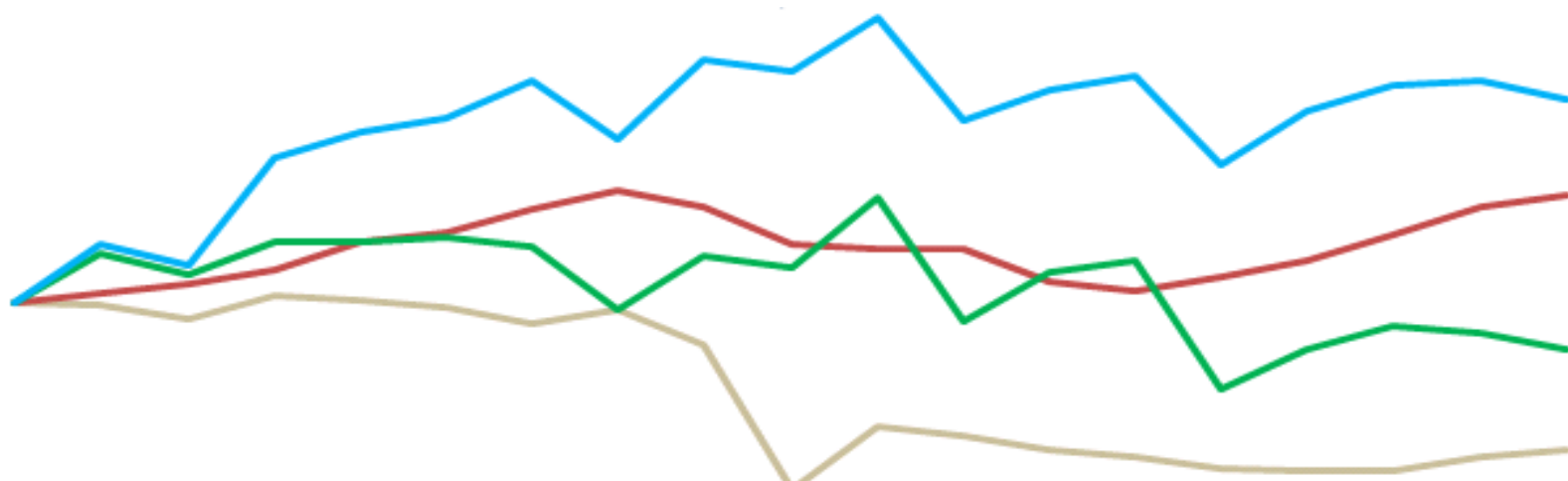


JRC SCIENCE FOR POLICY REPORT

Energy Consumption and Energy Efficiency trends in the EU-28, 2000-2018

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2020



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EU Science Hub

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JRC120681

EUR 30328 EN

PDF ISBN 978-92-76-21074-0 ISSN 1831-9424 doi:10.2760/847849

Luxembourg: Publications Office of the European Union, 2020

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How to cite this report: Tsemekidi Tzeiranaki, S., Bertoldi, P., Paci, D., Castellazzi, L., Ribeiro Serrenho, T., Economidou, M., Zangheri, P., Energy Consumption and Energy Efficiency Trends in the EU-28, 2000-2018. EUR 30328 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-21074-0, doi:10.2760/847849, JRC120681.

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Abstract

This report discusses the latest status of energy consumption trends in the EU-28, in the four main energy consuming sectors: residential, tertiary, transport and industry. During the last years, there have been notable efforts by the European Union to cut down on energy consumption and improve energy efficiency in the framework of the EU energy consumption targets within the Europe 2020 and 2030 strategies. The report explores the energy consumption progress from 2000 to 2018 in the four main sectors of the economy. Special focus is drawn on changes in the use of electricity and natural gas, as well as penetration of renewable energy sources in the energy mix. Energy indicators such as energy intensity and energy consumption per capita are also analysed. The report includes an analysis of the most important factors influencing energy consumption trends such as economic growth, population, heating demand, household characteristics and energy prices.

Acknowledgements

The authors would like to thank the reviewers for the useful and constructive comments. Special thanks to Bodgan Atanasiu (DG ENER).

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Executive summary

Policy context

The context of this report is set in relation to the current EU legislative framework on energy efficiency. This framework aims to directly or indirectly improve energy efficiency in different economic sectors: households, services, transport and industry. The main horizontal policies implemented at European level include: the Energy Efficiency Directive, the Energy Performance of Buildings Directive, the Clean energy for all Europeans package, the Eco-design Directive, the Energy Labelling Regulation, the Directive establishing an Emissions Trading Scheme in the European Union; the Effort Sharing Regulation, the Renewable Energy Directive, the Industrial Emissions Directive and the Regulation regarding CO₂ emissions of new passenger cars. A wealth of additional EU level measures also support improvements in energy efficiency in the transport sector: Clean Vehicle Directive, Directive on alternative fuels infrastructure, 4th Railway Package, Combined Transport Directive, etc. These are complemented by national policies and measures as described in the National Energy Efficiency Action Plans and in the integrated National Energy and Climate Plans.

Key conclusions

In the period from 2000 to 2018, the European Union has achieved a reduction in its total energy consumption by 4.2% in primary energy and 0.8% in final energy. This decrease has been accompanied with a drop in energy intensity and energy consumption per capita, thus driving up competitiveness at global level. While an encouraging trend was observed in the EU up until the year 2014 when the 2020 target set in the EED was achieved in terms of final energy (1,068 Mtoe in 2014 vs target of 1,086 Mtoe), this trend was subsequently reversed. After 2014, energy consumption experienced growth year-on-year, with the latest available data revealing a final and primary energy consumption¹ of 1,123 Mtoe and 1,552 Mtoe in 2018, respectively. Whilst the consumption increase of 2018 in comparison to 2017 was negligible in final energy, the 2018 gap to the 2020 final energy target stands at 3.5%. Primary energy consumption² decreased mildly by 0.7% compared to 2017, the first time after three continuous years of increase. The 2018 gap to the 2020 primary target stands at 4.7%. In both cases (primary and final energy consumption), the highest levels in the studied period were registered in 2006 and the lowest ones in 2014. The financial and economic crises as well as the economic development after the crisis have caused remarkable changes in the dynamics and growth rates of the different economic sectors in the EU Member States. In contrast to other economic sectors³, transport and services increased their final energy consumption over the analysed period (by 10.8% and 20.2%, respectively). The residential energy consumption declined by 4.5% and the industrial consumption reduced more significantly (by 14.6%). The rising consumption trend in the tertiary sector is expected to continue as a consequence of the on-going tertiarization process in the EU as well as a consequence of the increased use of electricity in the IT sector and data centres. In the residential and tertiary sectors, the energy demand depends on weather and climate conditions, although there are multiple additional factors affecting

¹ Due to changes in methodology in energy balances of Eurostat, the indicators "Final Consumption – energy use" (FC_E) and "can't provide values that are comparable with the Europe 2020 targets. In order to allow this comparison established prior to the new Eurostat methodology, the indicator "Final energy consumption (Europe 2020-2030)" (FEC2020-2030) has been used in this analysis. This indicator estimates final energy consumption calculated under the old Eurostat methodology, which was in place when the Energy Efficiency Directive and Europe 2020 targets were established. According to Eurostat this indicator should be used also for tracking progress towards Europe 2030 targets. The arithmetic definition of this indicator is provided in the Annex.

² In the same context with the previous note, the indicator "Primary energy consumption (Europe 2020-2030)" (PEC2020-2030) has been used in this analysis. This indicator reflects on the definition given in Article 2 of the Directive 2012/27/EU as well as the methodology of energy balances in place at the time of establishing the Directive and Europe 2020 targets. This indicator should be used also for tracking progress towards Europe 2030 targets. The arithmetic definition of this indicator is provided in the Annex.

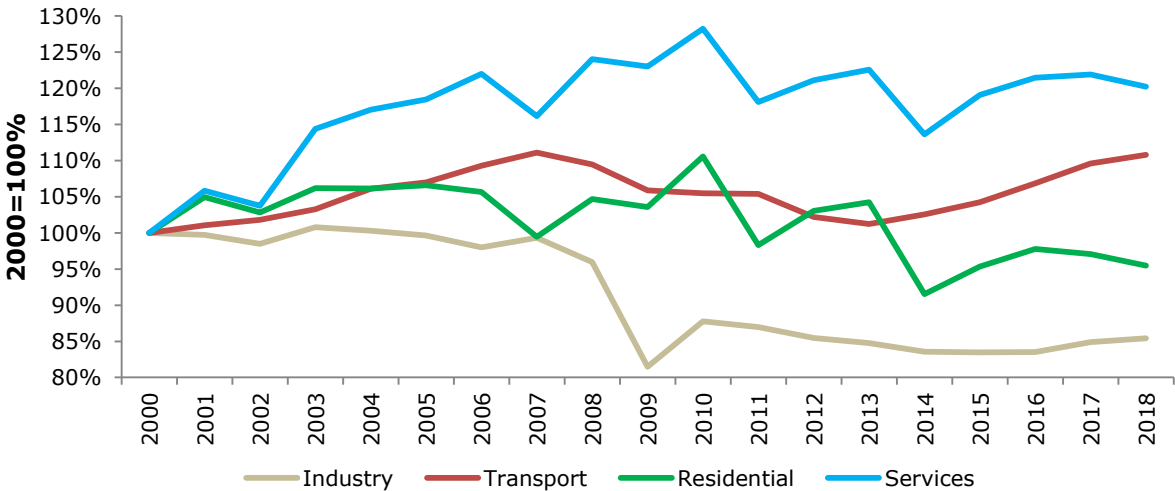
³ Sectoral energy consumption trends have been analysed using the old methodology Eurostat tables in order to be comparable with the EU 2020 targets.

consumption including economic conditions, population and employment, energy prices, building characteristics (e.g. building envelope, insulation level, location, etc.) or social and cultural reasons (lifestyle, habits, etc.) among others. On the other hand, the declining trend in industry has been largely influenced, among others, by the financial and economic crisis and by the deindustrialisation process. In industry, energy consumption mainly depends on industrial production and economic development while in transport it depends on fuel prices, vehicle population, and on passenger and goods transportation volumes.

As regards the energy sources mix evolution, it is important to highlight the electrification trend, especially in residential and tertiary sectors, in part due to the increase in the demand of electric appliances and heating pumps, the development of big data centres and growth of new information and communication technologies. In addition, there has been an important penetration of renewable energies during the analysed period. On the contrary, the use of petroleum products, natural gas and solid fossil fuels as energy sources is gradually declining.

Main findings

Over the 29-year period from 1990 to 2018, the second lowest level of final energy consumption was observed in 1994 (the first being in 2014 as previously discussed). From 2015 onwards, we observed a rise in consumption that continued in 2016, 2017 and 2018. However, the level of consumption remained below the average of the studied period and every year the annual growth rate was lower, while in 2018 it was minor (0.1%). When analysing the overall EU energy consumption trends, the individual growth rates of the EU-28 Member States may not be representative. Four Member States (i.e. Germany, France, the United Kingdom and Italy) consumed over 50% of the final energy consumption (54.5%) and 14 Member States (half of the European Union States) consumed less than 9% (8.5%) of the total final energy consumption in 2018. Industrial and transport sectors registered a slight increase (by 0.6% and 1.1% respectively) in final energy consumption in 2018 compared to 2017, in contrast to the residential and service sectors which registered a drop of 1.6% and 1.4% respectively.



More analytically, in residential sector, final energy consumption decreased in 2018 compared to 2017 and 2018 is one of the 3 years with the lowest final energy consumption values registered over the analysed period (2000-2018). From 2008 onwards, the tertiary sector has registered the highest energy consumption values for the period 2000-2018; with the exceptions of 2011 and 2014. However, in 2018 it decreased. From 2014 and onwards, transport has reversed its decreasing trend that started in 2008. The increase in consumption in transport can be viewed alongside the increasing trend in greenhouse gas emissions, driven by the sustained economic growth in the European Union over the last years [1] and the low oil price environment. Road transport and, more specifically car transport, represent the largest consuming transport

mode. Biofuels (especially biodiesels, biogasoline and biogas) have significantly developed from 2000 to 2018 even though diesel and gasoline still remain the main fuel types to date. The industrial final energy consumption was slightly increased in 2018 but it is well below the average value for the period from 2000 to 2018.

Related and future JRC work

The report provides an in-depth analysis of the energy consumption and energy efficiency trends based on the latest available official data. This is a periodic report, with future updates foreseen on an annual basis (e.g. analysis for the periods 2000-2019 or 2000-2020). In the future, a more thorough analysis of each analysed economic sector and case studies of the EU28 Member States might be considered subject to data availability, together with more tailored research on specific topics including 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 energy consumption trends in four main energy consuming sectors (i.e. residential, services, transport and industry) in the EU for the period from 2000 to 2018. When 2018 data are not available, the most recent data (usually 2017) are instead discussed. The year 2009 has been selected to divide the whole studied period in two equal sub periods (2000-2009, 2009-2018). During these sub periods, energy consumption experienced diverse trends possibly as a result of various factors (economic crisis, implemented energy efficiency policies etc.) which are studied in this report. During the last years, there have been efforts by the European Union to reduce energy consumption, and improve energy efficiency. Thus, this analysis is needed in order to evaluate whether and how the collective policy actions have influenced energy consumption.

It is important to note that the main data sources used in this analysis are Eurostat [2], Odyssee [3], European Environmental Agency (EEA) [4], and the Statistical Pocketbook of DG MOVE [5]. In 2019, a change in methodology of Eurostat energy balances was implemented. However, in some cases the indicators established prior to the new Eurostat methodology continue to be updated. In these cases, these indicators have been selected for this report in order to enable the comparison with the EU 2020 targets. On the contrary, when the old methodology indicators are not updated anymore by Eurostat, the new methodology indicators have been used for the purpose of this analysis.

1 Introduction

One of the five objectives of the European Union regarding the strategy for *Europe 2020* focuses on climate and energy, with energy efficiency at the heart of the EU's Europe 2020 Strategy for smart, sustainable and inclusive growth⁴.

The EU has set three key targets based on climate change and energy sustainability for 2020, 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 and final energy consumption⁵.

The EU has also set climate and energy targets for 2030⁶:

- 40% cut in greenhouse gas emissions compared to 1990 levels;
- at least a 32% share of renewable energy consumption;
- at least 32.5% energy savings compared with the business-as-usual scenario⁷

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*⁸ as a key step towards achieving our long-term energy and climate goals.

On 28 November 2018, the Commission presented its strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy by 2050.⁹ The strategy shows how Europe can lead the way to climate neutrality by investing into realistic technological solutions, empowering citizens, and aligning action in key areas such as industrial policy, finance, or research – while ensuring social fairness for a just transition. The European Parliament endorsed the net-zero greenhouse gas emissions objective in its resolution on climate change in March 2019 and resolution on the European Green Deal in January 2020.

Many important EU directives and regulations to promote energy efficiency have been implemented, are in the planning phase just before entering the implementation phase or are still under discussion by the co-legislators. Furthermore, the EU Member States 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 Less¹⁰, where it was indicated the cost-effective potential supported by several studies.

In 2006, the Action Plan for Energy Efficiency¹¹ 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.

⁴ COM(2010) 2020

⁵ 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).

⁶ European Commission Press Release on the political agreement on the governance of Energy Union. http://europa.eu/rapid/press-release_IP-18-4229_en.htm

⁷ Business as Usual scenario modelled with Primes in 2007.

⁸ COM(2010) 639

⁹ COM(2018) 773, source: https://ec.europa.eu/clima/policies/strategies/2050_en

¹⁰ COM(2005) 265

¹¹ COM(2006) 545

The Energy End-use Efficiency and Energy Services Directive¹² (ESD) introduced the indicative energy saving target of 9% over a 9 year period 2008-2016. Each Member State 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 Member States 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 National Energy Efficiency Action Plans (NEEAP), which each Member State had to adopt in order to reach the 9% ESD energy saving target. At the time of the ESD adoption only a few Member States 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 NEEAP¹³ should be a strategic document showing a coherent set of policies and measures needed in a specific Member State to reach the 9% target. In addition, the second and third NEEAP should include a thorough analysis and evaluation of the preceding NEEAP. Each Member State 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 Member States 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 Directive¹⁴ (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 energy¹⁵. Targets have been already met for final energy consumption in 2014 (1,068 Mtoe of final energy consumption in 2014), however final energy registered a slight increase during the last four years (it was 1,124 in 2018). In 2014 the EU was on the track to reach the primary energy consumption target, however primary energy increased in 2015, in 2016 and in 2017. In 2018, primary energy consumption was 1,552 Mtoe; corresponding to a gap of 4.7%.

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 allowing Member States to 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 30 November 2016, the European Commission presented the Clean Energy Package that included various legislative proposals with the goal of providing the stable legislative framework needed to facilitate the clean energy transition – and thereby taking a significant step towards the creation of the Energy Union. These proposals cover among

¹² Directive 2006/32/EC

¹³ The evaluation of the quality of NEEAPs and the saving reported is not in the scope of the present report.

¹⁴ Directive 2012/27/EU

¹⁵ The indicated values refer to EU-28. When the EED was introduced the values were referred to 27 Member States and were: 1,474 Mtoe of primary energy or no more than 1,078 Mtoe of final energy.

others the amendment of Energy Performance in Buildings and Energy Efficiency Directive¹⁶. The political agreement by the Council and the European Parliament in 2018-2019, enabled all of the new rules of Clean Energy Package to be in force by mid-2019, and gave to EU Member States 1-2 years to transpose the new directives into national legislation.

More analytically, the Clean Energy Package includes the new amended Directive on Energy Efficiency¹⁷ that was aimed to update the policy framework in view of 2030 and beyond. The most important element of this Directive is an energy efficiency target for 2030 of at least 32.5% as well as measures to facilitate the achievement of the target. This target has to be achieved collectively by EU Member States and is set based on the 2007 modelling projections for 2030. In absolute terms, this means that EU energy consumption should be no more than 1273 Mtoe of primary energy and no more than 956 Mtoe of final energy. It also included an extension to the energy savings obligation in end-use sectors, introduced in the 2012 directive. Under the amending directive, EU countries will have to achieve new energy savings of 0.8% each year of final energy consumption for the period from 2021 to 2030.

In addition, On December 2018, the Governance of the Energy Union and Climate Action¹⁸ entered into force as part of Clean energy for all Europeans package. According to this law, EU Member States have to develop integrated National Energy and Climate Plans (NECPs) that cover the dimensions of the energy union¹⁹ (for the period 2021 to 2030 (and every subsequent ten year period) based on a common template.

The main EU policy for both residential and non-residential buildings is the Energy Performance of Building Directive²⁰ (EPBD) which was introduced firstly in 2002 and then recast in 2010²¹ and in 2018²². Under this Directive, Member States implemented a set of national measures such as energy performance certificates (to be included in all advertisements for the sale or rental of buildings), regular inspections of heating and air-conditioning systems, nearly zero-energy levels for all new buildings by 31 December 2020 (new buildings occupied and owned by public authorities by 31 December 2018). The EPBD also introduced a set of minimum energy performance requirements for new buildings and existing building undergoing major renovation (including the replacement or retrofit of building elements such as heating and cooling systems, roofs, walls, etc.) based on cost optimality. Member States have also implemented other measures and instruments such as financial incentives to promote stimulate efficiency improvements in buildings. In 2018, the EPBD was amended²³. The revised provisions as part of the Clean Energy for all Europeans package regard the acceleration of the cost-effective renovation of existing buildings, with the vision of a decarbonised building stock by 2050 and the mobilisation of investments. Furthermore, the revision aims to enhance smart technologies and technical building systems including automation. The Clean Energy for all Europeans package also includes the revised Directive for Renewable Energies and the Directive for the internal market of electricity.

Another important energy efficiency policy action at EU level has been the introduction of minimum efficiency requirements for products. The Eco-design Directive²⁴ 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 Directive²⁵ was introduced a number of

¹⁶ Source: <https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans>

¹⁷ Directive (EU) 2018/2002

¹⁸ Regulation (EU) 2018/1999

¹⁹ More information on: <https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/building-energy-union>

²⁰ Directive 2002/91/EC

²¹ Directive 2010/31/EU

²² Directive (EU) 2018/844

²³ Source: <https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings>

²⁴ Directive 2009/125/EC

²⁵ Directive 2005/32/EC

implementing Regulations have been adopted introducing efficiency requirements for residential appliances (e.g. refrigerators, freezers, washing machines, dishwashers, etc.), lamps, televisions, air-conditioners, heaters and water heaters, electric motors, power transformers and ventilation units among others²⁶. Efficiency requirements have been complemented by mandatory energy labelling²⁷ as established in the Energy Labelling Regulation²⁸. Energy labelling of residential equipment was first introduced in 1992²⁹, with the first energy label introduced in 1994 for refrigerators. Energy label has contributed to enlarge the market for efficient appliances³⁰ [6]. 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 [7].

It is within this legislative framework where the present report sets out to investigate the latest status and discuss current energy consumption trends in the EU-28 Member States, in each of the four main energy consuming sectors: residential, tertiary, transport and industry. In the residential sector, a special focus on the electricity and natural gas consumption of main household appliances and equipment is carried out, as well as in the most important determinants influencing the final energy consumption trends.

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 on cars energy consumption. Chapter 6 provides an overview of the main changes in the industry sector and subsectors regarding the energy consumption and production output. Chapter 7 corresponds to the conclusions and findings of the report.

²⁶ 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

²⁷ 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

²⁸ Regulation (EU) 2017/1369

²⁹ Council Directive 92/75/EEC

³⁰ There is an on-going energy labelling directive revision process (see COM (2015) 341 final).

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

Gross inland consumption³¹ represents the quantity of energy necessary to satisfy inland consumption of a geographical entity under consideration [8]. It is composed by the final energy consumption by end-users from different sectors, the distribution and transformation losses, the consumption of the energy sector and the statistical differences not captured on primary and final energy consumption³². Final energy consumption is the amount of energy that is actually consumed by end-users from different sectors. Final energy consumption excludes energy used by the energy sector, including for deliveries, and transformation.³³ 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. The primary energy consumption is equal to the gross inland consumption excluding non-energy uses.³⁴ Primary energy consumption measures the total energy demand of a country. It covers consumption of the energy sector itself, losses during transformation (for example, from oil or gas into electricity) and distribution of energy, and the final consumption by end users.³⁵

This chapter covers the gross inland, primary and 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 consumption³⁶ in the EU-28 declined from 1,732 Mtoe in 2000 to 1,651 Mtoe in 2018. Figure 1 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 (1,124 Mtoe) represented the 66.3% of the gross inland consumption in 2018. That means that a large share of energy equal to 33.7% is consumed during the process of the energy transformation and delivery to end-users. This share has slightly dropped compared to 2000, when it was 36.2%. Looking at this data is important for understanding the efficiency of the entire energy system.

The gross inland consumption in the EU-28 reached a maximum of 1,847Mtoe in year 2006. A significant drop of 6.1% took place in 2009 in comparison with 2008, followed by a rise of in 2010. Since then a decreasing trend can be observed, which has interrupted in 2015 (Figure 2). In 2018, the gross inland consumption fell by 0.9% compared to 2017.

³¹ It is important to note that there is a similar term called Total Primary Energy Supply, defined by IEA (International Energy Agency) as the total of Indigenous production, imports, exports, international marine bunkers-international aviation bunkers and stock changes (source: IEA balances definitions)

³² Definition provided by Eurostat. Gross inland consumption does not include energy (fuel oil) provided to international maritime bunkers. It is calculated as follows: primary production + recovered products + net imports + variations of stocks - bunkers. (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Gross_inland_energy_consumption)

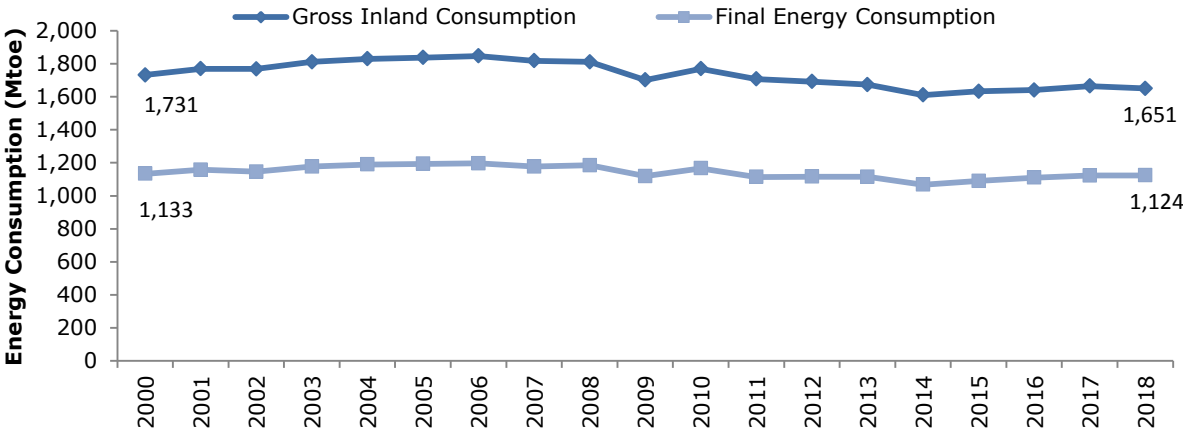
³³ Definition provided by Eurostat. Final energy consumption also excludes fuel transformed in the electrical power stations of industrial auto-producers and coke transformed into blast-furnace gas where this is not part of overall industrial consumption but of the transformation sector. (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Final_energy_consumption)

³⁴ Definition included in Energy Efficiency Directive, Article 2, Paragraph 2

³⁵ Definition by Eurostat (https://ec.europa.eu/eurostat/statisticsexplained/index.php/Glossary:Primary_energy_consumption)

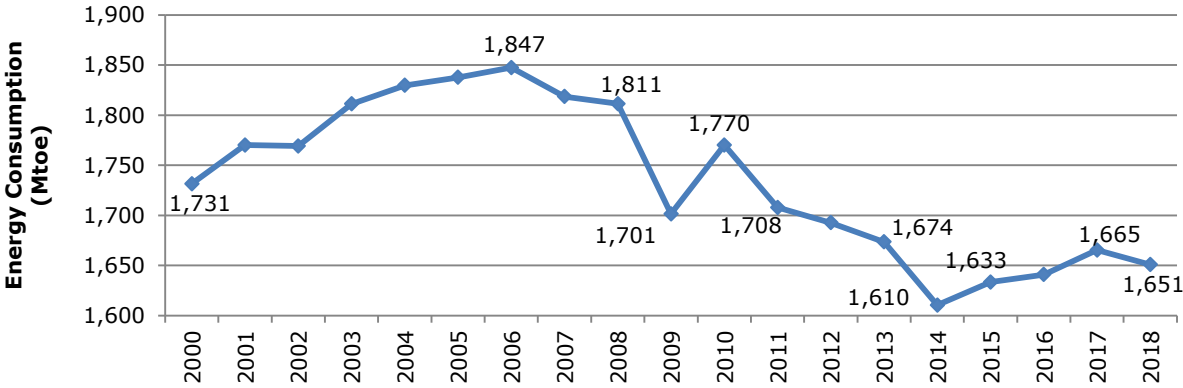
³⁶ In the same context with primary and final energy consumption, the indicator "Gross inland consumption (Europe 2020-2030)" (GIC2020-2030) has been used in this analysis. This indicator estimates Gross inland consumption to that calculated under the old Eurostat methodology – the methodology in place at the time of establishing the Europe 2020 targets. This indicator should be used also for tracking progress towards Europe 2030 targets. The arithmetic definition of this indicator is provided in the Annex.

Figure 1: Gross inland energy consumption – Final energy consumption in the EU-28, 2000-2018



Source: Eurostat

Figure 2: Gross inland consumption in the EU-28, 2000-2018

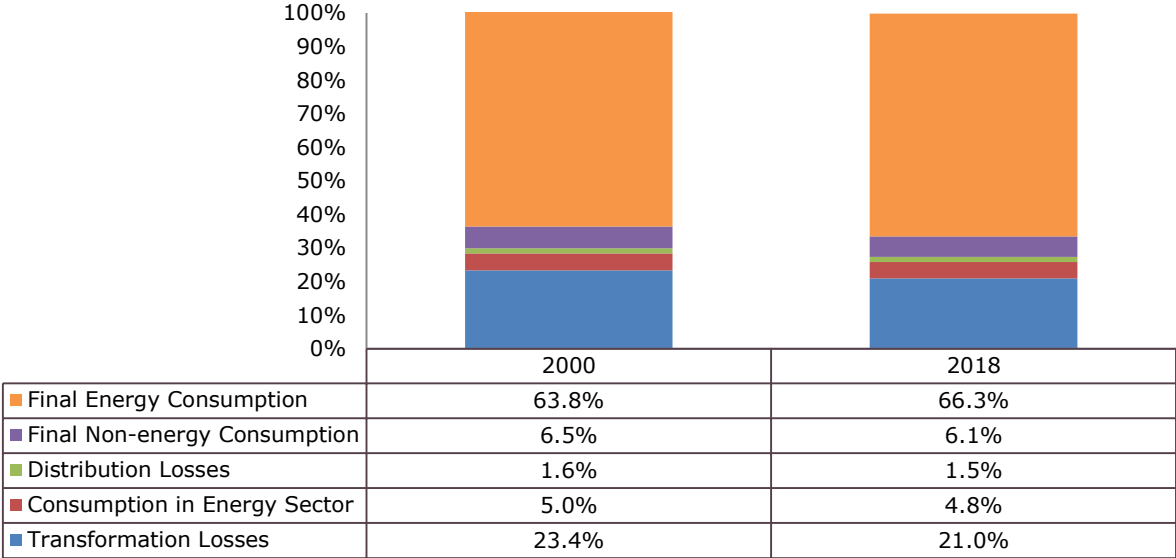


Source: Eurostat

In 2018, the difference between gross inland and final energy consumption is due to transformation losses (22.0%), consumption in the energy sector (4.8%), final non-energy consumption (6.1%) and distribution losses (1.5%)³⁷ (Figure 3). Compared to 2000, there has been a slight increase (+2.6%) of the ratio of the final energy to gross inland consumption. This is the result of the reduction of the shares of all the components, with the only exception the share of final energy that has increased. However, these changes are very small and the main consumption patterns have remained the same.

³⁷ Gross inland consumption breakdown has been studied using the new methodology Eurostat tables for energy balances based on the availability of the data.

Figure 3: Gross inland energy consumption breakdown in the EU-28, 2000 and 2018

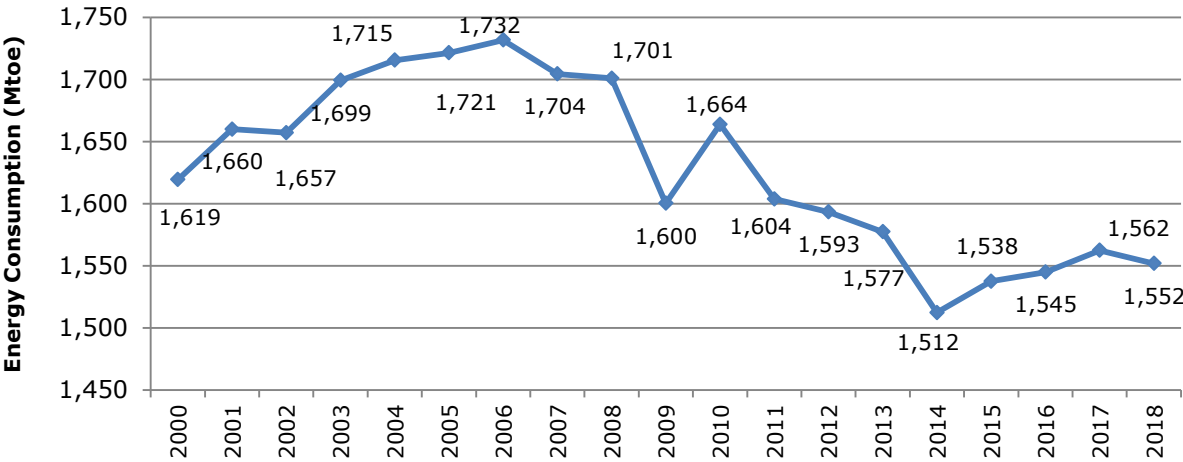


Source: Eurostat

2.2 Primary energy consumption

Primary energy consumption in the EU-28 declined from 1,619 Mtoe in 2000 to 1,552 Mtoe in 2018; representing a drop of 4.2 % over this period. Primary energy consumption followed an increasing trend from 2000 to 2006 (with the exception of 2002), reaching the maximum value over the analysed period in 2006 (1,732 Mtoe). In 2009, the maximum annual growth rate change was observed; when the primary energy consumption dropped by 5.9% in comparison to the year 2008. In 2014, the EU primary energy consumption registered the lowest value over the analysed period (1,512 Mtoe) with a fall of 4.1% in comparison to 2013. From 2015 to 2017 the consumption increased again. In 2018 the primary energy consumption decreased with a reduction rate of 0.7% in comparison with 2017, but remained still above the EU 2020 target. The actual gap to accomplish the target is 4.7 % as per the data corresponding to 2018.

Figure 4: Primary energy consumption in the EU-28, 2000-2018

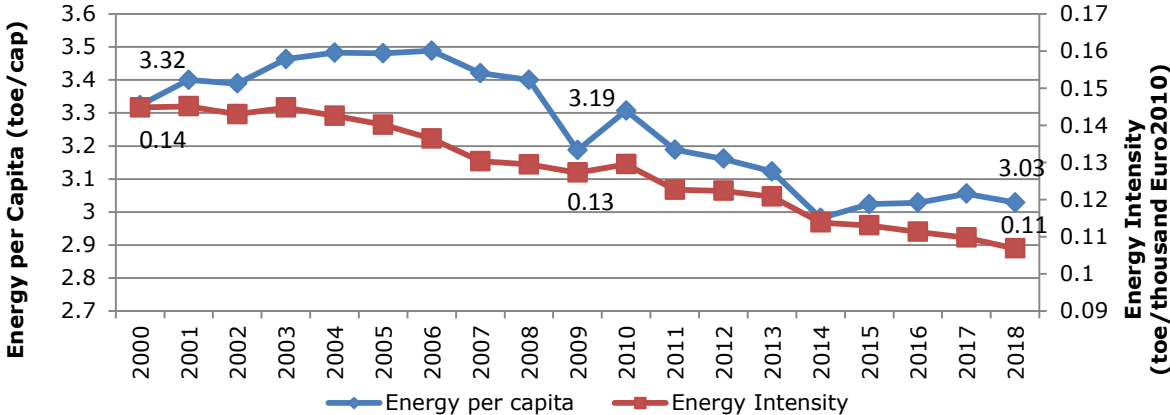


Source: Eurostat

Looking at other representative energy indicators such as energy intensity³⁸ and energy per capita, it can be observed that primary energy intensity declined from 0.14 to 0.11 toe/thousand Euro in the period 2000-2018. From 2000 onwards, there has been a continuous gradual decrease of this indicator, with the exception of 2003 and the period from 2007 to 2010, when energy intensity remained quasi-constant with a value of approximately 0.13 toe/thousand Euro as illustrated in Figure 5. In general, 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 European and national level. In 2018 a decrease of 2.6% was registered compared to 2017.

Energy per capita has decreased by 0.29 toe/cap during the analysed period. It peaked in 2006 (3.49 toe/cap) and dropped to the lowest value in 2014 (2.98 toe/cap). During the period 2014-2017 a modest increasing trend was observed. Primary energy consumption per capita was increased by 2.5% from 2014 to 2017 while it decreased by 0.8% from 2017 to 2018. Both, the EU population growth (Figure 35) and gross inland energy consumption drop have led to the overall reduction of this indicator from 2000 to 2018.

Figure 5: Energy indicators for primary energy consumption: energy per capita and energy intensity³⁹ in the EU-28, 2000-2018



Source: Eurostat

2.3 Final energy consumption in end-users sectors

In 2018 total final energy consumption in EU-28 was 1,124 Mtoe. In comparison to 2017, final energy consumption has remained stable (with a minor increase of 0.1%).

The EU final energy consumption decline of 0.8% has not been gradual for the period 2000-2018. Up until 2010, final energy consumption was higher every year compared to 2000, with the exception of the year 2009 (Figure 6). From 2003 to 2006 there was a constant growth reaching a maximum in 2006 with 1,197 Mtoe. During the period 2011-2013, the final energy consumption has remained nearly constant. Final energy consumption in 2014 has significantly dropped by 4.3% in comparison to 2013 (Table 1), establishing the minimum consumption of the whole period with annual growth rates from 1.2% to 2.1%. After 3 following years of continuous increase, in 2017 it remained almost stable but still above the 2020 EU target (Figure 6). A decrease of 0.8 % can be observed in comparison to the year 2000, when the consumption was 1,133 Mtoe. In

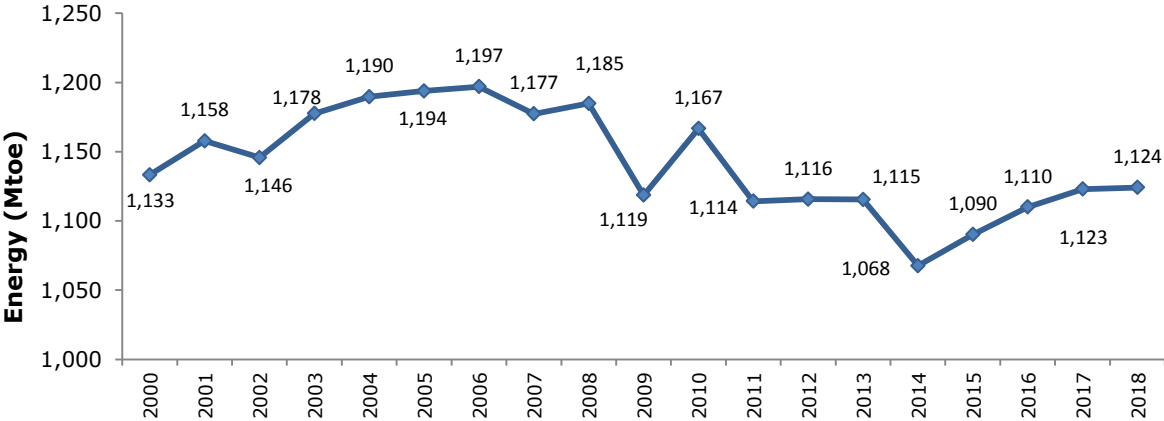
³⁸ Energy intensity is defined as the ratio between the energy consumption and Gross Domestic Product (GDP) calculated for a calendar year. Generally, the lower energy intensity, the higher competitiveness of the region or country analysed.

³⁹ GDP values at market prices have been considered to calculate the energy intensity values reported in the graph. Unit of measure: chain linked volumes (2010), million euro

comparison to 2017, final energy consumption has remained stable (with a minor increase of 0.1%).

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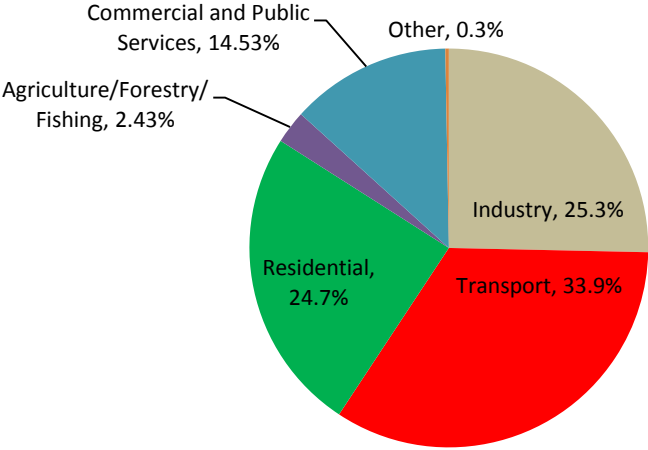
Figure 6: Final energy consumption in the EU-28, 2000-2018



Source: Eurostat

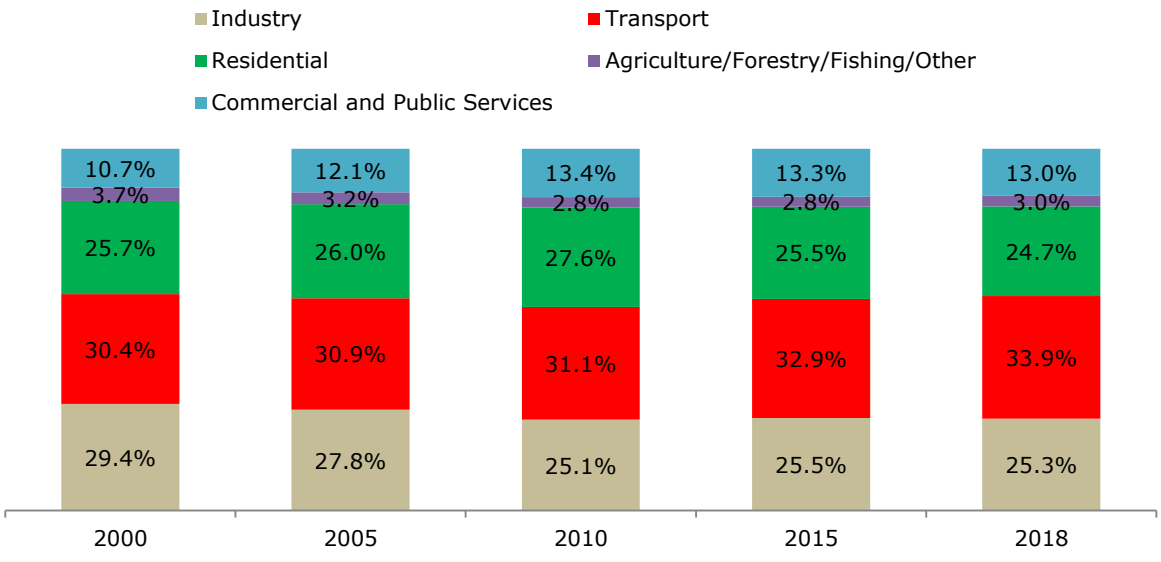
In total, 97.0% of the final energy was consumed by industry, residential, transport and services sectors as illustrated in Figure 7. In 2018, the sector with the largest share of final energy consumption was the transport sector, which consumed 33.9% of the total amount of final energy consumption. The second largest was the industry sector, consuming 25.3%, followed by residential sector with a share of 24.7%. The least consumption sector is service s, with a share of 13.0%. The final energy consumption breakdown by sector for five different years (i.e. 2000, 2005, 2010, 2015 and 2018) is shown in Figure 8. It can be observed that the shares have slightly changed during the period; however the ranking of the sectors regarding final energy consumption has in most cases been maintained (with the exception of residential and industry consumption).

Figure 7: Final energy consumption breakdown into sectors in the EU-28, 2018



Source: Eurostat

Figure 8: Final energy consumption shares by sector in the EU-28, 2000, 2005, 2010, 2015 and 2018



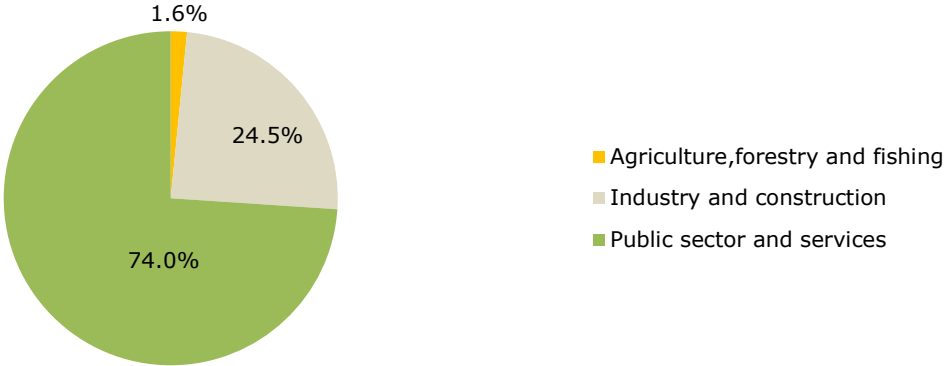
Source: Eurostat

An important indicator to take into consideration when analysing the energy consumption trends by sector is the Gross Value Added. The following figure shows the share of the Gross Value⁴⁰ added of the main economic sectors. Services⁴¹ (including public sector) is the largest contributor of GVA with a total share of 74.0% for the year 2018 while it has one of the smallest shares in total final energy consumption. (If agriculture/forestry/fishing and non-specified final energy consumption is not calculated, it has the smallest share). Industry (including construction) has also an important share

⁴⁰ Unit of measure for GVA: chain linked volumes (2010), million euro
⁴¹ Services include: Wholesale and retail trade, transport, accommodation and food service activities, Information and communication, Financial and insurance activities, Real estate activities, Professional, scientific and technical activities; administrative and support service activities, Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies, Public administration, defense, education, human health and social work activities.

of GVA (24.5%) but it also represents a large share of the total final energy consumption.

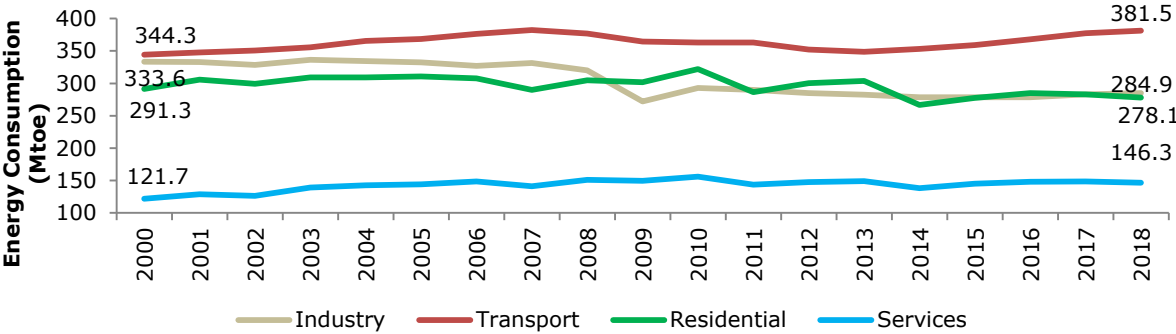
Figure 9: Percentage of gross value added in current prices by economic sector in the EU-28, 2018



Source: Eurostat

Figure 10 shows the final energy consumption breakdown by sector from 2000 to 2018. Final energy consumption of the industrial and residential sectors and residential sectors has varied notably throughout the different years (e.g. between 2008 and 2009 for the industrial sector and between 2013 and 2014 for the residential one), while final energy of transport and services has changed more gradually. The opposing trends of transport and services' increasing trend and, on the other hand, industry's decreasing trend might be representative of an on-going tertiarization process in the European Union. In 2018, however, final energy consumption has increased in industry and transport sector while in services and residential sector it has slightly decreased.

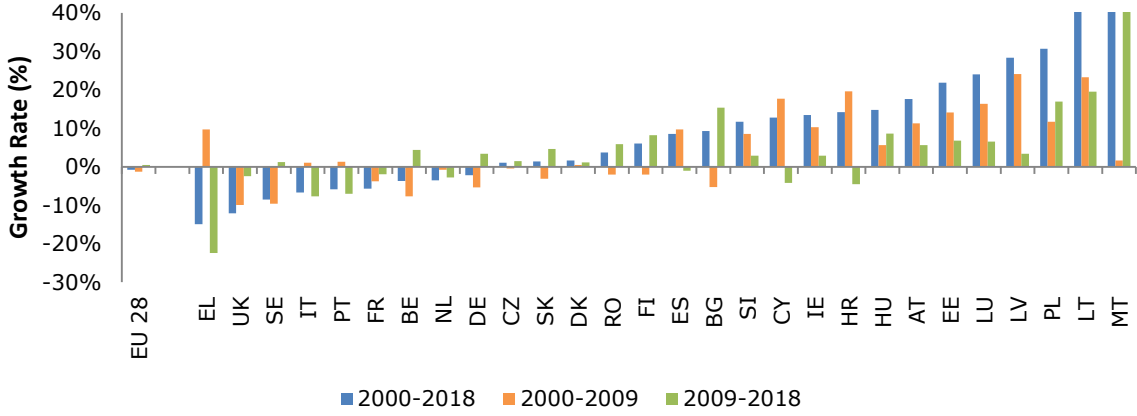
Figure 10: Final energy consumption dynamics through main sectors in the EU-28, 2000-2018



Source: Eurostat

Figure 11 shows the changes of final energy consumption per member state. As regards the analysed period, final energy consumption growth rate varied considerably among the Member States of the European Union. As a whole, the EU-28 countries experienced a reduction rate of -0.8% from 2000 to 2018.

