analysis of residential energy consumption.

Disposable income of households may be defined as the net amount they have earned, or received as social transfers, during the accounting period excluding exceptional flows linked to capital transfers or changes in the volume/value of their assets minus current transfers in cash (taxes on income and wealth, etc.). It is mainly composed of wages received, revenues of the self-employed and net property income such as interest received on deposits minus interest paid on loans and dividends.

Adjusted gross disposable income also includes social transfers that account for the flows of individual services which are provided free of charge by the government. These services mainly consist of education, health and social services but also housing, cultural and recreational services. They exclude collective services that are provided simultaneously to all the members of the community, such as security and defence, legislation and regulation. Thus, adjusted disposable income improves the comparison of income levels across countries, by taking into account the different degrees of involvement of governments in the provision of free services to households [4]. **Figure 40** shows the trend-line comparison of both adjusted disposable income per capita and GDP per capita for the 11-years period between 2005 and 2015. It can be observed that there is a notable difference between these two variables; in 2015 the difference reached EUR 7,286. Thus the GDP, although largely used, if adopted in the analysis of the residential sector may turn into an unfavourable indicator for end-users in so far as it does not reflect the real purchasing power of the inhabitants.



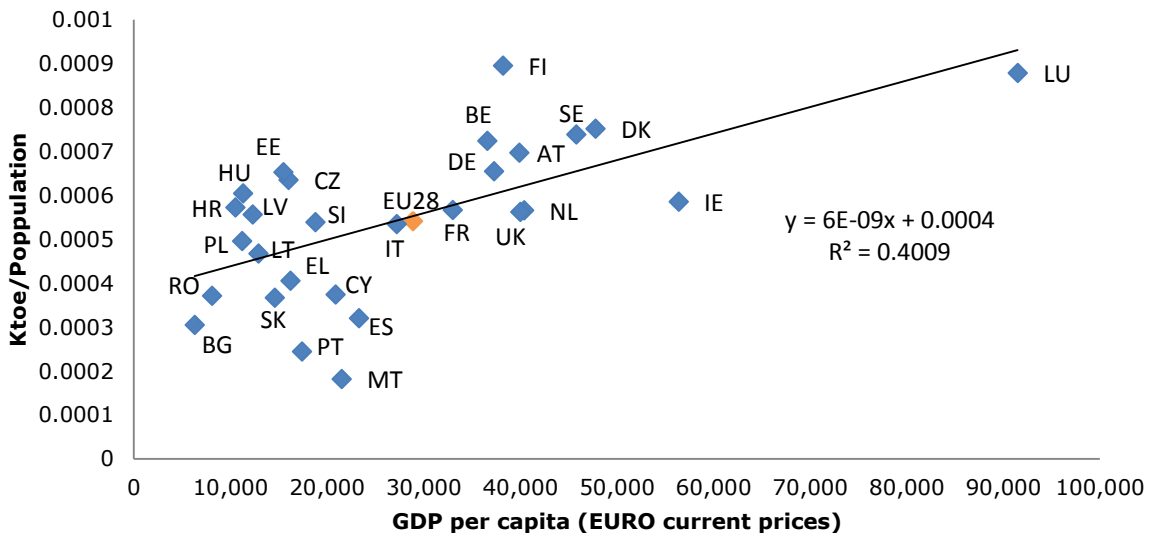
**Figure 40:** Adjusted disposable income per capita and GDP per capita at current market prices in the EU-28, 2005-2015



Source: Eurostat

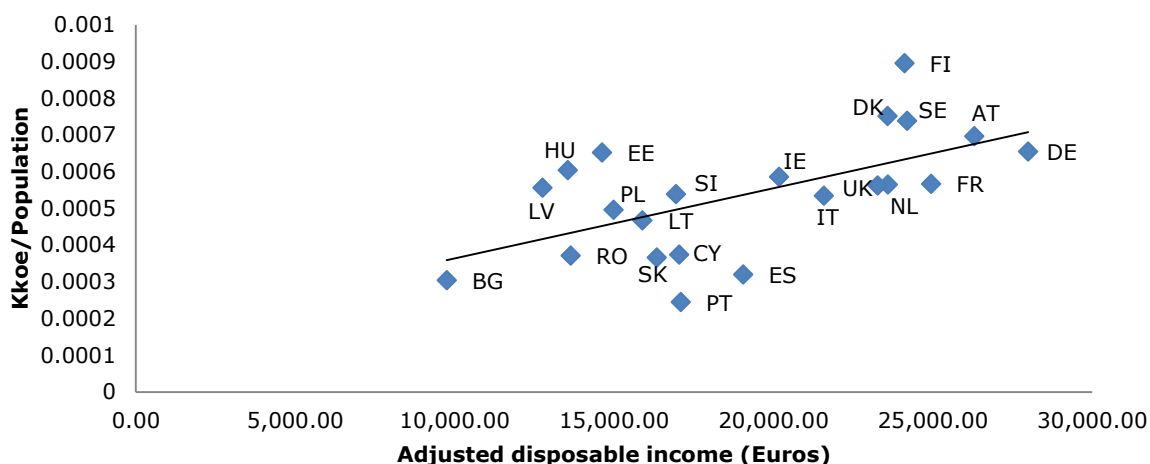
**Figure 41** shows the correlation between residential energy consumption per capita and GDP per capita, while **Figure 42** shows the correlation between energy consumption per capita and adjusted disposable income. In the first case it is not possible to trace a clear path for the residential consumption based just on the GDP per capita, with the only exception of the Nordic countries where the correlation between GDP per capita and energy consumption is probably higher. In the case of adjusted disposable income the correlation with energy consumption seems to be generally stronger, despite still very weak.

**Figure 41:** Correlation between residential energy consumption and GDP per capita (current prices) in the EU-28 Member States, 2015



Source: Eurostat

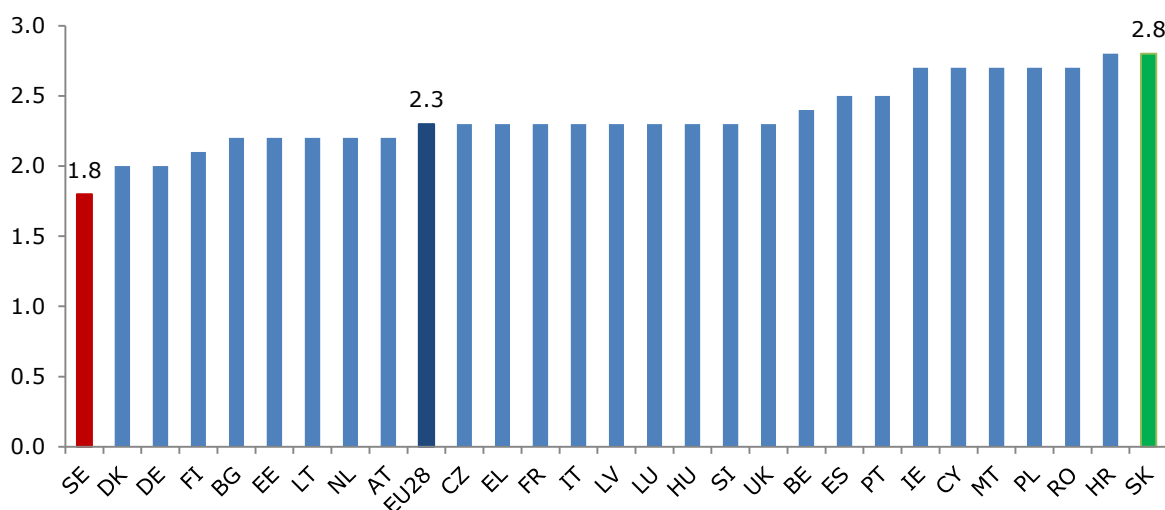
**Figure 42:** Correlation between residential energy consumption and Adjusted disposable income in the EU-28 Member States<sup>32</sup>, 2015



Source: Eurostat

Per capita residential energy consumption is also influenced by the number of people living together in one household. Most of the energy-using equipment is indeed shared (e.g. heating and cooling equipment, major domestic appliances and electronic equipment). The average number of persons per household in the EU-28 was 2.3 in the year 2015. Sweden and Denmark have the lowest average number of persons per household (1.8 and 2) and Slovakia the highest (2.8), as shown by **Figure 43**. Notice that Luxembourg has the highest GDP per capita and also an above EU-28 average household size. Looking at the trends displayed by Eurostat data it is possible to notice that the overall trend in Europe is an increase in population accompanied by an increase in the number of smaller households (in terms of persons per household) which seems to contribute to a rise in energy consumption per household.

**Figure 43:** Average number of people per household in the EU-28 Member States, 2015

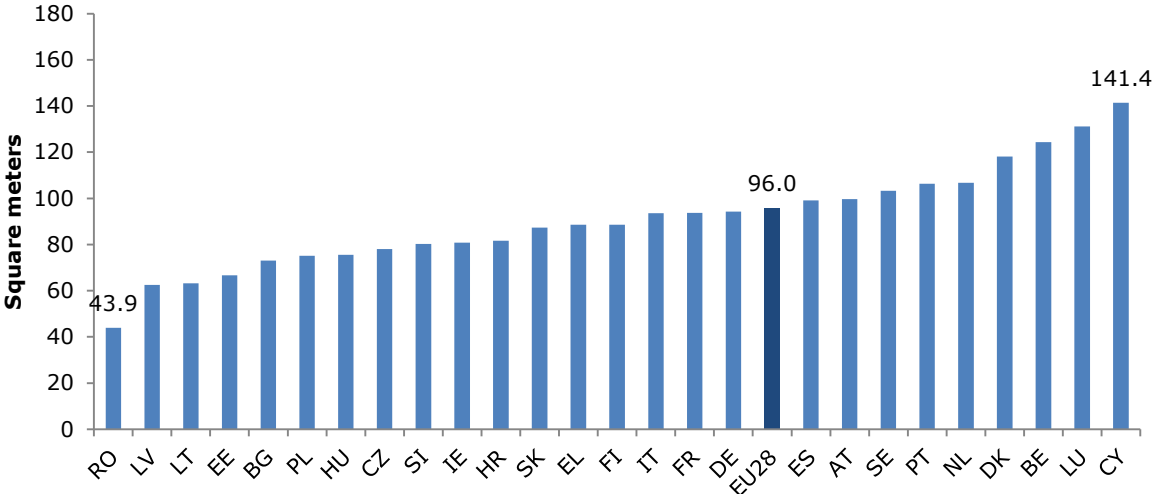


Source: Eurostat

<sup>32</sup> Data on the adjusted disposable income are not available for LU and MT.

In addition to the number of people per household, the actual size in square meters of household dwellings is another interesting indicator of the households' energy consumption. Large dwellings generally have a higher heating and cooling demand and higher energy consumption by lighting equipment. Romania is one of the Member States with the largest average number of persons per household (2.7) but it has the smallest dwellings average size. Cyprus, Luxembourg and Belgium are the Member States with the largest average size of dwellings.

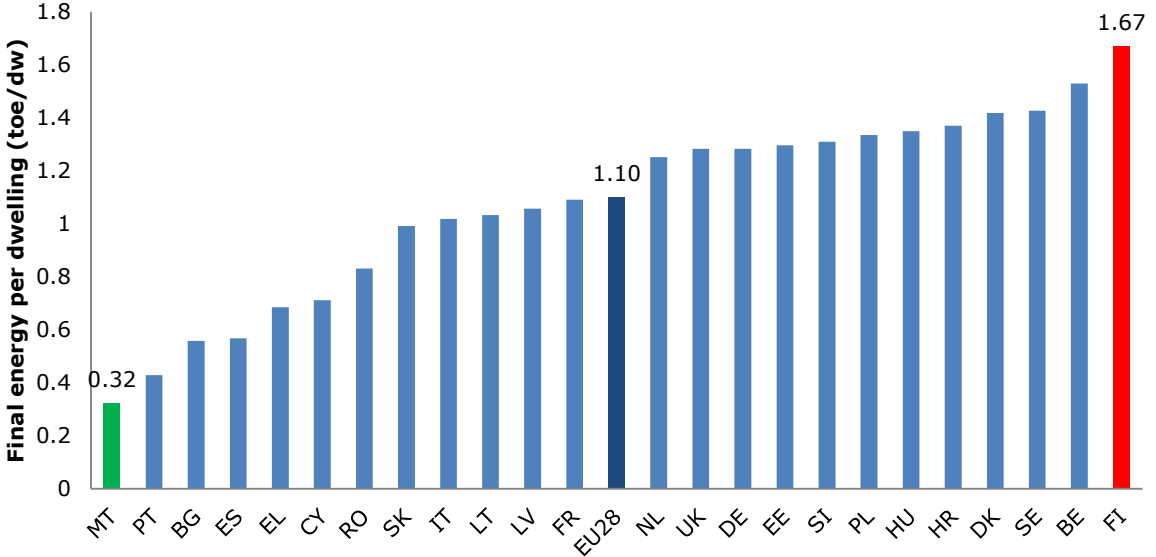
**Figure 44:** Average size of dwellings for countries with available data in the EU-28, year 2012<sup>33</sup>



Source: Eurostat

The average final residential energy consumption per dwelling in the EU-28 in the year 2015 reached 1.10 toe. Finland registered the highest consumption (1.67 toe) and Malta (0.32 toe) the lowest.

**Figure 45:** Final residential energy consumption per dwelling in the EU-28<sup>34</sup>, year 2015.



Source: JRC calculation based on Eurostat data

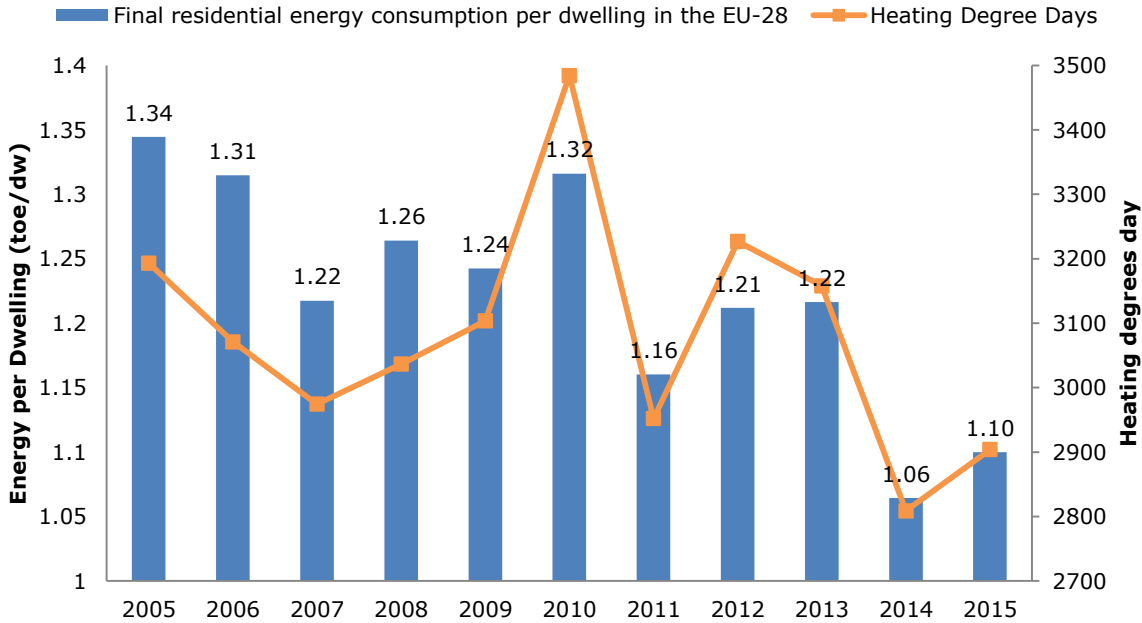
<sup>33</sup> Data for the following years are not available.

<sup>34</sup> Data for AT, CZ, IE, LU are not available.

Weather and climate are environmental conditions that affect energy consumption: for instance severity of winter or hot summer seasons can lead to occasional consumption peaks. The parameters which are related to the heating and cooling needs are the so-called heating degree days (HDD) and cooling degree days<sup>35</sup> (CDD).

The final residential energy consumption per dwelling has been decreasing during the 11-years period from 2005 to 2015 in the EU-28. In 2005 the residential consumption per dwelling was 1.34 toe. In 2015, the consumption per dwelling is 1.10 toe, meaning a decrease of 17.9%. Part of this decrease can be explained assuming an existing correlation between the calculated energy consumption per dwelling and the changing climatic conditions (heating degree days) as shown in the **Figure 46**. Variations in the final energy consumption per dwelling follows the HDDs variations with exception of variations observed between years 2008 and 2009 and between years 2012-2013. These exceptions might be explained by the influence of other factors, notably income levels, building design, energy systems and occupants behaviours. For instance, in 2009 the impact of the economic crisis on consumption may explain the negative correlation between final energy consumption and HDD, as GDP per capita and disposable income fell that year.

**Figure 44:** Final residential energy consumption per dwelling and heating degree days in the EU-28, 2005-2015



Source: Eurostat<sup>36</sup>, Odyssee

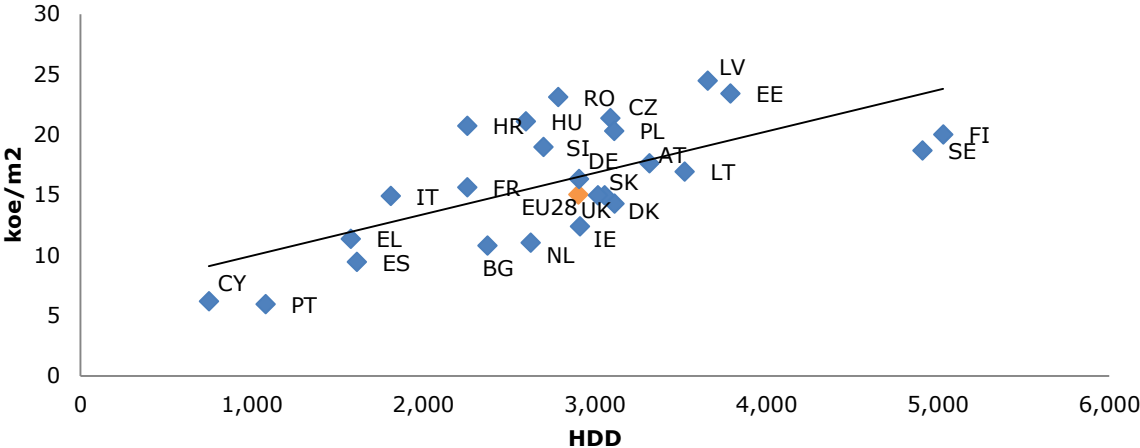
**Figure 47** shows the correlation between energy consumption per m<sup>2</sup> and HDD in the EU-28 Member States. The first evidence is that, as expected, countries with a colder climate have, on average, higher levels of residential consumption. The second, and more interesting evidence, is that countries with the same climatic conditions can perform very differently in terms of residential consumption. Countries below the trend line can be assumed to be more efficient countries in terms of residential consumption.

<sup>35</sup> A degree-day is defined as the difference in temperature between the outdoor mean temperature over a 24-hour period and a given base temperature. Per definition, the base temperature is 18°C. Thus, HDD and CDD are the number of degrees that a day's average temperature is below/above 18°C which is the outside temperature below which buildings need to be heated or cooled [Source: EEA].

<sup>36</sup> Final residential energy consumption per dwelling has been calculated by the report authors as the ratio between the final residential energy consumption and the total stock of dwellings in the EU-28 as made available by Odyssee.

Eastern European countries show higher level of residential consumption. Among the countries with a cold climate Sweden and Finland provide an example of relatively low level of residential energy consumption.

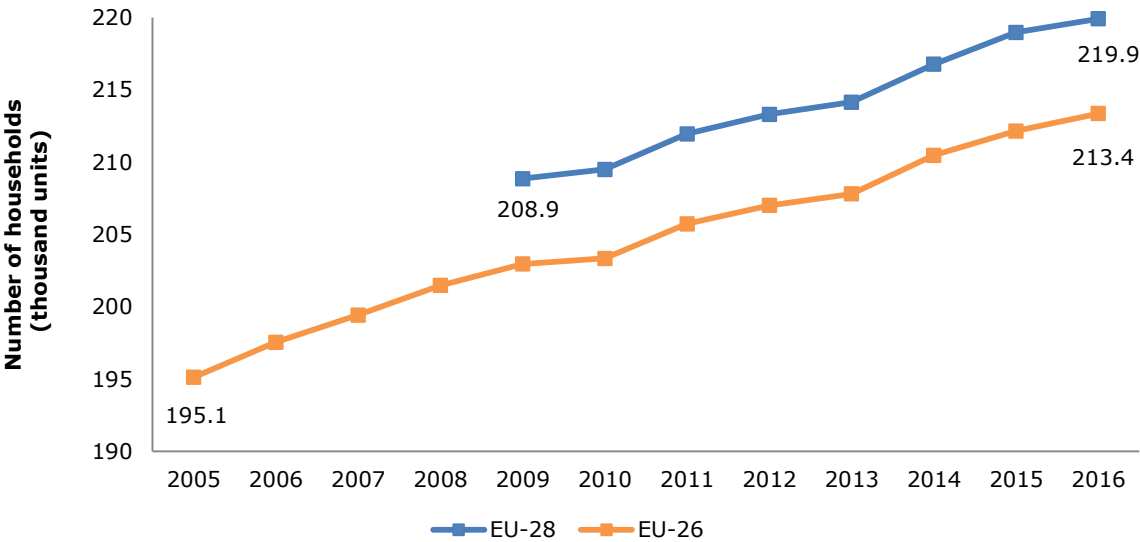
**Figure 45:** Correlation between HDD and residential energy consumption per floor size, in the EU-28 Member States<sup>37</sup>, 2014



Source: Eurostat, Odyssee

Although the number of private households in the EU-28 has been continuously growing and the size of houses in terms of persons per household has slightly decreased, the final residential energy consumption follows a decreasing trend.

**Figure 46:** Number of private households (in thousands) in the EU-28<sup>38</sup>, 2005-2016



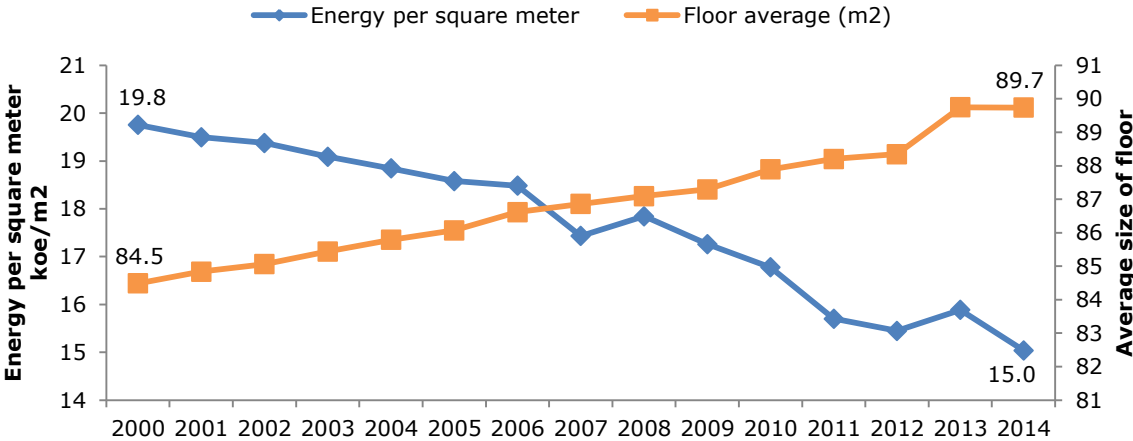
Source: Eurostat

<sup>37</sup> Data for BE, LU, and MT are not available.

<sup>38</sup> EU-26 excludes Ireland and Sweden. The complete time series for EU-28 is available starting from year 2009.

Between 2000 and 2014 the average size of dwelling did, however, not considerably change (increase by 5.2 sqm in the whole period). The decrease in consumption per dwelling during the same period can thus not be explained by smaller households, and it may be result of higher share of more efficient equipment and appliances, and other improvements in building elements, for example building's envelopes.

**Figure 47:** Average energy per unit of area a year and floor size in the EU-28, 2000-2014

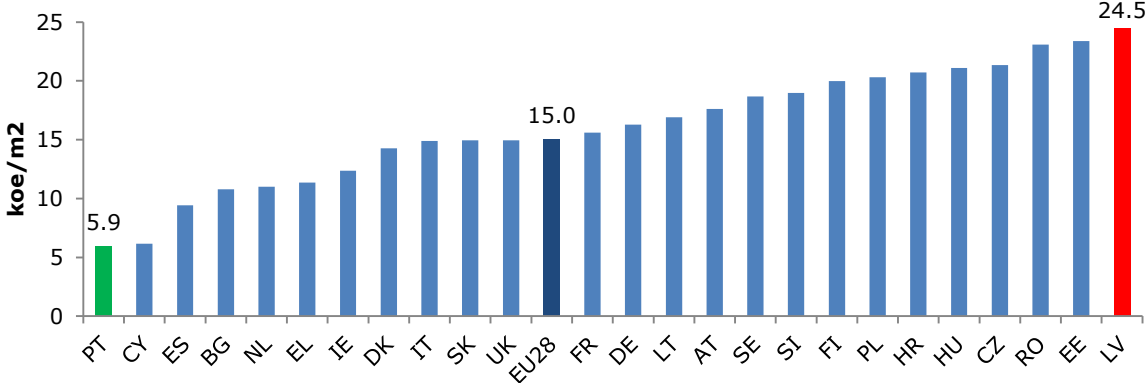


Source: Odyssee

The average energy per unit of area at EU-28 level was 15 koe/m<sup>2</sup> in 2014. This represents a drop by 24.24% which sets the lowest value along the analysed period (2000-2014). It can be observed that the increase of average floor area during the same period contributed to reduce the value of this indicator.

The residential energy consumption per unit of area across the EU-28 Member States for the year 2014 is illustrated in **Figure 50**. To be noted that the average EU-28 level is very close to the median. In 2014, Member States with the highest residential energy consumption per floor area were Latvia and Estonia (24.5 and 23.4 koe/m<sup>2</sup>), followed by Romania (23.1 koe/m<sup>2</sup>) and Czech Republic (21.4 koe/m<sup>2</sup>). On the other hand, the Member States with the lowest values were Portugal (5.9 koe/m<sup>2</sup>), Cyprus (6.1 koe/m<sup>2</sup>) and Spain (9.4 koe/m<sup>2</sup>).

**Figure 48:** Residential energy consumption per household floor size in the EU-28 Member States, 2014

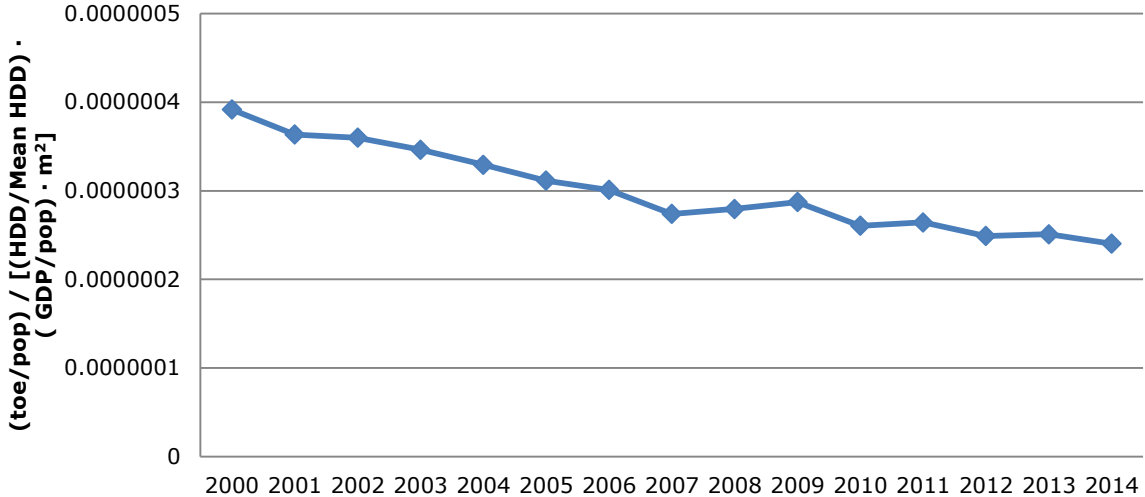


Source: Odyssee<sup>39</sup>

<sup>39</sup> Excludes BE, LU, and MT due to incomplete data.

The following figure establishes a relationship between the residential energy consumption per capita and the mentioned influencing factors (i.e. economic growth, climatic conditions and living conditions).

**Figure 49:** Residential energy per capita, normalized by HDD, GDP per capita and average floor area in the EU-28, 2000-2014

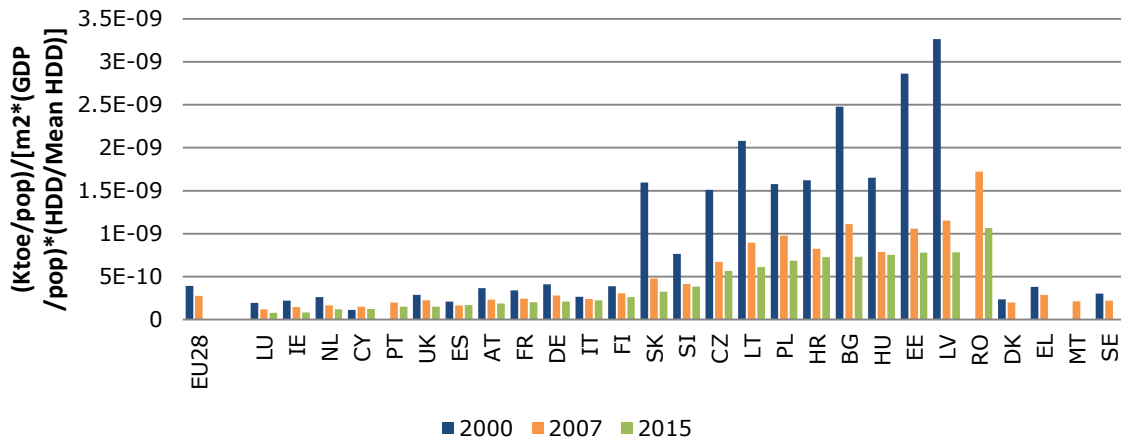


Source: Eurostat, Odyssee

During the period 2000-2014 the residential energy consumption adjusted to take into account all the aforementioned factors shows a decreasing trend ( -39%). The trend is mainly bound to the growing trends of income levels (GDP) and the average size of households in terms of square meter per person, together with the decreasing trend in the residential energy consumption. The alterations in the trend may be explained by the influence of these factors. For instance, in 2007 a mild winter that led to lower energy consumption, together with the rise of GDP per capita that year, brought down the indicator. A different dynamics was registered in 2009, when despite the mild winter, the GDP reduction due to the impact of the financial and economic crisis caused a rise by 2.8% in comparison to the previous year. In the following year (2010), the GDP recovery and the higher number of HDD brought the value back to its overall decreasing trend.

The following figure shows the adjusted final energy consumption per capita per Member State. Compared to **Figure 35** it is possible to notice that, introducing climatic, economic and dwelling-related corrections, the consumption ranking widely changes. Luxembourg that was the State with the second highest level of energy consumption becomes the State with the lowest level of final residential energy consumption, followed by Ireland and Netherland. At the same time countries that in terms of absolute values of final energy consumption performed very well, result in the following figure among the countries that consume the most.

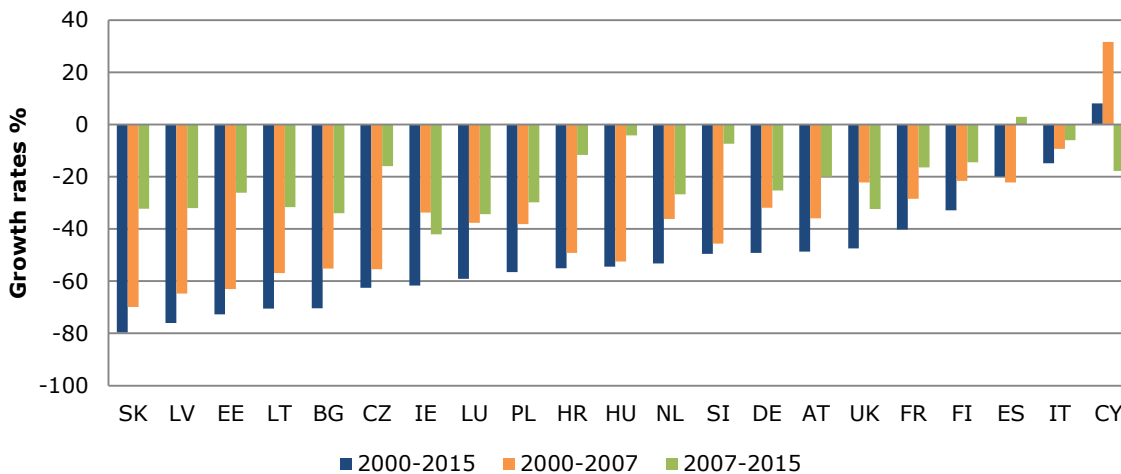
**Figure 50:** Adjusted final residential energy consumption per capita by EU-28 Member State, comparison 2000, 2007 and 2015



Source: Eurostat, Odyssee

Looking at the growth rates of the adjusted final residential energy consumption per capita over different time horizons it is interesting to notice how, irrespective of the period and the State considered and with the exception of Cyprus and Spain, the growth rate is negative.

**Figure 51:** Adjusted final residential energy per capita consumption growth rates by MS in the EU-28<sup>40</sup>; 2000-2015, 2000-2007 and 2007-2015



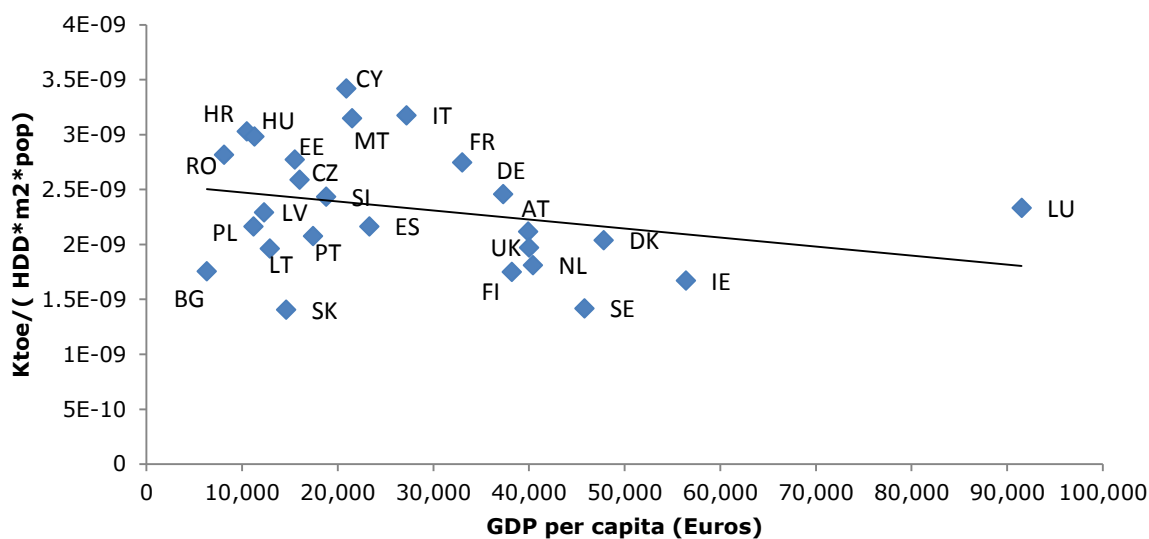
Source: Eurostat, Odyssee

**Figure 54** shows the correlation between residential energy consumption and GDP per capita, corrected to take into account population, floor area of dwellings, and HDD. In this case it is possible to observe a negative correlation between residential consumption and GDP per capita. This counterintuitive result is important in order to show how the results change when climatic conditions are considered. In this case Nordic European countries that are more efficient in terms of energy consumption position themselves below the trend line.

<sup>40</sup> For BE and Mt data are not available. For EU28, DK, EL, PT, RO, SE data are incomplete.



**Figure 52:** Correlation between adjusted residential energy consumption and GDP per capita in the EU-28 Member States<sup>41</sup>, 2015



Source: Eurostat

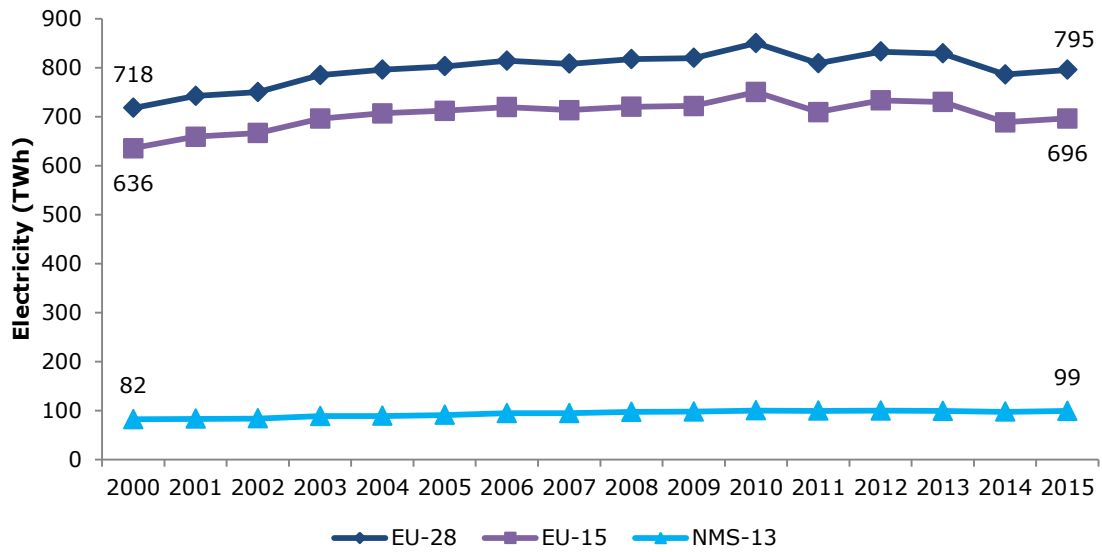
### 3.2 Electricity consumption trends in the residential sector

Electricity accounted for 24.9% of the final residential energy consumption in the EU-28 in 2015. This is the second highest share after gas consumption share (35.4%). The final residential electricity consumption in the EU-28 has grown by 10.7% in the period between 2000 and 2015. The electricity consumption reached 795 TWh in 2015, 87.6% of which was consumed in EU-15 (696 TWh) and the remaining 12.5% in NMS-13 (99 TWh). EU-15 and NMS-13 have increased their final electricity consumption over the same period by 9.43% and 20.73% respectively.

The highest consumption level during the analysed period has been registered in 2010 when final electricity consumed grew up to 850 TWh. Between 2000 and 2010 the final electricity consumption in the residential sector was continuously increasing (with the only exception of year 2007). After the peak in 2010 the consumption started to fluctuate, by registering the most significant drops in 2011 (-4.86%) and 2014 (-5.18%). In 2015 it increased by 1.21%.

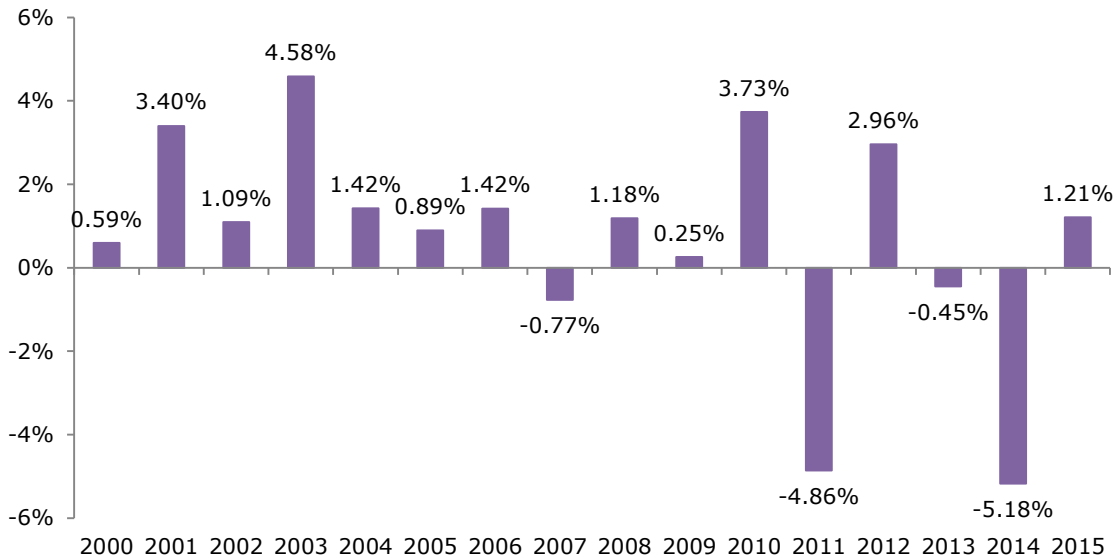
<sup>41</sup> Data on average floor area are not available for EU-28, BE, and EL for year 2015.

**Figure 53:** Final residential electricity consumption in the EU-28, 2000-2015



Source: Eurostat

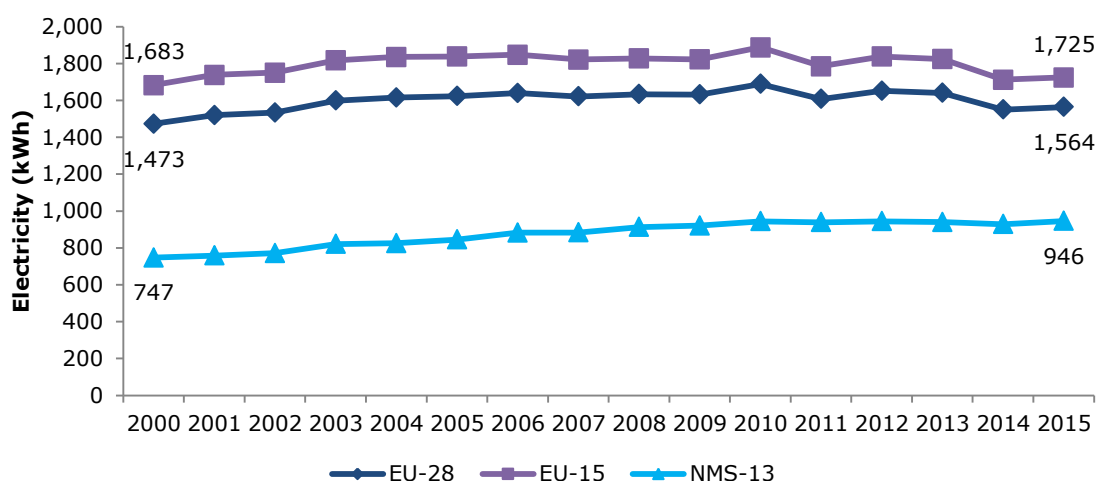
**Figure 54:** Final residential electrical energy consumption annual growth rates in the EU-28, 2000-2015



Source: Eurostat

The final residential electricity consumption per capita in the EU-28 has grown by 6.18% between 2000 and 2015. The average per capita electricity consumption in the residential sector was 1,564 kWh in 2015. In EU-15 the residential electricity consumption per capita registered a value of 1,725 kWh, with an increase of 2.49% over the period 2000-2015. The consumption was 1.82 times higher than that of NMS-13. To be noted that the increase in the final residential energy consumption (26.6%) in NMS-13 has been accompanied by a population's decrease by -4.6% in the same period.

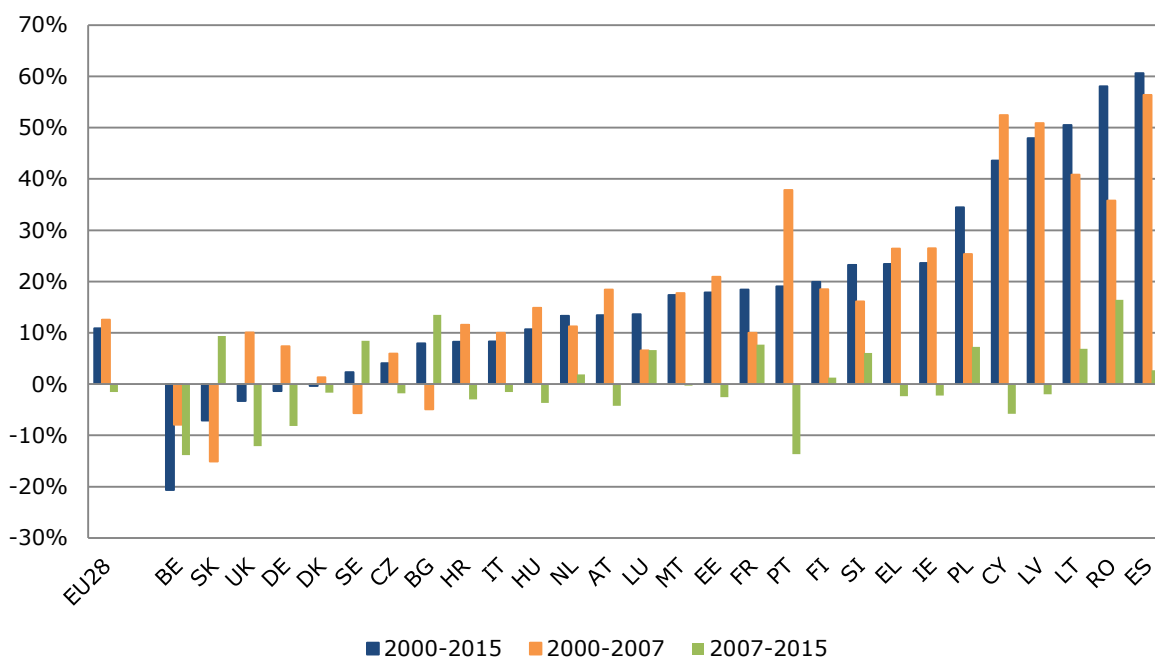
**Figure 55:** Final residential electricity consumption per capita in the EU-28, 2000-2015



Source: Eurostat

Concerning final residential electricity consumption growth rates across the EU-28 Member States for period 2000-2015, it can be observed that eleven MS registered growth rates below the European average (10.85%).

**Figure 56:** Final residential electricity consumption growth rates in the EU-28 by Member State; 2000-2015, 2000-2007 and 2007-2015

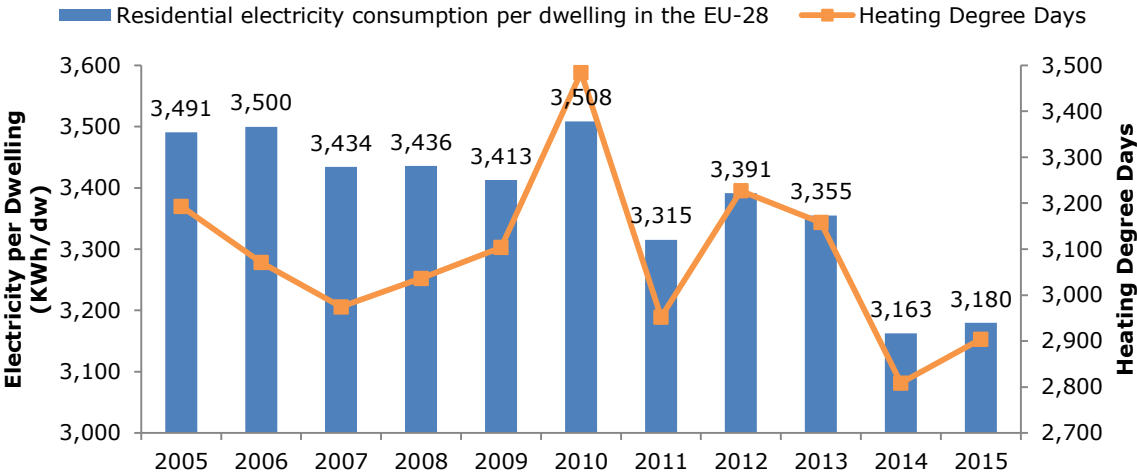


Source: Eurostat

The Member State with the lowest growth rate between 2000 and 2015 has been Belgium with -20.65%, followed by Slovakia (-7.09%) and United Kingdom (-3.29%). The Member States with the highest final residential electricity consumption growth rate have been Spain (60.61%), Romania (58.06%), and Lithuania (50.54%). **Figure 58** shows the growth rates for three different periods. It can be clearly noticed that there is

a dramatic change in the consumption pattern after the financial and economic crisis which peaked in 2008. For instance, Spain drastically changed its consumption pattern from a growing trend of 56.39% for the period 2000-2007 to a growing trend of 2.70% for the period 2007-2015. Ten countries have undergone a positive growth rate in the period 2007-2015. The highest growth rate took place in Romania (16.42%).

**Figure 57:** Residential electricity consumption per dwelling in the EU-28, 2005-2015

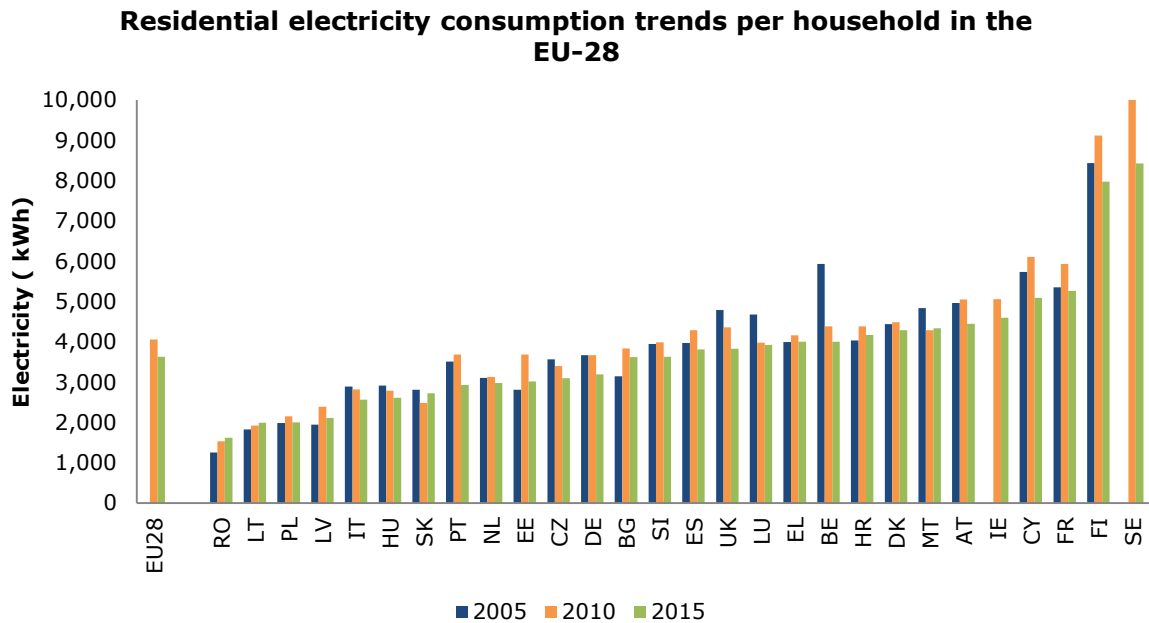


Source: Eurostat

The residential electricity consumption per dwelling was 3,180 KWh/dw in 2015, the second lowest value registered during the whole period after year 2014. Over the period 2000-2015 this value has been reduced by 8.91% (**Figure 59**). The lowering trend is observed along the whole 11-years period with the exception of the years 2006, 2008, 2010, 2012, and 2015 when the consumption of electrical energy per dwelling grew in comparison to the previous year. A positive correlation between the consumption per dwelling and the heating degree days can be observed with exception of years 2006 and 2009. The negative correlation observed in 2009 was probably due to an income effect as GDP had a significant drop that year.

Looking at the energy consumption per household in 2015, it is possible to observe that Romania was the country with lowest electricity consumption per dwelling with 1,619 kWh, followed by Lithuania (1,998 kWh) and Poland (2,004 kWh). In contrast, Sweden (8,429 kWh), Finland (7,976 kWh) and France (5,269 kWh) were the Member States with the highest residential electricity consumption per household. Fourteen of the Member States have residential electrical energy consumption per household below the EU-28 average. Only six Member States have increased their consumption in the 11-years period comprised between 2005 and 2015, these are: Bulgaria, Estonia, Latvia, Lithuania, Poland and Romania. To be noted that all of them are NMS-13.

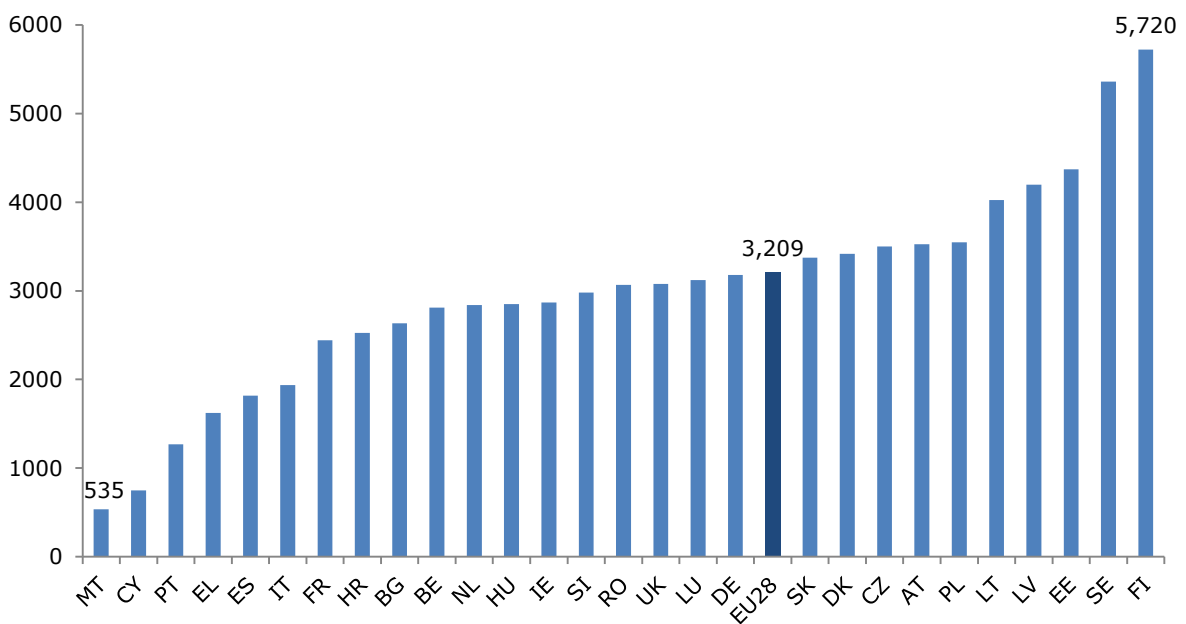
**Figure 58:** Residential electricity consumption trends per household by Member State in the EU-28; 2005, 2010 and 2015



Source: Eurostat

As previously mentioned, weather conditions have an influence on energy consumption. **Figure 61** shows the mean heating degree days in the EU-28 by Member State between 1980 and 2015. The EU-28 Member States with the highest value of mean heating degree days are Finland, Sweden and Estonia.

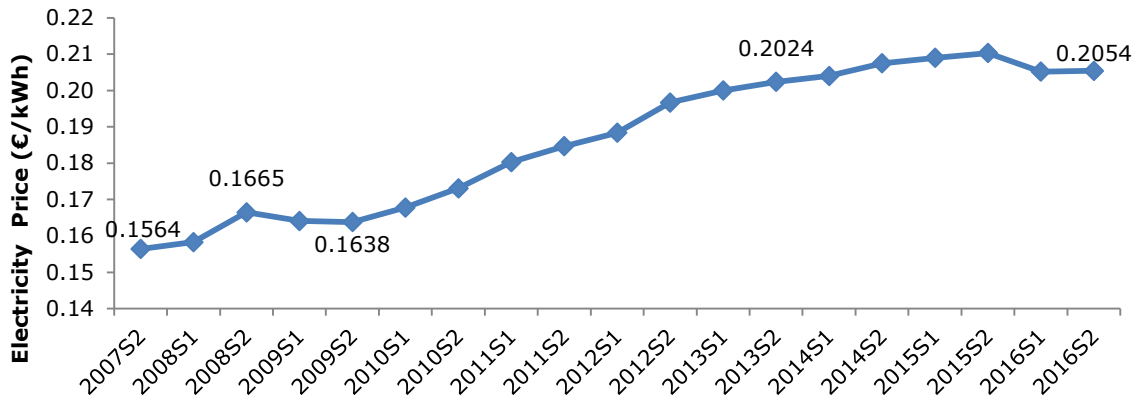
**Figure 59:** Mean Heating Degree days (1980-2015) in the EU-28<sup>42</sup> by Member State



Source: Eurostat

<sup>42</sup> Values for Croatia are included in the Eurostat database starting from 2013.

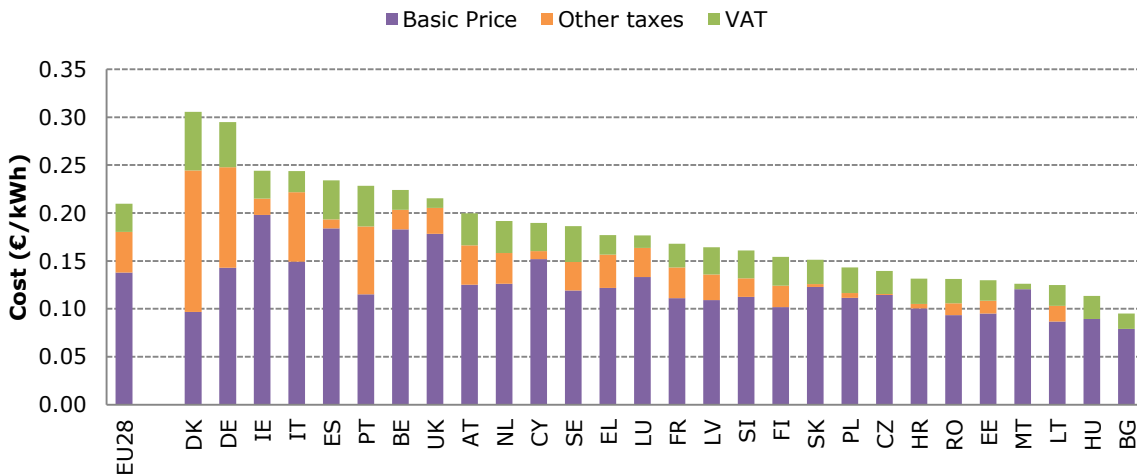
**Figure 60:** Electricity prices for household consumers in the EU-28 by semesters, band DC - all taxes and levies included, 2007S2-2016S2



Source: Eurostat

Electricity expenses as part of residential utilities are a cost to consider. In 2015, the average EU-28 expenses per dwelling for electricity were EUR 666.60<sup>43</sup>. The electricity price for household consumers has continuously grown during the last years (see **Figure 62**). In the second semester of 2007 the average EU-28 electricity price was EUR 0.1564/kWh and in the second semester of 2015 the price has reached EUR 0.2103/kWh. In 2016, for the first time over the period considered, the electricity price registered a decline (EUR 0.2054/kWh in the second semester). From 2007 to 2016 the price increased by 31.33%.