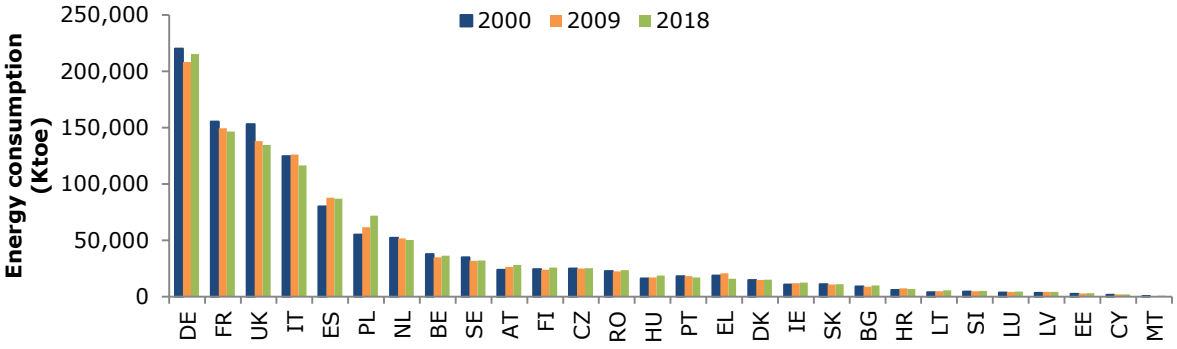
Figure 11: Final energy consumption growth rate by EU-28 Member State; 2000-2018, 2000-2009 and 2009-2018



Source: Eurostat

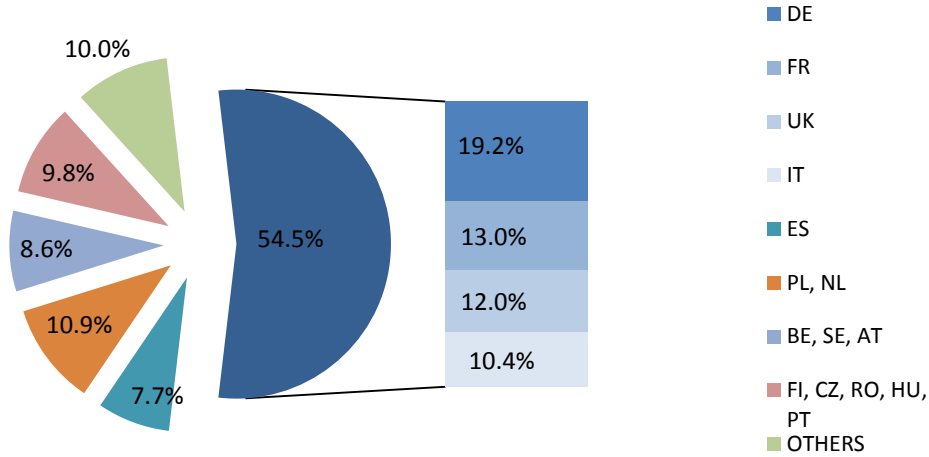
In the period 2000-2018, nine Member States were associated with larger than the EU average reduction rates. The highest reduction rate was observed in Greece (-14.9%), followed by the United Kingdom (-12.1%) and Sweden (-8.5%). In contrast, Malta (48.1%), Lithuania (47.3%) and Poland (30.6%) were the countries with the highest relative increase in final energy consumption compared to 2000. In 2018, Germany had the largest final energy consumption (215.4 Mtoe), which represented a 19.2% share of the total EU final energy consumption. Together with France (146.6 Mtoe; 13.0%), the United Kingdom (134.7 Mtoe; 12.0%) and Italy (116.5 Mtoe; 10.4%), these countries accounted for more than 50% of the EU final energy consumption. Figure 13 shows that fourteen Member States consumed less than 9% of the total energy consumption.

Figure 12: Final energy consumption per Member State in the EU-28, 2000, 2009 and 2018



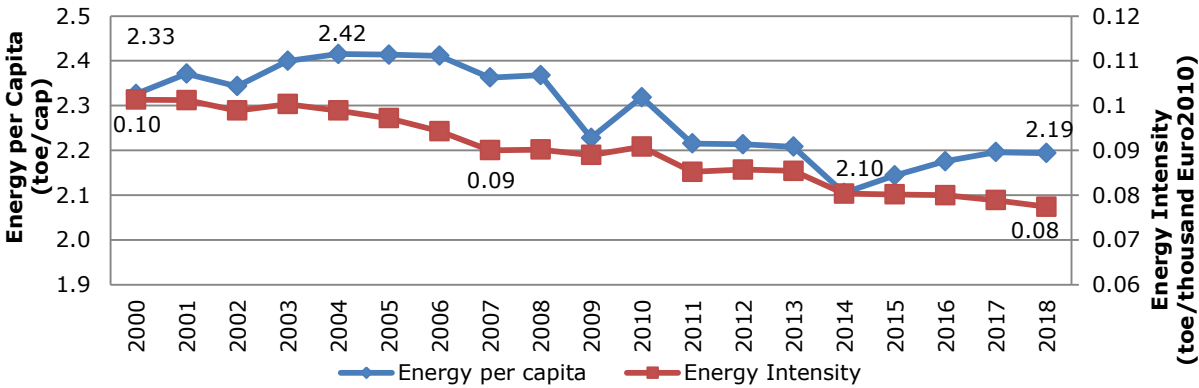
Source: Eurostat

Figure 13: Shares of EU-28 Member States to final energy consumption, 2018



Source: Eurostat

Figure 14: Energy indicators for final energy consumption: energy per capita and energy intensity⁴² in the EU-28, 2000-2018



Source: Eurostat

Final Energy intensity (EI) and energy per capita are depicted in Figure 14. From 2000 to 2018, the EU-28 energy intensity fell by 0.02 toe/thousand Euro, reaching a value 0.08 toe/thousand Euro in 2018. After reaching the lowest value in 2014 over the analysed period (2.10 toe/capita), energy per capita was 2.19 toe/capita in 2018. Energy per capita is mainly influenced by final energy consumption, where growth trends are mostly influenced by the dynamics of final energy more than changes in population. Final energy consumption per capita trends are mostly important for the residential sector consumption analysis. Instead of this, the other sectors are more influenced by other factors such as the economic structure, the number of employees, the industrial production, the performed activities, the stock of vehicles, and not by the population. However, it's important to study the evolution of this indicator in order to understand better the energy consumption trends in correlation with the total population.

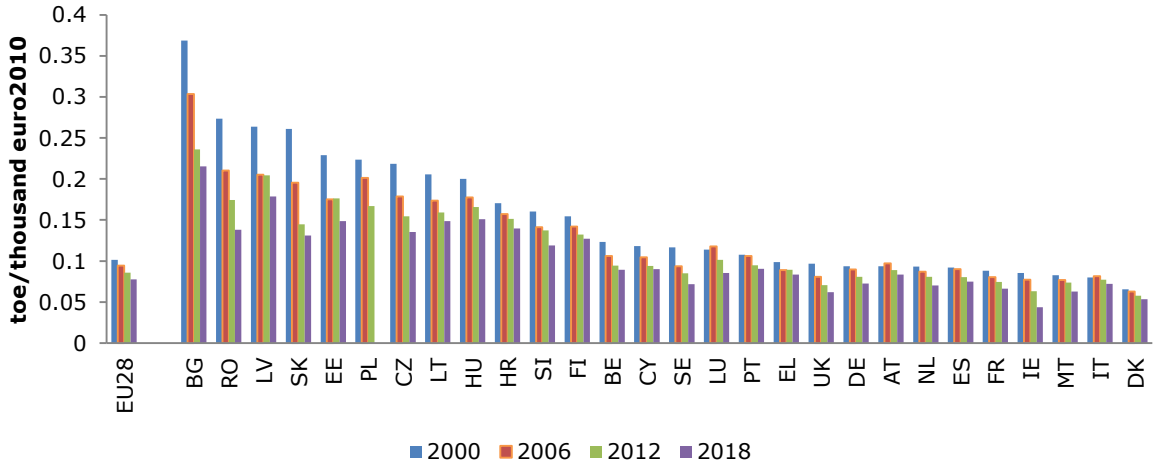
When analysing the energy intensity by country it is possible to notice that in 2018 the member state with the lowest energy intensity was Ireland (0.044 toe/thousand Euro), followed by Denmark (0.054 toe/thousand Euro) and the United Kingdom (0.062 toe/thousand Euro). On the other hand, the MSs with the highest energy intensity in the

⁴² GDP values at market prices have been considered to calculate the energy intensity values reported in the graph. Unit of measure: chain linked volumes (2010), million euro

same year were Bulgaria (0.215 toe/thousand), Latvia (0.179 toe/ thousand Euro) and Hungary (0.151 toe/ thousand Euro). For ten European countries, energy intensity was below EU average in 2018 (<0.077 toe/ thousand Euro).

The highest energy intensity drop during the 19-year period from 2000 to 2018 are found in Slovakia (-49.8%), Romania (-49.5%) and Ireland (-49.0%). Italy, Austria and Greece are the countries whose energy intensity has reduced the least during this period (-9.8%, -10.6% and -15.3% respectively). The overall European EI trends can reflect the interest and efforts made by the EU states to increase their levels of competitiveness as the EU reduction rate has been -23.6% (2000-2018).

Figure 15: Final Energy intensity⁴³ in the EU-28 (GDP at chain linked volumes 2010, million euro), 2000, 2006, 2012 and 2018



Source: Eurostat

Table 1 presents an overview of the EU-28 final energy consumption changes. It provides data about the main consuming sectors, as well as growth rates expressed in percentage with respect to year 2000 and the previous year. Looking at the growth rate respect to 2000 it can be observed that, over the period 2001-2008, EU-28 experienced positive growth rates compared to the baseline year. In contrast, from 2009 onwards, only year 2010 showed a higher level of final energy consumption. Specific insights about the main consuming sectors are given in each of the subsequent chapters.

⁴³ GDP values at market prices have been considered to calculate the energy intensity values reported in the graph. Unit of measure: chain linked volumes (2010), million euro. Poland: not available data for GDP at chain linked volumes (2010) in 2018

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

Final Energy Consumption per Sector, EU-28										
(Mtoe)	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Total	1,133	1,158	1,146	1,178	1,190	1,194	1,197	1,177	1,185	
Industry	334	333	329	336	335	332	327	331	320	
Transport	344	348	351	356	365	368	376	383	377	
Residential	291	306	299	309	309	310	308	290	305	
Services	122	129	126	139	142	144	149	141	151	
(Mtoe)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	1,119	1,167	1,114	1,116	1,116	1,068	1,090	1,110	1,123	1,124
Industry	272	293	290	285	283	279	278	279	283	285
Transport	365	363	363	352	349	353	359	368	377	382
Residential	302	322	286	300	304	267	278	285	283	278
Services	150	156	144	147	149	138	145	148	148	146
% Growth rate to year 2000										
(%)	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Total		2.2%	1.1%	3.9%	5.0%	5.3%	5.6%	3.9%	4.5%	
Industry		-0.3%	-1.5%	0.8%	0.3%	-0.4%	-2.0%	-0.7%	-4.0%	
Transport		1.1%	1.8%	3.3%	6.1%	7.0%	9.3%	11.1%	9.4%	
Residential		4.9%	2.8%	6.2%	6.1%	6.6%	5.7%	-0.6%	4.7%	
Services		5.8%	3.7%	14.4%	17.0%	18.4%	22.0%	16.1%	24.0%	
(%)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	-1.3%	3.0%	-1.7%	-1.6%	-1.6%	-5.8%	-3.8%	-2.1%	-0.91%	-0.8%
Industry	-18.5%	-12.2%	-13.0%	-14.6%	-15.3%	-16.4%	-16.5%	-16.5%	-15.1%	-14.6%
Transport	5.9%	5.5%	5.4%	2.2%	1.2%	2.5%	4.2%	6.8%	9.6%	10.8%
Residential	3.6%	10.6%	-1.7%	3.1%	4.2%	-8.5%	-4.7%	-2.2%	-2.9%	-4.5%
Services	23.0%	28.2%	18.1%	21.1%	22.6%	13.6%	19.1%	21.5%	21.9%	20.2%
% Growth rate to previous year										
(%)	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Total		2.2%	-1.0%	2.8%	1.0%	0.4%	0.3%	-1.6%	0.6%	
Industry		-0.3%	-1.3%	2.4%	-0.5%	-0.7%	-1.6%	1.4%	-3.4%	
Transport		1.1%	0.8%	1.4%	2.8%	0.8%	2.2%	1.7%	-1.5%	
Residential		4.9%	-2.0%	3.3%	-0.1%	0.4%	-0.8%	-5.9%	5.3%	
Services		5.8%	-2.0%	10.3%	2.3%	1.2%	3.0%	-4.8%	6.8%	
(%)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	-5.6%	4.3%	-4.5%	0.1%	0.0%	-4.3%	2.1%	1.8%	1.2%	0.1%
Industry	-15.1%	7.7%	-0.9%	-1.8%	-0.8%	-1.4%	-0.1%	0.1%	1.6%	0.6%
Transport	-3.3%	-0.4%	-0.1%	-3.0%	-1.0%	1.3%	1.6%	2.5%	2.6%	1.1%
Residential	-1.0%	6.8%	-11.1%	4.8%	1.1%	-12.2%	4.2%	2.6%	-0.7%	-1.6%
Services	-0.8%	4.3%	-7.9%	2.6%	1.2%	-7.3%	4.8%	2.0%	0.4%	-1.4%

Source: Eurostat

2.4 Final energy consumption per fuel types

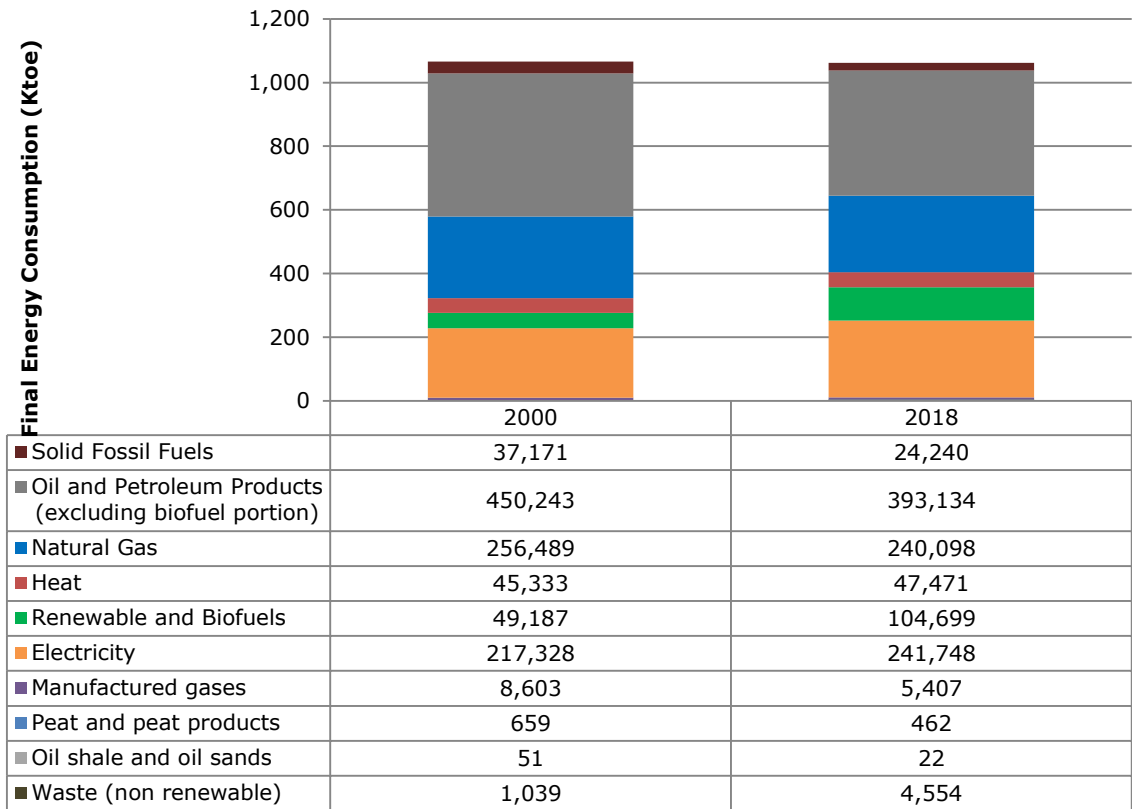
The main energy fuels are petroleum products, electricity and natural gas, which provide the 37.0%, 22.8% and 21.6% of the final energy consumption⁴⁴ in 2018 respectively (Figure 16).

Renewables, solid fossil fuels and heat, have a total share of around 16.61%. Renewable energy sources include hydro, tide, wave and ocean, wind, solar photovoltaic, solar thermal, geothermal, primary solid biofuels, charcoal, biogases, renewable municipal waste, pure and blended biogasoline, pure and blended biodiesels, pure and bio jet kerosene, other liquid biofuels and ambient heat. Over the period 2000-2018 there have been reductions in oil shale and oil sands, peat and peat products, manufactured gases, natural gas, oil and petroleum products and solid fossil fuels while there have been increases in non renewable waste, electricity, renewables and biofuels, and heat. This shows that the slight drop in final energy consumption from 2000 to 2018 is to a considerable extent, the combined result of diverse changes in the energy mix. For instance the energy gap due to a decline of 16.4 Mtoe in natural gas, in 57.1 Mtoe in petroleum and in 12.9 Mtoe in solid fuels has been covered by the increase of other energy types such as renewables, electricity and heat and waste. 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 natural gas or other energy sources.

Furthermore, in the specific case of electricity, the consumption share is expected to grow in the future. This will be the result of the high growth of ICT sector, the development of big data centres, the development of household electrical appliances and devices with advanced features, requiring increased use of electrical energy and the extended use of heating pumps. All those elements signal a significant change in the end-users' consumption behaviour patterns. This may lead to a rising trend of electrification, especially in residential and service sector. Secondly, the 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. This could be an additional factor that may lead to the increase of electricity consumption next years.

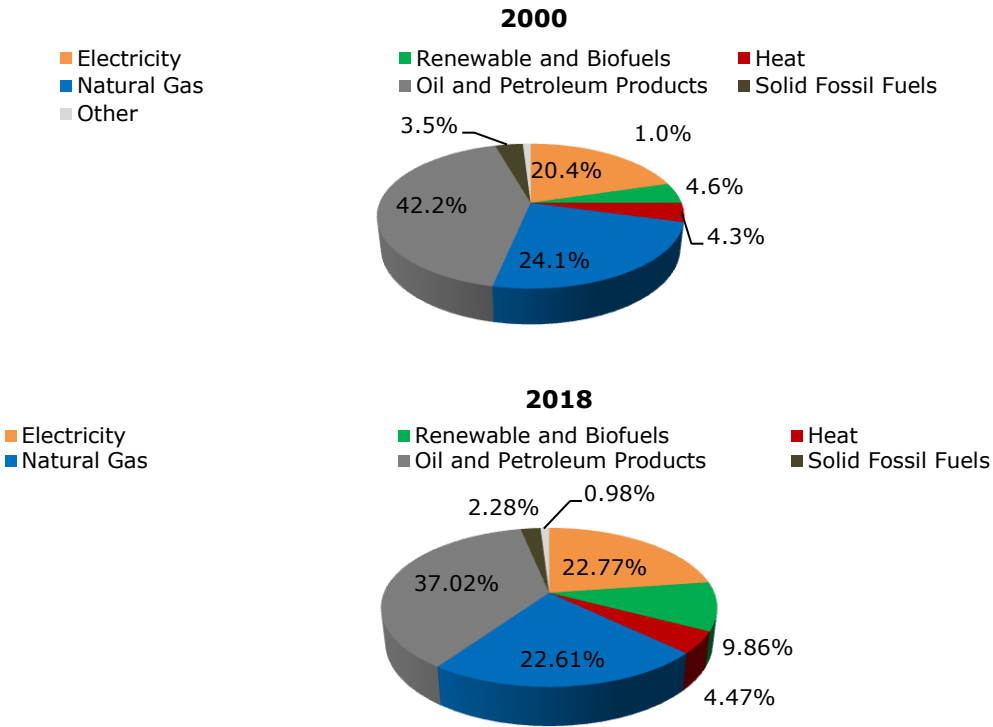
⁴⁴ The analysis of final energy consumption per fuel type uses the new methodology Eurostat tables for energy balances based on the availability of the data.

Figure 16: Final energy consumption by energy types in the EU-28, 2000 and 2018



Source: Eurostat

Figure 17: Share of energy source to final energy consumption in the EU-28, 2000 and 2018



Source: Eurostat

With regard to different energy source shares, from 2000 to 2018 electricity has raised its share (by 2.4%). the share of renewable energy sources' has notably augmented (more than doubled), derived heat's and other sources⁴⁵ shares have remained almost stable, while the shares of solid fuels, natural gas, petroleum and oil product have decreased by 1.2%, 1.5% and 5.2% respectively.

Several changes in energy sources' ranking occurred from 2000 to 2018. Total petroleum products were in the first position during the analysed period while solid fossil fuels were in the final position (if other sources are not counted). Natural gas and electricity swapped several times their ranking positions. Renewables and biofuels and heat were in the fourth and fifth positions in both studied years (2000 and 2018).

No significant changes in ranking and shares of the different energy sources occurred from 2017 to 2018. Renewables and biofuels and other had slightly increased their shares. Electricity and natural gas shares remained almost stable (minor increases). All other sources have decreased slightly their shares.

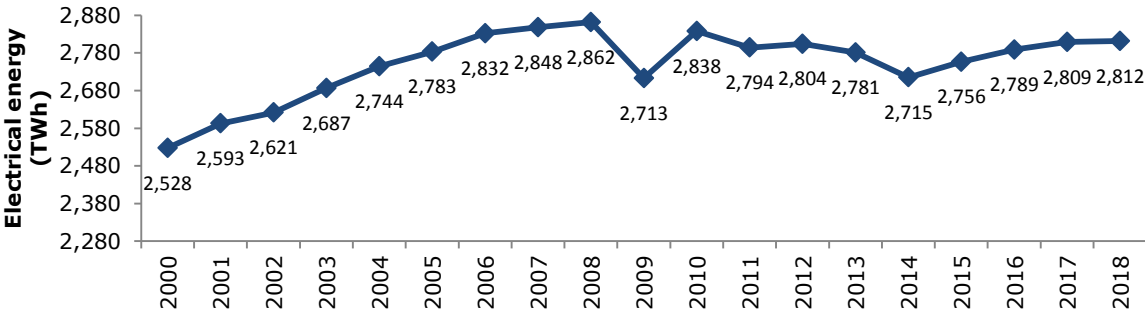
2.5 Final electricity and natural gas consumption in different sectors

This subchapter covers the analysis of electricity and gas consumptions in different sectors over the period 2000-2018 in the 28 countries of the European Union.

Final Electricity consumption

In 2018, total electricity consumption⁴⁶ across the EU-28 countries was 2,811.5 TWh. It corresponds to an increase of 11.2% compared to 2000, when the electricity consumption was 2,527.5 TWh. In 2018, electricity consumption reached its maximum level (2,861.5 TWh) while the minimum value was registered in 2000. A drop of 5.2% interrupted the increasing trend observed from 2000 to 2008 (Figure 18). A decreasing trend has also been observed from 2010 to 2014 (with the exception of the year 2012). After this period, the values started to rise again. In 2018 final electricity consumption remained stable compared to 2017 (annual growth rate by 0.1%).

Figure 18: Final electricity consumption in the EU-28, 2000-2018



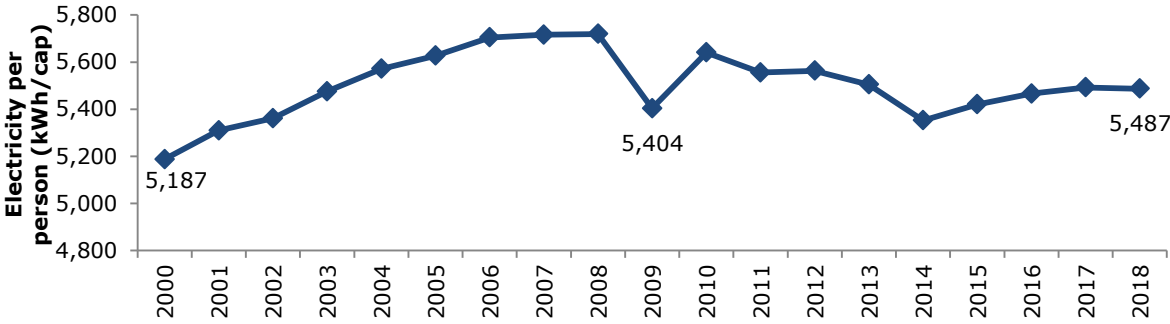
Source: Eurostat

In 2018, final electricity per capita consumption was 5,487 kWh. This value represents a rise of 5.8% in comparison to 2000. From 2017 to 2018 it remained almost stable with a minor reduction rate of -0.1% (Figure 19).

⁴⁵ Other includes waste (non-renewable), oil shales and oil sands, peat and peat products and manufactured gases.

⁴⁶ The analysis of electricity consumption uses the new methodology Eurostat tables for energy balances based on the availability of the data

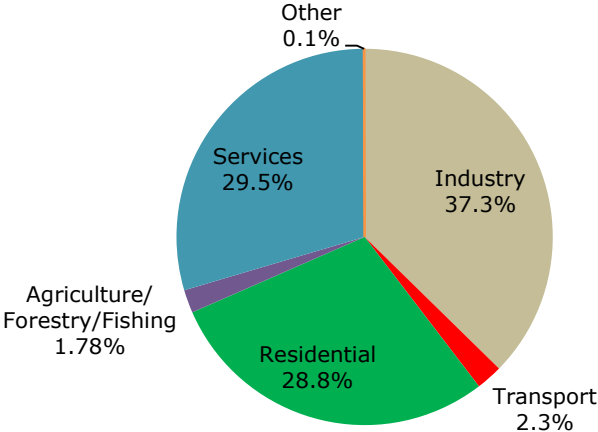
Figure 19: Final electricity per capita consumption in the EU-28, 2000-2018



Source: Eurostat

Three sectors account for more of 95% of the electricity consumption⁴⁷ in EU-28. A total 37.3% of the electricity is consumed in the industry sector, 29.5% in the service sector and 28.8% in the residential (Figure 20).

Figure 20: Electricity consumption breakdown into sectors in the EU-28, 2018



Source: Eurostat

In the period 2000-2018, the industry sector has always been the sector with the highest electricity consumption, reaching a maximum of 1,140 TWh in 2007. For the same sector, a pronounced dip corresponding to a 13.6% in the electricity consumption took place between 2008 and 2009, as a result of the impact of the financial crisis. While the industrial electricity consumption at European level started to rise again in 2010-2011, it declined at a slow pace from 2011 to 2014. However, since 2015 it has started to increase once more. In 2018, it increased by 0.4% compared to 2017, reaching the value of 1,050 TWh. The residential and service sectors had different growth rates from 2000 to 2008. Since then these sectors have experienced more similar trends as illustrated in Figures 21 and 22.

⁴⁷ Sectoral analysis of electricity consumption has been studied using the new methodology Eurostat tables for energy balances based on the availability of the data.

Figure 21: Final electricity Consumption trends of main consuming sectors in the EU-28, 2000-2018

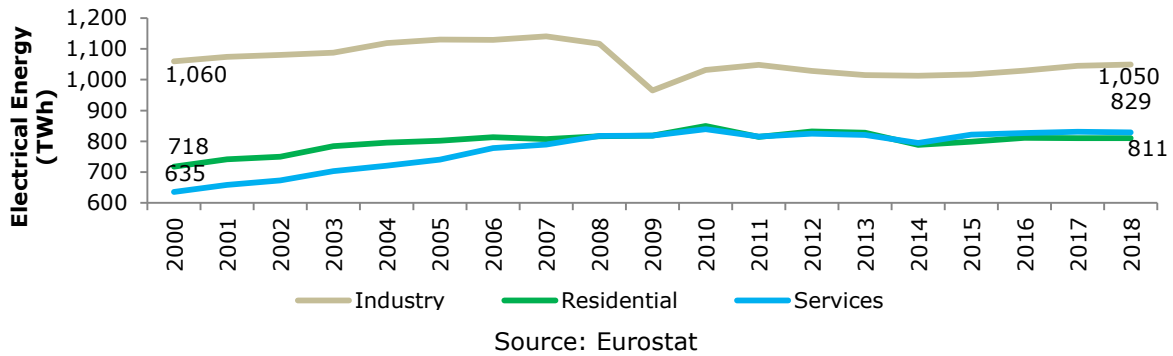


Figure 22: Final electricity Consumption trends of main consuming sectors in the EU-28, 2000-2018 (2000=100%)

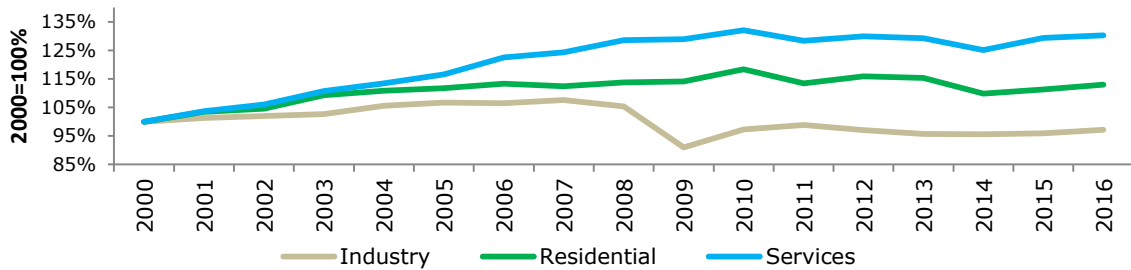
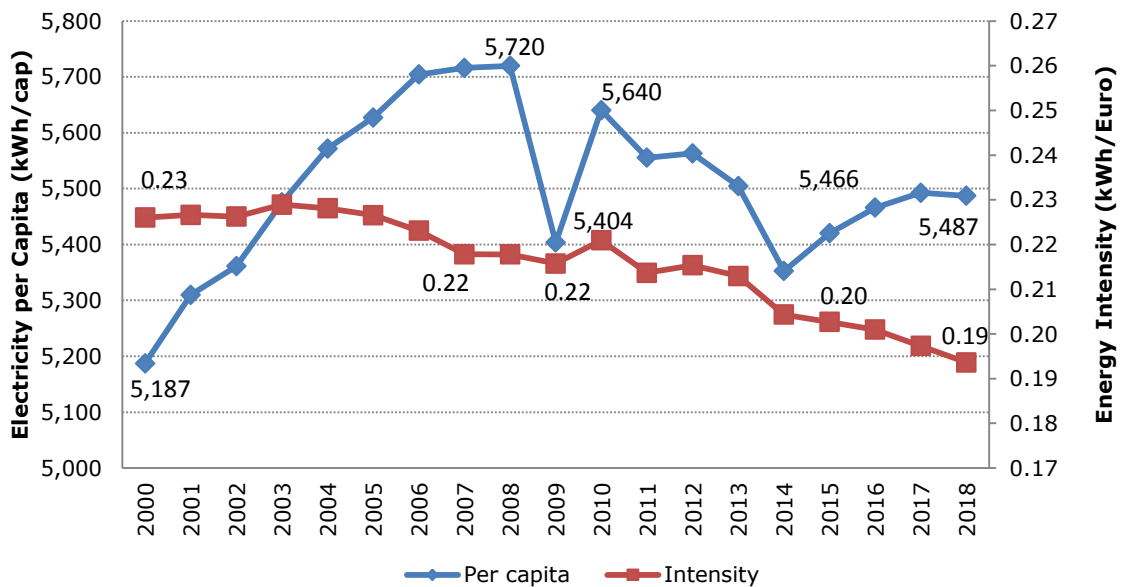


Figure 23: Energy indicators for final electricity consumption: electricity per capita and electrical energy intensity⁴⁸ in the EU-28, 2000-2018



Source: Eurostat

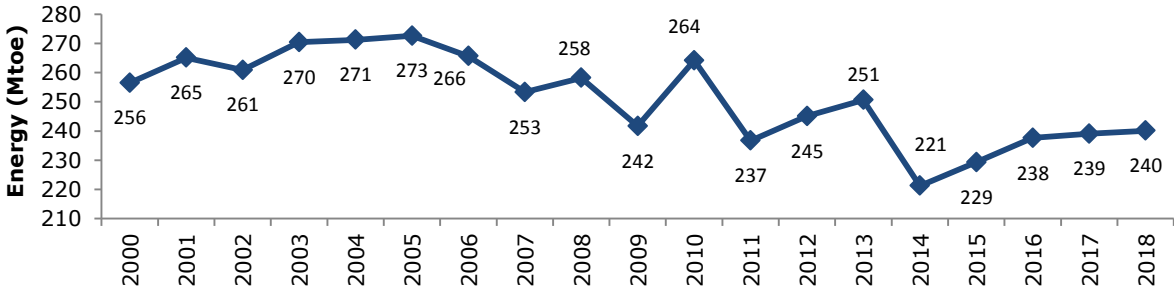
⁴⁸ GDP values at market prices have been considered to calculate the energy intensity values reported in the graph. Unit of measure: chain linked volumes (2010), million euro. Electricity consumption values have been taken from new methodology Eurostat databases based on to the availability of data.

Figure 23 describes the trend of the energy intensity of the final electricity consumption and the trend of final electricity consumption per capita. In 2018 the energy intensity of the final electricity consumption was 0.19 kWh/Euro, the lowest value over the analysed 19-year period. This corresponds to a drop by 1.9% compared to 2017. In the period from 2000 to 2018, the energy intensity of the final electricity has gradually dropped by 0.04 kWh/Euro, corresponding to a drop by 14.3%. Between 2007 and 2009, the value remained stable around 0.22 kWh/Euro. In the period 2000-2017, the final electrical energy consumption per capita has grown by 300 kWh/cap. This indicator reached a maximum in 2008 with 5,720 kWh/cap, followed by a fall of 316 kWh/cap in 2009. From 2010 to 2014, this indicator has continuously dropped with the exception of 2012 when remained relatively stable. In the period 2014-2017 it has increased by 140 kwh/cap however the value of 2018 (5,487 kwh/cap) is still below the level of 2013 (5,505 kwh/cap) and stable compared to the value registered in 2017.

Final Natural Gas Consumption

In 2018, the total natural gas consumption⁴⁹ of the EU-28 countries reached 240 Mtoe. This established a drop of 6.4% in comparison to the level of year 2000 when the consumed gas was equal to 257 Mtoe. During the whole studied period several fluctuating trends can be observed. The maximum value was registered in 2005 (273 Mtoe) while the minimum value was registered in 2014 (221 Mtoe). A continuous increasing trend has been observed from 2014 to 2018. In 2018 it increased very slightly compared to 2017 (by 0.5%).

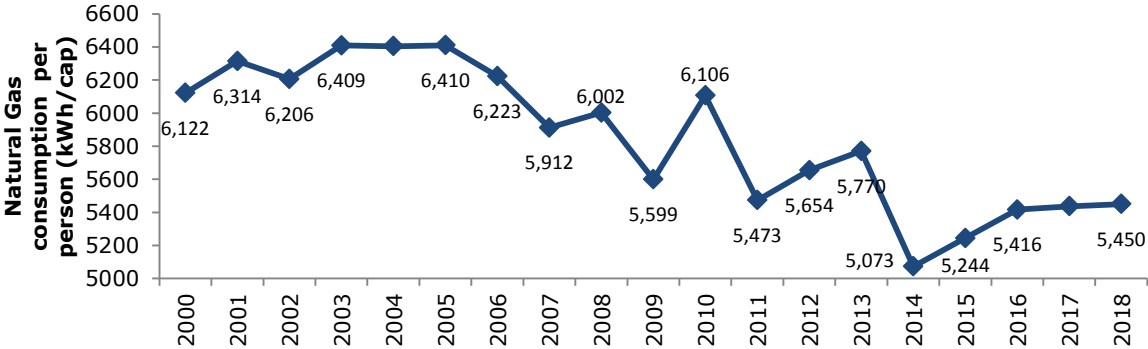
Figure 24: Final natural gas consumption trends in the EU-28, 2000-2018



Source: Eurostat

In 2018, the final natural gas consumption per capita in the EU-28 was 5,450 kWh. This value represents a drop of 11.0% in comparison to the year 2000. From 2017 to 2018 it remained almost stable with a minor growth rate of 0.3% (Figure 25).

Figure 25: Final natural gas per capita consumption trend in the EU-28, 2000-2018

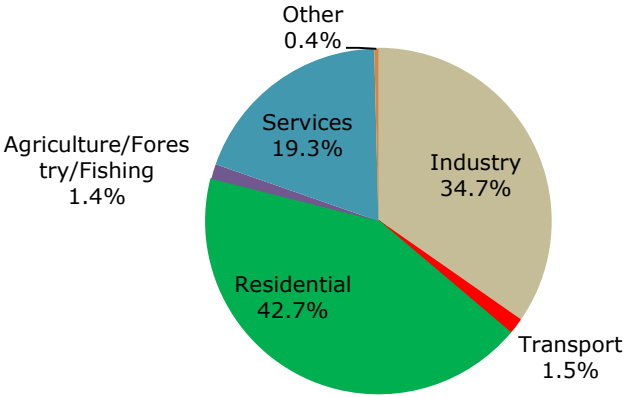


Source: Eurostat

⁴⁹ The analysis of natural gas consumption uses the new methodology Eurostat tables for energy balances based on the availability of the data.

As in the case of final electricity consumption, natural gas consumption is primarily associated with three sectors. The residential sector is the highest consumer of gas with 42.8%, followed by industry sector with 34.7% and service sector which accounts for 19.3% of total final gas consumption. The three sectors together cover almost the 97% of the gas consumption of the European Union, as illustrated in Figure 26.

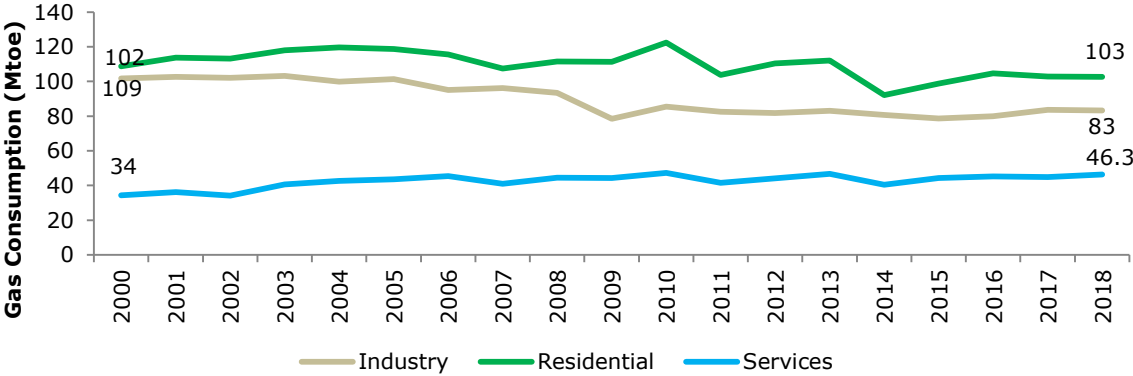
Figure 26: Natural gas consumption breakdown into sectors in the EU-28, 2018



Source: Eurostat

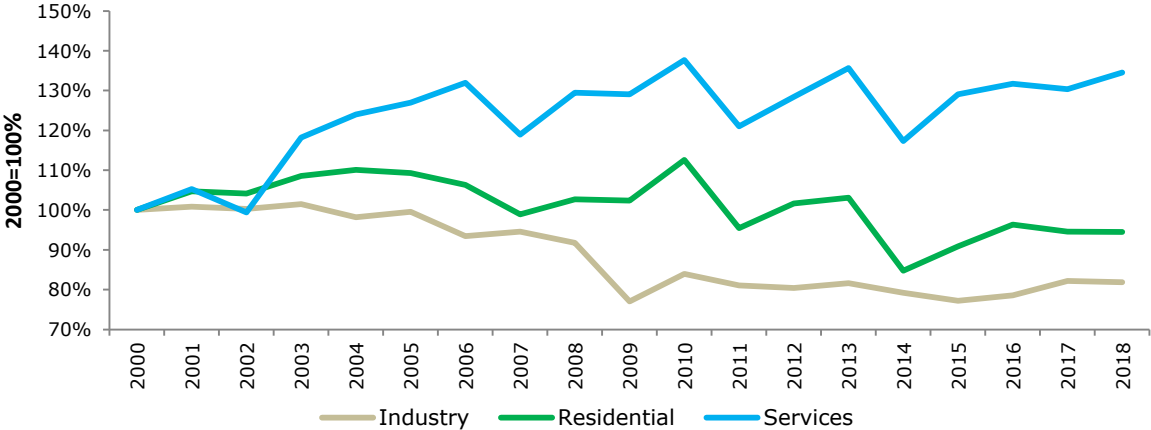
Figures 27 and 28 show the natural gas consumption trend for the period 2000-2018 for the three aforementioned sectors. In 2000, the residential and industry sectors had the highest shares of consumption of natural gas, 108,661 ktoe (42.4%) and 101,748 ktoe (39.7%) respectively. During this the period, the trends have reversed but the ranking has remained the same. Both sectors have occasionally experienced significant changes in consecutive years, e.g. between 2008 and 2009 the consumption of natural gas in industry sector declined by 16.0% and between 2010 and 2011 it dropped by 15.2% in the residential sector. Overall industry has experienced a reduction in natural gas consumption; services sector has experienced a gradually rising trend, while residential sector has experienced an overall slight increase from 2000 to 2018. From 2017 to 2018, natural gas consumption has remained almost stable in industry and residential while it has slightly increased in services sector.

Figure 27: Final natural gas consumption dynamics through main consuming sectors in the EU-28, 2000-2018



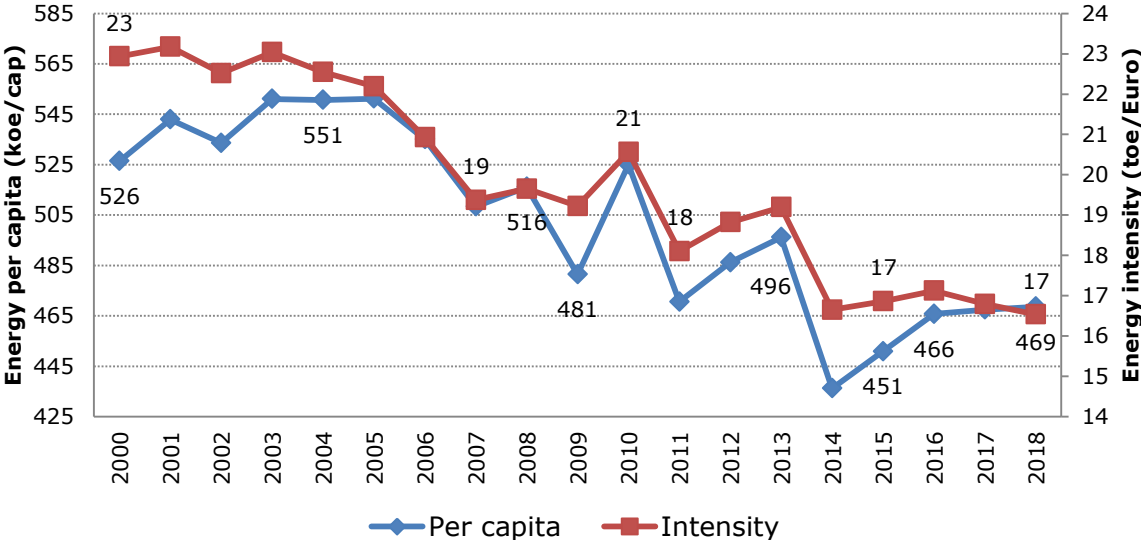
Source: Eurostat

Figure 28: Final natural gas consumption dynamics through main consuming sectors in the EU-28, 2000-2018 (2000=100%)



Source: Eurostat

Figure 29: Energy indicators for final natural gas consumption: gas consumption per capita and gas energy intensity⁵⁰ in the EU-28, 2000-2018



Source: Eurostat

Figure 29 describes the trend of the energy intensity of the final gas consumption and the trend of final natural gas consumption per capita. In 2018 the final energy intensity for natural gas consumption was 16.5 toe/Euro, the lowest value over the analysed 19-year period. In 2018 the energy intensity decreased by 1.5% compared to 2017 with the value of 16.7 toe/Euro. In the period from 2000 to 2018, the energy intensity of the final natural gas consumption has dropped by 6.4 toe/Euro. Between 2004 and 2018, the value remained within the range of 16.5-17.1 toe/Euro. In the period 2000-2018, the final natural gas energy consumption per capita has decreased by 57.8 koe/cap. This indicator reached its maximum in 2005 with 551.2 toe/cap. Since 2008, it registered fluctuating trends. In 2018, a very slight annual positive growth rate was registered

⁵⁰ GDP values at market prices have been considered to calculate the energy intensity values reported in the graph. Unit of measure: chain linked volumes (2010), million euro. Natural gas consumption values have been taken from new methodology Eurostat databases based on the availability of data.

(0.3%). The overall drop of 11% can be attributed in part to the increase of population and of the energy efficiency policies implemented during the analysed period.

3 Energy Consumption and Energy Efficiency Trends in the Residential Sector

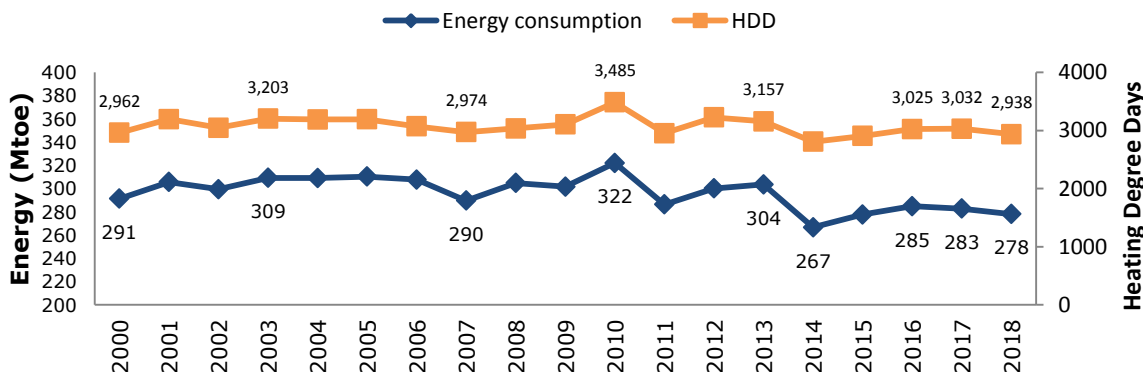
This chapter covers energy efficiency and energy consumption trends in the residential sector, with a focus on electricity and natural gas consumption. Consumption related data are presented together with data regarding some main energy consumption drivers such as economic growth, population growth,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

3.1 Final energy consumption trends in the residential sector

This section shows the final residential energy consumption trends⁵¹ for the period 2000-2018. Influencing factors in the energy consumption such as economic development and weather conditions are qualitatively analysed. In 2018, the residential sector represented 24.7% of the final energy consumption in the EU, being the third consuming sector after transport (33.9%) and industry (25.3%). 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 significant decreases in 2011 and 2014 of 11.1% and 12.2% respectively.

Figure 30 shows the final residential energy consumption trend at European level along with the weather conditions measures in Heating Degree Days. It can be observed that, after a peak in 2010 (322.1 Mtoe), the energy consumption has reached its minimum in 2014 (266.6 Mtoe). These two values represent the maximum and minimum respectively for the 29-year period from 1990 to 2018. During the period 2000-2018, the final residential energy consumption in the EU-28 has dropped by 4.5%, from 291.3 Mtoe to 278.1 Mtoe while it dropped by 1.6% compared to 2017.

Figure 30: Final residential energy consumption in the EU-28, 2000-2018



Source: Eurostat

In Figure 30 is studied also whether there is a correlation between weather conditions and final energy consumption in residential sector. It's true that 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. Simple parameters, which can be related to the heating and cooling needs, are the so-called Heating Degree Day (HDD)⁵² and Cooling Degree Day (CDD). As shown in Figures 30 and 31, the final residential energy consumption line follows Heating Degree Days line with the exception of years 2009 and 2013. This indicates that there is a strong correlation between the two

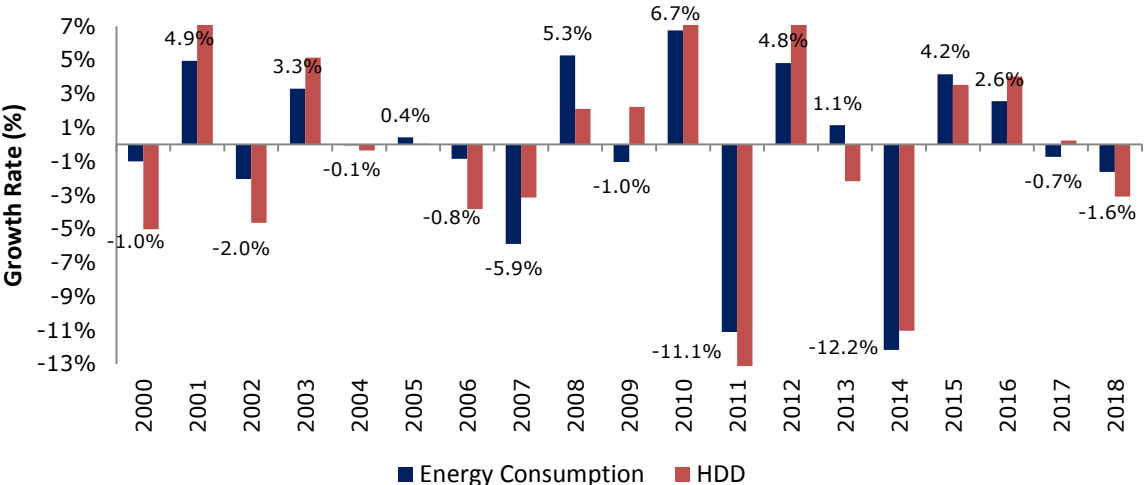
⁵¹ Residential energy consumption trends have been analysed using the old methodology Eurostat tables in order to be comparable with the EU 2020 targets.