**Figure 61:** Electricity prices for household consumers in the EU-28, band DC, 2015



Source: Eurostat

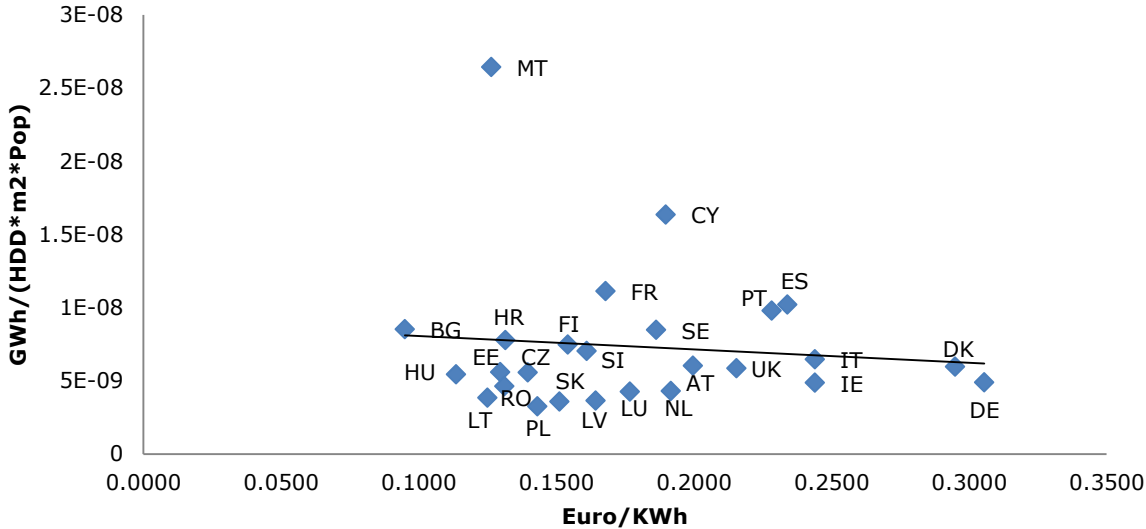
Looking at the electricity prices across the EU-28 Member States for the year 2015, Denmark has the highest electricity price (EUR 0.3055/kWh) followed by Germany (EUR 0.2949/kWh) and Ireland (EUR 0.244/kWh). The lowest electricity prices are found in Bulgaria (EUR 0.0950/kWh), Hungary (EUR 0.1136/kWh) and Lithuania (EUR 0.1250/kWh). To be noted that Denmark has the highest electricity price and 68.41% of

<sup>43</sup> This value has been calculated from the average electricity price for household consumers (band DC) multiplied by the residential electricity consumption per dwelling as calculated under Figure 59.

the price is composed by taxes and levies. This value almost doubles the EU-28 average percentage of taxes and levies for the year 2015 (34.34%).

**Figure 64** shows the correlation between the electricity price and the residential electricity consumption adjusted to take into account population, floor area of dwellings, and HDD. As expected electricity consumption decreases if price increases, according to the basic law of market demand.

**Figure 62:** Correlation between adjusted residential electricity consumption and the price of electricity in EU-28 Member States<sup>44</sup>, 2015



Source: Eurostat

The following table provides an overview of the final residential electricity consumption across the EU-28 Member States. It shows electricity consumption in the residential sector for years 2000, 2007 and 2015, as well as the growth rates over the different periods. Data have been already used and analysed along the chapter.

<sup>44</sup> Data on average floor area are not available for EU-28, BE, and EL for year 2015.

**Table 2:** Overview of final residential electricity consumption in the EU-28 Member States, 2000-2015

	Residential Electricity Consumption (GWh)			Growth Rates (%)		
	2000	2007	2015	2000-2015	2000-2007	2007-2015
<b>EU-28</b>	717,561	807,789	795,406	10.85%	12.57%	-1.53%
<b>BE</b>	23,738	21,856	18,835	-20.65%	-7.93%	-13.82%
<b>BG</b>	9,858	9,376	10,644	7.97%	-4.89%	13.52%
<b>CZ</b>	13,822	14,646	14,382	4.05%	5.96%	-1.80%
<b>DK</b>	10,215	10,349	10,177	-0.37%	1.31%	-1.66%
<b>DE</b>	130,500	140,100	128,700	-1.38%	7.36%	-8.14%
<b>EE</b>	1,466	1,773	1,728	17.87%	20.94%	-2.54%
<b>IE</b>	6,375	8,063	7,881	23.62%	26.48%	-2.26%
<b>EL</b>	14,207	17,957	17,538	23.45%	26.40%	-2.33%
<b>ES</b>	43,619	68,214	70,056	60.61%	56.39%	2.70%
<b>FR</b>	128,720	141,589	152,441	18.43%	10.00%	7.66%
<b>HR</b>	5,729	6,392	6,202	8.26%	11.57%	-2.97%
<b>IT</b>	61,112	67,220	66,187	8.30%	9.99%	-1.54%
<b>CY</b>	1,055	1,608	1,515	43.60%	52.42%	-5.78%
<b>LV</b>	1,189	1,794	1,759	47.94%	50.88%	-1.95%
<b>LT</b>	1,767	2,489	2,660	50.54%	40.86%	6.87%
<b>LU</b>	792	844	900	13.64%	6.57%	6.64%
<b>HU</b>	9,792	11,250	10,839	10.69%	14.89%	-3.65%
<b>MT</b>	559	658	656	17.35%	17.71%	-0.30%
<b>NL</b>	20,019	22,268	22,682	13.30%	11.23%	1.86%
<b>AT</b>	14,962	17,723	16,974	13.45%	18.45%	-4.23%
<b>PL</b>	21,034	26,369	28,280	34.45%	25.36%	7.25%
<b>PT</b>	10,056	13,863	11,974	19.07%	37.86%	-13.63%
<b>RO</b>	7,652	10,389	12,095	58.06%	35.77%	16.42%
<b>SI</b>	2,601	3,021	3,205	23.22%	16.15%	6.09%
<b>SK</b>	5,419	4,602	5,035	-7.09%	-15.08%	9.41%
<b>FI</b>	17,441	20,662	20,917	19.93%	18.47%	1.23%
<b>SE</b>	42,020	39,638	42,987	2.30%	-5.67%	8.45%
<b>UK</b>	111,842	123,076	108,157	-3.29%	10.04%	-12.12%

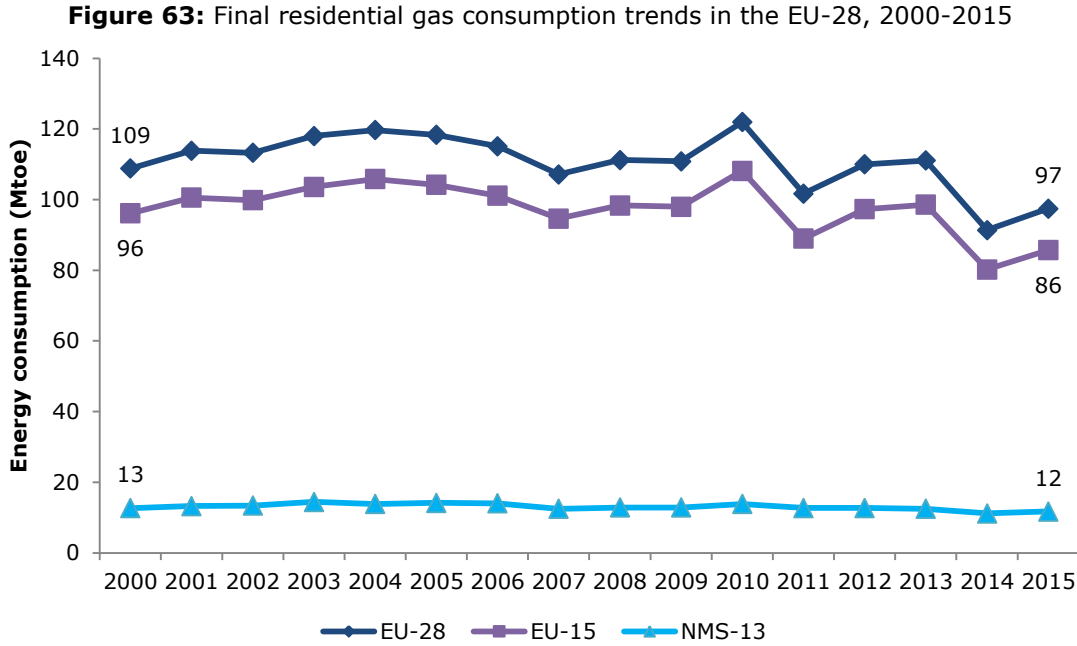
Source: Eurostat

### 3.3 Gas consumption trends in the residential sector

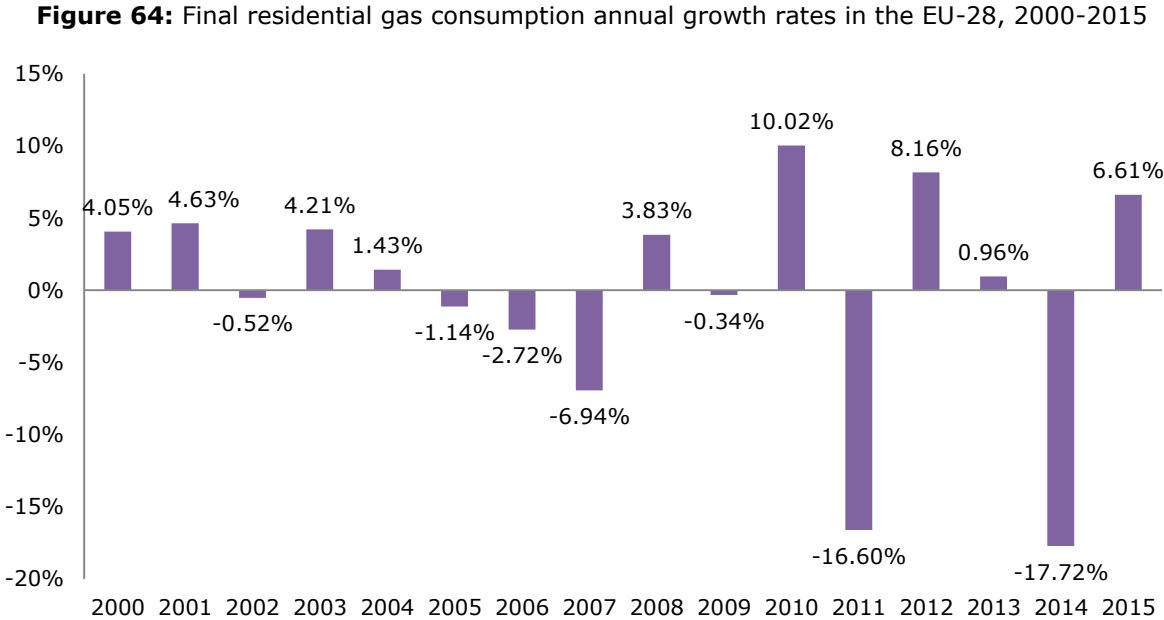
Gas consumption accounted for 35.4% of the final residential energy consumption in the EU-28 in 2015, confirming gas as the main source of final energy. The final residential gas consumption in the EU-28 has dropped by 11% in the 16-years period between 2000 and 2015. The gas consumption reached 97 Mtoe in 2015, out of which 87.95% was consumed in EU-15 (86 Mtoe) and 12.05% (12 Mtoe) in the NMS-13. EU-15 and NMS-13 have both decreased their final gas consumption by 10.42% and 7.69% respectively.



The highest consumption during the period between 2000 and 2015 occurred in 2010 when the gas consumption reached 121.96 Mtoe. In contrast, the highest consumption drops occurred in 2011 and 2014 when gas consumption decreased by 16.60% and 17.72% compared to the previous year.



Source: Eurostat

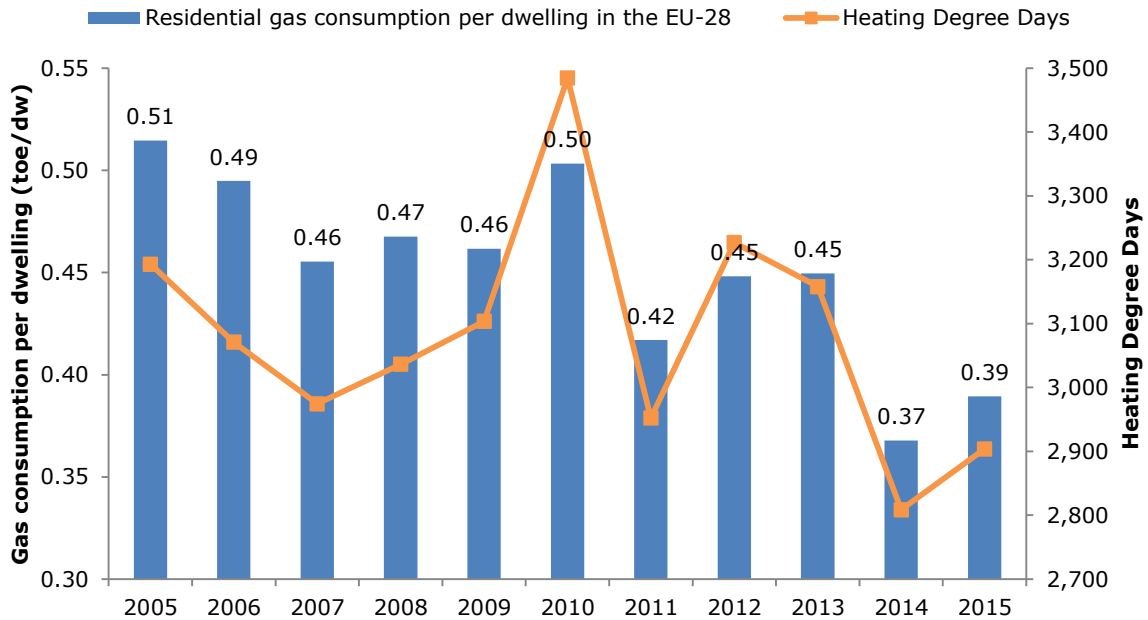


Source: Eurostat

The final residential gas consumption per dwelling in the EU-28 has reached 0.39 toe in 2015, which represents a drop by 23.53% in comparison to year 2005 level. Between 2005 and 2009 there was a decreasing trend which was interrupted in 2010 by a rise of 8.7%. In 2011, the final residential gas consumption per dwelling again decreased to 0.42 toe and grew in 2012 and 2013. In 2014, it has dropped again by 17.78% in

comparison to the previous year, registering the lowest value of the analysed 11-years period.

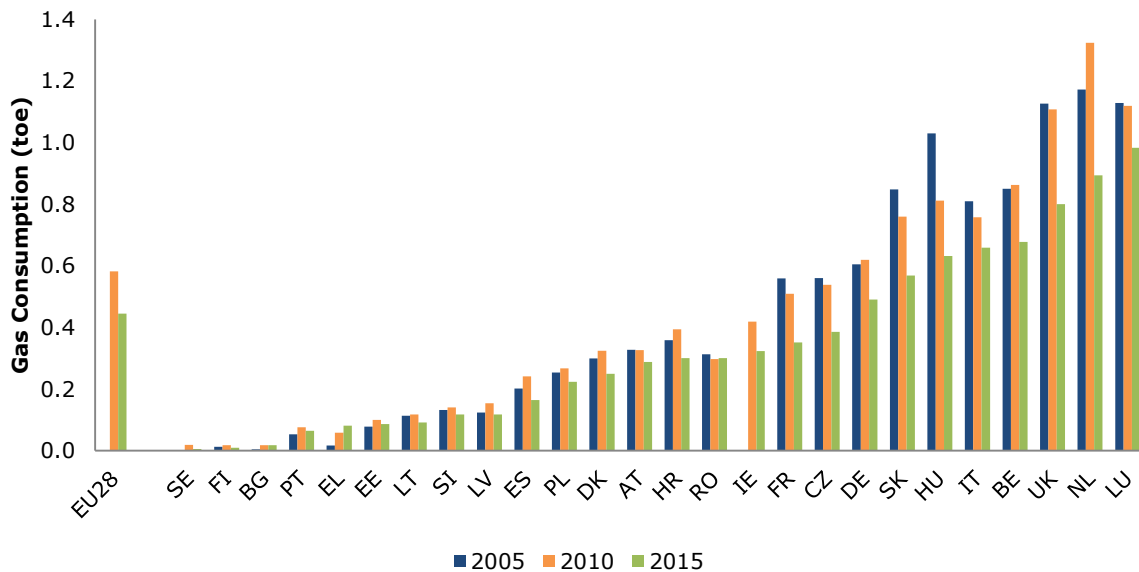
**Figure 65:** Final residential gas consumption per dwelling and heating degree days in the EU-28, 2005-2015



Source: Eurostat

Looking at the residential gas consumption per household across the EU-28 Member States, it can be observed that during 2015 seventeen MSs have had below average EU-28 gas consumption which is 0.44 toe per household (5175.2 kWh/household).

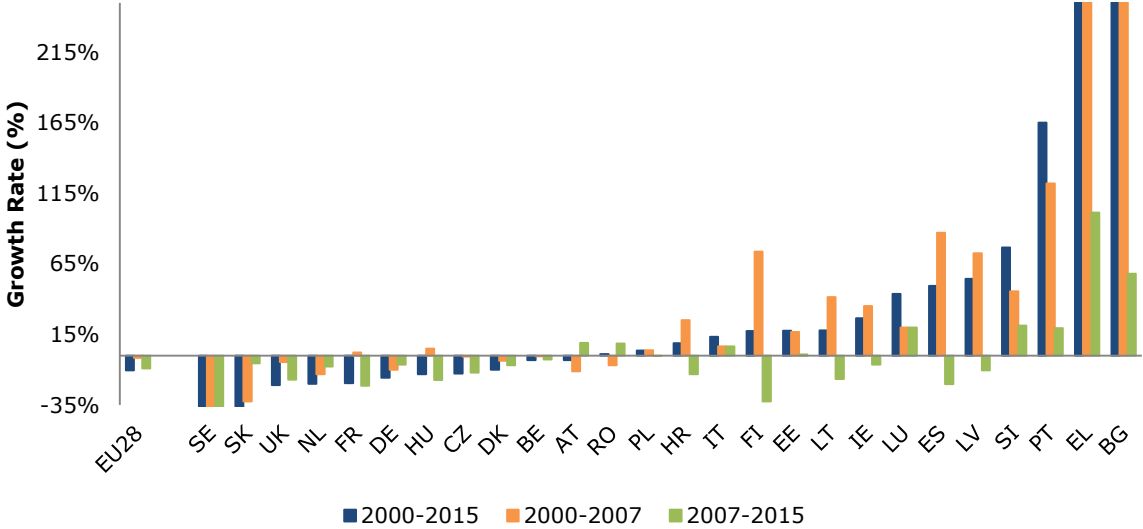
**Figure 66:** Residential gas consumption trends per household in the EU-28 Member States, 2005, 2010 and 2015



Source: Eurostat

The MS with the highest residential gas consumption per household has been Luxembourg (0.98 toe/household), followed by the Netherlands (0.89 toe/household) and the United Kingdom (0.80 toe/household). The lowest gas consumption per household occurred in Sweden (0.006 toe/household), Finland (0.010 toe/household) and Bulgaria (0.017 toe/household). The lowest values of gas consumption achieved by Sweden and Finland despite their high value of mean heating degree days might be explained by the use of other energy sources such as electricity, biomass or district heating plants for heating purposes. It is notable that all the countries but Bulgaria, Estonia, Greece and Portugal have decreased their consumption in comparison to year 2005.

**Figure 67:** Final residential gas consumption growth rates in the EU-28 per Member State; 2000-2015, 2000-2007 and 2007-2015



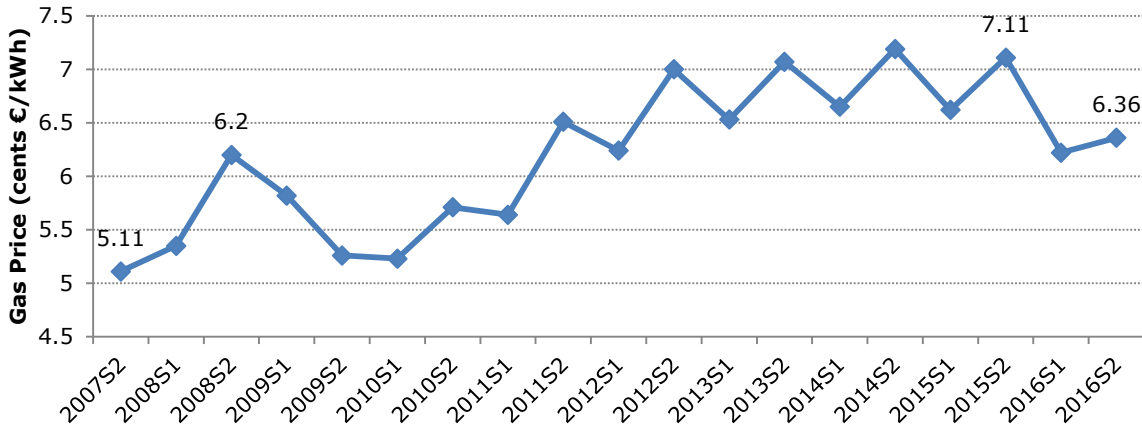
Source: Eurostat

As already mentioned, the final residential gas consumption has decreased by 10.45% in the period between 2000 and 2015. The MS with the highest growth rate has been Bulgaria with an increase in consumption over this period equal to 25,800%, followed by Greece (7,159%) and Portugal (165%); whereas the highest reduction rates have occurred in Sweden (-71%), Slovakia (-36%), and the United Kingdom (-21%). Overall, it can be observed a significant change in the consumption trend from 2007 onwards, as illustrated in **Figure 69**. To be noted the cases of Bulgaria, Greece and Portugal, where the growth rates sharply changed between the periods 2000-2007 and 2007-2015.

Since gas represents the energy source with the highest share at residential level, it is expected to have a considerable cost in the yearly energy bills. In 2015, the average EU-28 expenses per dwelling for gas were EUR 311.51<sup>45</sup>. Despite its considerable fluctuations the average EU-28 gas price for households has undergone a rise of 24.5% between the second semester of 2007 and the second semester of 2016, when prices were EUR 0.0511/kWh and EUR 0.0636/kWh respectively. The highest price level (EUR 0.0719/kWh) was reached during the second half of 2014.

<sup>45</sup> This value has been calculated from the average gas price for household consumers (band D2) multiplied by residential gas consumption per dwelling.

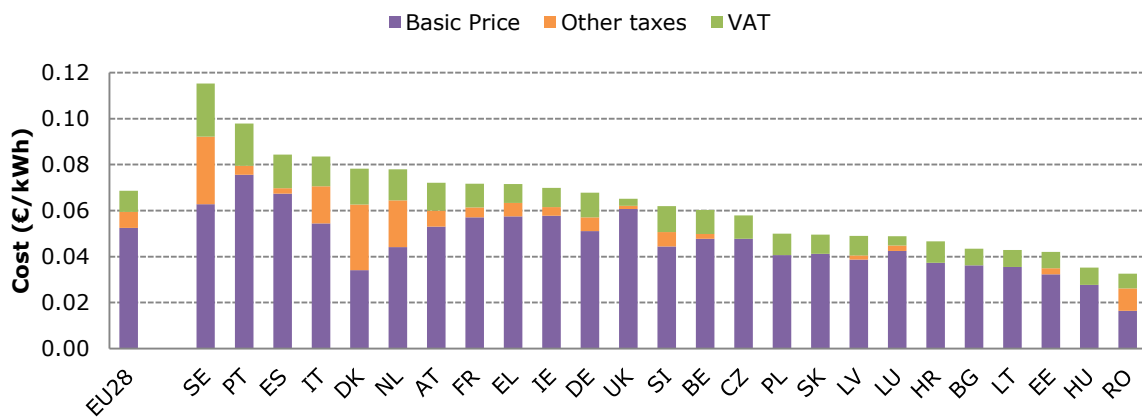
**Figure 68:** Gas prices for household consumers in the EU-28 by semesters, band D2 - all taxes and levies included, 2007S2-2016S2



Source: Eurostat

Looking at the gas prices across the EU-28 Member States for the year 2015 (**Figure 71**), it is possible to notice that Sweden has the highest gas price (EUR 0.1152/kWh) followed by Portugal (EUR 0.0979/kWh) and Spain (EUR 0.0844/kWh). The lowest gas prices are found in Romania (EUR 0.0326/kWh), Hungary (EUR 0.0353/kWh) and Estonia (EUR 0.042/kWh). As for electricity prices, Denmark has the highest percentage (56.45%) of gas taxes and levies. The EU-28 average percentage of taxes and levies in 2015 is equal to 23.6%.

**Figure 69<sup>46</sup>:** Gas prices for household consumers in the EU-28, band D2, 2015

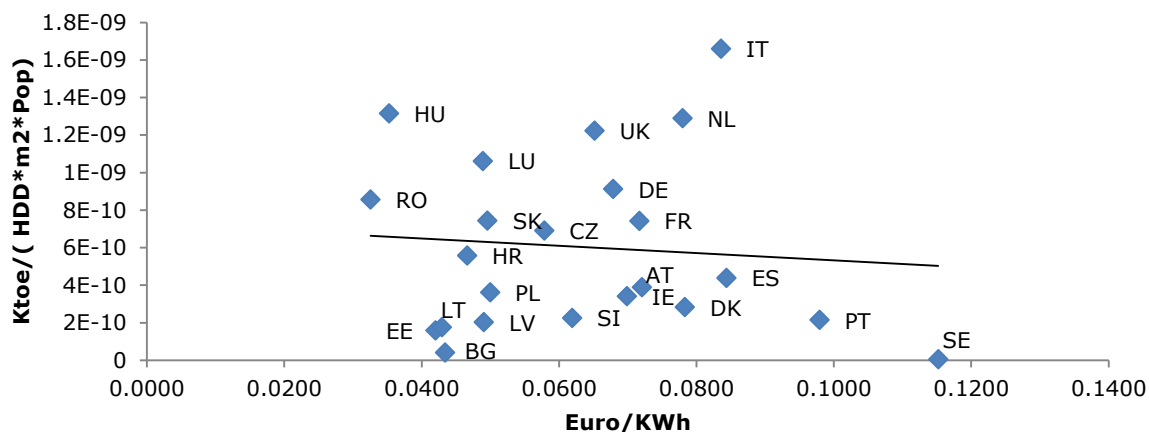


Source: Eurostat

<sup>46</sup> Data are not available for CY, FI, and MT.

**Figure 72** shows the correlation between the price of gas and the residential gas consumption adjusted to take into account population, floor area of dwellings, and HDD. Looking at the scatter plot it is possible to observe that the points are very dispersed and the two variables look like uncorrelated.

**Figure 70:** Correlation between adjusted residential gas consumption and the price of gas in EU-28 Member States<sup>47</sup> 2015



Source: Eurostat

The following table provides an overview of the final residential gas consumption across the EU-28 Member States. It summarizes data about gas consumption in the residential sector for years 2000, 2007 and 2015, as well as the growth rates over different periods. Data have been already used and analysed along the chapter.

**Table 3:** Overview of final residential gas consumption in the EU-28 Member States, 2000-2015

	Residential Gas Consumption (ktoe)			Growth rates (%)		
	2000	2007	2015	2000-2015	2000-2007	2007-2015
<b>EU28</b>	108,804.8	107,120.3	97,436.8	-10.45%	-1.55%	-9.04%
<b>BE</b>	3,292.6	3,278.8	3,186.7	-3.22%	-0.42%	-2.81%
<b>BG</b>	0.2	32.8	51.8	25800.00%	16300.00%	57.93%
<b>CZ</b>	2,049.3	2,036.1	1,789.4	-12.68%	-0.64%	-12.12%
<b>DK</b>	658.5	634.7	591.8	-10.13%	-3.61%	-6.76%
<b>DE</b>	23,441.0	21,071.6	19,738.8	-15.79%	-10.11%	-6.33%
<b>EE</b>	41.9	48.9	49.3	17.66%	16.71%	0.82%
<b>IE</b>	437.8	591.7	554.0	26.54%	35.15%	-6.37%

<sup>47</sup> Data on average floor area are not available for EU-28, BE, and EL for year 2015.

	Residential Gas Consumption (ktoe)			Growth rates (%)		
	2000	2007	2015	2000-2015	2000-2007	2007-2015
<b>EL</b>	4.9	176.6	355.7	7159.18%	3504.08%	101.42%
<b>ES</b>	2,019.9	3,779.0	3,018.1	49.42%	87.09%	-20.13%
<b>FR</b>	12,661.4	12,940.5	10,183.0	-19.57%	2.20%	-21.31%
<b>HR</b>	410.2	513.5	446.3	8.80%	25.18%	-13.09%
<b>IT</b>	14,974.8	15,942.1	16,985.6	13.43%	6.46%	6.55%
<b>LV</b>	63.5	109.6	98.1	54.49%	72.60%	-10.49%
<b>LT</b>	104.0	147.2	122.7	17.98%	41.54%	-16.64%
<b>LU</b>	156.6	187.8	225.2	43.81%	19.92%	19.91%
<b>HU</b>	3,025.3	3,174.4	2,625.8	-13.21%	4.93%	-17.28%
<b>NL</b>	8,508.6	7,393.9	6,814.0	-19.92%	-13.10%	-7.84%
<b>AT</b>	1,134.3	1,008.0	1,098.0	-3.20%	-11.13%	8.93%
<b>PL</b>	3,051.7	3,169.6	3,157.7	3.47%	3.86%	-0.38%
<b>PT</b>	99.2	220.2	262.9	165.02%	121.98%	19.39%
<b>RO</b>	2,216.9	2,067.4	2,242.8	1.17%	-6.74%	8.48%
<b>SI</b>	58.6	85.3	103.5	76.62%	45.56%	21.34%
<b>SK</b>	1,642.2	1,110.3	1,050.5	-36.03%	-32.39%	-5.39%
<b>FI</b>	22.4	38.9	26.3	17.41%	73.66%	-32.39%
<b>SE</b>	102.9	54.5	29.9	-70.94%	-47.04%	-45.14%
<b>UK</b>	28,625.8	27,307.1	22,629.0	-20.95%	-4.61%	-17.13%

CY, MT – No available data.

Source: Eurostat

### 3.4 Overview – Residential sector

The residential sector accounted for 25.38% of the EU-28 total final energy consumption in 2015 and it is the third energy consuming sector after transport and industry.

The final residential energy consumption in the EU-28 shows a reduction of 5.5% from 2000 to 2015. The EU-28 average final residential energy per capita for the year 2015 is equal to 0.57 toe; it represents a fall of 9.5% compared to the year 2000. For what concerns the residential energy mix, the main energy types which contributed to the final residential energy consumption in the EU-28 in 2015 were gas (35.4%), electrical energy (24.9%) and renewable energies (16%).

There are several factors which must be considered, at least qualitatively, when analysing statistics related to residential energy consumption trends. These factors are related to economic growth, population growth, weather conditions and living conditions (e.g. average number of people per household). For instance, a positive correlation is often observed between the residential energy consumption (final energy, electricity and gas consumptions) and heating degree days. Other factors such as income levels may also contribute to explain energy consumption data trends. The choice of variables considered to better understand energy consumption trends can affect significantly the interpretation. In the case of the residential sector, energy consumption indicators and ratios based on GDP values might be less important than others based on the disposable income of households or the adjusted gross disposable income since these latter variables are more closely related to the purchasing power of residential energy consumers.

The final residential electricity consumption in the EU-28 has grown by 10.7% in the period 2000-2015. The increase has been more pronounced in the NMS-13 (20.73%) than in the EU-15 (9.43%). Differences across EU-28 Member States are notable. The lowest growth rate has been registered in Belgium (-20.65%) and the highest growth rate in Spain (60.61%). Overall it is possible to observe a break in the growing trend as a consequence of the economic and financial crisis which peaked in 2007-2008.

The residential electricity consumption per household was 3,180 kWh/dw in 2015, the second lowest value registered during the whole period after year 2014. Over the period 2000-2015 this value has been reduced by 8.91%. The average EU-28 expenses per dwelling for electricity were EUR 666.60 for the same year.

The electricity price for residential consumers is characterized by an increasing trend; the average EU-28 electricity price has risen by 31.33% in the period between 2007-S2 and 2016-S2. In the second semester (S2) of 2013 the threshold of 0.20 EUR/kWh was exceeded and the total price, with levies and taxes included, reached a value of 0.2024 EUR/kWh for residential consumers. The electricity price is composed for a large part by taxes and levies: the average percentage level of taxes and levies in EU-28 was 34.34% of the total price in the year 2015.

In 2015, the final residential gas consumption in the EU-28 has instead dropped by 11% in comparison to year 2000. It is possible to observe a decreasing trend both in EU-15 and in NMS-13 with growth rates over the period 2000-2015 of -10.42% and -7.69% respectively. As pointed out for the final electricity consumption, there was a clear impact of the financial and economic crises which have affected the gas consumption during and after years 2007-2008.

The final residential gas consumption per dwelling in the EU-28 has reached 0.39 toe in 2015, which represents a drop by 23.53% in comparison to year 2005 levels. The differences among the EU-28 Member States are significant. For instance, Luxembourg is the highest gas consumer per household (0.98 toe/household) and Sweden the lowest consumer of gas per household (0.006 toe/household). The average EU-28 expenses per dwelling for gas consumption were EUR 311.51 in 2015.

The price of gas for household consumers has registered fluctuating growth rates and the average EU-28 price has increased by 24.5% between the second semester of 2007 and the second semester of 2016. The average percentage level of taxes and levies on gas price in the EU-28 was 23.6% of the total price in the year 2015.

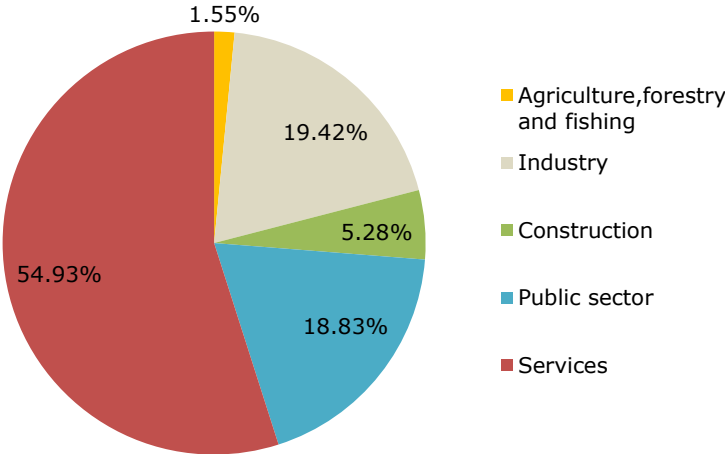


## 4 Energy Consumption Trends in the Tertiary Sector

In this report the definition of tertiary sector includes public sector, professional, scientific and technical activities, services and commerce<sup>48</sup>. This chapter covers the energy consumption trends in the tertiary sector, with a focus on electricity and gas consumption trends.

The tertiary sector accounts for a large share of GDP in the European Union. 73.76% of the total gross value added was generated by this sector in 2015. It is also expected to further grow in importance during the next years due to: (i) the shift in end consumer preference towards services; (ii.) the demand for services from services firms. These factors point to a general tertiarization trend related to labour force and production.

**Figure 71:** Percentage of gross value added in current prices by economic sector in the EU-28, 2015



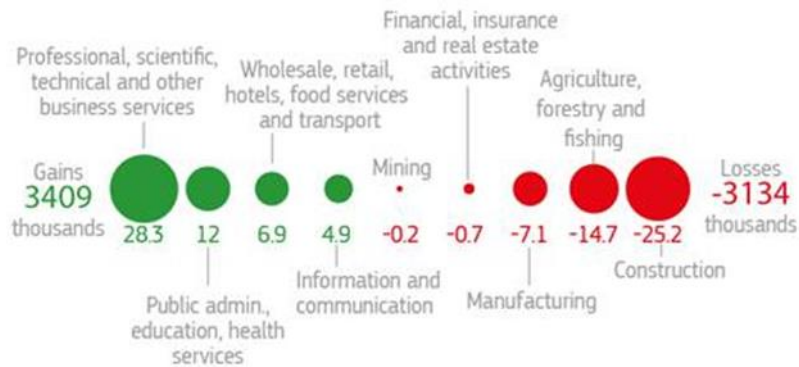
Source: Eurostat

Also employment rates registered in the recent years show that there have been changes which have provided opportunities for increased productivity in knowledge-intensive sectors, leading to additional possibilities for labour re-allocation and employment growth in certain sectors. Manual workers – in particular in manufacturing and agriculture – are however replaced in the process of automation (**Figure 74**)<sup>49</sup>.

<sup>48</sup> This category is also known as the "commercial sector" and represents non-residential buildings in the services sector.

<sup>49</sup> Organization for Economic Cooperation and Development (2015), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society*, Paris: OECD Publishing.

**Figure 72:** Change in total employment in the EU-28, 2010-2014, absolute numbers



Source: OECD, 2015.

**Figure 74** shows indeed that employment in the tertiary sector (i.e. professional, scientific and technical services, public administration and health services, wholesale, retail, etc.) has increased, while employment in other sectors (mostly manufacturing, construction, agriculture, forestry and fishing), has markedly decreased during the recent years.

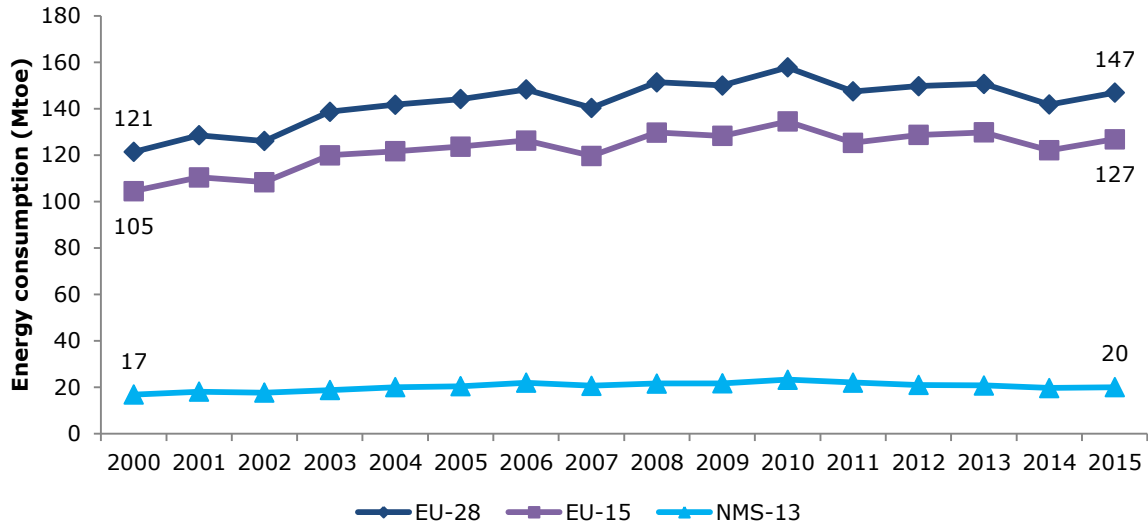
#### 4.1 Final energy consumption trends in the tertiary sector

The tertiary sector accounted for 13.55% of total final energy consumption in the year 2015. Considering its share in value added this is relatively low compared to e.g. the industry sector. This latter sector consumed 25.35% of total final energy but with a contribution of just 19.42%<sup>50</sup> to the total value added in 2015.

The final tertiary energy consumption in the EU-28 has risen by 21.5% in the period from 2000 to 2015. This increase has been experienced by both EU-15 and NMS-13 where final energy consumption increased by 20.95% and 17.65% respectively. In 2015, the final tertiary energy consumption reached 147 Mtoe, out of which 86.4% (127 Mtoe) was consumed in EU-15 area and 13.6% (20 Mtoe) was consumed in the NMS-13. The peak of consumption was reached in the year 2010 (157.8 Mtoe) as illustrated in **Figure 75**.

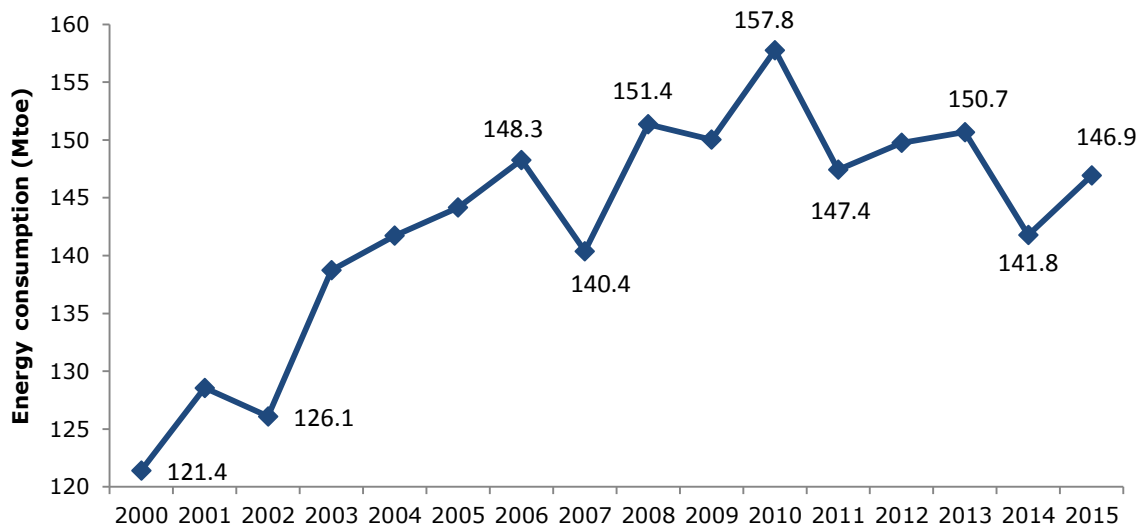
<sup>50</sup> Construction sector is accounted independently – see Figure 103.

**Figure 73:** Final tertiary energy consumption in the EU-28, 2000-2015



Source: Eurostat

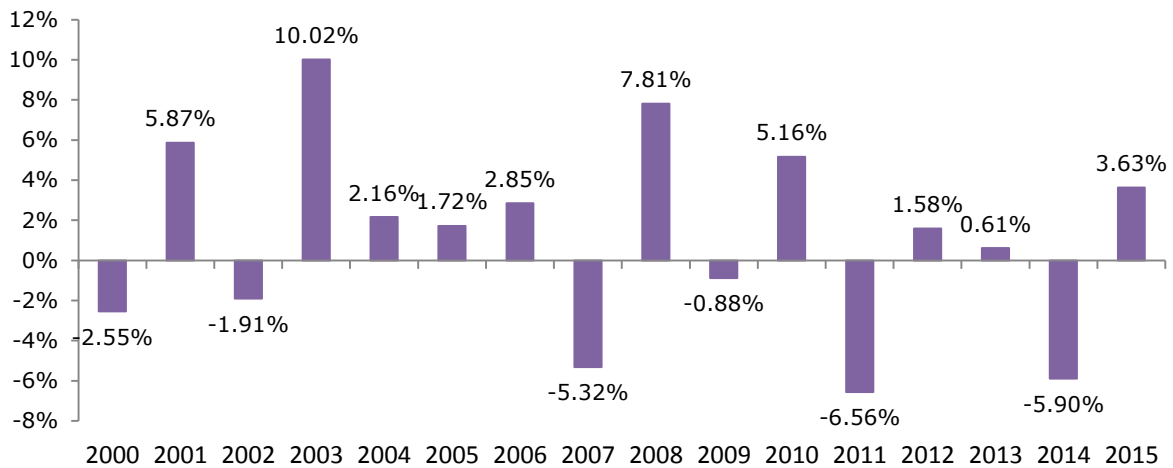
**Figure 74:** Final tertiary energy consumption in the EU-28, 2000-2015 (detailed)



Source: Eurostat

Looking at the growth rates along the same period (**Figure 77**), a general growing trend can be observed between 2000 and 2010 with the exception of the years 2002, 2007 and 2009. Notably, an increase by around 10% has been registered in 2003 in comparison to the previous year. This considerable increase in the energy consumption can be partially explained by looking at the weather conditions: 2003 was a very hot year, fact which may explain the increase in the energy consumption (e.g. higher use of air-conditioning systems). After 2010, the final tertiary energy consumption moved in different directions. To be noted that the decreases seen in 2011 and 2014 have brought back the final tertiary energy consumption to 2007 levels. A new increase of 3.63% has been registered in 2015.

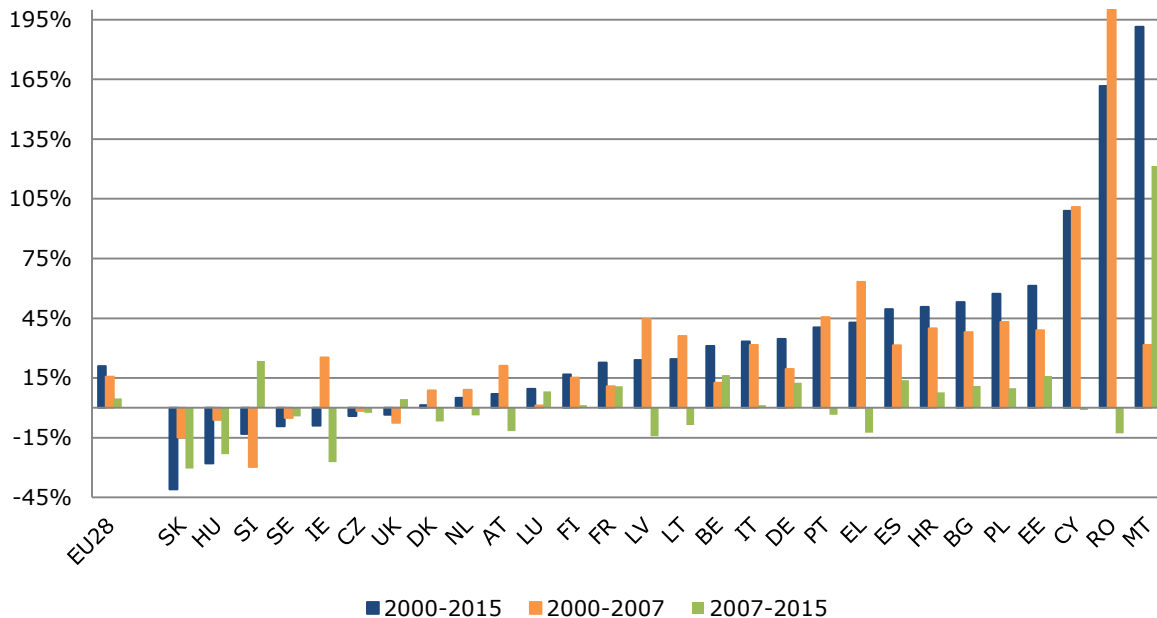
**Figure 75:** Tertiary final energy consumption annual growth rates in the EU-28, 2000-2015



Source: Eurostat

As previously mentioned, the EU-28 final tertiary energy consumption has grown by 21.5% in the last 16 years. Nevertheless, the growth rates are markedly different before and after 2007 for the majority of the Member States. The Member State with the highest reduction rate of final tertiary energy consumption over the entire period was Slovakia with -40.92%, followed by Hungary (-27.86%) and Slovenia (-13.18%). In contrast, the Member States which have experienced the highest growth rates in energy consumption in the service sector were Malta (191.45%), Romania (161.70%) and Cyprus (98.88%), all belonging to NMS-13 group.

**Figure 76:** Final tertiary energy consumption growth rates by MS in the EU-28; 2000-2015, 2000-2007 and 2007-2015

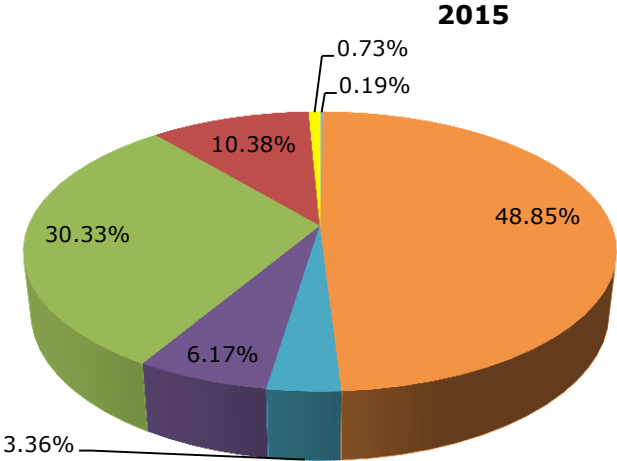
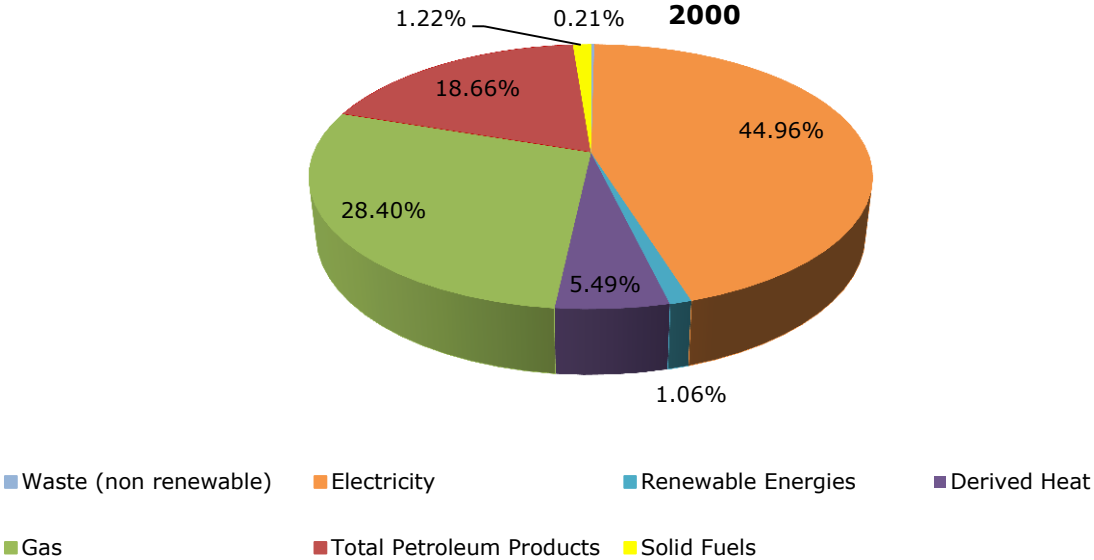


Source: Eurostat

To be noted the significant change in the growth rates across different sub-periods in Romania, Greece, Lithuania, Latvia, Austria and Ireland. In Romania, in particular, the growth rate passed from +200% in the period 2000-2007, to -12.76% during 2007-2015 period, It is also true that overall, the growth rates of Member States do not show as significant differences between the sub-periods (i.e. 2000-2007 and 2007-2015) as in other economic sectors. As remarked before, this might be the result of an on-going tertiarization process at European level.

The final energy mix in the tertiary sector of EU-28 was mainly formed by three energy sources which accounted for more than 90% of the total final energy consumption in 2015. Electricity had the highest share (48.85%), followed by gas (30.33%) and total petroleum products (10.38%). Other contributors to the energy mix have been derived heat (6.17%), renewable energies (3.36%), waste (0.19%) and solid fuels (0.73%). Changes compared to the scenario of year 2000 are mainly due to a reduction in the share of petroleum products (-8.28%). Electricity (+3.89%) and gas (+1.93%) have instead acquired larger shares together with derived heat (+0.68) and renewable energies (+2.3). Solid fuels and waste have reduced their shares by 0.49% and 0.02% respectively.

**Figure 77:** Final energy mix in the tertiary sector in the EU-28, 2000 and 2015

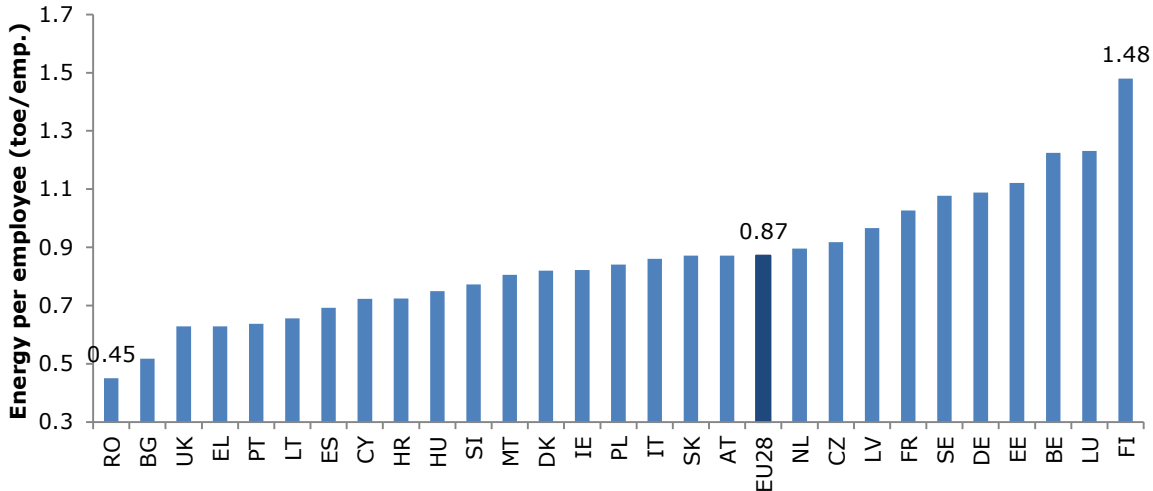


Source: Eurostat

An interesting indicator to consider in the analysis of the energy trends in the tertiary sector is the energy consumed per employee. The final average energy consumption per employee in the tertiary sector in the EU-28 was 0.87 toe per employee in 2015 (**Figure 80**).

In 2015, the Member States with the highest energy consumption per employee were Finland (1.48 toe/emp.), Luxembourg (1.23 toe/emp.), and Belgium (1.23 toe/emp.). On the other hand, Romania (0.45 toe/emp.), Bulgaria (0.52 toe/emp.), United Kingdom (0.63 toe/emp.) and Greece were the Member States with the lowest final tertiary energy consumption per employee.

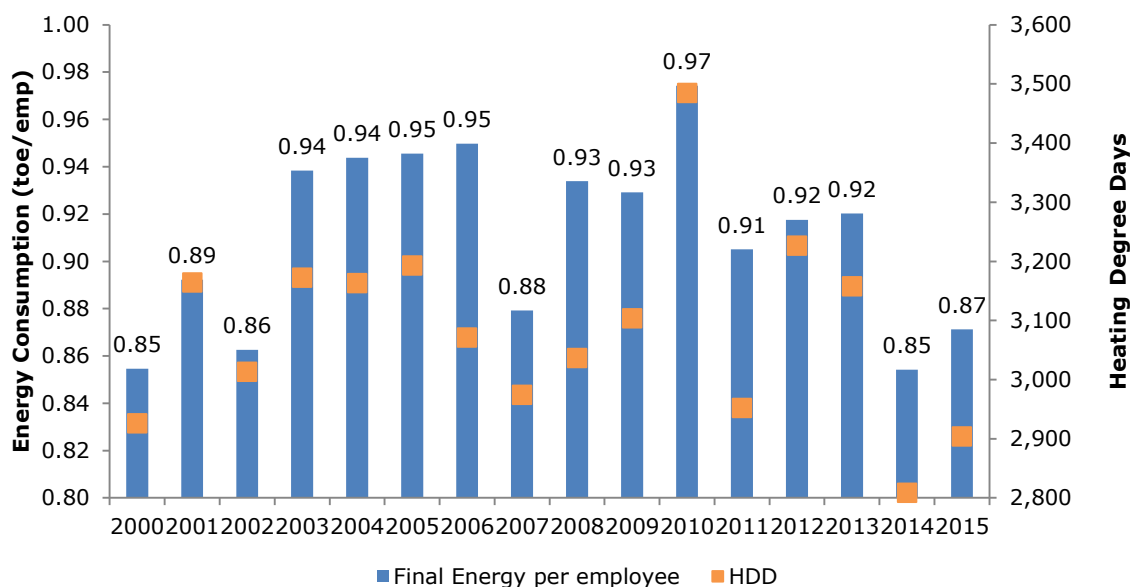
**Figure 78:** Final energy consumption per employee in the tertiary sector in the EU-28 Member States, 2015



Source: Eurostat

Looking at the trend of this indicator over the period 2000-2015 (**Figure 81**) it is possible to notice that it has registered the same value (0.85 toe/emp.) in both years 2000 and 2014. The maximum was reached in 2010 (0.97 toe/emp.). In 2015 its value was equal to 0.87 toe/emp.