⁵² 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].

indicators. The differences in trends registered for 2009 and 2013 might be explained by the influence of other factors, and probably of economic and behavioural nature, since both these years are after two periods of economic crisis. In 2009 the society crisis concern and the economic repercussion may explain the negative correlation between both variables (final energy consumption and HDD) as GDP per capita and disposable income fell that year. On the contrary the final consumptions increased in 2013 despite a reduction of HDD, probably because of new positive outlook for the European economy.

Figure 31 complements the previous figure by providing a visualisation of the yearly growth rates over the period 2000-2018. In this way, it is possible to have an idea about the magnitude of the variation across years. It can be observed that from 2003 to 2006 the consumption remained quasi-constant with the highest change of -0.8% between 2005 and 2006. Since 2007 onwards, the final residential energy consumption has registered an almost continuous fluctuation. To be noted that when consumption decreases, the growth rate is higher compared to when the energy consumption grows.

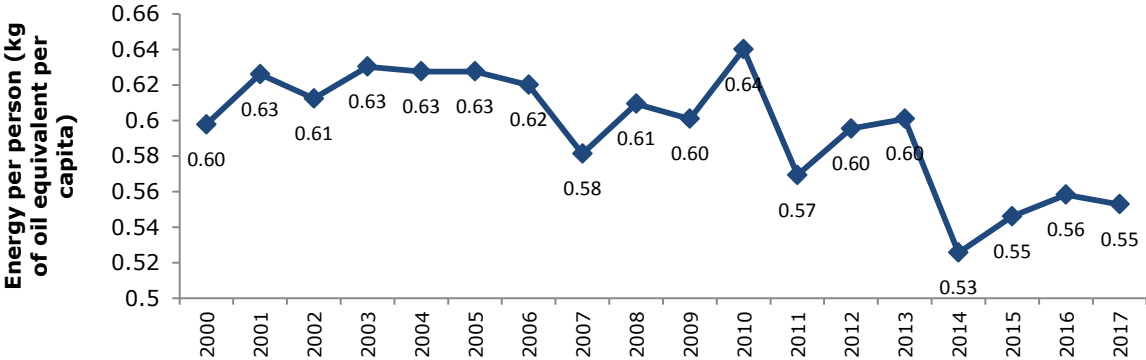
Figure 31: Final residential energy consumption and Heating Degree Days annual growth rates in the EU-28, 2000-2018



Source: Eurostat

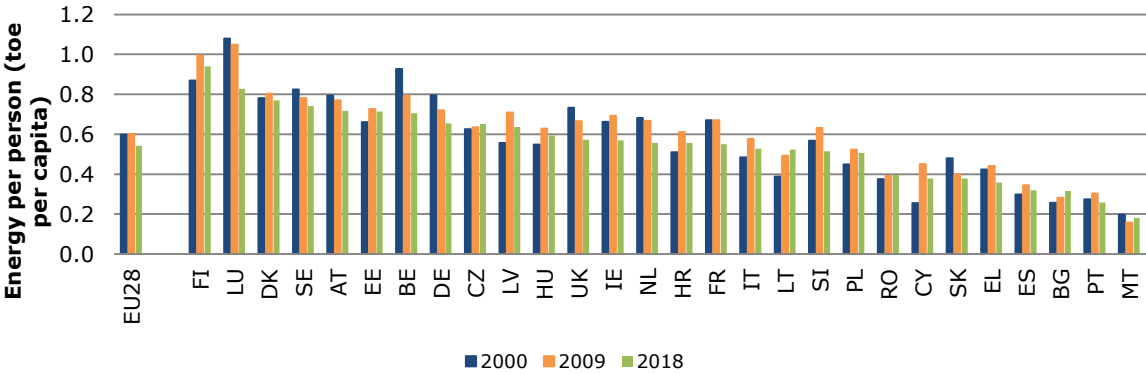
Per capita final energy consumption in the residential sector has lowered by 55.0 koe at European level from 2000 to 2018, meaning a drop of 9.2%. The trend of this indicator mainly follows that of the final residential energy consumption, as the changes in the population growth rates have been much less sharp than the energy consumption changes. Therefore, despite the fact that the EU-28 population has been continuously growing (it has increased by 5.2% from 2000 to 2018), its influence on the final residential energy consumption changes is quite limited.

Figure 32: Final residential energy consumption per capita in the EU-28, 2000-2018



Source: Eurostat

Figure 33: Final residential energy consumption per capita by EU-28 Member State, comparison 2000, 2009 and 2018

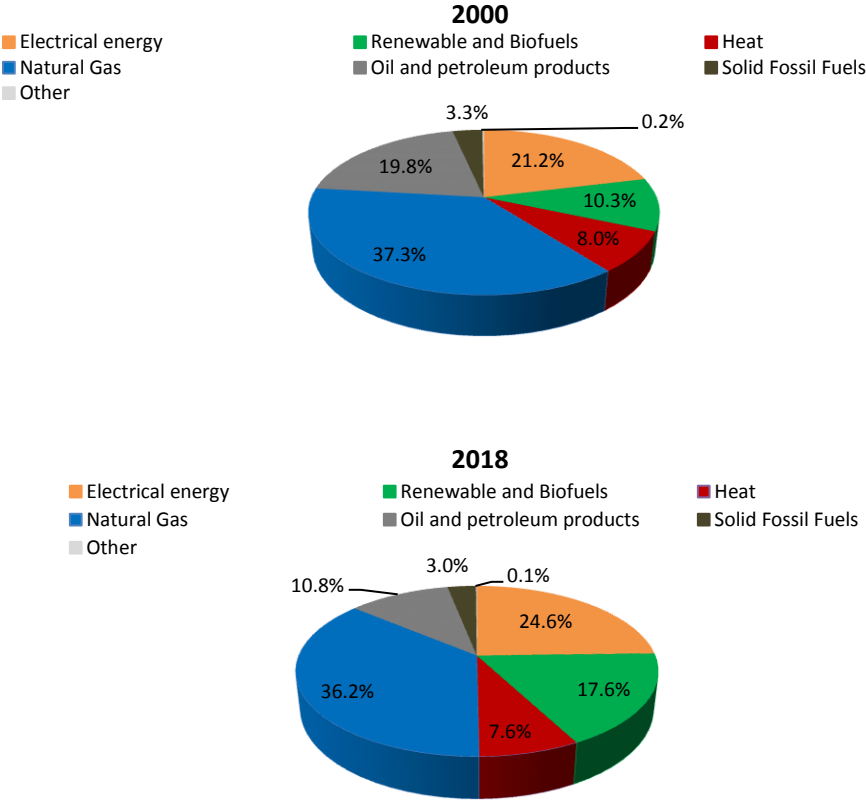


Source: Eurostat

When analysing the final residential energy per capita by Member State (Figure 33), it is observed that in 2018 the countries with highest consumption are Finland with 0.94 toe/cap, followed by Luxembourg (0.83 toe/cap) and Denmark (0.77 toe/cap). In contrast, Malta, Portugal and Bulgaria have the lowest rate with 0.18, 0.26 and 0.32 toe/cap respectively.

Twelve countries, have registered a final energy consumption per capita below the value of EU-28 (< 0.54 toe/cap) in 2018. 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. . All other Countries belong to the Eastern European area (Bulgaria, Slovakia, Romania, Poland, Slovenia, and Lithuania). This indicates that also cultural habits may influence the residential consumptions.

Figure 34: Share of fuel types to final residential energy consumption in the EU-28, 2000 and 2018



Source: Eurostat

Figure 34 shows the share of each fuel type to final residential energy consumption⁵³. In 2018, natural gas has accounted for 36.2% of the consumption, followed by electrical energy (24.6%) and renewable energies and biofuels (17.6%). Compared to the year 2000, there are several changes in the ranking and the share of energy sources. For example, the share of renewable energies has increased from 10.3% to 17.6%. As a consequence, renewable energies are the third contributor to the energy mix in residential sector in 2018 while it was the fourth one in 2000. Electricity also increased its share from 21.2% to 24.6% and maintained the second ranking position in both studied years. On the other hand, oil and petroleum products reduced their share from 19.8% in 2000 to 10.8% in 2017. Natural gas reduced its share but it maintains the first ranking position also in 2018. From 2017 to 2018, there are no changes in the ranking of energy sources and slight changes in their shares.

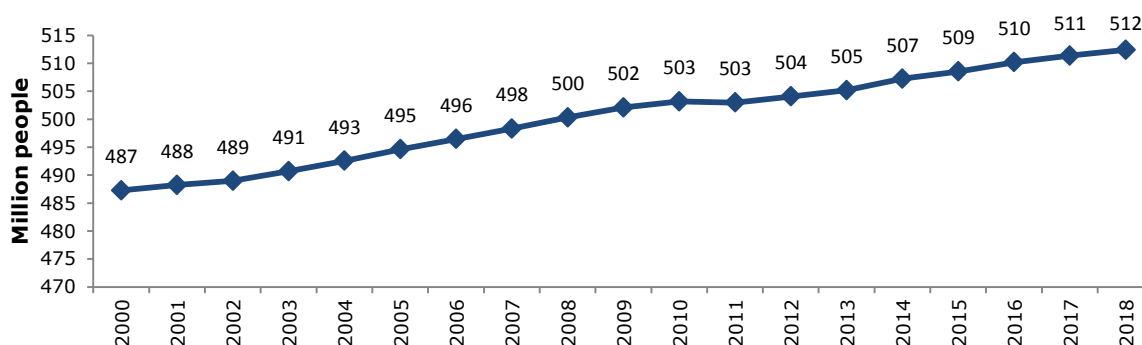
Natural gas and electricity are the main energy sources for the residential sector, their consumption trends have been analysed independently later in this chapter. However, there are notable examples of Member States that don't follow this trend in energy sources. For example solid fuels are widely used in Poland while derived heat is widely used in Denmark and Finland. Derived heat is used for warming spaces and for industrial processes and is obtained by burning combustible fuels like coal, natural gas, oil, renewables (biofuels) and wastes, or also by transforming electricity to heat in electric boilers or heat pumps. Oil and petroleum products and electricity are among the main energy sources in Cyprus and Malta, while the use of natural gas, solid fuels and derived heat is equal to zero in these Member States.

⁵³ The analysis of residential final energy consumption per fuel type uses the new methodology Eurostat tables for energy balances based on the availability of the data

Factors influencing residential energy consumption

When analysing energy consumption, it is important to consider influencing factors such as population growth, economic development, energy prices 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: population, GDP per capita, adjusted disposable income per capita, weather conditions (actual heating degree days), number of dwellings per country, average number of persons per household, average size of dwellings per country. Considering the influence of these factors can provide a better understanding of the relation between energy consumption and efficiency trends in the residential sector.

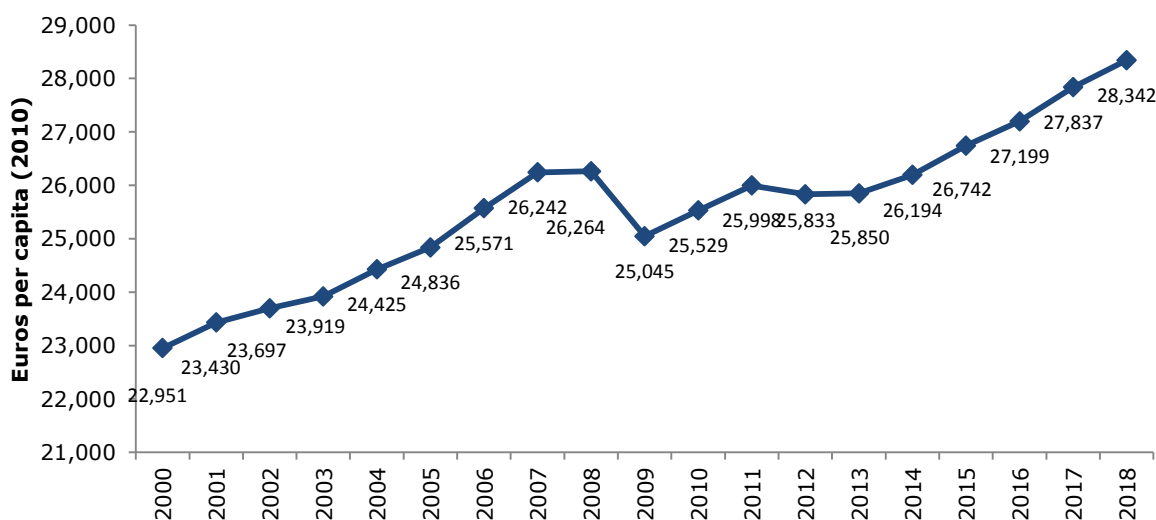
Figure 35: Population in the EU-28, 2000-2018



Source: Eurostat

Between 2000 and 2018 the population in the EU-28 grew by 5.2%. In the same period the residential final energy consumption dropped by 4.5%.

Figure 36: Gross Domestic Product per capita at market prices, chain linked volumes (2010), million euro in the EU-28, 2000-2018



Source: Eurostat

Other factors that can influence energy consumption are the economic development and the economic situation of the countries. GDP per capita in the EU-28 (Figure 36) has been continuously increasing between 2000 and 2018 with a fall in 2009 due to the economic and financial crisis worldwide and a second fall in 2012. Between 2013 and

2018 the GDP per capita increased again by an annual average rate of 1.6% in the EU-28.

The GDP per capita in current market prices across countries⁵⁴ in the EU-28 for the year 2018 results very largely dispersed as illustrated in Figure 37. In 2018, it was EUR 6,527 in Bulgaria whereas it was EUR 84,410 in Luxembourg. In EU-28, the average GDP per capita in current market prices was EUR 28,342. While GDP per capita over the period 2000-2018 increased by 23.5%, final residential energy consumption per capita fell by 9.2% in the same period. Given the large dispersion in GDP per capita in the EU-28 it is interesting to look at the disaggregated data per country for what regards final residential consumption (Figure 33). Finland, Luxembourg and Denmark which are the countries with highest consumption per capita also have above EU-28 GDP per capita value.

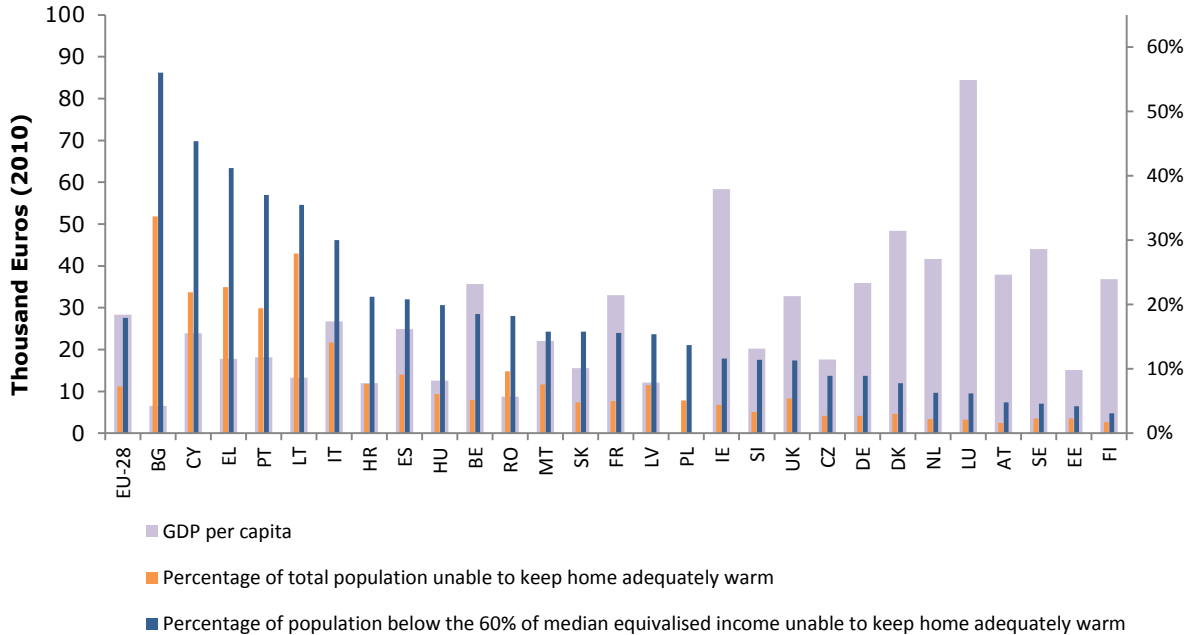
This could suggest that higher GDP levels may indeed lead to buy more energy, by using equipment at home resulting in higher energy consumption. On the other hand, Bulgaria and Romania, which are the Member States with low levels of GDP per capita, are also countries with low residential energy consumption per capita values. This could suggest that lower GDP levels may lead to the inability of many households to ensure the required levels of energy in the home, a condition commonly called energy poverty [9].

Indeed, Figure 37⁵⁵ shows that many Member States with below EU-28 GDP per capita levels and low final residential energy consumption values registered high percentages of people without the ability to keep home adequately warm in both total and low income population. For example, Bulgaria and Greece, registered above 25% percentages of people without the ability to keep home adequately warm in total population (33.7% and 22.7% respectively) while at the same time the respective percentages registered by these Member States in population below the 60% of median equivalised income were above 40% (56.0% and 41.2% respectively). On the other hand, Luxemburg and Denmark, both Member States with high values of final residential energy consumption values but also high GDP per capita values registered low percentages of people not able to ensure the energy required for heating needs in both total (2.1% and 3.0% respectively) and low income population (6.2% and 7.8% respectively).

⁵⁴ GDP at market prices, chain linked volumes (2010) million euro, PL: not available data for GDP in 2018

⁵⁵ Data for this indicator are being collected as part of the EU Statistics on Income and Living Conditions (EU-SILC) to monitor the development of poverty and social inclusion in the EU. The data collection is based on a survey, which means that indicator values are self-reported.

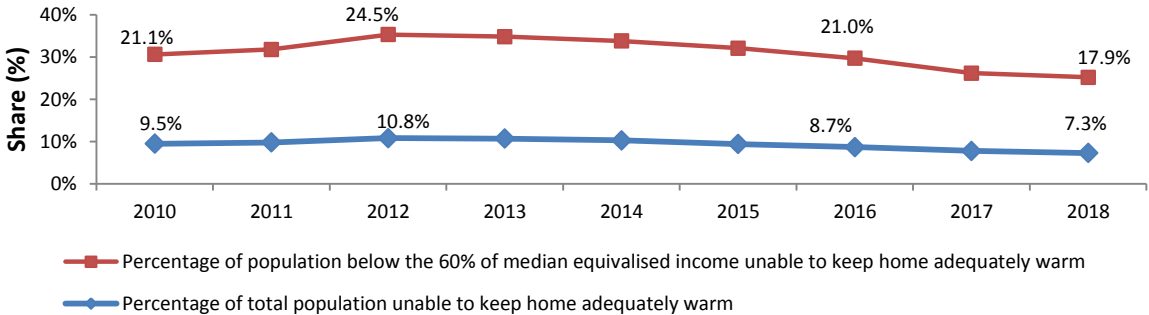
Figure 37: Gross Domestic Product per capita at market prices (chain linked volumes, 2010) and percentage of total and of below the 60% of median equivalised income population unable to keep home adequately warm in the EU-28 Member States, 2018



Source: Eurostat

As shown in Figure 38, overall, the shares of people not able to keep home warm in total and low income population have been decreased in EU-28 from 2010 to 2018. Possibly, there is an inverse correlation between this indicator and GDP per capita. Further studies have to be done in order to understand better this correlation.

Figure 38: Percentage of total and of below the 60% of median equivalised income population unable to keep home adequately warm in the EU-28, 2010-2018



Source: Eurostat

The growth in GDP per capita despite the population's increase observed 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. In addition, despite the increased GDP values observed in 2018, this year residential energy consumption has registered a negative growth rate compared to 2017.

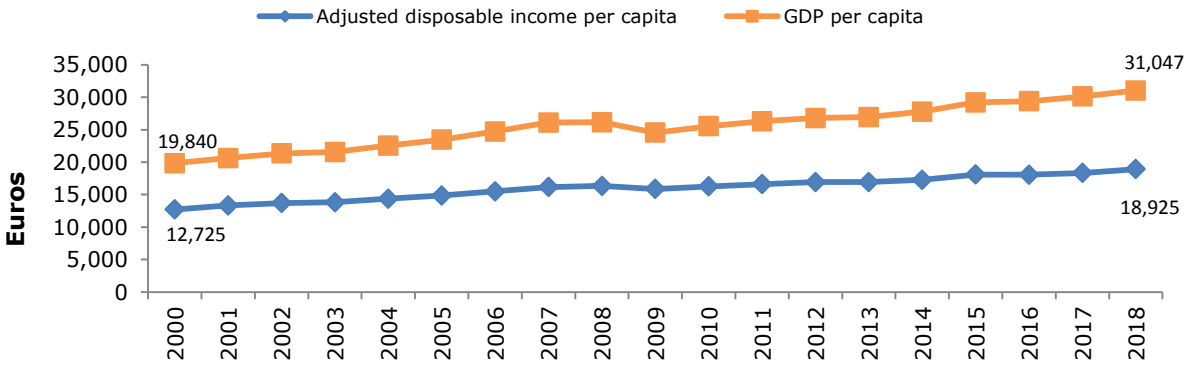
It is clear that economic development is positively correlated with total final energy consumption. However, especially in the residential sector, economic growth in the EU can be accompanied by a more efficient usage of energy, due to the adoption of more energy efficient equipment resulting in lower energy consumption levels. In the household sector a development in this sense can translate into more efficient appliances and systems and better insulated buildings in general. Climatic and dwelling-related corrections need to be used in final energy consumption per capita values in order to understand the actual correlation between economic development and energy consumption trends.

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, which 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 in kind 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 [10]. Figure 39 shows the trend-line comparison of both adjusted disposable income per capita and GDP per capita for the 19-year period between 2000 and 2018. It can be observed that there is a notable difference between these two variables; in 2018 the difference reached EUR 12,122. 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 39: Adjusted disposable income per capita and GDP per capita at current market prices in the EU-28, 2000-2018

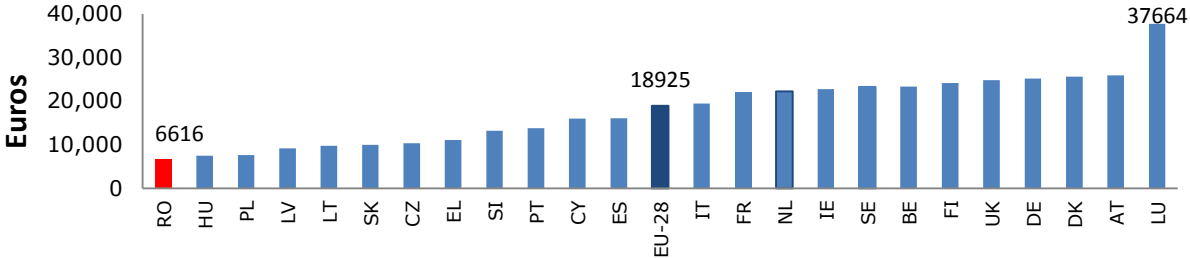


Source: Eurostat

Figure 40 shows that the Member States with the highest adjusted disposable income levels (Luxemburg, Austria and Denmark are also among the five Member States with the highest final residential energy consumption per capita for the year 2018). On the contrary, Romania which registered with the lowest adjusted disposable income per

capita from the Member States with available data, has also registered a below EU value for residential energy consumption per capita value. This may indicate that there is an important correlation between final residential energy consumption per capita and adjusted disposable income.

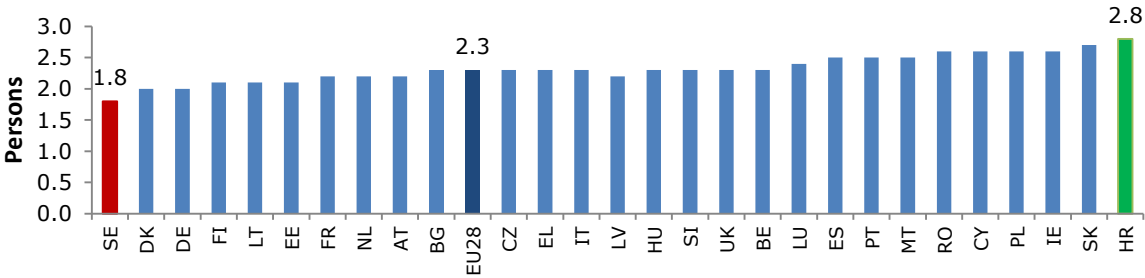
Figure 40: Adjusted disposable income per capita in the EU-28⁵⁶, year 2018.



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 2018. Sweden and Denmark have the lowest average number of persons per household (1.8 and 2.0) and Croatia the highest (2.8), as shown by Figure 41. The overall trend in Europe is an increase in population accompanied by an increase in the number of smaller households as the average number of people per household has decreased from 2.4 to 2.3 during the period 2009-2018. In general, this may lead to a rise in the total final residential energy consumption.

Figure 41: Average number of people per household in the EU-28 Member States, 2018

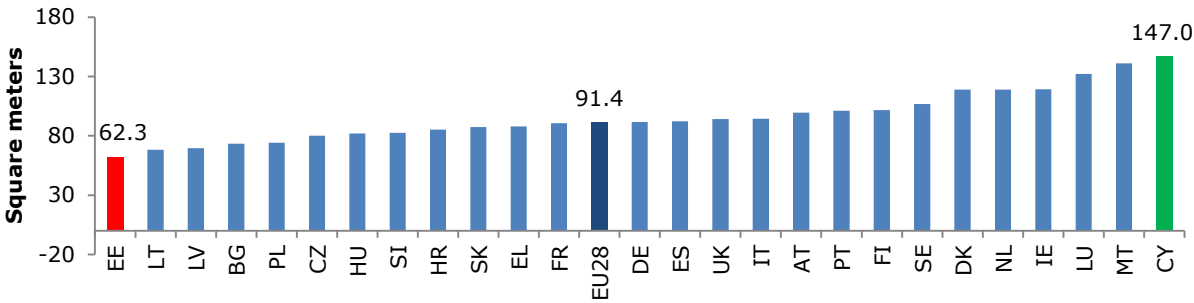


Source: Eurostat

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. Croatia and Poland are Member States with large average number of persons per household (2.8 and 2.6 respectively) but they have small dwellings average size. Cyprus, Malta and Luxemburg are the Member States with the largest average size of dwellings.

⁵⁶ Provisional data are included. BG, HR, MT data are not available.

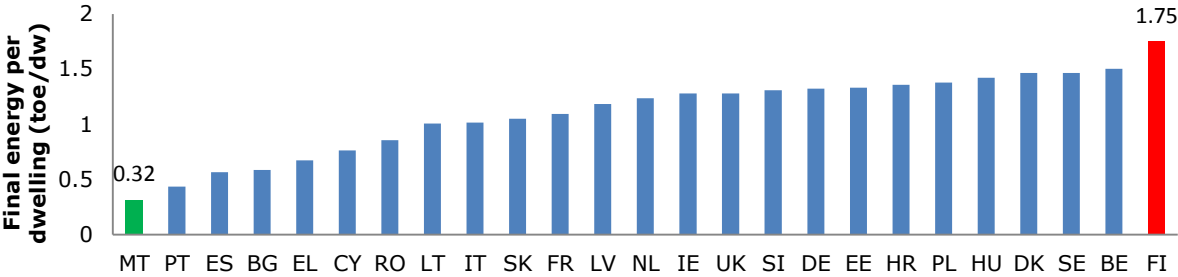
Figure 42: Average size of dwellings for countries with available data in the EU-28, year 2017⁵⁷



Source: Odyssee data

The average final residential energy consumption per dwelling in the EU-28 varies among the Member States in 2017. From the Member States with available data, Finland registered the highest consumption (1.75 toe) and Malta (0.32 toe) the lowest.

Figure 43: Final residential energy consumption per dwelling in the countries with available data year 2017⁵⁸



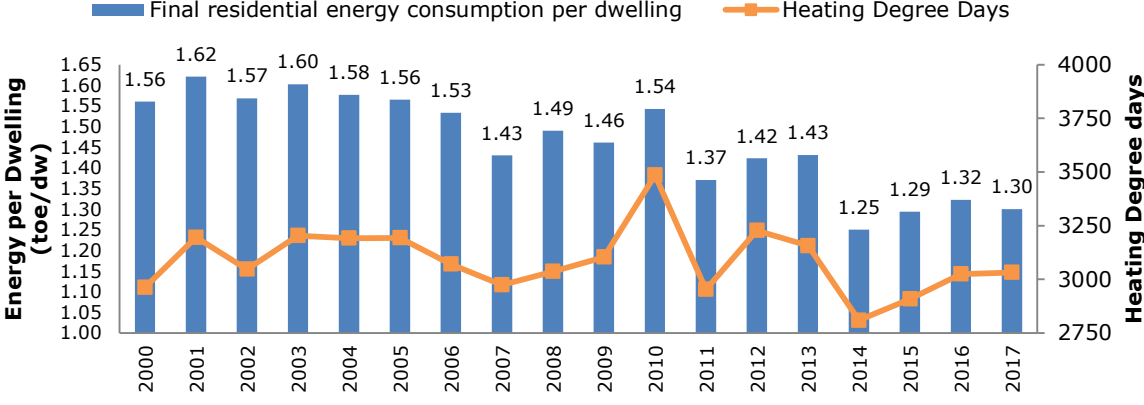
Source: JRC calculation based on Eurostat and Odyssee

The final residential energy consumption per dwelling has been decreasing during the 18-year period from 2000 to 2017 in the EU-28. In 2000 the residential consumption per dwelling was 1.56 toe. In 2017, the consumption is 1.30 toe per dwelling, meaning a decrease of 16.5%. This may indicate an existing correlation between the energy consumption per dwelling and climatic conditions (heating degree days) as shown in the Figure 44. The final energy consumption per dwelling follows the HDDs with exception of year 2009 and 2013, as happens also with the total final residential energy consumption. The correlation between climatic conditions and energy consumption is also presented in Figure 45. The trend-line indicates that the Member States with more HDDs, thus with colder climate, as expected tend to consume more energy per unit of area. A second, and more interesting evidence arising from Figure 45, 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. 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.

⁵⁷ Incomplete data for more recent years

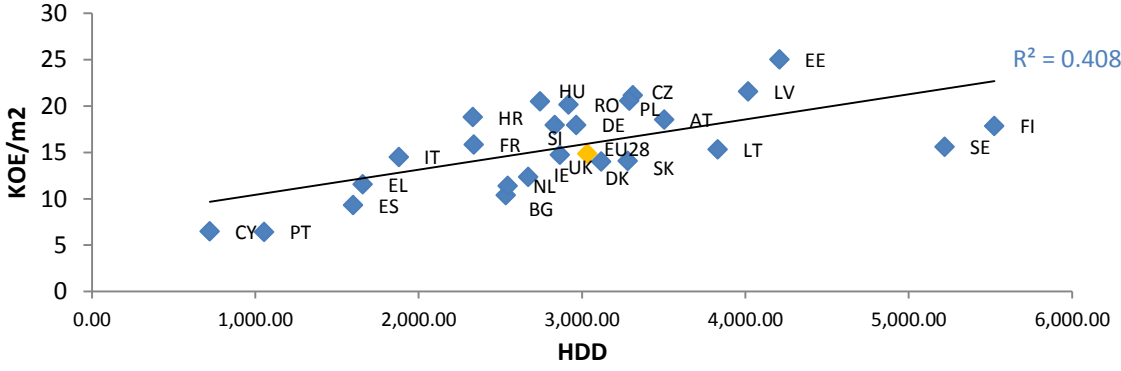
⁵⁸ Incomplete data for more recent years

Figure 44: Final residential energy consumption per dwelling⁵⁹ and Heating Degree Days in the EU-28, 2000-2017



Source: Eurostat, Odyssee

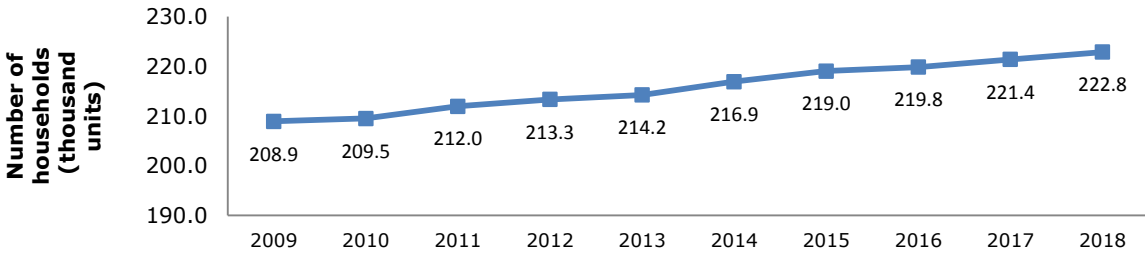
Figure 45: Average energy per unit area⁶⁰ and heating degree days in the EU-28 Member States⁶¹, year 2017



Source: Eurostat (HDD), Odyssee (energy)

Although the number of private households in the EU-28 has been continuously growing since 2009⁶² 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, 2009-2017

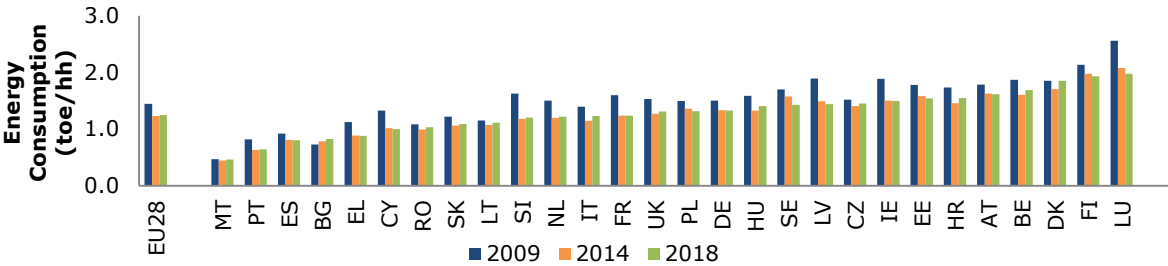


Source: Eurostat

⁵⁹ Final residential energy consumption per dwelling has been calculated by the report authors as the ratio between the final residential energy consumption and the stock of permanently occupied dwellings in the EU-28 as made available by Odyssee.
⁶⁰ Unit consumption per m2 (koe/m2): Calculated by Odyssee. It relies on the energy consumption of households (climate corrected) to the average size of dwelling (m2).
⁶¹ BE, LU, MT: not available data for 2017. Incomplete data for more recent years
⁶² Not available data before 2009

Looking at the residential energy consumption per household in 2018, it is possible to observe that Malta was the country with lowest energy consumption per household with 0.46 toe/HH, followed by Portugal (0.64 toe/HH) and Bulgaria (0.80 toe/HH). In contrast, Luxembourg (1.980 toe/HH), Finland (1.93 toe/HH) and Denmark (1.85 toe/HH) were the Member States with the highest residential energy consumption per household. Thirteen of the Member States have residential energy consumption per household below the EU-28 value (1.25 toe/HH). Only Bulgaria has increased their consumption in the 10-year period comprised between 2009 and 2018. The EU-28 energy consumption value per household dropped by 13.6% for the 10-year period between 2009 and 2018.

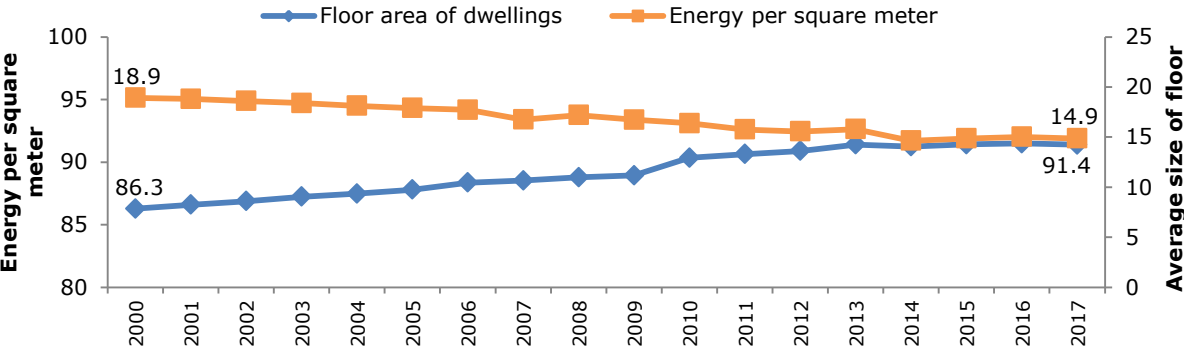
Figure 47: Final Residential energy consumption trends per household in the EU-28 Member States, 2009, 2014 and 2018



Source: Eurostat

Between 2000 and 2017⁶³ the average size of dwelling did, however, not considerably change: it increased by 5.1 m² in the whole period as shown in Figure 48. 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 better building's envelopes.

Figure 48: Average energy per unit of area⁶⁴ a year and floor size in the EU-28, 2000-2017



Source: Odyssee

The average energy per unit of area at EU-28 level was 14.9 koe/m² in 2017. This represents a drop of 21.2% which sets the third lowest value along the analysed period (2000-2017) after 2014 and 2015. It can be observed that the increase of average floor area during the same period helped to reduce this indicator.

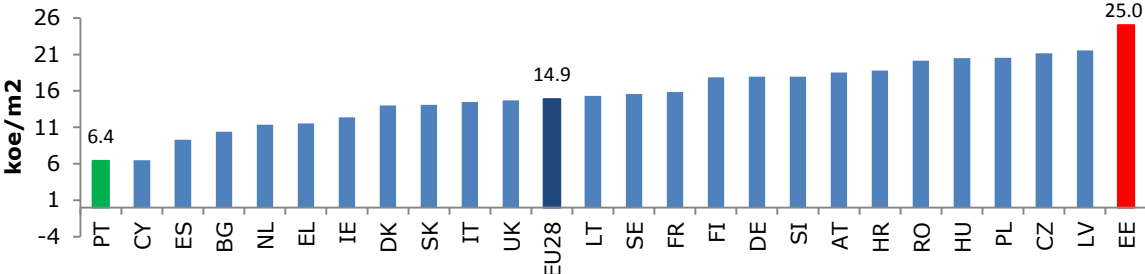
The residential energy consumption per unit of area across the EU-28 Member States for the year 2017 is illustrated in figure 49.

⁶³ 2018: data not available

⁶⁴ Energy consumption per m² (koe/m²) has been calculated by Odyssee. It relies on the energy consumption of households (climate corrected) to the average size of dwelling (m²).

In 2017, Member States with the highest residential energy consumption per floor area were Estonia and Latvia (25.0 and 21.6 koe/m² respectively). On the other hand, the Member States with the lowest values were Portugal and Cyprus (6.4 and 6.5 koe/m² respectively).

Figure 49: Average residential energy consumption per floor area in the countries with available data, 2017



Source: Odyssee⁶⁵

The following figures establish a relationship between the residential energy consumption and the mentioned influencing factors (i.e. economic growth, climatic conditions and living conditions). The trend line and the R-squared value⁶⁶ of the Figure 50 can't lead to a clear conclusion regarding the correlation between residential energy consumption and GDP. However, it's observed that some countries with high GDP per capita levels (i.e., more economically developed countries) tend to consume more energy in the residential sector. Despite this, there are significant differences in energy consumption between member states with similar economic conditions. In general, Nordic countries seem to present a higher correlation between GDP per capita and energy consumption. It's observed that there are countries registering relatively low levels of energy per capita (below trend line), although they have increased heating needs (above EU average HDD) and economic growth (above EU average GDP per capita). This possibly indicates a more efficient use of energy sources¹.

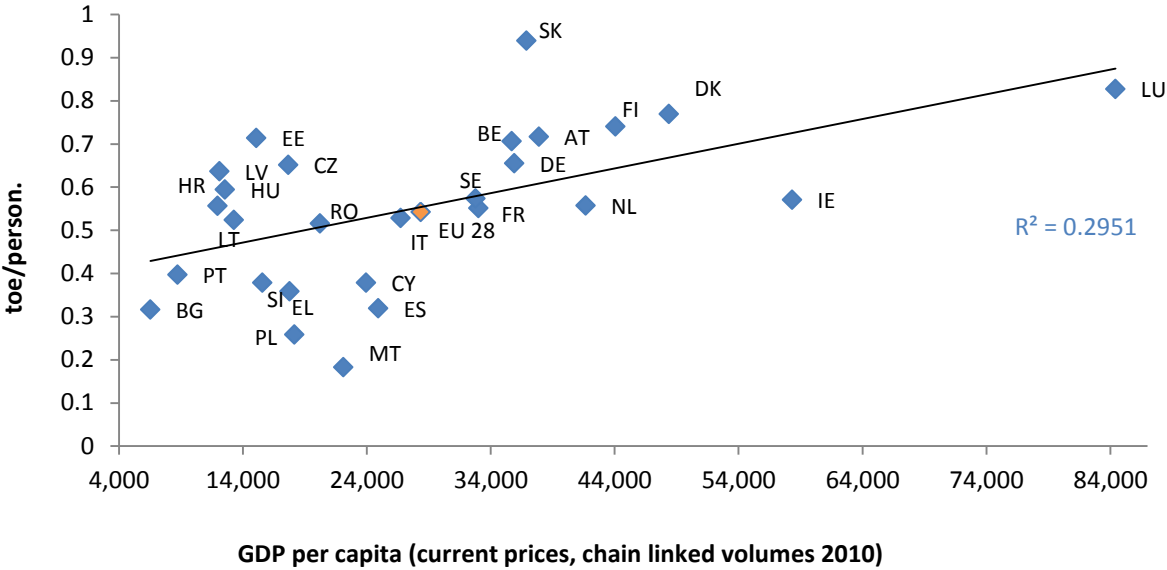
In the case of adjusted disposable income, the correlation with energy consumption seems to be generally stronger, despite still very weak. Even if the R squared values in both regressions are low, the slope of the trend lines shows the tendency of economically developed countries to consume more energy.

Finally, Figure 52 shows that there is a very low degree of negative correlation (less than 0.1) between residential final energy consumption per capita and per average floor area climatic corrected (toe/(HDD*m²*pop) and GDP per capita (current market prices, chain linked volumes 2010).

⁶⁵ 2018: incomplete data

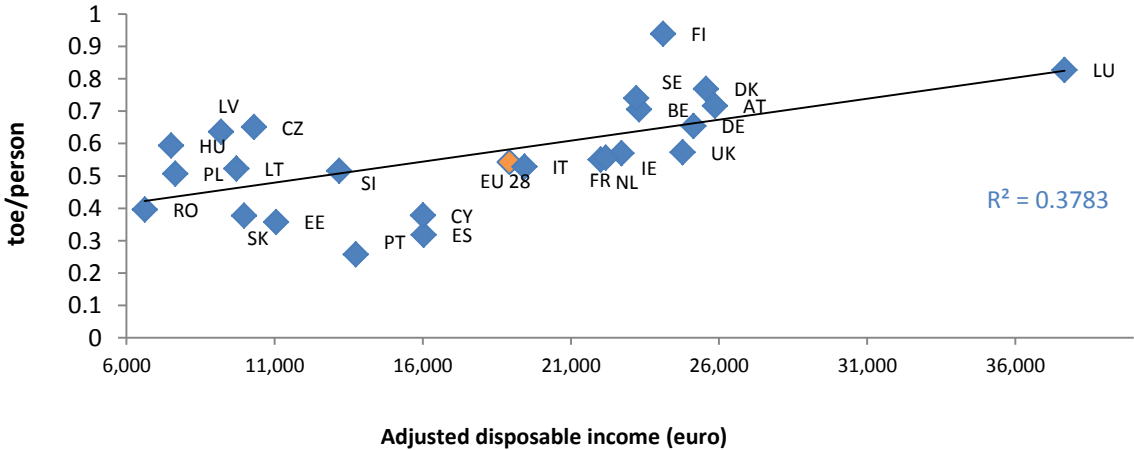
⁶⁶ R-squared is a statistical measure that represents the proportion of the variance for a dependent variable that is explained by an independent variable or variables in a linear regression.

Figure 50: Residential energy per capita and GDP per capita⁶⁷ for EU Member States, Year 2018



Source: Eurostat

Figure 51: Residential energy per capita and adjusted disposable income in euros for EU Member States⁶⁸, Year 2018

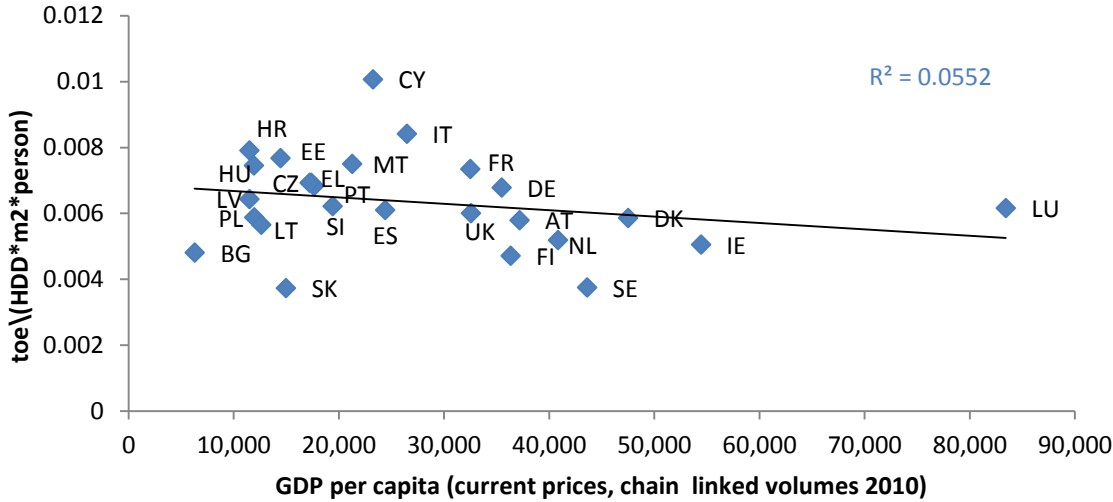


Source: Eurostat

⁶⁷ GDP at market prices, current prices, chain linked volumes (2010), million euro

⁶⁸ MT, BG and HR excluded due to incomplete data. Estimated data are included

Figure 52: Residential energy normalized by HDD⁶⁹, m², population, and GDP per capita for EU Member States⁷⁰, Year 2017⁷¹



Source: Eurostat, Odyssee

The following figures show that despite the climatic conditions (colder winters), the economic growth (increase of GDP per capita values) and the increase of population, the final residential energy consumption has experienced a gradual decrease in the analysed period.

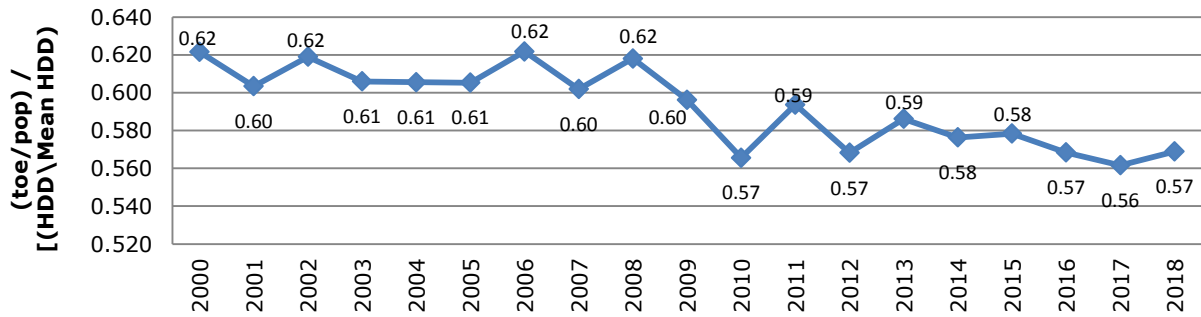
In detail, residential consumption per capita climatic corrected⁷² in EU-28 has decreased by 8.5% from 2000 to 2018, while it has increased very slightly (by 1.3)% in 2018 compared to 2017. (Figure 53)

Figure 54 shows that residential consumption per capita normalized by GDP per capita has decreased by 26.5% during the 19-year analysed period while it has recorded a decrease of 3.6% in 2018 compared to 2017.

Figure 55 shows that residential energy consumption per capita normalized by HDD, GDP per capita and average floor area decreased by 29.7% from 2000 to 2017⁷³. 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 led to lower energy consumption and the rise of GDP per capita that year helped lower this indicator. Opposite occurred in 2009, despite the fact of not being a severe winter and thus the correlation's value should have decreased the GDP reduction due to the impact of the financial and economic crisis made the value rise by 1.0% in comparison to the previous year. In the following year (2010), the GDP recovery and the high number of HDD made the value return to its overall decreasing trend. To be noted that, although the energy consumption and the HDD are positively correlated, the impact produced by the HDD is higher due to the larger range of their values.

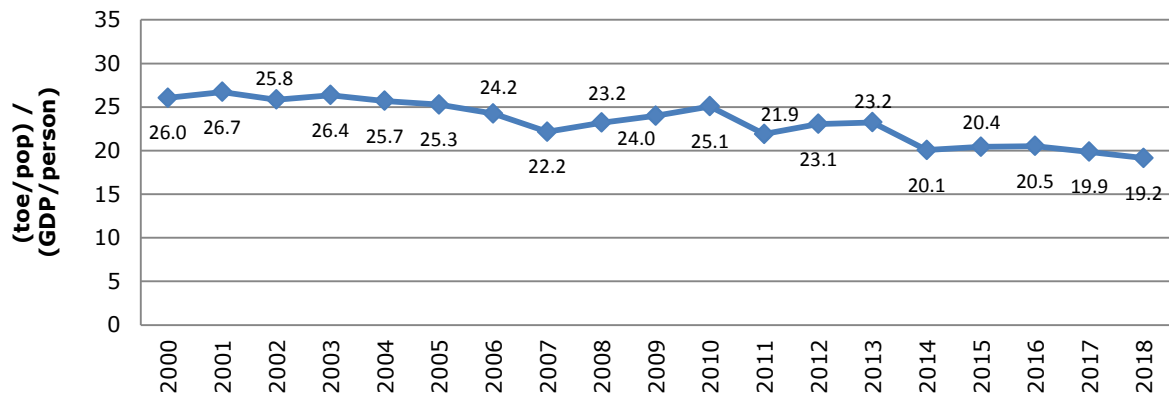
⁶⁹ HDD normalization: HDD of Member State/mean HDD of EU-28 Member States for 2017
⁷⁰ BE, RO excluded due to incomplete data.
⁷¹ Incomplete data for 2018
⁷² Climatic correction: EU-28 HDD/ EU-28Mean HDD of reference period 2000-2018
⁷³ Incomplete data for 2018

Figure 53: Residential final energy consumption per capita normalized by HDD in EU-28, 2000-2018



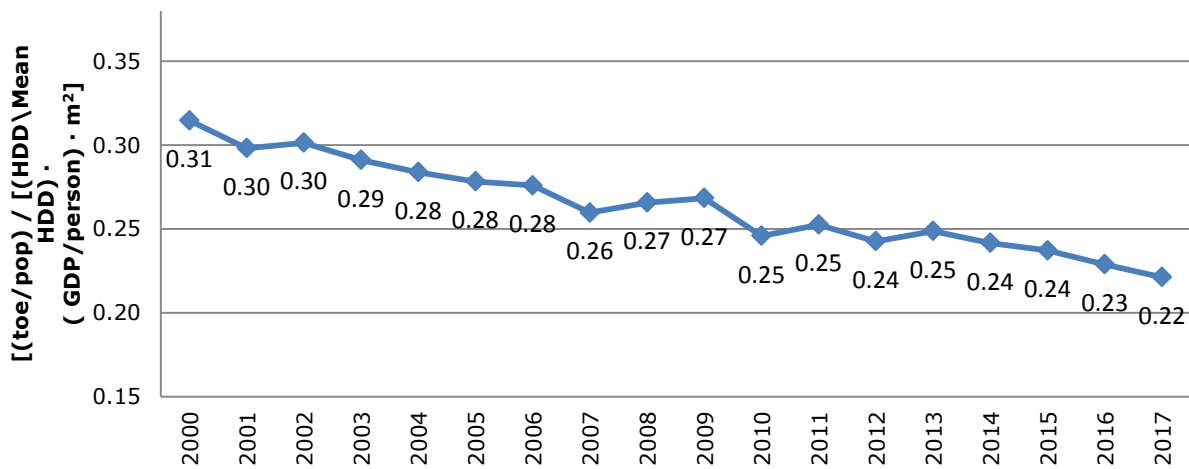
Source: Eurostat

Figure 54: Residential final energy consumption per capita normalized by GDP per capita⁷⁴ in EU-28, 2000-2018



Source: Eurostat

Figure 55: Residential energy per capita, normalized by HDD⁷⁵, GDP per capita⁷⁶ and average floor area in the EU-28, 2000-2017



Source: Odyssee, Eurostat

⁷⁴ GDP at current market prices, chain linked volumes (2010), million euro

⁷⁵ HDD normalization: HDD of year/mean HDD of the period 2000-2017

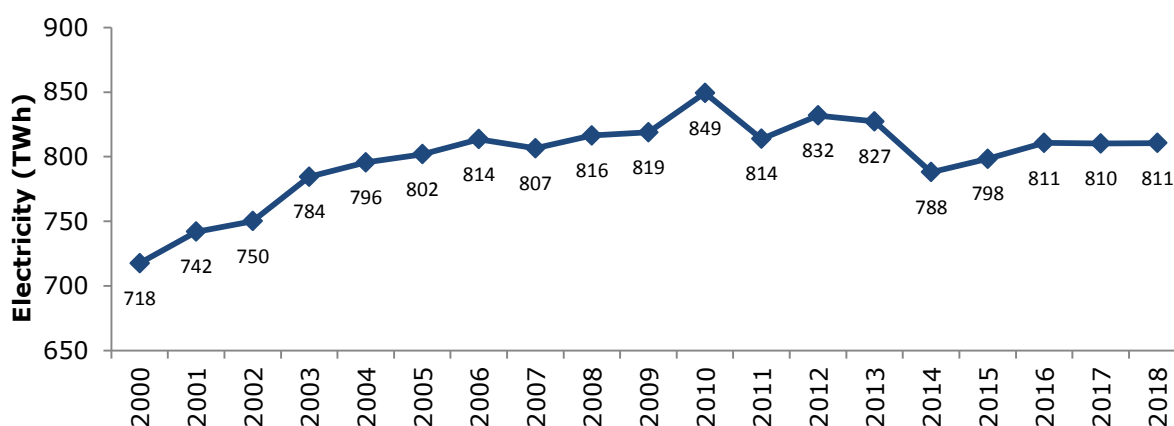
⁷⁶ GDP at current market prices, chain linked volumes (2010), million euro

3.2 Electricity consumption trends in the residential sector

Electricity accounted for 24.6%⁷⁷ of the final residential energy consumption in the EU-28 in 2018. This is the second highest share after natural gas consumption share (35.8%). The final residential electricity consumption in the EU-28 has grown by 13.0% in the period between 2000 and 2018. The electricity consumption reached 810.6 TWh in 2018.

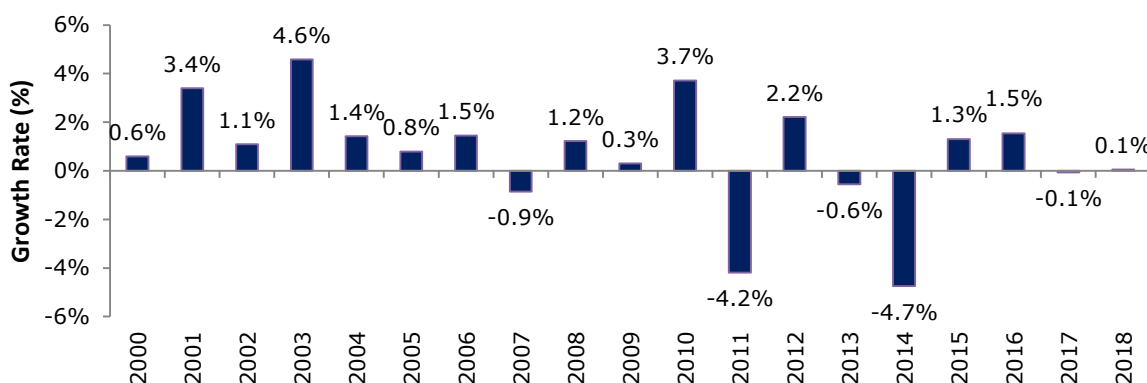
The highest consumption level during the analysed period has been registered in 2010 when final electricity consumed grew up to 849.4 TWh (Figure 56). Between 2000 and 2010 the final electricity consumption in the residential sector was continuously increasing (with the only exception of year 2007). After the peak in 2010 the consumption started to fluctuate, by registering the most significant drops in 2011 (-4.2%) and 2014 (-4.7%). From 2016 to 2018, it has remained almost stable.

Figure 56: Final residential electricity consumption in the EU-28, 2000-2018



Source: Eurostat

Figure 57: Final residential electrical energy consumption annual growth rates in the EU-28, 2000-2018

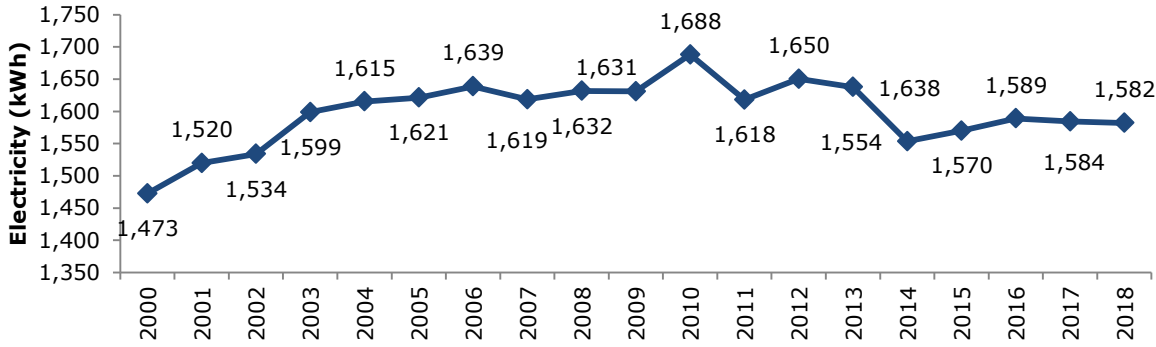


Source: Eurostat

The final residential electricity consumption per capita in the EU-28 has grown by 7.4% between 2000 and 2018. The average per capita electricity consumption in the residential sector was 1,581 kWh in 2018.

⁷⁷ The analysis of residential electricity consumption uses the new methodology Eurostat tables for energy balances based on the availability of the data

Figure 58: Final residential electricity consumption per capita in the EU-28, 2000-2018

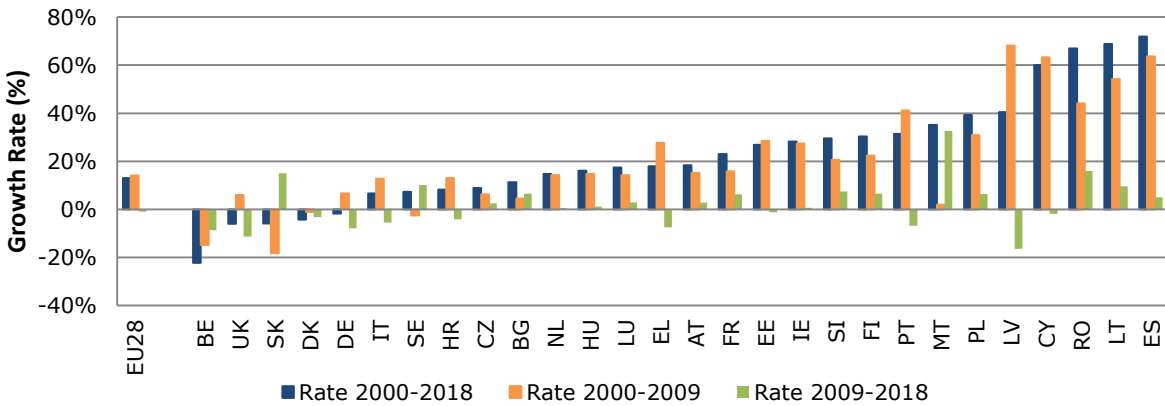


Source: Eurostat

Concerning final residential electricity consumption growth rates across the EU-28 Member States for period 2000-2018, it can be observed that ten Member States registered growth rates below the EU-28 growth rate(13.0%).

The Member State with the highest reduction rate has been Belgium with -22.3%, followed by the United Kingdom (-6.1%) and Slovakia (-6.0%). The Member States with the highest final residential electricity consumption growth rate have been Spain (72.0%), Lithuania (68.9%), and Romania (67.0%). It's important to note that the majority of the countries with Mediterranean climate (Spain, Cyprus, Greece, Portugal, and Malta) have registered growth rates above the one EU-28 for the period 2000-2018. This may have been the result of climate change leading to the increase of the cooling needs. Figure 59 shows the growth rates for three different periods. It can be clearly noticed that there is a significant change in the consumption pattern between the two studied sub-periods. For instance, Spain drastically changed its consumption pattern from a growing trend of 63.7% for the period 2000-2009 to a growing trend of 5.0% for the period 2009-2018. Seventeen countries have experienced a positive growth rate in the period 2009-2018. The highest growth rate took place in Romania (16.0%).

Figure 59: Final residential electricity consumption growth rates in the EU-28 by Member State; 2000-2018, 2000-2009 and 2009-2018



Source: Eurostat

Figure 60: Residential electricity consumption per dwelling⁷⁸ and heating degree days in the EU-28, 2000-2017

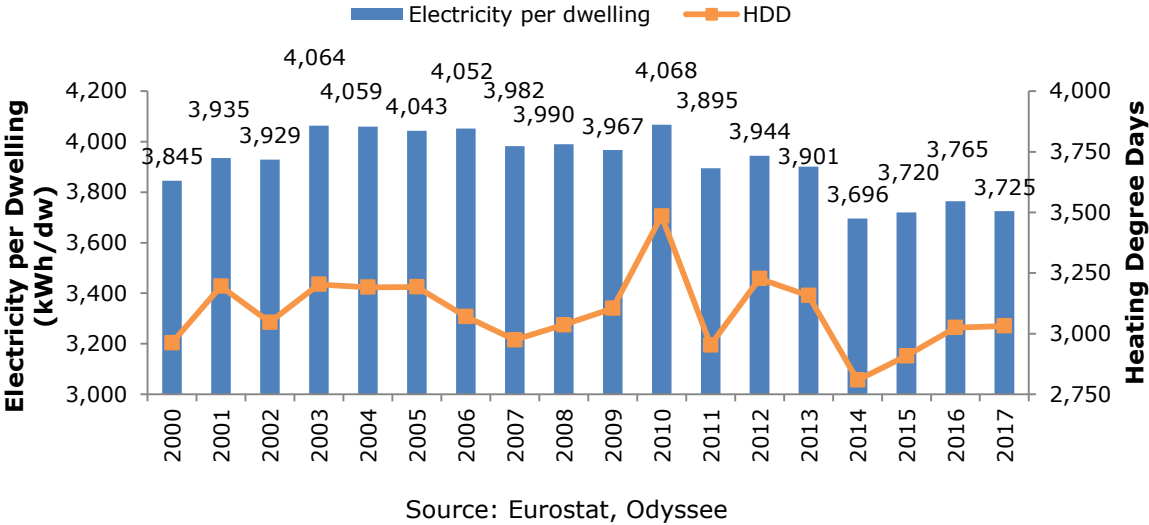
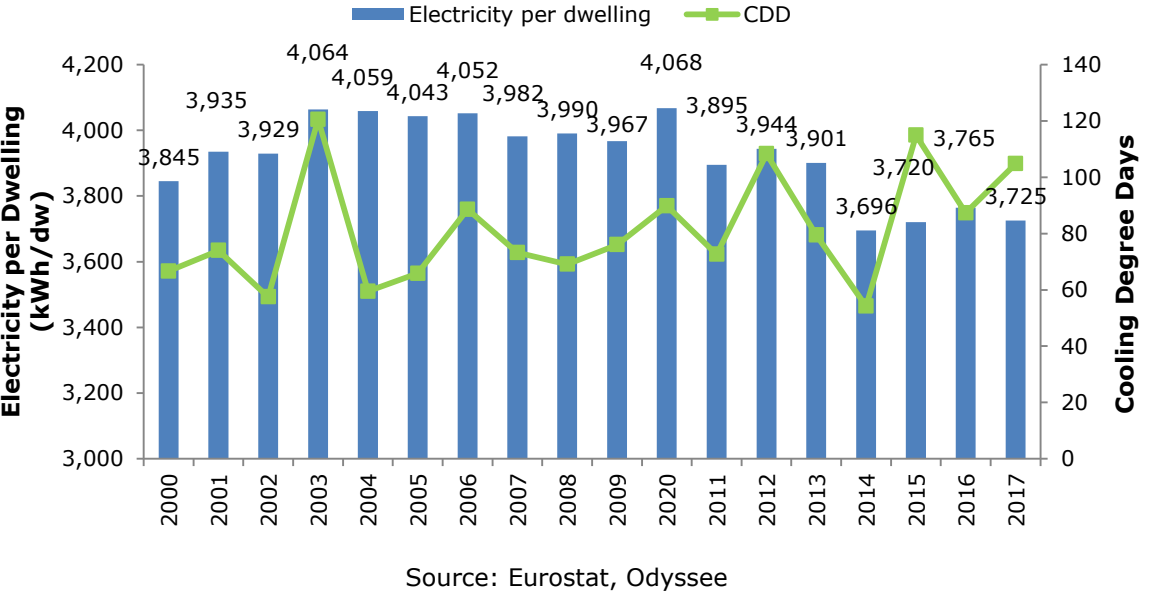


Figure 61: Residential electricity consumption per dwelling⁷⁹ and EU-28 mean cooling degree days in the EU-28, 2000-2017



The residential electricity consumption per dwelling was 3,725 kWh/dw in 2017, the third lowest value registered during the period 2000-2017 after year 2014 (3,696 kWh/dw) and 2015 (3,720 kWh/dw). Over the period 2000-2017 this value has been reduced by 3.1% (Figure 60). This trend was inverted several times during the whole 18-year period. It is observed a positive correlation between the consumption per dwelling and the heating degree days with exception of year 2009. This was probably due to an income effect as GDP had a significant drop that year.

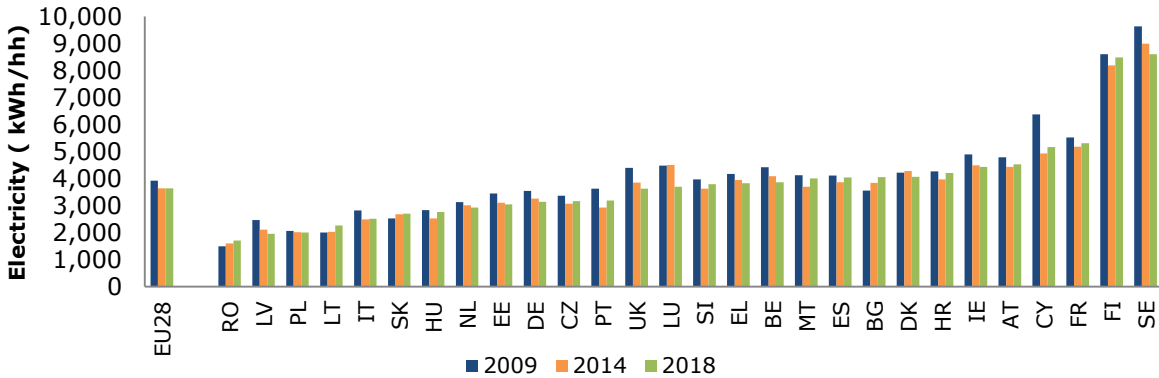
⁷⁸ Residential electricity consumption per dwelling has been calculated by the report authors as the ratio between the final residential energy consumption and the stock of permanently occupied dwellings) in the EU-28 as made available by Odyssee.

⁷⁹ Residential electricity consumption per dwelling has been calculated by the report authors as the ratio between the final residential energy consumption and the stock of permanently occupied dwellings) in the EU-28 as made available by Odyssee.

Figure 61 shows that there is also a positive correlation between residential electricity consumption per dwelling and the Cooling Degree Days average of EU-28 Member States. This indicates that an important amount of electricity is used for space cooling.

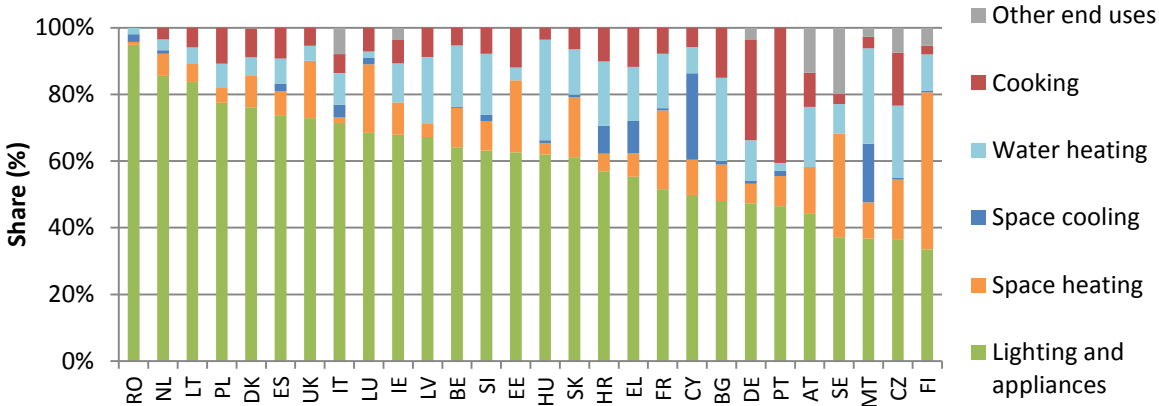
Looking at the electricity consumption per household in 2018, it is possible to observe that Romania was the country with lowest electricity consumption per household with 1,705 kWh, followed by Latvia (1,955kWh) and Poland (2,005 kWh). In contrast, Sweden (8,602 kWh), Finland (8,491 kWh) and France (5,313 kWh) were the Member States with the highest residential electricity consumption per household. Thirteen of the Member States have residential electrical energy consumption per household below the EU-28 value. Only four Member States have increased their consumption in the 10-year period comprised between 2009 and 2018, these are: Romania, Lithuania, Slovakia and Bulgaria.

Figure 62: Residential electricity consumption trends per household by Member State in the EU-28; 2009, 2014 and 2018



Source: Eurostat

Figure 63: Residential electricity consumption by type of end-use in the EU-28 Member States, 2018

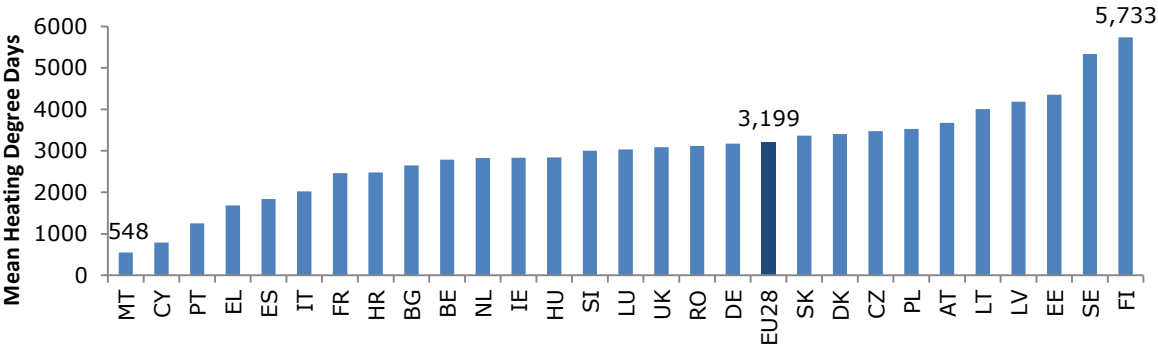


Source: Eurostat

Figure 63 shows the end-uses in which the electricity is consumed per Member State. The majority of the Member States consume the largest share of electricity in lighting and appliances. Most countries with increased heating needs due to climate conditions like Finland and Sweden have consumed a relevant part of electricity for space heating. Germany and Portugal have consumed an over 30% share of electricity for cooking while Hungary consumed more than 30% for water heating. Finally, some Member States with

Mediterranean climate like Malta and Cyprus, have consumed a notable share for space cooling needs.

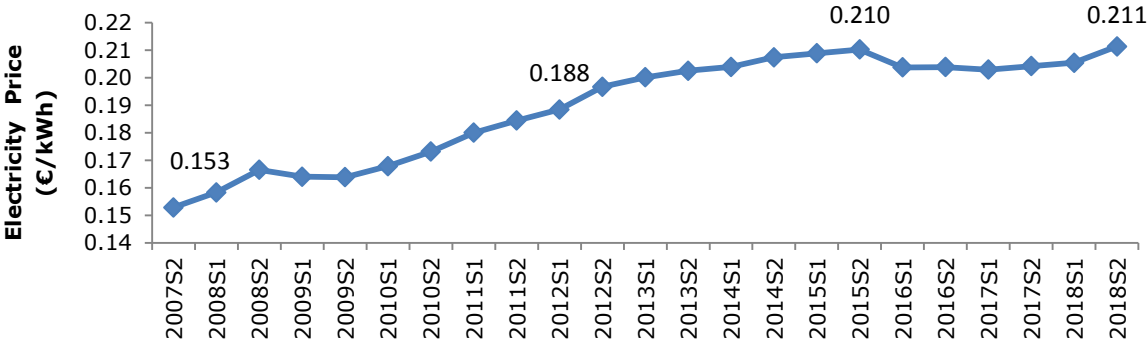
Figure 64: Mean Heating Degree days (1980-2018) in the EU-28 by Member State



Source: Eurostat

As previously mentioned, weather conditions have an influence on energy consumption. Especially in residential sector, the electricity consumption is highly influenced by the heating and cooling needs. Figure 64 shows the mean heating degree days in the EU-28 by Member State between 1980 and 2018. The EU-28 Member States with the highest values of mean heating degree days are Finland, Sweden and Estonia.

Figure 65: Electricity prices for household consumers in the EU-28 by semesters, band DC - all taxes and levies included, 2007S2-2018S2

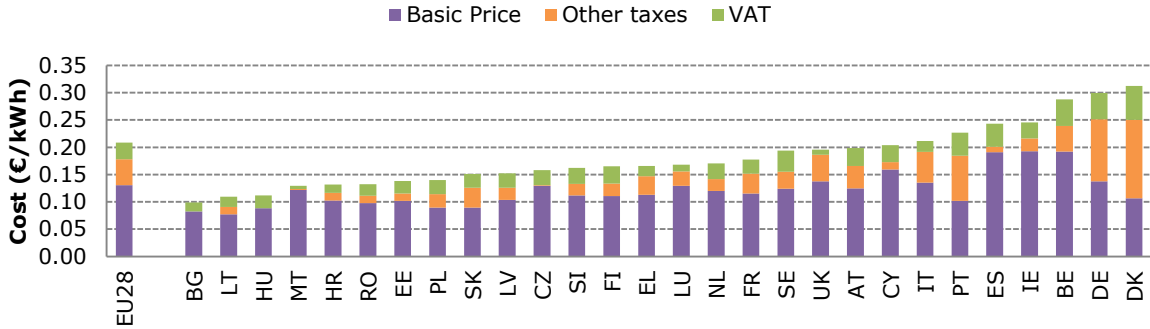


Source: Eurostat

Electricity expenses as part of residential utilities are a cost to consider. In 2018, the average EU-28 expenses per household for electricity were EUR 757.9⁸⁰. The electricity price for household consumers has continuously grown during the last years (Figure 65) with the exception of the years 2009, when prices drop to EUR 0.164/kwh in the second semester and the years 2009 and 2016. In the second semester of 2007 the average EU-28 electricity price was EUR 0.153/kWh and in the second semester of 2018 the price has reached EUR 0.211/kWh. This corresponds to an increase by 38.3%.

⁸⁰ This value has been calculated from the average total electricity price for household consumers (band DC) multiplied by residential electricity consumption per household.

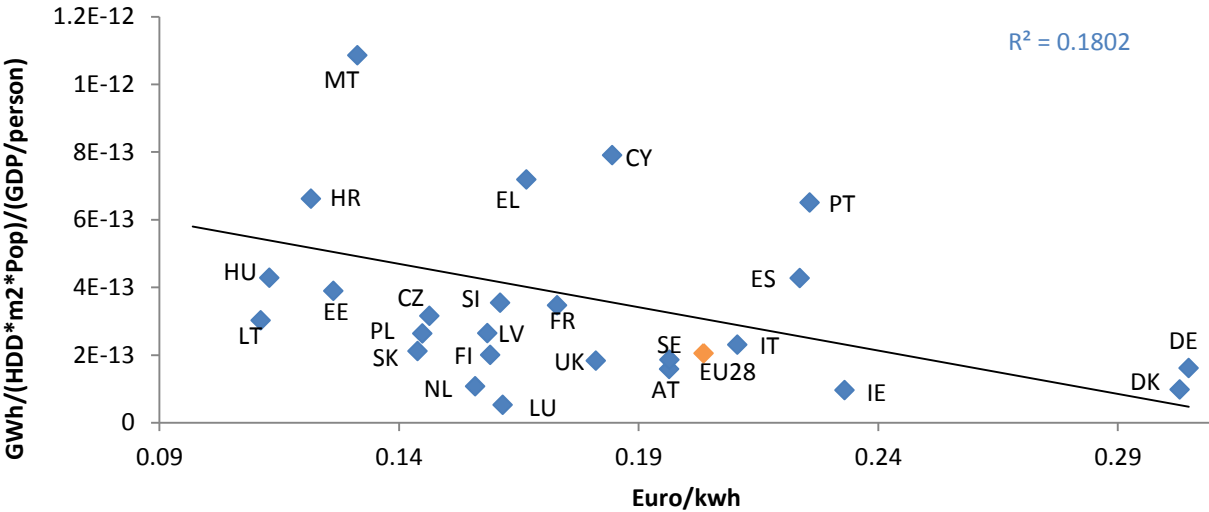
Figure 66: Electricity prices for household consumers in the EU-28 Member States, band DC, 2018



Source: Eurostat

Looking at the electricity prices across the EU-28 Member States for the year 2018, Denmark has the highest electricity price (EUR 0.313/kWh) followed by Germany (EUR 0.2994/kWh) and Belgium (EUR 0.288/kWh). The lowest electricity prices are found in Bulgaria (EUR 0.099/kWh), Lithuania (EUR 0.110/kWh) and Hungary (EUR 0.112/kWh). To be noted that Denmark and Germany registered the highest shares of taxes and levies in the total electricity price (66.0% and 54.0% respectively). Denmark's share almost doubles the EU-28 percentage of taxes and levies for the year 2018 (37.3%).

Figure 67: Electricity consumption normalized by HDD⁸¹, m², population, GDP per capita⁸² and electricity prices⁸³ for EU Member States⁸⁴, Year 2017



Source: Eurostat, Odyssee

The trend-line of the Figure 67 shows the correlation between the electricity price and the residential electricity consumption adjusted to take into account population, floor area of dwellings, climatic and economic factors. As expected electricity consumption decreases if price increases, according to the basic law of market demand.

The following table provides an overview of the final residential electricity consumption across the EU-28 Member States. It provides with electricity consumption at residential

⁸¹ HDD normalization: HDD of Member State/mean HDD of EU-28 Member States for 2017

⁸² GDP at current market prices, chain linked volumes (2010), million euro

⁸³ Includes all taxes and levies

⁸⁴ Excludes BE and RO due to incomplete data

sector for years 2000, 2009 and 2018, as well as the growth rates over different periods. Data have been already introduced and analysed along the chapter.

Table 2: Overview of final residential electricity consumption in the EU-28 Member States, 2000-2018

	2000 (GWh)	2009 (GWh)	2018 (GWh)	2000-2018 (%)	2000-2009 (%)	2009-2018 (%)
EU-28	717,561	818,876	810,582	13.0%	14.1%	-1.0%
BE	23,738	20,210	18,441	-22.3%	-14.9%	-8.8%
BG	9,858	10,302	10,963	11.2%	4.5%	6.4%
CZ	13,822	14,687	15,050	8.9%	6.3%	2.5%
DK	10,215	10,096	9,773	-4.3%	-1.2%	-3.2%
DE	130,500	139,200	128,200	-1.8%	6.7%	-7.9%
EE	1,466	1,884	1,860	26.9%	28.5%	-1.3%
IE	6,375	8,123	8,174	28.2%	27.4%	0.6%
EL	14,207	18,131	16,763	18.0%	27.6%	-7.6%
ES	43,619	71,411	75,006	72.0%	63.7%	5.0%
FR	128,720	149,032	158,330	23.0%	15.8%	6.2%
HR	5,729	6,471	6,202	8.3%	13.0%	-4.2%
IT	61,112	68,924	65,138	6.6%	12.8%	-5.5%
CY	1,055	1,722	1,688	60.0%	63.2%	-2.0%
LV	1,189	2,000	1,670	40.5%	68.2%	-16.5%
LT	1,767	2,725	2,985	68.9%	54.2%	9.5%
LU	792	904	931	17.5%	14.2%	2.9%
HU	9,792	11,235	11,370	16.1%	14.7%	1.2%
MT	559	570	756	35.2%	2.0%	32.6%
NL	20,019	22,872	22,971	14.7%	14.3%	0.4%
AT	14,962	17,233	17,711	18.4%	15.2%	2.8%
PL	21,034	27,534	29,284	39.2%	30.9%	6.4%
PT	10,056	14,190	13,213	31.4%	41.1%	-6.9%
RO	7,652	11,021	12,780	67.0%	44.0%	16.0%
SI	2,601	3,137	3,368	29.5%	20.6%	7.4%
SK	5,419	4,428	5,095	-6.0%	-18.3%	15.1%
FI	17,441	21,346	22,731	30.3%	22.4%	6.5%
SE	42,020	40,946	45,068	7.3%	-2.6%	10.1%
UK	111,842	118,541	105,065	-6.1%	6.0%	-11.4%

Source: Eurostat

3.3 Natural gas consumption trends in the residential sector

Natural gas consumption⁸⁵ accounted for 36.2% of the final residential energy consumption in the EU-28 in 2018, confirming it as the main source of final energy in residential sector. The final residential natural gas consumption in the EU-28 has dropped

⁸⁵ The analysis of residential natural gas consumption uses the new methodology Eurostat tables for energy balances based on the availability of the data.

by 5.55% in the 19-year period between 2000 and 2018 and remained almost stable between 2017 and 2018. The gas consumption reached 102.6 Mtoe in 2018.

The highest consumption during the period between 2000 and 2018 occurred in 2010 when it reached 122.3 Mtoe. In the same year the price registered the highest growth rate compared to the previous year (9.9%). In contrast, the highest drops occurred in 2011 and 2014 when gas consumption decreased by 15.2% and 17.8% compared to previous years (Figure 69).

Figure 68: Final residential natural gas consumption trends in the EU-28, 2000-2018

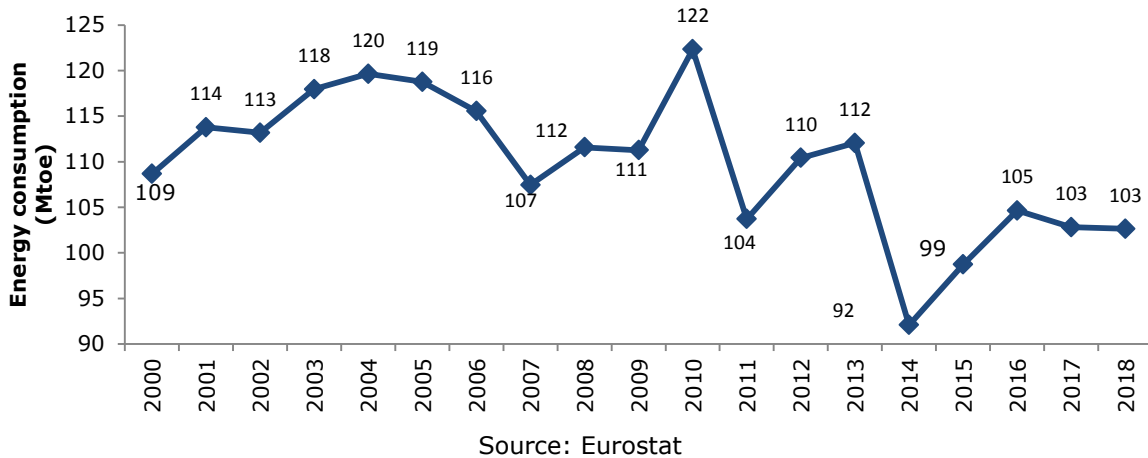
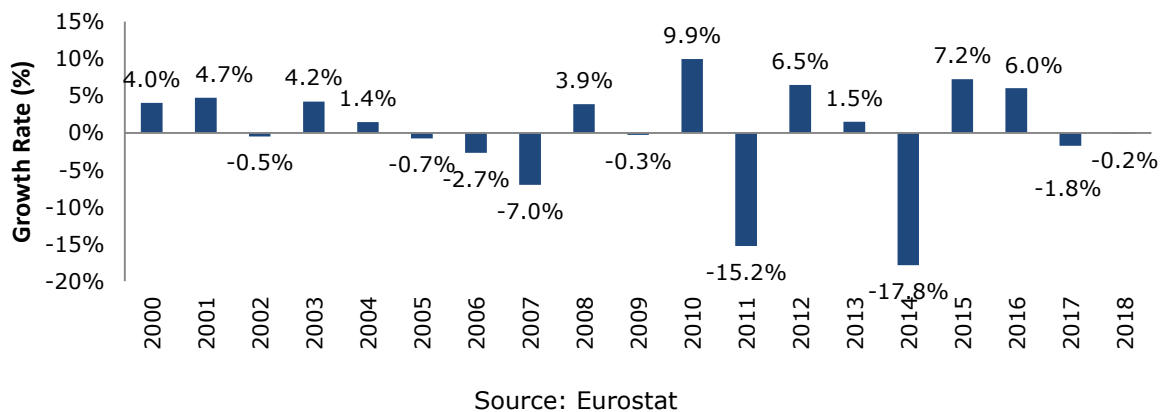
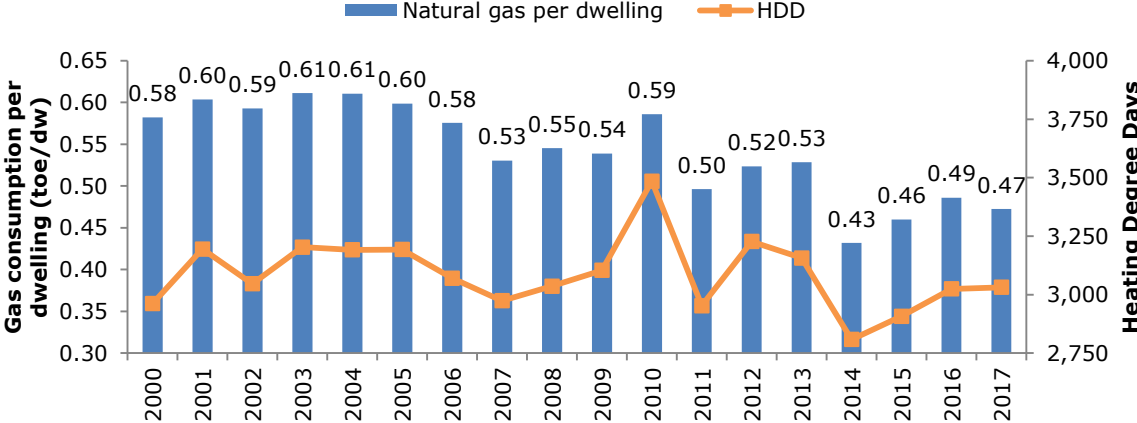


Figure 69: Final residential natural gas consumption annual growth rates in the EU-28, 2000-2018



The final residential natural gas consumption per dwelling in the EU-28 has reached 0.47 toe in 2017, which represents a drop of 18.8% in comparison to the year 2000 level. This trend was fluctuated several times during the whole studied period, however the lowest values were registered the last 4 studied years (from 2014 to 2017). It is observed a positive correlation between the consumption per dwelling and the heating degree days with exception of years 2009 and 2013. This was probably resulted from other factors such as economic differentiations.

Figure 70: Final residential gas consumption per dwelling⁸⁶ and heating degree days in the EU-28, 2000-2017

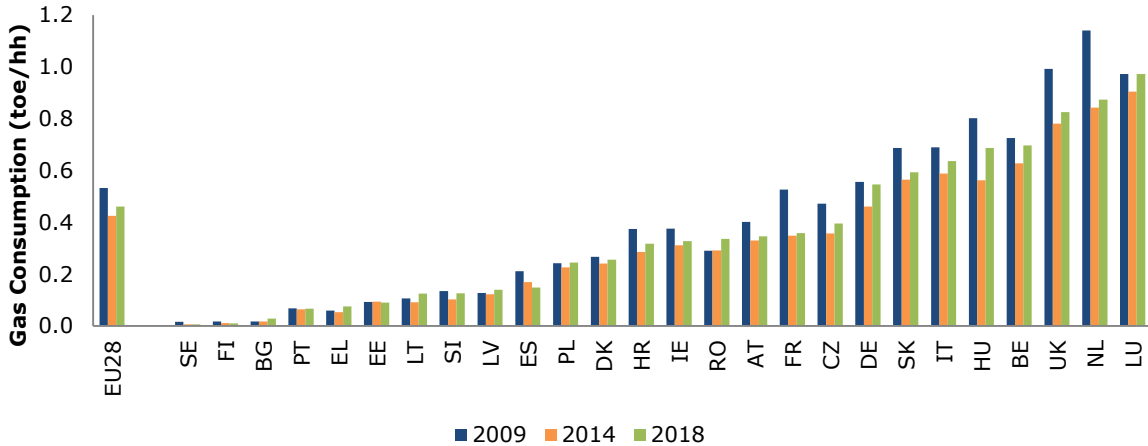


Source: Eurostat, Odyssee

Looking at the residential gas consumption per household across the EU-28 Member States, it can be observed that during 2018 eighteen Member States have had natural gas consumption values below the European one which was 0.461 toe per household. Malta and Cyprus have been excluded from these figures as in both cases residential natural gas consumption was equal to 0. The Member State with the highest residential natural gas consumption per household has been Luxembourg (0.972 toe/household), followed by the Netherlands (0.873 toe/household) and the United Kingdom (0.825 toe/household). In contrast the lowest natural gas consumption per household occurred in Sweden (0.006 toe/household), Finland (0.009 toe/household) and Bulgaria (0.029 toe/household). The lowest values of natural 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 when focusing on heating purposes while the low values of natural gas in Bulgaria can be explained by economic reasons. It is notable that all the countries but Bulgaria, Greece, Latvia, Lithuania, Romania and Poland have decreased their consumption in comparison to the year 2009.

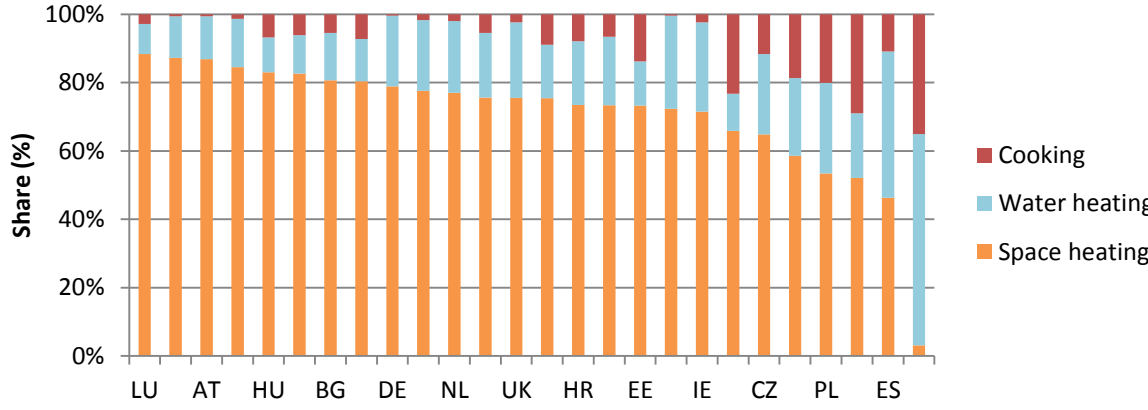
⁸⁶ Residential electricity consumption per dwelling has been calculated by the report authors as the ratio between the final residential energy consumption and the stock of permanently occupied dwellings) in the EU-28 as made available by Odyssee.

Figure 71: Residential natural gas consumption trends per household in the EU-28 Member States, 2009, 2014 and 2018



Source: Eurostat

Figure 72: Residential natural gas consumption by type of end-use in the EU-28 Member States⁸⁷, 2018

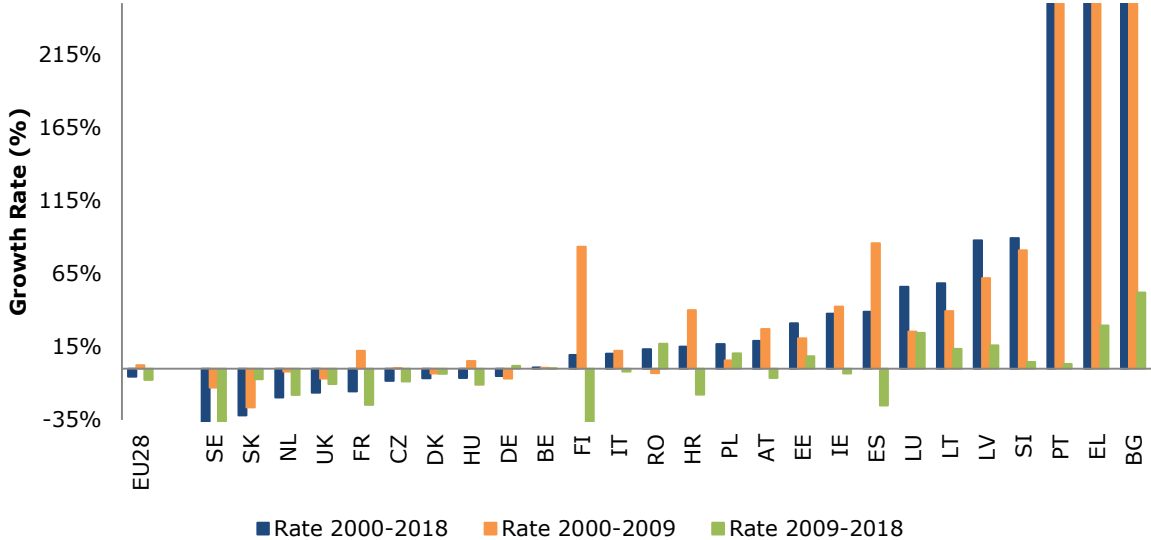


Source: Eurostat

Figure 72 shows the end-uses in which the natural gas is consumed per Member State. The majority of the Member States consume the largest share of natural gas in space heating. Portugal and Spain have consumed more than 40% for water heating while Portugal, Lithuania and Latvia and Poland have consumed more than 20% of natural gas for cooking.

⁸⁷ CY and MT excluded from final graph as their residential natural gas consumption was equal to 0.

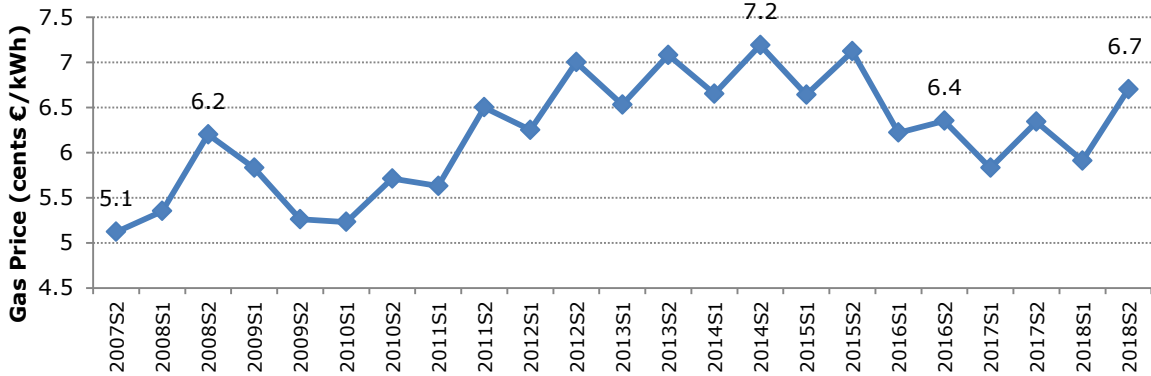
Figure 73: Final residential natural gas consumption growth rates in the EU-28 per Member State; 2000-2018, 2000-2009 and 2009-2018



Source: Eurostat

The final residential natural gas consumption has decreased by 5.6% in the period between 2000 and 2018. The Member States with the highest growth rate has been Bulgaria with an increase in consumption over the period equal to 39,941.5%, followed by Greece (6,720.1%) and Portugal (273.2%). These extremely high positive growth rates may be the result of the development of natural gas networks in these Member States over the studied period. On the other hand, the highest reduction rates have occurred in Sweden (-58.9%), Slovakia (-31.9%), and the Netherlands (-19.6%). Overall, it can be observed a significant change in the consumption trend from 2009 onwards, as illustrated in Figure 73. To be noted the cases of Bulgaria, Greece and Portugal, where the growth rates sharply changed between the periods 2000-2009 and 2009-2018.