**Figure 79:** Final energy consumption per employee in the tertiary sector and Heating Degree Days in the EU-28, 2000-2015



Source: Eurostat<sup>36</sup>

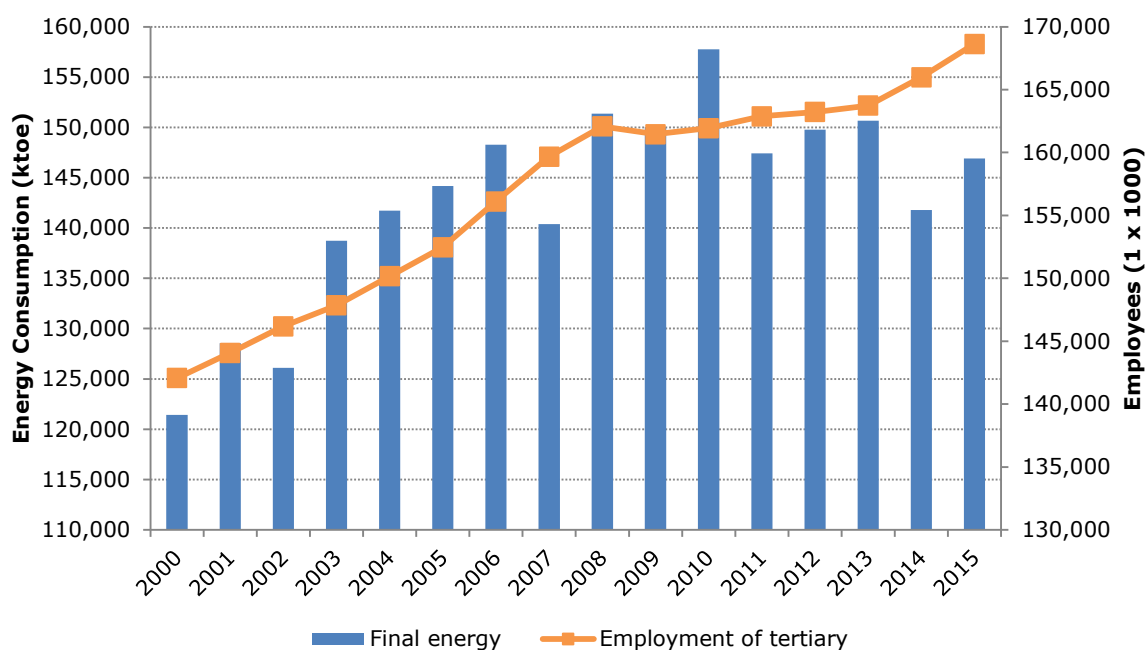
A qualitative analysis of the energy consumption trends per employee can be attempted by considering some influencing factors such as weather and climate conditions and employment values in the tertiary sector. The tertiary sector has created 26.6 million employees in the period from 2000 to 2015, with a growth rate of 18.70%. There is a clear impact on the employment rate by the recent financial and economic crisis. A 13.98% growth rate was indeed registered during the period 2000-2010, whereas the employment growth rate was only 4.14% during the period 2010-2015. Despite this recent slowdown in the growth of number of employees, the tertiary sector continues to constantly increase in the European Union.

Given the nature of the tertiary sector which includes public sector, professional, scientific and technical activities, service and commerce; comfort conditions (e.g. temperature or humidity levels) are important and can be considered as key factors in the evaluation of energy consumption in the tertiary sector. Therefore, it is also of interest comparing qualitatively the heating degree days with the trends in energy consumption and employment.

**Figure 81** shows the heating degree days together with the final energy consumption per employee. A certain degree of correlation between the two trends can be inferred by this figure.

**Figure 82** shows the trend of employment together with the final energy consumption in the tertiary sector. This graph, as the previous one, helps in analysing the influence of external factors, related to weather and population dynamics, on energy consumption. By looking at the graphics it can be stated that weather conditions had a greater influence on per capita consumption than the employment rate. For instance, during the period 2000-2008 when the employment rates were increasing continuously; an expected negative correlation between consumption and employment should have made decrease the values of final energy consumption per employee. In contrast, consumption augmented as was the case for heating degree days (HDD), as illustrated in **Figure 81**.

**Figure 80:** Final energy consumption and employment rates in the tertiary sector in the EU-28, 2000-2015



Source: Eurostat

The following table provides an overview of the final energy consumption in the tertiary sector with a breakdown by Member States.

**Table 4:** Final tertiary energy consumption in the EU-28 Member States

	Final Tertiary Energy Consumption in the EU-28 MS (ktoe)								Growth Rate
	2000	2005	2010	2011	2012	2013	2014	2015	2000-2015 (% year)
<b>EU28</b>	<b>121,420</b>	<b>144,160</b>	<b>157,770</b>	<b>147,425</b>	<b>149,759</b>	<b>150,674</b>	<b>141,784</b>	<b>146,924</b>	21.01%
<b>BE</b>	3,476	4,152	5,027	4,449	4,540	4,904	4,225	4,558	31.11%
<b>BG</b>	648	824	989	1,047	1,023	965	926	992	53.10%
<b>CZ</b>	2,973	3,105	3,154	3,032	2,936	2,885	2,799	2,852	-4.06%
<b>DK</b>	1,843	2,002	2,128	1,948	1,979	1,965	1,815	1,867	1.27%
<b>DE</b>	25,793	33,193	35,356	31,910	33,250	34,489	33,043	34,716	34.59%
<b>EE</b>	289	389	424	402	424	418	458	466	61.25%
<b>IE</b>	1,367	1,644	1,523	1,331	1,333	1,305	1,237	1,245	-8.93%
<b>EL</b>	1,311	1,946	1,952	1,868	1,938	1,818	1,712	1,873	42.79%
<b>ES</b>	6,710	8,415	9,797	10,203	10,046	9,615	8,845	10,037	49.59%
<b>FR</b>	18,359	20,760	23,176	21,712	22,882	23,245	22,159	22,542	22.78%
<b>HR</b>	492	692	775	761	731	711	676	742	50.73%
<b>IT</b>	11,542	15,053	16,979	15,751	15,931	15,847	14,667	15,392	33.35%
<b>CY</b>	108	161	248	237	223	203	203	214	98.88%
<b>LV</b>	473	595	598	557	623	600	609	586	24.08%
<b>LT</b>	464	562	603	587	614	597	594	577	24.49%



Final Tertiary Energy Consumption in the EU-28 MS (ktoe)									Growth Rate
	2000	2005	2010	2011	2012	2013	2014	2015	2000-2015 (% year)
<b>EU28</b>	<b>121,420</b>	<b>144,160</b>	<b>157,770</b>	<b>147,425</b>	<b>149,759</b>	<b>150,674</b>	<b>141,784</b>	<b>146,924</b>	21.01%
<b>LU</b>	365	368	426	371	397	413	362	399	9.55%
<b>HU</b>	3,027	3,511	3,049	3,053	2,354	2,337	2,115	2,184	-27.86%
<b>MT</b>	43	48	92	88	100	109	120	126	191.45%
<b>NL</b>	6,241	6,932	7,803	6,937	7,175	7,194	6,327	6,553	5.00%
<b>AT</b>	2,549	3,325	3,335	3,012	2,989	2,882	2,801	2,725	6.92%
<b>PL</b>	4,965	6,728	8,832	8,425	8,357	8,071	7,794	7,814	57.39%
<b>PT</b>	1,396	2,195	1,883	1,855	1,843	1,787	1,901	1,960	40.41%
<b>RO</b>	673	1,670	1,881	1,774	1,763	1,785	1,768	1,762	161.70%
<b>SI</b>	527	475	533	532	453	468	427	457	-13.18%
<b>SK</b>	2,200	1,751	2,106	1,603	1,452	1,711	1,234	1,300	-40.92%
<b>FI</b>	2,324	2,618	3,078	2,844	3,008	2,886	2,869	2,714	16.80%
<b>SE</b>	4,405	4,297	4,550	4,025	4,085	3,962	4,034	3,999	-9.22%
<b>UK</b>	16,860	16,750	17,475	17,112	17,311	17,504	16,067	16,275	-3.47%

Source: Eurostat

## 4.2 Electricity consumption trends in the tertiary sector

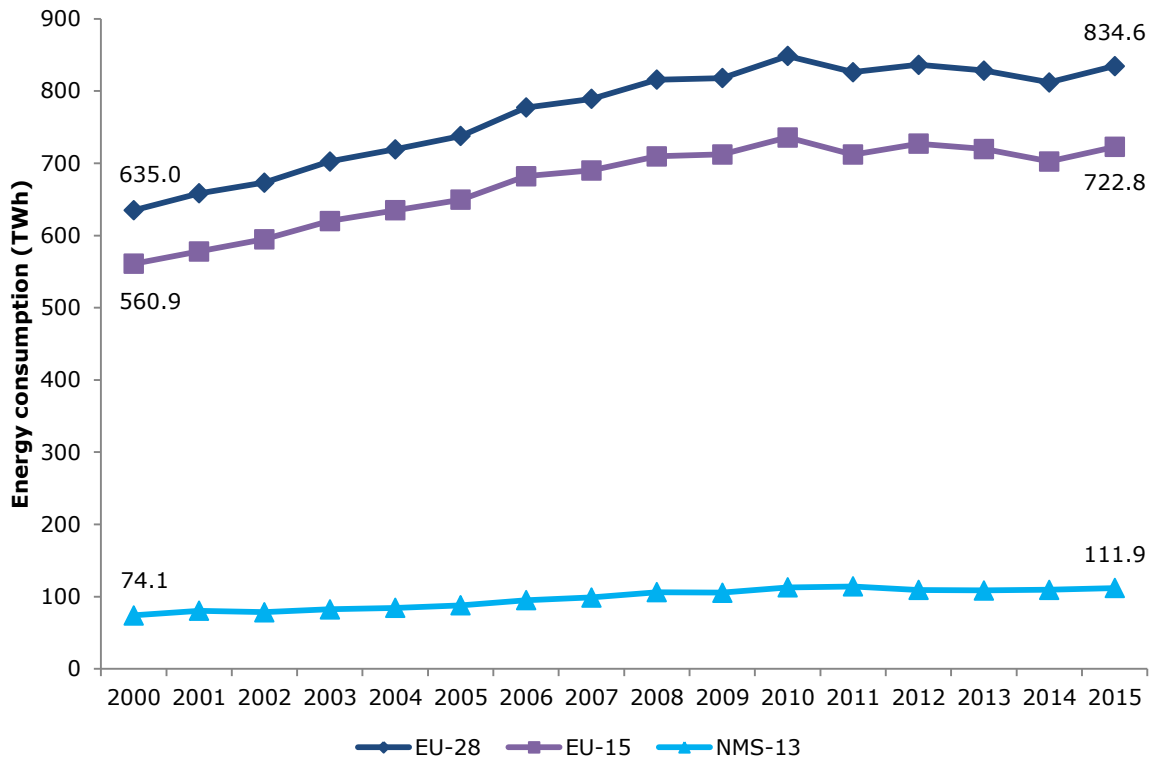
In 2015, the service sector accounted for 30.45% of the final electrical energy consumption. It had the largest share of consumption after the industry sector (36.35%), as reported in **Figure 24**.

Turning to the tertiary sector energy mix, electricity accounted for 48.85% in 2015, representing the highest share among the different energy types.

The total final electricity consumption increased by 31.43% during the period from 2000 to 2015. In 2015, the EU-28 electricity consumption reached 834.6 TWh, 86.6% of which were consumed by EU-15 Member States. A continuous increase with an average growth rate above 3% per year can be observed between 2000 and 2010 in the EU-28. In this year electricity consumption in the sector reached its maximum level (848.6 TWh). Since 2011 a decreasing trend has been registered. In 2011, a fall by 2.63% occurred due to the reduction in the consumption of EU-15 area (-3.23%), while NMS-13 increased their consumption by 1.22% in the same period. After a new decrease in 2014, in 2015 it is possible to observe an increase of 2.79% in the final tertiary electricity consumption.

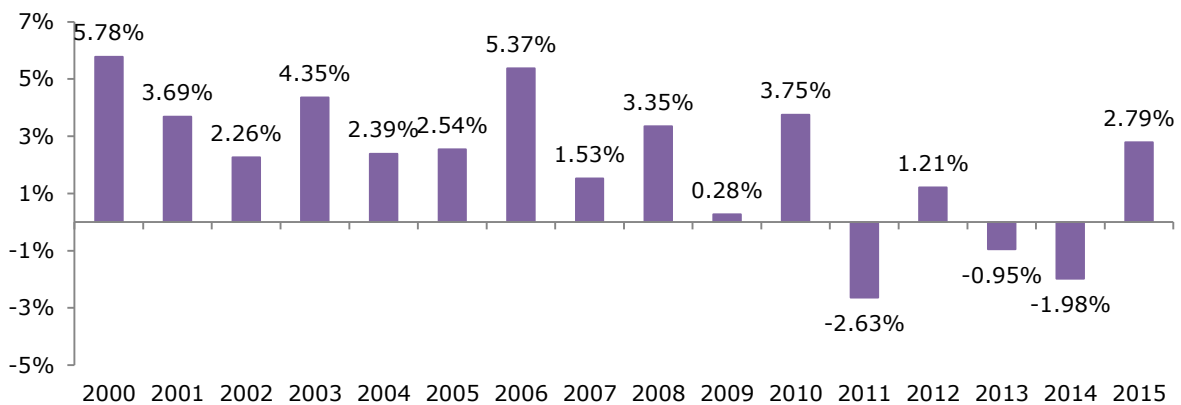
The overall raise in the final tertiary electricity consumption has been more relevant in the NMS-13 area than in the EU-15. NMS-13 experienced a raise by 51.01%, whereas EU-15 increased their electricity consumption by 28.86%.

**Figure 81:** Final tertiary electricity consumption in the EU-28, 2000-2015



Source: Eurostat

**Figure 82:** Tertiary electricity consumption annual growth rates in the EU-28, 2000-2015

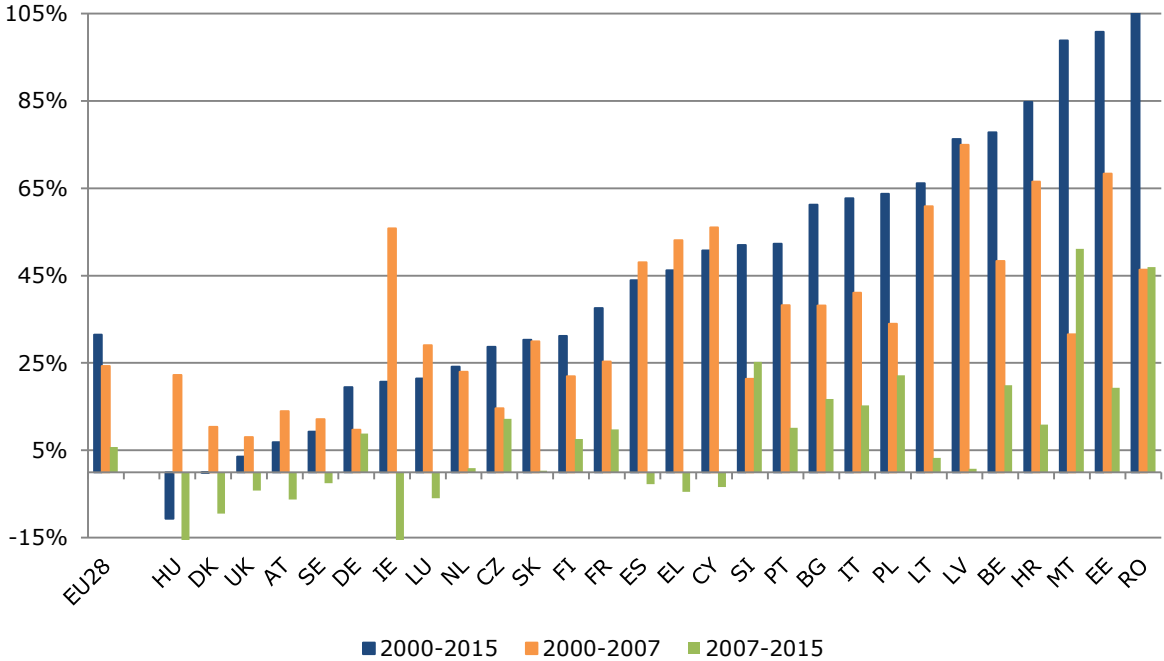


Source: Eurostat

As already mentioned, the final tertiary electricity consumption has increased by 31.43% in the period 2000-2015. Looking at the growth rates of the different Member States (**Figure 85**), it is observed that twelve MSs have registered a growth rate below the EU-28 average. During the previously mentioned period, the MSs with the highest growth rates have been Romania (115.12%), Estonia (100.79%) and Malta (98.81%).

In contrast, the MSs with the lowest growth rates have been Hungary (-10.62%), Denmark (0.09%) and the United Kingdom (3.53%). All the MSs, without exceptions, show a positive growth rate in the period from 2000 to 2007. The highest growth rates were found in Latvia (74.90%), Estonia (68.31%) and Croatia (66.54%) during this latter time period. In the period from 2007 to 2015, ten EU-28 countries have reversed their growth rate trends and turned them into negative ones. The highest growth rates occurred in Malta (51.13%), Romania (46.95%), and Slovenia (25.27%); while the lowest growth rates took place in Hungary (-26.87%), Ireland (-22.55%) and Denmark (-9.50%).

**Figure 83:** Final tertiary electricity consumption growth rates by MS in the EU-28; 2000-2015, 2000-2007 and 2007-2015



Source: Eurostat

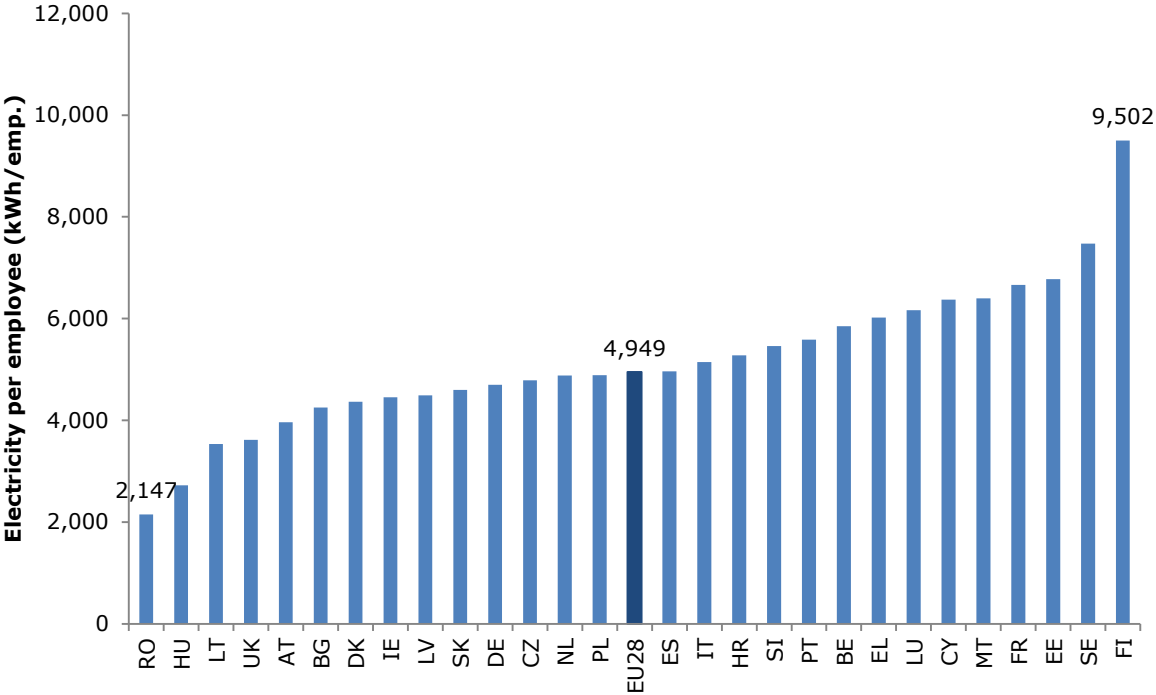
The average annual electricity consumption per employee was 4,949 kWh/emp in the EU-28 in 2015. Fourteen Member States had above EU-28 average electricity consumption per employee as illustrated in **Figure 86**. The MSs with the highest consumptions per employee were Finland (9,502 kWh/emp), Sweden (7,474 kWh/emp) and Estonia (6,775 kWh/emp). On the other hand, the countries with the lowest electricity consumptions per employee were Romania (2,147 kWh/emp), Hungary (2,726 kWh/emp) and Lithuania (3,536 kWh/emp).

Weather and climatic conditions cannot explain the large differences in per capita electricity consumption observed e.g. between Finland and Lithuania. The climatic conditions may not explain this difference as both countries are ranked as first and fifth respectively in the value of Mean Heating Degree days (see **Figure 61**). The difference may be explained not even by referring only to GDP influence, as again, United Kingdom and Finland have e.g. similar values of GDP per capita (see **Figure 39**). Among the other factors that might explain this difference in electricity per employee it is possible to find: installation of more energy efficient technologies in the tertiary sector, cultural and social habits, energy consumption patterns of different energy types, structural differences in the national economies and/or the combination of all these factors.

For instance, analysing the general energy consumption values per employee of Sweden and Finland, it is observed that these countries rely more on electricity than on gas as

energy type (see **Figure 91**). Other States, such as Lithuania or Latvia, have consumption levels per employee below the average of EU-28 both for electricity and gas. In these countries a high percentage of citizens is served by District Heating and the energy mix seems more balanced.

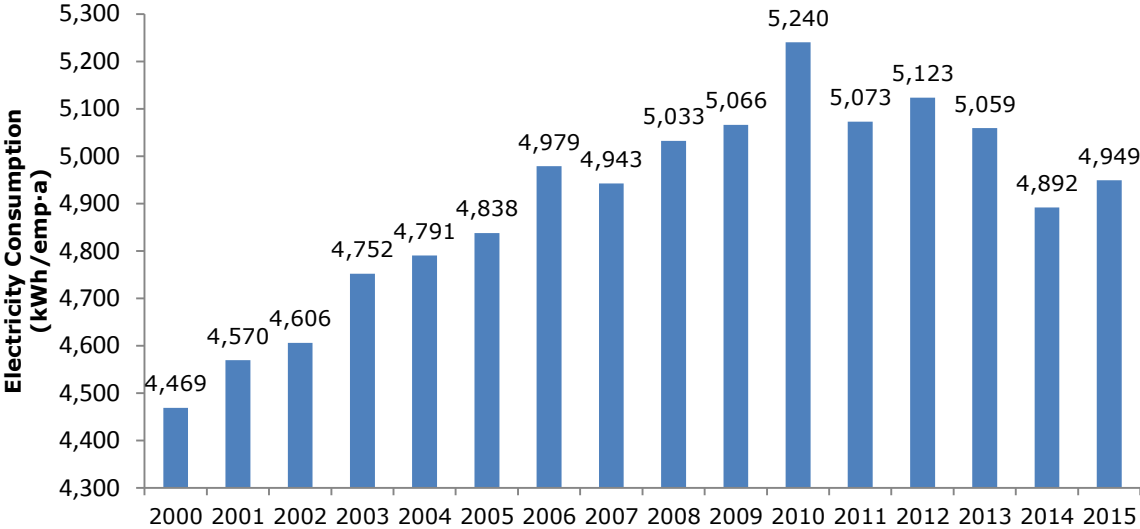
**Figure 84:** Annual electricity consumption per employee in the tertiary sector in the EU-28, 2015



Source: Eurostat

The average European electricity consumption per employee has risen by 11.2% in the period from 2000 to 2015. An overall growing trend has been experienced as shown in **Figure 87**. The maximum in the analysed time series was registered in 2010, when the electricity consumption per employee reached 5,240 kWh/emp. The highest values of electricity consumptions per employee have been registered in the period from 2008-2013, when the consumption remained steadily above 5,000 kWh/emp. In 2014, a fall by 3.3% was registered and the electricity consumption per employee declined to 4,892 kWh/emp. In 2015 the consumption level increased by 1.2%, standing at 4,949 kWh/emp, still below the threshold of 5,000 kWh/emp.

**Figure 85:** Annual electricity consumption per employee in the EU-28 tertiary sector, 2000-2015



Source: Eurostat

Table 5 provides an overview of the final electrical energy consumption in the tertiary sector with a breakdown by Member States.

**Table 5:** Final tertiary electricity consumption in the EU-28 Member States

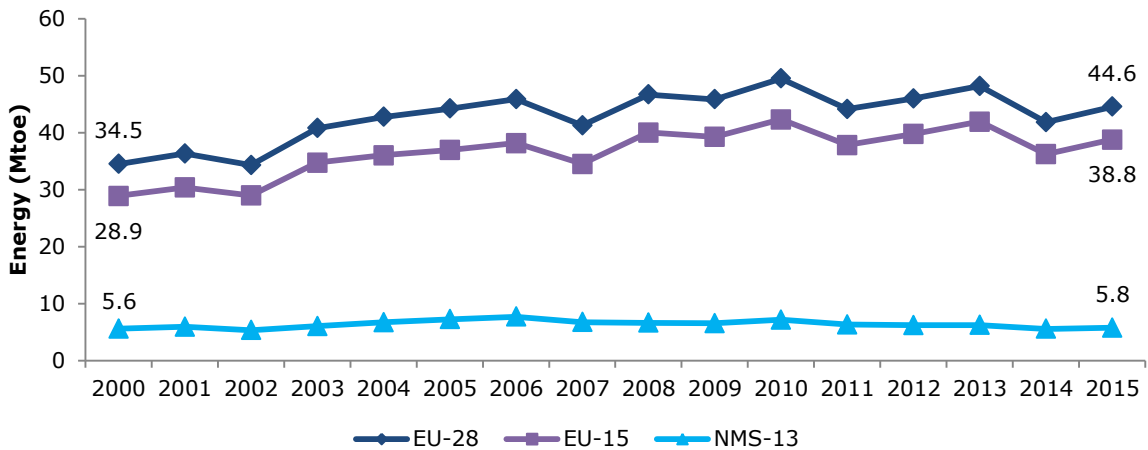
	Final Tertiary Energy Consumption in the EU-28 MS (ktoe)								Growth Rate
									2000-2015
	2000	2005	2010	2011	2012	2013	2014	2015	(% year)
EU28	634,955	737,672	848,611	826,258	836,282	828,336	811,952	834,642	31.45%
BE	12,236	12,703	22,182	21,653	21,954	22,262	21,421	21,755	77.80%
BG	5,062	6,143	8,101	8,437	8,170	7,954	7,831	8,163	61.26%
CZ	11,559	12,530	14,851	14,471	14,469	14,809	14,464	14,875	28.69%
DK	9,954	10,472	10,835	10,656	10,481	10,227	10,039	9,945	-0.09%
DE	125,453	137,235	154,075	146,990	150,511	150,947	142,868	149,872	19.46%
EE	1,401	1,929	2,511	2,378	2,536	2,530	2,795	2,813	100.79%
IE	5,590	8,465	7,166	6,501	6,279	6,366	6,439	6,746	20.68%
EL	12,260	16,479	18,000	16,839	18,470	17,008	16,802	17,926	46.22%
ES	50,023	63,823	83,892	81,300	80,212	75,569	70,309	72,001	43.94%
FR	106,313	125,188	144,664	136,494	141,622	140,556	142,574	146,269	37.58%
HR	2,926	4,413	5,385	5,516	5,513	5,387	5,215	5,405	84.72%
IT	56,595	73,875	85,619	86,912	90,279	88,982	88,489	92,085	62.71%
CY	1,251	1,786	2,256	2,138	2,000	1,786	1,838	1,886	50.76%
LV	1,546	2,142	2,420	2,487	2,798	2,703	2,882	2,725	76.26%
LT	1,872	2,686	2,839	2,953	3,114	3,130	3,218	3,110	66.13%
LU	1,647	1,750	1,994	1,881	1,946	1,999	1,974	2,000	21.43%
HU	8,880	9,931	11,355	11,466	7,817	7,507	7,647	7,937	-10.62%
MT	504	563	797	829	888	896	943	1,002	98.81%
NL	28,796	33,698	36,766	36,911	36,106	36,238	35,506	35,752	24.16%
AT	11,586	10,989	11,953	12,051	12,636	13,265	12,025	12,385	6.90%
PL	27,756	33,357	43,669	44,190	44,378	43,130	45,172	45,443	63.72%
PT	11,288	14,407	16,397	16,270	16,007	15,707	16,756	17,193	52.31%
RO	3,908	4,000	7,581	7,869	7,897	7,961	8,223	8,407	115.12%
SI	2,126	2,421	3,066	3,261	3,168	3,218	3,141	3,232	52.02%
SK	5,268	6,151	8,014	8,232	6,450	7,549	6,145	6,866	30.33%
FI	13,287	15,523	17,846	17,263	17,857	17,505	17,459	17,433	31.20%
SE	25,383	26,135	27,187	24,636	25,741	25,504	26,347	27,736	9.27%
UK	90,485	98,878	97,190	95,674	96,983	97,641	93,430	93,680	3.53%

Source: Eurostat

### 4.3 Gas consumption trends in the tertiary sector

In 2015, 18.86% of the total final gas energy consumption of the EU-28 was generated in the service sector, this being the third highest share after those of the residential sector (41.24%) and the industry sector (36.67%), as shown in **Figure 28**. When focusing on the tertiary sector energy mix, gas accounted for 30.33% of total final consumption in 2015, representing the second highest share among the different energy types after electricity.

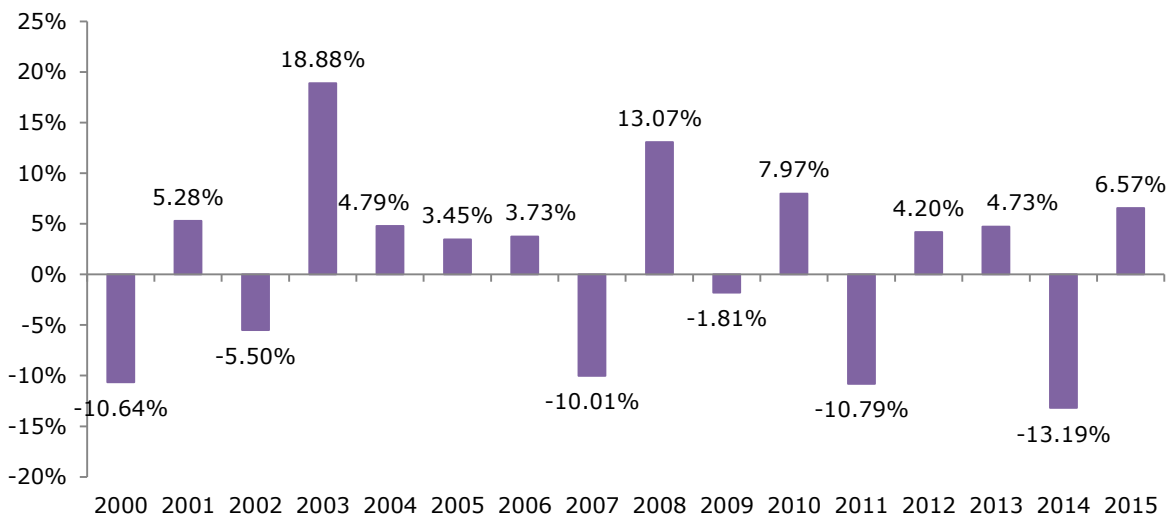
**Figure 86:** Final tertiary gas consumption in the EU-28, 2000-2015



Source: Eurostat

The final tertiary gas consumption in the EU-28 has grown by 29.3% in the period between 2000 and 2015, mainly due to the influence of the EU-15 area where it has increased by 34.3%. NMS-13 area has raised its tertiary gas consumption by only 3.6%. In 2015, the EU-28 tertiary gas consumption reached 44.6 Mtoe, out of which 87% was consumed by EU-15. The tertiary gas consumption of the NMS-13 was 5.8 Mtoe. From 2000 to 2010 an increasing trend in the consumption has been registered (leading to an overall increase of 43.5%) with the exception of 2002, 2007 and 2009. The maximum consumption was reached in 2010 (49.5 Mtoe). After an annual decrease by -10.79% occurred in 2011, there has been a rise by 9.1% in the period 2011-2013. In 2014, the tertiary gas consumption has been reduced by -13.19% in comparison to 2013 and has approximately returned to the levels of 2007. A new increase (6.57%) has been registered in 2015.

**Figure 87:** Annual tertiary gas consumption growth rates in the EU-28, 2000-2015

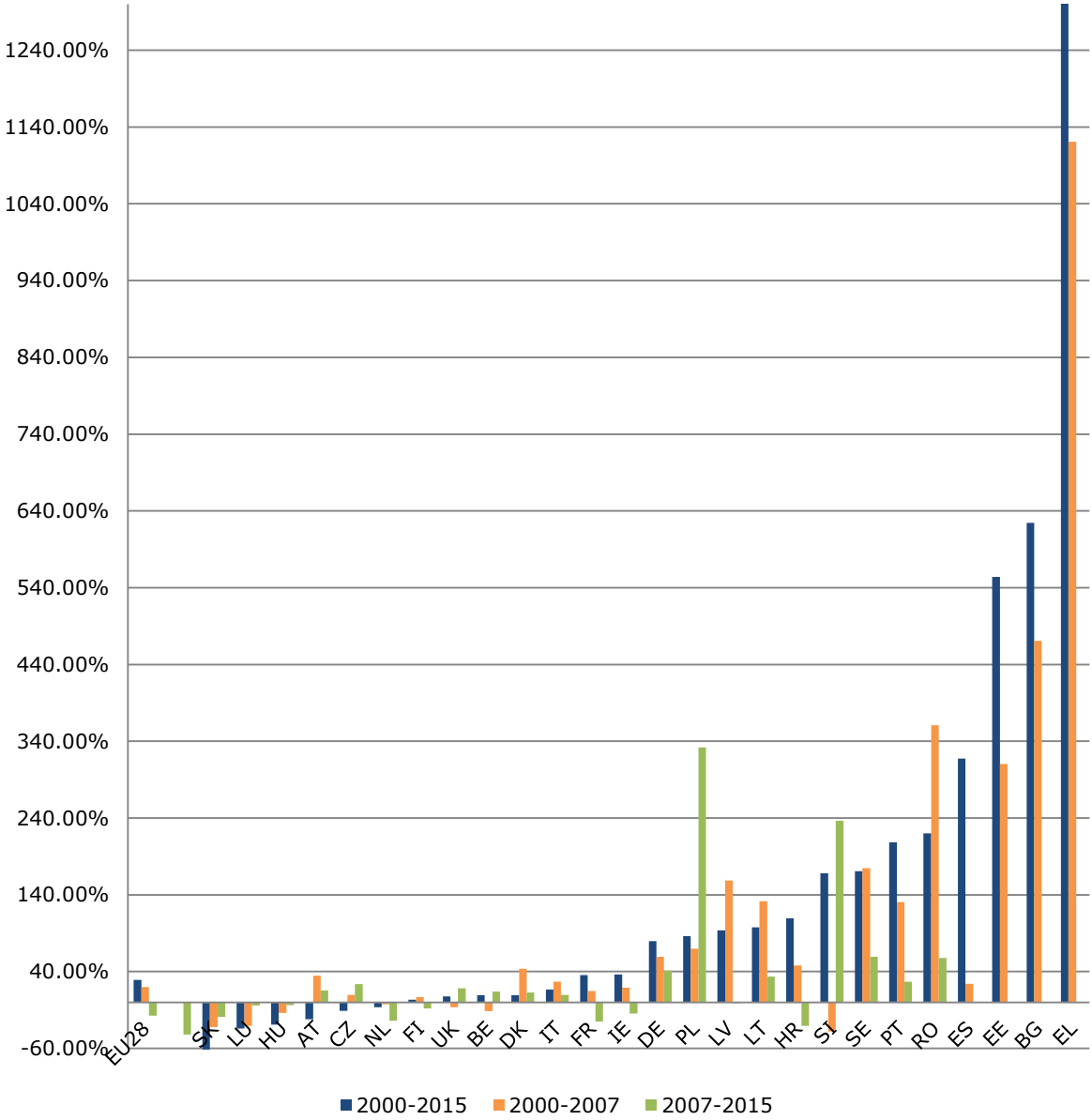


Source: Eurostat

There are notable differences across the EU-28 Member States regarding the final tertiary gas consumption growth rates during the period 2000-2015. It can be observed that countries such as Greece, Bulgaria or Estonia have experienced a very large increase

in their tertiary gas consumption over this period. This may be the result of a gradual development of gas networks and a consequent boost in the consumption of this fuel type by those States. Individual case studies and further research would however be needed in order to explain these growth rates. Eleven Member States have registered a growth rate below the European average growth rate (29.21%) for the same period. The recent financial and economic crisis has impacted less on total EU-28 tertiary gas consumption compared to the impact on gas consumption in other economic sectors, although it has totally reversed the tendencies in countries such as Austria (it went from an increase of 34.67% between 2000-2007 to a decrease of 41.97% in 2007-2015) or Denmark (passed from 43.52% in 2000-2007 to -23.81% in 2007-2015) as illustrated in **Figure 90**.

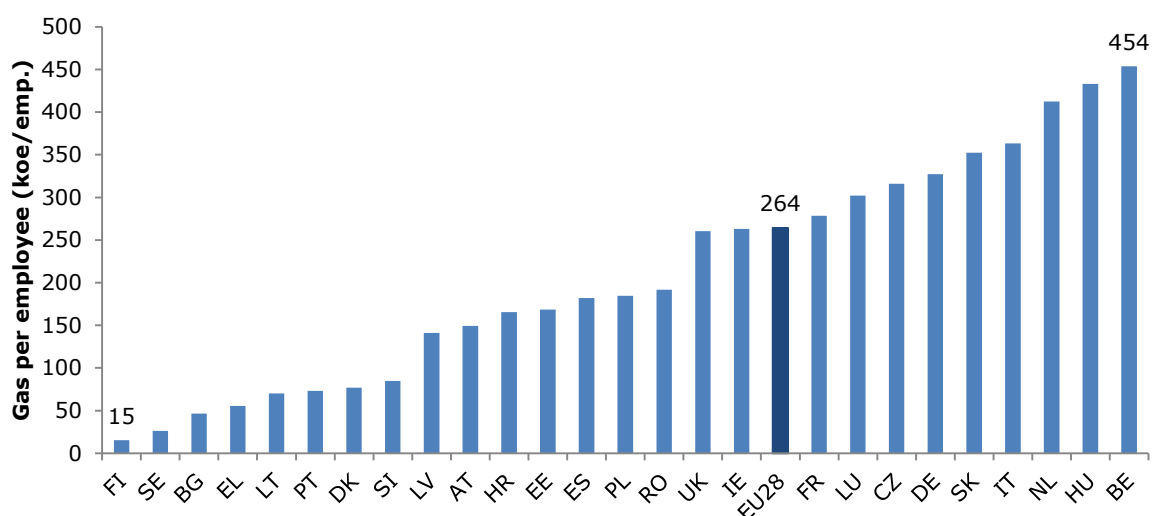
**Figure 88:** Final tertiary gas consumption growth rates by MS in the EU-28; 2000-2015, 2000-2007 and 2007-2015



Source: Eurostat



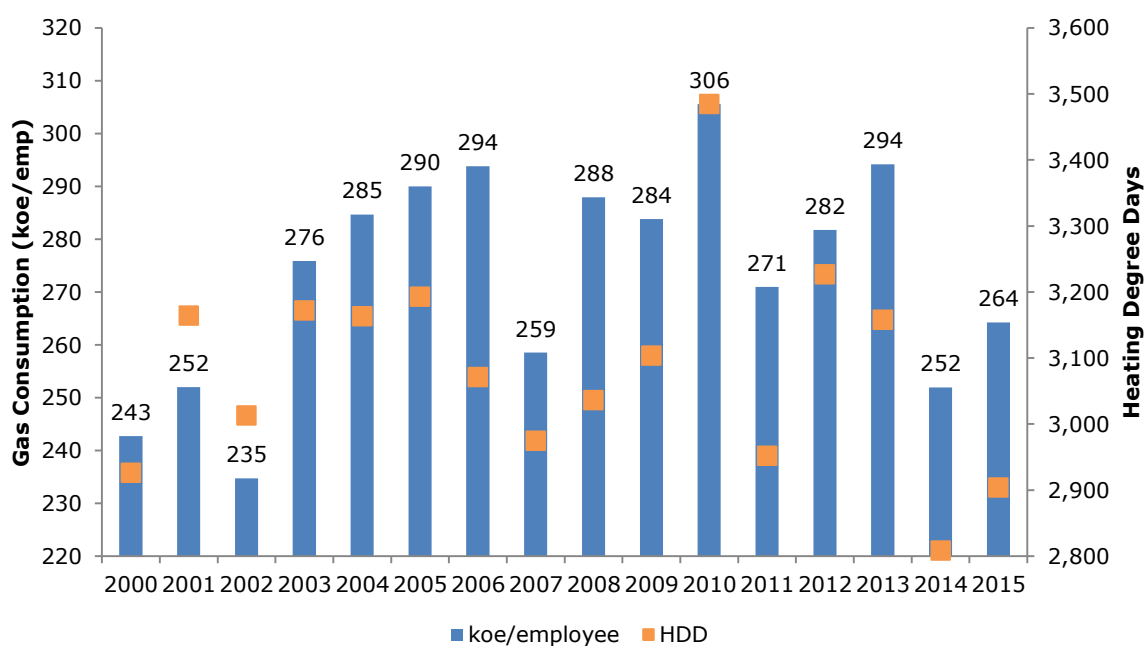
**Figure 89:** Annual final gas consumption per employee in the tertiary sector in the EU-28 Member States, 2015



Source: Eurostat<sup>51</sup>

The average gas consumption per employee in the EU-28 in the tertiary sector was 264 koe/emp. in the year 2015. Differences among the EU-28 Member States are remarkable. The European country with the lowest gas consumption per employee was Finland which registered 15 koe/emp., followed by Sweden (26 koe/emp.) and Bulgaria (46 koe/emp.). On the other hand, the Member State with the highest consumption was Belgium (454 koe/emp.). The second was Hungary (433 koe/emp) and the third the Netherlands (412 koe/emp). Nine countries registered consumption levels above EU-28 level as illustrated in **Figure 91**.

**Figure 90:** Annual final gas consumption per employee in the tertiary sector in the EU-28, 2000-2015



Source: Eurostat

<sup>51</sup> Data for Cyprus and Malta equal zero.

Unlike electricity which can be used for other purposes, gas has heating as major usage. Therefore, the qualitative correlation between gas consumption per employee in the tertiary sector and the weather conditions (heating degree days) is of great interest in this case. **Figure 92** shows degree days and gas consumption per employee in the EU-28 for the 16-years period from 2000 to 2015. During this period, the gas consumption per employee in the EU-28 has raised by 8.6% (from 243 koe/emp in 2000 to 264 koe/emp in 2015). The maximum value was achieved in 2010 (306 koe/emp) when the highest HDD value (3,484) was also achieved.

Table 6 provides an overview of the final gas energy consumption in the tertiary sector with a breakdown by Member States.

**Table 6:** Final tertiary gas consumption in the EU-28 Member States

Final tertiary gas energy consumption, EU-28									
(ktoe)	2000	2005	2010	2011	2012	2013	2014	2015	2000-2015 (% year)
<b>EU28</b>	<b>34,485.7</b>	<b>44,215.7</b>	<b>49,478.7</b>	<b>44,138.2</b>	<b>45,989.8</b>	<b>48,165.8</b>	<b>41,813.3</b>	<b>44,558.5</b>	<b>29.21%</b>
<b>BE</b>	1,545.3	1,770.9	1,945.4	1,589.0	1,700.1	1,937.1	1,513.2	1,687.4	9.20%
<b>BG</b>	12.3	43.6	80.1	82.6	81.7	78.0	83.2	89.1	624.39%
<b>CZ</b>	1,103.7	1,273.6	1,200.2	1,145.6	1,052.3	1,013.4	987.6	982.1	-11.02%
<b>DK</b>	160.4	221.3	227.6	177.8	198.4	207.4	153.4	175.4	9.35%
<b>DE</b>	5,806.5	9,228.1	9,953.1	8,961.6	9,135.4	10,696.8	9,969.7	10,436.5	79.74%
<b>EE</b>	10.7	46.2	29.7	31.0	34.9	43.3	66.8	70.0	554.21%
<b>IE</b>	292.7	297.9	439.3	365.6	400.2	406.0	400.5	398.4	36.11%
<b>EL</b>	8.6	73.8	139.0	164.8	138.0	124.7	125.3	165.7	1826.74%
<b>ES</b>	632.4	706.4	1,064.6	1,755.6	1,617.7	1,497.2	1,450.5	2,640.1	317.47%
<b>FR</b>	4,518.3	5,579.0	6,691.1	5,615.7	6,764.4	7,213.4	6,129.8	6,116.1	35.36%
<b>HR</b>	80.9	124.4	157.7	141.9	132.3	136.1	132.5	169.4	109.39%
<b>IT</b>	5,571.8	7,434.4	8,613.8	7,254.5	7,276.4	7,259.0	6,012.1	6,499.2	16.64%
<b>LV</b>	44.2	93.7	115.6	104.4	98.0	83.6	90.6	85.6	93.67%
<b>LT</b>	31.1	50.6	66.4	60.1	63.3	63.2	58.4	61.5	97.75%
<b>LU</b>	148.5	97.7	136.4	81.7	120.6	117.4	95.2	98.0	-34.01%
<b>HU</b>	1,773.1	2,280.9	1,715.2	1,725.8	1,387.1	1,407.9	1,243.2	1,261.1	-28.88%
<b>NL</b>	3,227.3	3,523.1	4,035.1	3,221.7	3,633.4	3,646.4	2,887.5	3,019.6	-6.44%
<b>AT</b>	597.0	915.2	784.5	646.2	640.2	546.5	543.5	466.6	-21.84%
<b>PL</b>	921.3	1,634.0	1,993.2	1,870.1	1,932.3	1,827.4	1,610.6	1,715.5	86.20%
<b>PT</b>	73.0	136.3	196.3	217.6	217.9	218.9	215.9	225.1	208.36%
<b>RO</b>	234.6	781.6	935.6	756.0	764.0	784.6	775.8	750.6	219.95%
<b>SI</b>	18.7	25.5	23.6	39.4	13.2	31.8	36.7	50.1	167.91%
<b>SK</b>	1,360.1	900.6	843.0	356.8	644.2	771.9	493.4	526.1	-61.32%
<b>FI</b>	27.0	31.5	30.6	37.1	33.5	34.8	29.9	27.9	3.33%
<b>SE</b>	35.9	95.2	107.1	96.4	123.8	108.1	98.5	97.2	170.75%
<b>UK</b>	6,250.3	6,849.9	7,954.7	7,639.3	7,786.5	7,910.9	6,609.7	6,744.4	7.91%

Source: Eurostat

#### 4.4 Overview – Tertiary sector

The tertiary sector represented 73.76% of the EU-28 GDP in the year 2015. Tertiary sector is related to activities such as professional, scientific and technical services, public administration, wholesale, retail, etc. These activities have caused an increase in employment by 3,409 thousand units across the EU-28 during the period from 2010 to 2015.

In 2015, the tertiary sector accounted for 13.55% of total European final energy consumption. The final energy consumption of the sector has increased by 21.5% (from 121 Mtoe to 147 Mtoe) in the period from 2000 to 2015. A similar increase has been followed by EU-15 and NMS-13 areas which have increased their consumption by 20.95% and 17.65% respectively. The sector registered a final energy consumption of 147 Mtoe in 2015, out of which 86.4% (127 Mtoe) was generated by EU-15 area. The maximum level of consumption was reached in the year 2010 (157.8 Mtoe). Consumption's decreases registered in 2011 and 2014 have led the final tertiary energy consumption to 2007 levels. A new increase of 3.63% has been observed in 2015.

Very different growth rates have been registered across the EU-28 Member States. In the period from 2000 to 2015, the MSs with the highest reduction rates of final tertiary energy consumption were Slovakia (-40.92%), Hungary (-27.86%) and Slovenia (-13.18%). The Member States with the highest consumption growth rates were Malta (191.45%), Romania (161.70%) and Cyprus (98.88%), all of them belonging to NMS-13.

Compared to the period 2000-2007, a significant change in the growth rates occurred over the period 2007-2015 in Romania, Greece, Lithuania, Latvia, Austria and Ireland. A positive growth rate during the first sub period made way for a negative one in the second sub period. However the growth rates variations between these two sub periods are not as significant as the variations occurred in other economic sectors. This can be the result of an on-going tertiarization process at European level.

The energy mix in the final energy consumption in the EU-28 in the tertiary sector in 2015 was mainly composed by three energy types which accounted for above 90% of the total. Electricity had the highest share (48.85%), followed by gas (30.33%) and total petroleum products (10.38%). Changes compared to the scenario of year 2000 are mainly due to a reduction in the share of petroleum products (-8.28%). Electricity (+3.89%) and gas (+1.93%) have instead acquired larger shares together with derived heat (+0.68) and renewable energies (+2.3). Solid fuels and waste have reduced their shares by 0.49% and 0.02% respectively.

Weather and climate conditions as well as economic growth and employment growth can be energy consumption influencing factors in the tertiary sector. Given the nature of the tertiary sector which includes public sector, professional, scientific and technical activities, service and commerce; comfort conditions (e.g. temperature or humidity levels) are important and can be considered as key factors in the evaluation of energy consumption in the tertiary sector. With regard to the employment creation during the period 2000-2015, the sector has increased by 21.7% (by creating about 30 millions of new employees). Despite this favourable trend, there is a clear impact of the economic crisis: from 2010 to 2015 it is possible to observe a slowdown in the job creation. In this direction an interesting indicator to consider in the analysis of the energy trends in the tertiary sector is the energy consumed per employee. The final average energy consumption per employee in the tertiary sector in the EU-28 was 0.87 toe per employee in 2015. The Member States with the highest energy consumption per employee were Finland (1.48 toe/emp.), Luxembourg (1.23 toe/emp.), and Belgium (1.23 toe/emp.). On the other hand, Romania (0.45 toe/emp.), Bulgaria (0.52 toe/emp.), United Kingdom (0.63 toe/emp.) and Greece were the Member States with the lowest final tertiary energy consumption per employee.

With regard the weather conditions it is possible to observe a correlation between the final energy consumption per employee and the value of HDD. The influence of weather

conditions on per capita consumption has proved to be greater than the influence of the employment rate.

The total final electricity consumption in the service sector accounted for 30.45% of the final electrical energy consumption. It had the largest share of consumption after the industry sector (36.35%). Regarding the tertiary sector energy mix, electricity accounted for 48.85% of the total final energy consumption in the same year, confirming electricity as the main consumed fuel type.

The final electricity consumption trend in the service sector shows an increase in the consumption by 31.43% (from 635 TWh to 834.6 TWh) during the 16-year period from 2000 to 2015. The raise in the consumption has been more relevant in the NMS-13 countries (51.01%) than in the EU-15 (28.86%). Concerning the growth rates of the different Member States over this period, it is observed that twelve MSs have registered a growth rate below the EU-28 average (31.45%) during the period 2000-2015. The MSs with the highest growth rates have been Romania (115.12%), Estonia (100.79%) and Malta (98.81%). The lowest growth rates have been registered in Hungary (-10.62%), Denmark (-0.09%) and the United Kingdom (3.53%); these last two values might be the result of energy efficiency actions. To be noted that all the MSs without exceptions show a positive growth rate in the period from 2000 to 2007. Nevertheless, this trend changed in the period from 2007 to 2015 during which ten EU-28 countries have reversed their growth rates turning them into negative ones.

The electricity consumption per employee in the EU-28 for the year 2015 was 4,949 kWh/emp. Fourteen Member States had above EU-28 average electricity consumption per employee. The MSs with the highest consumption per employee were Finland (9,502 kWh/emp.), Sweden (7,474 kWh/emp.) and Estonia (6,775 kWh/emp.). On the other hand, the countries with the lowest electricity consumptions per employee were Romania (2,147 kWh/emp.), Hungary (2,726 kWh/emp.) and Lithuania (3,536 kWh/emp.).

The average European electricity consumption per employee has increased by 11.2% in the period from 2000 to 2015. The maximum registered value occurred in 2010 (5,240 kWh/emp.). The highest electricity consumption per employee has been experienced in the period 2008-2013. In 2014, electricity consumption per employee declined by 3.3%. In 2015 the consumption level increased by 1.2% (4,949 kWh/emp.), but remained below the level reached in 2013.

The final gas consumption in the service sector accounted for 18.86% of the total final gas consumption of the EU-28 in 2015. This sector was the third highest gas consumer after the residential sector (41.24%) and the industry sector (36.67%). Regarding the tertiary sector energy mix, gas accounted for 30.33% of the total final energy consumption, representing the second highest share among the different energy types after electricity.

Over the period 2000-2015 the consumption of final gas increased by 29.3% (from 34.5 to 44.6 Mtoe). This raise has been mainly due to the EU-15 MSs which have increased their consumption by 34.3%. NMS-13 areas have instead only raised their tertiary gas consumption by 3.6%.

There are notable differences across the EU-28 Member States regarding the final tertiary gas consumption growth rates during the period 2000-2015. It can be observed that countries such as Greece, Bulgaria or Estonia have experienced a very large increase in their tertiary gas consumption over this period. This may be the result of a gradual development of gas networks and a consequent boost in the consumption of this fuel type by those States. Individual case studies and further research would however be needed in order to explain these growth rates. Eleven Member States have registered a growth rate below the European average growth rate (29.21%) for the same period. The recent financial and economic crisis has impacted less on total EU-28 tertiary gas consumption compared to the impact on gas consumption in other economic sectors, although it has totally reversed the tendencies in countries such as Austria (it went from

an increase of 34.67% between 2000-2007 to a decrease of 41.97% in 2007-2015) or Denmark (passed from 43.52% in 2000-2007 to -23.81% in 2007-2015).

The average gas consumption per employee in the EU-28 in the tertiary sector was 264 koe/emp. in the year 2015. The European country with the lowest gas consumption per employee was Finland which registered 15 koe/emp., followed by Sweden (26 koe/emp.) and Bulgaria (46 koe/emp.). On the other hand, the Member State with the highest consumption was Belgium (454 koe/emp.). The second was Hungary (433 koe/emp.) and the third the Netherlands (412 koe/emp.).

Gas as energy fuel has its major application in heating applications. Therefore it is of interest to analyse gas consumption correlation with the weather conditions (Heating Degree Days). From 2000 to 2015 the gas consumption per employee in the EU-28 has raised by 8.6% (from 243 koe/emp. to 264 koe/emp.). The maximum value was achieved in 2010 (306 koe/emp.) when the highest HDD value (3,484) was also achieved.

## 5 Energy Consumption Trends and Environmental Performances of the Transport Sector

This chapter covers the energy consumption trends in the transport sector and in the main subsectors such as rail, road, international and domestic aviation and domestic navigation. In order to complement the analysis of energy consumption, some insight about the road sector, passenger and freight transport and carbon dioxide emissions is also provided.

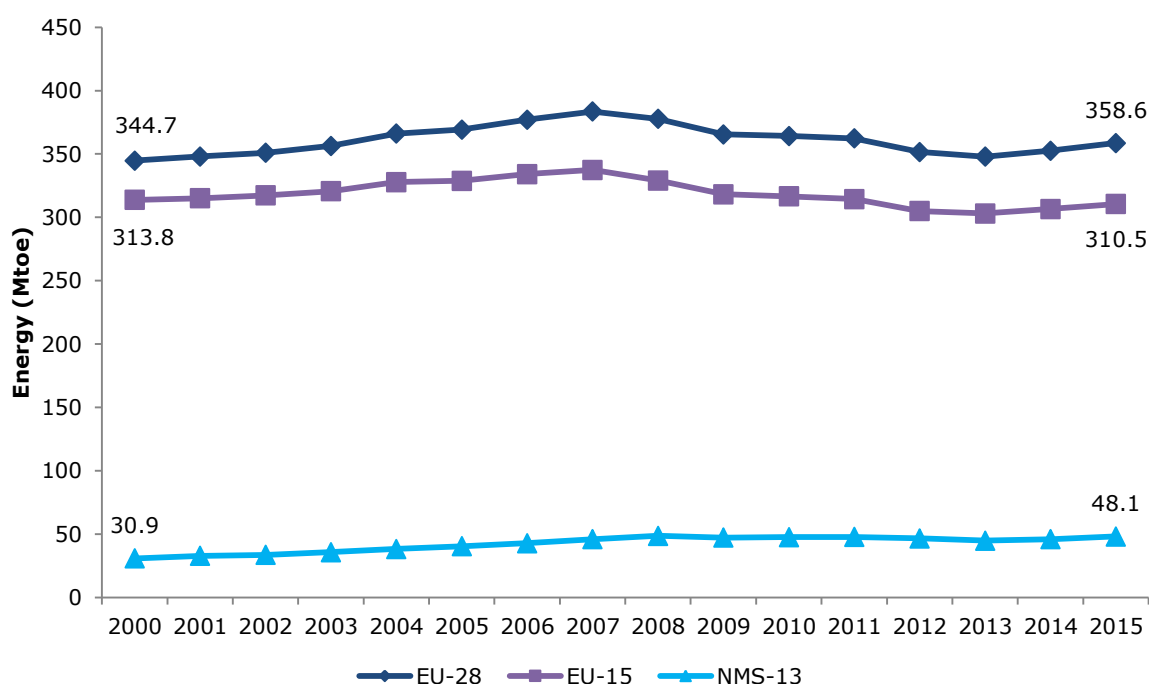
### 5.1 Final energy consumption and energy mix of the transport sector

The transport sector proved to be the main consuming sector, accounting for 33.09% of total final energy consumption in the year 2015 (**Figure 9**).

The final energy consumption in the EU-28 transport sector has increased by 4.04% in the 16-year period from 2000 to 2015. This increase has not been followed in the same way by both EU-15 and NMS-13 areas. The EU-15 area has reduced its consumption by 1.05%, whereas NMS-13 have increased their final energy demand by 55.66%. In 2015, the final energy consumption reached 358.6 Mtoe. 86.59% (310.5 Mtoe) was accounted by EU-15 area and the other 13.41% (48.1 Mtoe) was consumed in the NMS-13. The maximum consumption during the analysed period took place in the year 2007 when the EU-28 consumption reached 383.5 Mtoe, while the minimum occurred in the year 2000 (344.7 Mtoe). As it is possible to see from **Figure 93** and **Figure 94** there is a reversing trend before and after 2007.