Figure 74: Natural gas prices for household consumers in the EU-28 by semesters, band D2 - all taxes and levies included, 2007S2-2018S2



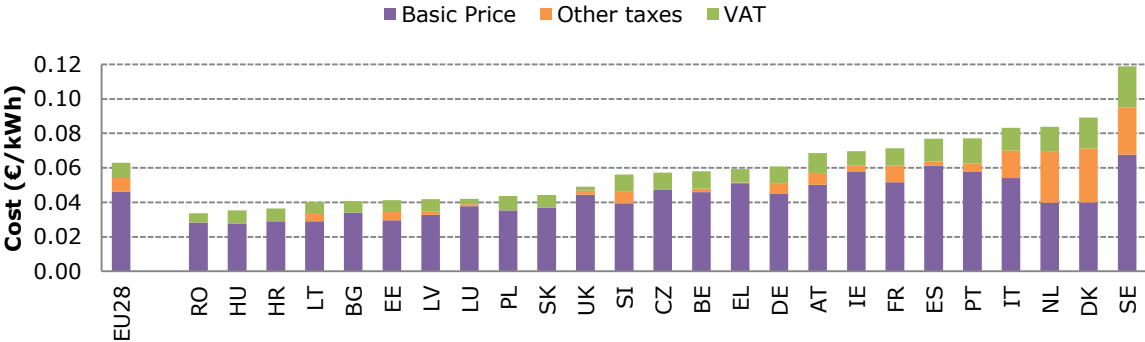
Source: Eurostat

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 2017, the average EU-

28 expenses per household for natural gas were EUR 337.7⁸⁸. Despite its considerable fluctuations the average EU-28 natural gas price for households has experienced a rise of 30.9% between the second semester of 2007 and the second semester of 2018, when prices were EUR 0.051/kWh and EUR 0.067/kWh respectively (Figure 74). The highest price level (EUR 0.072/kWh) was reached during the second half of 2014.

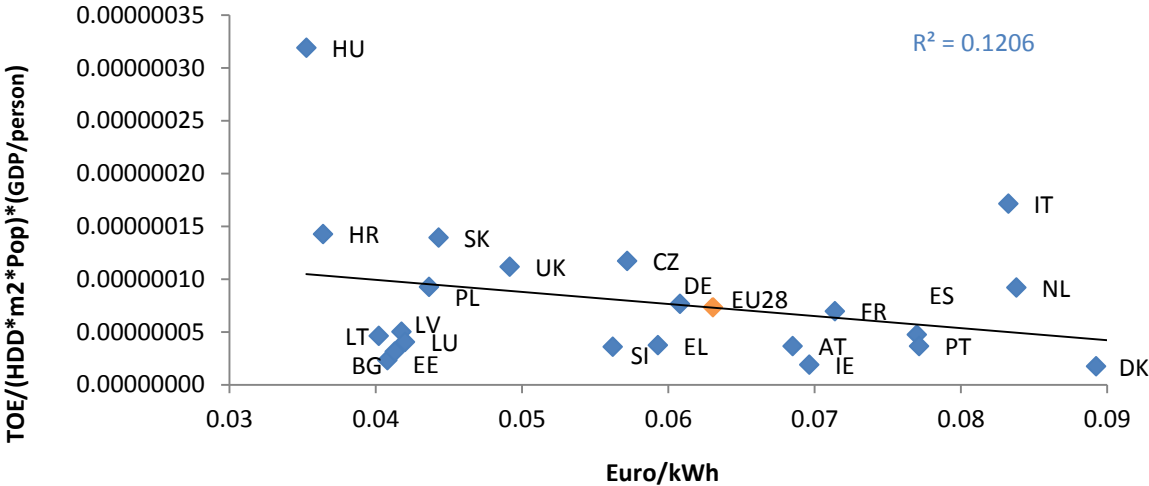
Looking at the natural gas prices across the EU-28 Member States for the year 2018 (Figure 75), it is possible to notice that Sweden has the highest gas price (EUR 0.119/kWh) followed by Denmark (EUR 0.089/kWh) and Netherlands (EUR 0.084/kWh). In contrast, the lowest natural gas prices are found in Romania (EUR 0.034/kWh), Hungary (EUR 0.035/kWh) and Croatia (EUR 0.036/kWh). As for electricity prices, Denmark has the highest percentage (55.2%) of taxes and levies. The EU-28 percentage of taxes and levies in 2018 was equal to 26.8%.

Figure 75: Natural Gas prices for household consumers in the EU-28⁸⁹, band D2, 2018



Source: Eurostat

Figure 76: Gas consumption normalized by HDD⁹⁰, m², population, GDP per capita⁹¹ and natural gas prices⁹² for EU-28 Member States⁹³, Year 2017



Source: Eurostat, Odyssee

⁸⁸ This value has been calculated from the average natural gas total price for household consumers (band D2) multiplied by residential gas consumption per household in kWh.
⁸⁹ Data are not available for Finland. Malta and Cyprus: natural gas consumption equal to zero
⁹⁰ HDD normalization: HDD of Member State/mean HDD of EU-28 Member States for 2017
⁹¹ GDP per capita at current market prices, chain linked volumes (2010), million euro
⁹² Includes all taxes and levies
⁹³ Excludes FI, RO, BE due to incomplete data
 CY, MT zero consumption

The trend-line of the Figure 76 shows that there is a negative correlation between the residential natural gas adjusted to take into account population, floor area of dwellings, GDP and HDD, and the gas prices. This means that when the gas prices increased, the energy consumption tend to decrease.

The following table provides an overview of the final residential natural gas consumption across the EU-28 Member States. It summarizes data about gas consumption in the residential sector for years 2000, 2009 and 2018, as well as the growth rates over different periods. Data have been already introduced and analysed along the chapter.

Table 3: Overview of final residential gas consumption in the EU-28 Member States, 2000-2018

	2000 (ktoe)	2009 (ktoe)	2018 (ktoe)	2000-2018 (%)	2000-2009 (%)	2009-2018 (%)
EU28	108,661.3	111,263.7	102,634.9	-5.6%	2.4%	-7.8%
BE	3,292.6	3,312.7	3,320.2	0.8%	0.6%	0.2%
BG	0.2	50.8	77.3	39941.5%	26218.7%	52.1%
CZ	2,049.3	2,059.3	1,878.8	-8.3%	0.5%	-8.8%
DK	658.5	637.6	615.1	-6.6%	-3.2%	-3.5%
DE	23,430.8	21,849.2	22,265.0	-5.0%	-6.8%	1.9%
EE	41.9	50.7	55.0	31.2%	20.9%	8.5%
IE	437.8	623.4	602.9	37.7%	42.4%	-3.3%
EL	4.9	255.9	331.3	6720.2%	5168.3%	29.5%
ES	1,972.2	3,665.7	2,740.3	38.9%	85.9%	-25.2%
FR	12,641.8	14,194.4	10,671.2	-15.6%	12.3%	-24.8%
HR	405.7	568.1	467.2	15.2%	40.0%	-17.8%
IT	14,970.5	16,820.7	16,499.4	10.2%	12.4%	-1.9%
LV	63.5	102.8	119.2	87.7%	61.9%	15.9%
LT	104.0	145.1	164.7	58.3%	39.5%	13.5%
LU	156.6	196.4	244.4	56.06%	25.4%	24.6%
HU	3,025.3	3,181.6	2,830.6	-6.4%	5.2%	-11.0%
NL	8,508.6	8,342.3	6,840.2	-19.6%	-2.0%	-18.0%
AT	1,134.3	1,442.3	1,351.3	19.1%	27.2%	-6.3%
PL	3,047.9	3,221.0	3,561.5	16.9%	5.7%	10.6%
PT	73.2	264.2	273.1	273.2%	261.0%	3.4%
RO	2,216.9	2,146.8	2,513.8	13.4%	-3.2%	17.1%
SI	58.6	106.1	110.9	89.3%	81.0%	4.6%
SK	1,642.2	1,205.9	1,118.9	-31.9%	-26.6%	-7.2%
FI	22.4	41.1	24.5	9.3%	83.3%	-40.4%
SE	75.8	66.1	32.7	-56.9%	-12.8%	-50.5%
UK	28,625.8	26,713.6	23,925.5	-16.4%	-6.7%	-10.4%

CY, MT – Gas consumption equal to 0

Source: Eurostat

3.4 Overview – Residential sector

The residential sector accounted for almost the one quarter of the EU-28 total final energy consumption in 2018 and it is the third energy-consuming sector after transport and industry.

The final residential energy consumption in the EU-28 shows a slight reduction from 2000 to 2018 (-4.5%) and an even more slight drop from 2017 to 2018 (-1.6%).

The EU-28 final residential energy per capita for the year 2018 decreased notably compared to the year 2000 (-9.2%).

For what concerns the residential energy mix, the main fuel types which contributed to the final residential energy consumption in the EU-28 in 2018 were natural gas, electrical energy and biofuels and renewables.

There are several key factors which can be considered, at least qualitatively, when analysing residential energy statistics. These factors are related to economic growth, population growth, weather conditions, energy prices and living conditions (e.g. average number of people per household, total number of private households, total stock of dwellings).

Between 2000 and 2018 the population in the EU-28 grew. The overall trend in Europe is an increase in population accompanied by an increase in the number of smaller households as the average number of people per household. In general, this may lead to a rise in total final residential energy consumption.

Although the number of private households in the EU-28 has been continuously growing and since 2009 the size of houses in terms of persons per household has slightly decreased, the final residential energy consumption follows a decreasing trend in the period 2000-2018.

GDP per capita in the EU-28 has been continuously increasing between 2000 and 2018 with a fall in 2009 due to the economic and financial crisis worldwide and a second very slight fall in 2012. Although this trend, final residential energy consumption per capita fell in the same period.

The GDP per capita at current market prices (in chain linked volumes -2010) across countries in the EU-28 for the year 2018 results very largely. Luxembourg and Denmark which are countries with high consumption per capita values also have registered high GDP per capita values.

This could suggest that higher GDP levels may indeed lead to buy more energy, by using equipment at home resulting in higher energy consumption. On the other hand, Bulgaria and Romania, which are the two States with the minimum GDP per capita, are also countries with low residential energy consumption per capita values. This could suggest that lower GDP levels may lead to the inability of many households to ensure the required levels of energy in the home, a condition commonly called energy poverty.

The growth in GDP per capita despite the population's increase observed 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.

In the case of residential sector, energy indicators and ratios based on GDP values might not be as representative as others based on disposable income of households or adjusted gross disposable income since these variables are more closely related to the purchasing power of the inhabitants.

A positive correlation is often observed between the residential energy consumption (final energy, electricity and gas consumptions) and heating degree days. A positive correlation between electricity consumption and cooling degree days is also observed. Final residential energy consumption is corrected by climatic, economic, population and dwelling-related indicators in order to explain better the trends.

The analysis of the final residential energy consumption per capita trends in EU-28 in combination with various indicators such as GDP per capita, average floor area of dwellings, HDD show that that despite the worsen of the climatic conditions (colder

winters), the economic growth (increase of GDP per capita values) and the increase of population, the final residential energy consumption has experienced a gradual decrease in the analysed period.

The final residential electricity consumption in the EU-28 has grown in the period 2000-2018 and remained stable from 2017 to 2018. The final residential natural gas consumption in the EU-28 has dropped in 2018 in comparison to the year 2000 while it remained almost stable from 2017 to 2018. Differences across EU-28 Member States are notable.

The EU-28 residential electricity and natural gas consumption per dwelling and per household values for the year 2018 were dropped compared to 2000.

The majority of the Member States consume the largest share of electricity in lighting and appliances. All the Member States consume the largest share of natural gas for space heating needs.

The average EU-28 expenses per household for electricity were EUR 757.9 EUR while for natural gas were EUR 337.7 in 2018.

The electricity price for household consumers has risen significantly in the period between 2007-S2 and 2018-S2. The price of natural gas for household consumers has registered fluctuating growth rates but overall it increased importantly between the second semester of 2007 and the second semester of 2018.

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 commerce⁹⁴. This chapter covers the energy consumption trends in the tertiary sector, with a focus on electricity and gas.

The tertiary sector accounts for a large share of GDP in the EU. 74.0% of the total gross value added was generated by this sector in 2018 (Figure 9). 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 [11].

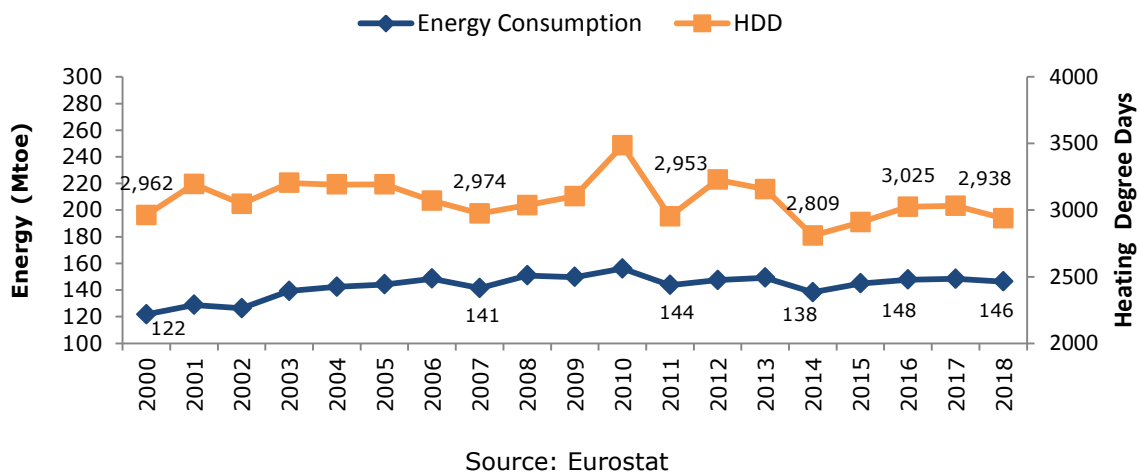
Also employment rates registered in the recent years show that there have been changes which have provided opportunities for increased productivity in knowledge-intensive sectors, leading to additional possibilities for labour re-allocation and employment growth in certain sectors. Manual workers – in particular in manufacturing and agriculture – are however relocated to services in the process of automation [12].

4.1 Final energy consumption trends in the tertiary sector

The tertiary sector accounted for 13.0% of total final energy consumption⁹⁵ in the year 2018. Considering its share in value added this is relatively low compared to e.g. the industry sector. This latter sector consumed 25.3% of total final energy but with a contribution of just 24.5%⁹⁶ to the total value added in 2018.

The final tertiary energy consumption in the EU-28 has risen by 20.2% in the period from 2000 to 2018. The peak of consumption was reached in the year 2010 (156.1 Mtoe) as illustrated in Figure 77. From 2017 to 2018, tertiary final energy consumption has decreased by 1.4% after three continuous years of positive growth rates.

Figure 77: Final tertiary energy consumption in the EU-28, 2000-2018



In Figures 77 and 78 it is also studied whether there is a correlation between weather conditions and final energy consumption in tertiary sector. As shown in this figures, the final tertiary energy consumption trends are similar to Heating Degree Days line with the exception of years 2004, 2006 and 2009 and 2013. This indicates that there is a correlation between the two indicators, but energy consumption may be also affected by other factors such as the number of employees. A further analysis on which is the most

⁹⁴ This category is also known as the "commercial sector" and represents non-residential buildings in the services sector.

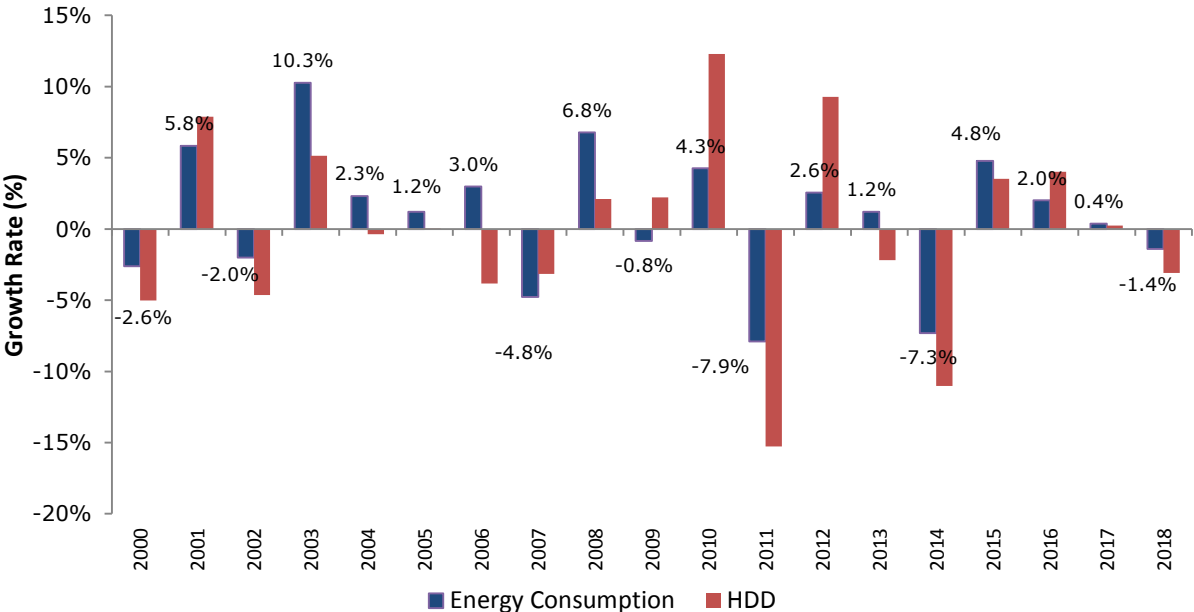
⁹⁵ Tertiary energy consumption trends have been analysed using the old methodology Eurostat tables in order to be comparable with the EU 2020 targets.

⁹⁶ Construction sector is included – see Figure 9.

influencing factor in tertiary sector energy consumption is going to be presented in this chapter(Figures 81-83).

Looking at the growth rates along the same period (Figure 78), a general growing trend can be observed between 2000 and 2010 with the exception of the years 2002, 2007 and 2009. Notably, an increase of 10.3% 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. 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 close to 2007 levels. A new increasing trend has started in 2015 and continued in 2016 and 2017. In 2018, tertiary energy consumption decreased.

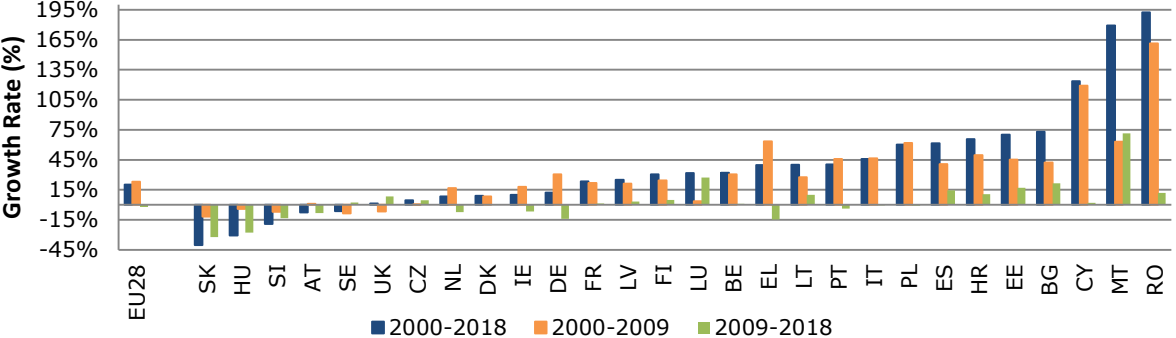
Figure 78: Tertiary final energy consumption and Heating Degree Days annual growth rates in the EU-28, 2000-2018



Source: Eurostat

As previously mentioned, the EU-28 final tertiary energy consumption has grown by 20.2% in the 19 years studied. Nevertheless, the growth rates are markedly different before and after 2009 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 -40.2%, followed by Hungary (-30.7%) and Slovenia (-19.2%). In contrast, the Member States, which have experienced the highest growth rates in energy consumption in the service sector, were Romania (192.2%), Malta (179.2%) and Cyprus(123.5%).

Figure 79: Final tertiary energy consumption growth rates by Member State in the EU-28; 2000-2018, 2000-2009 and 2009-2018



Source: Eurostat

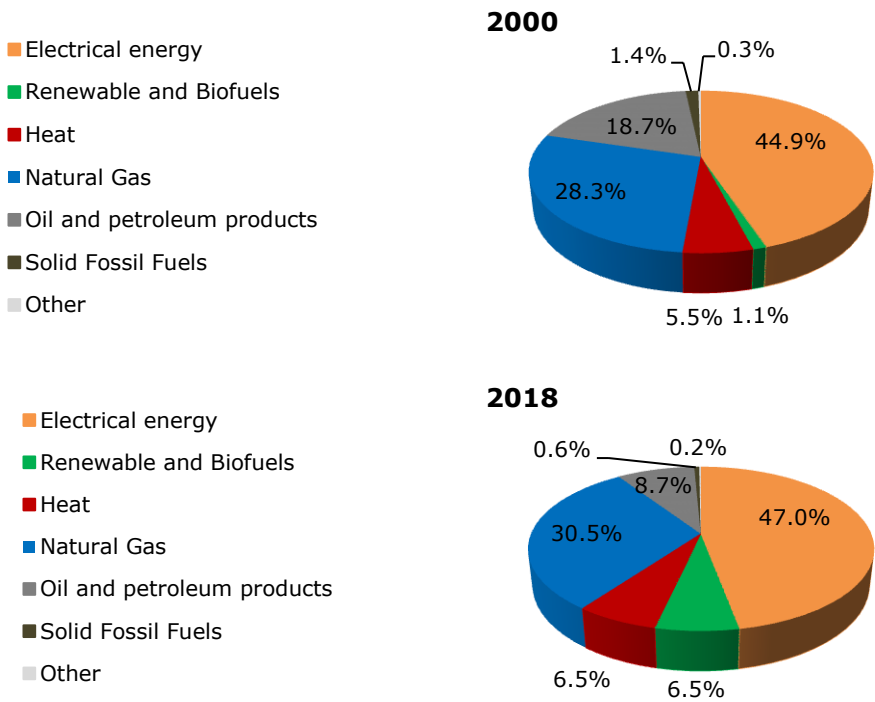
To be noted the significant change in the growth rates across different sub-periods in Romania, Cyprus, Greece, Portugal, Italy, Poland, Germany and the Netherlands. In Cyprus, in particular, the growth rate passed from +123.5% in the period 2000-2009, to +2.0% during 2009-2018 period. At the same time, a positive growth rate during the first sub period made way for a negative one in the second sub period in Poland, Italy, Portugal, Greece, Germany, the Netherlands, Austria and Ireland.

The final energy mix in the tertiary sector⁹⁷ of EU-28 was mainly formed of three energy sources which accounted for almost the 90% of the total final energy consumption in 2018. Electricity had the highest share (47.0%), followed by natural gas (28.3%) and oil and petroleum products (18.7%). Other contributors to the energy mix have been renewable energies and biofuels (6.5%), heat (6.5%), solid fossil fuels (0.6%) and other not already mentioned sources⁹⁸ (0.17%). Changes compared to the scenario of year 2000 are mainly due to a reduction in the share of petroleum products (-10.0%). Electricity (+2.2%) and natural gas (+2.3%) have instead acquired larger shares together with heat (+1.1%) and renewable energies and biofuels (+5.5%). Solid fossil fuels have reduced their shares by 0.9%.

There are no significant changes in the shares of energy sources used in services in 2018 compared to the years 2017. The ranking also remained the same. The most important change is the further decreased share of oil and petroleum products (-2.4%).

⁹⁷ The analysis of tertiary energy consumption per fuel type uses the new methodology Eurostat tables for energy balances based on the availability of the data.
⁹⁸ Peat and peat products, manufactured gases and non-renewable waste are included.

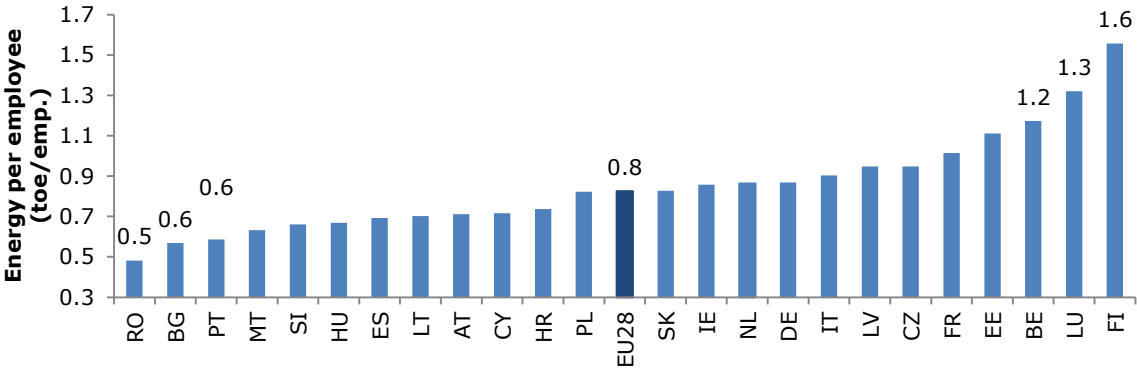
Figure 80: Final energy mix in the tertiary sector in the EU-28, 2000 and 2018



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 0.83 toe per employee in 2018 (Figure 81).

Figure 81: Final energy consumption per employee⁹⁹ in the tertiary sector in the EU-28 Member States¹⁰⁰, 2018



Source: Eurostat

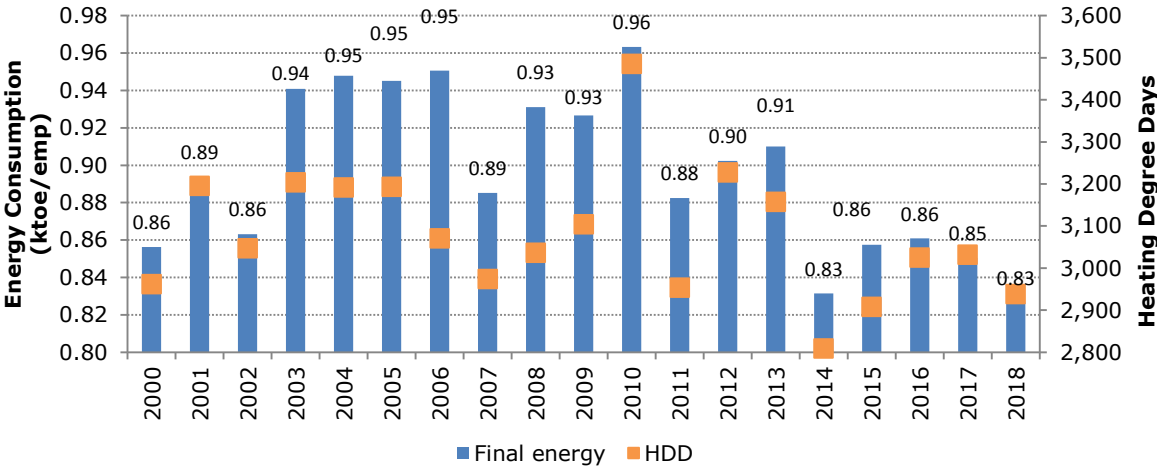
⁹⁹ Employees in the figure cover the following subsectors: Wholesale and retail trade, transport, accommodation and food service activities, Information and communication, Financial and insurance activities, Real estate activities, Professional, scientific and technical activities; administrative and support service activities, Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies, Public administration, defense, education, human health and social work activities

¹⁰⁰ UK, Denmark, Sweden and Greece excluded due to incomplete data

In 2018, the Member States with the highest energy consumption per employee were Finland (1.6 toe/emp.), Luxembourg (1.3 toe/emp.), and Belgium (1.3 toe/emp.). On the other hand, Romania (0.5 toe/emp.), Bulgaria and Portugal (0.6 toe/emp. both) were the Member States with the lowest final tertiary energy consumption per employee.

Looking at the trend of this indicator over the period 2000-2018 (Figure 82) it is possible to notice that 2014 has registered the lowest value (0.8 toe/emp.) in the 19-year analysed period. The maximum was reached in 2010 (1.0 toe/emp.). In 2018 its value was equal to 0.8 toe/emp (decreased by 2.8% compared to 2017 and by 3.5% compared to 2000).

Figure 82: Final energy consumption per employee in the tertiary sector and Heating Degree Days in the EU-28, 2000-2018



Source: Eurostat

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 34.9 million employees in the period from 2000 to 2018, with a growth rate of 24.6%. A slowdown in the growth of number of employees rates was observed between 2008-2012 possibly as a result of the economic crisis. Despite this, from 2013 to 2018, the tertiary sector continued to increase rapidly in the EU.

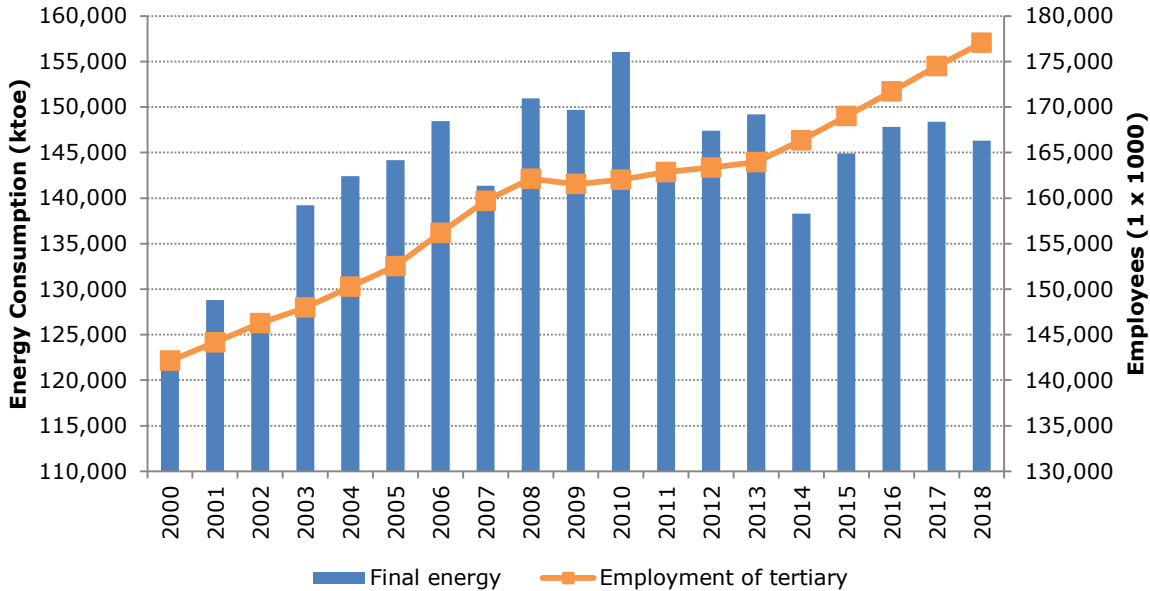
Given the nature of the tertiary sector which includes public sector, professional, scientific and technical activities, service and commerce; comfort conditions (e.g. temperature and humidity levels) are important and can be considered as key factors in the evaluation of energy consumption in this sector.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

Figure 82 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 83 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 82.

Figure 83: Final energy consumption and employment rates in the tertiary sector in the EU-28, 2000-2018



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

ktoe	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2000 - 2018 (% year)
EU28	121,714	144,151	156,055	143,722	147,411	149,188	138,291	144,897	147,826	148,389	146,328	20.2%
BE	3,476.2	4,122	4,941	4,396	4,505	4,897	4,205	4,573	4,601	4,591	4,592	32.1%
BG	658	824	989	1,047	1,023	965	927	1,004	1,076	1,080	1,139	73.0%
CZ	2,972	3,136	3,244	3,127	3,033	3,002	2,914	2,967	3,079	3,167	3,111	4.7%
DK	1,843	2,002	2,128	1,948	1,979	1,964	1,848	1,900	1,958	2,016	2,011	9.1%
DE	25,820	33,738	34,831	30,723	32,013	33,502	30,713	32,232	31,798	31,995	29,004	12.3%
EE	288	389	424	402	424	418	458	465	498	469	491	70.2%
IE	1,331	1,597	1,498	1,310	1,310	1,280	1,213	1,257	1,320	1,373	1,465	10.1%
EL	1,318	1,953	1,957	1,870	1,939	1,821	1,714	1,875	2,038	1,963	1,841	39.7%
ES	6,679	8,316	9,790	10,232	10,115	9,680	8,827	10,408	10,973	10,827	10,782	61.4%
FR	18,658	20,918	23,945	21,749	23,352	24,073	22,100	22,948	23,063	23,352	23,058	23.6%
HR	492	693	776	763	733	714	676	743	763	800	816	65.8%
IT	11,542	15,053	16,979	15,751	15,931	15,847	14,667	15,391	15,440	15,693	16,842	45.9%
CY	108	161	248	236	223	203	200	207	225	236	240	123.5%
LV	473	595	598	557	623	600	609	586	592	606	591	25.1%
LT	463	562	601	584	610	593	586	575	603	634	650	40.2%
LU	363	367	424	353	397	411	361	397	401	456	478	31.6%
HU	3,026	3,501	3,049	3,054	2,354	2,337	2,115	2,204	2,183	2,154	2,099	30.7%
MT	43	63	92	88	100	103	111	121	118	124	121	179.2%
NL	6,242	6,933	7,804	6,938	7,178	7,199	6,335	6,714	6,596	6,821	6,766	8.4%
AT	2,552	2,923	2,552	2,454	2,421	2,367	2,300	2,354	2,280	2,475	2,361	-7.5%
PL	4,966	6,730	8,831	8,423	8,357	8,071	7,776	7,828	8,488	8,079	7,962	60.3%
PT	1,400	2,200	1,883	1,855	1,843	1,787	1,901	1,969	1,900	1,899	1,967	40.5%
RO	673	1,670	1,881	1,774	1,763	1,785	1,768	1,762	1,806	1,841	1,968	192.2%
SI	527	476	533	531	453	468	427	455	492	480	426	19.2%
SK	2,200	1,751	2,105	1,602	1,451	1,711	1,233	1,300	1,308	1,427	1,315	40.2%
FI	2,326	2,619	3,100	2,865	3,029	2,907	2,890	2,736	2,889	2,923	3,035	30.5%
SE	4,409	4,105	4,332	3,865	4,046	3,958	3,958	4,019	4,212	4,014	4,124	-6.5%
UK	16,864	16,753	16,519	15,223	16,206	16,526	15,459	15,907	17,123	16,896	17,075	1.3%

Source: Eurostat

4.2 Electricity consumption trends in the tertiary sector

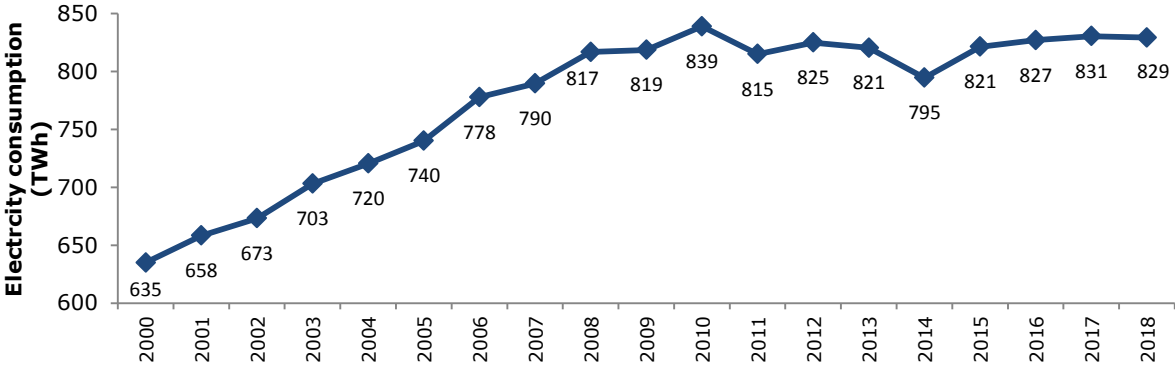
In 2018, the service sector accounted for 29.5%¹⁰¹ of the final electrical energy consumption. It had the largest share of consumption after the industry sector (37.3%), as reported in Figure 20.

¹⁰¹ The analysis of tertiary electricity consumption uses the new methodology Eurostat tables for energy balances based on the availability of the data.

Turning to the tertiary sector energy mix, electricity accounted for 47.0% in 2018, representing the highest share among the different energy types.

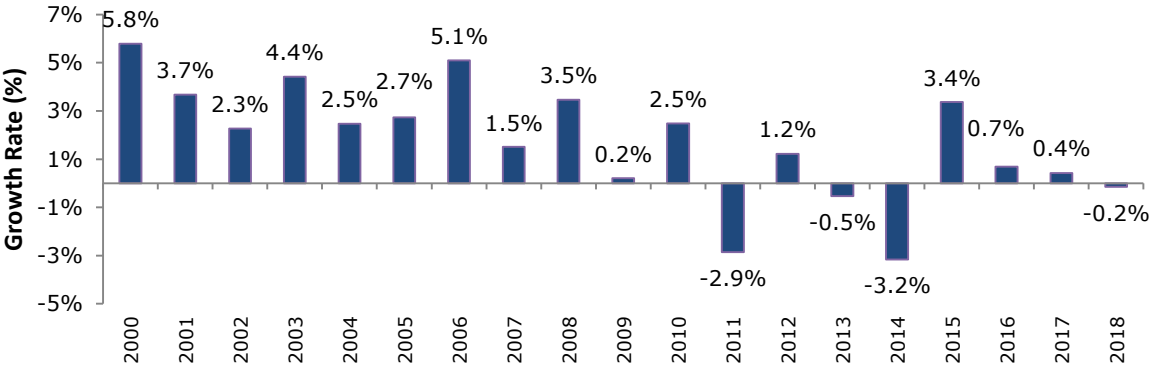
The total final electricity consumption increased by 30.6% during the period from 2000 to 2018. In 2018, the EU-28 electricity consumption reached 829.3 TWh. A continuous increase with an average growth rate above 3% per year can be observed between 2000 and 2010 in the EU-28. In this year electricity consumption in the sector reached its maximum level (839.0 TWh). From 2011 to 2014 fluctuating trends have been registered. From 2015 to 2017 it is possible to observe a new increasing trend in the final tertiary electricity consumption. In 2018, the total final electricity consumption of the service sector remained almost stable (reduced by only 0.2%) after three continuous years with positive growth rates.

Figure 84: Final tertiary electricity consumption in the EU-28, 2000-2018



Source: Eurostat

Figure 85: Tertiary electricity consumption annual growth rates in the EU-28, 2000-2018

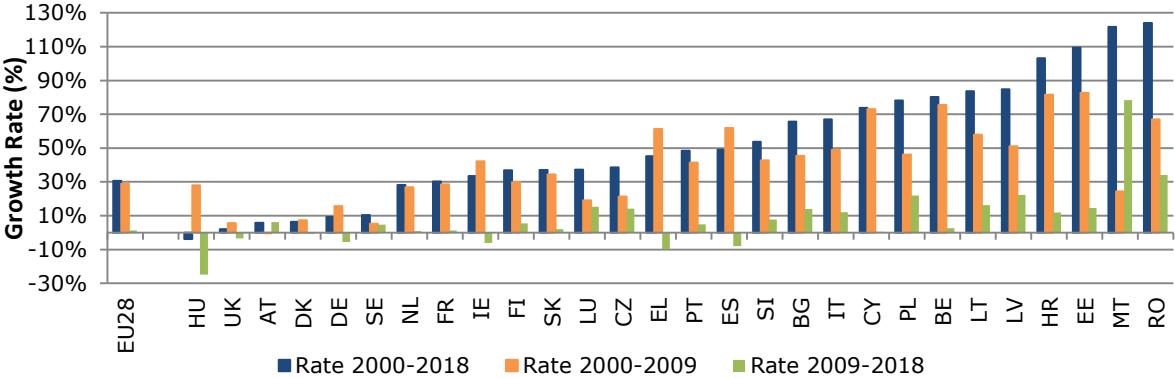


Source: Eurostat

As already mentioned, the final tertiary electricity consumption has increased by 30.6% in the period 2000-2018. Looking at the growth rates of the different Member States (Figure 86), it is observed that nine Member States have registered a growth rate below the EU-28 growth rate (HU,UK,AT,DK,DE,SE,NL,FR). During the previously mentioned period (2000-2018), the Member States with the highest growth rates have been Romania (124.0%), Malta (121.8%) and Estonia (109.4%). In contrast, the Member States with the highest reduction rates have been Hungary (-3.8%), the United Kingdom (2.0%) and Austria (5.8%). All the Member States except Austria, show a positive growth rate in the period from 2000 to 2009. The highest growth rates were found in Estonia (82.7%), Croatia (81.5%) and Cyprus(73.0%) during this latter time period. In the

period from 2009 to 2018, eight EU-28 countries have reversed their growth rate trends and turned them into negative ones. The highest growth rates for the period 2009-2018 occurred in Malta (78.3%), Romania (34.1%), and Latvia (22.3%); while the highest reduction rates took place in Hungary (-24.8%), Greece (-9.9%) and Spain (-8.0%).

Figure 86: Final tertiary electricity consumption growth rates by Member State in the EU-28; 2000-2018, 2000-2009 and 2009-2018



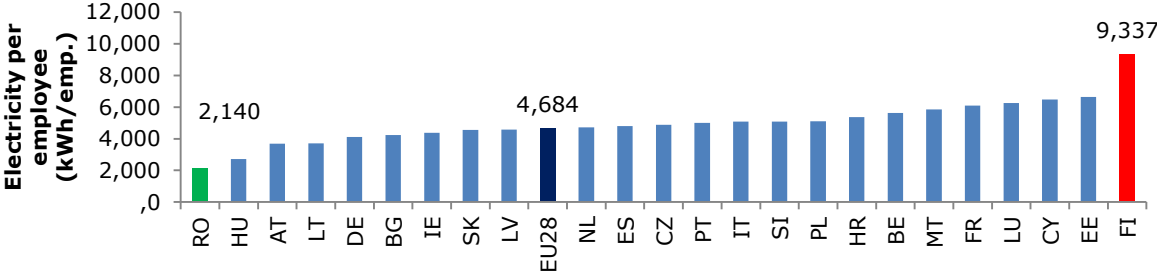
Source: Eurostat

The EU-28 annual electricity consumption per employee was 4,684 kWh/emp in the EU-28 in 2018. Fifteen Member States had above EU-28 electricity consumption per employee as illustrated in Figure 87. The Member States with the highest consumptions per employee were Finland (9,337 kWh/emp), Estonia (6,642 kWh/emp) and Cyprus (6,473 kWh/emp). On the other hand, the countries with the lowest electricity consumptions per employee were Romania (2,140 kWh/emp), Romania (2,722 kWh/emp) and Austria (3,696 kWh/emp).

Weather and climatic conditions cannot explain the large differences in per employee electricity consumption observed e.g. between Finland and Lithuania (around 151.7%), as both countries are ranked as first and fifth respectively in the value of Mean Heating Degree days (Figure 64). The difference may be explained not even by referring only to GDP influence, as again, Germany and Finland have e.g. similar values of GDP per capita (Figure 37). 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 in Finland and Cyprus, it is observed that these countries rely more on electricity than on natural gas as energy type (Figure 91). Other States, such as Lithuania or Latvia, have consumption levels per employee below the EU-28 value both for electricity and natural gas. In these countries a high percentage of citizens is served by District Heating and the energy mix seems more balanced.

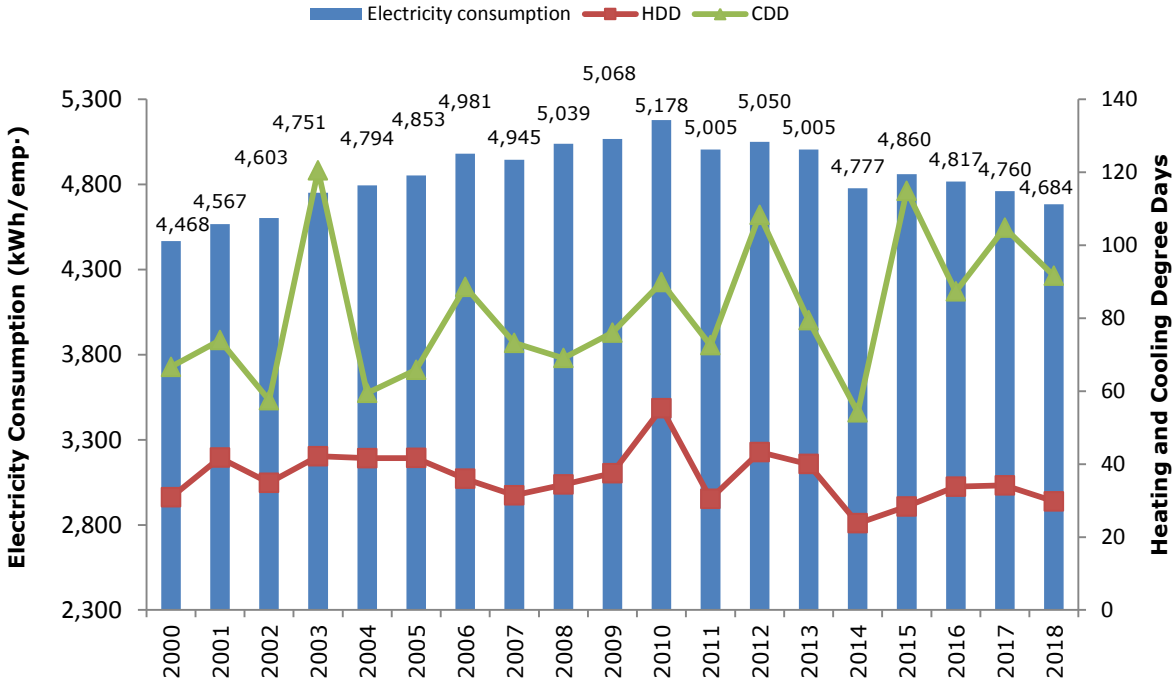
Figure 87: Annual electricity consumption per employee in the tertiary sector in the EU-28¹⁰², 2018



Source: Eurostat

The European electricity consumption per employee has risen by 4.9% in the period from 2000 to 2018. An overall growing trend has been experienced as shown in Figure 88. The maximum in the analysed time series was registered in 2010, when the electricity consumption per employee reached 5,178 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 2018, the electricity consumption per employee decreased by 1.6% compared to 2017 and remained below the threshold of 5,000 kWh/emp (4,684 kwh/emp). It is observed a more clear correlation between electricity per employee and HDD (with the exception of the year 2006) compared to the CDD.

Figure 88: Annual electricity consumption per employee in the EU-28 tertiary sector, 2000-2018



Source: Eurostat

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

¹⁰² UK, Denmark, Sweden, Greece : excluded due to incomplete data

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

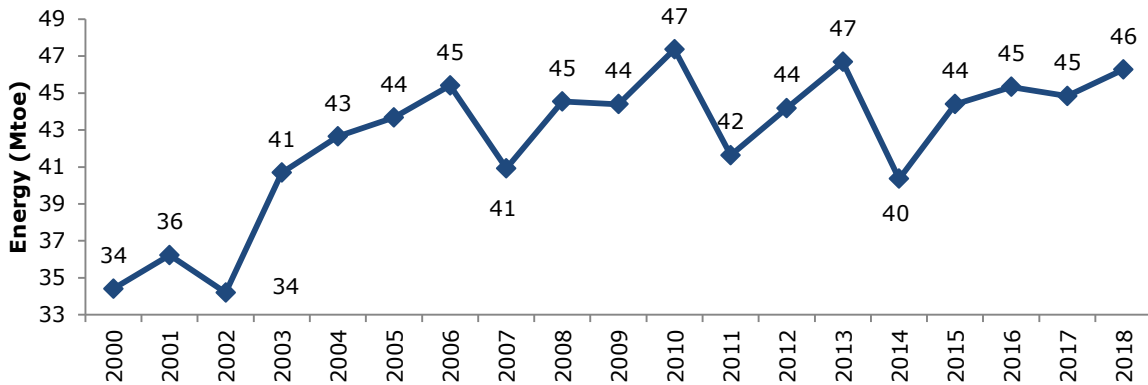
GWh	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2000 - 2018
												(% year)
EU28	635,008	740,171	838,952	815,038	824,970	820,526	794,622	821,369	827,054	830,603	82932.7	30.6%
BE	12,236	12,703	22,182	21,653	21,954	22,262	21,323	21,669	21,808	21,767	22047.9	80.2%
BG	5,115	6,143	8,101	8,437	8,170	7,954	7,831	8,076	8,505	8,434	8470.547	65.6%
CZ	11,559	12,911	14,851	14,471	14,469	14,809	14,464	14,875	15,327	15,618	16027.523	38.7%
DK	9,954	10,472	10,835	10,656	10,481	10,227	10,288	10,087	10,217	10,685	10594.387	6.4%
DE	125,453	137,767	144,372	136,306	139,210	142,062	131,515	140,736	141,585	141,479	13709.7	9.3%
EE	1,401	1,929	2,511	2,378	2,536	2,530	2,795	2,813	2,971	2,715	2933	109.4%
IE	5,590	8,465	7,166	6,501	6,279	6,366	6,439	6,746	6,951	7,027	7462.226	33.5%
EL	12,260	16,479	18,000	16,839	18,470	17,008	16,802	17,926	19,448	19,243	17807.75	45.3%
ES	50,023	63,823	83,892	81,825	80,752	76,302	70,562	74,108	73,388	75,307	74513	49.0%
FR	106,313	125,188	144,664	135,742	141,859	142,102	135,994	139,343	139,852	139,382	13848.7.65	30.3%
HR	2,926	4,413	5,385	5,516	5,513	5,387	5,215	5,405	5,433	5,777	5945.2	103.2%
IT	56,595	73,875	85,619	86,912	90,279	88,982	88,489	92,085	91,736	93,492	94489.798	67.0%
CY	1,251	1,786	2,256	2,138	2,000	1,786	1,838	1,886	2,065	2,097	2174.034	73.8%
LV	1,546	2,142	2,420	2,487	2,798	2,703	2,882	2,725	2,733	2,765	2856.007	84.7%
LT	1,872	2,686	2,839	2,953	3,114	3,130	3,218	3,110	3,280	3,307	3436.5	83.6%
LU	1,647	1,751	1,994	1,881	1,946	1,999	1,932	1,920	1,794	2,252	2261.93	37.3%
HU	8,880	9,931	11,355	11,466	7,817	7,507	7,647	7,937	8,045	8,323	8540	-3.8%
MT	504	563	797	829	888	896	943	1,002	992	1,093	1117.828	121.8%
NL	28,796	33,698	36,766	36,911	36,130	36,283	35,590	36,174	36,165	36,615	36907.129	28.2%
AT	11,586	12,574	11,815	11,697	12,005	12,004	12,257	12,274	11,541	12,215	12253.928	5.8%
PL	27,756	33,357	43,669	44,190	44,378	43,130	45,171	45,443	47,800	47,019	49441.15	78.1%
PT	11,288	14,407	16,397	16,270	16,007	15,707	16,756	17,193	16,457	16,370	16749.644	48.4%
RO	3,908	4,000	7,581	7,869	7,897	7,961	8,223	8,407	8,581	8,548	8752.686	124.0%
SI	2,126	2,421	3,066	3,261	3,168	3,218	3,141	3,232	3,365	3,524	3269.099	53.8%
SK	5,268	6,151	8,014	8,232	6,450	7,549	6,145	6,866	6,946	7,674	7218	37.0%
FI	13,287	15,523	17,846	17,263	17,857	17,505	17,459	17,450	17,645	17,520	18200	37.0%
SE	25,383	26,135	27,187	24,636	25,741	25,504	26,347	27,736	28,733	27,563	28012	10.4%
UK	90,485	98,878	97,372	95,718	96,802	97,652	93,356	94,144	93,692	92,792	92256.781	2.0%

Source: Eurostat

4.3 Natural gas consumption trends in the tertiary sector

In 2018, 19.27% of the total final natural gas energy consumption¹⁰³ of the EU-28 was generated in the service sector, this being the third highest share after those of the residential sector (42.8%) and the industry sector (34.7%), as shown in Figure 26. When focusing on the tertiary sector energy mix, natural gas accounted for 30.5% of total final consumption in 2018, representing the second highest share among the different energy types after electricity.