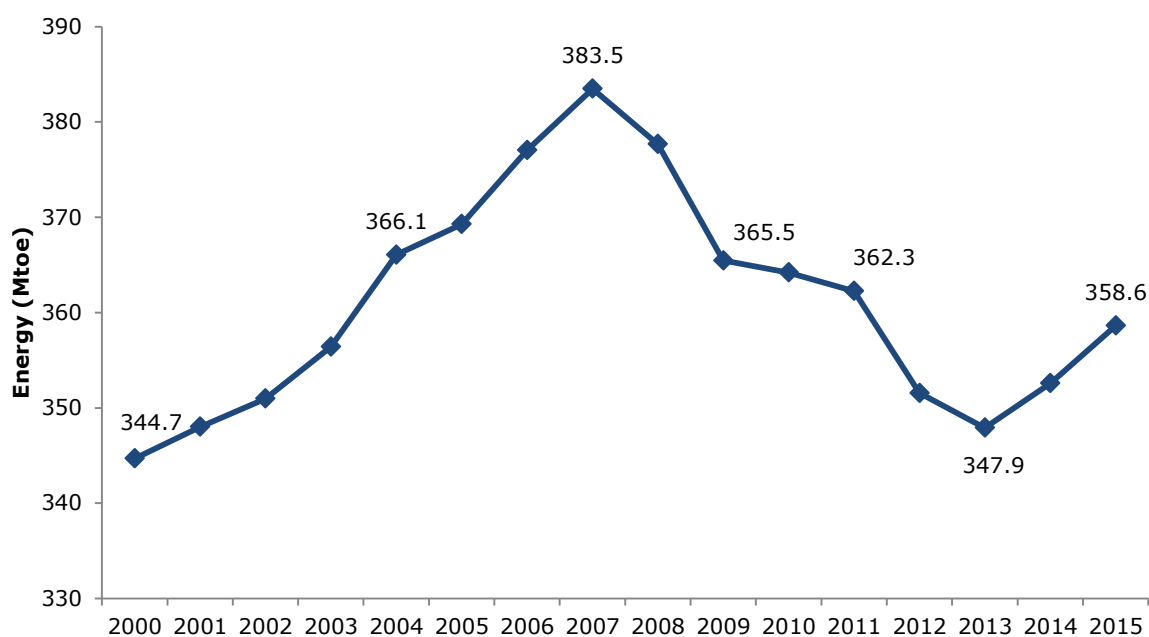
Over the period 2000-2007, it is possible to observe an increasing trend (the average growth rate was equal to 1.4%). In contrast, from 2007 to 2013 there has been a fall in the final energy consumption with an average reduction of 1.6% per year. In 2014, this trend was interrupted and the final energy consumption in the transport sector grew by 1.34%. The increase in energy consumption in the sector was confirmed by the positive growth rate of 1.72% registered in 2015.

**Figure 91:** Final energy consumption in the transport sector in the EU-28, 2000-2015



Source: Eurostat

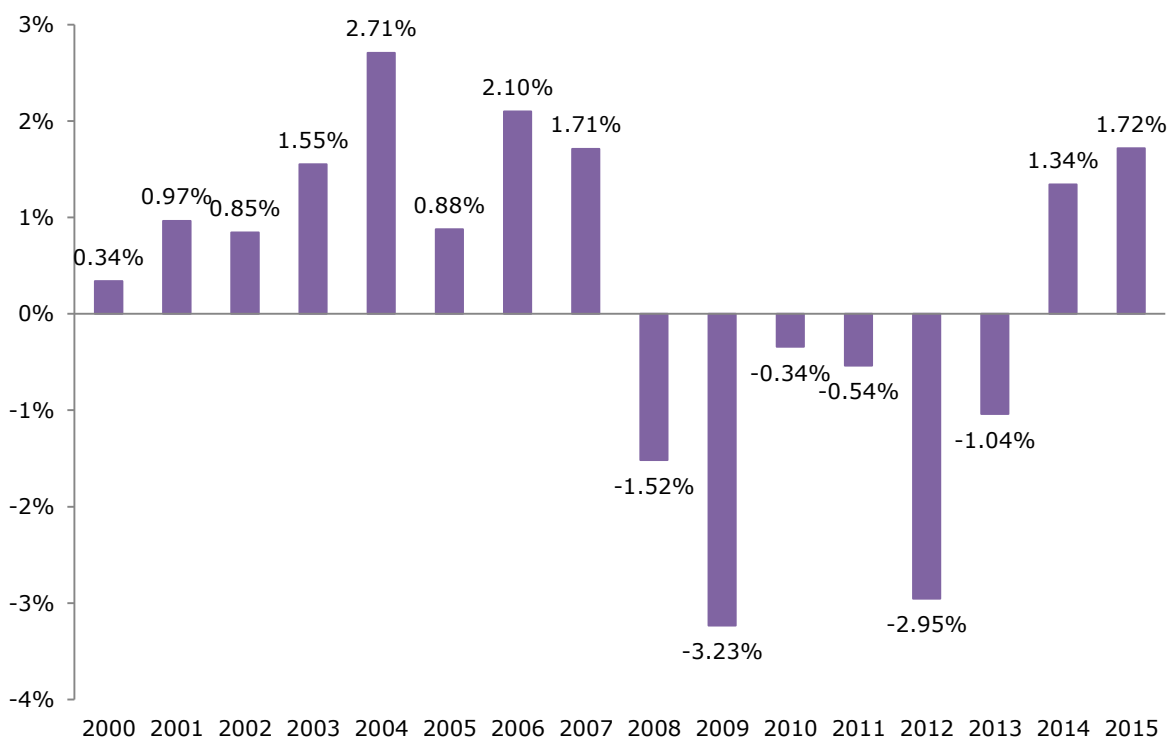
**Figure 92:** Final energy consumption in the transport sector in the EU-28, 2000-2015 (detailed)



Source: Eurostat

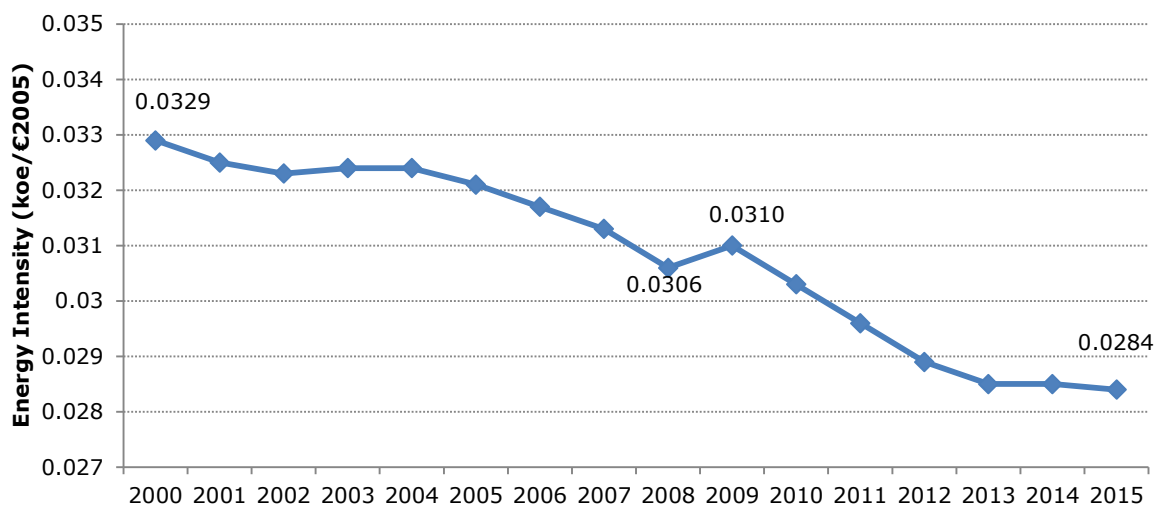
During the period 2000-2007 (**Figure 95**), the highest growth rate occurred in 2004 when there was an increase by 2.7% compared to the previous year. In contrast, 2009 registered the lowest growth rate, -3.2%. The reduction of the energy consumption in the transport sector in the years following 2007 could be explained, among others, by the impact of the financial and economic crisis.

**Figure 93:** Annual energy consumption growth rates in the EU-28 transport sector, 2000-2015



Source: Eurostat

**Figure 94:** Energy intensity of transport sector in the EU-28, 2000-2015



Source: Odyssee

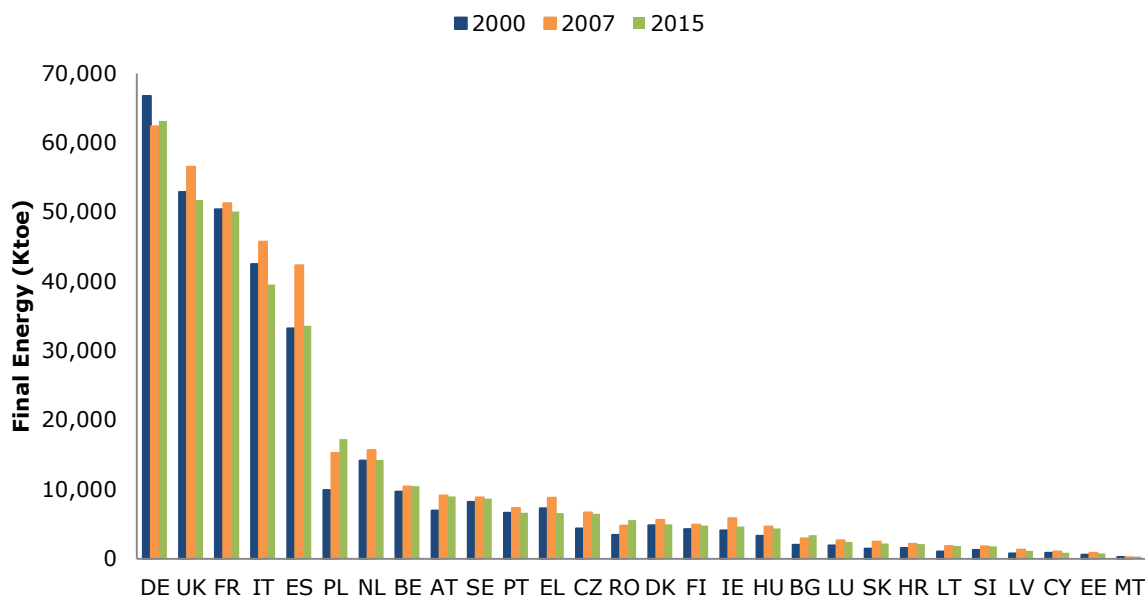
During the period from 2000 to 2015 (**Figure 96**), the energy intensity in the transport sector has decreased by 13.7% until registering the value of 0.0284 koe/€2005 in 2015. The decreasing trend along the whole period was interrupted only in 2009 by a rise of 1.3% due to the impact of the financial and economic crisis on GDP.

In 2015, the Member State with the highest consumption in the transport sector was Germany (63.2 Mtoe), followed by the United Kingdom (51.8 Mtoe) and France (50.1 Mtoe). It is worth noticing that in 2000 these three countries occupied the same positions in the ranking of the most final energy consumers for transport (see **Figure 97**).

The mentioned three Member States together with Italy accounted for more than 57% of the final energy consumption in the sector. If also Spain is added, the share reaches more than 66% of the final energy consumption. Fourteen Member States accounted for less than 10% of the final energy consumption in 2015 (see **Figure 98**).

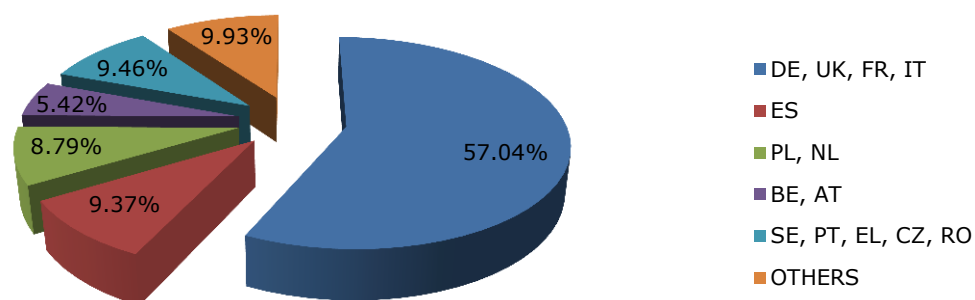


**Figure 95:** Final energy consumption in the transport sector in the EU-28 Member States, 2000, 2007 and 2015



Source: Eurostat

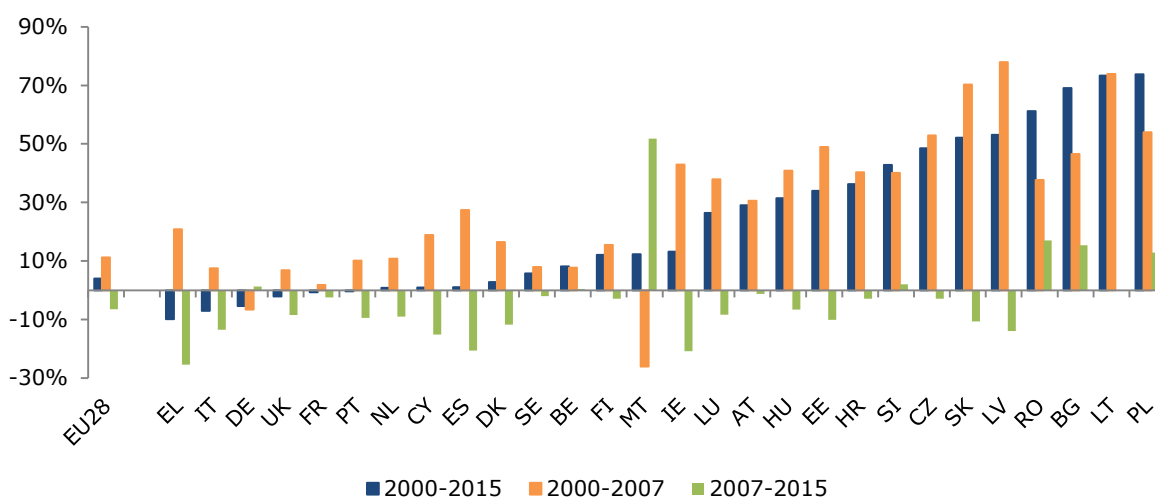
**Figure 96:** Share of EU-28 Member States final energy consumption in the transport sector (2015)



Source: Eurostat

**Figure 99** shows the growth rates of the final energy consumption by Member State during different time horizons. The States with the highest growth rates in the final energy consumption in the transport sector between 2000 and 2015 have been Poland (73.82%), Lithuania (73.37%) and Bulgaria (69.05%), while the Member States with the lowest growth rates were Greece (-9.87%), Italy (-7.01%) and Germany (-5.39%). Ten EU-28 countries registered consumption values below the European average (4.4%). In the period 2000-2007, all the Member States with the exception of Germany and Malta registered an increase in their final energy consumption. The average European growth rate was 11.25% during the same period. The trends were significantly different in the period from 2007 to 2015 when seven Member States recorded a positive growth rate. This latest sub-period reflects the energy consumption decline produced by the financial and economic crisis which can be clearly observed in the overall European final energy consumption trends.

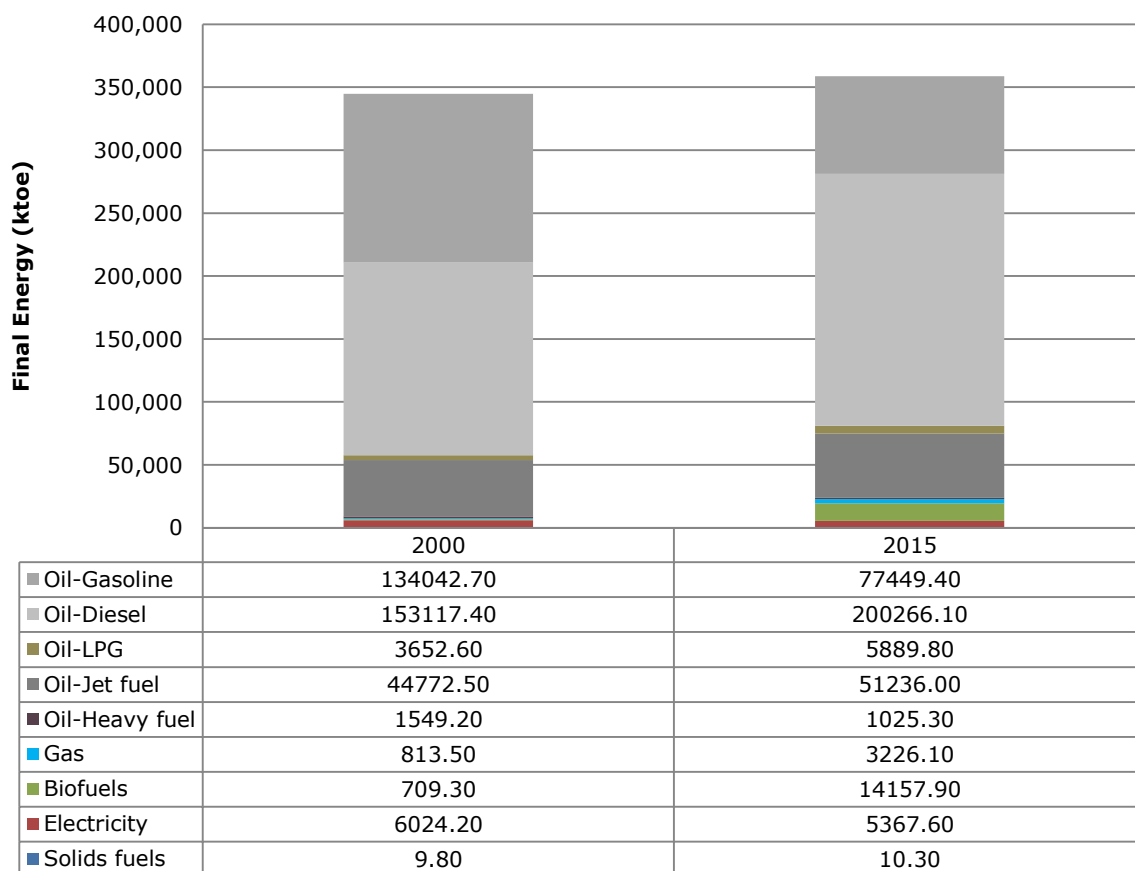
**Figure 97:** Final energy consumption growth rates at transport sector in the EU-28 Member States; 2000-2015, 2000-2007 and 2007-2015



Source: Eurostat

The final energy mix in the transport sector is mainly provided by petroleum products. Petroleum products represented 93.65% (335,867 ktoe) in 2015. This represents a reduction in the share in comparison to 2000 (97.81%; 337,134 ktoe) (see **Figure 100**).

**Figure 98:** Final energy mix in the transport sector in the EU-28 (absolute numbers), 2000 and 2015

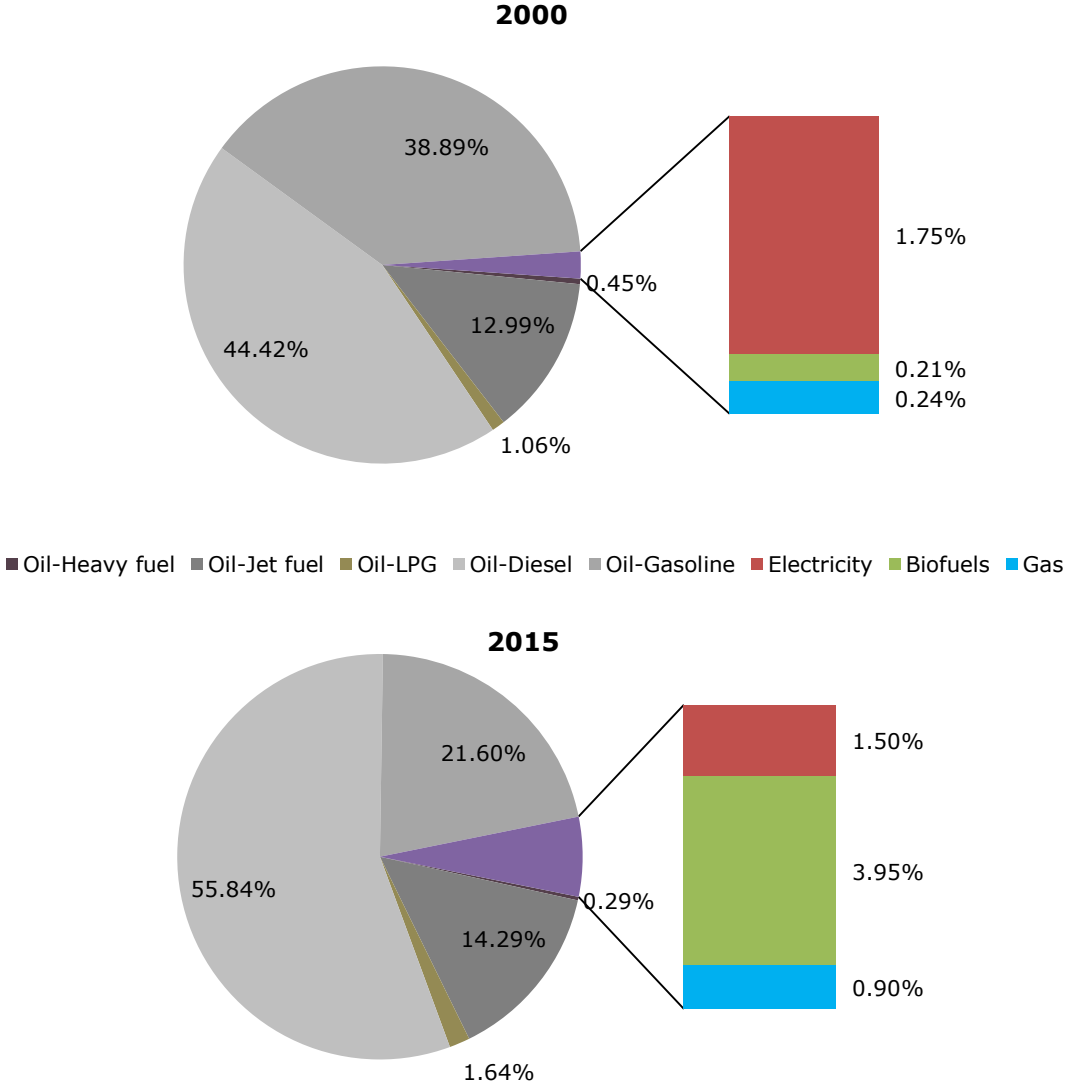


Source: Eurostat

Among the petroleum products, diesel and gasoline stand out. In 2015, oil-diesel accounted for 55.84% (200,266.1 ktoe) and gasoline for 21.60% (77,449.4 ktoe). The remaining shares were completed by jet fuel (14.29%; 51,236 ktoe), biofuels (3.95%; 14,157.9 ktoe), LPG (1.64%; 5,889.8 ktoe), electricity (1.5%; 5,367.6 ktoe), gas (0.90%; 3,226.1 ktoe), and heavy fuel (0.29%; 1025.3 ktoe). Solid fuels represented a negligible share in the final energy mix (0.003%; 10.3 ktoe).

A reduction of the gasoline share by 17.29% (56.6 Mtoe), together with an increase by 11.0% (47.1 Mtoe) and 3.74% (13.4 Mtoe) in the shares of diesel and biofuels respectively constituted the most significant changes in the final energy mix in comparison to the year 2000 scenario.

**Figure 99:** Final energy mix in the transport sector in the EU-28 (shares), 2000 and 2015

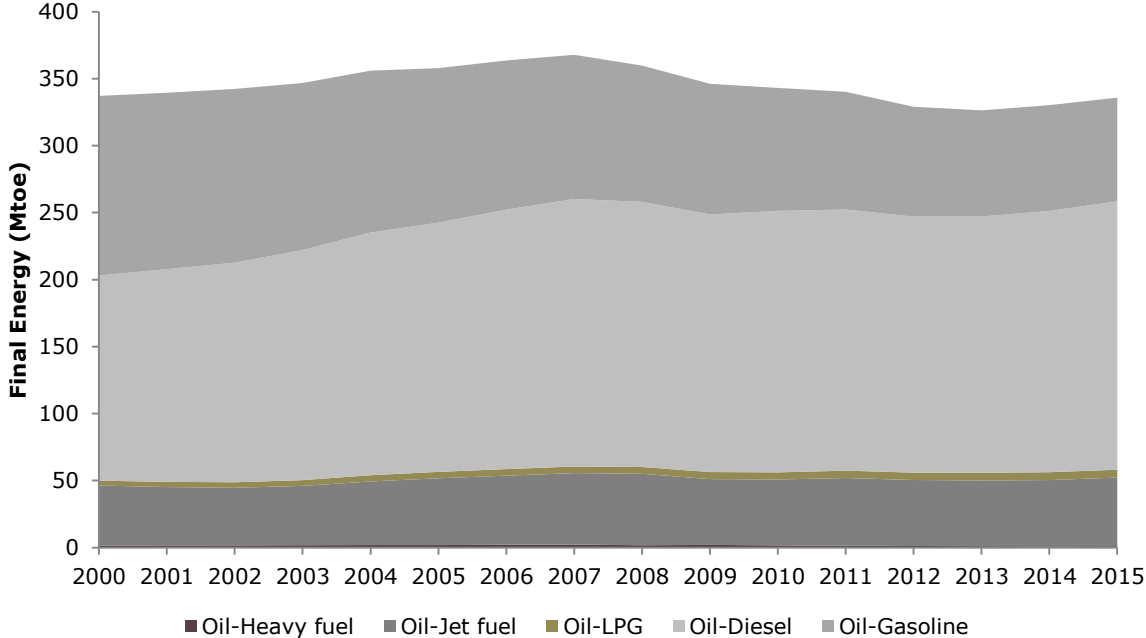


Source: Eurostat

From 2000 to 2015, the petroleum products consumption has dropped by 0.38% (1.3 Mtoe). During this period the diesel has gradually increased its presence; diesel's consumption has increased by 30.79%, while gasoline's has declined by 42.22%. Heavy fuel has registered a significant fall by 33.82% (-523.9 ktoe) in the same period. The

changes in the petroleum products consumption have occurred gradually during the analysed 16-years period as illustrated in **Figure 103**.

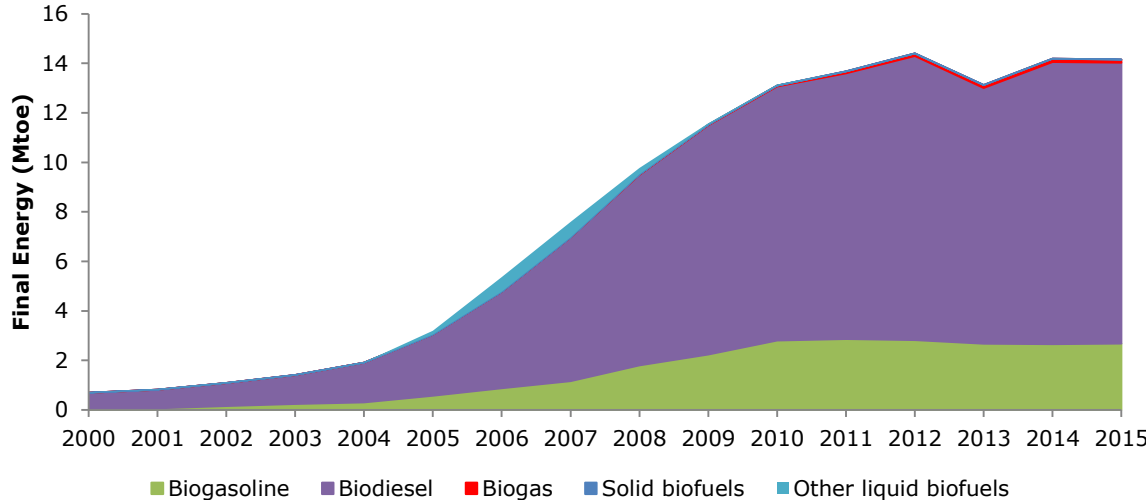
**Figure 100:** Final energy consumption of oil products in the EU-28 transport sector, 2000-2015



Source: Eurostat

Despite petroleum products being the main fuel type in the transport sector, the increase in renewable energies (biofuels) in the energy mix is a fact to consider, as the production of transport fuels from biomass, in either liquid or gaseous form, holds the promise of a low net fossil-energy requirement and low life-cycle greenhouse gas (GHG) emissions [5].

**Figure 101:** Final energy consumption of biofuels in the EU-28 transport sector, 2000-2015



Source: Eurostat

The biofuels have highly developed during the period from 2000 to 2015. The increase in the consumption took place especially between 2005 and 2010 when the consumption rose by four times (from 3,199 ktoe to 13,140 ktoe). The increase was mainly bound to the growth of biodiesels that represent the highest consumed renewable fuel type (see **Figure 103**). In 2013 a drop by 10% (1.1 Mtoe) in the biodiesel consumption occurred. In 2014 the consumption returned to the levels of 2012 and remained stable at this level also in 2015.

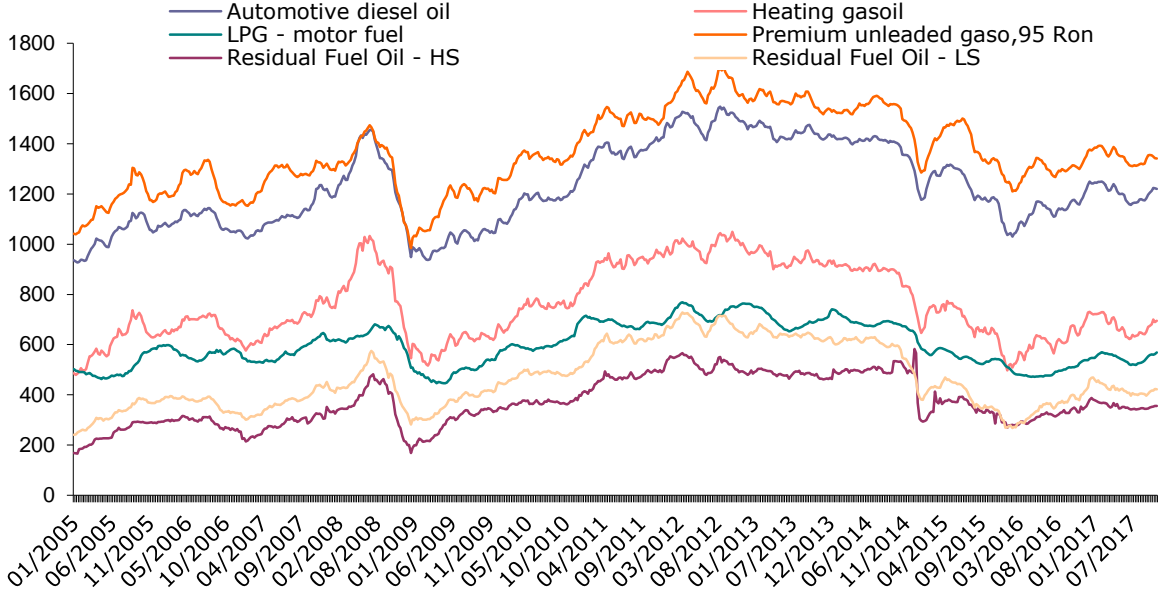
Biogasoline is the second highest consumed biofuel. Its growth started after 2004. Since 2010 the energy consumption of this fuel type has remained stable. The biogas started being consumed in 2008 (19.1 ktoe). Since then, an increase by 570% has been registered until 2015. The energy consumption of other liquid biofuels<sup>52</sup> was observed between 2005 and 2010. In the recent years solid biofuels have had a negligible consumption (below 1 ktoe a year).

**Fuel prices**

Automotive diesel oil and gasoline prices increased from 2005 onwards. From mid-2008 to mid-2009 a significant drop took place. Afterwards, the prices continued rising until September-October 2012 where the maximum of the period 2000-2015 were registered (gasoline 95 Ron: 1.693 Euro/litre; automotive diesel oil: 1.536 Euro/litre). Since then, a progressive reduction in the prices has been occurring as illustrated in **Figure 104**. Between the 4<sup>th</sup> quarter of 2014 and the 1<sup>st</sup> quarter of 2015 a significant drop was registered. That drop in the consumer prices was linked to the sharp decline in the price of crude oil barrels.

The decline in oil prices was driven by a number of factors: several years of increase in the production of unconventional oil; a weakening of global demand; a significant shift in OPEC policy; an unwinding of some geopolitical risks; an appreciation of the U.S. dollar [6], [7].

**Figure 102:** Consumer prices of petroleum products inclusive of duties and taxes - Eurozone weighted average, January 2005 – February 2016



Source: EC DG-ENER

<sup>52</sup> This category includes liquid biofuels, used directly as fuel, not included in the definitions of biogasoline, biodiesel or bio jet kerosene and liquid biofuels consumption that cannot be reported under the right category because of missing information. Source: Eurostat.

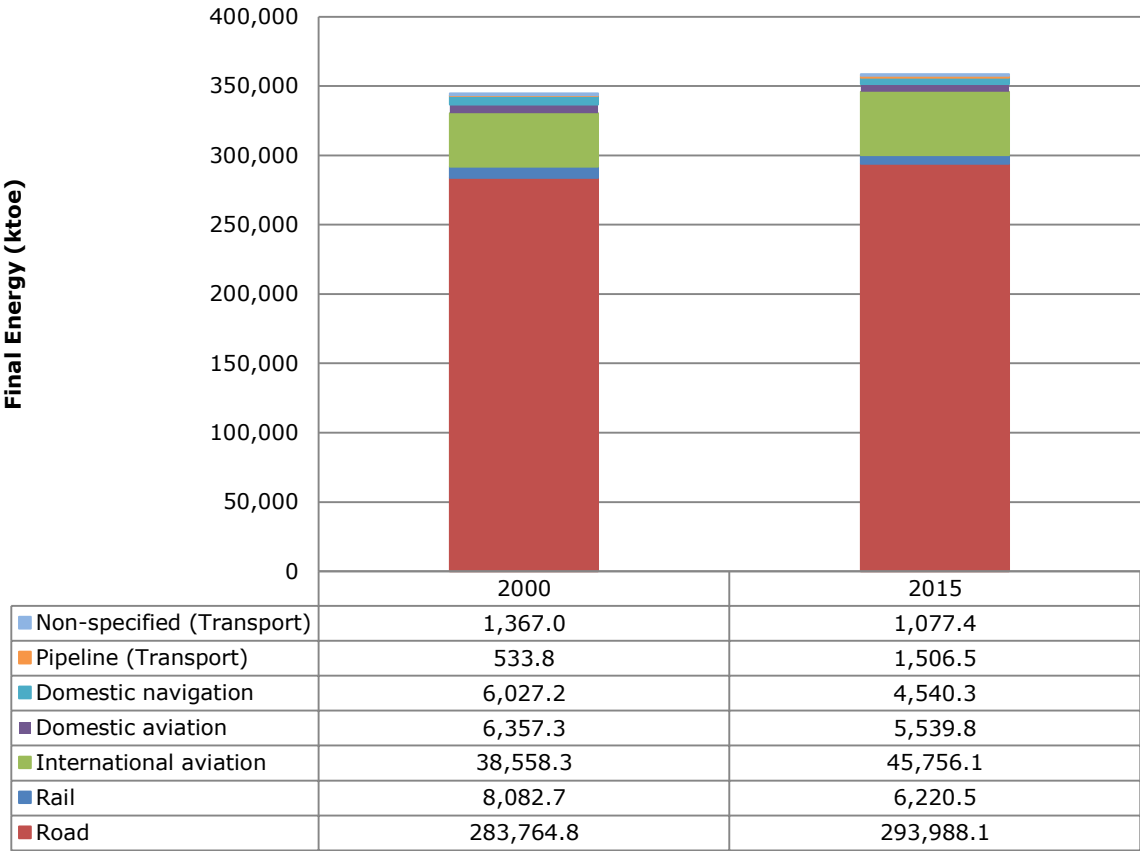
From mid-2015 to January 2016, the overall prices registered a decreasing trend before starting to increase again until the first quarter of 2017.

In October 2017 the average consumer prices of petroleum products in the Eurozone were: gasoline 95 Ron (1.343 Euro/litre), automotive diesel oil (1.224 Euro/litre), heating gasoil (0.690Euro/litre), LPG – motor fuel (0.568 Euro/litre), residual fuel oil – LS (0.417 Euro/litre), and residual fuel oil – HS (0.356 Euro/litre).

### 5.2 Transport subsectors

In this section, final energy consumption in the transport sector is broken down into different transport subsectors: road, rail, international aviation, domestic aviation, domestic navigation, pipeline transport, and other transports<sup>53</sup>. Consumption trends and changes in these transport subsectors over the period 2000-2015 are analysed.

**Figure 103:** Final energy consumption in the EU-28 transport subsectors, 2000 and 2015



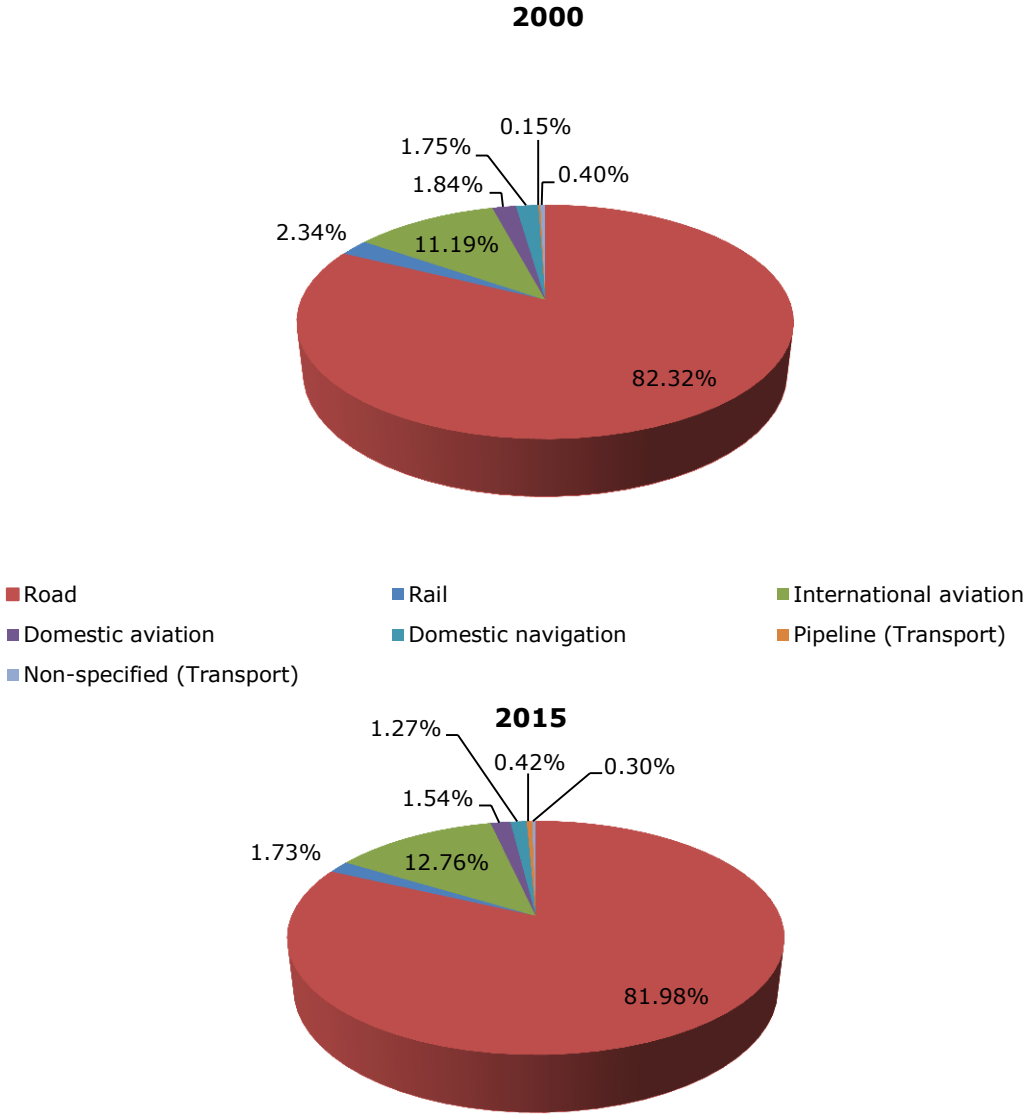
Source: Eurostat

Road transport is extensively the main energy consuming subsector. It consumed 81.98% (294 Mtoe) of the final energy share in 2015. In the same year, the second consuming subsector was international aviation (12.76%; 45.8 Mtoe), followed by rail (1.73%; 6.2 Mtoe), domestic aviation (1.54%; 5.5 Mtoe), domestic navigation (1.27%; 4.5 Mtoe), pipeline transport (0.42%; 1.5 Mtoe) and other non-specified transport (0.30%; 1.1 Mtoe). The most remarkable change compared to the year 2000 scenario is the energy consumption of pipeline transport that has increased by nearly three times (from 534 ktoe to 1,501 ktoe). In comparison to the year 2000, rail, domestic

<sup>53</sup> It includes fuels used by airlines for their road vehicles and fuels used in ports for ships' unloaders, various types of cranes. Source: Eurostat.

navigation, domestic aviation, and non-specified transport have reduced their shares, while the rest of transport subsectors (i.e. road, international aviation, and pipeline transport) have increased their shares as illustrated in **Figure 106** and **Figure 107**.

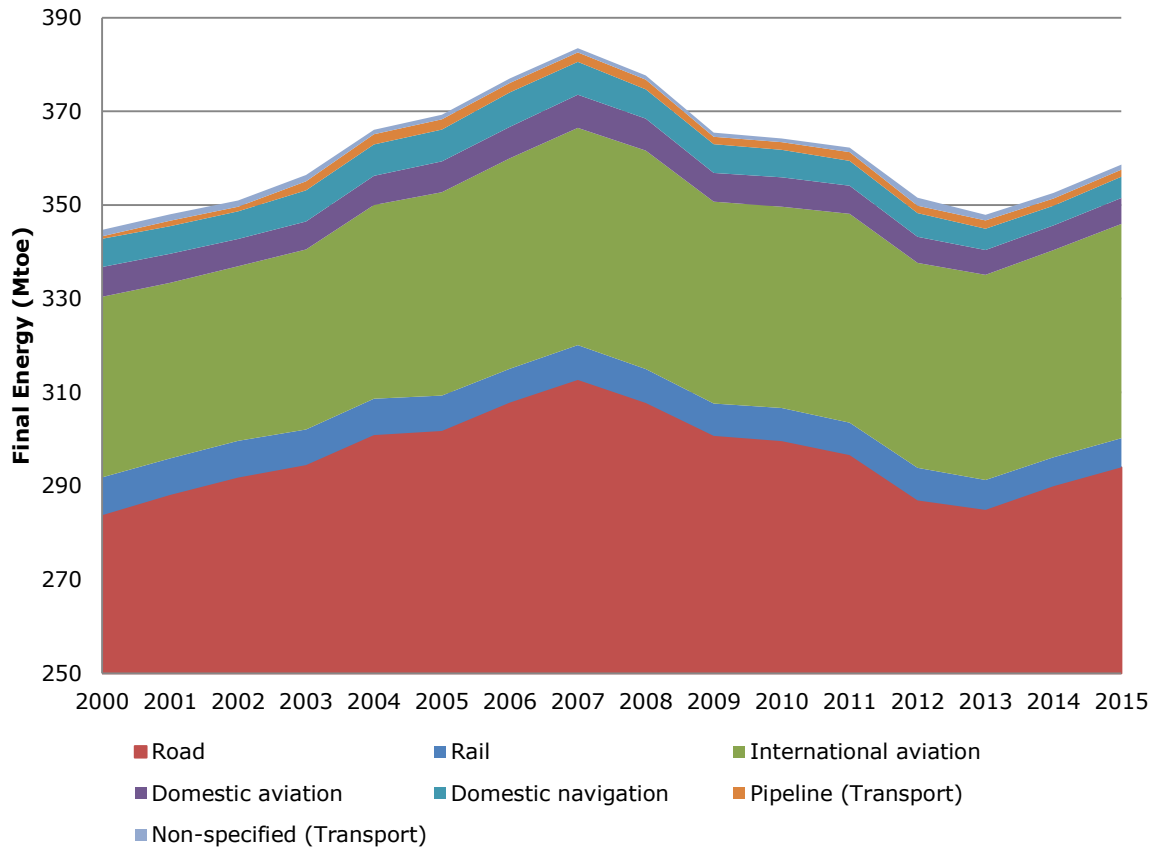
**Figure 104:** Share of transport subsector to final energy consumption, 2000 and 2015



Source: Eurostat

The contribution of the different subsectors to the aggregate energy consumption for the period 2000-2015 is shown in **Figure 107**. During this period, the total final energy consumption in the sector has increased by 4.04%. However, this increase has not been followed by all the subsectors. Domestic navigation has been the sector where consumption declined the most (by 24.67%). Rail, domestic aviation and non-specified transport have decreased their energy consumption by 23.04%, 12.86%, and 21.19% respectively. In contrast, pipeline transport, international aviation, and road transport are the subsectors which have registered an increase in their consumption in comparison to the year 2000 by 182.22%, 18.66%, and 3.60% respectively.

**Figure 105:** Final energy consumption in the EU-28 transport subsectors, 2000-2015



Source: Eurostat

**Table 7** provides an overview of the final energy consumption and growth rates occurred in the transport subsectors from 2000 to 2015.

**Table 7:** Growth rates of energy consumption transport subsectors, 2000 and 2015

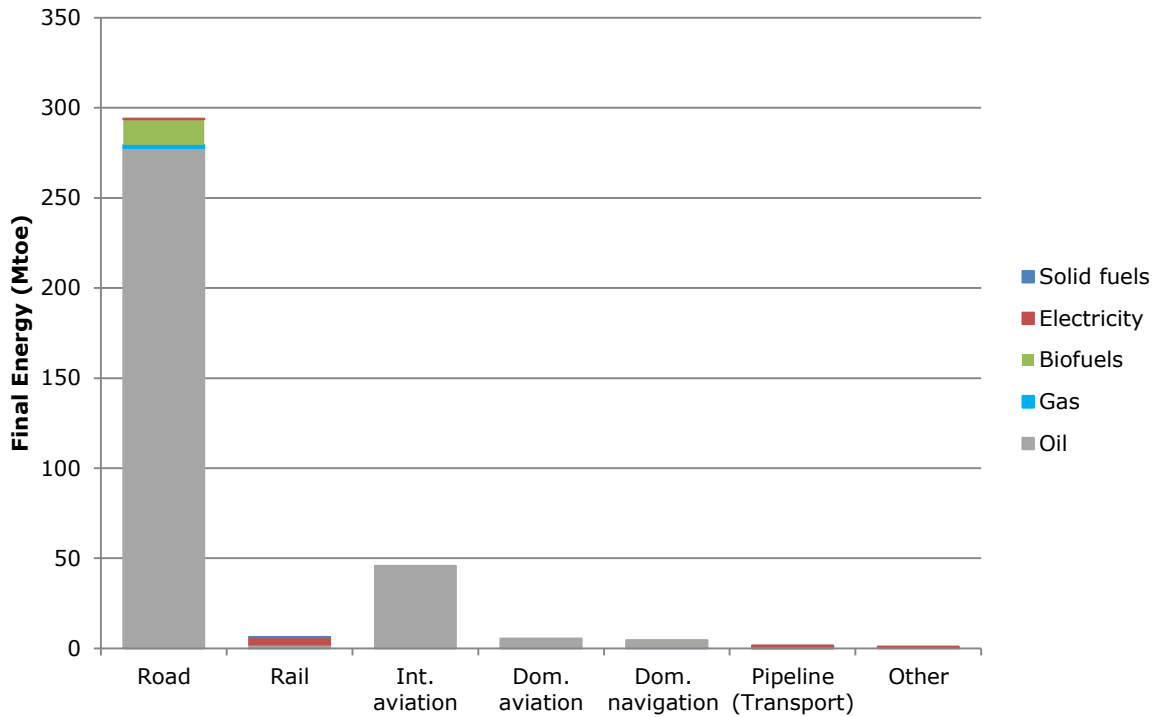
	Final Energy (ktoe)		Growth Rate (%)	Share in %		Change of shares
	2000	2015	2000-2015	2000	2015	2000-2015
<b>Transport</b>	344,691	358,629	<b>4.04%</b>			
Rail	8,083	6,221	<b>-23.04%</b>	2.34%	1.73%	<b>-0.61%</b>
Road	283,765	293,988	<b>3.60%</b>	82.32%	81.98%	<b>-0.35%</b>
International aviation	38,558	45,756	<b>18.67%</b>	11.19%	12.76%	<b>1.57%</b>
Domestic aviation	6,357	5,540	<b>-12.86%</b>	1.84%	1.54%	<b>-0.30%</b>
Domestic Navigation	6,027	4,540	<b>-24.67%</b>	1.75%	1.27%	<b>-0.48%</b>
Consumption in Pipeline	534	1,507	<b>182.22%</b>	0.15%	0.42%	<b>0.27%</b>
Other transports	1,367	1,077	<b>-21.19%</b>	0.40%	0.30%	<b>-0.10%</b>

Source: Eurostat

**Figure 108** and **Figure 109** show the energy mix in the different subsectors for the year 2015 in both absolute numbers and percentage of the total final energy consumption per subsector. It can be observed how oil (petroleum products) is the only fuel type in the domestic and international aviation and it is the main contributor in domestic navigation (99.9%) and in the road transport (94.46%).



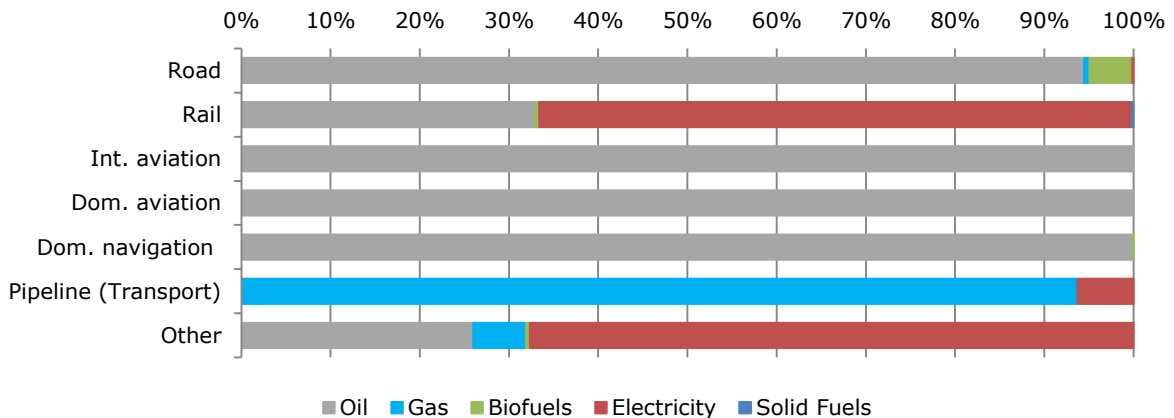
**Figure 106:** Final energy per fuel type and transport subsector in the EU-28, 2015



Source: Eurostat

In 2015, electricity represented the main consuming fuel in rail (66.47%) and other transports (67.65%). Gas was the major fuel type used in pipeline transport (93.65%). With regard to renewable energies, biofuels occupied a share in road (4.8%), rail (0.43%), other transports (0.45%), and domestic navigation (0.10%).

**Figure 107:** Share of fuel type and transport subsector in the EU-28, 2015



Source: Eurostat

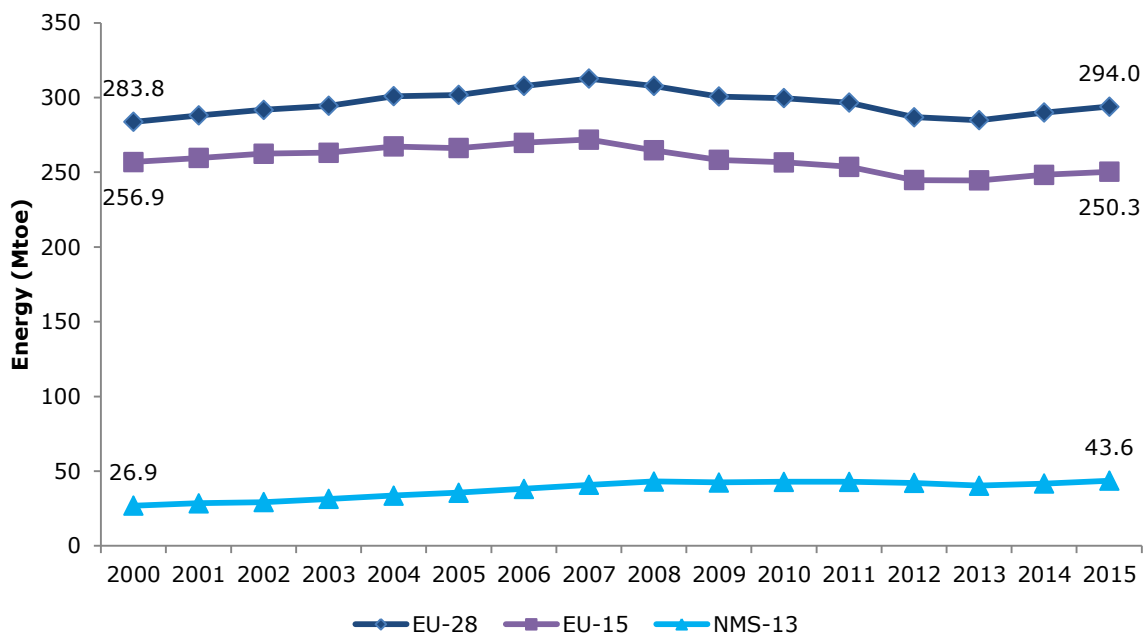
It can be observed that road transport clearly outstands among the rest subsectors in terms of final energy consumption. Thus, it can be assumed that overall transport sector trends are mainly influenced by the road transport changes.

### 5.3 Road sector

In this section a specific analysis of the road sector energy consumption trends is carried out. This insight is interesting due to the fact that the road sector accounted for 81.98% of total final energy consumed in the transport sector in 2015.

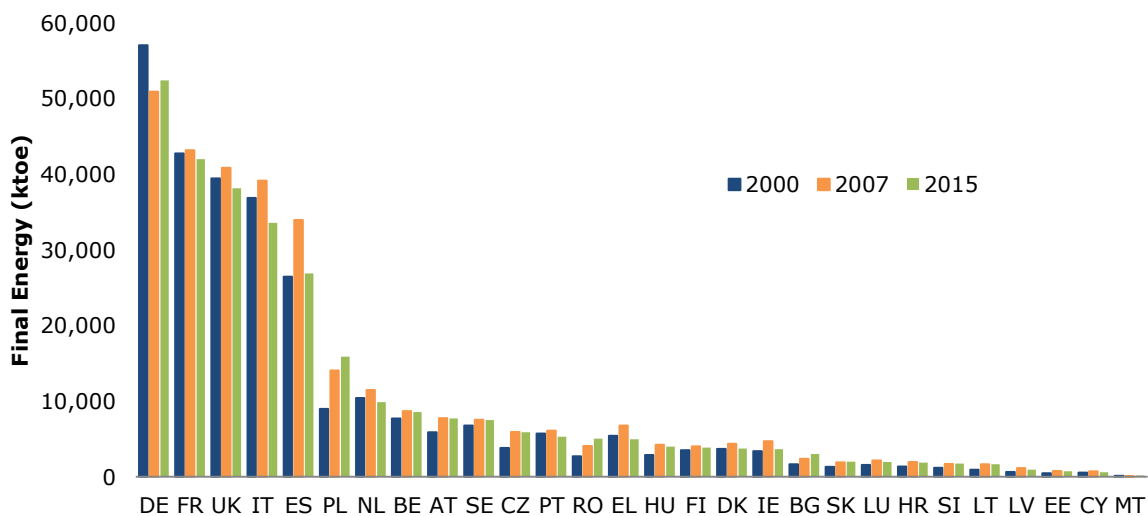
The final energy consumption in the road transport has increased by 3.6% (10.2 Mtoe) in the period from 2000 to 2015. The increase has not been the same in EU-15 area and NMS-13 area. NMS-13 have increased their final energy consumption by 62.1%, while EU-15 have registered a drop by 2.6%. In 2015, 85.1% (250.3 Mtoe) was consumed in the EU-15 area as illustrated by **Figure 110**.

**Figure 108:** Final energy consumption in the EU-28 road transport, 2000-2015



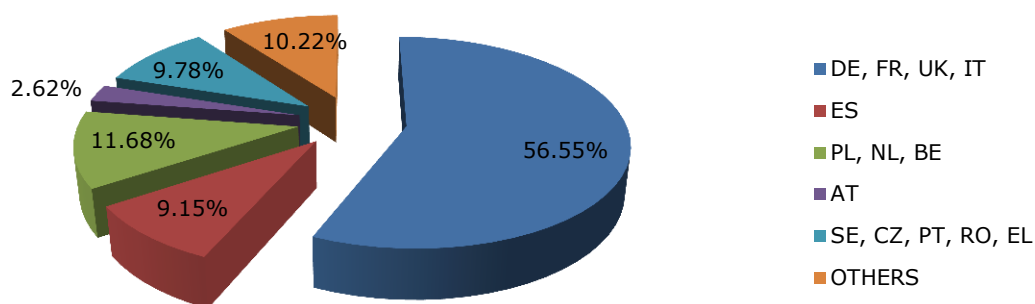
Source: Eurostat

**Figure 109:** Final energy consumption in road transport per Member State in the EU-28 2000, 2007 and 2015



Source: Eurostat

**Figure 110:** Accumulated share in the EU-28 for final energy consumption in road transport (2015)



Source: Eurostat

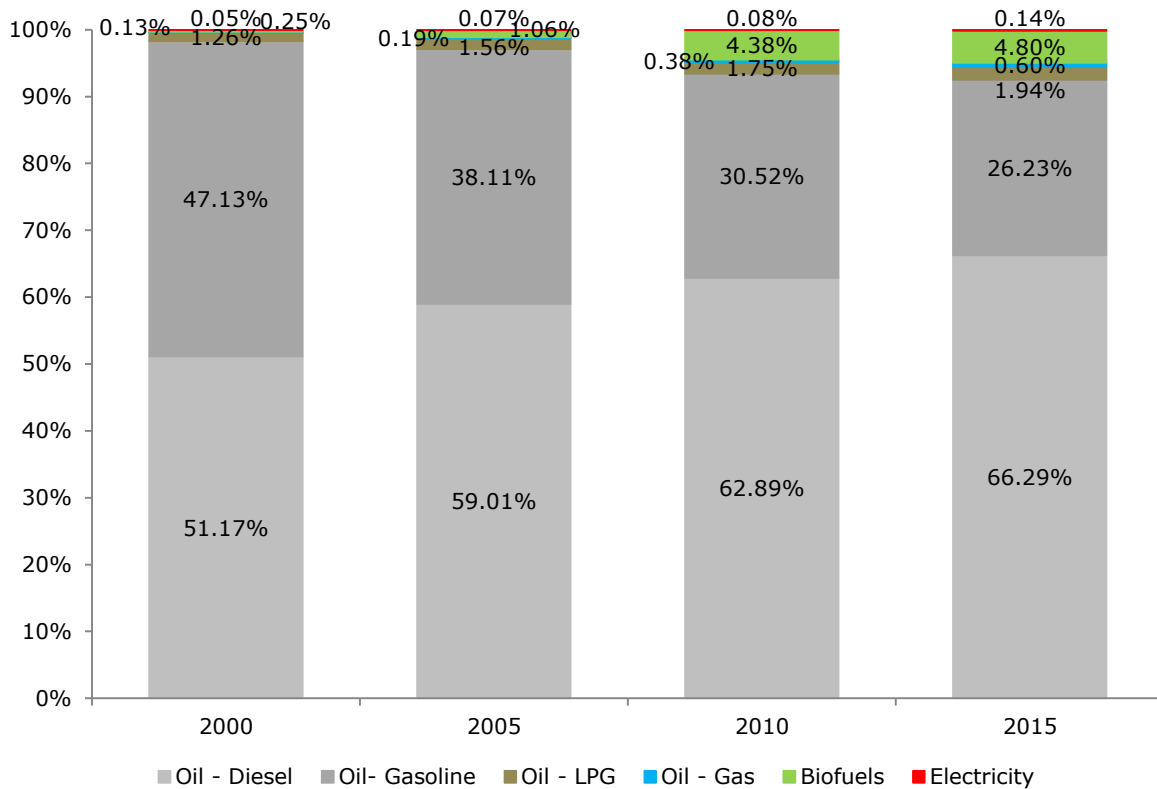
Across the EU-28 Member States there are remarkable differences in the final energy consumption. In 2015, the countries with the highest road energy consumption were Germany (52.4 Mtoe), France (42.0 Mtoe), United kingdom (38.2 Mtoe) and Italy (33.6 Mtoe). These four countries accounted for more than 56% of the total final energy consumption in the road transport. In the same year, fourteen Member States consumed less than 10% of the final energy consumption in the road transport.