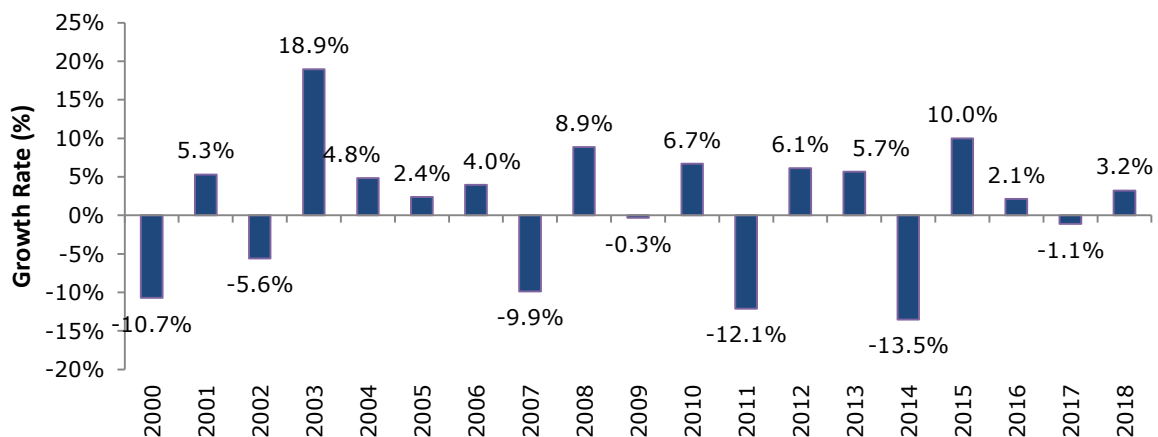
Figure 89: Final tertiary natural gas consumption in the EU-28, 2000-2018



Source: Eurostat

The final tertiary natural gas consumption in the EU-28 has grown by 34.5% in the period between 2000 and 2018. In 2018, the EU-28 tertiary natural gas consumption reached 46.3 Mtoe. From 2000 to 2010 an increasing trend in the consumption has been registered (leading to an overall increase of 37.7%) with the exception of 2002, 2007 and 2009. The maximum consumption was reached in 2010 (47.4 Mtoe). After an annual decrease by -12.1% occurred in 2011, there has been a rise of 12.1% in the period 2011-2013. In 2014, the tertiary natural gas consumption has been reduced by -13.5% in comparison to 2013 and has returned to the levels of 2007. A new increase (12.3%) has been registered in the period 2014-2016. In 2018, natural gas consumption of service sector increased by 3.2% approximately reaching the levels of 2013.

Figure 90: Annual tertiary natural gas consumption growth rates in the EU-28, 2000-2018

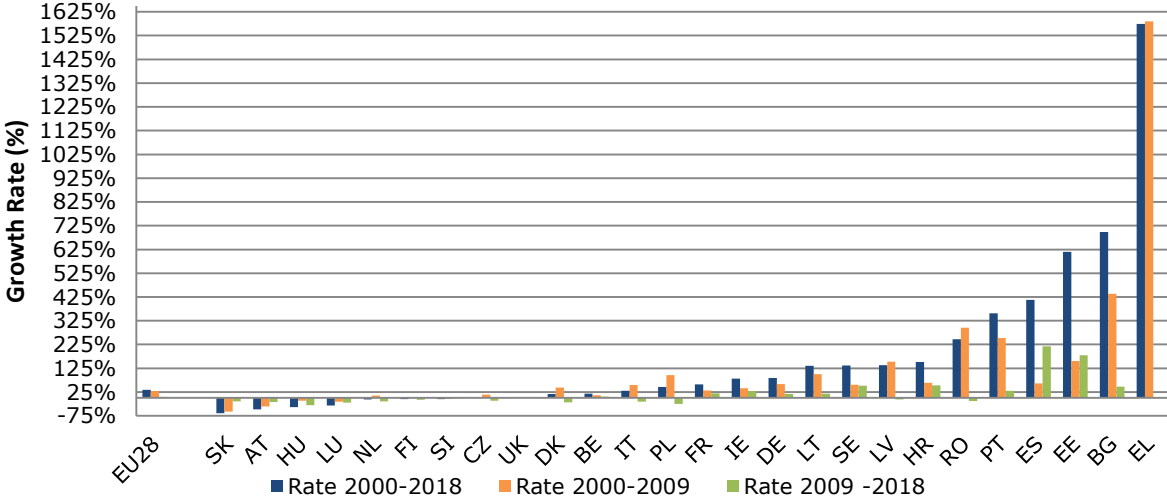


Source: Eurostat

¹⁰³ The analysis of tertiary natural gas consumption uses the new methodology Eurostat tables for energy balances based on the availability of the data.

There are notable differences across the EU-28 Member States regarding the final tertiary natural gas consumption growth rates during the period 2000-2018. In Figure 91, it can be observed that countries such as Greece, Bulgaria and Estonia have experienced a very large increase in their tertiary gas consumption over this period (+1574.2%, +698.1% and +614.8% respectively). This is possibly the result of the development of natural 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 high growth rates. Twelve Member States have registered a growth rate below the European average growth rate (34.5%) for the same period. The recent financial and economic crisis has impacted less on total EU-28 tertiary natural gas consumption compared to the impact on in other economic sectors, although it has totally reversed the tendencies in countries such as Romania (it went from an increase of 296.0% between 2000-2009 to a decrease of 12.4% in 2009-2018) or Latvia (passed from 152.5% in 2000-2009 to -5.9% in 2007-2018) as illustrated in Figure 91.

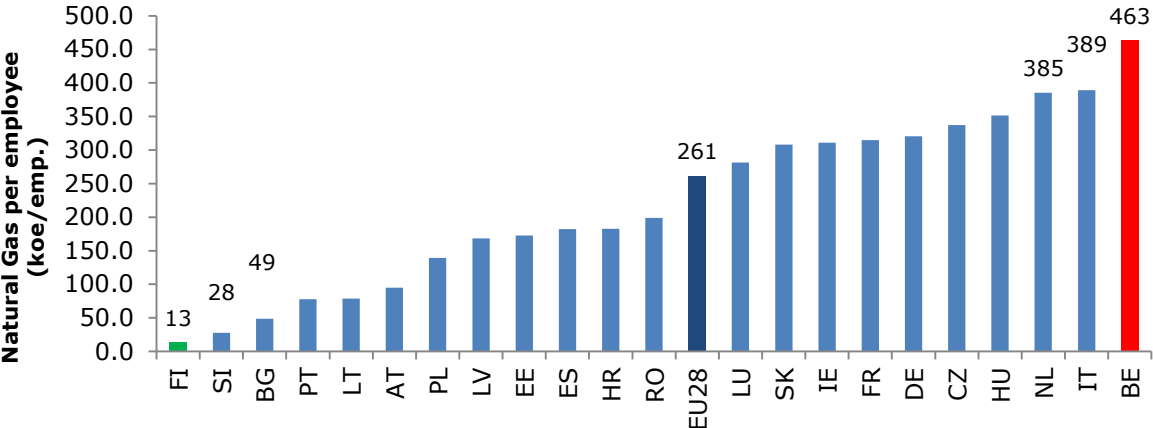
Figure 91: Final tertiary natural gas consumption growth rates by Member State¹⁰⁴ in the EU-28; 2000-2018, 2000-2009 and 2009-2018



Source: Eurostat

¹⁰⁴ CY and MT eliminated in the final graphics

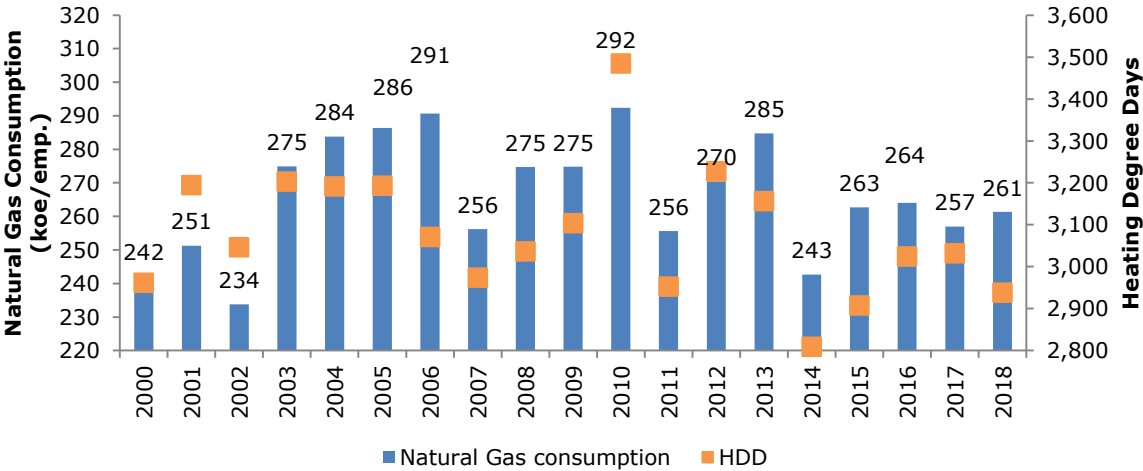
Figure 92: Annual final natural gas consumption per employee¹⁰⁵ in the tertiary sector in the EU-28 Member States, 2018



Source: Eurostat

The natural gas consumption per employee in the EU-28 in the tertiary sector was 261.4 koe/emp. in the year 2018. Differences among the EU-28 Member States are remarkable. The European country with the lowest natural gas consumption per employee was Finland which registered 13.2 koe/emp., followed by Slovenia (27.8 koe/emp.) and Bulgaria (48.9 koe/emp.). On the other hand, the Member State with the highest consumption was Belgium (463.3 koe/emp.). The second was Italy (389.2 koe/emp.) and the third the Netherlands (385.3 koe/emp.). Ten countries registered consumption levels above EU-28 level as illustrated in Figure 92.

Figure 93: Annual final natural gas consumption per employee in the tertiary sector in the EU-28, 2000-2018



Source: Eurostat

Unlike electricity which can be used for other purposes, natural gas has heating as major usage. Therefore, the qualitative correlation between natural gas consumption per employee in the tertiary sector and the weather conditions (heating degree days) is of great interest in this case. Figure 93 shows degree days and gas consumption per employee in the EU-28 for the 19-year period from 2000 to 2018. During this period, the

¹⁰⁵ Data for Cyprus and Malta equal zero. Denmark, Sweden, UK, Greece : incomplete data

natural gas consumption per employee in the EU-28 has raised by 8.0% (from 242.6 koe/emp. in 2000 to 261.4 koe/emp. in 2018). The maximum value was achieved in 2010 (292.3 koe/emp.) when the highest HDD value (3,485) 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 natural gas consumption in the EU-28 Member States

ktoe	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2000-2018 (% year)
EU28	34,404	43,672	47,364	41,630	44,177	46,678	40,359	44,389	45,330	44,834	46,271	30.3%
BE	1,545	1,771	1,945	1,589	1,700	1,937	1,535	1,716	1,816	1,811	1,815	17.2%
BG	12	44	80	83	82	78	83	89	90	95	98	673.0%
CZ	1,104	1,274	1,291	1,241	1,149	1,106	1,082	1,078	1,128	1,190	1,106	7.8%
DK	160	221	228	178	198	207	154	174	183	193	187	20.5%
DE	5,804	9,228	9,102	8,062	8,291	9,934	9,085	9,620	9,553	9,579	10,713	65.0%
EE	11	46	30	31	35	43	67	70	79	73	76	584.5%
IE	293	298	439	366	400	406	400	432	454	483	531	65.1%
EL	9	74	139	165	138	125	125	166	148	151	144	1652.8%
ES	552	579	1,018	1,725	1,629	1,492	1,409	2,827	3,209	2,868	2,831	419.8%
FR	4,539	5,610	6,749	6,155	7,036	7,565	6,498	6,908	7,026	7,263	7,157	60.0%
HR	80	122	156	141	132	136	132	169	181	192	202	139.0%
IT	5,572	7,434	8,614	7,254	7,276	7,259	6,012	6,499	6,542	6,590	7,250	18.3%
LV	44	94	116	104	98	84	91	86	94	101	105	128.5%
LT	31	51	66	60	63	63	54	62	65	69	73	121.4%
LU	149	98	136	82	121	117	97	104	117	90	102	-39.4%
HU	1,773	2,281	1,715	1,726	1,387	1,408	1,243	1,261	1,226	1,170	1,102	-34.0%
NL	3,227	3,523	4,035	3,222	3,633	3,646	2,888	3,122	2,995	3,120	3,019	-3.3%
AT	597	477	397	331	376	369	325	350	325	345	314	-42.1%
PL	921	1,634	1,993	1,870	1,932	1,827	1,611	1,715	1,934	1,452	1,345	57.7%
PT	57	136	196	218	218	219	216	234	253	255	262	346.3%
RO	235	782	936	756	764	785	776	751	762	812	813	246.1%
SI	19	26	24	39	13	32	37	50	65	49	18	160.9%
SK	1,360	901	843	357	644	772	493	526	533	571	489	-58.0%
FI	27	32	31	37	34	35	30	28	28	29	26	8.0%
SE	33	88	103	94	122	106	101	95	96	75	78	126.8%
UK	6,250	6,850	6,982	5,745	6,706	6,928	5,816	6,258	6,427	6,206	6,415	-0.7%

Data for CY and MT equal zero

Source: Eurostat

4.4 Overview – Tertiary sector

The tertiary sector represented about more than 70% of the EU-28 GDP in the year 2018 while at the same time it accounted for the lowest share of energy consumption among

the four studied sectors. Tertiary sector is related to activities such as professional, scientific and technical services, public administration, wholesale, retail, etc. These activities have caused a significant increase in employment during the period from 2010 to 2018.

The final energy consumption of the tertiary sector has increased significantly in the studied period (+20.2%). The maximum level of consumption was reached in the year 2010. In 2018, tertiary final energy consumption registered a slight decrease (-1.4%) after three continuous years of positive growth rates.

Very different growth rates have been registered across the EU-28 Member States. In the period from 2000 to 2018, the Member States with the highest reduction rates of final tertiary energy consumption were Slovakia, Hungary (-28.8%) and Slovenia (-9.6%). The Member States with the highest consumption growth rates were Romania, Malta and Cyprus. Some significant changes in the growth rates across different sub-periods have been observed in some Member States.

In 2018, the final energy mix in the tertiary sector of EU-28 was mainly formed by three energy sources which accounted for almost the 90% of the total final energy consumption. These are electricity, natural gas and oil and petroleum products. Renewable energies and biofuels have increased notably their share compared to 2000 while oil and petroleum products share has been decreased.

Weather and climate conditions, energy prices, as well as economic 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 its energy consumption. With regard to the employment creation during the period 2000-2018, the sector has increased significantly. 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 has decreased slightly compared to 2000 (-3.5%). The Member States with the highest energy consumption per employee were Finland and Belgium. On the other hand, Romania, Bulgaria and Portugal showed the lowest final tertiary energy consumption per employee.

With regard to 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.

Commercial and public services accounted for almost one third of the final electrical energy consumption, the largest share after the industry sector.

The final electricity and final natural gas consumption trends in the service sector show an important increase in the consumption during the 19-year period from 2000 to 2018. Concerning the growth rates of the different Member States over this period, it is observed that nine Member States have registered a growth rate below the EU-28 value for electricity and twelve for natural gas. The Member States with the highest growth rates have been Romania for electricity and Greece for natural gas. The highest reduction rates have been registered in Hungary for electricity and in Slovakia for natural gas. It is important to note that the development of natural gas networks in some Member States resulted in very high growth rates in gas consumption.

The electricity and natural gas consumption per employee values in the EU-28 for the year 2018 increased compared to 2000. Fifteen Member States had above EU-28 electricity consumption per employee and ten had above EU-28 natural gas consumption per employee. The Member States with the highest consumption per employee were Finland for electricity and Belgium for natural gas while the Member State with the lowest

electricity consumptions per employee was Romania and the Member State with the lowest natural gas consumption per employee was Finland.

Natural gas as energy fuel has its major application in heating applications. Therefore a natural gas consumption correlation with the weather conditions (Heating Degree Days) is observed. A similar correlation is observed also between tertiary electricity consumption and Heating Degree Days.

5 Energy Consumption Trends in the Transport Sector

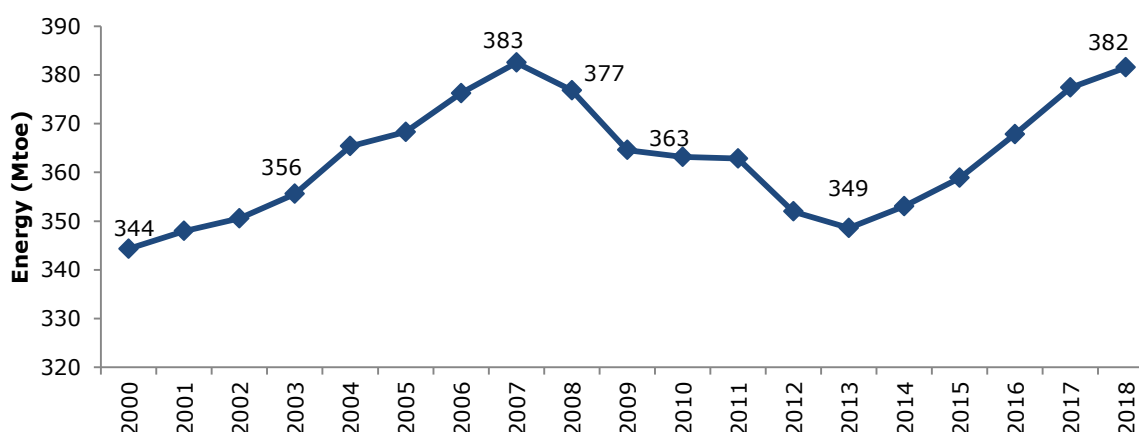
This chapter covers the energy consumption trends in the transport sector including rail, road, international and domestic aviation and domestic navigation. In order to complement the analysis of energy consumption, some insights about road sector and passenger and freight transport are also provided.

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

The transport sector accounted for 33.9%¹⁰⁶ of the total final energy consumption in the year 2018 (Figure 7), the largest share of final energy consumption. The final energy consumption in the EU-28 transport sector has increased by 10.8% in the 19-year period from 2000 to 2018. The EU-28 consumption reached a peak in the year 2007 (383 Mtoe); the lowest consumption was registered in the year 2000 (344 Mtoe). As shown in Figure 94 the increasing trend has been reversed after 2007 and until 2013 and from 2013 onwards it has been reversed again.

Over the period 2000-2007 an increasing trend is observed (the average growth rate was equal to 1.4%). In contrast, from 2008 to 2013 a fall in the final energy consumption took place, with an average reduction of 1.5% per year. From 2014 to 2018 this trend was reversed again and the final energy consumption in the transport sector grew by average of 1.8% per year. The energy consumption in the sector has increased by 1.1% from 2017 to 2018.

Figure 94: Final energy consumption in the transport sector in the EU-28, 2000-2018



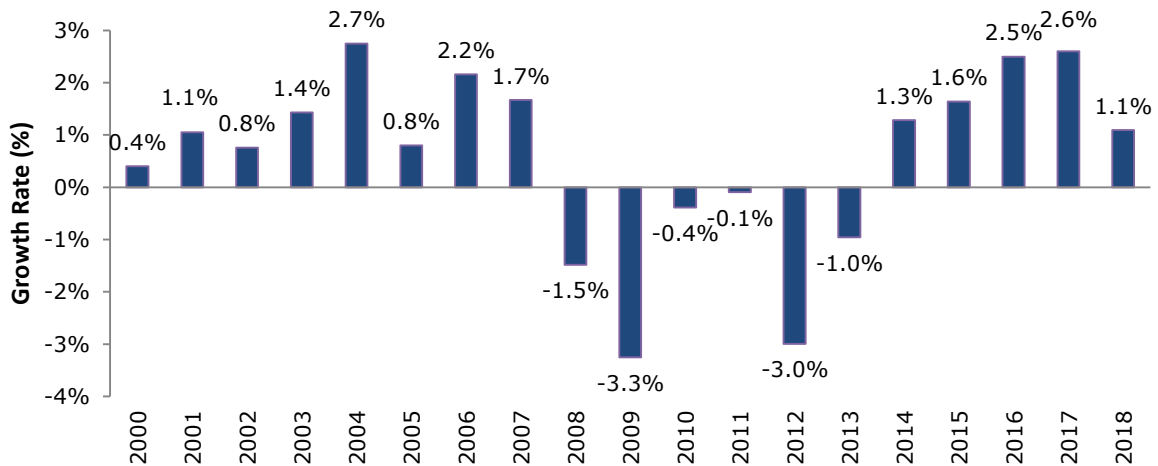
Source: Eurostat

During the period 2000-2007, the highest growth rate occurred in 2004 (by 2.8% compared to the previous year). In contrast, 2009 registered the highest decrease, (-3.3% less compared to the previous year). The reduction of the energy consumption in the transport sector from 2008 to 2013 could be explained, among others, by improvements in energy efficiency of passenger cars and the impact of the financial and economic crisis. About 40% of the post-2007 reduction is estimated to be due to the economic crisis, with the stabilisation of passenger traffic and the decrease in freight traffic. However, the remaining 60% mostly originates from improvements in energy efficiency of passenger cars. Energy efficiency improvements for road freight have slowed

¹⁰⁶ Transport energy consumption trends have been analysed using the old methodology Eurostat tables in order to be comparable with the EU 2020 targets.

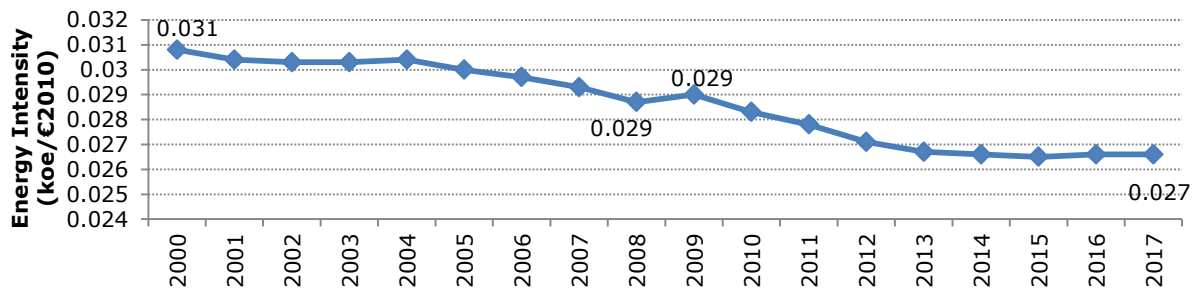
down after 2007, driven by the fall in traffic and the less efficient operation of the vehicle fleet as shown by the lower load factors¹⁰⁷.

Figure 95: Annual energy consumption growth rates in the EU-28 transport sector, 2000-2018



Source: Eurostat

Figure 96: Energy intensity of transport sector in the EU-28, 2000-2017



Source: Odyssee

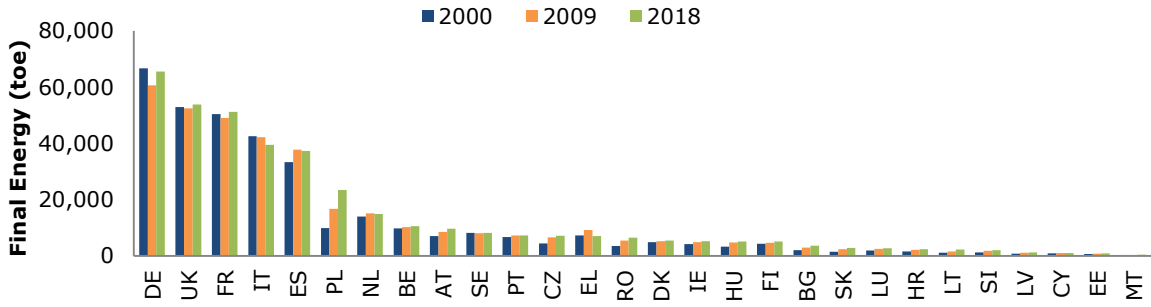
During the period from 2000 to 2017, the energy intensity in the transport sector has decreased by 13.6% reaching 0.027 ktoe/€ in 2017. The decreasing trend along the period was interrupted in 2009 and then from 2016 by rises of 1.1% and 0.4% respectively compared to the previous year. In 2009, it may have been due to the impact of the financial and economic crisis on the countries' GDP. In the second period it followed the trend of the increasing final transport energy consumption, in the context of a lower oil price environment. In 2017 it remained stable compared to 2016.

In 2018, the Member State with the highest consumption in the transport sector was Germany (65.5 Mtoe), followed by the United Kingdom (53.8 Mtoe) and France (51.1 Mtoe) (Figure 97). It is worth noticing that in the years 2000, 2009 and 2018 these three countries occupied the same positions in the ranking in terms of final energy consumption in transport.

The three Member States together with Italy accounted for more than 55% of the final energy consumption in the sector. If also Spain is added, the share reaches almost the 65% of the final energy consumption. Fourteen Member States accounted for less than 11% of the final energy consumption in 2017 (Figure 98).

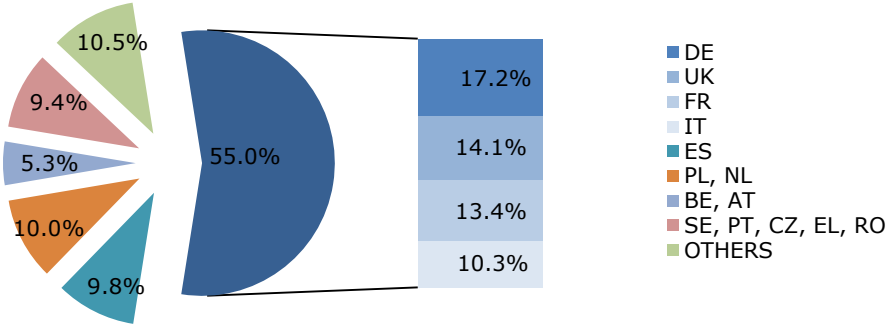
¹⁰⁷ Odyssee-Mure (2015): Trends and policies for energy savings and emissions in transport (available at: <http://www.odyssee-mure.eu/publications/br/energy-efficiency-in-transport.html>)

Figure 97: Final energy consumption at transport sector in the EU-28 Member States, 2000, 2009 and 2018



Source: Eurostat

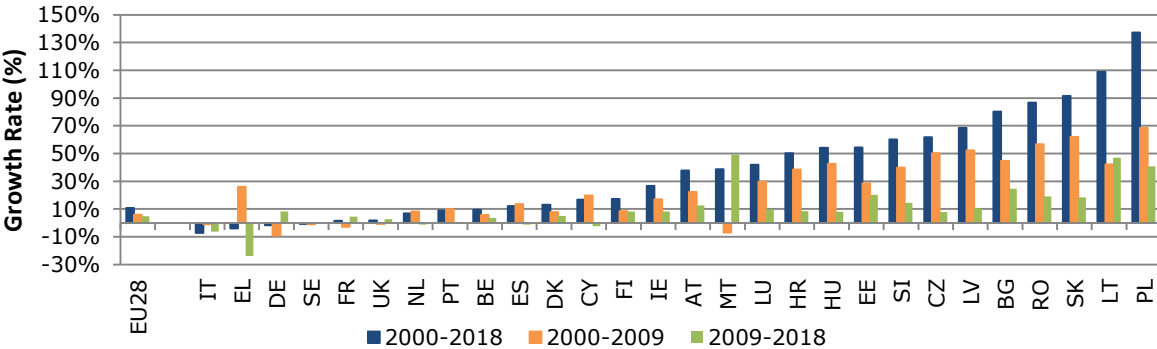
Figure 98: Shares of EU-28 Member States to final transport energy consumption, 2018



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 2018 have been Poland (137.2%), Lithuania (108.9%) and Slovakia (91.6%), while the Member States with highest decreases in terms of growth rates were Italy (-7.3%), Greece (-4.1%) and Germany (-1.6%). Nine EU-28 countries registered consumption values below the European growth rate (10.8%). In the period 2000-2009, only six Member States registered an decrease in their final energy consumption. The European growth rate was 5.88% during this period. There is no significant difference in the growth rates of the period from 2009 to 2018 like observed in other sectors. This could mean that stronger efforts are required to reduce the final consumption in transport sector.

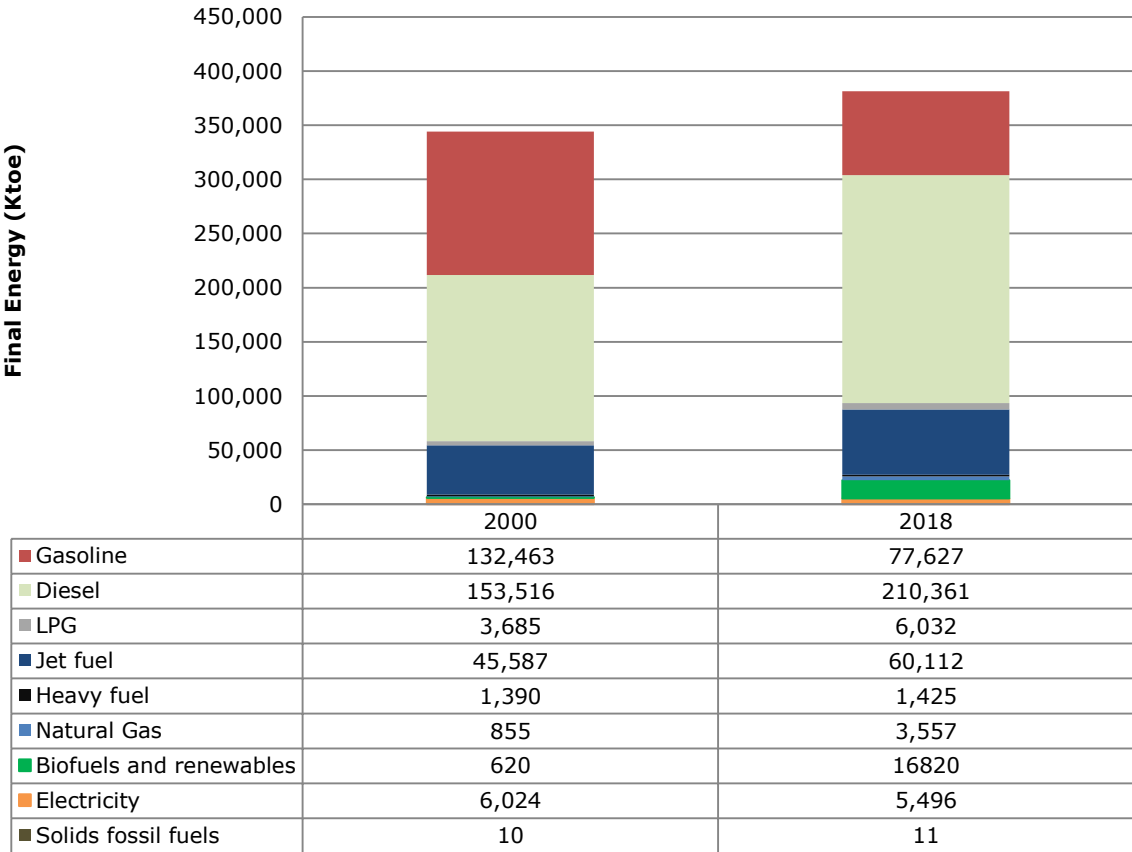
Figure 99: Final energy consumption growth rates in the transport sector in the EU-28 Member States; 2000-2018, 2000-2009 and 2009-2018



Source: Eurostat

In terms of the energy mix (Figure 100)¹⁰⁸ oil and petroleum products provide the largest share of the final energy consumption in transport. Petroleum products represented 93.2% (355,627 ktoe) of the final energy demand in 2017. However, the share has been reduced relative to 2000 (97.8%; 336,811 ktoe).

Figure 100: Final energy mix in the transport sector in the EU-28 (absolute numbers), 2000 and 2018



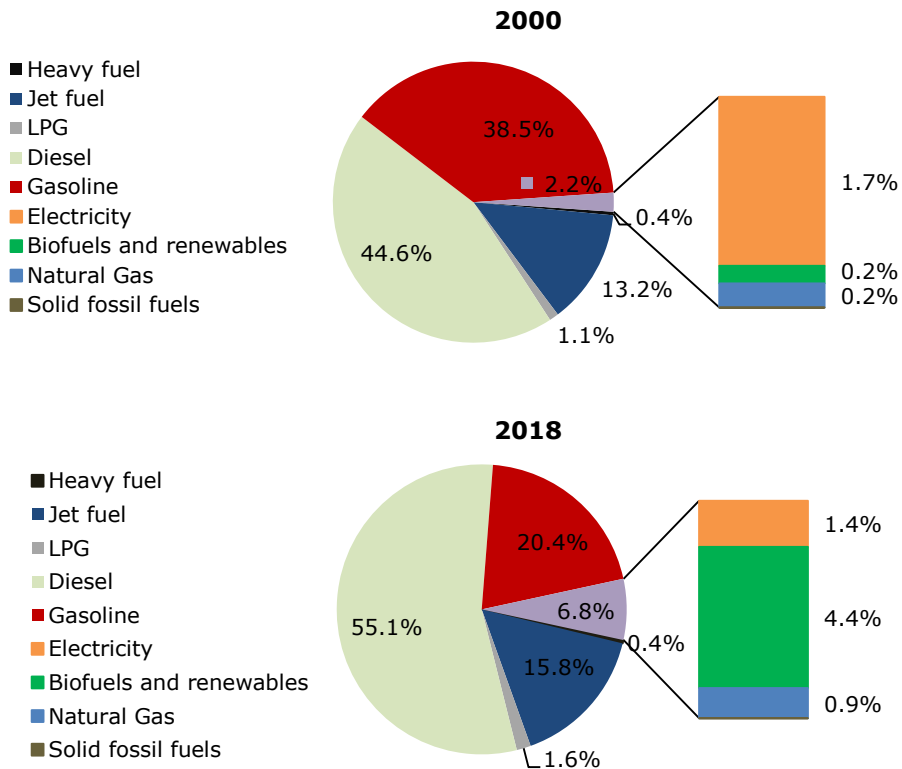
Source: Eurostat

¹⁰⁸ The analysis of transport energy consumption per fuel type uses the new methodology Eurostat tables for energy balances based on the availability of the data.

Among the petroleum products diesel and gasoline provide the largest share (Figure 101). In 2018, diesel accounted for 55.1% (210,361 ktoe) of the final energy demand and gasoline for 20.4% (77,698 ktoe). Other fuels and energy carriers showed lower shares in the energy mix: jet fuel (15.8%; 60,112 ktoe), biofuels and renewables (4.4%; 16,821 ktoe), LPG (1.6%; 6,032 ktoe), electricity (1.4%; 5,496 ktoe), natural gas (0.9%; 3,557 ktoe), and heavy fuel (0.4%; 1425 ktoe). Solid fuels represented a negligible share in the final energy mix (below 0.01%; 10.7 ktoe).

The gasoline share decreased from 38.5% in 2000 to 20.4% in 2018. The share of diesel increased from 44.6% in 2000 to 55.1% in 2018. The share of biofuels and renewables increased from 0.2% in 2000 to 4.4% in 2018. These were the most significant changes in the final energy mix during 2000-2018.

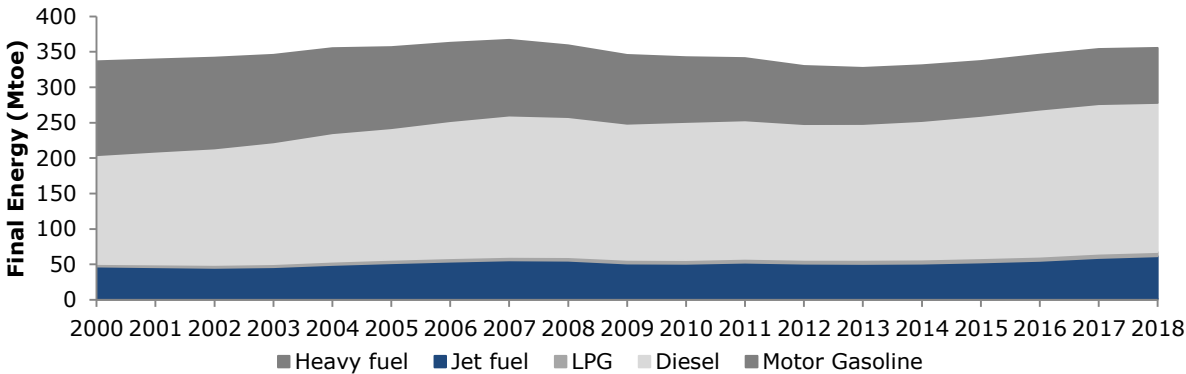
Figure 101: Final energy mix in the transport sector in the EU-28 (shares), 2000 and 2018



Source: Eurostat

From 2000 to 2018, the oil and petroleum products consumption has increased by 5.6% (18.8 Mtoe). During this period diesel has gradually increased its presence. Diesel's consumption has increased by 37.0%, while gasoline has declined by 41.4%. However, in 2018 diesel consumption has decreased by 0.3% compared to 2017. Heavy fuel has registered an increase by 2.5% and jet fuel by 31.9% from 2000 to 2018. The changes in the petroleum products consumption have occurred gradually during the analysed 19-year period as illustrated in Figure 102.

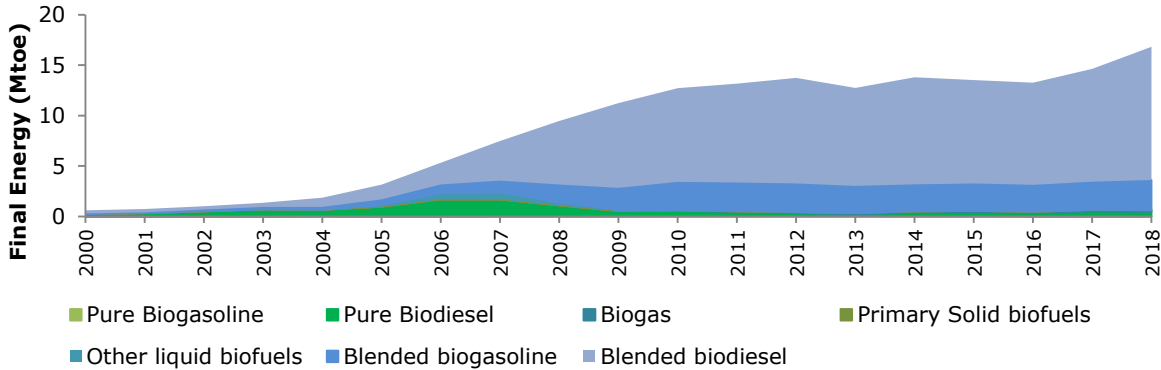
Figure 102: Final energy consumption of oil and petroleum products in the EU-28 transport sector, 2000-2018



Source: Eurostat

Although the petroleum products dominate the fuel mix in the transport sector, biofuels and renewables significantly increased their share between 2000 and 2018, driven by the Renewable Energy Directives¹⁰⁹.

Figure 103: Final energy consumption of biofuels in the EU-28 transport sector, 2000-2018



Source: Eurostat

A significant increase in the consumption of biofuels took place especially between 2005 and 2010 when the consumption rose by four times (from 3,161 ktoe to 12,721 ktoe). The increase was mainly driven by the growth in biodiesels that represent the highest consumed renewable fuel type. Pure and blended biodiesels represent the 81.25% of biofuels. In 2018 they registered an increase by 17.0% compared to 2017.

Biogasoline is the second highest consumed type of biofuel. Pure and blended biogasoline represent the 17.8% of biofuels. From 2000 to 2018 they increased from 59 ktoe to 2999 ktoe (5010.8%). Biogas represented 19 ktoe in 2008 and has increased significantly by 2018, when it reached 154 ktoe. This corresponds to an increase of increase of 707.1%. The energy consumption of other liquid biofuels¹¹⁰ was more limited. Solid biofuels consumption was negligible (below 1 ktoe per year).

Fuel prices

According to the weekly oil bulletin of DG-Energy [13], automotive diesel oil and gasoline prices generally showed an increasing trend, driven by the evolution of the crude oil price. However, during 2008-2009 a significant drop took place, driven by the economic crises. Mid-2009, the prices started rising again until August-September 2012 when the peak of the period 2000-2019 was registered (gasoline 95 Ron: 1726 Euro/litre; automotive diesel oil: 1,528 Euro/litre). During 2012-2016, a progressive reduction in the prices has taken place as illustrated in Figure 104, with a more significant decrease being registered between the 4th quarter of 2015 and the 1st quarter of 2016 - driven by the price of crude oil. Since mid-2016 prices started going up again while in the late 2018 a drop has registered.

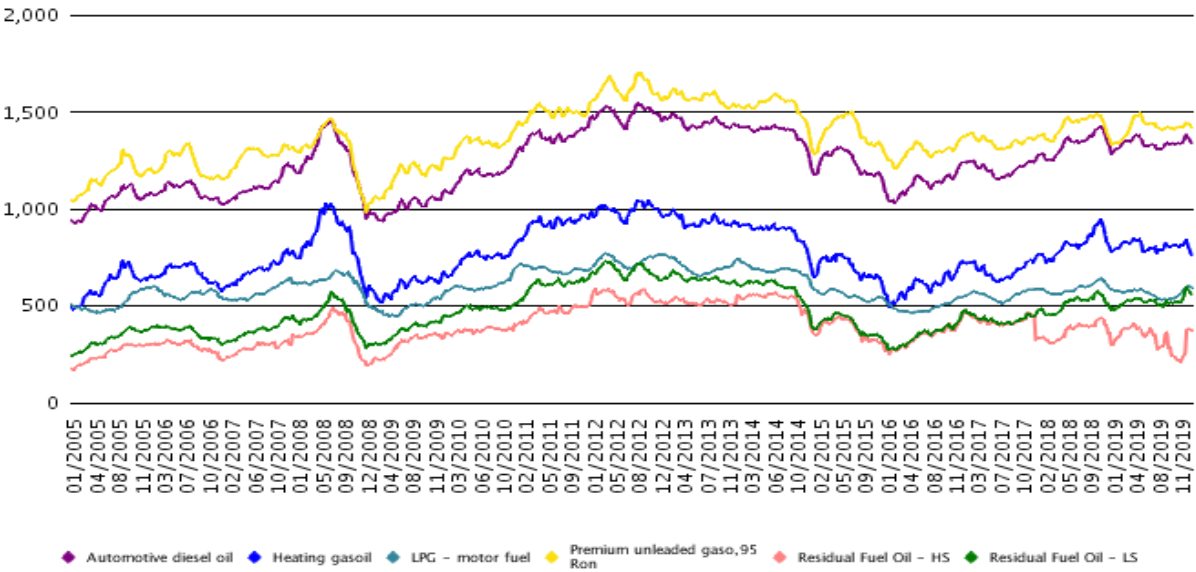
The evolution of crude oil prices was driven by many factors such as the weakening of global demand, a significant shift in OPEC¹¹¹ policy, some geopolitical risks or the appreciation of the U.S. dollar [14], [15].

¹⁰⁹ Directive on Electricity Production from Renewable Energy Sources 2001/77/EC (2001), Transport Biofuels Directive 2003/30/EC (2003), Renewable Energy Directive 2009/28/EC (2009) and Renewable Energy Directive 2018/2001/EU (2018)

¹¹⁰ 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.

¹¹¹ Organization of the Petroleum Exporting Countries

Figure 104: Consumer prices of petroleum products inclusive of duties and taxes - Eurozone weighted average, January 2005 – November 2019



Source: EC DG-ENER

5.2 Final energy demand by transport mode

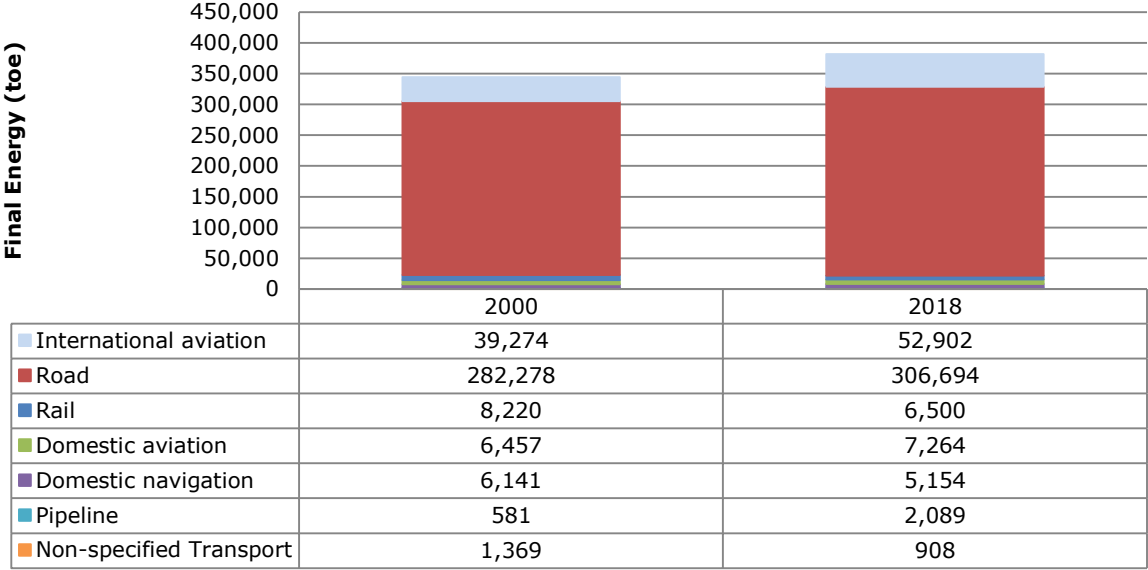
In this section final energy consumption in the transport sector is broken down by mode: road, rail, international aviation, domestic aviation, domestic navigation, pipeline transport, and other transports. Domestic aviation and domestic navigation include the activity taken place within the Member States¹¹². International aviation includes also the intra-EU activity. Other transportation¹¹³ includes the energy consumed in the transport infrastructures (ports and airports) related to the transport activity. Consumption trends and changes the period 2000-2018 are analysed by mode of transport¹¹⁴ (Figure 105).

¹¹² The domestic/international split is determined on the basis of departure and landing locations and not by the nationality of the airline. Source: Eurostat.

¹¹³ It includes fuels used by airlines for their road vehicles and fuels used in ports for ships' unloaders, various types of cranes. Source: Eurostat.

¹¹⁴ Transport energy consumption trends by transport subsector have been analysed using the old methodology Eurostat tables in order to be comparable with the EU 2020 targets.