With regard to the energy mix in the road transport, petroleum products (i.e. diesel, gasoline, LPG and gas) are the major consumed fuel types. In 2015, diesel was the most consumed fuel type (66.29%), followed by gasoline (26.23%), biofuels (4.80%), LPG (1.94%), gas (0.60%) and electricity, which accounted for a residual share (0.14%) of the final energy consumption.

**Figure 113** shows the final energy mix for four different years (i.e. 2000, 2005, 2010 and 2015). It can be observed the gradual reduction of gasoline consumption and the increase in the final energy consumption of diesel and biofuels. Oil-LPG, gas and electricity have slightly increased their energy consumption shares. In the last five years considered, electricity has almost doubled its share, although it remains non-significant.

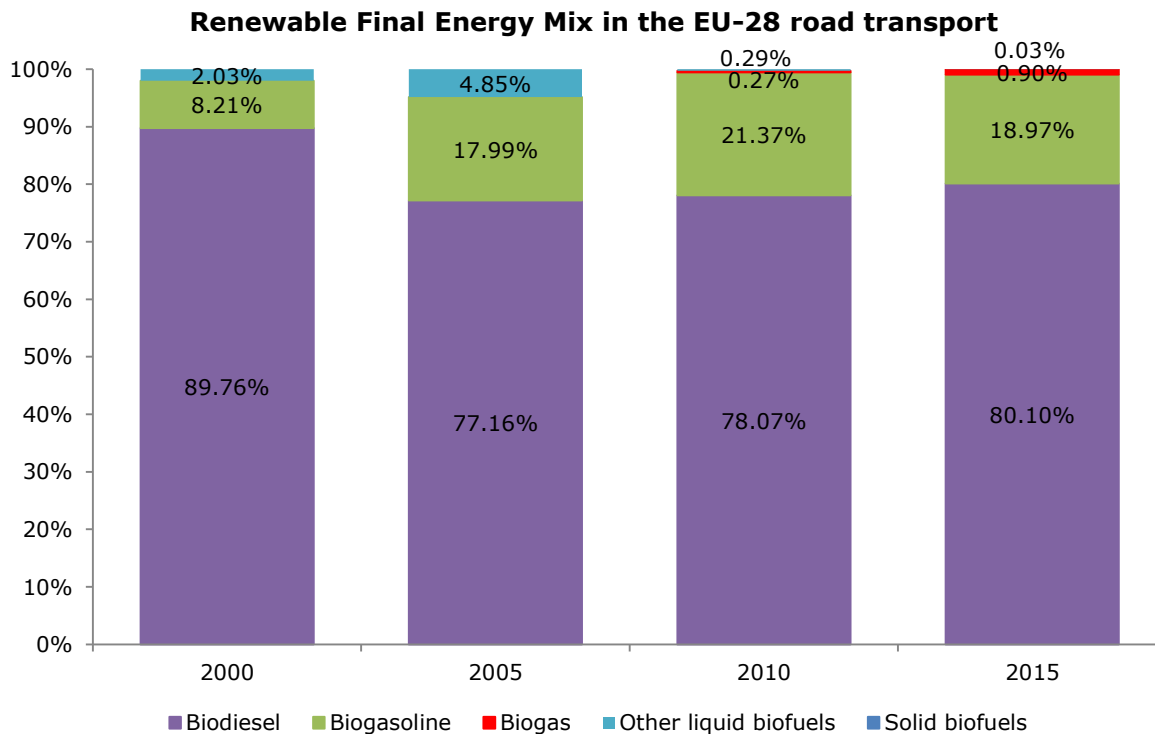
The increase in the share of biofuels is noteworthy as this trend shows the development towards a more sustainable way of road transport. Biodiesel has been the main biofuel along the entire analysed period (2000-2015). Already in 2000, biodiesel accounted for 89.76% of the total consumption of biofuels in the road sector, followed by biogasoline (8.21%) and other liquid biofuels (2.03%). After 16 years, in 2015, biodiesel was still the major renewable fuel type with a share of 80.1% of the total consumption of biofuels. Biogasoline was the second with a share of 18.97%. The consumption of biogas started after 2008 and reached a 1% share in the renewable energy mix in 2015. The consumption of other liquid biofuels have largely reduced over the period, until registering 0.03% in 2015. Solid biofuels has totally disappeared from the final energy consumption of road transport in the last 16 years, as shown in **Figure 114**.

**Figure 111:** Final energy mix in the EU-28 road transport, years 2000, 2005, 2010 and 2015



Source: Eurostat

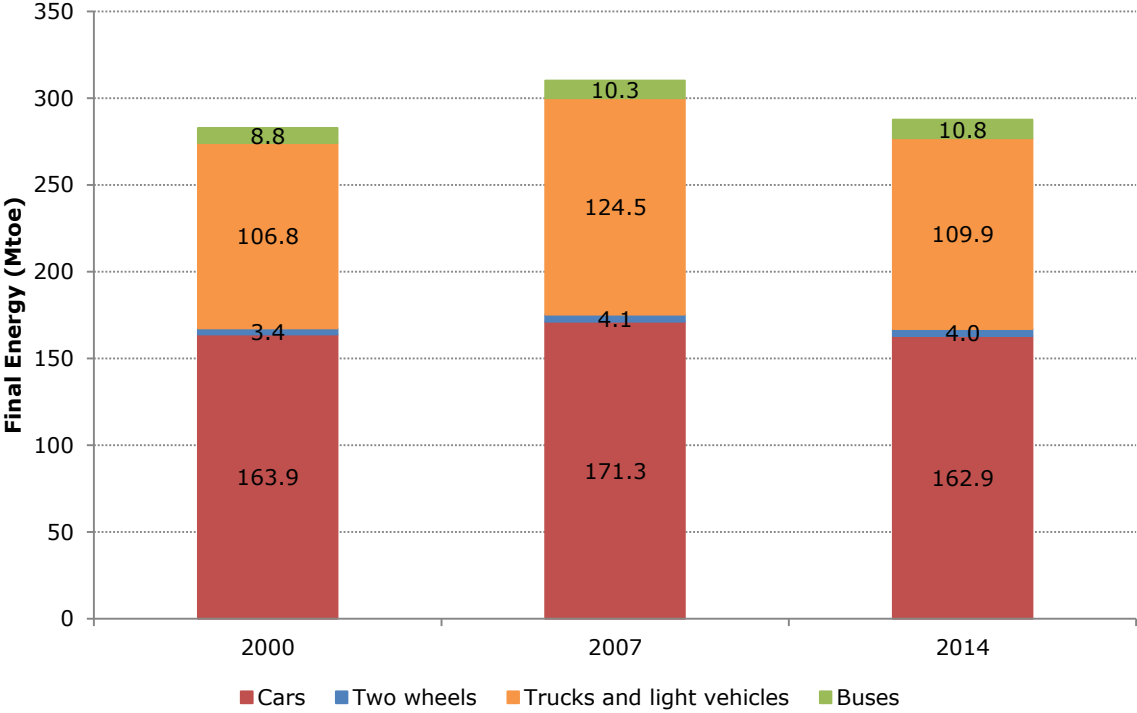
**Figure 112:** Renewable final energy mix in the EU-28 road transport, years 2000, 2005, 2010 and 2015



Source: Eurostat

Among the different vehicle types, cars outstand as the main energy consumers in the road transport. In 2014, cars accounted for 56.64% (162.9 Mtoe) of the road final energy consumption, followed by trucks and light vehicles (38.21%; 109.9 Mtoe), buses (3.75%; 10.8 Mtoe) and two wheels vehicles (1.39%; 4 Mtoe). There have not been remarkable differences between 2000 and 2014. Nevertheless, during this period increases in the consumption have been registered (e.g. in 2007 when the highest energy consumption in the road transport was registered), due to the increased energy demand coming from cars and trucks and light vehicles, as illustrated in **Figure 115**.

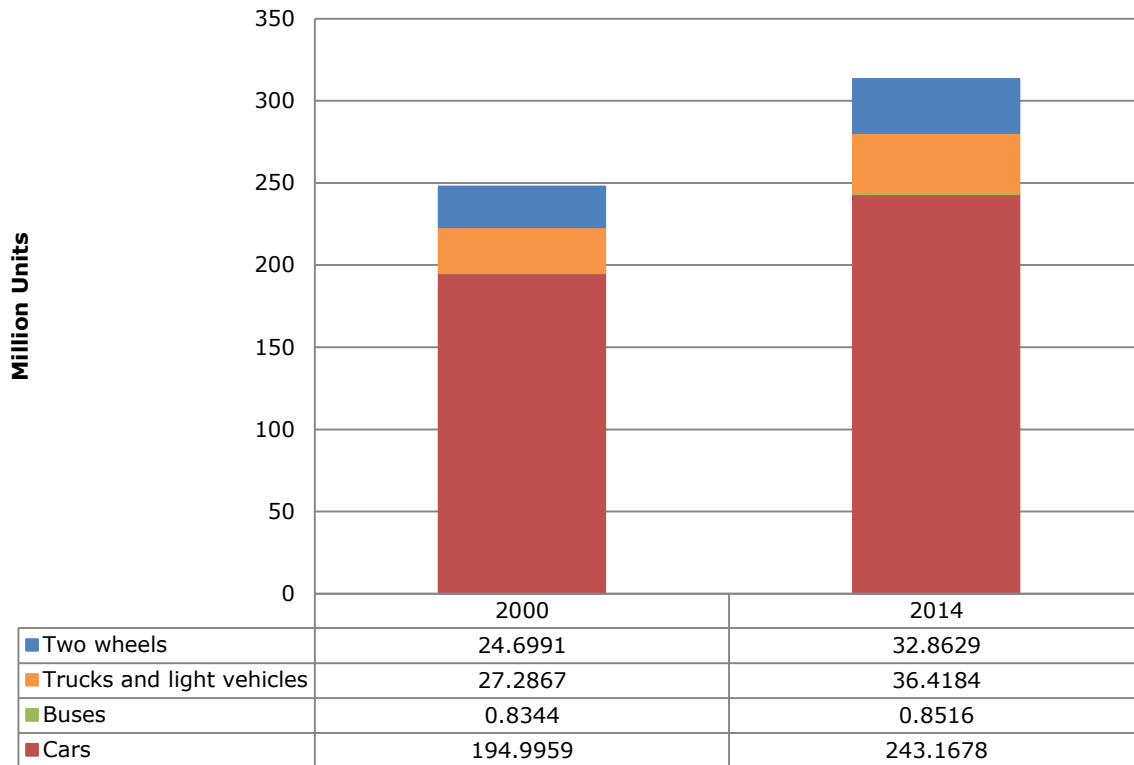
**Figure 113:** Road energy consumption per vehicle type in the EU-28, 2000, 2007 and 2014



Source: Odyssee

The stock of vehicles in the EU-28 was mainly composed by cars (77.61% in 2014). In 2014, there were registered 243.2 millions of cars in Europe. Trucks and light vehicles have been the second vehicle type according to the stock size with over 36.4 millions of units, followed by two wheels vehicles (32.9 million units) and buses (851 thousand units). In comparison with the year 2000, the total stock of vehicles has increased by 65.5 million units, representing an increase by 26.4%. All the vehicle types have increased their stock. Trucks and light vehicles are the vehicle types which have experienced the highest stock growth, with an increase by 33.5% (9.1 million units). Two-wheel vehicles have enlarged their stock in a similar range (33.1%; 8.2 million units). Cars and buses have incremented their stock numbers by 24.7% and 2.1% respectively (**Figure 116**).

**Figure 114:** Number of vehicles in the EU-28, 2000 and 2014

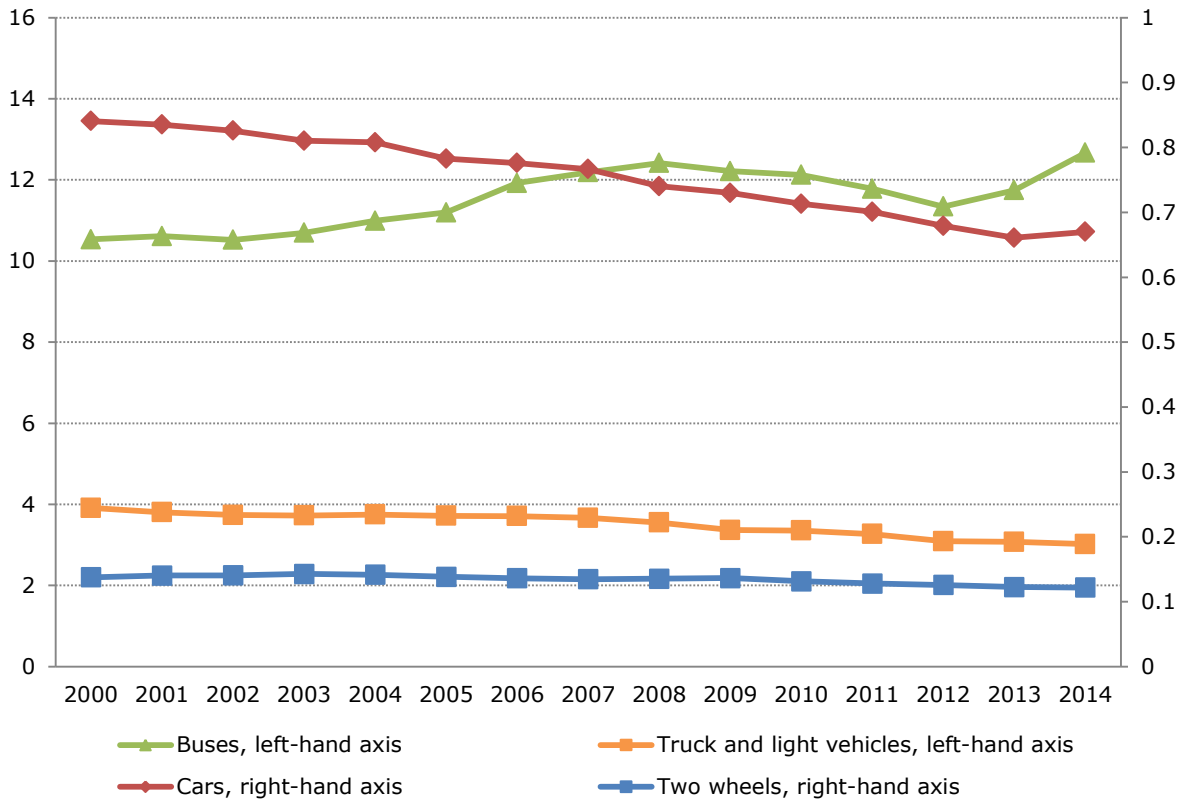


Source: Odyssee

Buses have the largest energy consumption per vehicle. This is easily understandable due to the average size of this kind of vehicles. In 2014, the average European energy consumption for buses was 12.67 toe/vehicle. In the same year trucks and light vehicles consumed 3.02 toe/veh, cars 0.67 toe/veh and two wheels 0.12 toe/veh. In comparison to the year 2000 scenario, cars' energy consumption decreased by 20.2%, two wheels by 14.3% and trucks and light vehicles by 22.8%. In contrast, buses have registered an increase by 20.3%.

To be noted that buses are the only vehicle type that has experienced an increase in its energy consumption per unit during the period 2000-2014 (**Figure 117**). This might be the result of an increase in the usage of buses as transportation mode, for instance, city buses. A higher number of kilometres per year driven by bus would lead to higher energy consumption per vehicle. Also, it might be ancillary increased by the incorporation of additional built-in services to enhance the comfort of the passengers such as air-conditioning, reading-lights, display screens, or internet-related services (i.e. Wi-Fi). Most of these services are largely spread nowadays among the buses fleet in many European regions in both private and publicly operated buses.

**Figure 115:** Energy consumption per vehicle type (toe/veh) in the EU-28, 2000-2014



Source: Eurostat

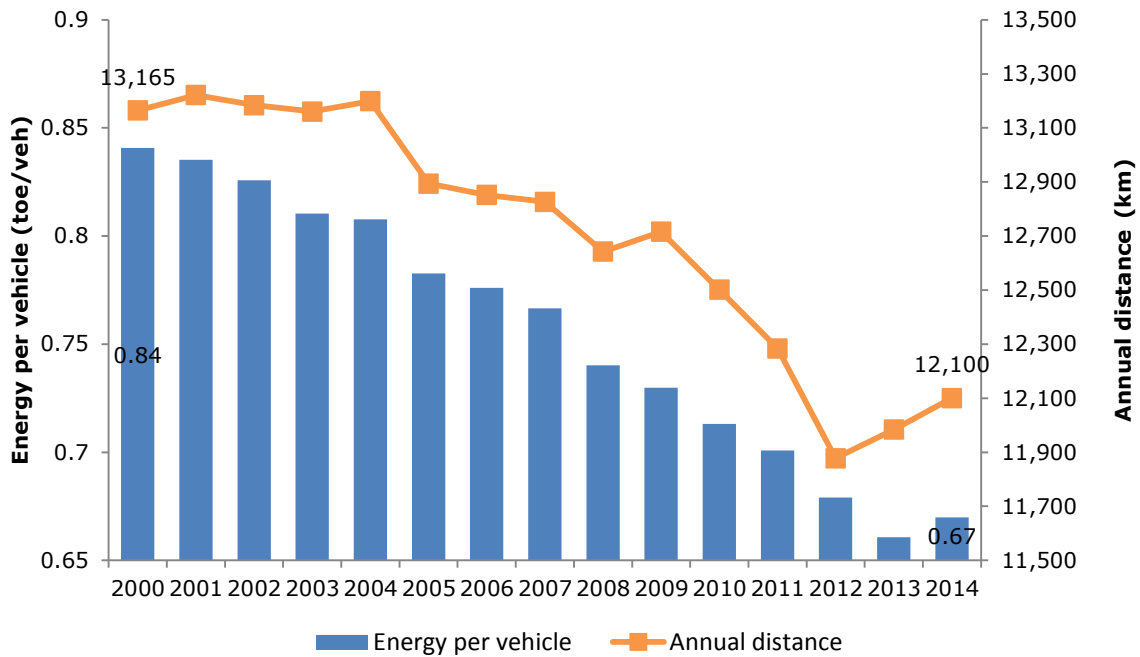
### 5.3.1 Road sector – Cars

Cars represented 77.61% of the stock of vehicles and 56.64% of the final road energy consumption in 2014. Therefore a specific analysis of the car, intended as a subsector of the road sector, can provide a better understanding of how energy consumption in the road transport, and consequently in the transport sector is evolving.

In 2000, the average energy consumption per car in the EU-28 registered the value of 0.84 toe per vehicle. During the period from 2000 to 2014, a gradual lowering trend has been observed which led to a drop by 20.2% in 2014.

**Figure 118** shows the energy consumption per car, together with the average annual distance travelled by car in the EU-28 during the same period (2000-2014). It is possible to notice that the average annual distance travelled by car has decreased by 1,065 km along the 15-years period (from 13,165 km to 12,100 km). The minimum of the time series was registered in 2012 (11,878 km). Overall, the average annual distance per car shows a gradual lowering trend similar to that shown by the annual energy consumption. Therefore, a possible explanation for the decrease in the average annual energy consumption per car is not only related to the improvements of vehicles in terms of energy efficiency performance, but also bound to a lowering trend in the usage of the vehicles in terms of distance travelled per year. A further and more throughout research should be done regarding this topic in order to estimate quantitatively the influence of this factor.

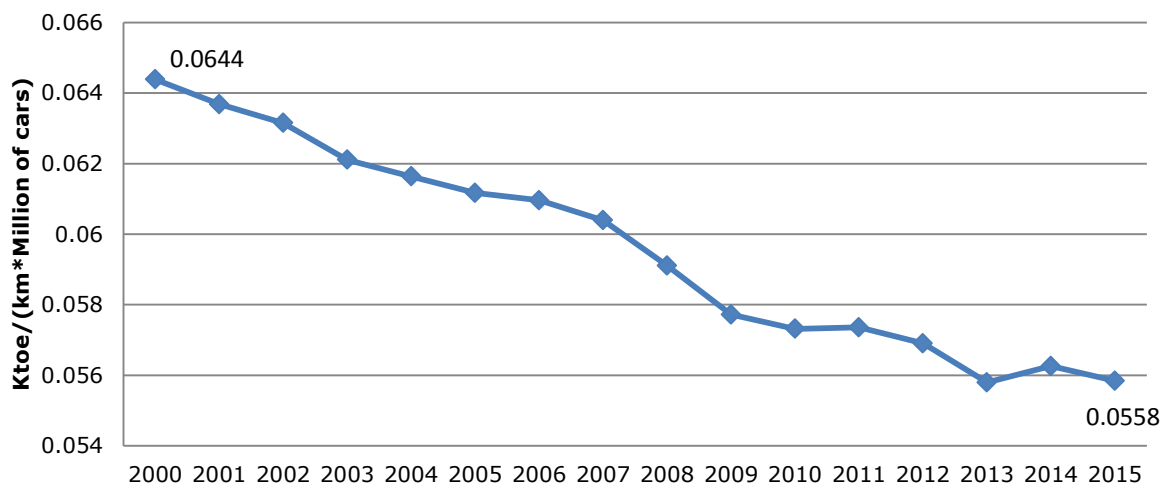
**Figure 116:** Annual energy consumption and annual distance travelled per car in the EU-28, 2000-2014



Source: Odyssee

**Figure 119** shows the total car energy consumption adjusted for the stock of vehicles and the average annual distance travelled by cars in the EU-28. From 2000 to 2015, there has been a total reduction of 13.35% in this indicator. This reduction could have been influenced by multiple factors such as: cars driving in speeds with the highest efficiency performance ratios, less traffic congestion, usage of smaller or more efficient car models.

**Figure 117:** Car energy consumption per vehicle adjusted for the stock of cars and the annual distance travelled by cars in the EU-28, 2000-2015

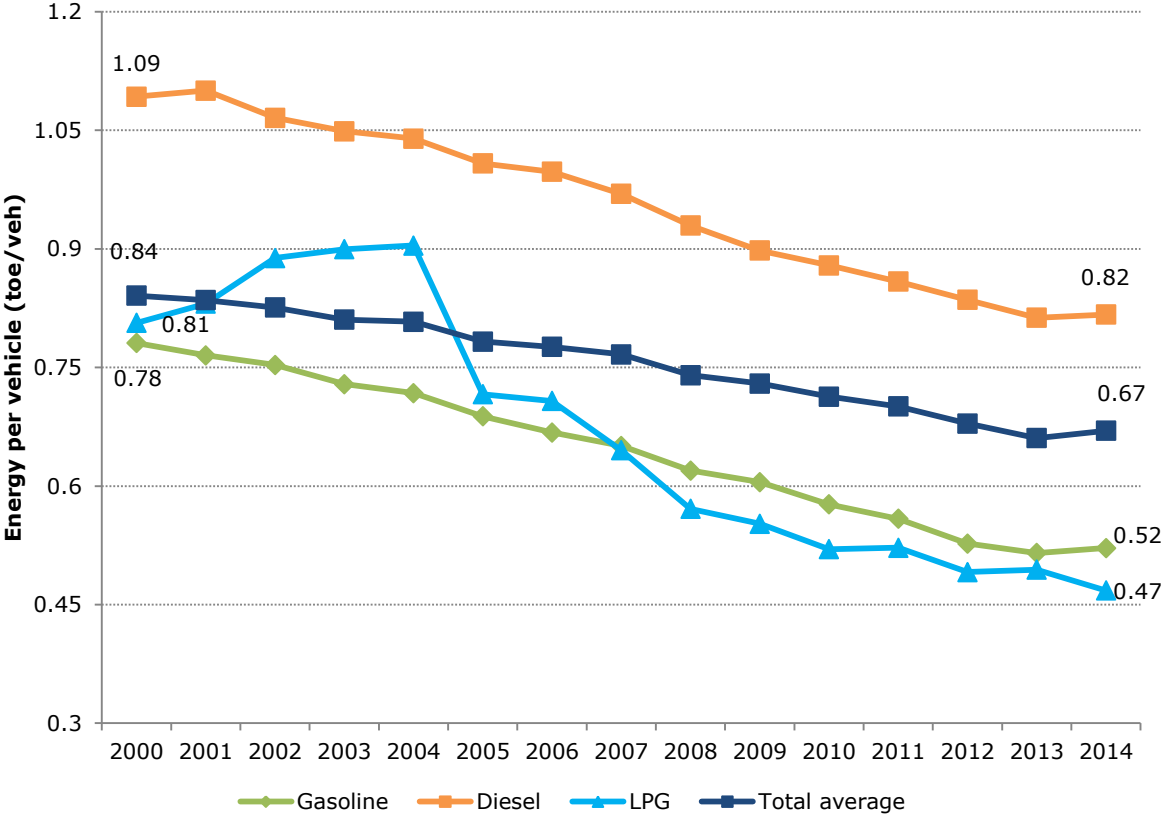


Source: Odyssee



**Figure 120** shows the energy consumption per vehicle differing by engine technology. Diesel-fuelled vehicles are the vehicles type with the highest unitary energy consumption. The reduction in total average energy consumption per vehicle registered during the period 2000-2014 (-20.2%) is the result of a reduction by 33.3% in gasoline-fuelled cars, a reduction by 24.8% in diesel fuelled cars and a reduction by 43% in the LPG-fuelled cars. Overall, a lowering trend has been experienced by the cars despite the engine technologies adopted. This is mainly due to energy efficiency performance improvements. The only exception was registered for LPG cars during the period 2000-2004 when the energy consumption yearly increased. Since 2004, LPG cars' trend has followed the others.

**Figure 118:** Average energy consumption per car engine technology in the EU-28, 2000-2014<sup>54</sup>



Source: Odyssee

The average specific consumption of cars shows the consumption of one vehicle in litres per 100 km. It is calculated from the total consumption of cars, stock of cars and average distance travelled by car per year. The average consumption of new cars is calculated from fuel consumption tests<sup>55</sup>. **Figure 121** shows that in both cases (i.e. average consumption calculated from data and from test values) and for the two main engine technologies (i.e. gasoline and diesel) there is an ongoing decline since 2000. In total, the average consumption of cars in the market has declined by 13.32%, while the consumption of new cars entering the market (tagged as 'test') is even larger at 27.5%. Comparing the average specific consumptions per engine technology, gasoline-fuelled cars consumed more fuel than any other engine technology. In the period from 2000 to 2014, gasoline and diesel cars already in the market have registered a reduction by

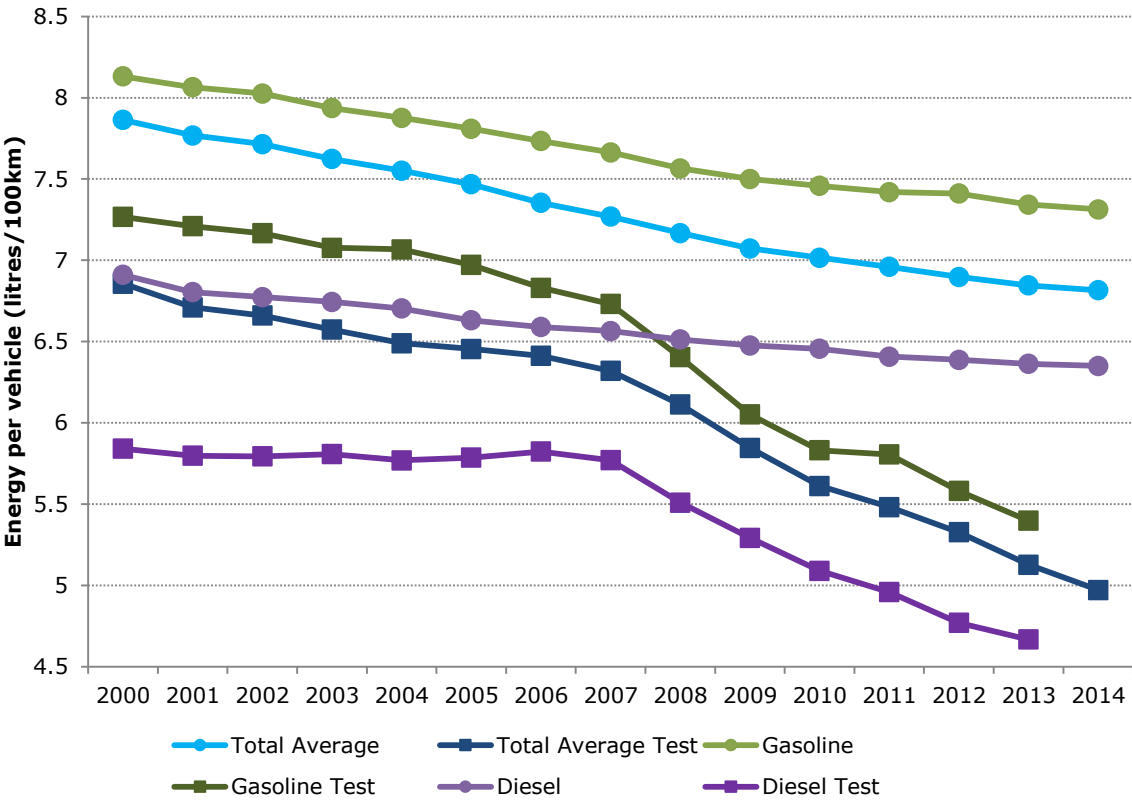
<sup>54</sup> The series 'Total Average' also includes the energy consumption per vehicle of biofuel-fuelled vehicles.

<sup>55</sup> Refer to Odyssee database for details.

10.07% (from 8.1 litres/100 km in 2000 to 7.3 litres/100 km in 2014) and 8.1% (from 6.9 litres/100 km in 2000 to 6.4 litres/100 km in 2014) respectively. In the same period, the new cars gasoline and diesel-fuelled entering into the market have also registered reductions in their specific consumption values.

To be noted that after 2007 the rate of decline in the consumption of new cars increased. These observed lowering trends in the average specific consumption values might be the result of the reaction of the automotive industry to the implementation of policies related to the CO<sub>2</sub> emissions of light-duty vehicles.

**Figure 119:** Average specific consumption per car engine technology in the EU-28, 2000-2014



Source: Odyssee

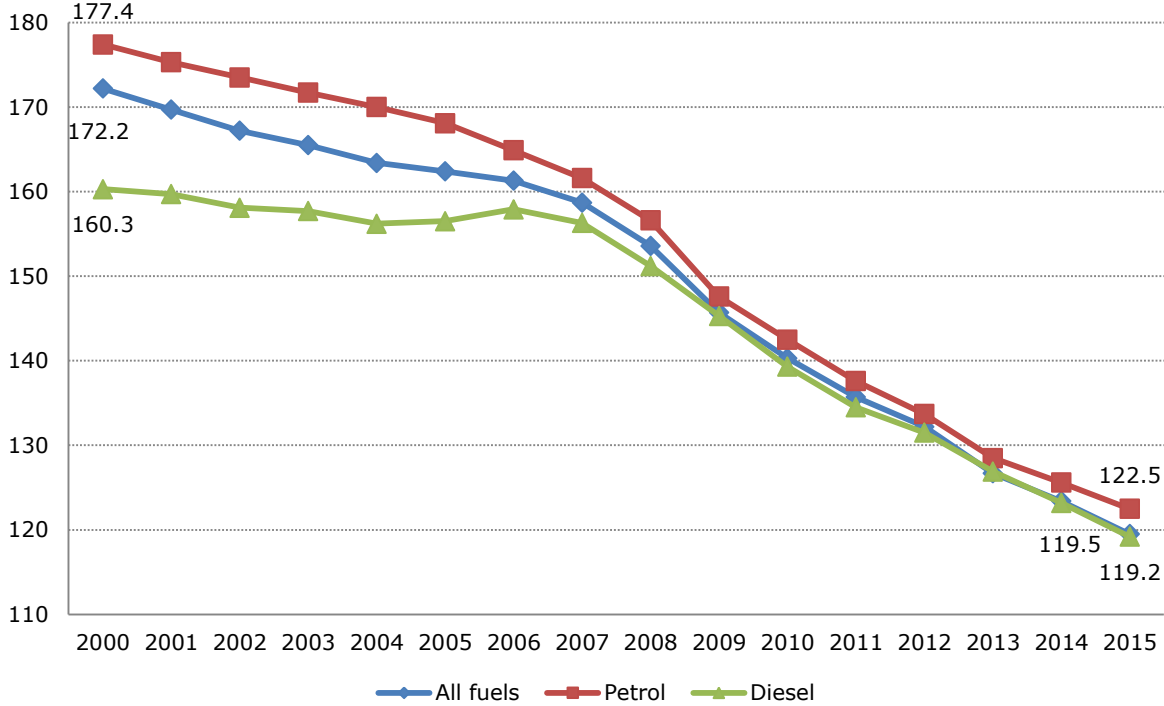
In March 2014, the European Regulation No 333/2014 amended the Regulation No 443/2009 which defined the emission performance standards for new passenger cars to reduce CO<sub>2</sub> emissions from light-duty vehicles.

The Regulation No 333/2014 sets a target of 95 g CO<sub>2</sub>/km for the average emissions of the new car fleet from 2020 onwards as measured in accordance with Regulation No 715/2007 (Euro 5 and Euro 6 emission standards) and the annex XII to Regulation No 692/2008.

**Figure 122** shows the average carbon dioxide emissions of new passenger cars for the period from 2000 to 2015. The average EU level of carbon dioxide emissions was 119.5 g CO<sub>2</sub>/km in 2015; it represents a drop by 30.6% in comparison with the year 2000. It is possible to observe that there are not remarkable differences in the average CO<sub>2</sub> emissions of petrol and diesel fuelled passenger cars in the recent years (from 2009 onwards). Passenger cars fuelled by gasoline (petrol) registered an average level of CO<sub>2</sub> emissions of 122.5 g CO<sub>2</sub>/km in 2015; while passenger cars diesel-fuelled registered 1.3

g CO<sub>2</sub>/km more (124.5 g CO<sub>2</sub>/km) in the same year. Those registers represent reductions of 29.8% and 23.1% for petrol and diesel-fuelled vehicles respectively.

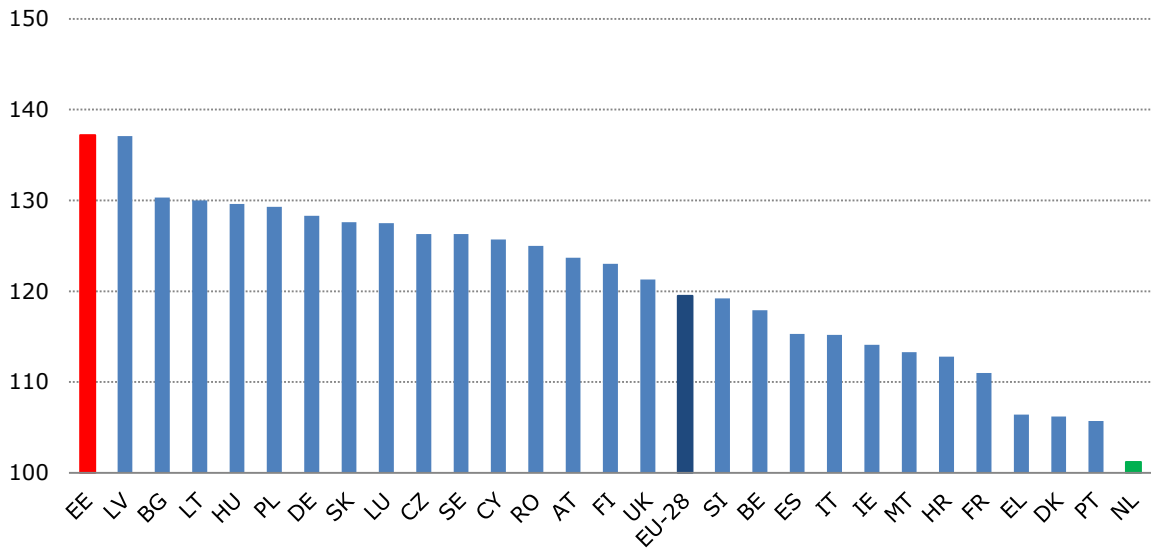
**Figure 120:** European average CO<sub>2</sub> emissions per kilometre of new passenger cars (gCO<sub>2</sub>/km), 2000-2015



Source: EEA

Across the EU-28 Member States, Estonia (137.2 g CO<sub>2</sub>/km), Latvia (137.1 g CO<sub>2</sub>/km) and Bulgaria (130.3 g CO<sub>2</sub>/km) were the countries with the highest average emissions of the new car fleet in 2015. In contrast, the Netherlands (101.2 g CO<sub>2</sub>/km), Portugal (105.7 g CO<sub>2</sub>/km), and Denmark (106.2 g CO<sub>2</sub>/km) registered the lowest average emissions of new cars in the same year (see **Figure 123**).

**Figure 121:** Average CO<sub>2</sub> emissions per kilometre of new passenger cars in the EU-28, 2015 (gCO<sub>2</sub>/km)

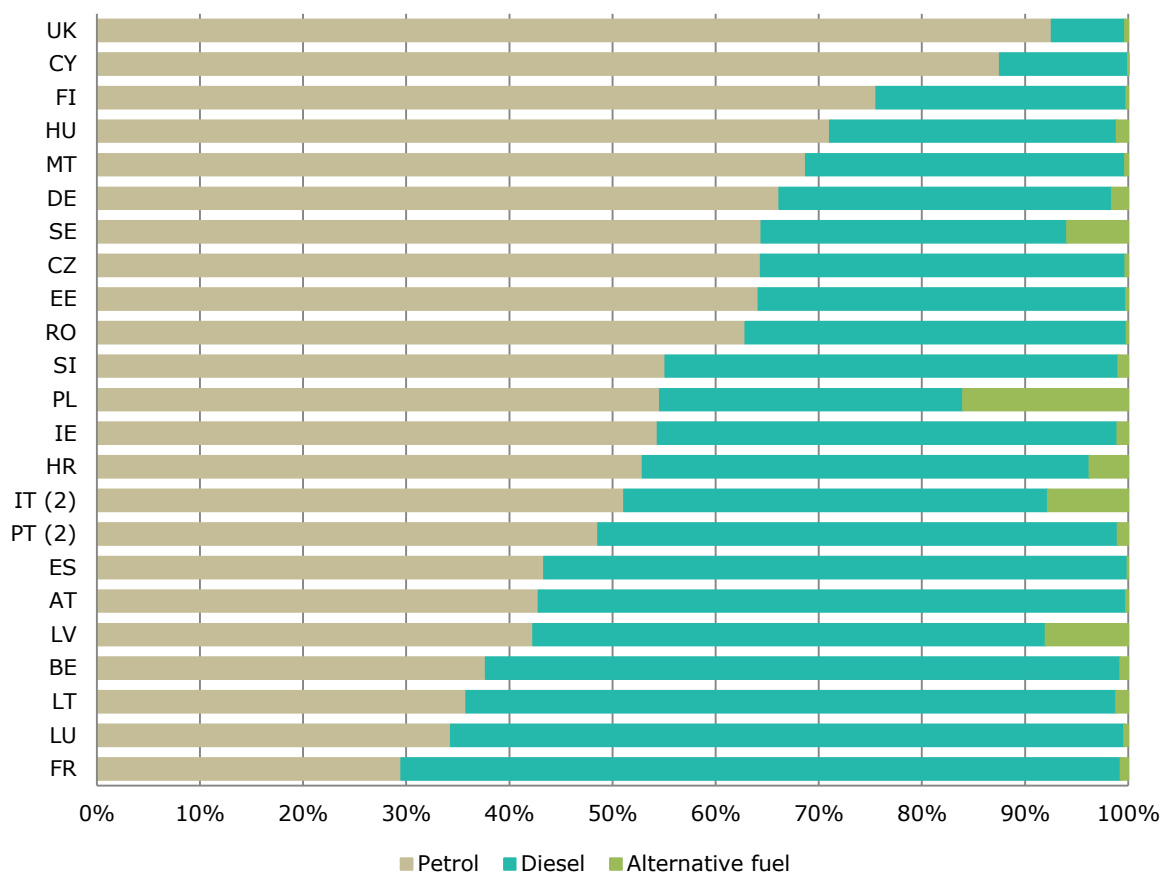


Source: EEA

Across the EU-28 Member States in 2015, the countries with the highest percentage of petrol (gasoline) fuelled passenger cars were the United Kingdom (92.58%), Cyprus (87.57%), and Finland (75.59%). The States with the highest presence of diesel-fuelled passenger cars were France (69.75%), Luxembourg (65.28%), and Lithuania (62.99%). Poland (16.01%), Latvia (8%), Italy (7.78%), and Sweden (5.91%) were the European countries where alternative-fuelled engines<sup>56</sup> have reached the largest shares (see **Figure 124**).

<sup>56</sup> Types of motor energy other than the conventional fuels, petrol and diesel are considered. Alternative fuels include electricity, LPG, natural gas (NGL or CNG), alcohols, mixtures of alcohols with other fuels, hydrogen, bio-fuels (such as biodiesel), etc. (this list is not exhaustive). Alternative fuels do not include unleaded petrol, reformulated petrol or city (low-sulphur) diesel.

**Figure 122:** Passenger cars by type of engine fuel, 2015 (% of all passenger cars)<sup>57</sup>



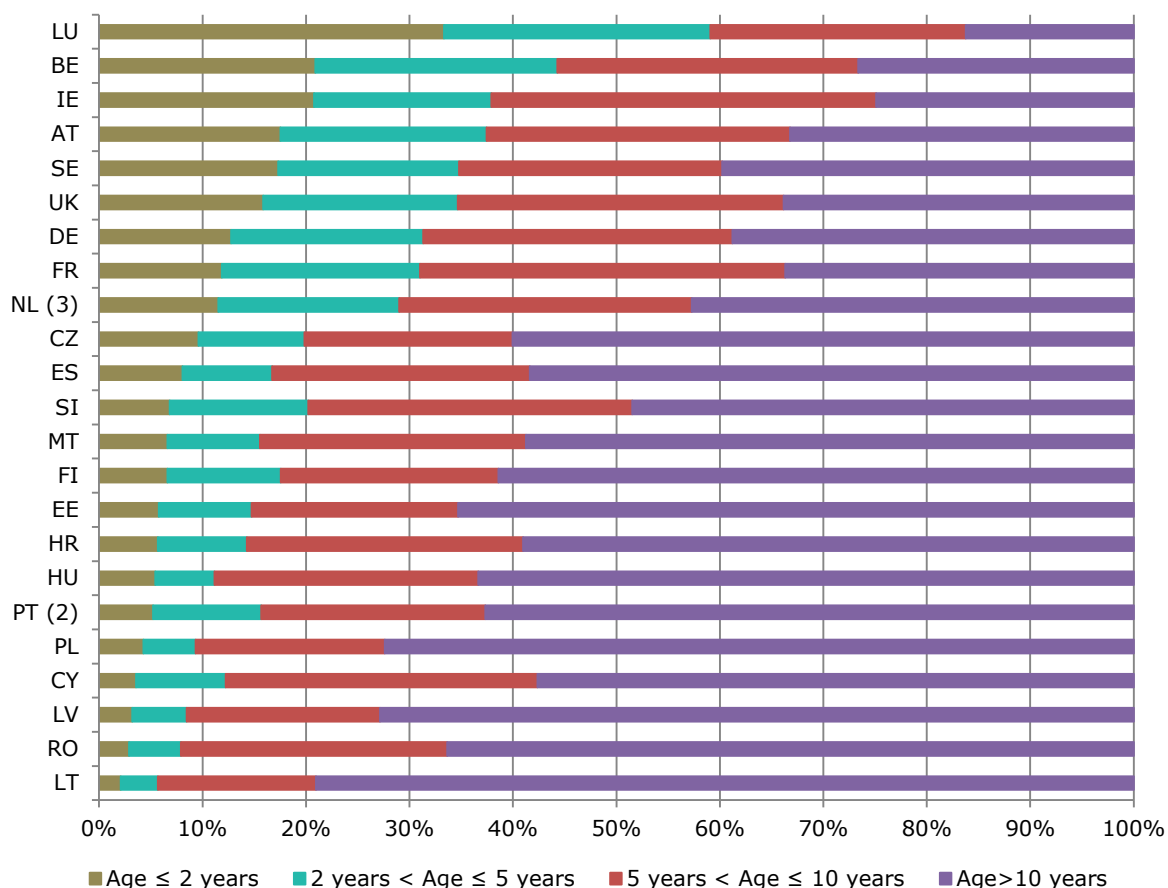
Source: Eurostat

The age of the vehicles fleet is a matter of interest in order to better understand energy consumptions and emissions in the near future. Looking at the energy consumption per vehicle, which follows a decreasing trend year by year, it is possible to see that the lower the age of the vehicles, the lower the energy consumption per vehicle. In 2015, the EU-28 Member State with the newest fleet of passenger cars was Luxembourg with 33.34% of its passenger cars below or equal 2 years old, followed by Belgium (20.91%) and Ireland (20.77%). In contrast, the oldest fleet of passenger cars (older than 10 years) were registered in Lithuania (79.03%), Latvia (72.86%) and Poland (72.39%) as illustrated in **Figure 125**. The highest share of passenger cars between 2 and 5 years old is found in Luxembourg (25.73%), Belgium (23.38), and Austria (19.94%), while the highest number of passenger cars between 5 and 10 years was registered in Ireland (37.21%), France (35.32%), and the United Kingdom (35.5%).

Overall, Luxembourg, Ireland, Belgium and Austria have the newest fleet of passenger cars (these MSs have the lowest share of above 10 years old passenger cars). Despite this positive fact that, as already mentioned, could lead to lower energy consumption in the road transport in the short-term or mid-term future, there are multiple factors to consider regarding the rest of characteristics of the vehicles which could instead not cause any energy savings. Also, this scenario could completely change if a slow renovation rate of the fleet of vehicles would occur as the newer cars would age turning into old cars and the old cars would be replaced by new models in the countries with the oldest car fleet.

<sup>57</sup> (1) BG, DK, EL, NL and SK: Data not available; (2) 2014 data.

**Figure 123:** Passenger cars by age, 2015 (% of all passenger cars)<sup>58</sup>



Source: Eurostat

The Member State with the highest number of passenger cars per 1,000 inhabitants was Luxembourg (661 cars) in 2015; the second State was Malta (634 cars) and the third Italy (610 cars). In contrast, the lowest number of passenger cars per thousand inhabitants was registered in Romania (261 cars), Hungary (325 cars) and Latvia (345 cars) for the same year as illustrated in **Figure 126**.

<sup>58</sup> (1) BG, DK, EL, IT and SK: data not available; (2) 2014 data; (3) 2013 data.

**Figure 124:** Number of passenger cars per 1,000 inhabitants, 2015<sup>59</sup>

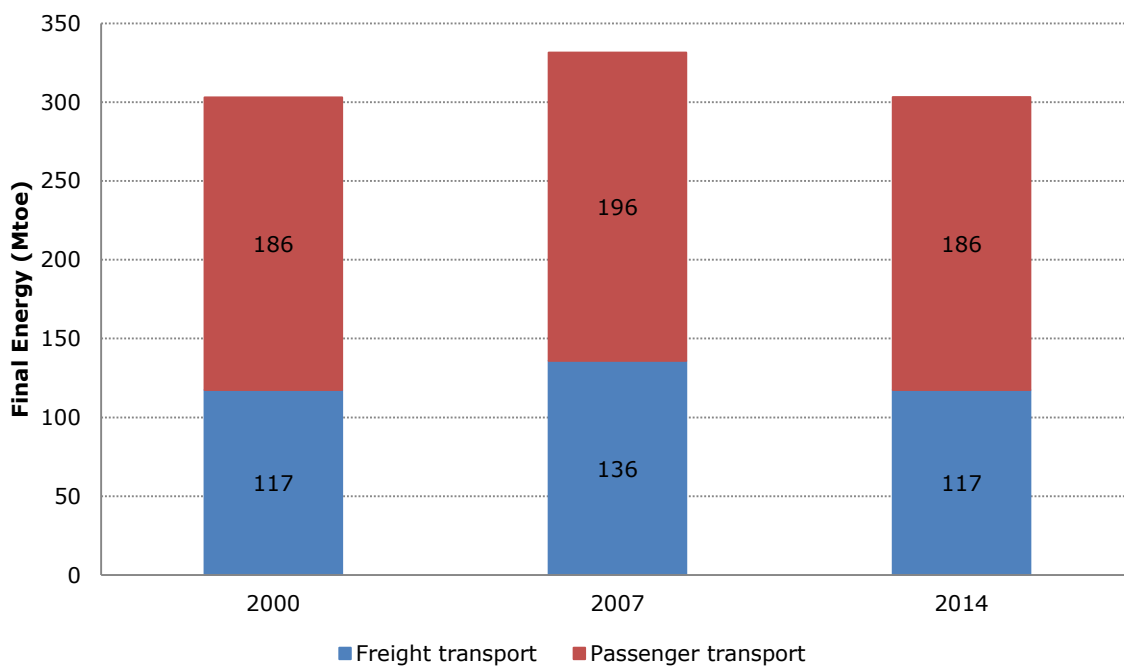


Source: Eurostat

## 5.4 Passenger and freight transport

Most of the energy used in the transport sector is for domestic transportation, which can be divided into passenger and freight transport. Passenger transport accounted for the 61.39% of the domestic transport and freight transport for 38.61% in 2014. Overall, domestic transport has remained stable between 2000 and 2014 (303 Mtoe).

**Figure 125:** Final energy consumption by passenger and freight domestic transport in the EU-28, 2000, 2007 and 2014



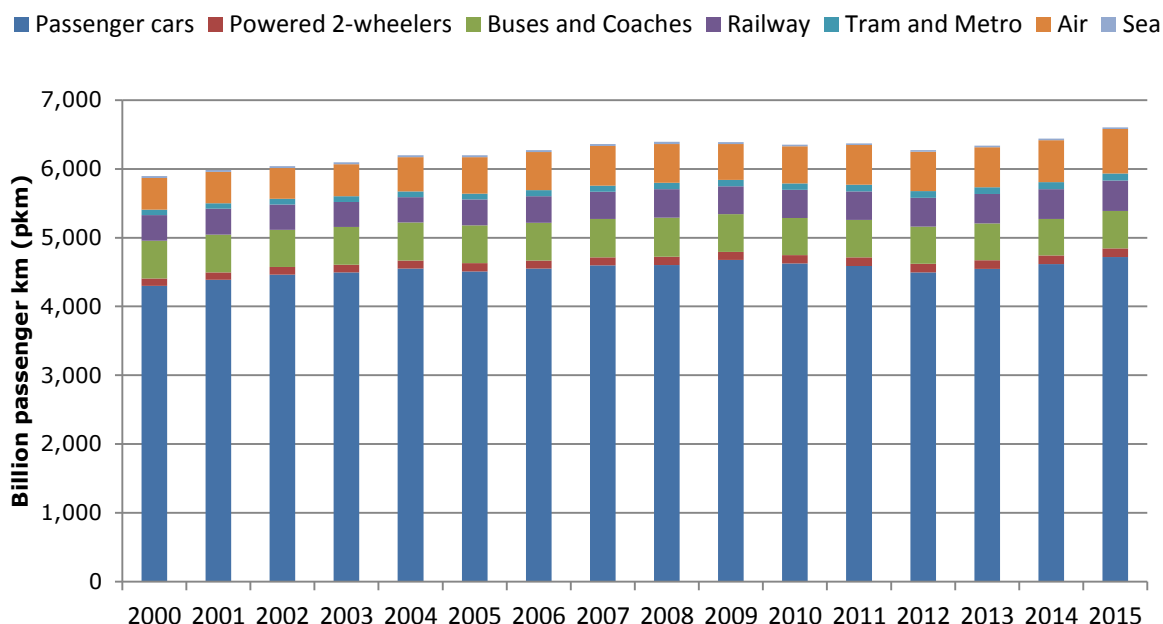
Source: Odyssee

<sup>59</sup> (1) DK: data not available; (2) 2014 data; (3) 2013 data.

### 5.4.1 Passenger traffic

The passenger transport volume has risen by 11.97% in the period from 2000 to 2015. In 2015, the value registered 6,602 billion pkm, the maximum passenger volume registered during the period 2000-2015.

**Figure 126:** Passenger transport volume and modal split in the EU-28, 2000-2015



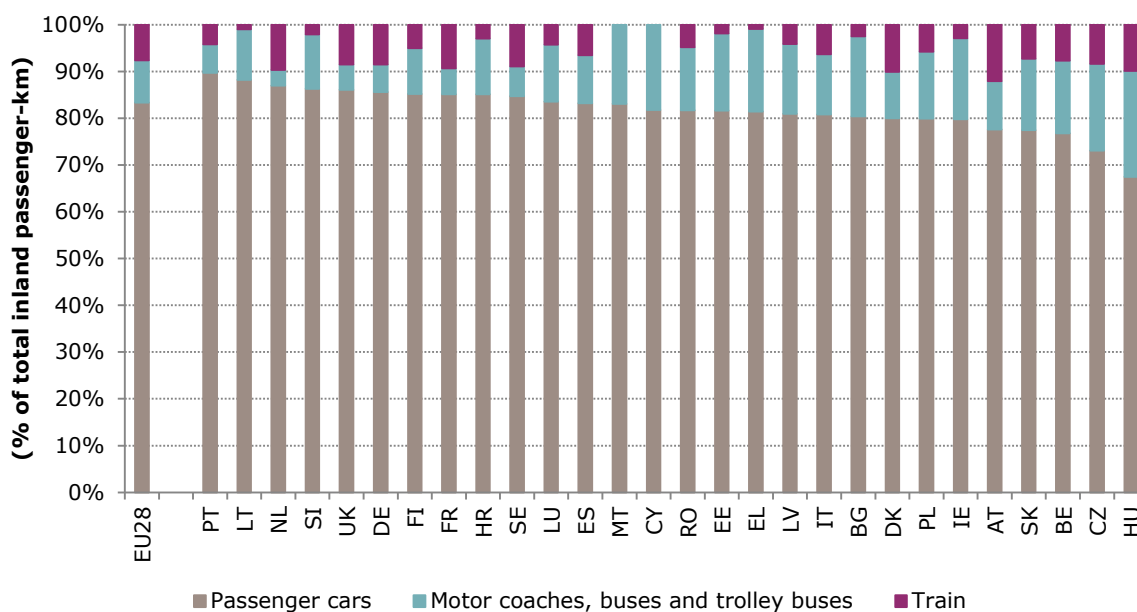
Source: EC DG-MOVE

Distinguishing by conveyance, passenger cars are the transportation with the highest volume of passengers. Passenger cars registered 4,719 billion pkm (71.48% of the total) in 2015 which corresponds to an increase by 9.7% in comparison with 2000. Between the years 2000 and 2015 and regarding the rest of conveyances, air transport has increased by 41.09%, tram and metro by 27.5%, powered 2-wheelers by 20.19% and railways by 18.82%. In contrast the volume of passengers during the same period dropped by 24.14% and by 1.45% in sea transportation and buses and coaches.

Analysing the inland passenger transport in the EU-28 Member States, it can be observed that Portugal was the European country with the highest volume of passenger cars (89.8%) in 2014, followed by Lithuania (88.2%) and the Netherlands (87%). In contrast, in the same year, Hungary (67.5%), Czech Republic (73.1%) and Belgium (76.8%) were the Member States with the lowest percentage of inland passenger transport. Seventeen Member States registered a passenger cars' percentage in 2014 below the European average (<83.4%). The relative importance of motor coaches, buses and trolley buses exceeded one fifth of inland passenger transport only in Hungary (22.6%). This share was between 10.0% and 20.0% in 19 other Member States while the lowest share for motor coaches, buses and trolley buses was registered in the Netherlands (3.3%). Regarding to railways, the highest share of train transport were recorded in Austria (12.1%), Denmark (10.1%), and Hungary (9.9%). According to the data, Hungary seems to have the most balanced inland passenger transport among the EU-28 MSs considering passenger cars, trains and motor coaches, buses and trolley buses in 2014.



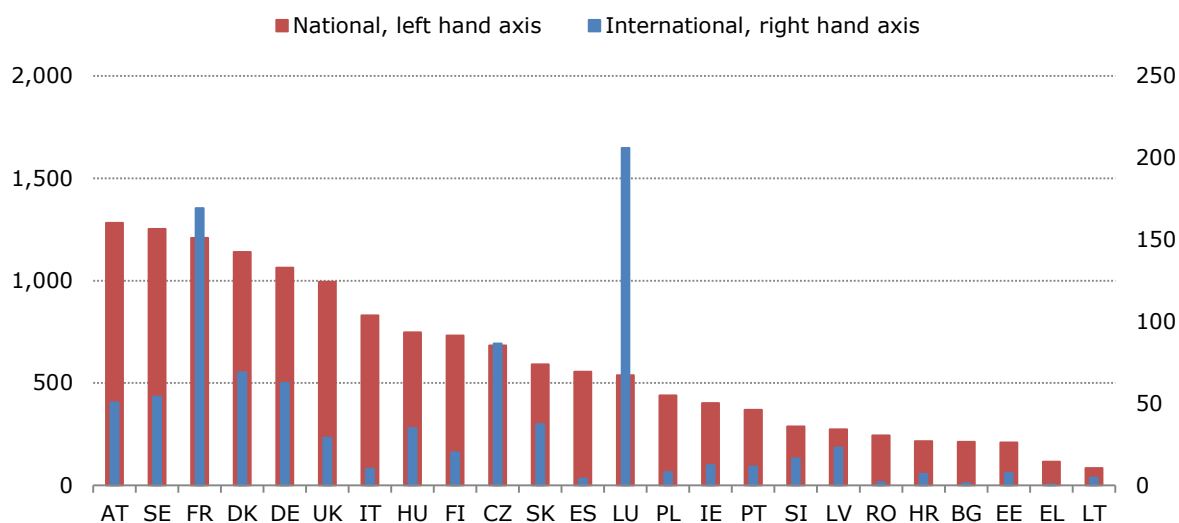
**Figure 127:** Modal split of inland passenger transport in the EU-28, 2014<sup>60</sup>



Source: Eurostat

In 2015, Austria registered the highest passenger volume in rail transport at national level with the value 1,282 passenger-km per inhabitant. The second was Sweden (1,253) and the third France (1,209). In terms of international rail travel, only Luxembourg (206) and France (169) reported averages of more than 100 passenger-kilometres per inhabitant in 2015, as illustrated in **Figure 130**.