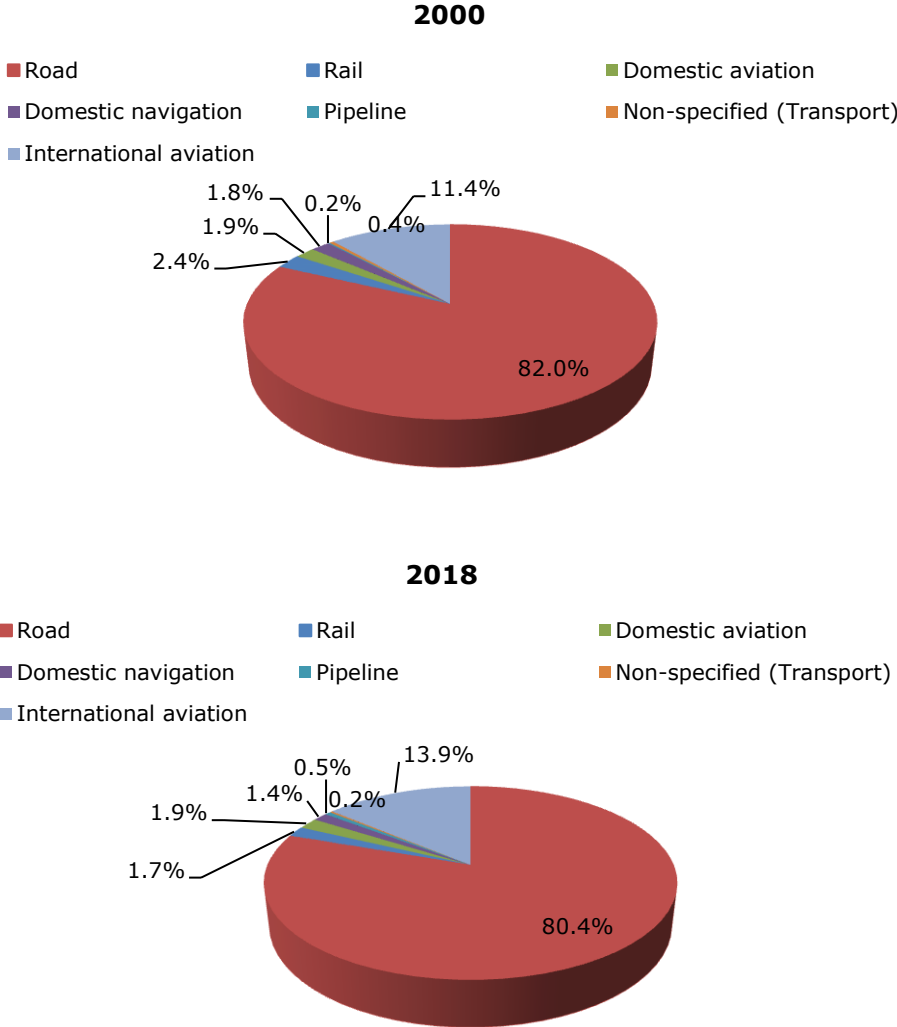
Figure 105: Final energy consumption in the EU-28 by transport mode, 2000 and 2018



Source: Eurostat

Road transport is extensively the main energy consuming mode of transport. It represented 80.4% (307 Mtoe) of the transport final energy share in 2018. In the same year, international aviation ranked second in the terms of energy consumption (13.9%; 52.9 Mtoe), followed by domestic aviation (1.9%; 7.3 Mtoe), rail (1.7%; 6.5 Mtoe), domestic navigation (1.4%; 5.2 Mtoe), pipeline transport (0.55%; 2.1 Mtoe) and other non-specified transport (0.24%; 1.0 Mtoe). The most remarkable change compared to the year 2000 scenario is the energy consumption of pipeline transport that has increased by more than three times (from 581 ktoe to 2,089 ktoe). In comparison to the year 2000 road, rail and domestic navigation have reduced their shares, while the rest of transport modes (i.e. international and domestic aviation, pipeline and non-specified transport) have increased their shares as illustrated in Figure 106.

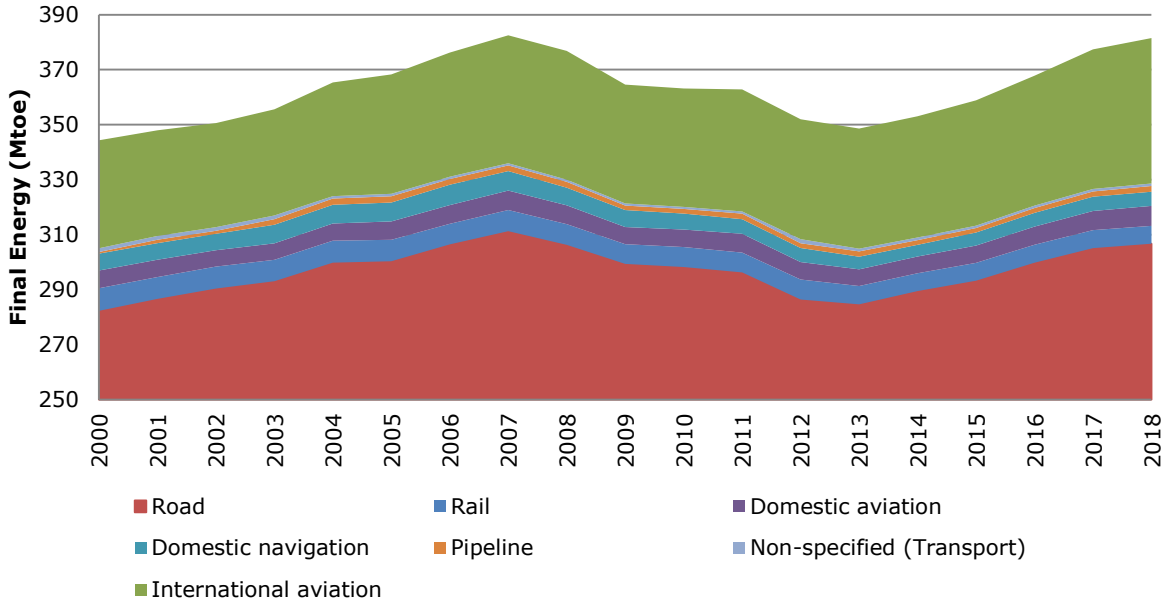
Figure 106: Share of transport modes in final energy consumption, 2000 and 2018



Source: Eurostat

The contribution of the different transport modes to the aggregate energy consumption for the period 2000-2018 is shown in Figure 107. During this period, the total final energy consumption in the sector has increased by 10.8%. However, this increase has not taken place in all transport modes. Non-specified transport has been the sector where consumption declined the most (by 33.7%). Rail and domestic navigation have decreased their energy consumption by 20.9% and 16.1% respectively. In contrast, pipeline transport, international aviation, domestic aviation and road transport are the subsectors which have registered an increase in their consumption in comparison to the year 2000 by 259.5%, 34.7%, 12.5% and 8.7% respectively.

Figure 107: Final energy consumption in the EU-28 by transport mode, 2000-2018



Source: Eurostat

Table 7 provides an overview of the final energy consumption and growth rates by transport mode from 2000 to 2018.

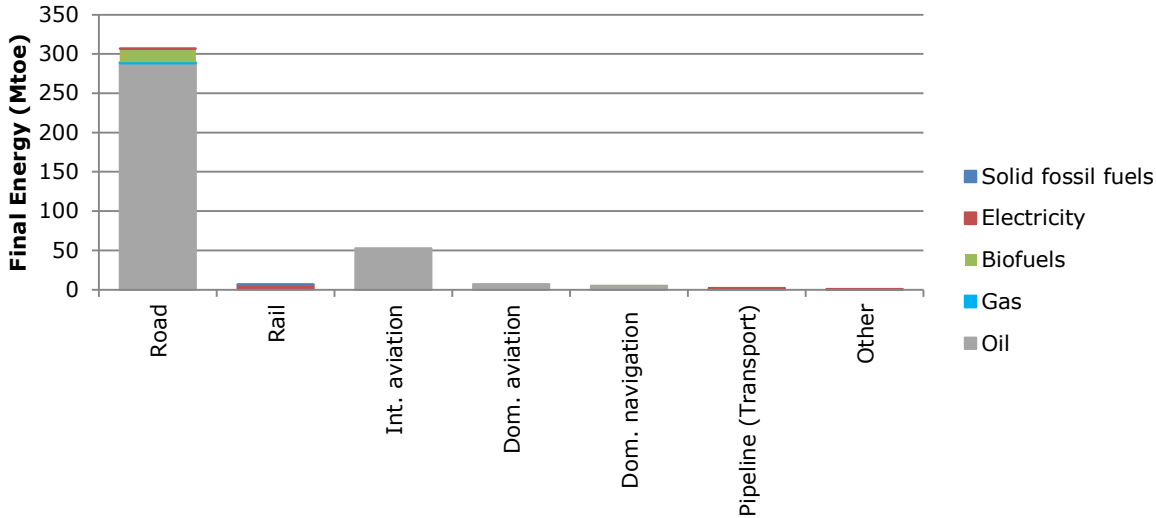
Table 7: Growth rates of energy consumption and transport modes, 2000 and 2018

	Final Energy (toe)		Growth Rate (%)	Share in %		Change of shares
	2000	2018	2000-2018	2000	2018	2000-2018
Transport	344,320	381,511	10.8%			
Rail	8,220	6,500	-20.9%	2.4%	1.7%	-0.7%
Road	282,278	306,694	8.7%	82.0%	80.4%	-1.6%
Domestic aviation	6,457	7,265	12.5%	1.9%	1.9%	0.0%
Domestic Navigation	6,141	5,154	-16.1%	1.8%	1.4%	-0.4%
Consumption in Pipeline	581	2,089	259.5%	0.2%	0.6%	0.4%
International aviation	39,274	52,902	34.7%	11.4%	13.9%	2.5%
Other transports	1,369	908	-33.7%	0.4%	0.2%	-0.2%

Source: Eurostat

Figures 108 and 109 show the energy mix by transport mode for the year 2018 in both absolute numbers and percentage of the total final energy consumption by mode. The figures show that aviation exclusively uses petroleum products. Petroleum products also provide 99.9% of energy use in domestic navigation and 93.9% of the energy use in road transport.

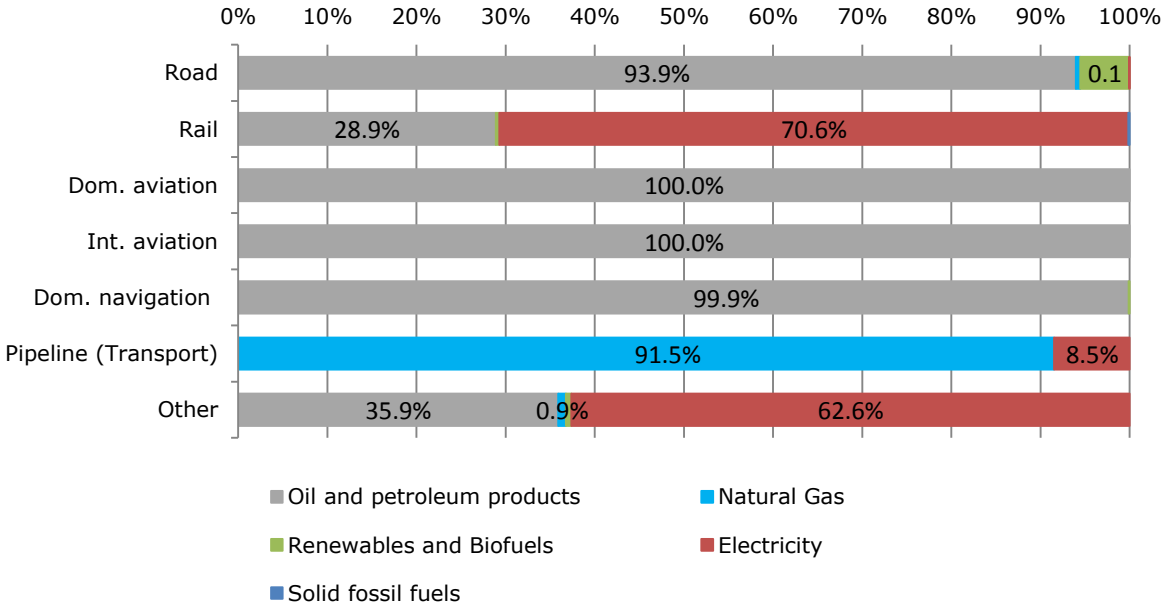
Figure 108: Final energy per fuel type¹¹⁵ and transport mode in the EU-28, 2018



Source: Eurostat

In 2018, electricity represented the main energy type used in rail (70.6%) and other transports (62.6%). In terms of shares, natural gas represented 91.5% of the energy use in pipeline transport. Renewables Biofuels provided about 5.5% of the energy use in road transport, 0.4% for rail transport, 0.61% for other transport, and 0.1% for domestic navigation.

Figure 109: Share of fuel type and transport modes in the EU-28, 2018



Source: Eurostat

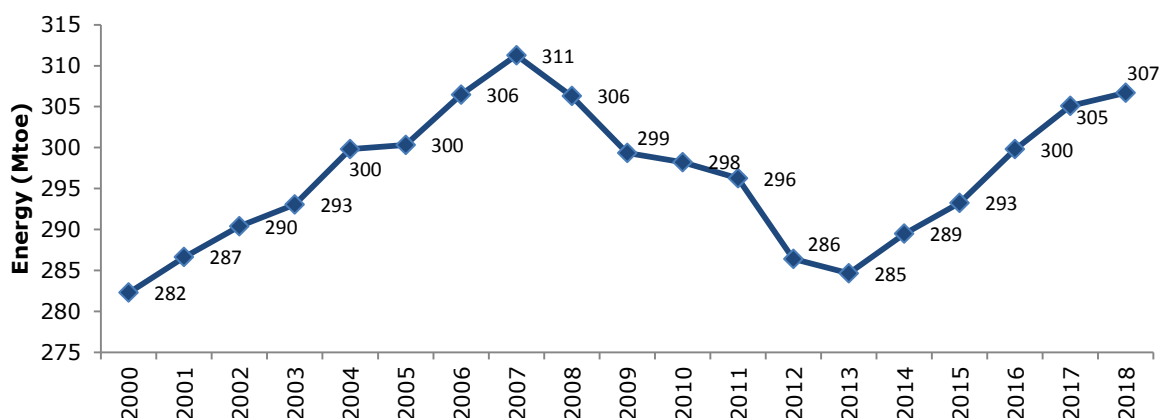
As road transport provides the highest share of final energy demand in transport (80.4%), it is further analysed in the section below.

¹¹⁵ The analysis of transport subsectoral energy consumption per fuel type uses the new methodology Eurostat tables for energy balances based on the availability of the data.

5.3 Final energy demand in road transport sector

The final energy consumption in the road transport¹¹⁶ has increased by 8.7% (24.4 Mtoe) in the period from 2000 to 2018. It has increased by only 0.5% from 2017 to 2018 (Figure 110).

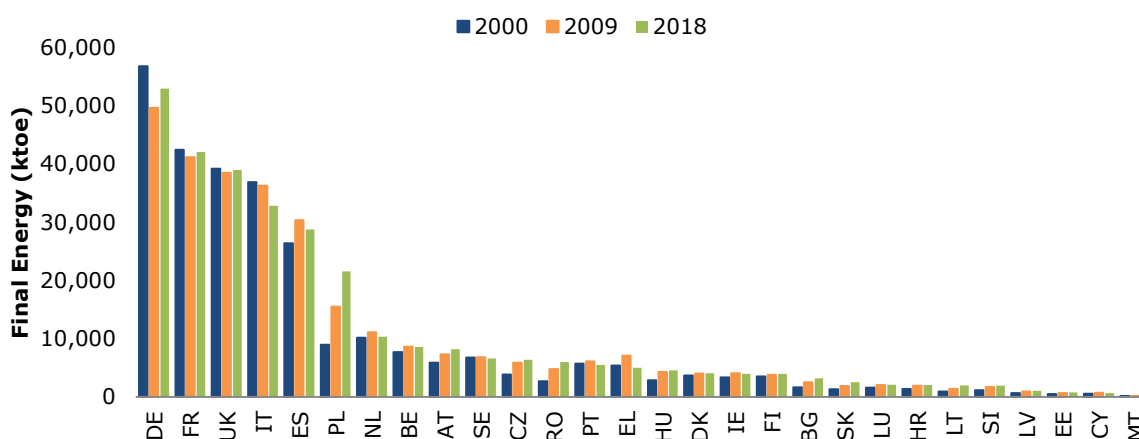
Figure 110: Final energy consumption in the EU-28 road transport, 2000-2018



Source: Eurostat

Across the EU-28 Member States there are remarkable differences in the final energy consumption (Figure 111). In 2018, the countries with the highest road transport energy consumption were Germany (52.9 Mtoe), France (42.0 Mtoe), United Kingdom (38.9 Mtoe) and Italy (32.8 Mtoe). These four countries accounted for almost the 55% of the total final energy consumption in the road transport. In the same year, fourteen Member States consumed less than 11% of the final energy consumption in the road transport (Figure 112).

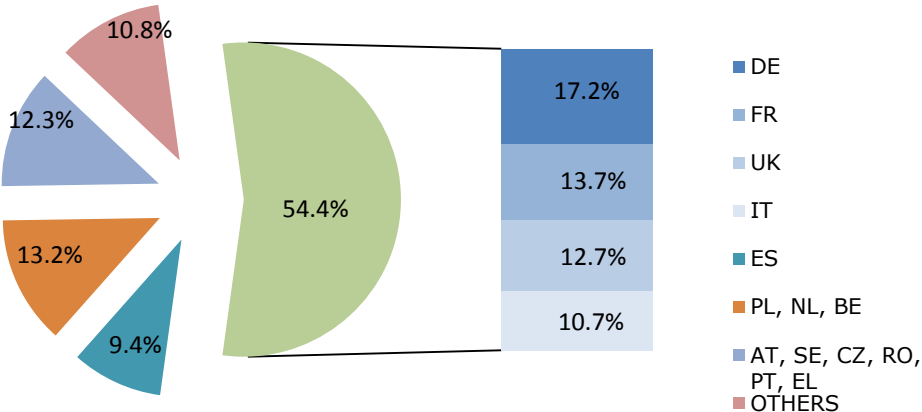
Figure 111: Final energy consumption in road transport per Member State in the EU-28, 2000, 2009 and 2018



Source: Eurostat

¹¹⁶ Road transport energy consumption trends have been analysed using the old methodology Eurostat tables in order to be comparable with the EU 2020 targets.

Figure 112: Shares of EU-28 Member States to final road transport energy consumption, 2018

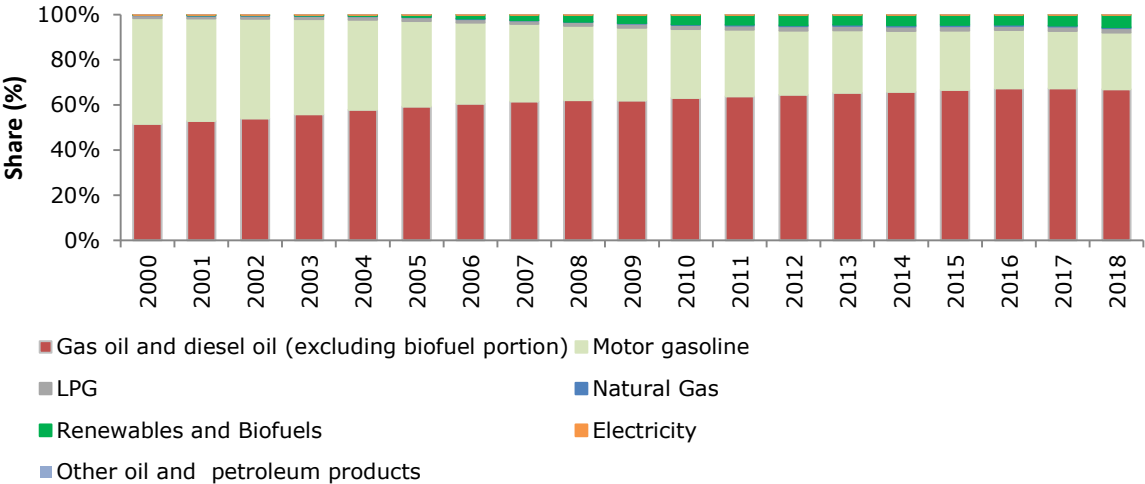


Source: Eurostat

With regard to the energy mix¹¹⁷ in the road transport, petroleum products (i.e. diesel, gasoline, LPG) are main fuel types used. In 2018, diesel represented 66.8% of the energy use in road transport, followed by motor gasoline (25.2%), renewables and biofuels (5.5%), LPG (1.9%), natural gas (0.5%) and electricity and other oil and petroleum products, which accounted for less than 0.1% of the final energy consumption.

Figure 113 displays the energy mix for the period 2000-2018. It shows the gradual reduction of gasoline consumption and the increase in the consumption of diesel and biofuels. LPG, natural gas and electricity have slightly increased their shares in energy consumption. Renewables and biofuels share has increased from 2017 to 2018 while diesel share has decreased.

Figure 113: Final energy mix in the EU-28 road transport, 2000-2018



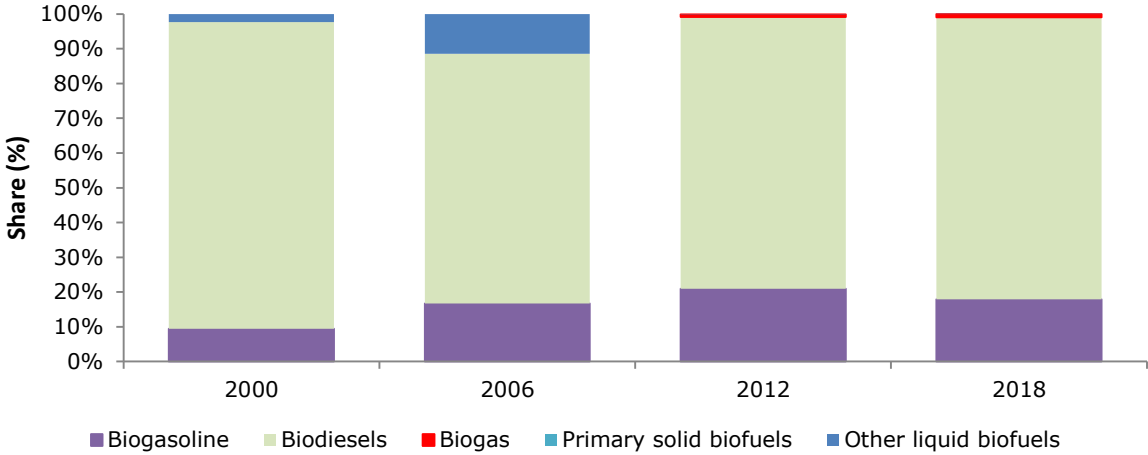
Source: Eurostat

Biodiesel has been the main type of biofuel used during 2000-2018. Already in 2000, biodiesel (pure and blended) accounted for 88.2% of the total consumption of biofuels in the road sector, followed by biogasoline (pure and blended) (9.5%) and other liquid

¹¹⁷ The analysis of road transport energy consumption per fuel type uses the new methodology Eurostat tables for energy balances based on the availability of the data.

biofuels (2.3%). In 2018, after 19 years, biodiesel still provided 81.2% of the total consumption of biofuels. Biogasoline increased its share to 17.9%. The uptake of biogas started after 2008 reaching 0.9% of the total liquid and gaseous biofuels in 2018 (Figure 114).

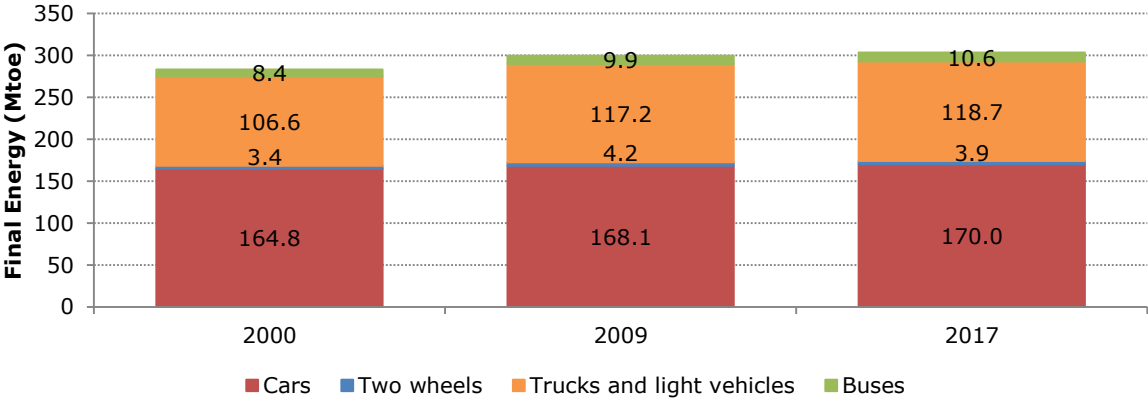
Figure 114: Liquid and gaseous biofuels mix in the EU-28 road transport, years 2000, 2006, 2012 and 2018



Source: Eurostat

Among the different vehicle types, cars are estimated to provide the highest share of road transport energy consumption. According to Odyssee database (Figure 115), in 2017, cars accounted for 56.1% (170.0 Mtoe) of the energy consumption in road transport, followed by trucks and light vehicles (39.2%; 118.7 Mtoe), buses (3.5%; 10.6 Mtoe) and powered two wheelers (1.3%; 3.9 Mtoe). There have not been remarkable differences between 2000 and 2017 within these indicators. 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.

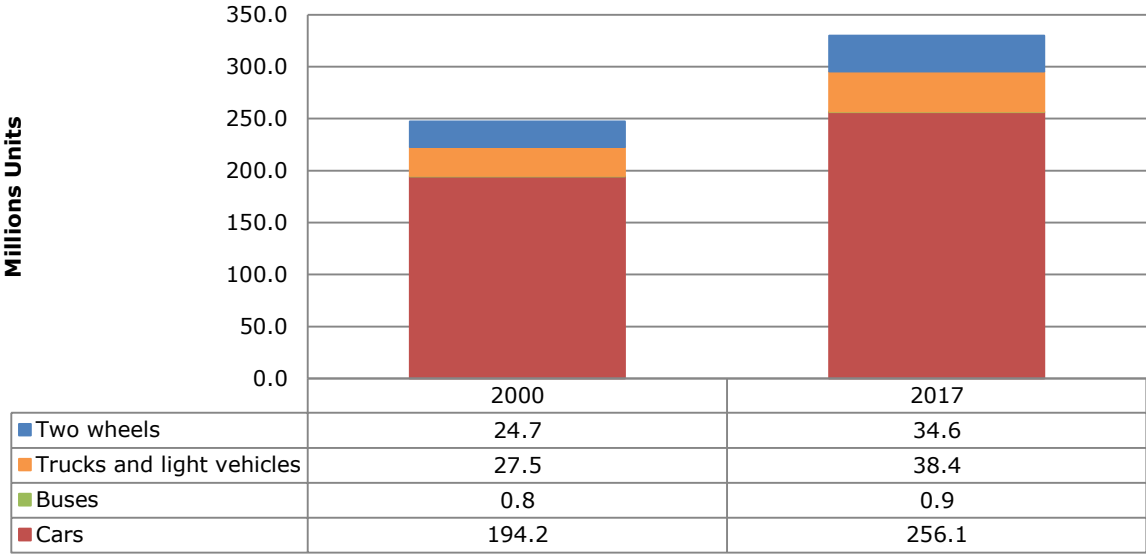
Figure 115: Road energy consumption per vehicle type in the EU-28, 2000, 2009 and 2017¹¹⁸



Source: Odyssee

¹¹⁸ 2018: not available data
Two-wheels: Data only for gasoline consumption

Figure 116: Number of vehicles in the EU-28, 2000 and 2017



Source: Odyssee

According to Odyssee database (Figure 116), in 2017, there were 256.1 million of cars registered in Europe, 38.4 million trucks and light vehicles¹¹⁹, 34.6 million powered two wheelers and 866.6 thousand buses. In comparison with the year 2000, the total stock of vehicles has increased. All the vehicle types have increased their stock. Two wheels are the vehicle types, which have experienced the highest growth rate, (40.0% or 9.9 million units). The stock of trucks and light vehicles increased by 39.8% (10.9 million units). Cars and buses have incremented their stock numbers by 31.9% and 4.6% respectively.

Buses have the largest energy consumption per vehicle (Figure 117). This is easily understandable due to the average size of this kind of vehicles and due to the kind of their journeys. In 2017, the average energy consumption per bus in EU-28 was 12.25 toe/veh. In the same year trucks and light vehicles consumed 3.09 toe/veh, cars 0.66 toe/veh and two wheels 0.11 toe/veh. In comparison to year 2000 scenario, cars' energy consumption decreased by 21.8%, two wheels by 16.5%, trucks, and light vehicles¹²⁰ by 21.6%. In contrast, buses have registered an increase by 20.5%.

To be noted that buses are the only vehicle type that has experienced an increase in its energy consumption per unit during the period 2000-2017. 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. In addition, it might be ancillary increased by the incorporation of additional built-in services to enhance the comfort of the passengers such as air-conditioning,

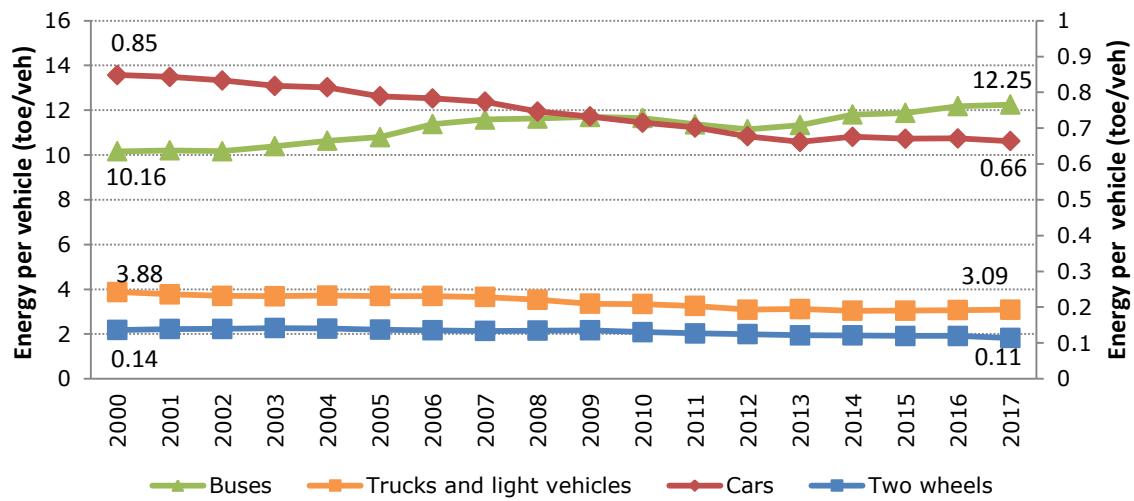
¹¹⁹ Light duty vehicles also called light commercial vehicles have a useful load below a certain threshold (e.g. <3 t). Trucks correspond to medium and heavy trucks (generally >3 t useful load); trucks should also include road tractors that pull trailers (articulated vehicles, also called trailer truck). Definition provided by Odyssee [16]

¹²⁰ According to Odyssee definitions, indicators related to trucks or heavy vehicles should be interpreted with care, as there may be limitations in the quality of diesel consumption data for these vehicles, for two reasons:

- The consumption of diesel by heavy vehicles or trucks is usually obtained as the difference between the total consumption of diesel and estimates of diesel consumption by cars and light vehicles; in recent years, most countries have experienced a rapid increase in the proportion of cars and light vehicles using diesel fuel, that may not always be fully reflected in these consumption estimates.
- In some countries, an increasing amount of diesel may be used by foreign trucks (transit traffic), which are not accounted for in the indicators. These two factors may lead to an overestimation in recent years of the consumption of diesel by trucks and heavy vehicles. [16]

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 public-operated buses.

Figure 117: Energy consumption per vehicle type (toe/veh) in the EU-28, 2000-2017



Source: Odyssee

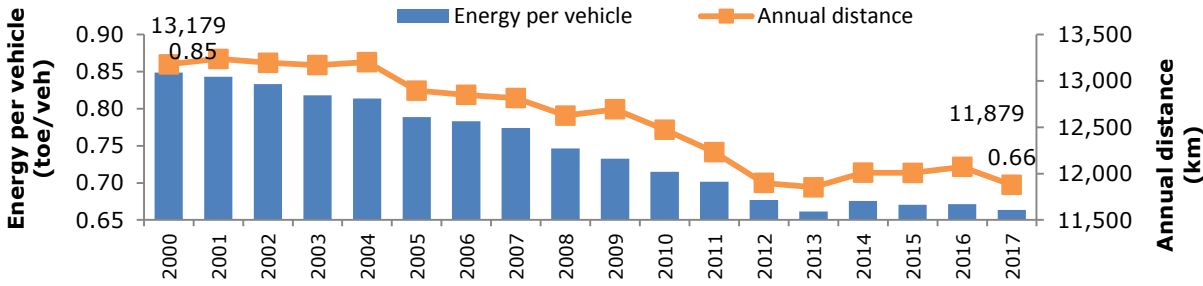
5.3.1 Passenger cars

According to Odyssee database, cars represented the 77.6% of the stock of vehicles in 2017 and the 56.1% of the final road energy consumption in 2017¹²¹. Therefore, a specific analysis of cars 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 0.85 toe per vehicle. During the period from 2000 to 2017, a gradual decreasing trend has been observed (a 21.8% drop during the period).

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 (2000-2017). The average annual distance travelled by car has decreased by 1,300 km during the 18-year period (from 13,179 km to 11,879 km). The lowest distance travelled was registered in 2013 (11,854 km). Overall, the average annual distance per car shows a gradual decreasing 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 related to lower usage of the vehicles in terms of distance travelled per year, driven by the higher fuel prices. More in depth analysis is needed to estimate quantitatively the influence of these factors.

¹²¹2018: not available data

Figure 118: Annual energy consumption and annual distance travelled per car in the EU-28, 2000-2017



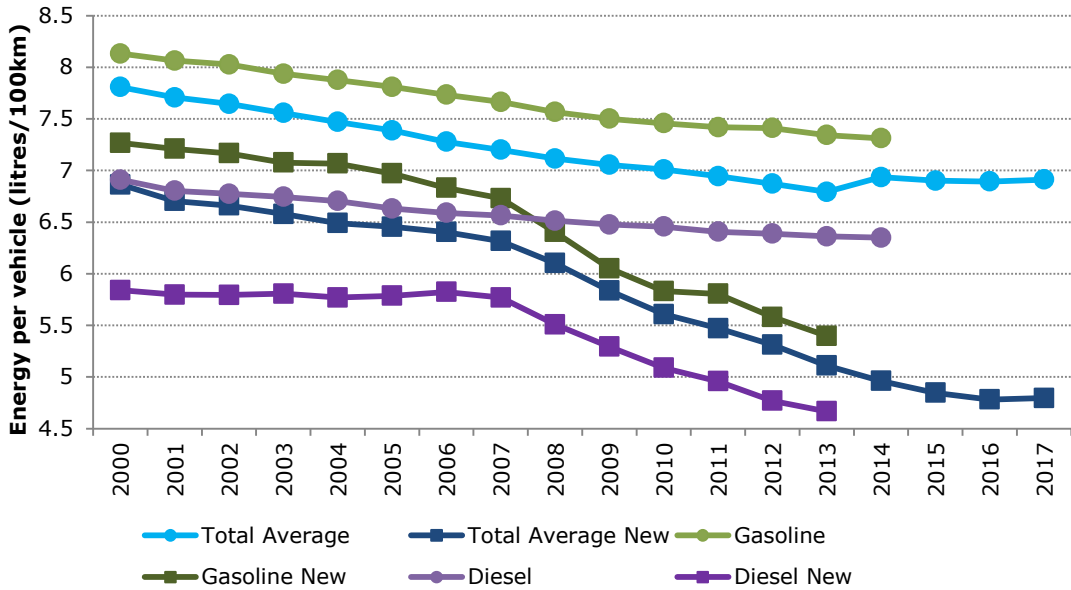
Source: Odyssee

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, the stock of cars and average distance travelled by car per year. The average consumption of new cars is calculated from fuel consumption according to the test cycle¹²². Figure 119 shows that in both cases (i.e. average consumption calculated from data and those based on test cycle) for the two main engine technologies (i.e. gasoline and diesel) there is an ongoing decline since 2000. The average consumption of registered cars in the market has declined by 11.5%, while the consumption of new cars entering the market (tagged as 'new') is even larger at 30.1%. Comparing the average specific consumptions per engine technology, gasoline-fuelled cars consumed more fuel than diesel. In the period from 2000 to 2014¹²³, registered gasoline and diesel cars showed a reduction of 10.1% (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. From 2000 to 2013¹²⁴, the new gasoline and diesel-fuelled cars also showed reductions in their specific consumption values. New gasoline cars have reduced by 25.7% their specific fuel consumption (from 7.3 litres/100 km in 2000 to 5.4 litres/100 km in 2013). New diesel cars have reduced by 20.1% their specific fuel consumption (from 5.8 litres/100 km in 2000 to 4.7 litres/100 km in 2013).

It is important to be noted that after 2009 the rate of decline in the consumption of new cars increased, driven by the regulations on CO2 emissions from light-duty vehicles.

¹²² Definition of energy efficiency indicators can be found in Odyssee database.
¹²³ No data available for more recent years
¹²⁴ No data available for more recent years

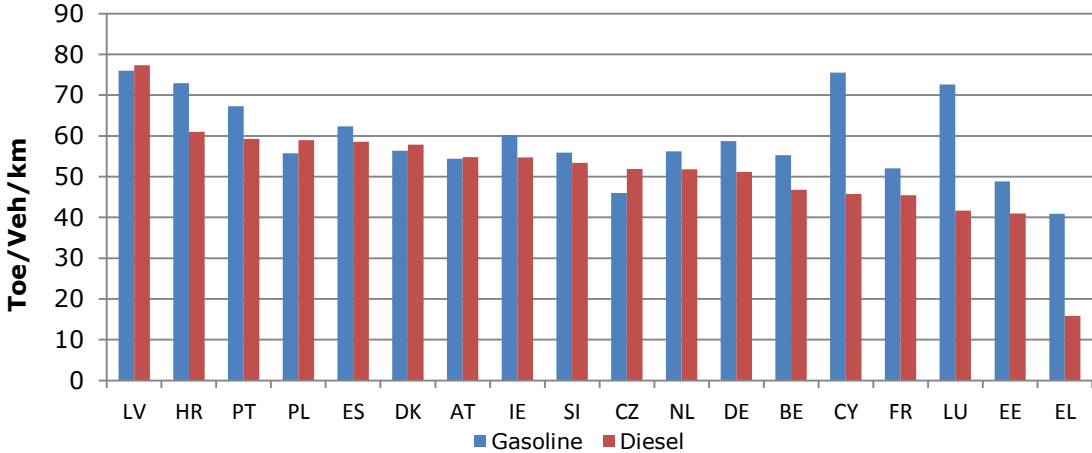
Figure 119: Average specific consumption per car engine technology in the EU-28, 2000-2017



Source: Odyssee

Figure 120 provides the energy consumption per km for one car per type of fuel in the Member States with available data. In most cases diesel cars are more efficient compared to gasoline ones. Variations among Member States could be the result of the differences in the age of the car fleet.

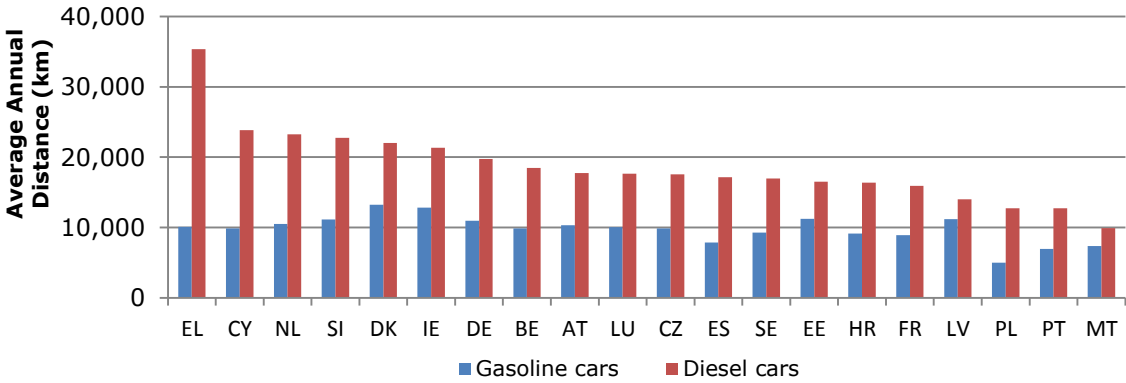
Figure 120: Energy consumption per vehicle and per average annual distance in the Member States with available data, 2017



Source: Odyssee

Figure 121 shows the average annual distance per vehicle travelled by diesel and gasoline cars in 2017. For all the Member States with available data, on average, diesel cars have realised longer distances than gasoline cars.

Figure 121: Average annual distance travelled by car per fuel in the Member States with available data, 2017

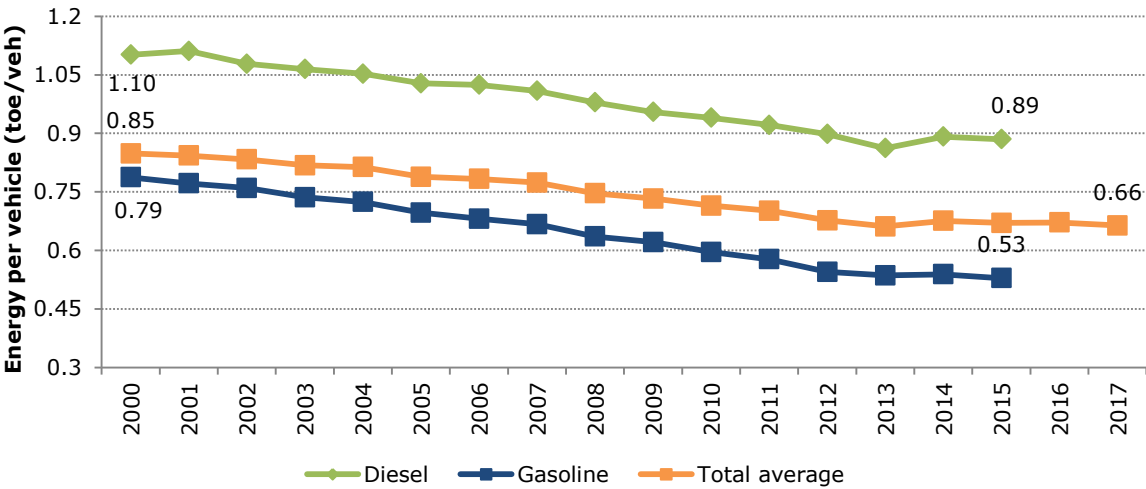


Source: Odyssee

All the figures presented above show that Diesel cars tend to consume less energy adjusted per km and per vehicle while their average specific consumption also presented lower values. Despite this, the average consumption per vehicle is higher in diesel than in gasoline cars (Figure 122). This could be explained by the bigger size of diesel cars and the longer journeys that they normally realize.. Another factor that may have contributed to the relatively higher values of diesel consumption per vehicle is the diesel prices that may have worked as an incentive for longer travels. (Figure 123)

The reduction in total average energy consumption per vehicle registered during the period 2000-2017 was -21.8% while the reduction registered from 2000 to 2015¹²⁵ was -32.8% in gasoline-fuelled cars and -19.6% in diesel fuelled cars. Overall, a decreasing 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 in 2014 for all the studied engine technologies.

Figure 122: Average energy consumption per car engine technology¹²⁶ in the EU-28, 2000-2017

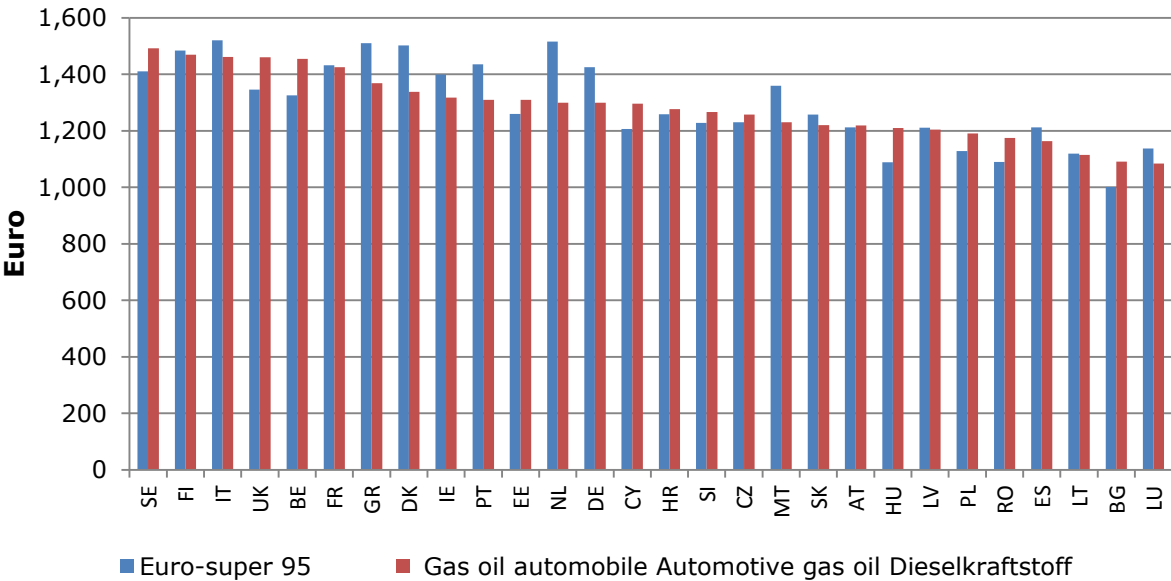


Source: Odyssee

¹²⁵ No data available for more recent years

¹²⁶ It is calculated by dividing the total car consumption per total stock of cars. The series 'Total Average' also includes the energy consumption per vehicle of biofuel-fuelled vehicles and the stock of electric and hybrid cars.

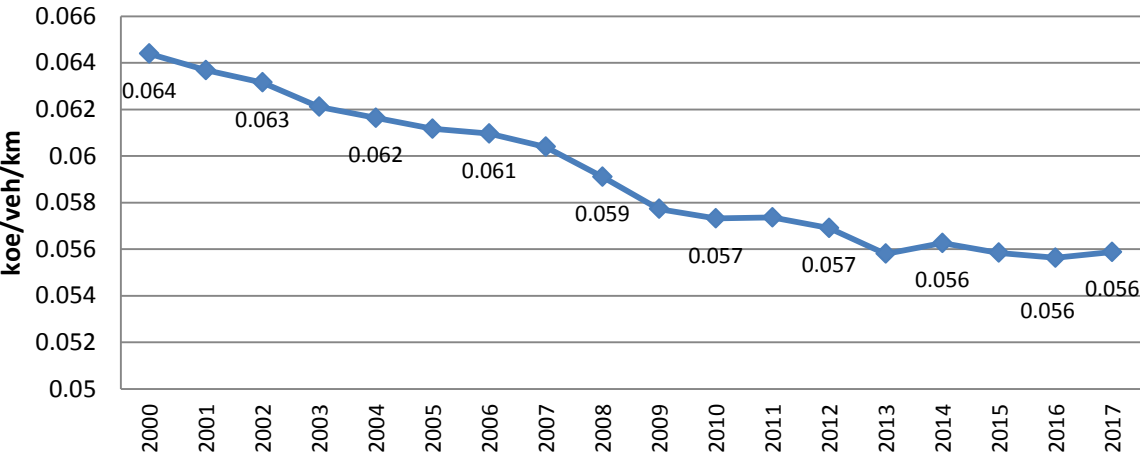
Figure 123: Consumer prices of petroleum products inclusive of duties and taxes on 18/12/2017 in the EU-28 Member States



Source: EC DG-ENER

Figure 124 shows the total car energy consumption per km for one car in the EU-28. From 2000 to 2017, there has been a total reduction of 13.2% in this indicator. The reduction could have been influenced by multiple factors such as traffic management, usage of smaller or more efficient car models.