**Figure 128:** Rail passenger transport (passenger-km per inhabitant) in the EU-28, 2015<sup>61</sup>



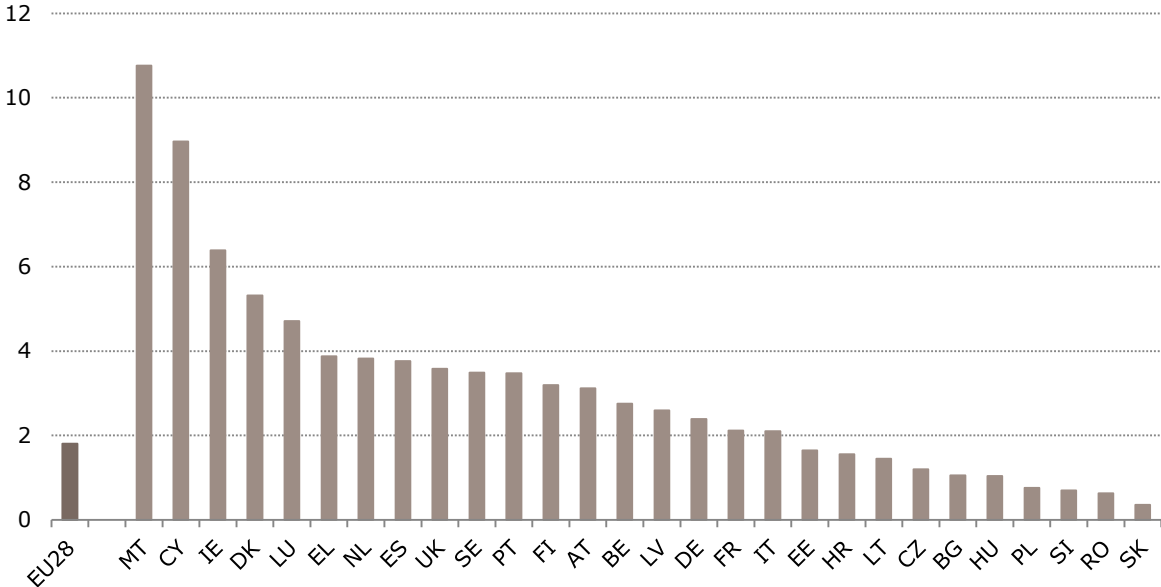
Source: Eurostat

<sup>60</sup> Note: Provisional data are included. The railway in Liechtenstein is owned and operated by the Austrian ÖBB and included in their statistics.

<sup>61</sup> Note: data not applicable for CY and MT and not available for BE and NL. The railway in Liechtenstein is owned and operated by the Austrian ÖBB and included in their statistics.

With regard to air passenger transport, Malta was the Member State with the highest rate of passengers per inhabitant in the year 2015 with 10.8 passengers per inhabitant; the second was Cyprus (9). Eighteen countries registered higher values than the average European rate for 2015 which was 1.8 passengers per inhabitant (see **Figure 131**).

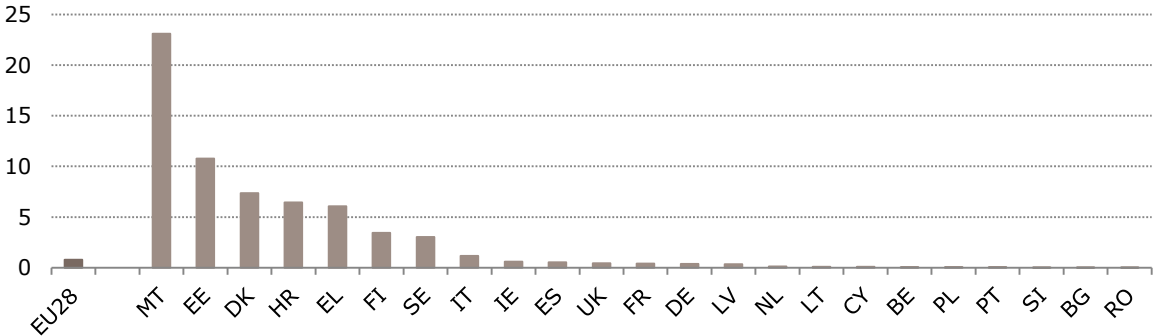
**Figure 129:** Air passenger transport (passengers per inhabitant) in the EU-28, 2015<sup>62</sup>



Source: Eurostat

The average EU-28 number of passengers per inhabitant in 2015 in sea transport was equal to 0.8 passengers per inhabitant. Eight Member States registered higher values than the European average. The importance of maritime passenger transport was particularly high in Malta (23.08), followed by Estonia (10.77), Denmark (7.36), Croatia (6.45), and Greece (6.05).

**Figure 130:** Sea passenger transport (passengers per inhabitant) in the EU-28 Member States, 2015<sup>63</sup>



Source: Eurostat

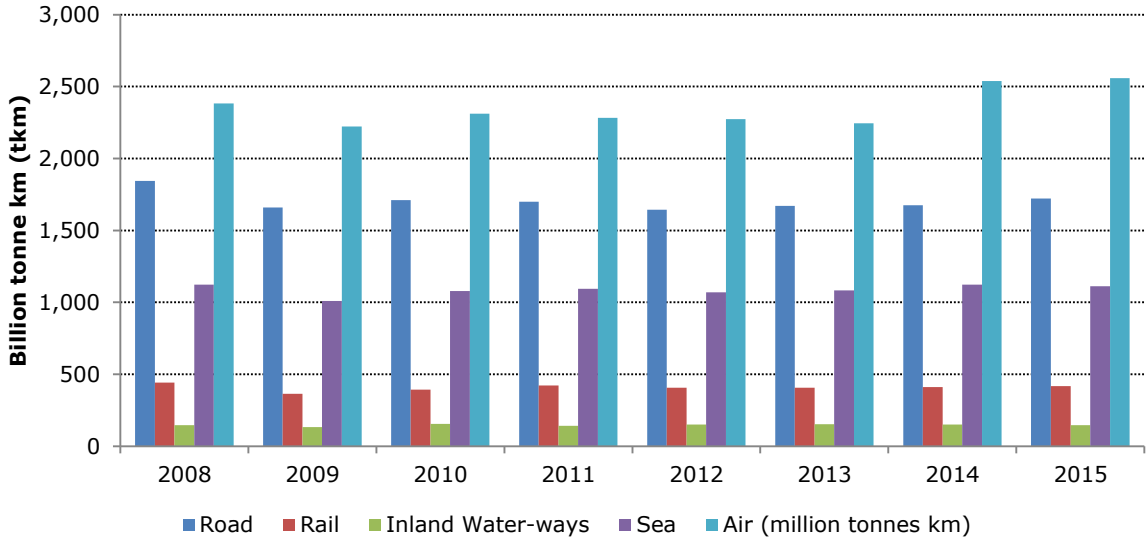
<sup>62</sup> Total passengers carried (arrivals and departures for national and international); aggregates exclude the double-counting impact of passengers flying between countries belonging to the same aggregate. If both the port of embarkation and disembarkation report data to Eurostat, then these passengers are counted twice.

<sup>63</sup> Figures refer to the number of passengers 'handled in ports' (the sum of passengers embarked and then disembarked in ports). If both the port of embarkation and disembarkation report data to Eurostat, then these passengers are counted twice. AT, CZ, HU, LU, and SK: not applicable.

### 5.4.2 Freight traffic

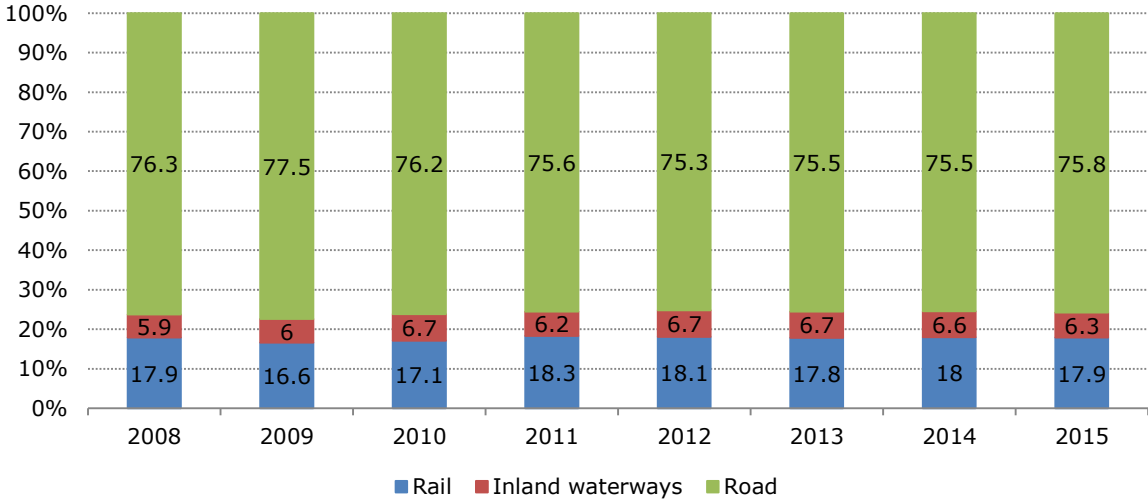
Total inland freight transport in the EU-28, including also pipelines, was estimated to be 3,516 billion tonne-kilometres (tkm) in 2015. In the period from 2008 to 2015, the total freight traffic has declined by 4.59% (169 billion tkm). Road is the mode of transport which dropped the most during these years (by 6.62%). Inland waterways and air transport slightly increased over the considered period.

**Figure 131:** Freight transport traffic (billion tkm) breakdown into conveyances in the EU-28, 2008-2015<sup>64</sup>



Source: EC DG-MOVE

**Figure 132:** Freight transport in the EU-28: modal split of inland transport modes (% of total tonne-kilometres), 2008-2015<sup>65</sup>



Source: Eurostat

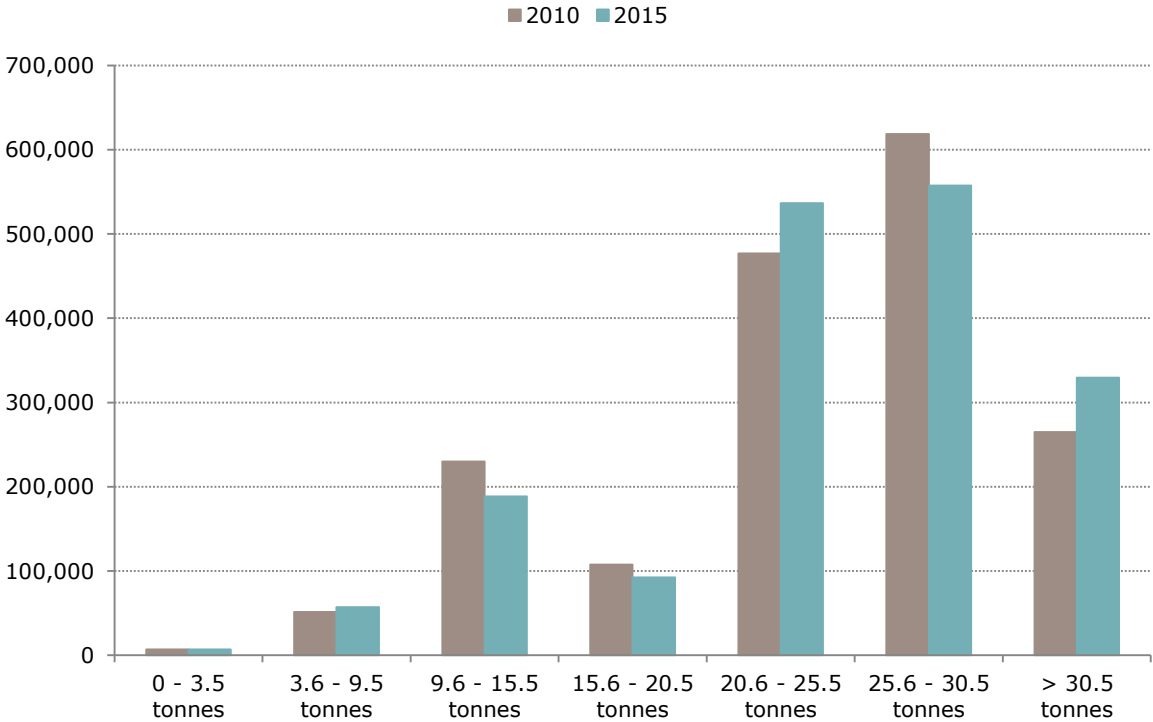
<sup>64</sup> Air and maritime cover only intra-EU transport (transport to/from countries of the EU) and exclude extra-EU transport.

<sup>65</sup> Note: EU aggregates contain estimated data for rail for 2012-2013 (BE, LU), inland waterways for 2008 (BG, RO) and exclude road freight transport for MT (negligible).

Analysing the inland transport modes, road registered 75.8% of the freight traffic in 2015, confirming this mode of transport as the major freight transport. Rail was the second freight transport with the highest presence in the EU-28 freight traffic (17.9%). During the period from 2008 to 2015, the shares of the different inland transport modes have not experienced significant changes.

Transportation of loads between 25.6-30.5 tonnes was the most common in the European road conveyance in the year 2015 (557,373 Mtkm). Road transport with capacity between 9.6-15.5 tonnes has reduced the most (-18%) during the period 2010-2015. During the same period the presence of freight traffic between 20.6-25.5 tonnes and above 30.5 tonnes has augmented (12.47% and 24.44% respectively).

**Figure 133:** Evolution of EU-28 road transport by load capacity, 2010 and 2015 (million tonne-kilometres)

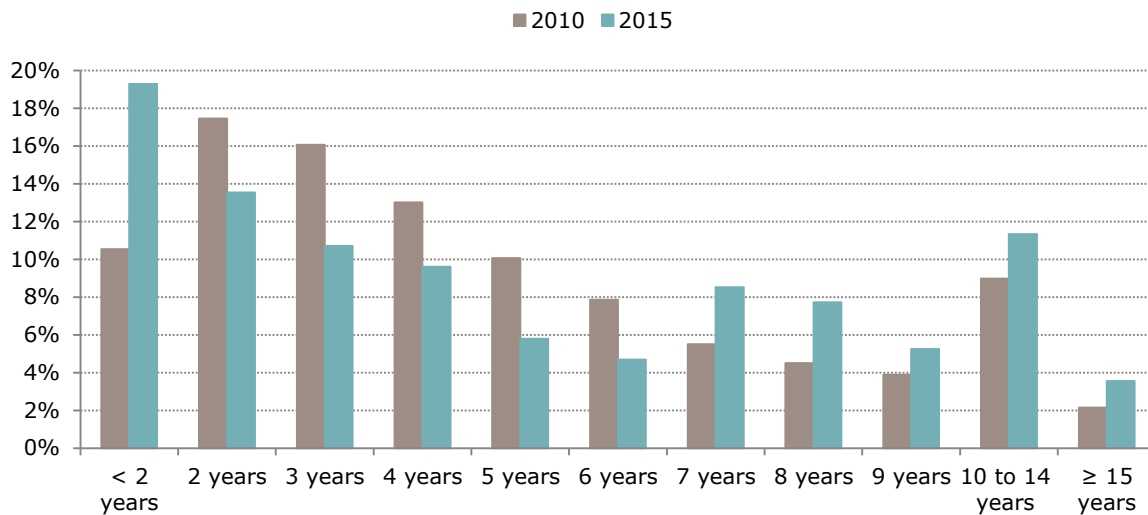


Source: Eurostat

The total road transport traffic declined by 0.5% during the last 5 years, from 1,756 billion tkm in 2010 to 1,765 billion tkm in 2015.

Regarding the fleet's age of the road goods transport, it is observed that over 50% of the vehicles fleet had 4 years or below in 2015 (**Figure 136**). In the same year, the vehicles of age below 2 years were the majority (19.28%). There is a decreasing presence of vehicles as the age of the vehicles rises. This trend is interrupted for vehicles of 7 years old; vehicles that might correspond to the newest ones from the year 2010 which have experienced a gradual aging. In comparison to the year 2010, the share of good transport of age below 2 years has increased by 8.75%. Overall, the fleet of vehicles up to 3 years of age have remained nearly the same (44.04% in 2010 vs 43.53% in 2015). Nevertheless, a general gradual aging of the fleet has been registered as vehicles up to 5 years old accounted for 67.13% in 2010, whereas in 2015 accounted for 58.93%.

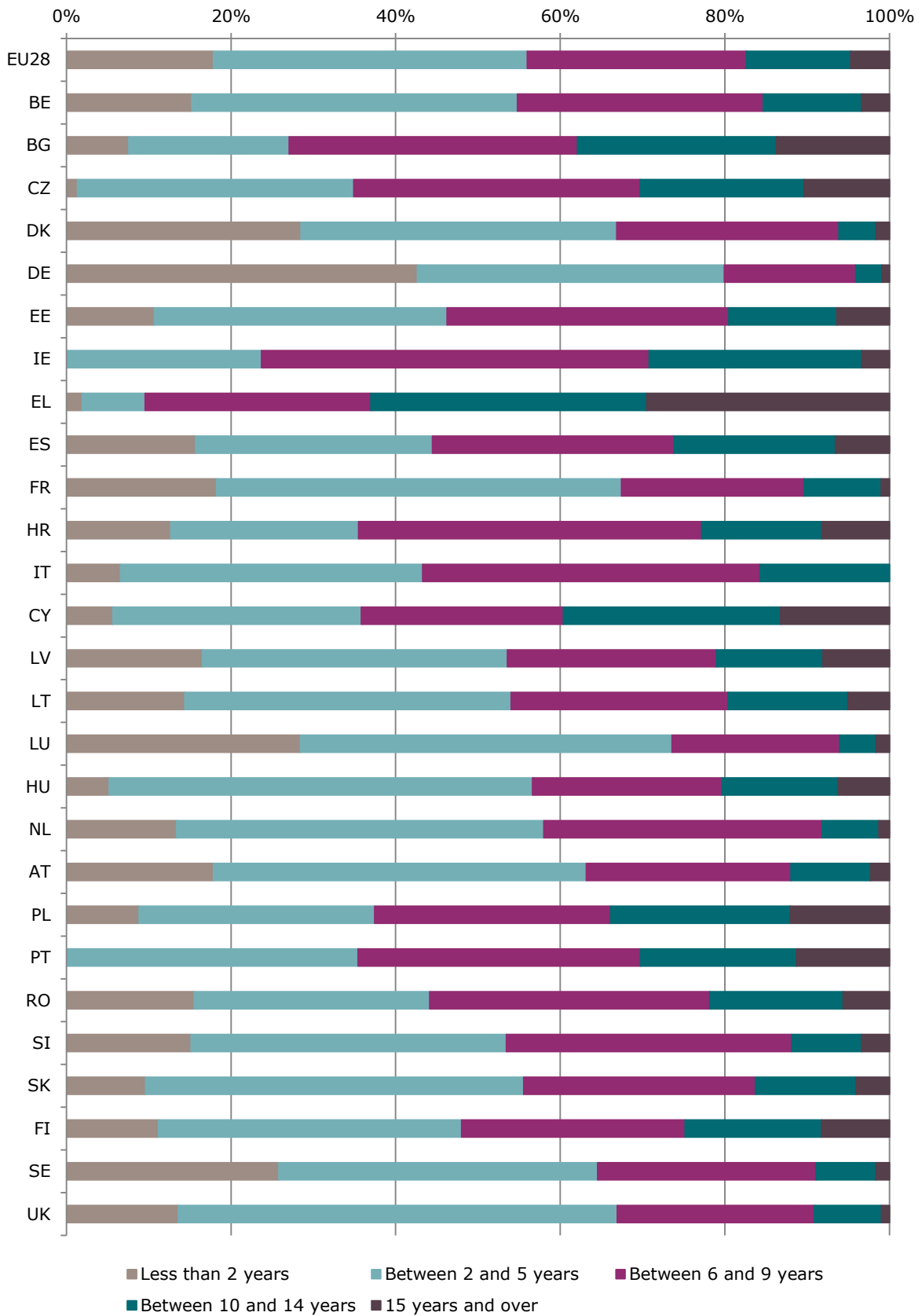
**Figure 134:** Road goods transport in the EU-28 by age of vehicle, 2010 and 2015 (% of total)



Source: Eurostat

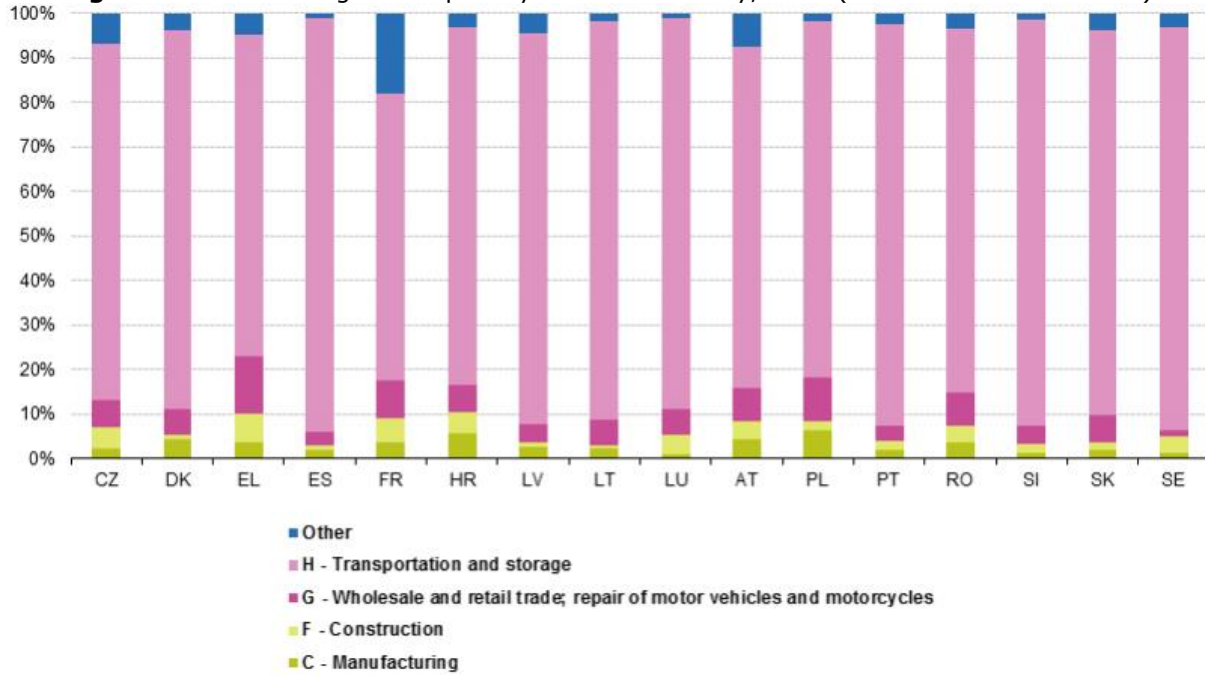
Analysing the age in road goods transport across the EU-28 Member States (**Figure 137**), it is found that the vehicles between 2 and 5 years were the majority in 2015. In 2015, the average EU-28 shares of goods transport vehicles by age have been: less than 2 years (17.89%); between 2 and 5 years (38.11%); between 6 and 9 years (26.61%); between 10 and 14 years (12.7%) and 15 years and over (4.68%). With 42.6% of its fleet with less than 2 years, Germany was the European country with the newest fleet of vehicles dedicated to goods transport; it has more than doubled the European average value for that year. Also taking into consideration all goods transport vehicles up to 5 years old Germany was the State with the newest vehicles' fleet (79.95% of total vehicles); closely followed by Luxembourg (73.58%), France (67.44%) and the United Kingdom (66.92%). Ireland registered the highest share of vehicles between 6 and 9 years (47.09%), while Greece had the oldest fleet of goods transport vehicles with 63% of the vehicles older than 10 years. Distinguishing by age ranges, Greece was also the European country with the oldest fleet of vehicles dedicated to road goods transport in the range between 10 and 14 years and in the range of 15 and over years (33.5% and 29.5% respectively).

**Figure 135:** Share of age categories in road goods transport, 2015 (% in vehicle-kilometres)



Source: Eurostat

**Figure 136:** Road freight transport by economic activity, 2015 (million tonne-kilometres)



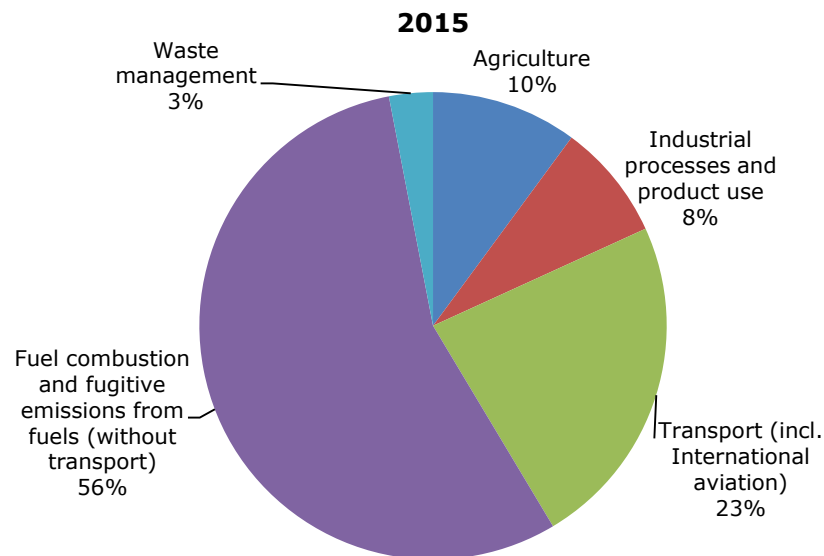
Source: Eurostat

Sixteen reporting countries have supplied data about the economic activity of the companies undertaking road transport (**Figure 138**). Transportation and storage of goods was the main economic activity related to freight traffic in the EU-28 in 2015. In the State with the least share this activity even accounted for a large representative share. On average, the second main economic activity was wholesale and retail trade and repair of motor vehicles and motorcycles, followed by freight transport related to manufacturing and, finally, from road freight transport related to construction.

## 5.5 Carbon Dioxide (CO<sub>2</sub>) Emissions

With regard to the greenhouse gas emissions, it is of relevance to follow the trend-line starting from 1990 as the European targets (the cut of 40% in greenhouse gas emissions) are set according to the levels of that year. Among the economic sectors analysed in this report, the transport sector is the major contributor to carbon dioxide emissions, excluding the emissions derived from fuel combustions which mainly take place in the energy sector. In 2015, the transport sector (including international aviation) was responsible of 23% of the CO<sub>2</sub> equivalent emissions<sup>66</sup>.

**Figure 137:** Greenhouse gas emissions by source sector in the EU-28, 2015 (percentage of total)



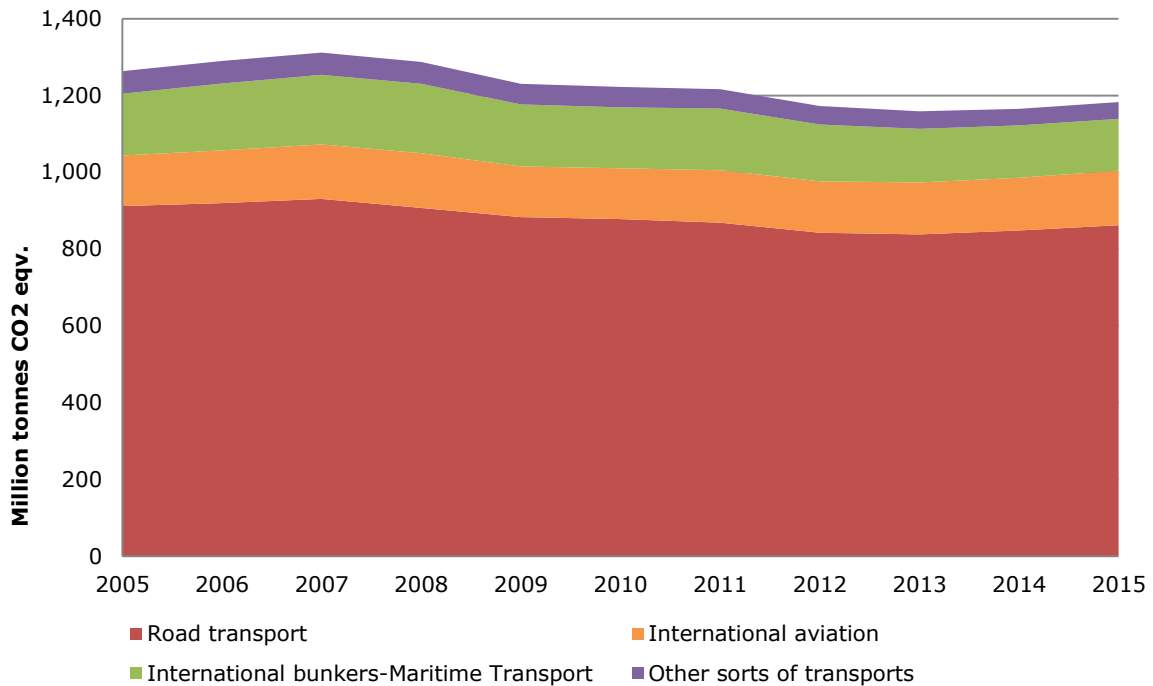
Source: EEA

The following figure shows the aggregated emissions generated by the transport sector in the last 11 years by sort of transport. The highest emissions' share has been registered in the road transport. In 2015 the road transport accounted for 72.88% of total emissions in the transport sectors. International aviation sector registered its maximum value in 2008 (142.6 Mtoe of CO<sub>2</sub> equivalent), and international bunkers-maritime transport in 2007 (181.3 Mtoe of CO<sub>2</sub> equivalent). Other transports category, which is formed by domestic aviation, domestic navigation, rail, non-specified and pipeline transport, have been responsible of 5-8% of the emissions per year in the transport sector along the period from 1990 to 2015.

<sup>66</sup> The air pollutants are quantified in CO<sub>2</sub> equivalent emissions, a metric measure used to compare the emissions from various [greenhouse gases](#) on the basis of their [global-warming potential](#). [Pollutant include](#) carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>).



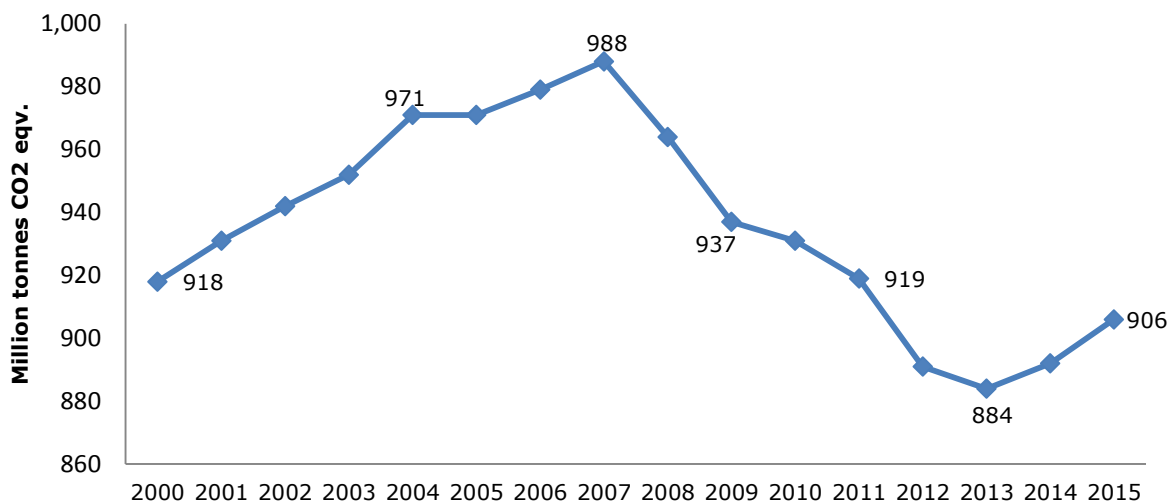
**Figure 138:** Greenhouse gas emissions by sort of transport in the EU-28, 2005-2015



Source: EEA

Overall, the greenhouse gas emissions in the transport sector have followed the trend of the energy consumption in the sector as per its direct causation. From 2000 to 2015 the CO<sub>2</sub> equivalent emissions have declined by 1.3% (12 MtCO<sub>2</sub>e). The maximum in the time series took place in 2007 when the value of 988 MtCO<sub>2</sub>e was reached, year which coincides with the maximum in the final energy consumption in the sector. From 2007 to 2013, a total reduction by 10.53% has been registered. In 2013, the minimum value for the analysed period was recorded (884 MtCO<sub>2</sub>e), reaching the emissions' levels of years 1997-1998. In 2014 and 2015 greenhouse gas emissions started to increase up to 906 MtCO<sub>2</sub>e in 2015.

**Figure 139:** Greenhouse gas emissions in transport sector in the EU-28



Source: EEA

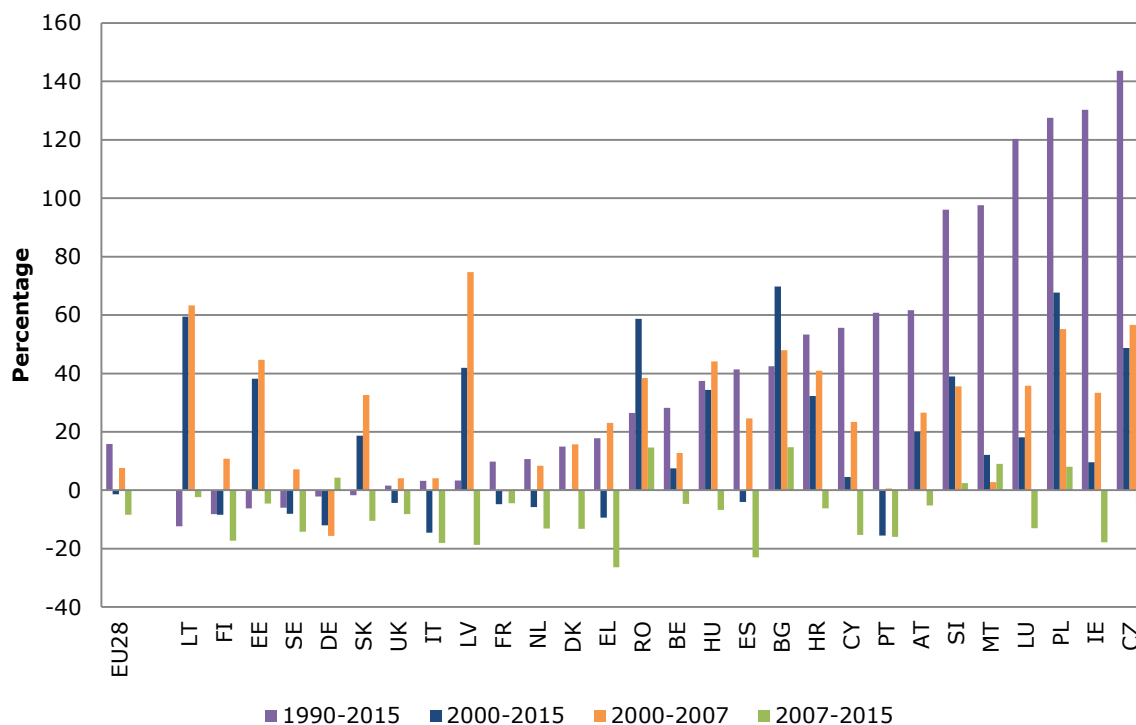
The following table provides an overview of the values of greenhouse gas emissions in the transport sector and its main subsectors, together with the growth rates in two different periods, i.e. 1990-2015 and 2000-2015.

**Table 8:** Greenhouse Gas Emissions in the EU-28 transport sector

		<b>Total Transport</b>	Road Transport	International Aviation	International maritime	Other Transports
Greenhouse Gas Emissions (kilotonnes of CO <sub>2</sub> equivalent)	1990	<b>961.4</b>	723.3	69.3	110.3	58.5
	2015	<b>1182.9</b>	862.1	142.2	134.8	43.8
	2014	<b>1165.2</b>	848.4	137.3	136.4	43.1
	2013	<b>1158.8</b>	838.2	135.2	139.7	45.7
	2012	<b>1172.6</b>	842.5	134.0	147.9	48.2
	2011	<b>1216.4</b>	868.7	136.6	160.6	50.5
	2010	<b>1222.3</b>	878.1	132.3	158.7	53.2
	2005	<b>1263.3</b>	911.9	131.7	161.0	58.7
	2000	<b>1168.6</b>	859.8	115.9	134.7	58.2
Growth Rates (%)	1990-2015	<b>23.0</b>	<b>19.2</b>	<b>105.2</b>	<b>22.2</b>	<b>-25.1</b>
	2000-2015	<b>1.3</b>	<b>0.3</b>	<b>22.7</b>	<b>0.1</b>	<b>-24.7</b>

Source: EEA

**Figure 140:** Greenhouse gas emissions growth rate in the transport sector (excluding international aviation and international maritime transport) in the EU-28 Member States; 1990-2015, 2000-2015, 2000-2015, 2000-2015, 2000-2015 and 2007-2015



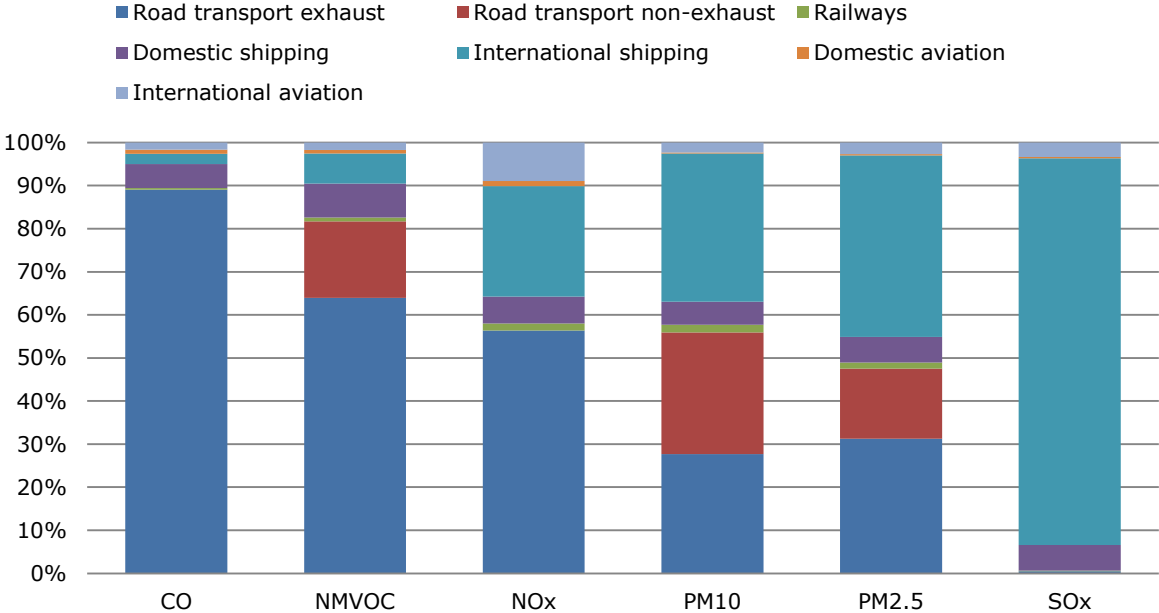
Source: EEA

Across the EU-28 Member States (**Figure 142**), the countries with the highest reduction rates during the period from 2000 to 2015 were Portugal (-15.5%), Italy (-14.6%), Germany (-12%), Greece (-9.3%) and Finland (-8.4%). In contrast, the Member States with the highest increase of greenhouse gas emissions during the same period were Bulgaria (69.8%), Poland (67.7%), Lithuania (59.5%), Romania (58.7%) and Czech Republic (48.7%). Ten Member States have registered higher reduction rates of emissions than the average European level (<-1.3%) for that period. To be noted that Germany was the only State that registered a reduction of CO<sub>2</sub> emissions in the period from 2000 to 2007. On the contrary from 2007 to 2015, only six countries registered an increase in the emissions: Bulgaria (14.8%), Romania (14.6%), Malta (9.1%), Poland (8.1%), Germany (4.3%), and Slovenia (2.5%). The reduction rates in the period 2007-2015 might indicate the consequences of the impact produced by the financial and economic crisis on the sector, in particular on freight transport. Regarding the growth rates of GHG emissions for the period 1990-2015 it is possible to observe that the EU-28 GHG emissions increased by 15.9%. Lithuania (-12.4%), Finland (-8.2%), and Estonia (-6.2%) are the European States with the highest reduction rates. The MSs with the highest increases over the period are Czech Republic (143.7%), Ireland (130.3%), and Poland (127.5%).

Distinguishing by air pollutants and transport subsectors (**Figure 143**), road transport was the main contributor to CO (89%), NMVOC (63.9%) and NO<sub>x</sub> (56.4%) emissions in 2015. In the same year, international shipping was the main responsible for SO<sub>x</sub> emissions (89.8%), PM<sub>2.5</sub> (42.2%) and PM<sub>10</sub> (34.4%). Road transport would also be the main polluter of PM<sub>10</sub> and PM<sub>2.5</sub> if road transport non-exhaust emissions (28.2% and 16.2% respectively) from fuel evaporation, tyre and brake wear emissions, were

accounted. NO<sub>x</sub> was the most emitted pollutant in railways, domestic shipping, international aviation, and domestic aviation, as illustrated in the following figure.

**Figure 141:** Contribution of the transport sector to emissions of the main air pollutants in the EEA-33, 2015



Source: EEA

### 5.6 Overview – Transport sector

The transport sector accounted for 33.09% of total final energy consumption in the year 2015, resulting as the main consuming sector. The final energy consumption in the sector has increased by 4.04% at an European level between 2000 and 2015. The increase in the final energy consumption has been the result of a reduction by 1.05% in the EU-15 area and an increase by 55.66% in NMS-13 area.

The maximum consumption during this period (2000-2015) was registered in the year 2007 (383.5 Mtoe), while the minimum during the analysed period corresponds to the year 2000 (344.7 Mtoe). There is a reversing (from growing to falling) trend before and after the year 2007 as a consequence of the financial and economic crisis.

In 2015, the final energy consumption in the transport sector grew by 1.72% (up to 358.6 Mtoe; out of which 86.59% was consumed by EU-15).

The energy intensity in the transport sector has decreased by 13.7% during the period from 2000 to 2015, registering the value of 0.0284 koe/€2005 in 2015. The lowering trend along the whole period was interrupted in 2009 by a rise of 1.3% as per the consequence crisis in the GDP values.

There are significant differences of final energy consumption in the transport sector among the Member States as fourteen States accumulated less than 10% of the final energy consumption in 2015. Germany (63.2 Mtoe), the United Kingdom (51.8 Mtoe), France (50.1 Mtoe) and Italy (39.5 Mtoe) are the highest final energy consumers of the sectors; they accounted for more than 57% of the final energy consumption in the sector in 2015.

Between 2000 and 2015, Poland (73.82%), Lithuania (73.37%) and Bulgaria (69.05%) are the EU-28 MSs with the highest growth rates in the final energy consumption in the

transport sector. In contrast, Greece (-9.87%), Italy (-7.01%) and Germany (-5.39%) registered the lowest growth rates over the period. Ten EU-28 countries (i.e. Greece, Italy, Germany, United Kingdom, France, Portugal, the Netherlands, Cyprus, Spain, and Denmark) registered consumption values below the European average (4.4%).

In the period 2000-2007, all the Member States with the exception of Germany and Malta registered an increase in their final energy consumption. The average European growth rate in that period was 11.25%. The trends were significantly different in the period from 2007 to 2015 when only seven Member States recorded a positive growth rate. The period 2007-2015 reflects the energy consumption decline produced by the financial and economic crisis (after 2007) which is clearly observed in the overall European final energy consumption trend.

The final energy mix in the transport sector is mainly provided by petroleum products. Petroleum products represented 93.65% (335,867 ktoe) in 2015. This represents a reduction in the share in comparison to 2000 (97.81%; 337,134 ktoe).

Among the petroleum products stand out diesel and gasoline. In 2015, oil-diesel accounted for 55.84% (200,266.1 ktoe) and gasoline for 21.60% (77,449.4 ktoe). The remaining shares were completed by jet fuel (14.29%; 51,236 ktoe), biofuels (3.95%; 14,157.9 ktoe), LPG (1.64%; 5,889.8 ktoe), electricity (1.5%; 5,367.6 ktoe), gas (0.90%; 3,226.1 ktoe), and heavy fuel (0.29%; 1025.3 ktoe). Solid fuels represented a negligible share in the final energy mix (0.003%; 10.3 ktoe).

A reduction of the gasoline share by 17.29% (56.6 Mtoe), together with an increase by 11.0% (47.1 Mtoe) and 3.74% (13.4 Mtoe) in the shares of diesel and biofuels respectively constituted the most significant changes in the final energy mix in comparison to year 2000 scenario.

From 2000 to 2015, the petroleum products consumption has dropped by 0.38% (1.3 Mtoe). During this period the diesel has gradually increased its presence; diesel's consumption has increased by 30.79%, while gasoline has declined by 42.22%. Heavy fuel has registered a significant fall by 33.82% (-523.9 ktoe) in the same period.

Automotive diesel oil and gasoline prices increased from 2005 onwards. From mid-2008 to mid-2009 a significant drop took place. Afterwards, the prices continued rising until September-October 2012 where the maximum of the period 2000-2015 were registered (gasoline 95 Ron: 1.693 Euro/litre; automotive diesel oil: 1.536 Euro/litre). Since then, a progressive reduction in the prices has been taking as illustrated in **Figure 104**. Between 4<sup>th</sup> quarter of 2014 and 1<sup>st</sup> quarter of 2015 a significant drop was registered. That drop in the consumer prices was linked to the sharp decline in the price of crude oil barrels.

Analysing the renewable energies, it is noted that biofuels have highly developed during the period from 2000 to 2015. Their energy consumption rose by four times between 2005 and 2010 (from 3,199 ktoe to 13,140 ktoe), mainly due to biodiesels and biogasoline usage. Since 2010 the energy consumption of biofuels type has remained nearly constant.

The analysis of transport subsectors can lead to a better understanding of how the final energy is consumed in the transport sector. The subsectors studied are: road; rail; international aviation; domestic aviation; domestic navigation; pipeline transport; and other transports.

Road transport is extensively the main energy consuming subsector. It consumed 81.98% (294 Mtoe) of the final energy share in 2015. In the same year, the second consuming subsector was international aviation (12.76%; 45.8 Mtoe), followed by rail (1.73%; 6.2 Mtoe), domestic aviation (1.54%; 5.5 Mtoe), domestic navigation (1.27%; 4.5 Mtoe), pipeline transport (0.42%; 1.5 Mtoe) and other non-specified transport (0.30%; 1.1 Mtoe). The most remarkable change compared to year 2000 scenario is the energy consumption of pipeline transport that has increased by nearly three times (from 534 ktoe to 1,501 ktoe).

During this period, the total final energy consumption in the sector has increased by 4.04%. However, this increase has not been followed by all the subsectors. Domestic navigation has been the sector where consumption declined the most (by 24.67%). Rail, domestic aviation and non-specified transport have decreased their energy consumption by 23.04%, 12.86%, and 21.19% respectively. In contrast, pipeline transport, international aviation, and road transport are the subsectors which have registered an increase in their consumption in comparison to the year 2000 by 182.22%, 18.66%, and 3.60% respectively.

In 2015 oil (petroleum products) is the only fuel type in the domestic and international aviation and it is the main contributor in domestic navigation (99.9%) and in the road transport (94.46%). In 2015, electricity represented the main consuming fuel in rail (66.47%) and other transports (67.65%). Gas was the major fuel type used in pipeline transport (93.65%). With regard to renewable energies, biofuels occupied a share in road (4.8%), rail (0.43%), other transports (0.45%), and domestic navigation (0.10%).

Focusing on road transport, the final energy consumption has increased by 3.6% (10.2 Mtoe) in the period from 2000 to 2015. NMS-13 areas have increased their final energy consumption by 62.1%, while EU-15 have registered a drop by 2.6%.

In the transport sector, 14 Member States consumed less than 10% of the final energy of the sector in 2015. Germany (52.4 Mtoe), France (42.0 Mtoe), United Kingdom (38.2 Mtoe) and Italy (33.6 Mtoe) accounted for more than 56% of the total final energy consumption in the road transport.

The energy mix in the road transport is chiefly associated to petroleum products (i.e. diesel, gasoline, LPG and gas). In 2015, diesel was the most consumed fuel type (66.29%), followed by gasoline (26.23%), biofuels (4.80%), LPG (1.94%), gas (0.60%) and electricity, which accounted for a residual share (0.14%) of the final energy consumption. Diesel is slightly substituting part of the gasoline oil.

During this 16-year period (2000-2015), it is to be highlighted a shift from fossil fuels to renewable energy sources representing the pathway towards a more sustainable mode of road transport; biofuels have increased its share by 4.6%.

In 2015, biodiesels were the major renewable fuel type with 80.1%. Biogasoline was the second with 18.97%. Biogas started to account in the final energy consumptions after 2008 and reached about 1% share of the renewable energy mix in 2015.

Analysing the vehicle types within the road transport, cars stand out as the main energy consumers in the road transport. There have not been remarkable differences between 2000 and 2014. In 2014, cars accounted for 56.64% (162.9 Mtoe) of the road final energy consumption, followed by trucks and light vehicles (38.21%; 109.9 Mtoe), buses (3.75%; 10.8 Mtoe) and two wheels vehicles (1.39%; 4 Mtoe).

The stock of vehicles in the EU-28 was mainly composed by cars (77.61% in 2014). In 2014, there were registered 243.2 millions of cars in Europe. Trucks and light vehicles have been the second vehicle type according to the stock size with over 36.4 millions of units, followed by two wheels vehicles (32.9 million units) and buses (851 thousand units). All the vehicle types have increased their stocks. In comparison with year 2000, the total stock of vehicles has increased by 65.5 million units, representing an increase by 26.4%. All the vehicle types have increased their stock. Trucks and light vehicles are the vehicle types which have experienced the highest stock growth, with an increase by 33.5% (9.1 million units). Two wheels vehicles have enlarged in a similar range their stock (33.1%; 8.2 million units). Cars and buses have incremented their stock numbers by 24.7% and 2.1% respectively.

Analysing the energy consumption per vehicle, buses have the higher consumption value. In 2014, the average European energy consumption per bus was 12.67 toe/veh. In the same year trucks and light vehicles consumed 3.02 toe/veh, cars 0.67 toe/veh and two wheels 0.12 toe/veh. In comparison to year 2000 scenario, cars' energy consumption decreased by 20.2%, two wheels by 14.3% and trucks and light vehicles by 22.8%. In

contrast, buses have registered an increase by 20.3%. This last finding might be the result of the increase of usage of buses in the cities; reporting a positive effect as the number of cars on the road decreases.

Cars represented 77.61% of the stock of vehicles and 56.64% of the final road energy consumption in 2014. In 2000, the average energy consumption per car in the EU-28 registered the value of 0.84 toe per vehicle. During the period from 2000 to 2014, a gradual lowering trend has been observed which led to a drop by 20.2% in 2014. This drop might be the result of an increase in the energy efficiency performance of the vehicles but also of the reduction in the annual distance travelled by car which has decreased by 1,065 km along the 15-years period (from 13,165 km in 2000 to 12,100 km in 2014).

Diesel-fuelled vehicles are the vehicles type with the highest unitary energy consumption (0.82 toe/veh in 2014). The reduction in total average energy consumption per vehicle registered during the period 2000-2014 (-20.2%) is the result of a reduction by 33.3% in gasoline-fuelled cars, a reduction by 24.8% in diesel fuelled cars and a reduction by 43% in the LPG-fuelled cars.

From 2000 to 2014 In the period from 2000 to 2014, gasoline and diesel cars already in the market have registered a reduction by 10.07% (from 8.1 litres/100 km in 2000 to 7.3 litres/100 km in 2014) and 8.1% (from 6.9 litres/100 km in 2000 to 6.4 litres/100 km in 2014) respectively. In the same period, the new cars gasoline and diesel-fuelled entering into the market have also registered reductions in their specific consumption values.

With regard to the EU average level of CO<sub>2</sub> emissions from new passenger cars, there has been registered a reduction by 30.6% (from 172.2 g CO<sub>2</sub>/km to 119.5 g CO<sub>2</sub>/km) during the period between 2000 and 2015. Both average specific fuel consumption and average CO<sub>2</sub> emissions per kilometre have declined from 2007 onwards. These trends may be the result of the implementation of EU regulations in the automotive sector (i.e. Regulation No 443/2009 and Regulation No 333/2014 on CO<sub>2</sub> emissions of new passenger cars).

The countries with the highest percentage of petrol (gasoline) fuelled passenger cars were the United Kingdom (92.58%), Cyprus (87.57%), and Finland (75.59%). The States with the highest presence of diesel-fuelled passenger cars were France (69.75%), Luxembourg (65.28%), and Lithuania (62.99%). Poland (16.01%), Latvia (8%), Italy (7.78%), and Sweden (5.91%) were the European countries where alternative-fuelled engines have reached the largest shares.

A lower age of the vehicles fleet can help reducing the energy consumption and GHG emissions in the future as the energy consumption trends have decreased. In 2015, the highest share of newest passenger cars (below or equal 2 years) were found in Luxembourg (33.34%), Belgium (20.91%) and Ireland (20.77%). In contrast, the oldest fleet of passenger cars (older than 10 years) were registered in Lithuania (79.03%), Latvia (72.86%) and Poland (72.39%). Luxembourg was the Member State with the highest number of passenger cars per 1,000 inhabitants in 2015 (661 cars); the second State was Malta (634 cars) and the third, Italy (610 cars). In contrast, the lowest number of passenger cars per thousand inhabitants was registered in Romania (261 cars), Hungary (325 cars), and Latvia (345 cars).

Domestic transportation which can be differentiated by passenger and freight transport was the major final energy consumer in 2014. Passenger transport accounted for the 61.39% and freight transport for the remainder 38.61%. Overall, the scenario of domestic transport has not largely changed compared to 2000 (constant consumption of 303 Mtoe).

The passenger transport volume has risen by 11.97% in the period from 2000 to 2015. In 2015, the value registered 6,602 billion pkm, the maximum passenger volume registered during the period 2000-2015.

Distinguishing by conveyance, passenger cars are the transportation with the highest volume of passengers. Passenger cars registered 4,719 billion pkm (71.48% of the total) in 2015 which corresponds to an increase of 9.7% in comparison with 2000. Between the years 2000 and 2015 and regarding the rest of conveyances, air transport has increased by 41.09%, tram and metro by 27.5%, powered 2-wheelers by 20.19% and railways by 18.82%. In contrast the volume of passengers during the same period dropped by 24.14% and by 1.45% in sea transportation and buses and coaches.

In 2014, Portugal was the EU-28 Member State with the highest volume of passenger cars (89.8%), followed by Lithuania (88.2%), and the Netherlands (87%). In contrast, Hungary (67.5%), Czech Republic (73.1%) and Belgium (76.8%) were the Member States with the lowest percentage of inland passenger transport. The average European passenger cars value was 83.4%. Hungary was the only State where motor coaches, buses and trolley buses exceeded one fifth of inland passenger transport (22.6%). Regarding to railways, the highest share of trains transport were recorded in Austria (12.1%), Denmark (10.1%), and Hungary (9.9%). According to the data reported, Hungary presented the most balanced inland passenger transport among the EU-28 MSs in 2014.

In 2015, Austria registered the highest passenger volume in rail transport at national level with the value 1,282 passenger-km per inhabitant. The second was Sweden (1,253) and the third France (1,209). In terms of international rail travel, only Luxembourg (206) and France (169) reported averages of more than 100 passenger-kilometres per inhabitant in 2015.

In 2015, air passenger transport was especially representative in Malta and Cyprus which registered 10.8 and 9 passengers per inhabitant respectively. Eighteen countries registered higher values than the average European rate for 2015 which was 1.8 passengers per inhabitant.

In the same year, for sea transport EU-28 registered an average of 0.8 passengers per inhabitant. Eight Member States registered higher values than the European average. The importance of maritime passenger transport was particularly high in Malta (23.08), followed by Estonia (10.77), Denmark (7.36), Croatia (6.45), and Greece (6.05).

Total inland freight transport in the EU-28, including also pipelines, was estimated to be 3,516 billion tonne-kilometres (tkm) in 2015. In the period from 2008 to 2015, the total freight traffic has declined by 4.59% (169 billion tkm). Road is the mode of transport which dropped the most during these years (by 6.62%). Inland waterways and air transport slightly increased over the considered period.

Road registered 75.8% of the freight traffic in 2015, confirming this mode of transport as the major freight transport. Rail was the second freight transport with the highest presence in the EU-28 freight traffic (17.9%). During the period from 2008 to 2015, the shares of the different inland transport modes have not experienced significant changes.

Transportation of loads between 25.6-30.5 tonnes was the most common in the European road conveyance in the year 2015 (557,373 Mtkm). Road transport with capacity between 9.6-15.5 tonnes has reduced the most (-18%) during the period 2010-2015. During the same period the presence of freight traffic between 20.6-25.5 tonnes and above 30.5 tonnes has augmented (12.47% and 24.44% respectively). This might indicate a gradual trend to transportation of larger loads in the road transport.

As for the passenger cars, the fleet's age of the road goods transport is a factor affecting future energy consumption and emissions values. In 2015, over 50% of the vehicles fleet had 4 years or below in the EU-28. Vehicles of age below 2 years were the majority (19.28%). In comparison to the year 2010, the share of good transport of age below 2 years has increased by 8.75%. Overall, the fleet of vehicles up to 3 years of age have remained nearly the same (44.04% in 2010 vs 43.53% in 2015). Nevertheless, a general gradual aging of the fleet has been registered as vehicles up to 5 years old accounted for 67.13% in 2010, whereas accounted for 58.93% in 2015.



In 2015, Germany was the European country with the newest fleet of vehicles (less than 2 years and) dedicated to goods transport (42.6%). Also taking into consideration all goods transport vehicles up to 5 years old Germany was the State with the newest vehicles' fleet (79.95% of total vehicles); closely followed by Luxembourg (73.58%), France (67.44%) and the United Kingdom (66.92%) In the same year, Greece had the oldest fleet of goods transport vehicles with 63% of the vehicles older than 10 years.

Transportation and storage of goods was the main economic activity related to freight traffic in the EU-28 in 2015. On average, the second main economic activity was wholesale and retail trade and repair of motor vehicles and motorcycles, followed by freight transport related to manufacturing and, finally, from road freight transport related to construction.

The transport sector, including international aviation, was responsible of 23% of the CO<sub>2</sub> equivalent emissions in 2015. From 2000 to 2015 the CO<sub>2</sub> equivalent emissions have declined by 1.3% (12 MtCO<sub>2</sub>e). The maximum GHG emissions record took place in 2007 (988 MtCO<sub>2</sub>e), year which coincides with the maximum in the final energy consumption in the transport sector. From 2007 to 2013, a total reduction by 10.53% has been registered. In 2014 and 2015 greenhouse gas emissions started to increase up to 906 MtCO<sub>2</sub>e in 2015. However, the EU-28 GHG emissions have increased by 23% if compared to year 1990 (reference year for European GHG emissions targets). Overall, the greenhouse gas emissions in the transport sector have followed the trend of the energy consumption in the sector as per its direct causation.

Excluding international aviation and international maritime transport, from 2000 to 2015, the Member States with the highest reduction emissions rates were Portugal (-15.5%), Italy (-14.6%), Germany (-12%), Greece (-9.3%) and Finland (-8.4%). In contrast, the Member States with the highest increase of greenhouse gas emissions during the same period were Bulgaria (69.8%), Poland (67.7%), Lithuania (59.5%), Romania (58.7%) and Czech Republic (48.7%).

To be noted that Germany was the only State that registered a reduction of CO<sub>2</sub> emissions in the period from 2000 to 2007. On the contrary from 2007 to 2015, only six countries registered an increase in the emissions: Bulgaria (14.8%), Romania (14.6%), Malta (9.1%), Poland (8.1%), Germany (4.3%), and Slovenia (2.5%). The reduction rates in the period 2007-2015 might be the consequences of the impact produced by the financial and economic crisis in the sectors such as freight transportation.

From 1990 to 2015, the Member States with the highest reduction emissions rates have been Lithuania (-12.4%), Finland (-8.2%), and Estonia (-6.2%) while the highest increases have been registered in Czech Republic (143.7%), Ireland (130.3%), and Poland (127.5%).

Distinguishing by air pollutants and transport subsectors, road transport was the main contributor to CO (89%), NMVOC (63.9%) and NO<sub>x</sub> (56.4%) emissions in 2015. In the same year, international shipping was the main responsible for SO<sub>x</sub> emissions (89.8%), PM<sub>2.5</sub> (42.2%) and PM<sub>10</sub> (34.4%). Road transport would also be the main polluter of PM<sub>10</sub> and PM<sub>2.5</sub> if road transport non-exhaust emissions (28.2% and 16.2% respectively) from fuel evaporation, tyre and brake wear emissions, were accounted. NO<sub>x</sub> was the most emitted pollutant in railways, domestic shipping, international aviation, and domestic aviation.

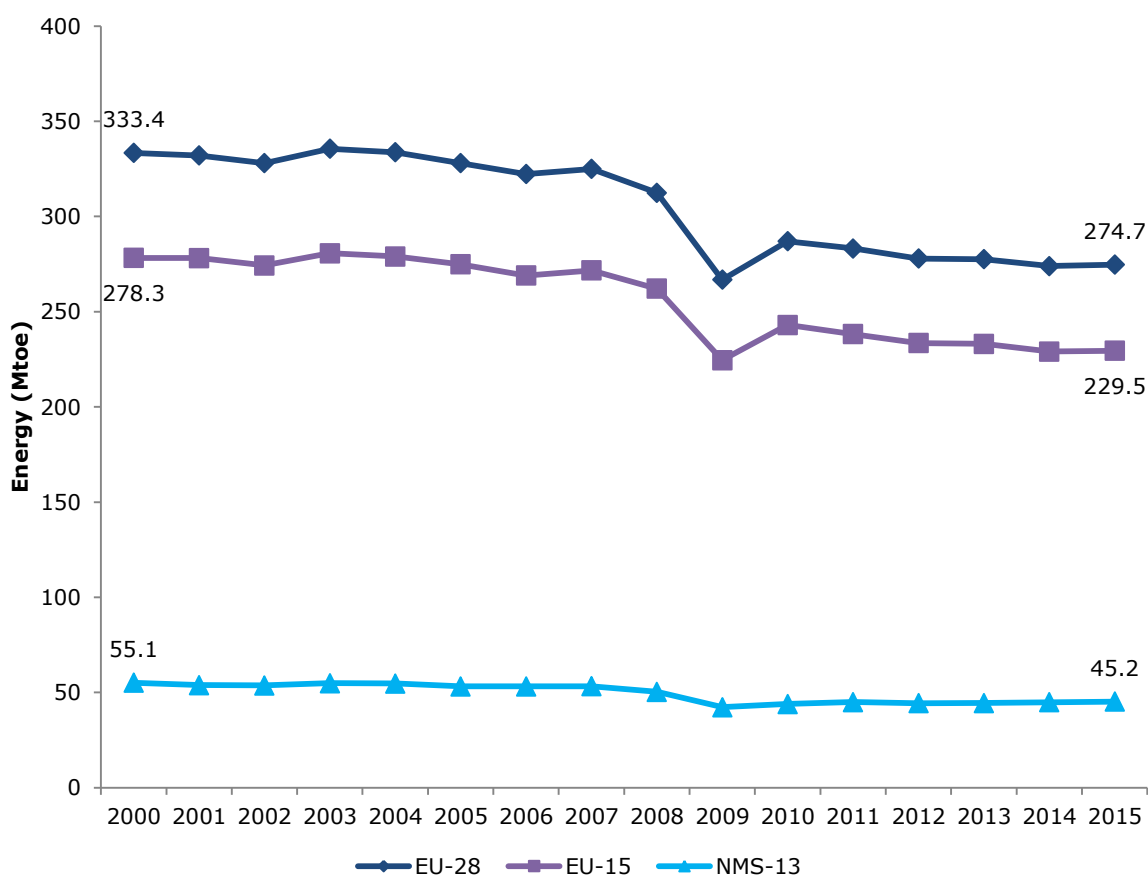
## 6 Energy Consumption and Energy Efficiency Trends in the Industry Sector

This chapter covers the energy consumption and the energy efficiency trends in the industry sector, which includes construction, mining and manufacturing industries.

### 6.1 Final energy consumption and energy mix of the industrial sector

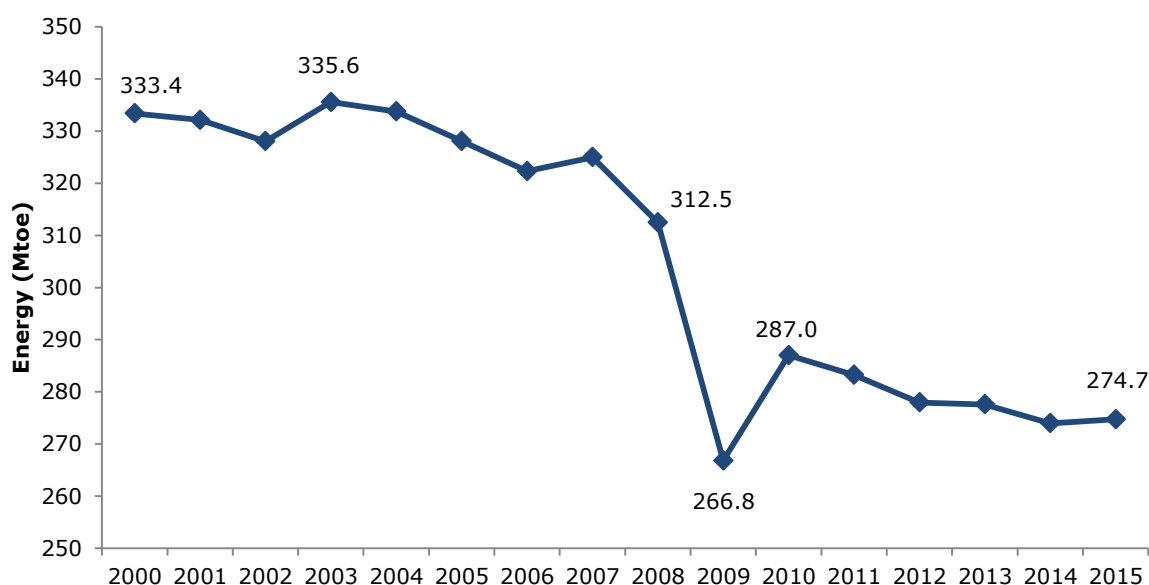
The industry sector accounted for 25.35% of the EU-28 total final energy consumption in the year 2015. This sets the industry sector at the second place after the transport sector (33.09%) in the ranking of the most energy consuming economy sectors. Industry final energy consumption in the EU-28 has fallen by 17.6% in the period 2000-2015. A similar decrease has been observed both in EU-15 and NMS-13 areas which have reduced their consumptions by 17.5% and 18% respectively. In 2015, industry final energy consumption reached 274.7 Mtoe, out of which 83.5% (229.5 Mtoe) was generated by EU-15 area. The maximum annual consumption of this period took place in the year 2003 when it reached 335.6 Mtoe, while the minimum occurred in 2009 when the final energy consumption decreased to 267 Mtoe, as illustrated in Figure 142. 2009 is the year with the lowest consumption not only during the analysed period but also considering the 26-years period comprised between 1990 and 2015. This has probably been due to the impact of the financial and economic crisis [54].

**Figure 142:** Industry sector: final energy consumption in the EU-28, 2000-2015



Source: Eurostat

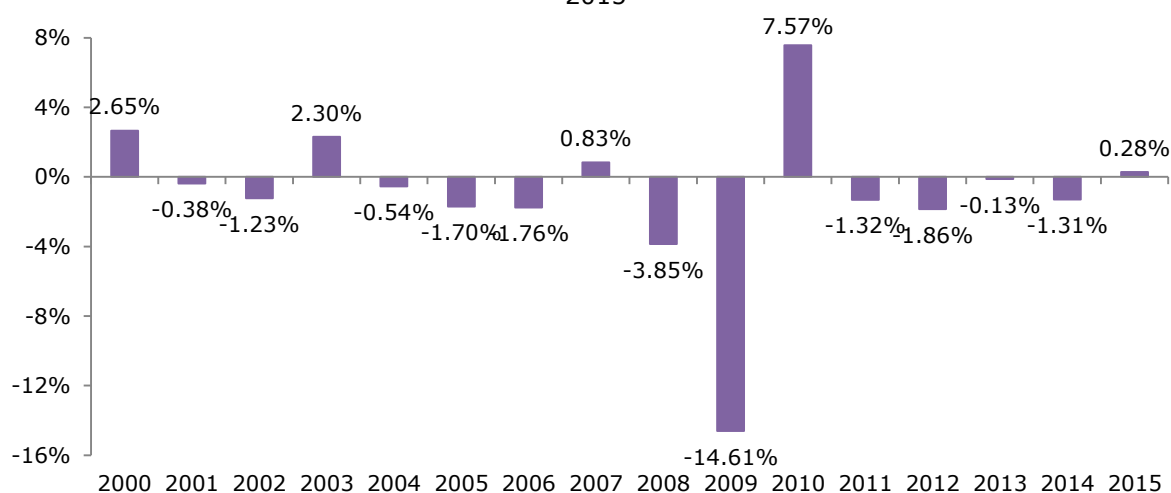
**Figure 143:** Industry sector: final energy consumption in the EU-28, 2000-2015 (detailed)



Source: Eurostat

A decreasing trend in the final energy consumption has been registered during the last 16-years period with the exception of year 2003 when a 2.3% rise occurred and the year 2010 when the consumption rebounded from the dramatic drop by 14.6% in year 2009 (Figure 146). Since 2010, the decreasing trend has been continued reaching in 2014 the second lowest value over the 1990-2015 period. In 2015 a slight increase (0.28%) has been registered but energy consumption in industry in EU is expected to keep a decreasing trend in the future due to the ongoing industry reallocation to countries where the cost of inputs is lower. This could lead to a permanently smaller manufacturing sector and to a larger services sector.

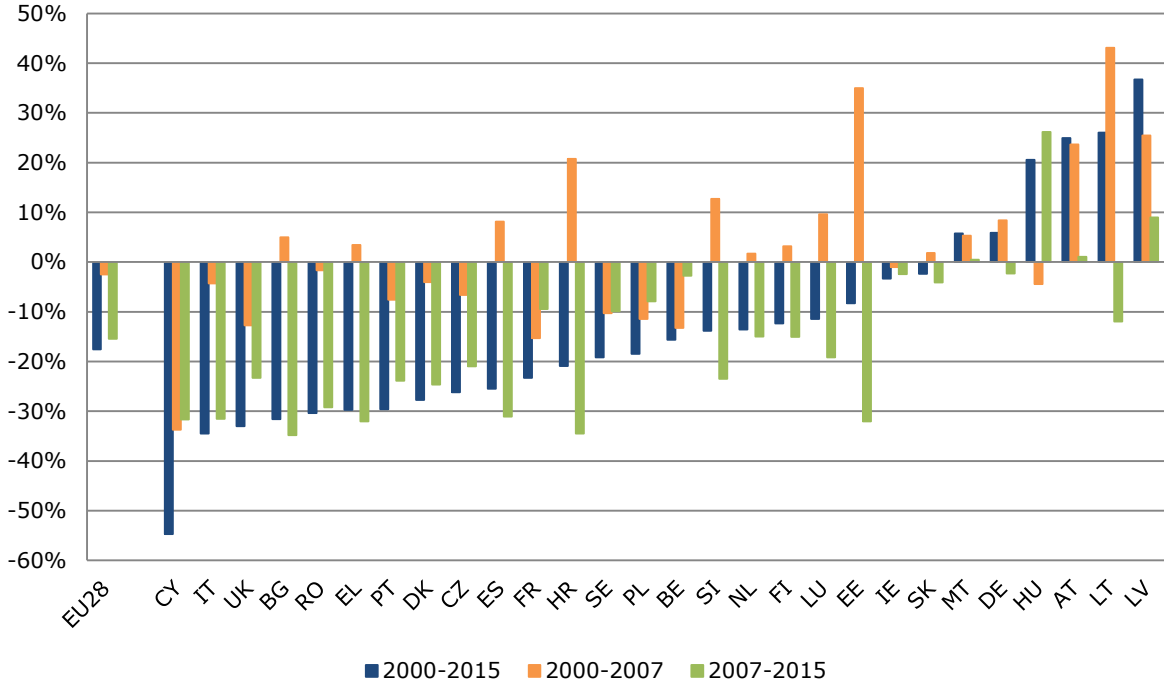
**Figure 144:** Industry sector: final energy consumption annual growth rates in the EU-28, 2000-2015



Source: Eurostat

By looking at the final energy consumption growth rates across the EU-28 Member States, it can be observed that only six MSs have registered a positive growth rate from 2000 to 2015. These are: Latvia, Lithuania, Austria, Hungary, Germany and Malta. The highest growth rate has been observed in Latvia (36.75%), Lithuania (26%) and Austria (24.91%). Fourteen EU-28 MSs have consumption growth rates below the EU-28 average (-17.59%). The impact of the crisis on the industry manufacturing and production rates is evident. Only four Member States have increased their consumption in the period 2007-2015. However, the existence of negative growth rates before 2007 indicates that there are probably other factors for the observed trends besides the economic crisis. The lowest growth rates over the period 2000-2015 have been observed in Cyprus (-54.73%), followed by Italy (-34.51%) and United Kingdom (-33.03%).

**Figure 145:** Industry sector: final energy consumption growth rates in the EU-28 Member States; 2000-2015, 2000-2007 and 2007-2015



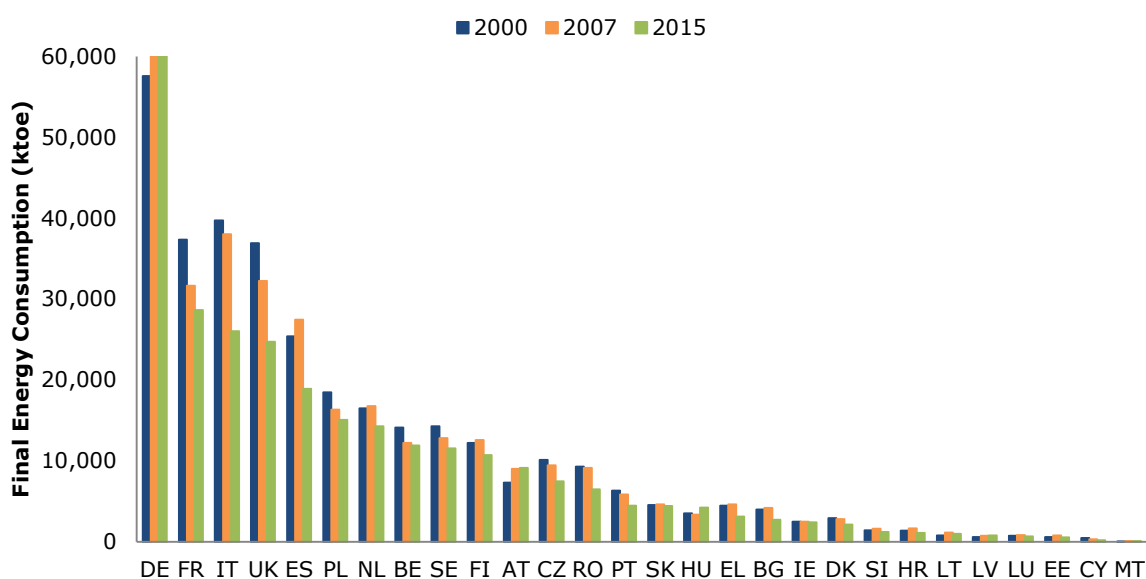
Source: Eurostat

In 2015, the Member State with the highest consumption in the industry sector was Germany (60.95 Mtoe), followed by France (28.64 Mtoe) and Italy (26.02 Mtoe). In 2000 and 2007, German industry was already the first energy consumer, followed by Italy and France which swapped their ranking positions in 2015.

Four Member States consumed more than 50% of the total final energy consumption in the industry sector in Europe. These are: Germany, France, Italy and the United Kingdom. Half of the EU-28 Member States (14 countries) generated less than 10% of EU-28 industry final energy consumption in 2015 (**Figure 148**).

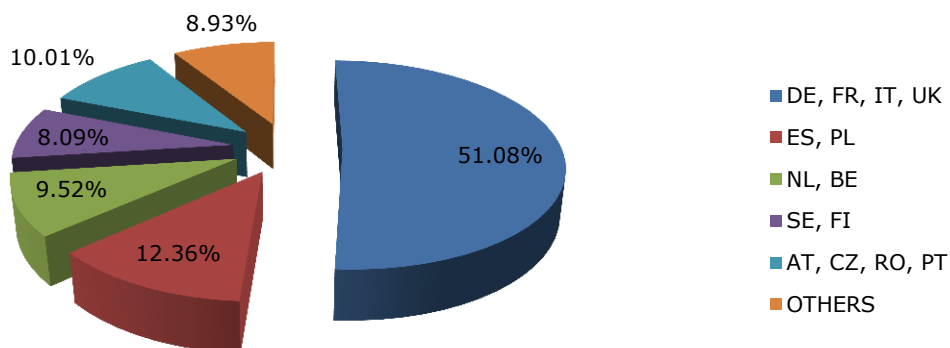
The European global energy consumption trend in the industry sector is therefore highly influenced by the consumption of a limited number of countries.

**Figure 146:** Final energy consumption in the industry sector in the EU-28 Member States, 2000,



Source: Eurostat

**Figure 147:** Share of EU-28 Member States final energy consumption in the industry sector (2015)



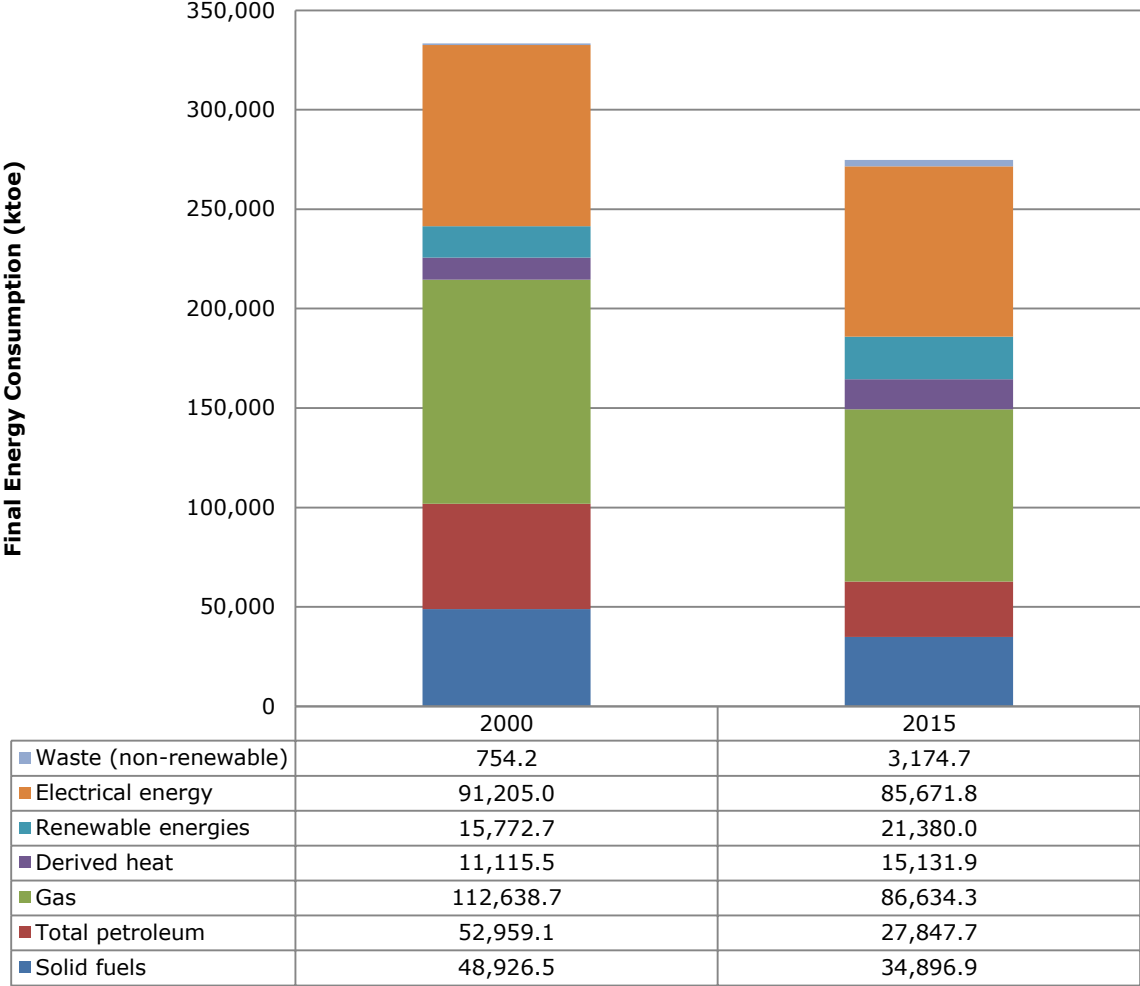
Source: Eurostat

In 2015, gas and electricity were the main contributors to the energy mix in the industry sector with 86.6 Mtoe and 85.7 Mtoe respectively. These fuels represented over 60% of the energy mix; gas accounted for 31.53% and electricity for 31.18% of the total consumption. The rest of the energy mix was constituted by solid fuels (12.70%), petroleum products (10.14%), renewable energies (7.78%), derived heat (5.51%) and non-renewable waste (1.16%).

While the ranking of the energy fuels contribution did not change compared to the year 2000, there are several differences to be noted. The usage of petroleum products has been reduced by 47.4% (above 25 Mtoe). Non-renewable waste, renewable energies and derived heat have enlarged their contributions in absolute value. On the other hand, petroleum products, electrical energy, gas and solid fuels have reduced the absolute

value of their contributions as illustrated in **Figure 150**. Overall, electricity, renewable energy sources<sup>67</sup>, derived heat and waste have grown in percentage, whilst the share of solid fuels, gas and petroleum products has decreased.

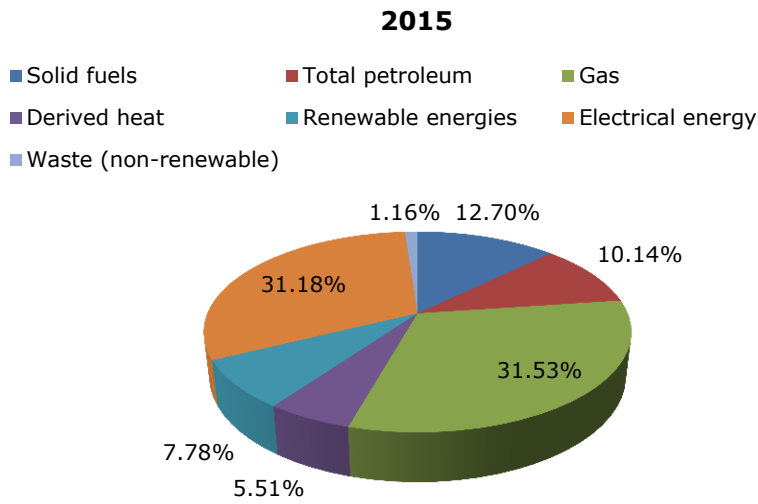
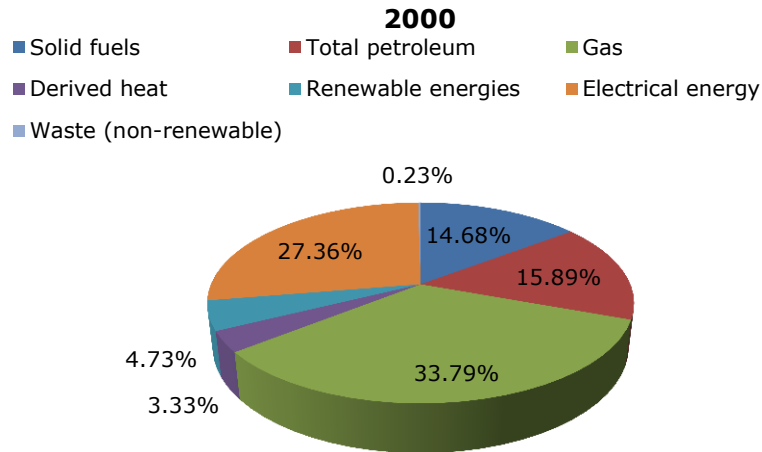
**Figure 148:** Industry sector: final energy mix, 2000 and 2015



Source: Eurostat

<sup>67</sup> Renewable energy sources other than Hydro power, Wind power, Tide, Wave and Ocean and Solar photovoltaic. These sources are accounted under the contribution generated by electricity consumption.

**Figure 149:** Industry sector: final energy mix by percentage, 2000 and 2015

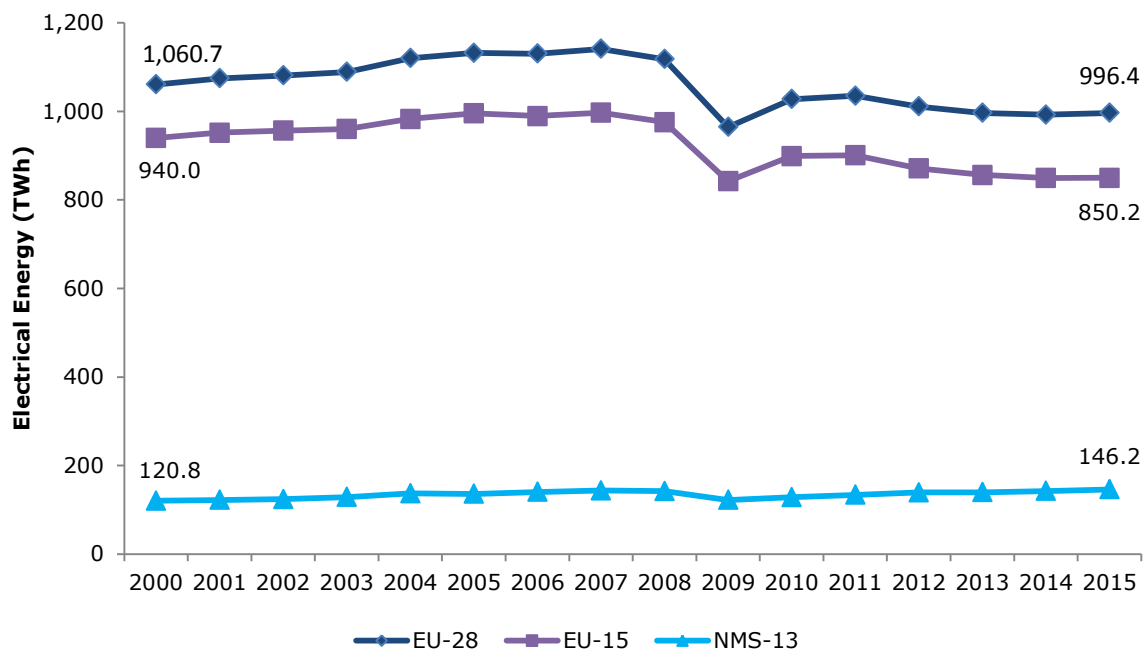


Source: Eurostat

## 6.2 Electricity consumption trend in the industry sector

The industry sector consumed 36.35% of the final electricity consumption of the EU-28 in 2015, this confirming industry as the main electricity consumer sector in Europe (see **Figure 23**).

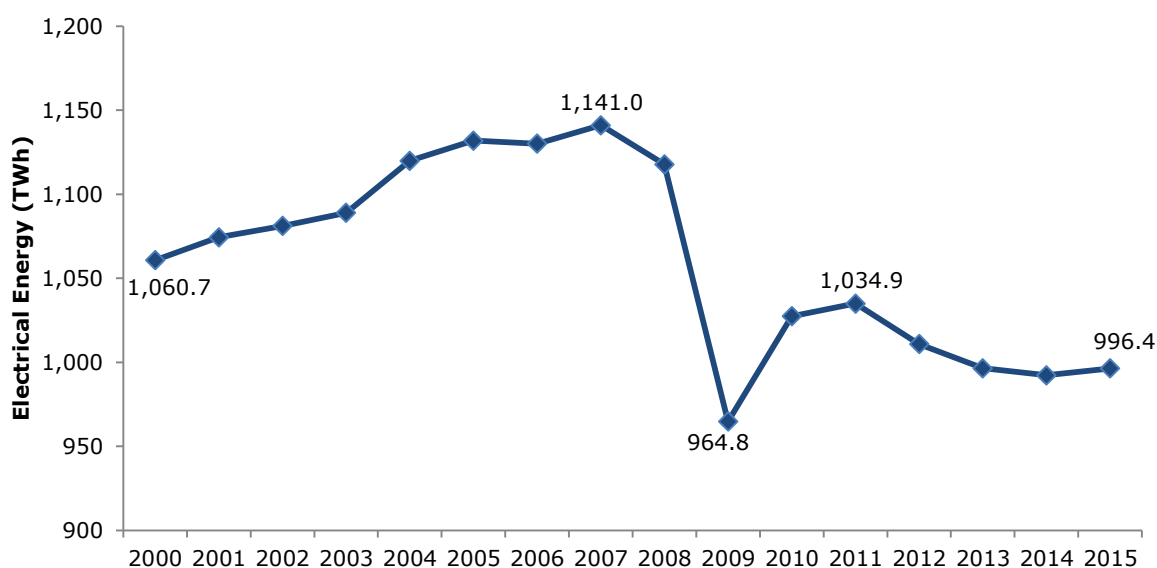
**Figure 150:** Industry sector: final electricity consumption in the EU-28, 2000-2015



Source: Eurostat

The final industrial electricity consumption in the EU-28 has fallen by 6.1% in the 16-years period from 2000 to 2015. This decrease has been caused by the overall trend registered in the EU-15 area (-9.6%). In contrast, the total electricity consumption of NMS-13 area has increased by 21%. In 2015, the final electricity consumption amounted to 996.4 TWh, out of which 85.3% (850.2 TWh) was generated in EU-15 area. The maximum consumption over the period considered took place in the year 2007 (1,141 TWh) which set the maximum also for the 26-years period from 1990 to 2015. The minimum value in the period 2000-2015 occurred in 2009 when the final electricity dropped to 964.8 TWh.

**Figure 151:** Industry sector: final industrial electricity consumption in the EU-28, 2000-2015 (detailed)



Source: Eurostat



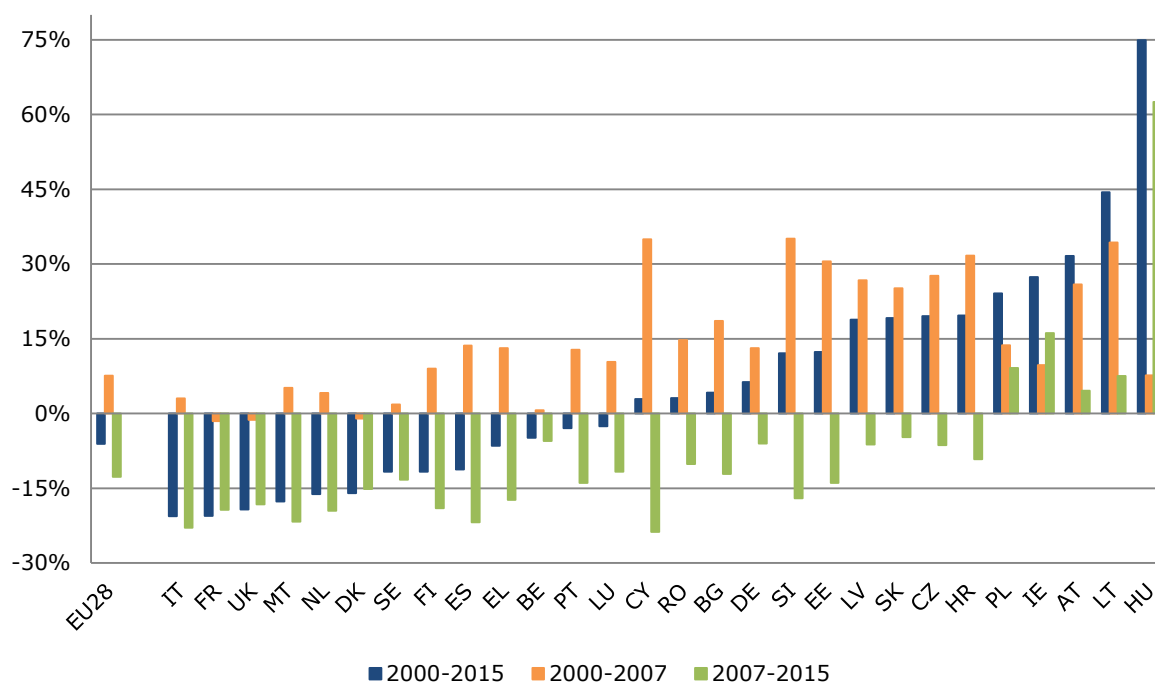
A continuous growth in the industry final electricity consumption can be substantially observed until 2007 except for the minor reduction registered in the year 2006 (-0.17% in comparison to the previous year). During years 2008 and 2009 the industry sector reduced its final electricity consumption (and its total final energy consumption) mainly for the impact of the financial and economic crisis on the sector's activity. The two following years (2010 and 2011) reported an increase in the consumption in comparison to the previous years (by 6.5% and 0.7% respectively). Since 2011 a decreasing trend has been registered, although the negative annual growth rate was smaller year after year and the annual electricity consumption registered a positive growth rate in 2015 as shown in **Figure 149**.

**Figure 152:** Industry sector: annual final electricity consumption growth rates, 2000-2015



Source: Eurostat

**Figure 153:** Industry sector: annual final electricity consumption growth rates (%) in the EU-28 ;



Source: Eurostat

Analysing the growth rates in the final electricity consumption in the EU-28 Member States, it can be observed that the countries with the highest growth rates in the period between 2000 and 2015 were Hungary (74.91%), Lithuania (44.42%) and Austria (31.64%). In the same period, the Member States with the lowest growth rates were Italy (-20.57%), France (-20.52%) and the United Kingdom (-19.27%). Only nine Member States have registered a growth rate lower than the EU-28 average growth rate (-6.7%) during the mentioned 16-years period. In the period from 2000 to 2007, only three states underwent a negative growth rate. In the period 2007-2015 the influence of the economic crisis has instead led most of the Member States (23 countries) to register a negative growth rate. The five Member States with a positive growth rate in that period were: Hungary (62.5%), Ireland (16.11%), Poland (9.11%), Lithuania (7.53%), and Austria (4.58%).

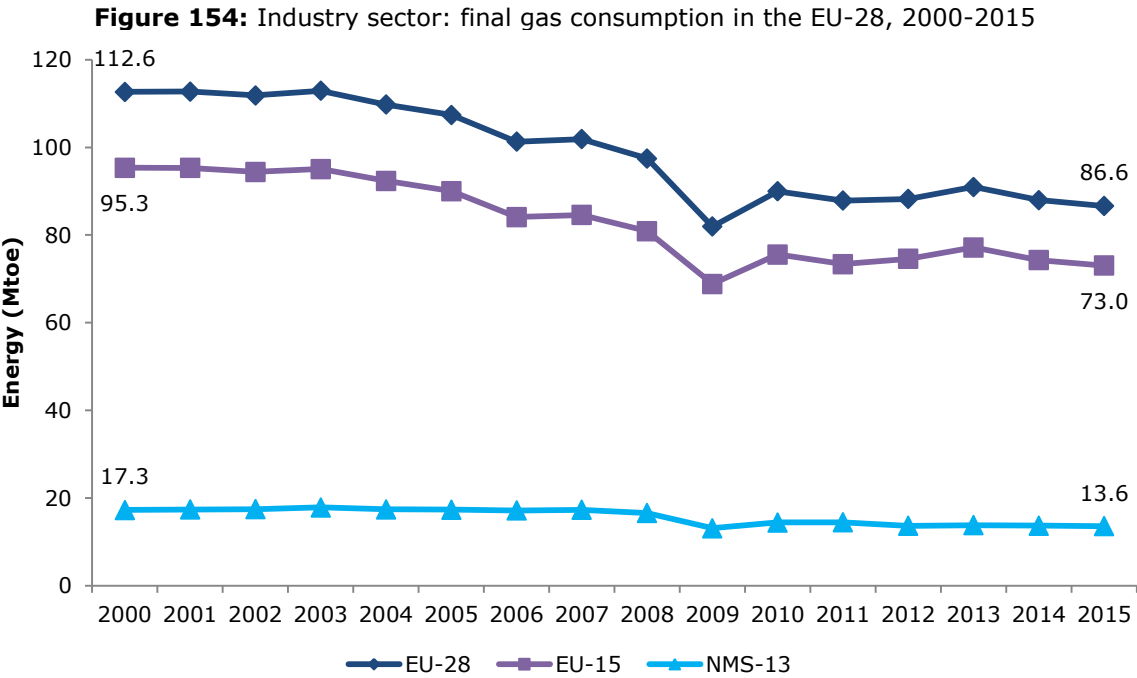
### 6.3 Gas consumption trend in the industry sector

The industry sector consumed 36.67% of the final gas consumption of the EU-28 in 2015, representing the second gas consumer after the residential sector (41.24%), see Figure 26.

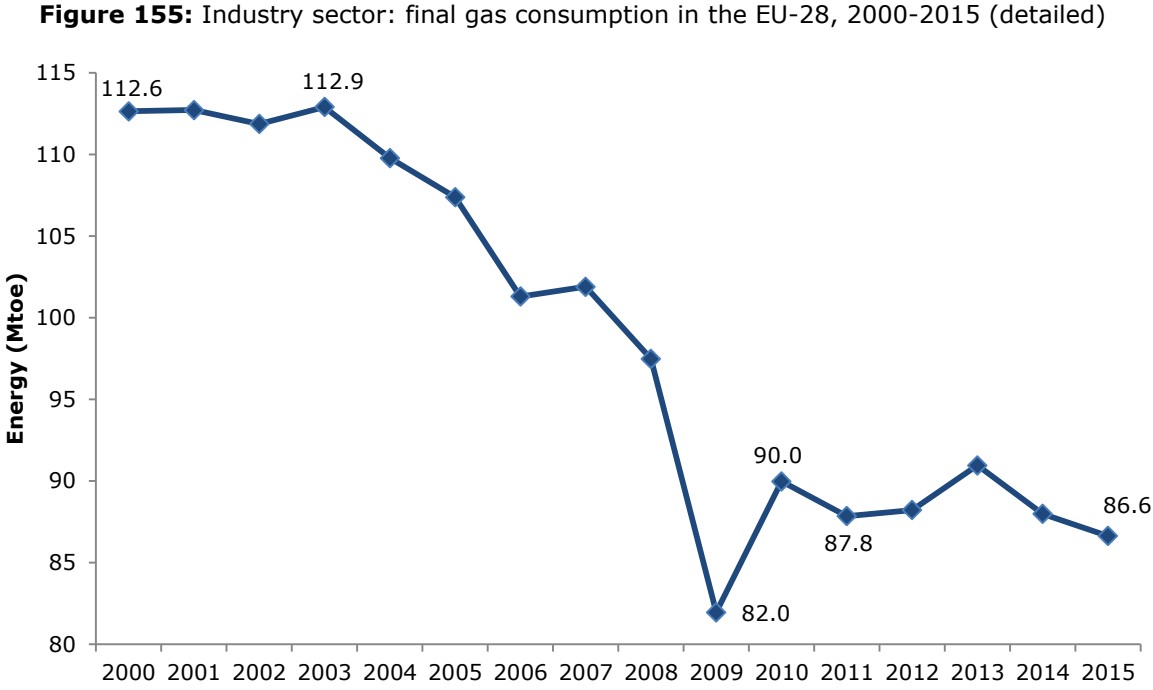
When focusing on the industrial sector energy mix, gas accounted for 31.53% of the total final energy consumption in 2015, confirming as the main final energy type consumed in the industry sector.

Industry final gas consumption has fallen by 23.1% in the EU-28 during the period from 2000 to 2015. A similar decrease has been registered both in the EU-15 and NMS-13 areas which have declined their consumptions by 23.4% and 21.4% respectively. In 2015, the final total gas consumption amounted to 86.6 Mtoe, out of which 84.3% (73 Mtoe) was generated in EU-15 area. The maximum consumption over the analysed period took place in the year 2003 (112.9 Mtoe). The minimum value in the period 2000-

2015 occurred in 2009 when the final gas consumption dropped to 82 Mtoe as illustrated in **Figure 156**. Since 2009, the European Union has been registering the lowest values of industry final gas consumption for the 26-years period between 1990 and 2015.



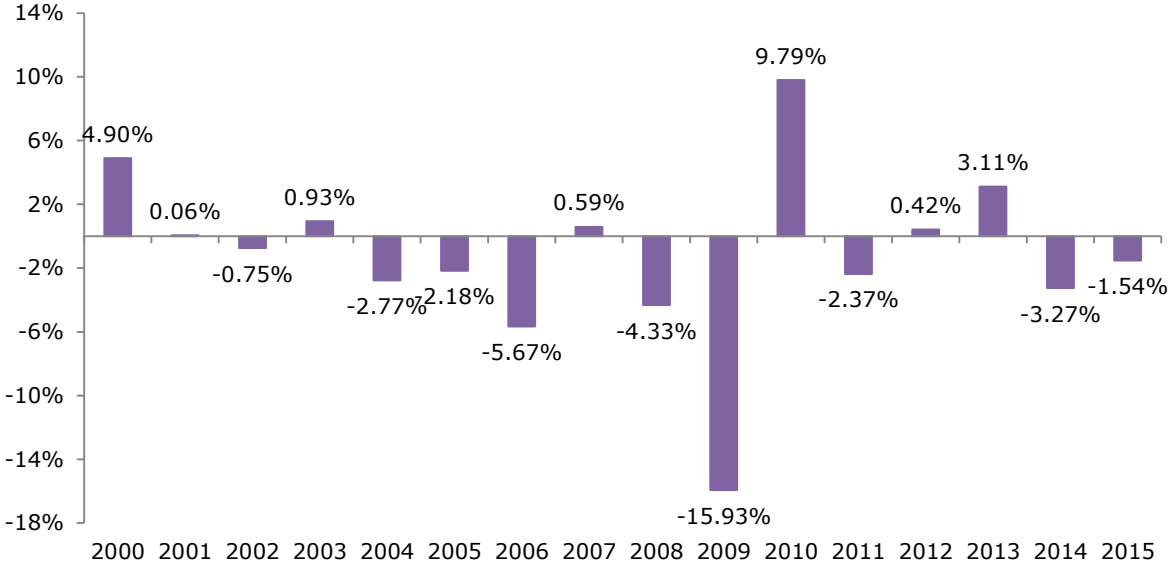
Source: Eurostat



Source: Eurostat

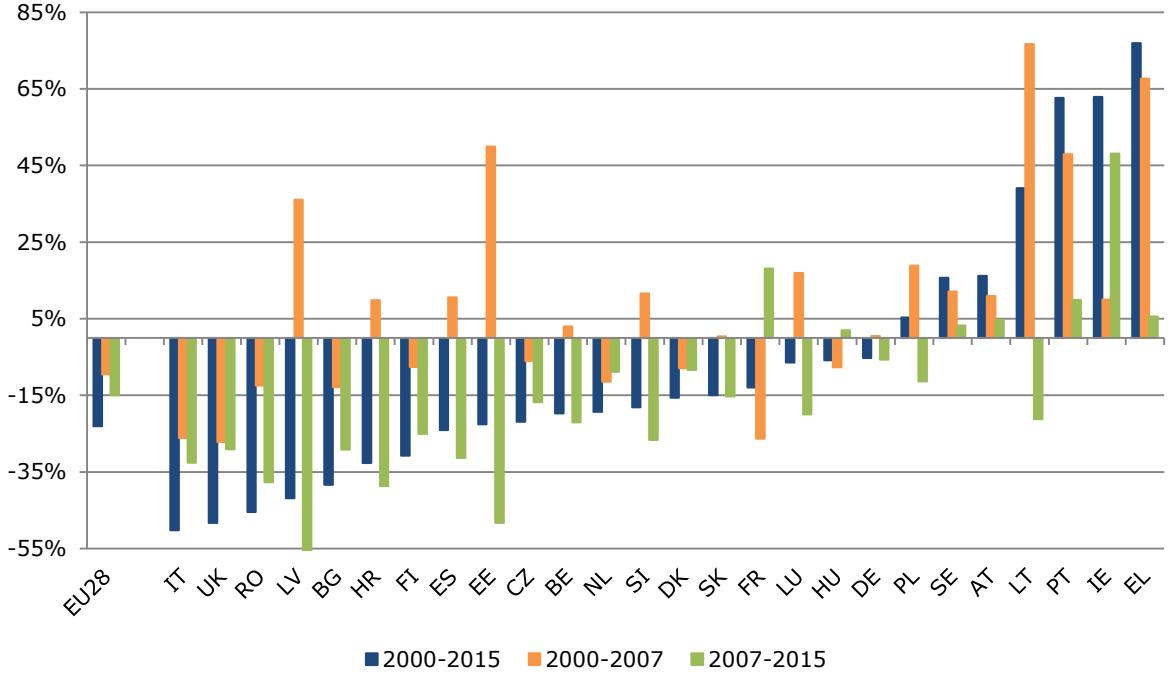
It can be observed that an overall decreasing trend has been followed during the whole analysed period. Until 2009 the growth rates are constantly negative with the exception of years 2003 and 2007 when rises by less than 1% occurred in comparison to the previous years. In 2009 (when the minimum value over the period 1990-2015 was registered) a drop by 15.93% has been observed in comparison to year 2008. From 2010 to 2015, the values have been fluctuating within a range between 86.6-91 Mtoe. In 2015, there was a fall by 1.54% in comparison to year 2014. The gas consumption in this year represents the second lowest consumption value over the period 1990-2015.

**Figure 156:** Industry sector: annual final gas consumption growth rates, 2000-2015



Source: Eurostat

**Figure 157:** Industry sector: final gas consumption growth rates in the EU-28; 2000-2015, 2000-2007 and 2007-2015



Source: Eurostat

From 2000 to 2015, the industry final gas consumption has dropped by 23.09% in the EU-28. Eight Member States have registered a decrease rate below the average European decrease rate (23.09%). The Member States with the highest growth rates are Greece (76.95%), Ireland (62.91%) and Portugal (62.67%). On the other hand, the EU-28 countries with the lowest growth rates are: Italy (-50.26%), the United Kingdom (-48.36%), and Romania (-45.45).

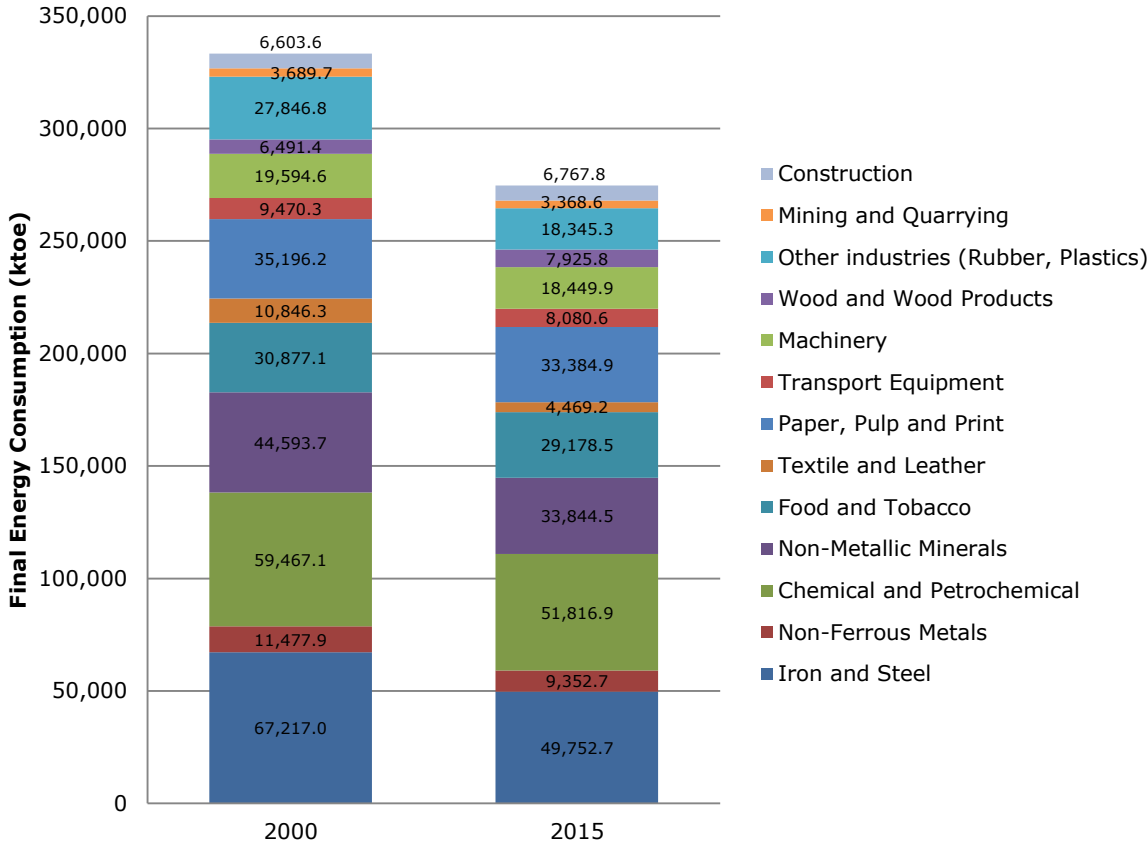
Across the EU-28 MSs, decreasing trends have been registered by 19 countries in the period 2007-2015. The countries with lowest growth rates over this period are: Latvia (-57.28%), Estonia (-48.36%) and Croatia (-38.70%).

### 6.4 Industry subsectors

In this section, the final energy consumption in the industry sector is broken-down into different industry subsectors. The industry subsectors can be mainly divided into Construction, Mining and Quarrying and Manufacturing. Manufacturing, in turn, can be split into eleven subsectors: Iron and Steel; Non-Ferrous Metals; Chemical and petrochemical; Non-Metallic Minerals; Food and Tobacco; Textile and Leather; Paper, Pulp and Print; Transport Equipment; Machinery; Wood and Wood Products; and Other Industries<sup>68</sup>.

The industry final energy consumption per subsector is reported in **Figure 160** and **Figure 161**.

**Figure 158:** Industry sector: final energy consumption by subsectors, 2000 and 2015



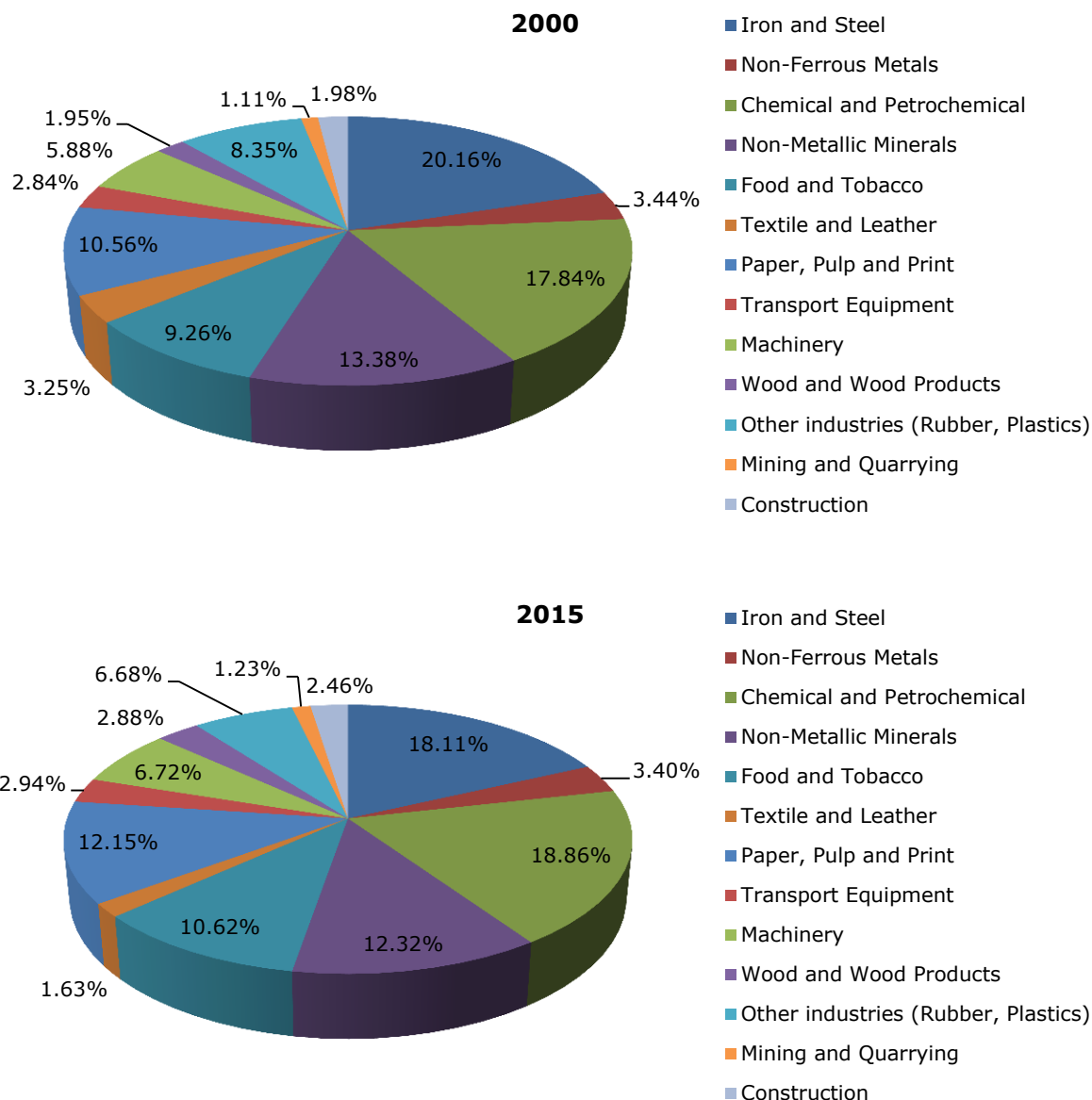
Source: Eurostat

<sup>68</sup> Energy consumption data regarding industry subsectors are provided by Eurostat.

In 2015, the industry subsector with the highest energy consumption was the Chemical and Petrochemical subsector which accounted for 18.86% (51,816.9 ktoe) of the total final industrial energy consumption, followed by Iron and Steel (18.11%; 49,752.7 ktoe) and Non-metallic Minerals (12.32%; 33,844.5 ktoe). The layout is completed by Paper, Pulp and Print (12.15%; 33,384.9 ktoe), Food and Tobacco (10.62%; 29,178.5 ktoe), Machinery (6.72%; 18,449.9 ktoe), Other Industries such as rubber and plastics (6.68%; 18,345.3 ktoe), Non-Ferrous Metals (3.40%; 9,352.7 ktoe), Transport Equipment (2.94%; 8,080.6 ktoe), Wood and Wood Products (2.88%; 7,925.8 ktoe), Construction (2.46%; 6,767.8 ktoe), Textile and Leather (1.63%; 4,469.2 ktoe) and Mining and Quarrying (1.23%; 3,368.6 ktoe).

In 2000, the most energy consuming subsector was iron and steel (20.16%), followed by chemical and petrochemical (17.84%). The rest of the industry subsectors have kept their ranking positions with regard to their final energy consumption with the exception of four subsectors, from the ninth to the twelfth position, which have swapped their ranks. In 2000 the ranking of these subsectors was: Textile and Leather, Transport Equipment, Construction, and Wood and Wood Products. In 2015 the ranking among these same four subsectors was: Transport Equipment, Wood and Wood Products, Construction, Textile and Leather.

**Figure 159:** Industry sector: final energy consumption percentage by subsectors, 2000 and 2015



Source: Eurostat

Table 9 provides an overview of the variations in the final energy consumption in the different energy subsectors between years 2000 and 2015. Absolute values of the final energy consumption and associated shares are presented for both years. Among the three main industry subsectors (i.e. Manufacturing, Mining and Quarrying, and Construction), manufacturing has registered the highest final energy consumption drop (by 18.10%). The Mining and Quarrying subsector has also undergone a fall by 8.7% in the period 2000-2015. In contrast, construction has increased its demand of final energy by 2.49%. Among the manufacturing subsectors, the only positive growth rate is found in Wood and Wood Products (by 22.10%). The rest of the manufacturing subsectors has registered negative growth rates. The lowest growth rates have been observed in Textile and Leather (-58.80%), Other Industries (-34.12%) and Iron and Steel (-25.98%).

**Table 9:** Growth rates and energy consumption shares in industry subsectors, 2000 and 2015

	Final Energy (ktoe)		Growth Rate (%)	Share in %		Change of shares
	2000	2015	2000-2015	2000	2015	2000-2015
<b>Manufacturing</b>	323,078	264,601	-18.10%	96.91%	96.31%	-0.60%
Iron and Steel	67,217.0	49,752.7	-25.98%	20.16%	18.11%	-2.05%
Non-Ferrous Metals	11,477.9	9,352.7	-18.52%	3.44%	3.40%	-0.04%
Chemical and Petrochemical	59,467.1	51,816.9	-12.86%	17.84%	18.86%	1.02%
Non-Metallic Minerals	44,593.7	33,844.5	-24.10%	13.38%	12.32%	-1.06%
Food and Tobacco	30,877.1	29,178.5	-5.50%	9.26%	10.62%	1.36%
Textile and Leather	10,846.3	4,469.2	-58.80%	3.25%	1.63%	-1.63%
Paper, Pulp and Print	35,196.2	33,384.9	-5.15%	10.56%	12.15%	1.59%
Transport Equipment	9,470.3	8,080.6	-14.67%	2.84%	2.94%	0.10%
Machinery	19,594.6	18,449.9	-5.84%	5.88%	6.72%	0.84%
Wood and Wood Products	6,491.4	7,925.8	22.10%	1.95%	2.88%	0.94%
Other industries (Rubber, Plastics)	27,846.8	18,345.3	-34.12%	8.35%	6.68%	-1.68%
<b>Mining and Quarrying</b>	3,689.7	3,368.6	-8.70%	1.11%	1.23%	0.12%
<b>Construction</b>	6,603.6	6,767.8	2.49%	1.98%	2.46%	0.48%
<b>Industry Total</b>	<b>333,372</b>	<b>274,737.40</b>	<b>-17.59%</b>			

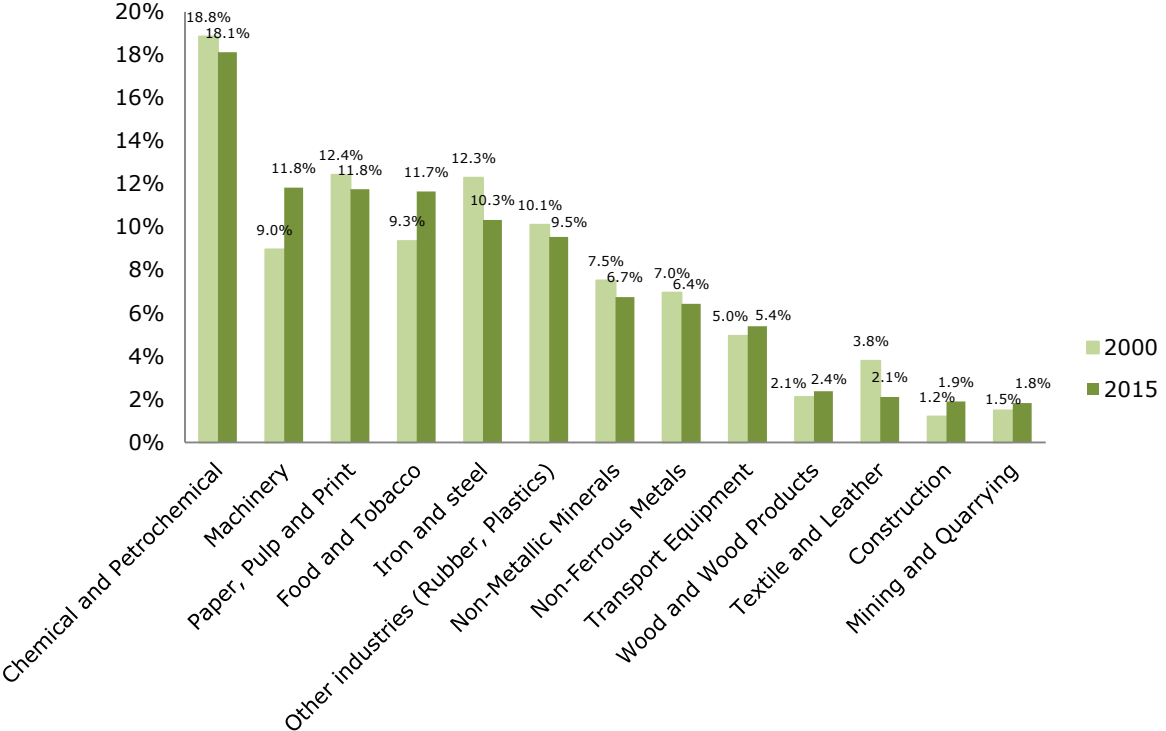
Source: Eurostat



**Figure 162** and **Figure 163** analyse electricity and gas consumptions in the different industry subsectors. Chemical and Petrochemical registered the highest electricity consumption in 2015 with a consumption of 180.5 TWh accounting for 18.1% of the industry final electricity consumption. It was followed by Machinery (117.9 TWh; 11.8%), Paper, Pulp and Print (117.1 TWh; 11.8), and Food and Tobacco (116.1 TWh; 11.7%). In 2000, Chemical and Petrochemical was the main electricity consumer (199.9 TWh), followed by Paper, Pulp and Print (131.8 TWh), and Iron and Steel (130.4 TWh).

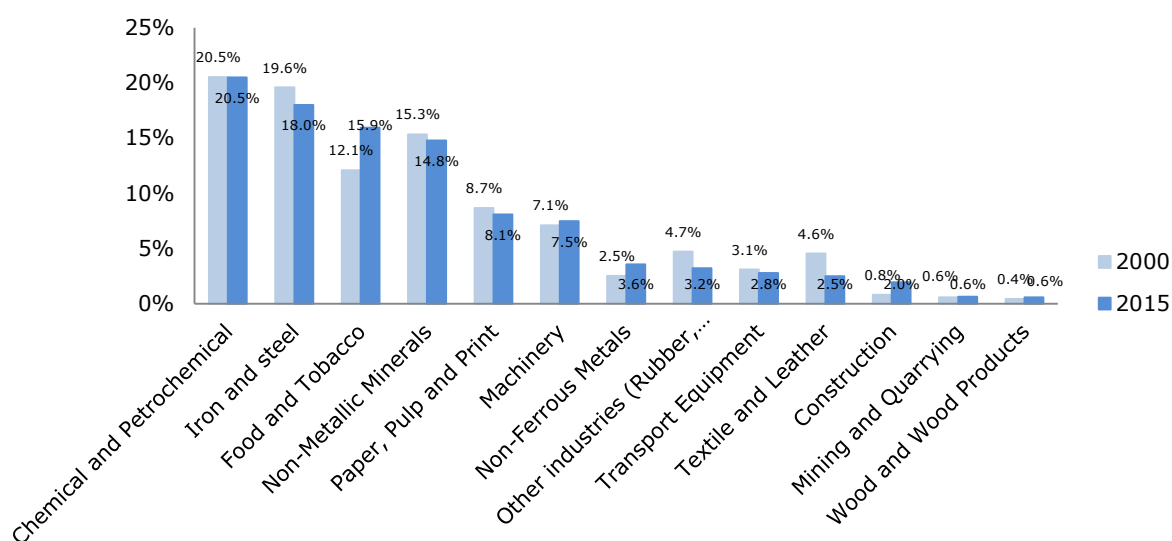
In 2015, the Chemical and Petrochemical manufacturing subsector was the main gas consumer with 20.5% (17,762.7 ktoe) of the share over the total final gas consumption. Iron and Steel was the second gas consuming subsector (18.01%; 15,606.1 ktoe) followed by Food and Tobacco (15.94%; 13,610.9 ktoe), and Non-Metallic Minerals (14.80%; 12,820 ktoe).

**Figure 160:** Industry sector: share of electricity consumption by industry subsectors, 2000 and 2015



Source: Eurostat

**Figure 161:** Industry sector: share of gas consumption by industry subsectors, 2000 and 2015



Source: Eurostat

Table 10 provides an overview of the changes between years 2000 and 2015 regarding the final electricity and gas consumption in the different energy subsectors. Absolute values of final gas and electricity consumption are also presented for both years.

Manufacturing, among the three main subsectors, is the one which has registered the lowest electricity consumption growth rate (-7.06%) and the lowest gas consumption growth rate (-24.03%) over the period 2000-2015. Among the manufacturing subsectors, Textile and Leather has registered the lowest growth rates for electricity and gas (-47.81% and -58.06% respectively). To be noted the increase by 82.90% in the gas consumption in the Construction subsector during the period 2000-2015.

**Table 10:** Growth rates of final electricity and gas consumptions in industry subsectors, 2000 and 2015

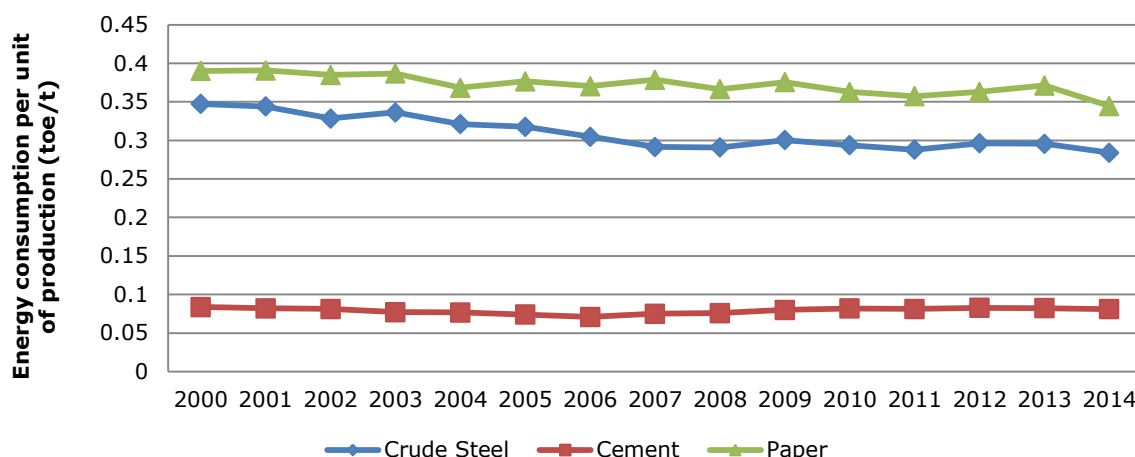
	Final Electricity (GWh)		Growth Rate (%)	Final Gas (ktoe)		Growth Rate (%)
	2000	2015	2000-2015	2000	2015	2000-2015
<b>Manufacturing</b>	1,032,149.7	959,238.9	-7.06%	111,079.1	84,391.2	-24.03%
Iron and Steel	130,373.5	102,853.4	-21.11%	22,059.1	15,606.1	-29.25%
Non-Ferrous Metals	73,814.4	64,059.2	-13.22%	2,827.4	3,087.6	9.20%
Chemical and Petrochemical	199,880.2	180,508.1	-9.69%	23,106.0	17,762.7	-23.13%

Non-Metallic Minerals (Cement, Glass)	79,808.5	67,186.5	- 15.82%	17,288.8	12,820.0	- 25.85%
Food and Tobacco	99,119.0	116,082.5	17.11%	13,610.9	13,810.3	1.47%
Textile and Leather	40,157.2	20,958.4	- 47.81%	5,125.5	2,149.8	- 58.06%
Paper, Pulp and Print	131,759.8	117,122.2	- 11.11%	9,776.2	7,003.3	- 28.36%
Transport Equipment	52,552.5	53,730.6	2.24%	3,479.0	2,407.1	- 30.81%
Machinery	95,007.8	117,917.7	24.11%	7,999.3	6,467.2	- 19.15%
Wood and Wood Products	22,397.1	23,674.0	5.70%	477.2	493.5	3.42%
Other Industries (Rubber, Plastics)	107,279.8	95,146.2	- 11.31%	5,329.7	2,783.6	- 47.77%
<b>Mining and Quarrying</b>	15,777.3	18,168.4	15.16%	634.8	551.4	- 13.14%
<b>Construction</b>	12,787.2	18,956.9	48.25%	924.9	1,691.6	82.90%
<b>Industry Total</b>	<b>1,060,714.2</b>	<b>996,364.2</b>	<b>- 6.07%</b>	<b>112,638.8</b>	<b>86,634.2</b>	<b>- 23.09%</b>

Source: Eurostat

An interesting indicator used as benchmark for the analysis of the energy efficiency levels in the manufacturing industry is the average energy consumption per unit of production. This ratio is shown for three main industrial products in EU-28: steel, cement and paper. Overall, this parameter shows stable values over the period 2000-2014. In 2014, the amount of energy consumed in order to produce a ton of paper was 0.3446 toe/t, representing a drop by 11.66% in comparison to year 2000. Among the three analysed products paper showed the highest ratio over the whole period, as illustrated in **Figure 164**. In 2014, the production of one tonne of crude steel consumed 0.2830 toe/t on average in EU-28. Crude steel is the product which has reduced its energy consumption per unit of production the most (by -18.28%). Cement has instead increased its ratio of energy consumed per unit of production by 3.23% during the analysed period, reaching 0.081 toe/t in 2014.

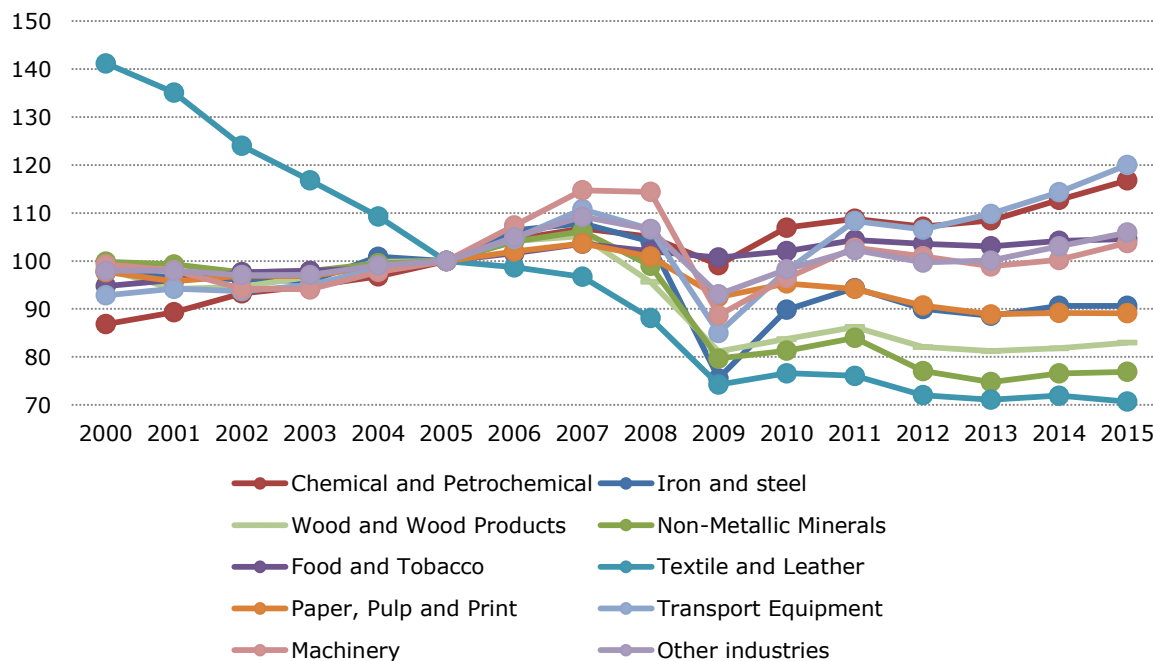
**Figure 164:** Average energy consumption per tonne of produced crude steel, cement and paper in EU-28, 2000-2014



Source: Odyssee

Industrial Production Indexes<sup>69</sup> (IPIs) allow measuring changes in the industry's output, as shown in **Figure 165**. This figure shows the value of this economic indicator for the different analysed manufacturing subsectors. It is observed that the most notable variations in the IPIs occurred after the financial crisis. All the manufacturing subsectors experienced a significant drop in their productions in 2009. Noticeably, the IPI of Textile and Leather has been continuously decreasing since 2000 and has accumulated a 50% drop till 2015. The most stable manufacturing subsector is Food and Tobacco.

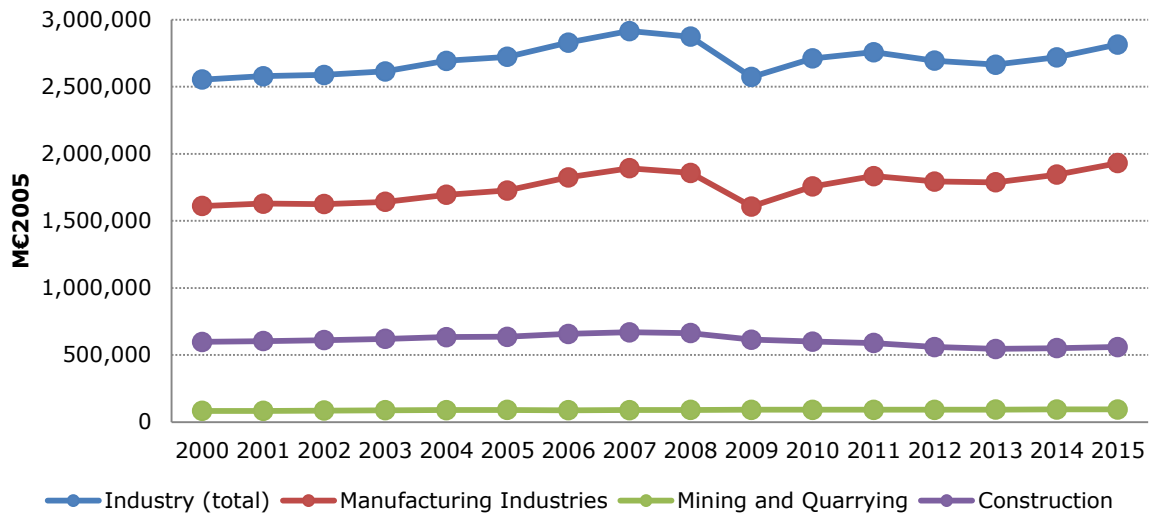
**Figure 162:** Industrial Production Indices of Manufacturing Industries (2005=100%), 2000-2015



Source: Odyssee

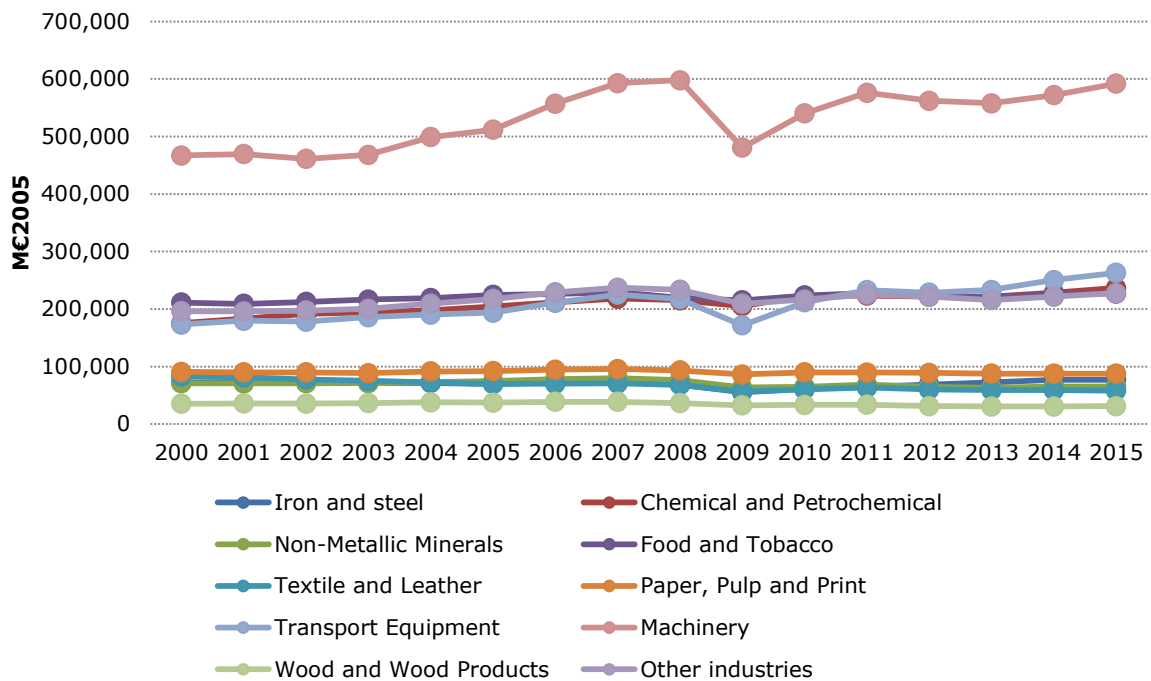
<sup>69</sup> The [industrial production index](#) (abbreviated IPI and sometimes also called industrial output index or industrial volume index) is a [business cycle](#) indicator which measures monthly changes in the price-adjusted output of industry.

**Figure 163:** Added value<sup>70</sup> per industrial subsector in the EU-28, 2000-2015<sup>71</sup>



Source: Odyssee

**Figure 164:** Added value per manufacturing subsector in the EU-28, 2000-2015



Source: Odyssee

The industry sector added value to GDP has risen by 10.2% in the period 2000-2015. Among the industry subsectors, Manufacturing and Mining and Quarrying industries have increased their added value by 19.81% and 13.67% respectively, while Construction has decreased its contribution by 6.32% in the previously mentioned time period. Within

<sup>70</sup> The contribution of industry sector or industry subsector to overall [Gross Domestic Product](#) (GDP).

<sup>71</sup> Total industry includes also energy industries.

manufacturing industries the highest growth rates in the value added are found in Transport Equipment (51.82%), Chemical and Petrochemical (34.76%), and Machinery (26.8%). On the other hand, the manufacturing industries with the lowest growth rates are Textile and Leather (-29.86%) and Wood and Wood Products (-11.81%). Machinery subsector is the largest contributor to the GDP added value among the manufacturing industries, its contribution (592,044 M€) is more than double than the second ranked industry subsector (Transport Equipment) which contributes with 262,976 M€.

Table 11 provides an overview of the industrial production indices and value added to GDP for the different industry subsectors for years 2000 and 2015.

**Table 11:** Industrial Production Indices and Value Added to GDP for Industry Subsectors, 2000 and 2015

	<b>Industrial Production Index</b> <b>(2005=100%)</b>		<b>Change of Production Index</b>	<b>Value Added to GDP</b> <b>(M€2005)</b>		<b>Change of shares</b>
	<b>2000</b>	<b>2015</b>	<b>2000-2015</b>	<b>2000</b>	<b>2015</b>	<b>2000-2015</b>
<b>Manufacturing</b>	96.287	99.433	<b>3.27%</b>	1,575,608	1,865,856	<b>18.42%</b>
Iron and Steel	97.785	87.919	<b>-10.09%</b>	72247.3	77034.7	<b>6.63%</b>
Chemical and Petrochemical	86.793	108.626	<b>25.16%</b>	175,506	236,505	<b>34.76%</b>
Non-Metallic Minerals (Cement, Glass)	99.642	74.637	<b>-25.09%</b>	70,949	65,447	<b>-7.75%</b>
Food and Tobacco	94.659	102.925	<b>8.73%</b>	211339	227246.6161	<b>7.53%</b>
Textile and Leather	140.378	71.299	<b>-49.21%</b>	82831.3	58099.2622	<b>-29.86%</b>
Paper, Pulp and Print	97.288	89.783	<b>-7.71%</b>	90836.7	87608.3802	<b>-3.55%</b>
Transport Equipment	92.462	108.421	<b>17.26%</b>	173218.7	262976.0851	<b>51.82%</b>
Machinery	97.83	100.482	<b>2.71%</b>	466923.9	592044.0126	<b>26.80%</b>

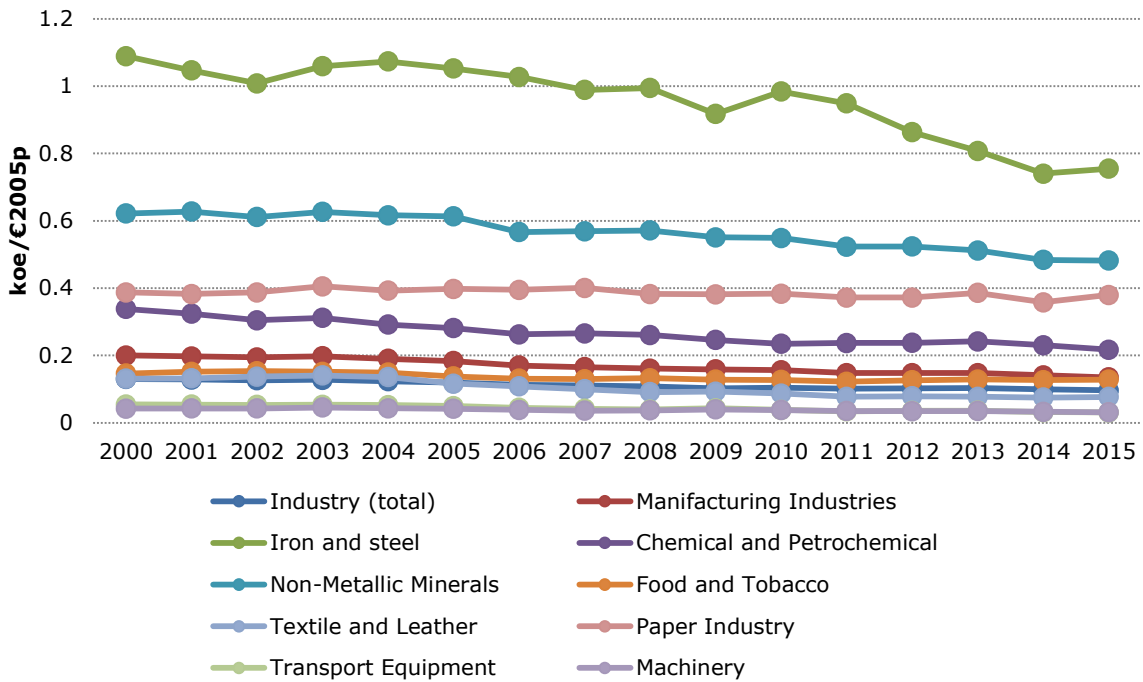
	<b>Industrial Production Index</b> <b>(2005=100%)</b>		<b>Change of Production Index</b>	<b>Value Added to GDP</b> <b>(M€2005)</b>		<b>Change of shares</b>
	<b>2000</b>	<b>2015</b>	<b>2000-2015</b>	<b>2000</b>	<b>2015</b>	<b>2000-2015</b>
Wood and Wood Products	98.274	81.453	<b>-17.12%</b>	35,375	31,196	- <b>11.81%</b>
Other industries (Rubber, Plastics)	98.524	96.567	<b>-1.99%</b>	196,381	227,699	<b>15.95%</b>
<b>Mining and Quarrying</b>	96.287	99.433	<b>3.27%</b>	83697.7	95138.3	<b>13.67%</b>
<b>Construction</b>	93.346	83.533	<b>-10.51%</b>	598566	560708.1	<b>-6.32%</b>
<b>Industry Total</b>	<b>95.244</b>	<b>94.763</b>	<b>-0.51%</b>	<b>2,257,871</b>	<b>2,521,702</b>	<b>11.68%</b>

Source: Odyssee

Table 11 shows that the Textile and Leather manufacturing subsector is the subsector with the highest decrease in the industrial production index (-49.21%). This is probably mostly due to the European textiles and clothing industry location decisions concerning where to set the production in the last years. A high degree of outsourcing and competition from low-wage environments, as well as high proportion of entry-level jobs for unskilled personnel, ease of transport and relatively low investment costs are probably the main factors that have influenced these decisions. Near-shore outsourcing to countries in the European Union and offshore outsourcing to non-EU countries are a well-known phenomenon particularly in the textiles and clothing industry. Overall, the European textiles and clothing companies respond to pressures for change by pursuing the following two business strategies [9]:

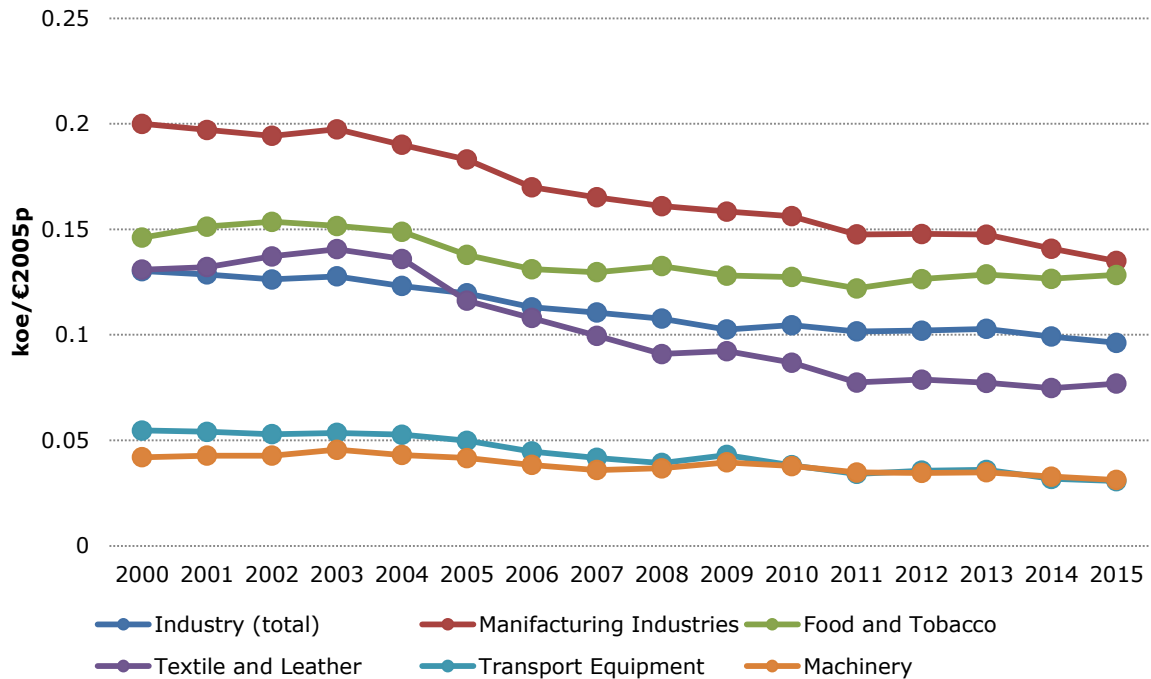
- Relocation of production and activities to low-cost countries;
- Development of added-value activities in the higher end of the value chain.

**Figure 165:** Energy intensity per industry subsector in the EU-28 (GDP at purchasing power parities), 2000-2015



Source: Odyssee

**Figure 166:** Energy intensity per industry subsector in the EU-28 (GDP at purchasing power parities), 2000-2015 (expanded)



Source: Odyssee



Energy Intensity of the industry sector was 0.0962 koe/€2005 in 2015, representing a drop by 26.11% in the period 2000-2015. The overall trend is a decreasing trend for all the industry subsectors during the mentioned period. It can be observed that Transport Equipment and Textile and Leather are the subsectors where the biggest changes have taken place as they have reduced their energy intensity by 43.88% (from 0.0547 koe/€2005 in 2000 to 0.0307 koe/€2005 in 2015) and 41.25% (from 0.1309 koe/€2005 in 2000 to 0.0769 koe/€2005 in 2015) respectively.

## 6.5 Overview – Industry sector

The industry sector accounted for 25.35% of the EU-28 total final energy consumption in the year 2015. It was the second energy consuming sector after transport (33.09%).

In 2015, industry final energy consumption reached 274.7 Mtoe, out of which 83.5% (229.5 Mtoe) was generated by EU-15. Industry's final energy consumption in the EU-28 has fallen by 17.6% in the period 2000-2015. A similar decrease has been observed both in EU-15 and NMS-13 areas which have reduced their consumptions by 17.5% and 18% respectively. The maximum annual consumption of this period took place in the year 2003 when it reached 335.6 Mtoe, while the minimum occurred in 2009 when the final energy consumption decreased to 267 Mtoe. 2009 is the year with the lowest consumption over the period 1990-2015.

The highest growth rates have been observed in Latvia (36.75%), Lithuania (26%) and Austria (24.91%). The lowest growth rates over the period 2000-2015 have been observed in Cyprus (-54.73%), followed by Italy (-34.51%), and United Kingdom (-33.03%).

In 2015, the Member State with the highest consumption in the industry sector was Germany (60.95 Mtoe), followed by France (28.64 Mtoe) and Italy (26.02 Mtoe). These three States together with the United Kingdom accounted for more than 50% of the total European final energy consumption in the sector. Half of the EU-28 Member States (14 countries) consumed less than 10% of the EU-28 industry final energy consumption in the same year.

Concerning the energy mix in industry sector, gas (86.6 Mtoe) and electricity (85.7 Mtoe) were the main energy types consumed in 2015. These two fuel types represented together over 60% of the total final energy consumption in the EU-28 (gas: 31.53%; electricity: 31.18%). The energy mix in the same year was also composed by solid fuels (12.70%), petroleum products (10.14%), renewable energies (7.78%), derived heat (5.51%) and non-renewable waste (1.16%). Compared to year 2000, the usage of petroleum products has registered the highest reduction (by 47.4% - more than 25 Mtoe from 2000 to 2015). Non-renewable waste, renewable energies and derived heat have enlarged their contributions in absolute value. On the other hand, petroleum products, electrical energy, gas and solid fuels have reduced the absolute value of their contributions

Industry sector consumed 36.86% of the final electricity consumption of the EU-28 in 2015, confirming that this sector is the main electricity consumer.

The industry electricity consumption has fallen by 6.1% in the EU-28 from 2000 to 2015. This decrease has been mostly caused by the EU-15 area (-9.6%), whereas NMS-13 area has increased its electricity demand by 21%. Since 2011 a decreasing trend has been registered every year, although the negative growth rate has been smoother year after year, until 2015 when the electricity consumption has increased compared to the previous year. The highest electricity consumption growth rates over the period 2000-2015 have been experienced by Hungary (74.91%), Lithuania (44.42%) and Austria (31.64%). The Member States with the lowest growth rates were Italy (-20.57%), France (-20.52%) and the United Kingdom (-19.27%). Twenty-three Member States have registered a negative growth rate over the period 2007-2015. The only states with a

positive growth rate in that period were: Hungary (62.5%), Ireland (16.11%), Poland (9.11%), Lithuania (7.53%), and Austria (4.58%).

The industry sector consumed 36.67% of the final gas consumption of the EU-28 in 2015, ranking as the second gas consuming sector after the residential sector (41.24%).

EU-28 gas consumption in industry has fallen by 23.1% in the period 2000-2015. This decrease has been registered in both EU-15 and NMS-13 areas which have decreased their consumptions by 23.4% and 21.4% respectively.

In 2015, the final total gas consumption amounted to 86.6 Mtoe, out of which 84.3% (73 Mtoe) was generated in EU-15 area. The maximum consumption over the analysed period took place in the year 2003 (112.9 Mtoe). The minimum value in the period 2000-2015 occurred in 2009 when the final gas consumption dropped to 82 Mtoe. Since 2009, the European Union has been registering the lowest values of industry final gas consumption for the 26-years period between 1990 and 2015.

Eight Member States have registered a decrease rate below the average European decrease rate (23.09%) over the period 2000-2015. The Member States with the highest growth rates are Greece (76.95%), Ireland (62.91%) and Portugal (62.67%). On the other hand, the EU-28 countries with the lowest growth rates are: Italy (-50.26%), the United Kingdom (-48.36%), and Romania (-45.45%).

The industry sector can be broken-down into subsectors for a deeper analysis. Construction, Mining and Quarrying, and Manufacturing industries are the main subsectors.

Manufacturing, in turn, can be split into eleven subsectors: Iron and Steel; Non-Ferrous Metals; Chemical and petrochemical; Non-Metallic Minerals; Food and Tobacco; Textile and Leather; Paper, Pulp and Print; Transport Equipment; Machinery; Wood and Wood Products; and Other Industries.

Manufacturing has registered the highest final energy consumption drop (-18.10%) over the period 2000-2015. Mining and Quarrying subsector has also undergone a fall by 8.70%. An opposite trend has been registered in the Construction subsector which has increased its demand of final energy by 2.49%.

Among the Manufacturing subsectors, the highest final energy consumption in 2015 has been registered in the Chemical and Petrochemical subsector which accounted for 18.86% (51,816.9 ktoe) of the total final industrial energy consumption, followed by Iron and Steel (18.11%; 49,752.7 ktoe) and Non-metallic Minerals (12.32%; 33,844.5 ktoe).

Among the manufacturing subsectors, the only positive growth rate is found in Wood and Wood Products (by 22.10%). The rest of the manufacturing subsectors has registered negative growth rates. The lowest growth rates have been observed in Textile and Leather (-58.80%), Other Industries (-34.12%) and Iron and Steel (-25.98%).

In 2015, chemical and petrochemical manufacturing industry was the industry subsector with the highest electricity (180.5 TWh; 18.12% on industry final electricity consumption) and gas consumptions (17,762.7 ktoe; 20.5%).

The manufacturing subsectors which follow in the electricity consumption ranking are Machinery (117.9 TWh; 11.83%), Paper, Pulp and Print (117.1 TWh; 11.75%), and Food and Tobacco (116.1 TWh; 11.65%). In 2000, Chemical and Petrochemical was the main electricity consumer (199.9 TWh), followed by Paper, Pulp and Print (131.8 TWh), and Iron and Steel (130.4 TWh).

In the case of gas consumption, the Chemical and Petrochemical manufacturing subsector is followed by Iron and Steel (18.01%; 15,606.1 ktoe), by Food and Tobacco (15.94%; 13,610.9 ktoe) and by Non-Metallic Minerals (14.80%; 12,820 ktoe).

When analysing the Industrial Production Indexes (IPIs) of the different manufacturing industries for the period from 2000 to 2015, it can be observed that the most notable variations in the IPIs occurred after the financial crisis. All the manufacturing subsectors

experienced a significant drop in their productions in 2009. Noticeably, the IPI of Textile and Leather has been continuously decreasing since 2000 and has accumulated a 50% drop till 2015. The most stable manufacturing subsector is Food and Tobacco which keeps IPI's variations within a 10% range.

The industry sector added value to GDP has risen by 10.2% in the period 2000-2015. Among the industry subsectors, in the same period, Manufacturing and Mining and Quarrying industries have increased their added value by 19.81% and 13.67% respectively, while Construction has decreased its contribution by 6.32%.

Regarding the economic contribution of manufacturing industries to the GDP, Machinery subsector is the largest contributor (592,044 M€). The second one is Transport Equipment which contributes with 262,976 M€.

The Energy Intensity (EI) of the industry sector has instead dropped by 26.11% in the period 2000-2015. In 2015, the EI was 0.0962 koe/€2005. The overall trend is a decreasing trend for all the industry subsectors during the mentioned period. It can be observed that Transport Equipment and Textile and Leather are the subsectors where the biggest changes have taken place as they have reduced their energy intensity by 43.88% (from 0.0547 koe/€2005 in 2000 to 0.0307 koe/€2005 in 2015) and 41.25% (from 0.1309 koe/€2005 in 2000 to 0.0769 koe/€2005 in 2015) respectively.

## 7 Conclusions

This report describes and analyses the energy consumption<sup>72</sup> patterns in the EU-28 for the period 2000-2015. Such analysis is important in order to obtain some insights about the impact and effectiveness of policies aimed at promoting energy efficiency in the EU. The sectors covered by the report are the residential, tertiary, transport and industry sectors.

The results show that EU inland gross energy consumption, primary energy consumption, and final energy consumption have declined from 2000<sup>73</sup> by 5.93%, 5.46%, and 4.31% respectively. The breakdown into sectors shows that: the largest decline of final energy consumption has been registered in the industry sector (-17.59%); in the residential sector there has been a decrease (-5.51%), the transport sector has registered a slight increase (4.04%), and the tertiary sector has experienced the highest positive growth rate (+16.48%).

Energy indicators such as energy intensity of final energy and final energy per capita have been reduced during the analysed period, by 37.32% and 8.32% respectively. This can be interpreted as a sign of a higher competitiveness of the European Union as global actor.

**Table 12:** Overview of energy consumption in the EU-28, 2000-2015

	2000	2007	2015	Growth Rate 2000-2015 (%)
Inland Gross Energy Consumption (Mtoe)	1,730.1	1,809.9	1,627.5	-5.93%
Primary Energy Consumption (Mtoe)	1,617.9	1,693.8	1,529.6	-5.46%
Total Primary Energy Supply per capita (toe/cap)	3.5507	3.6322	3.2005	-9.86%
Energy Intensity - Primary Energy (toe/1,000 Euro)	0.1549	0.1385	0.1204	-22.27%
Final Energy Consumption (Mtoe)	1,132.8	1,174.5	1,083.96	-4.31%
Final Energy Supply per capita (toe/cap)	2.3250	2.3570	2.1317	-8.32%
Energy Intensity - Final Energy (toe/1,000 Euro)	0.1174	0.0905	0.0736	-37.32%
	<b>2000</b>	<b>2015</b>		<b>Growth Rate</b>
				<b>2000-</b>

<sup>72</sup> The focus is on the final energy consumption.

<sup>73</sup> All growth rates refer to changes from 2000 to 2015, unless another period is specified.

					2015 (%)
	FEC (ktoe)	Share (%)	FEC (ktoe)	Share (%)	
Residential Sector	291,201	25.70 %	275,155	25.38%	-5.51%
Tertiary Sector	121,420	10.72 %	146,924	13.55%	21.01%
Transport Sector	344,691	30.43 %	358,629	33.09%	4.04%
Industry Sector	333,372	29.43 %	274,737	25.35%	-17.59%

Source: EC DG-JRC

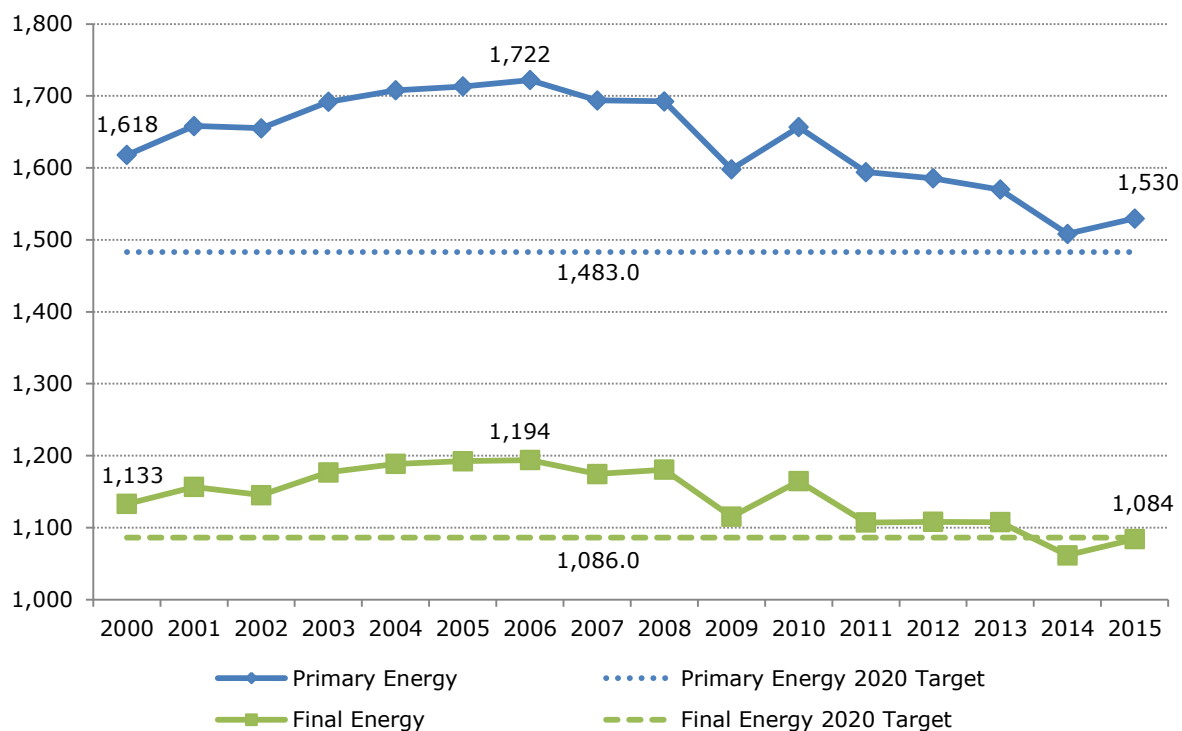
The main findings and results of the report for the period from 2000 to 2015 are:

- In 2015 the EU-28 final energy consumption increases by 2.01%, compared to the previous year, by registering a value of 1,084 Mtoe. Despite this increase the final energy consumption remains below the 2020 target (1,086 Mtoe) with a gap of -0.18%.
- In 2015 primary energy consumption increases by 1.5% compared to the previous year, registering a value of 1,530 Mtoe. This increase interrupts the decreasing trend started in 2010 and the primary energy consumption moves away from the 2020 target (1,483 Mtoe). The 2015 gap to accomplish the target is 3.2% versus a gap of 1.5% in 2014. In 2014 primary energy registered the lowest value since 1990.
- The transport and the tertiary sector have increased their final energy consumption over the analysed period while in the residential and industry sectors the final energy consumption has declined.
- European Union has reduced its energy intensity by 41.7% over the period 2000-2015 by reaching a value 0.07 toe/thousand Euro in 2015. Energy consumption per capita increases in 2015, by reflecting the dynamics of final energy consumption.
- Overall, the current final energy consumption trends show that the financial and economic crisis (which started in 2007 and peaked in 2008) has strongly affected dynamics and growth rates of the different economic sectors and Member States.
- The financial and economic crisis, paradoxically, has contributed to get the energy consumption back on track to reach the EU energy and environmental targets for 2020.
- 84.3% of final energy was consumed in EU-15 and 15.7% in NMS-13. The EU-15 shows a decrease of 6% for the period 2000-2015. In contrast, NMS-13 increased their consumption by 6%.
- Different energy consumption growth rates by Member States reflect national-specific energy-related scenarios and national policy efforts.
- Four Member States (i.e. Germany, France, the United Kingdom and Italy) consumed over 50% of the final energy consumption and fourteen Member States

(half of the European Union States) consumed less than 10% of the total final energy consumption in 2015.

- Greece (-25.19%), Spain (-18%) and Ireland (-15.58%) are the countries which have registered a highest final energy consumption reduction across the EU-28 Member States from 2007 to 2015.

**Figure 167:** Energy consumption trends with 2020 EU-28 energy targets, 2000-2015



Source: Eurostat

Specific findings and insights can be individually addressed for each of the analysed economic sectors:

### Residential Sector

The residential sector registered a decrease in the final energy consumption by 5.5% in the period from 2000 to 2015.

The residential energy consumption depends on many variables: heating degree days, population, GDP, number of dwellings, total floor area. Different combinations of these variables were used in order to assess whether the decreasing trend in residential energy consumption and the increase in 2015 are still there after correcting for these factors. Energy consumption analysis carried out considering the effect of GDP per capita, HDD, and population; energy consumption analysis per dwelling (per square meter); and energy consumption analysis per household, all return similar results: the EU has registered a very gradual decline in the residential energy consumption from 2000 onwards.

The main findings and conclusions regarding the residential energy consumption trends are:

- In 2015, the residential sector represented 25.38% of the final energy consumption in the European Union, being the third consuming sector after transport and industry sector.
- After the lowest value (over the period 1990-2015) registered in 2014, in 2015 final residential energy consumption increased by 4.02% compared to the previous year.
- The energy mix in the residential sector is mainly formed by gas (35.4%) and electricity (24.9%) consumption.
- The final residential electricity consumption increased by 10.7% in the EU-28 during the 16-years period 2000-2015.
- The final residential gas consumption dropped by 11% between 2000 and 2015.
- The residential sector was the third electricity consumer (29.02%) and the main gas consumer (41.34%) among the analysed sectors in 2015.
- The weather and climatic conditions impact on residential energy consumption. The results show that the colder the year the higher the energy consumption. There has been observed a positive correlation between the final energy consumption (also in the electricity and gas consumption) and the Heating Degree Days. Nevertheless, establishing a direct impact of climatic conditions on residential energy consumption is not easy given that several other factors such as building characteristics (i.e. building envelope, insulation level, location, etc.), social and cultural reasons (lifestyle, habits, etc.), and economic performance, among others, affect energy consumption.
- In the EU, there has been observed a lowering trend in the size of the households in terms of persons per household over the period 2000-2015, which might lead to a future increase in the residential energy consumption per capita values.
- Energy consumption per household and energy consumption per dwelling may be considered as reference variables to compare and analyse the energy consumption trends at residential level.
- Energy prices went up in the European Union. Electricity has grown by 31.33% (up to EUR 0.2054/kWh) and gas by 24.5%<sup>74</sup> (up to EUR 0.0636/kWh) between the second semester of 2007 and the second semester of 2016.
- The disposable income of households or adjusted gross disposable income can represent a more interesting economic indicator in the analysis of the residential energy consumption compared to the GDP per capita.

### **Tertiary Sector**

The tertiary sector has registered an increase in the final energy consumption by 21.5% in the period from 2000 to 2015. The main findings and conclusions regarding the tertiary energy consumption trends are:

- The final energy consumption increased by 3.63% in 2015 compared to 2014. However, the sector is registering the highest energy consumption numbers in the 25-years period from 1990 to 2015 during the recent years (2008 onwards) with the exception of year 2014.

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<sup>74</sup> It refers to the average European price for domestic consumers. Band DC (electricity) and band D2 (gas).

- The energy mix in the tertiary sector is mainly formed by electricity (48.85%), gas (30.33%) and petroleum products (10.38%) consumption.
- The final tertiary electricity consumption has grown (by 31.43%) in the EU-28 during the 16-years period 2000-2015.
- The final tertiary gas consumption has dropped (by 29.3%) between 2000 and 2015.
- The tertiary sector was the second electricity consumer (30.45%) and the third gas consumer (18.86%) among the analysed sectors in 2015.
- The tertiary energy consumption in the tertiary sector is expected to increase in the following years as per the on-going EU tertiarization trend.
- Weather and climate conditions are an influencing factor in the tertiary energy consumption as comfort conditions (e.g. temperature or humidity levels) play a key role within the sector.
- Weather conditions (heating and cooling degree days) and the final energy consumption (especially the gas consumption) present a positive correlation which may be influenced by comfort conditions.
- Energy per employee may be considered a reference parameter to compare and analyse the energy consumption trends at tertiary level.

## **Transport Sector**

The transport sector registered an increase in the final energy consumption by 4.04% in the period from 2000 to 2015.

The main findings and conclusions regarding the transport energy consumption trends are:

- The transport sector proved to be the main consuming sector, accounting for 33.09% of total final energy consumption in the year 2015.
- Since 2008 onwards, the transport sector is registering the lowest energy consumption numbers in the 26-years period from 1990 to 2015.
- There has been a complete reverse in the energy consumption dynamics from 2008 onwards for the period 2000-2015. It may be result of the impact financial and economic crisis as well as higher fuel prices and more efficient vehicles.
- In 2015 the final energy consumption in the transport sector increased by 1.72% compared to the previous year.
- The energy mix in the transport sector is mainly formed by petroleum products (93.65% in 2015).
- The transport sector was the least electricity (2.28%) and gas (1.37%) consumer among the analysed economic sectors in 2015.
- Road transport is clearly the main final energy consumer among the transport subsectors (81.98% in 2015).
- Diesel and gasoline consumption stand out among the petroleum products and diesel is the most consumed fuel in the road transport (66.29% in 2015).
- Biofuels have highly developed from 2000 to 2015 mainly due to biodiesels and biogasoline usage. Biodiesels were the major renewable fuel type (80.13% of the total biofuel consumption in 2015), followed by biogasoline (18.93%).



- Cars represented 77.61% of the stock of vehicles and 56.64% of the final road energy consumption in 2015.
- The average consumption of cars in the market has declined by 13.32% from 2000 to 2014. Gasoline and diesel cars already in the market have registered a reduction by 10.07% and 8.1% in their average consumption.
- The impact of energy and environmental policy actions in the automotive industry (e.g. CO<sub>2</sub> emission regulation for new passenger cars) may be reflected in the decrease of parameters such as the average specific consumption, as the initial decline of those parameters coincides with the implementation dates of the mentioned standards.
- A lower age of the vehicles fleet can help in reducing the energy consumption and GHG emissions in the future as the energy consumption of the vehicles has decreased in the recent years.
- Passenger transport and in detail passenger cars represent the highest energy consumer modes of transport.
- Transportation and storage of goods was the main economic activity related to freight traffic in the EU-28 in 2015.
- The transport was the main responsible GHG emitter among the analysed economic sectors (it accounted for 23% of the CO<sub>2</sub> equivalent emissions in 2015).
- The GHG emissions in the transport sector, including international aviation and international maritime transport, have increased (by 23%) from 1990-2015.
- The road transport is the main responsible of GHG emissions.

## **Industry Sector**

The industry sector registered a decrease in the final energy consumption by 17.6% in the period from 2000 to 2015.

The main findings and conclusions regarding the industry energy consumption trends are:

- The industry is the second in the ranking of the most energy consuming economy sectors, by accounting for 25.35% of the EU-28 total final energy consumption in the year 2015.
- Since 2008 onwards, the industry sector is registering the lowest energy consumption numbers in the 26-years period from 1990 to 2015.
- 2015 registered a slight increase in the final energy consumption.
- The industry sector was the main electricity consumer (36.35%) and the second gas consumer (36.67%) among the analysed economic sectors in 2015.
- The energy mix in the industry sector was mainly and evenly formed by gas (31.53%) and electricity (31.18%) in 2015.
- Overall, the industry sector has reduced its final energy consumption due to a contraction of production. For instance, Iron and Steel (the highest energy consumption manufacturing subsector in 2000) decreased its final energy consumption by 25.98%, and its industrial production index (IPI) by 10.09% during the period 2000-2015.
- The financial and economic crisis has further reduced the production output and has boosted the decrease of final energy consumption.

- Despite the IPI reduction (by 0.51%) from 2000 to 2015, the sector has enlarged the value added to GDP (by 11.68%) in the same period.
- The IPI reduction has not been evenly registered across the industry subsectors. For instance, Textile and Leather subsector's IPI has been continuously decreasing since 2000 and has accumulated a 50% drop till 2015. The most stable manufacturing subsector in terms of IPI was Food and Tobacco.
- Among the manufacturing subsectors Chemical and Petrochemical was the main final energy, electricity and gas consumer in 2015. Despite a negative growth rate (-12.86%) it registered an increase in IPI (25.16%) and in the share of value added to GDP (34.76) over the period 2000-2015.
- The Machinery subsector has been the largest contributor to the GDP among the manufacturing subsector during the period from 2000 to 2015.

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## List of abbreviations and definitions

AE	Annual Energy consumption
BAT	Best Available Techniques
CDD	Cooling Degree Day
CO	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
DC	District Cooling
DH	District Heating
EC	European Commission
EE	Energy Efficiency
EEA	European Environment Agency
EEAP(s)	Energy Efficiency Action Plan(s)
EED	Energy Efficiency Directive (2012/27/EU)
EEI	Energy Efficiency Index
EEOS(s)	Energy Efficiency Obligations Scheme(s)
EER	Energy Efficiency Ratio
EFTA	European Free Trade Association
EI	Energy Intensity
EPBD	Energy Performance of Buildings Directive (2010/31/EU)
ErP(s)	Energy related Product(s)
ESD	Energy End-use Efficiency and Energy Services Directive (2006/32/EC)
ETS	Emissions Trading System
EU	European Union
EU15	The EU15 includes the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and United Kingdom.
EU28	Group of countries which includes all the Member States of the European Union. These are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and United Kingdom.
EuP(s)	Energy using Product(s)
GDP	Gross Domestic Product
GWh	Gigawatt-hour
HHD	Heating Degree Day

HRE	Heat Roadmap Europe
ICT	Information and Communication Technologies
IPI	Industrial Production Index
JRC	Joint Research Centre
Ktoe	Thousand tonnes of oil equivalent (1,000 toe)
LED	Lighting Emitting Diode
LPG	Liquefied Petroleum Gas or Liquid Petroleum Gas
LV	Low Voltage
MDA	Major Domestic Appliances
MEPS	Minimum Energy Performance Standards
MS(s)	Member State(s)
MtCO <sub>2</sub> e	Million tonnes of carbon dioxide equivalent
Mtoe	Million tonnes of oil equivalent (1,000,000 toe)
MW	Megawatt
MWh	Megawatt-hour
NEEAP	National Energy Efficiency Action Plan
NH <sub>3</sub>	Ammonia or Azane
NMHC	Non-Methane Hydrocarbons
NMS	New Member State
NMS13	The NMS13 includes the following 13 countries: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.
NMVOC	Non-Methane Volatile Organic Compounds
NO <sub>2</sub>	Nitrogen Dioxide
NO <sub>x</sub>	Nitrogen Oxides
NZeB	Nearly Zero-energy Building(s)
PPP	Purchasing Power Parity
PPS	Purchasing Power Standard
PRODCOM	Production Communautaire Statistics
SME	Small and Medium Enterprise
SO <sub>x</sub>	Sulphur Oxides
sqm	Square metres
TFP	Total Factor Productivity
THC	Total Hydrocarbons
toe	tonnes of oil equivalent. Unit of measurement of energy consumption : 1 TOE = 41.868 GJ = 11.63 MWh.
TWh	Terawatt-hour
VA	Voluntary Agreement

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