Figure 124: Car energy consumption per vehicle in stock and annual distance in the EU-28, 2000-2017¹²⁷



Source: Odyssee, EC DG-MOVE

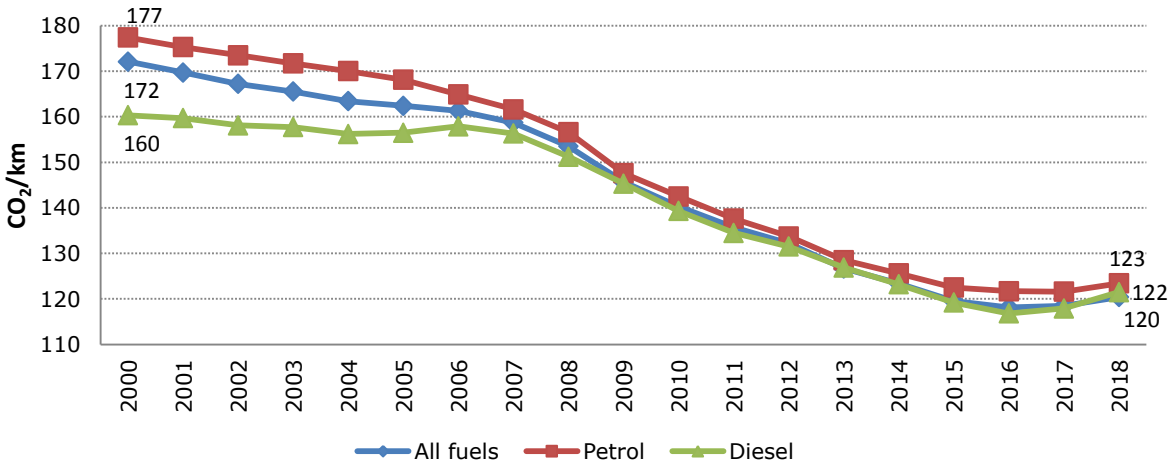
The Regulation No 333/2014 has set a target of 95 g CO₂/km for the new car average emissions for the period after 2021. Additionally, on November 2017, the European Commission proposed a legislative framework setting new CO₂ emission standards for

¹²⁷ This indicator is calculated dividing the total energy consumption of car per total stock of cars and per average annual travelled distance by car

passenger cars and light commercial vehicles (vans) in the EU from 2020 onwards. Regarding the period from 2030 onwards, the reduction amounts to 30% compared to 2021 while for 2025 cars and vans emissions shall be 15% lower compared to 2021, in order to achieve the earliest possible emission reductions. In March 2014, the European Regulation No 333/2014 amended the previous mentioned Regulation defining the modalities for reaching the 2020 target to reduce CO₂ emissions from new passenger cars¹²⁸.

Figure 125 shows the average carbon dioxide emissions of new passenger cars for the period from 2000 to 2018. The EU level of carbon dioxide emissions was 120.4 g CO₂/km in 2018; it represents a drop of 24.2% in comparison with the year 2000 but an increase of 3.1% compared to 2017. The figure shows that there are no remarkable differences in the average CO₂ 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 CO₂ emissions of 123.4 g CO₂/km in 2018; while passenger cars diesel-fuelled registered 3.0 g CO₂/km less (120.4 g CO₂/km) in the same year. Petrol-fuelled vehicles CO₂ emissions have dropped by 30.4% during 2000-2018 while diesel-fuelled vehicles has dropped by 30.04% during the same period. Compared to 2017, both vehicle types increased slightly their emissions by 1.5% and 1.6% respectively.

Figure 125: European average CO₂ emissions per kilometre of new passenger cars in the EU-28, 2000-2018

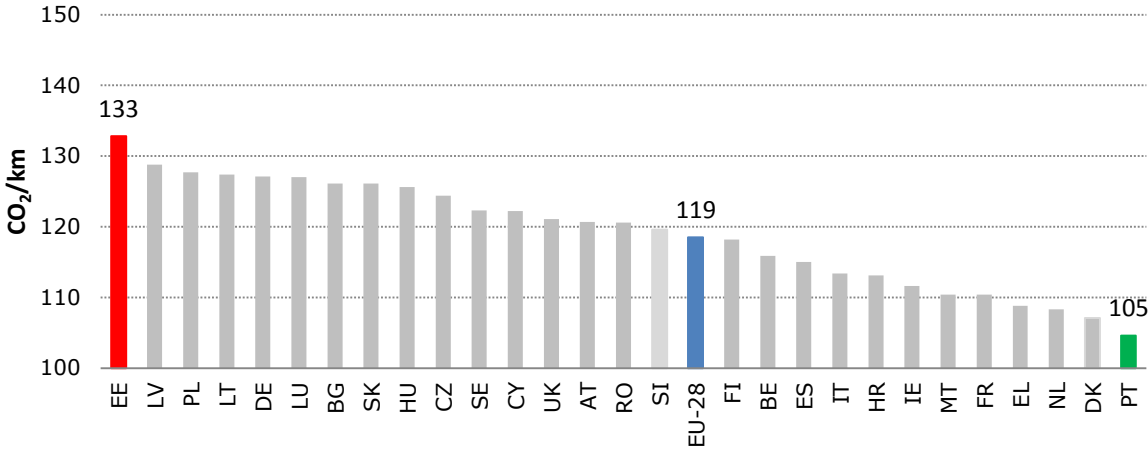


Source: EEA

Across the EU-28 Member States, Estonia (133 g CO₂/km), Latvia (129 g CO₂/km) and Poland (128 g CO₂/km) were the countries with the highest average emissions of the new car fleet in 2017. In contrast, Portugal (105 g CO₂/km), Denmark (107 g CO₂/km), and the Netherlands (108 g CO₂/km) registered the lowest average emissions of new cars in the same year (Figure 126).

¹²⁸ Regulation (EU) No 333/2014 of the European Parliament and of the Council of 11 March 2014 amending Regulation (EC) No 443/2009 to define the modalities for reaching the 2020 target to reduce CO₂ emissions from new passenger cars, OJ : JOL_2014_103_R_0003

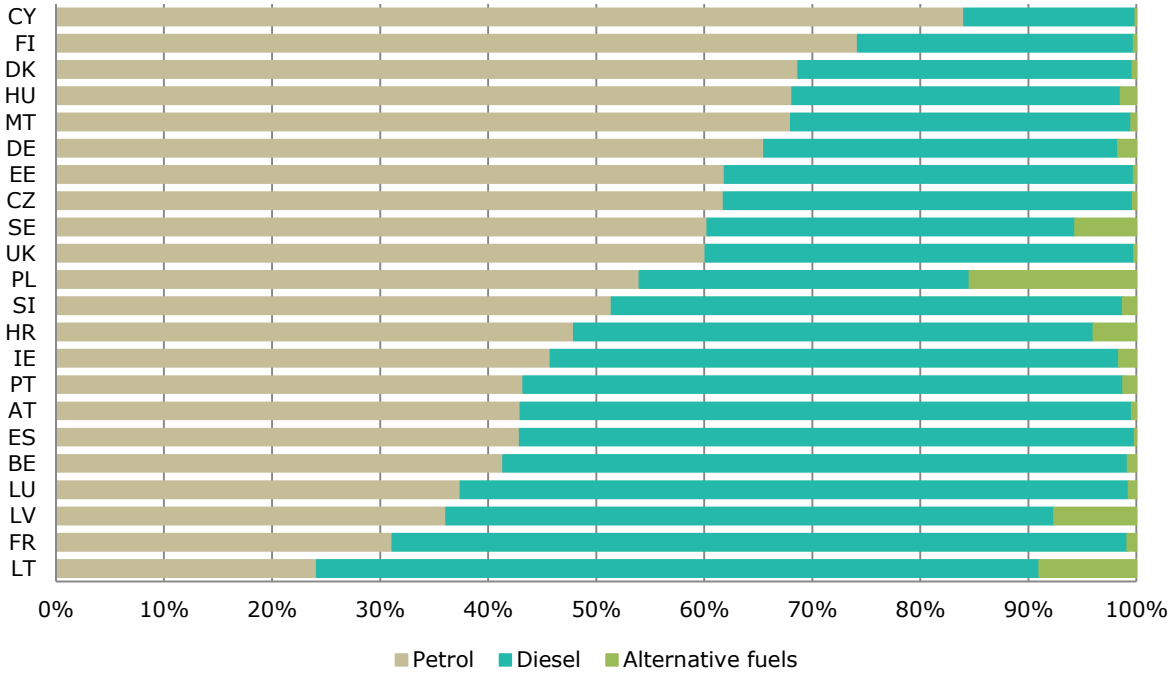
Figure 126: Average CO₂ emissions per kilometre of new passenger cars in the EU-28, 2017



Source: EEA

Across the EU-28 Member States in 2017, the countries with the highest percentage of petrol (gasoline) fuelled passenger cars were Cyprus (84.1%), Finland (74.2%), and Denmark (68.7%). The States with the highest presence of diesel-fuelled passenger cars were France (68.0%), Lithuania (66.9%), and Luxemburg (61.8%). Poland (15.4%), Lithuania (9.0%) and Latvia (7.6%) were the European countries where alternative-fuelled engines¹²⁹ have reached the largest shares (Figure 127).

Figure 127: Passenger cars by type of engine fuel, 2017 (% of all passenger cars)¹³⁰



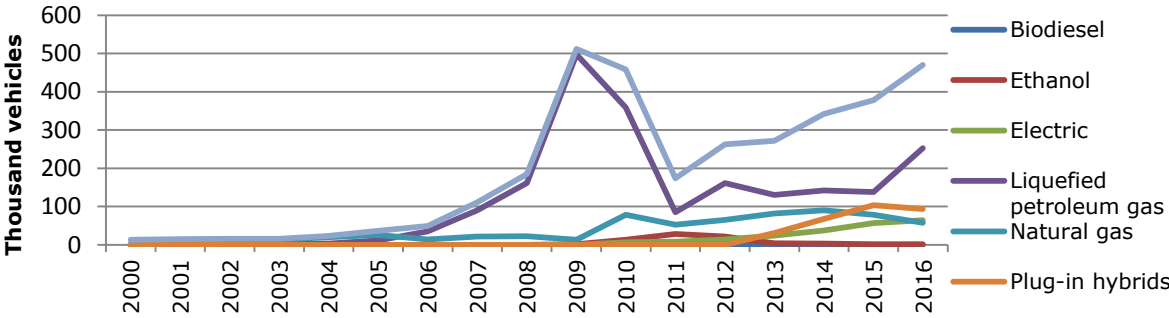
Source: Eurostat

¹²⁹ 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.

¹³⁰ BG, EL, NL, RO, SK, IT incomplete data

Figure 128 shows the evolution in registration of alternative-fuel passenger cars from 2000 to 2016¹³¹ in the EU-28. In this period 3.3 million alternative-fuel cars have been registered. The major part of alternative-fuel passenger cars were registered in 2009 (512 thousand vehicles). Overall, there is an increasing trend in the registration of the passenger cars working with alternative fuels, interrupted in 2010 and restarted again in 2012. From 2015 to 2016, 470 thousand registrations have been completed. Regarding the fuels, LPG cars had the highest number of registrations (2.1 million vehicles) during 2000-2016, followed by natural gas (639 thousand vehicles) and hybrid cars (296.6 thousand vehicles).

Figure 128: New registrations of alternative-fuel passenger cars in the EU-28¹³², 2000-2016



Source: EEA

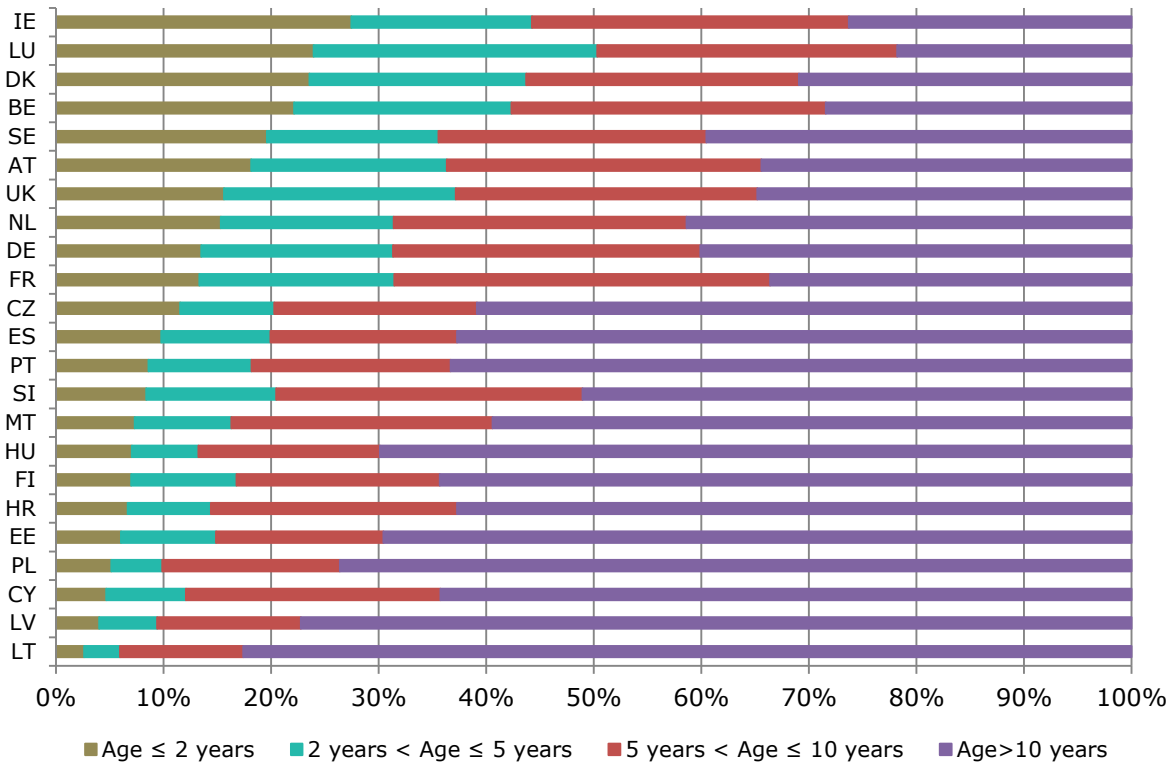
The age of the vehicles fleet is also important in order to better understand energy consumptions and emissions. Looking at the energy consumption per vehicle, which follows a decreasing trend year by year (with the main exception of year 2014 –Figure 118), it is possible to see that the lower the average age of the vehicles, the lower the average energy consumption per vehicle. In 2017 (Figure 129), the EU-28 Member State with the newest fleet of passenger cars was Ireland with 27.5% of its passenger cars below or equal 2 years old, followed by Luxemburg (24.0%) and Denmark (23.6%). In contrast, the oldest fleet of passenger cars (older than 10 years) were registered in Lithuania (82.6%), Latvia (77.2%) and Poland (73.6%) as illustrated in Figure 129. The highest share of passenger cars between 2 and 5 years old was found in Luxemburg (26.38%), the United Kingdom (21.6%) and Belgium (20.2%), while the highest number of passenger cars between 5 and 10 years was registered in France (34.9%), Ireland (29.5%), and Austria (29.2%).

Overall, Luxemburg, Ireland, Belgium and Denmark have the newest fleet of passenger cars (these MSs have the lowest share of above 10 years old passenger cars). As already mentioned, this could lead to lower energy consumption in the road transport in the short-term or mid-term future.

¹³¹ No data for more recent years

¹³² EU-28 totals do not include data for Croatia until 2013. For 2016, Poland reported information indicating that 34 % of new vehicle sales comprised LPG vehicles. Further investigation is required in order to ensure that fuel type is reported in accordance with the guidelines. No available data for 2017

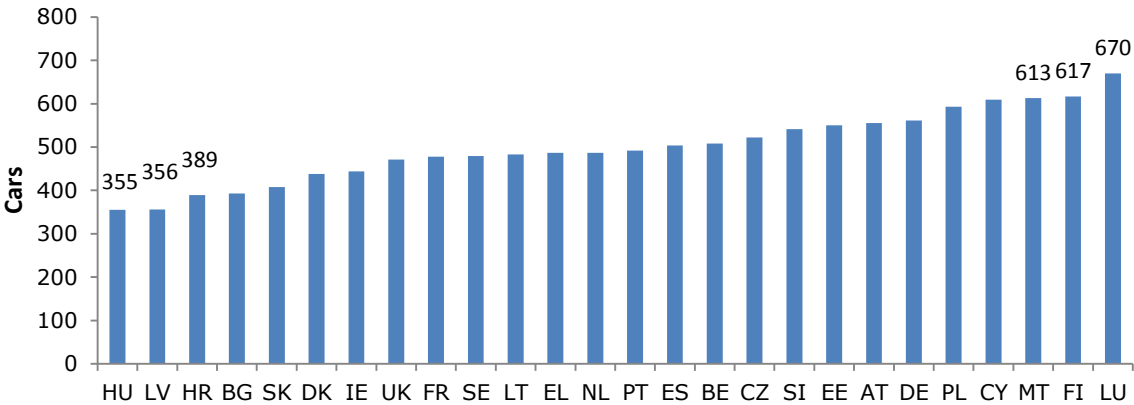
Figure 129: Passenger cars by age, 2017 (% of all passenger cars)¹³³



Source: Eurostat

The Member State with the highest number of passenger cars per 1,000 inhabitants was Luxembourg (670 cars) in 2017; the second State was Finland (617 cars) and the third Malta (613 cars). In contrast, the lowest number of passenger cars per thousand inhabitants was registered in Hungary (355 cars), Latvia (356 cars) and Croatia (389 cars) for the same year as illustrated in Figure 130.

Figure 130: Number of passenger cars per 1,000 inhabitants, 2017¹³⁴



Source: EC DG-MOVE

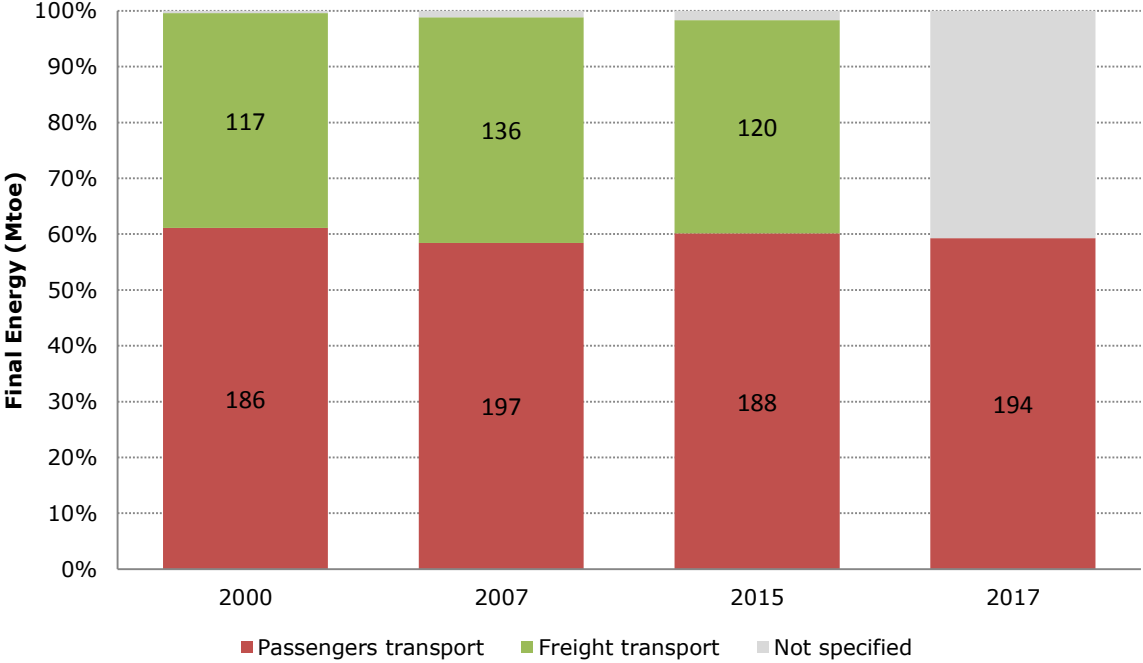
¹³³ BG, EL, RO, SK, IT: incomplete data

¹³⁴ IT, RO: no available data

5.4 Passenger and freight transport

Most of the energy used in the transport sector is for domestic transportation , which consists mainly of passenger and freight transport. According to Odyssee database, passenger transport accounted for the 59.3% of the domestic transport in 2017. In 2015, the consumption shares were 60.1% for passenger and 38.2% for freight transport while not-specified transport accounted for the 1.7% of the domestic transport. Overall, domestic transport has increased by 22.1 Mtoe or 7.3% between 2000 and 2017 (from 305 Mtoe to 327 Mtoe) (Figure 131).

Figure 131: Final energy consumption by passenger and freight domestic transport in the EU-28, 2000, 2007, 2015 and 2017

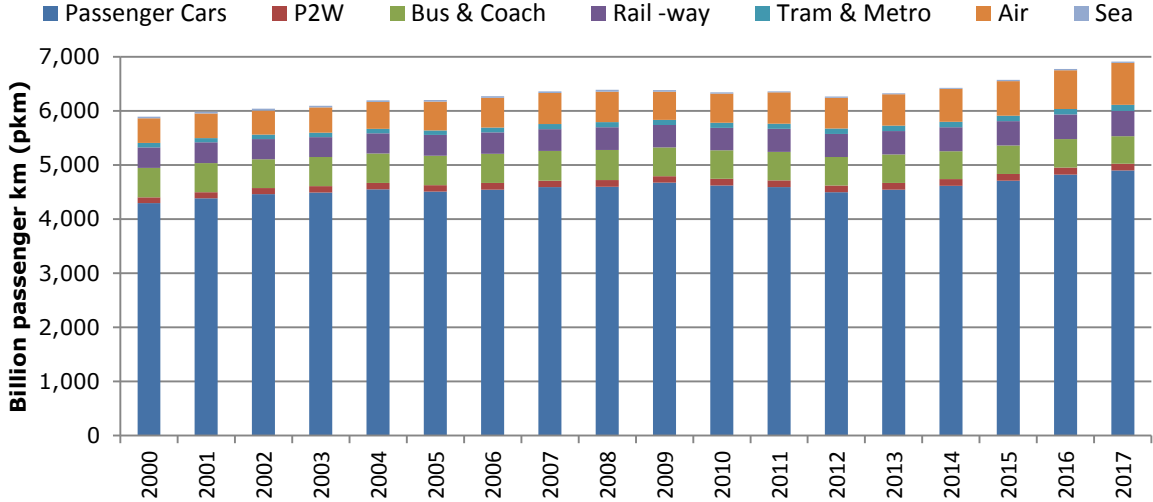


Source: Odyssee

5.4.1 Passenger traffic

The passenger transport volume has risen by 17.3% in the period from 2000 to 2017. In 2017, the value registered 6,913 billion pkm, the maximum passenger volume registered during the period 2000-2017.

Figure 132: Passenger transport volume and modal split in the EU-28¹³⁵, 2000-2017



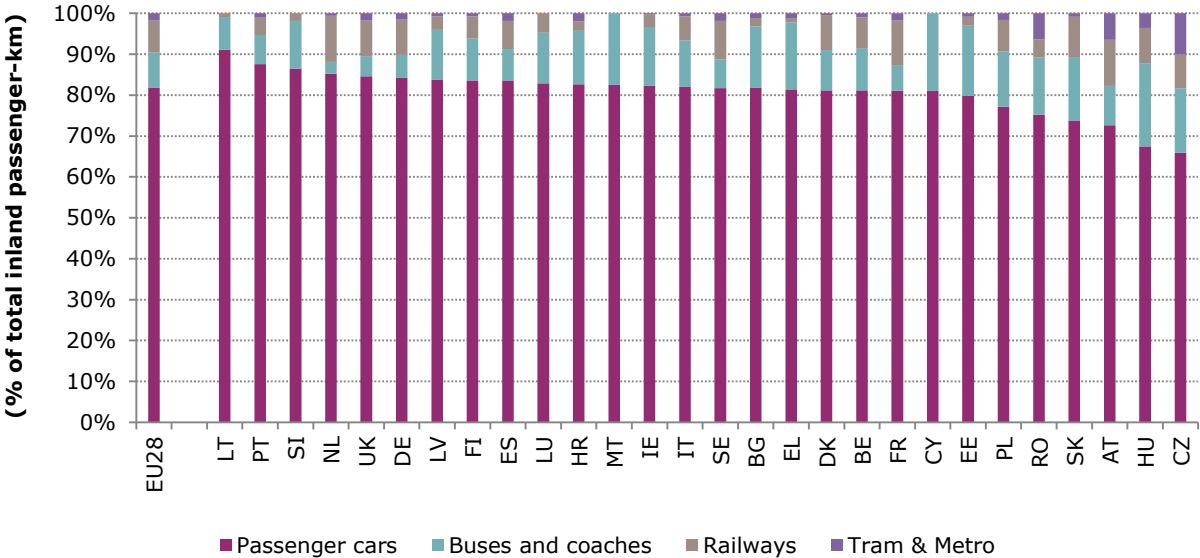
Source: EC DG-MOVE

Passenger cars provide the highest share of passengers transport activity (Figure 133). Passenger cars activity was equal to 4,901 pkm (70.9% of the total) in 2017 which corresponds to an increase of 14.0% in comparison with 2000. Between the years 2000 and 2017 domestic and intra-EU air transport has increased by 69.1%, tram and metro by 31.8%, powered 2-wheelers by 17.8% and rail transport by 24.6%. In contrast buses and coaches dropped by 6.4% and sea transportation by 16.1% during the same period. It is noteworthy that sea transportation represents the smallest share in total domestic and intra-EU passenger transport activity (0.4%).

Analysing the inland passenger transport in the EU-28 Member States, in 2017, Lithuania was the European country with the highest estimated activity of passenger cars in pkm (91.1%) , followed by Portugal (87.6%), and Slovenia (86.5%). In contrast, in the same year, Czech Republic (66.2%), Hungary (67.6%) and Austria (72.7%) were the Member States with the lowest percentage of cars activity in the inland passenger transport. Fourteen Member States registered a share of passenger cars activity in 2017 below the European average (<81.8%). The relative importance of buses and coaches activity exceeded one fifth of inland passenger transport activity only in Hungary (20.4%). This share was between 10.00% and 20.00% in 17 other Member States while the lowest share for buses and coaches activity was registered in the Netherlands (2.8%). Regarding to railways, the highest share of rail activity in transport activity by land was registered in the Netherlands (11.3%), Austria (11.4%) and France (10.9%). The highest share of tram & metro activity was registered in Czech Republic (10.1%), Austria (6.5%) and Romania (6.4%).

¹³⁵ Air and Sea: only domestic and intra-EU-28 transport; provisional estimates. P2W: Powered two-wheelers

Figure 133: Modal split of inland passenger transport in the EU-28 Member States, 2017¹³⁶

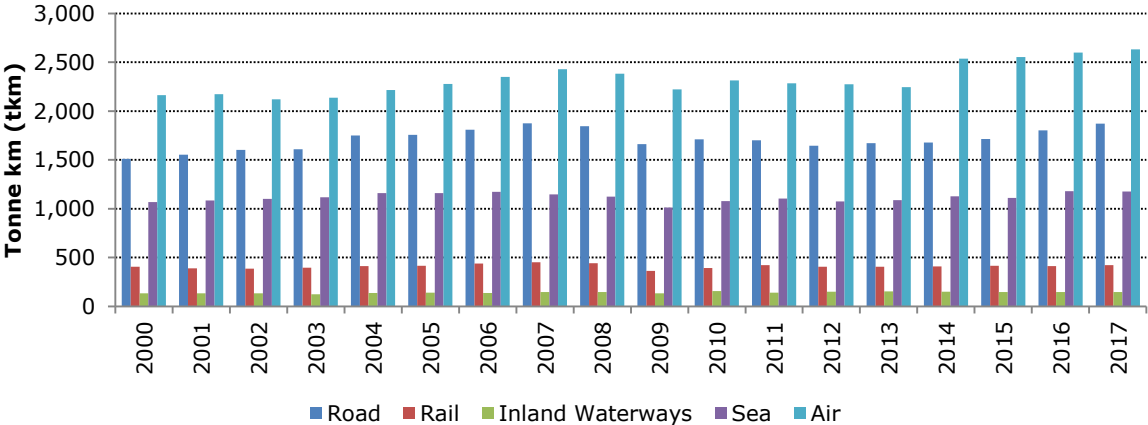


Source: EC DG-MOVE

5.4.2 Freight traffic

Total inland freight transport in the EU-28, including also pipelines, is estimated to be 3,731 tonne-kilometres (tkm) in 2017 (Figure 134). In the period from 2000 to 2017, the total freight traffic has increased by 15.0% (485 tkm). Road transport and air transport are the modes of transport which increased the most during these years (by 23.9% and 21.7% respectively), followed by national and intra-EU maritime (10.2%), inland waterways (9.8%) and rail (3.7%). Pipeline transport decreased by 10.3% during the period.

Figure 134: Freight transport traffic (billion tkm) breakdown into conveyances in the EU-28, 2000-2017¹³⁷¹³⁸



Source: EC DG-MOVE

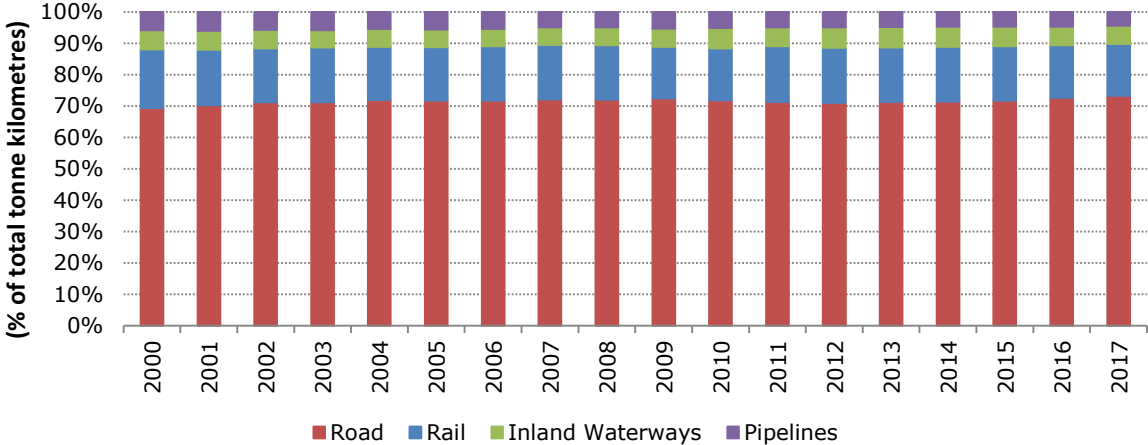
¹³⁶ If powered two-wheelers are included, they account for 2.0 % of the total in EU-28, while the share of the other modes becomes: 80.2% for passenger cars, 8.4% for buses and coaches, 7.7% for railways and 1.8% for tram and metro.

¹³⁷ Air and maritime cover only intra-EU transport (transport to/from countries of the EU) and exclude extra-EU transport. Pipeline transport excluded from the graph.

¹³⁸ Road: national and international haulage by vehicles registered in the EU-28 until 2004, from 2005 onwards the activity performed by European drivers within the EU territory.

Analysing the inland transport modes (Figure 135), road registered 73.3% of the freight traffic in 2017, the highest share of all modes. Rail was the second freight transport mode with a share of 16.5% in inland transport activity in 2017. In 2017 the share of road transport was larger relative to 2000.

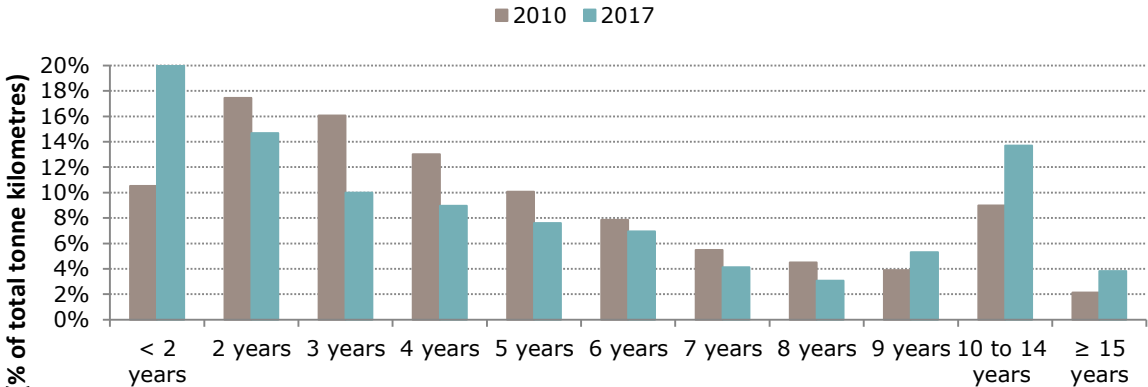
Figure 135: Freight transport in the EU-28: modal split of inland transport modes (% of total tonne-kilometres), 2000-2017



Source: EC DG-MOVE

Regarding the age of the vehicles used for the road goods transport (Figure 136), it can be observed that over 55% of the total tonne-km transport was done by vehicles younger than 4 years or below in 2017. In the same year, the 21.8% of the total tonne-km transport was done by vehicles of age below 2 years. Figure 136 shows that the youngest vehicles tend to be used more for goods transport.. In comparison to the year 2010, the share of tonne-km transport performed by vehicles of age below 2 years has increased by 11.3%. Overall, the share of activity performed by vehicles up to 3 years of age has increased slightly (44.0% in 2010 vs 46.5% in 2017). Nevertheless, a general gradual aging of the vehicles used for transportation of goods has been registered as vehicles up to 5 years old accounted for the performance of the 67.1% of the total tonne-km in 2010, whereas accounted for the 63.0% in 2017.

Figure 136: Road goods transport in the EU-28 by age of vehicle, 2010 and 2017 (% of total tonne-kilometres) ¹³⁹

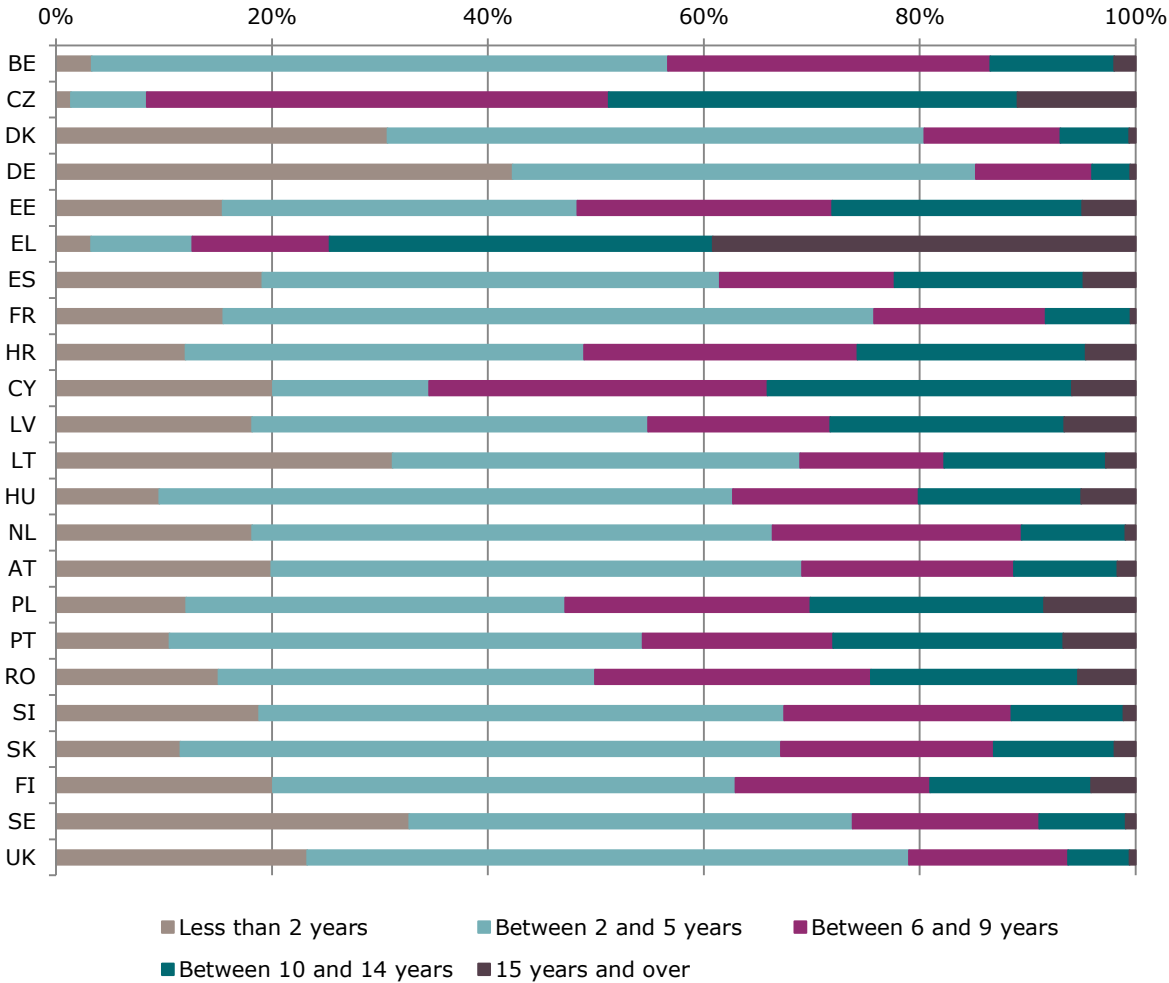


Source: Eurostat

¹³⁹ Total tonne kilometres don't include the tonne kilometres transferred by vehicles of unknown age. No data for EU-28 for more recent years

Analysing the age of vehicles used in road goods transport across the EU-28 Member States (Figure 137), it is found that the major part of the good transport activity was performed by vehicles between 2 and 5 years in 2018 in all the Member States except Czech Republic, Greece and Cyprus. The highest percentage of new cars (less than 2 years) is observed in Germany (42.3%) while the lowest in Czech Republic (1.4%). The highest percentage of old cars (15 years and older) is observed in Greece (39.2%) while the lowest in France (0.5%).

Figure 137: Road goods transport in the EU-28 Member States¹⁴⁰ by age of vehicle, 2018 (% of total tonne-kilometres)



Source: Eurostat

5.5 Overview – Transport sector

The transport sector was the most consuming among the end-use sectors in 2018 in the EU-28. The energy consumption in transport has increased notably (+10.8%) during the 2000-2018 period (second largest increase after services among the analysed sectors). The maximum consumption during this period was registered in 2007, while the minimum in 2000. Energy consumption has increased during 2000-2007, followed by a decrease until 2013. This decrease may be the result of the impact of the financial and economic crisis as well as higher fuel prices and more efficient vehicles. From 2014 onwards, energy consumption started rising again in the context of a higher growth of transport activity and a lower fuel prices environment.

¹⁴⁰ Excludes MT, IE, IT, BG, LU due to incomplete data

The energy intensity in the transport sector has decreased significantly during the period from 2000 to 2017 (-13.6%). The decreasing trend along the period was interrupted in 2009 and in 2016. In the first case it may have been due to the impact of the financial and economic crisis on the countries' GDP. In the second case it followed the trend of the increasing final transport energy consumption, in the context of a lower oil price environment. In 2017, it remained stable.

In 2018, 14 Member States accounted for less than 11% of the final energy consumption and 4 Member States (Germany, the United Kingdom, France and Italy) accounted for more than 55% of the final energy consumption in the sector. Between 2000 and 2018, Poland, Lithuania and Slovakia were the EU-28 MSs with the highest growth rates in the final energy consumption in the transport sector. In contrast, Italy, Greece and Germany registered the highest reduction rates over the period.

The final energy mix in the transport sector is mainly provided by petroleum products. Among the petroleum products diesel and gasoline provide the largest share. However, the share of biofuels and renewables increased from 2000 to 2018, while the share of petroleum products decreased. Biodiesels and biogasoline seem to be the most used biofuels during the studied period.

Automotive diesel oil and gasoline prices generally showed an increasing trend, driven by the evolution of the crude oil price. However, during 2008-2009 a significant drop took place, driven by the economic crisis. The maximum prices over the period from 2005 to 2019 took place in 2012. Then, a progressive reduction in the prices was registered. Since mid-2016 prices started going up again while in late 2018 another drop has occurred.

Among the transport modes, road transport is the main energy consuming mode of transport. It provided by far the highest final energy share in 2018, followed by international aviation, domestic aviation, rail, domestic navigation, pipeline transport and other non-specified transport. Rail has been the sector where consumption declined the most during the 2000-2018 period, while pipeline is the sector where consumption increased the most. In 2018, petroleum products are the only fuel types in the domestic and international aviation and the main contributors in domestic navigation and in road transport. Electricity represented the main consuming fuel in rail and other transports. Natural gas was the major fuel type used in pipeline transport (90.7%). Biofuels also occupied a share in some transport modes.

Focusing on road transport, the final energy consumption has increased in the period from 2000 to 2018 (+8.7%). It has increased very slightly from 2017 to 2018 (+0.5%). 14 Member States consumed less than 11% of the final energy of the sector in 2018 and 4 Member States (Germany, France, United Kingdom and Italy) consumed almost the 55% of the total final energy consumption in the road transport.

The energy mix in the road transport is chiefly associated to petroleum products. A gradual reduction of gasoline consumption and an increase in the consumption of diesel and biofuels have occurred during 2000-2018. LPG, natural gas and electricity have slightly increased their shares in energy consumption. As regards the biofuels, biodiesel had the largest share by far followed by biogasoline in 2018.

Analysing the vehicle types within the road transport, cars provide the highest share of road transport energy consumption, followed by trucks and light vehicles, buses and two wheels. Cars also account for the highest share in vehicle stock. Compared to 2000, all the vehicle types have increased their stock. Two wheels are the vehicle types which have experienced the highest growth rate.

During the period from 2000 to 2017, a gradual decreasing trend has been observed in the average energy consumption per car in the EU-28 (-21.8%). This drop might be the result of the improvements of vehicles in terms of energy efficiency performance, but also it could be related to lower usage of the vehicles in terms of distance travelled per year, driven by the higher fuel prices.

From 2000 to 2014, gasoline and diesel cars already in the market have registered a reduction in their average specific consumptions. From 2000 to 2013, the new gasoline and diesel-fuelled cars have also registered reductions.

Car energy consumption per vehicle in stock and annual distance indicator has also experienced a reduction from 2000 to 2017 (-13.2%) possibly because of improved traffic management and usage of smaller or more efficient car models.

Diesel cars tend to consume less energy adjusted per km and per vehicle while their average specific consumption present also lower values. Despite this, the average consumption per vehicle is higher in diesel than in gasoline cars. This could be explained if the bigger size of diesel cars and the longer journeys that they realize are taken into account. Another factor that may have contributed to the relatively higher values of diesel consumption per vehicle is the diesel prices that may have worked as an incentive for longer travels.

With regard to the EU average level of CO₂ emissions from new passenger cars, there has been registered a significant reduction during 2000-2018 (-24.2%). The Member State with the highest average emissions of new car fleets in 2017 was Estonia, while Portugal registered the lowest average emissions of new cars in the same year.

The countries with the highest percentage of petrol fuelled passenger cars in 2017 were Cyprus, Finland and Denmark. The States with the highest presence of diesel-fuelled passenger cars were France, Lithuania and Luxemburg. Poland, Lithuania and Latvia were the European countries where alternative-fuelled engines have reached the largest shares. From 2000 to 2016, 3.3 million registrations of alternative-fuel cars have been completed in the EU-28.

In 2017, the highest share of newest passenger cars was found in Ireland, Luxemburg and Denmark. The oldest fleet of passenger cars were registered in Lithuania, Latvia and Poland. Luxemburg was the Member State with the highest number of passenger cars per 1,000 inhabitants in 2017. The lowest number of passenger cars per 1000 inhabitants was registered in Hungary.

The passenger transport volume has risen notably in the period from 2000 to 2017 (+17.3%). The value registered in 2017 was the maximum in the analysed period. Buses and coaches and sea transportation where the only passenger transport modes to present a drop in the same period.

In 2017, Lithuania was the European country with the highest estimated activity of passenger cars in pkm, followed by Portugal and Slovenia. In contrast, in the same year, Czech Republic, Hungary and Austria were the Member States with the lowest percentage of cars activity in inland passenger transport. Hungary was the only State where buses and coaches exceeded one fifth of inland passenger transport. Regarding to railways, the highest share of train transport were recorded in the Netherlands. The highest share of tram & metro activity was registered in Czech Republic.

In the period from 2000 to 2017, the total freight traffic has increased (+15.0%). Road registered the highest share of the freight traffic in 2017, confirming this mode of transport as the major inland freight transport mode. Rail was the second inland freight transport mode with the highest presence in the EU-28 freight traffic. In 2017, over 55% of the total tonne-km performance was done by vehicles younger than 4 years or below. In the same year, the 21.80% of the total tonne-km performance was done by vehicles of age below 2 years. In general, the youngest vehicles tend to be used more for the goods transport.

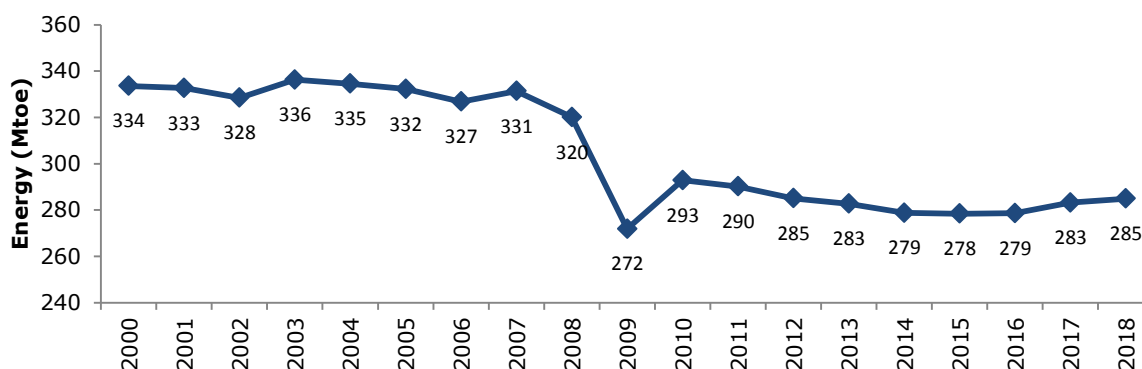
6 Energy Consumption Trends and Energy Efficiency trends in the Industry Sector

This chapter covers the energy consumption and the energy efficiency trends in the industry sector, which includes construction, mining and manufacturing industries. The energy consumption trends are analysed also by energy types.

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

The industry sector accounted for 25.3%¹⁴¹ of the EU-28 total final energy consumption in the year 2018. This sets the industry sector at the second place after the transport sector (33.9%) in the ranking of the most energy consuming economy sectors. Industry final energy consumption in the EU-28 has fallen by 14.6% in the period 2000-2018. It's the sector that has registered the highest fall in final energy consumption from 2000 to 2018 among the four analysed sectors. In 2018, industry final energy consumption reached 285 Mtoe. It corresponds to an increase by 0.6% compared to 2017. The maximum annual consumption over the 2000-2018 period took place in the year 2003 when it reached 336.3 Mtoe, while the minimum occurred in 2009 when the final energy consumption decreased to 272 Mtoe, as illustrated in Figures 138 and 139. 2009 is the year with the lowest consumption not only during the analysed period but also considering the 29-year period comprised between 1990 and 2018. This has probably been due to the impact of the financial and economic crisis [17].

Figure 138: Industry sector: final energy consumption in the EU-28, 2000-2018

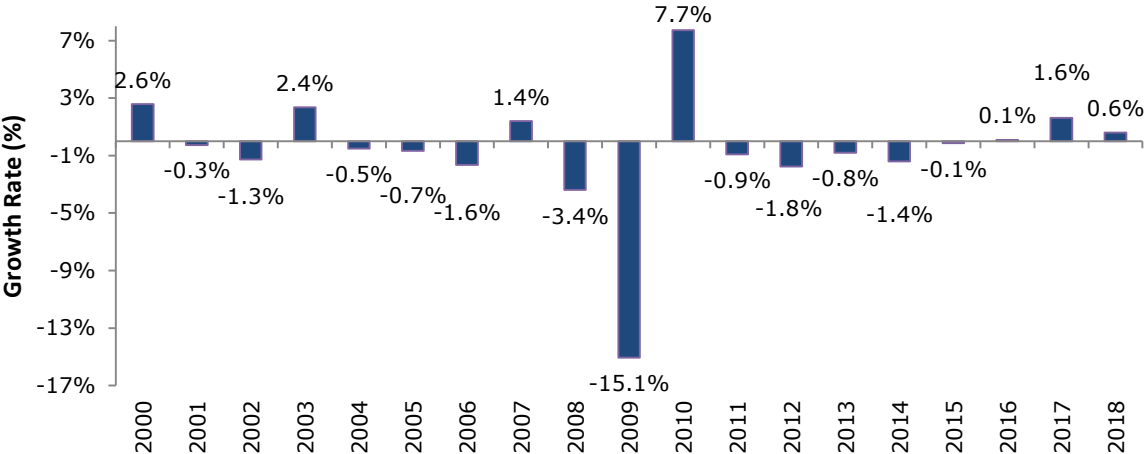


Source: Eurostat

A decreasing trend in the final energy consumption has been registered during the last 19-year period with the exception of year 2003 when a 2.4% rise occurred, the year 2007 an increase of 1.4% was registered and the year 2010 when the consumption rebounded from the dramatic drop of 15.1% in year 2009 (Figure 139). From 2010 to 2015, the decreasing trend has continued, reaching in 2015 the second lowest value over the 1990-2018 period. From 2016 to 2018 a slight increasing trend has been observed. However, energy consumption in industry could probably keep an overall decreasing trend, at least in the short and medium-term future, due to an expected shift towards less-energy-intensive manufacturing industries, ongoing structural changes towards tertiarization of EU economy, and technological and energy efficiency improvements under stricter policies and regulations.

¹⁴¹ Industry energy consumption trends have been analysed using the old methodology Eurostat tables in order to be comparable with the EU 2020 targets.

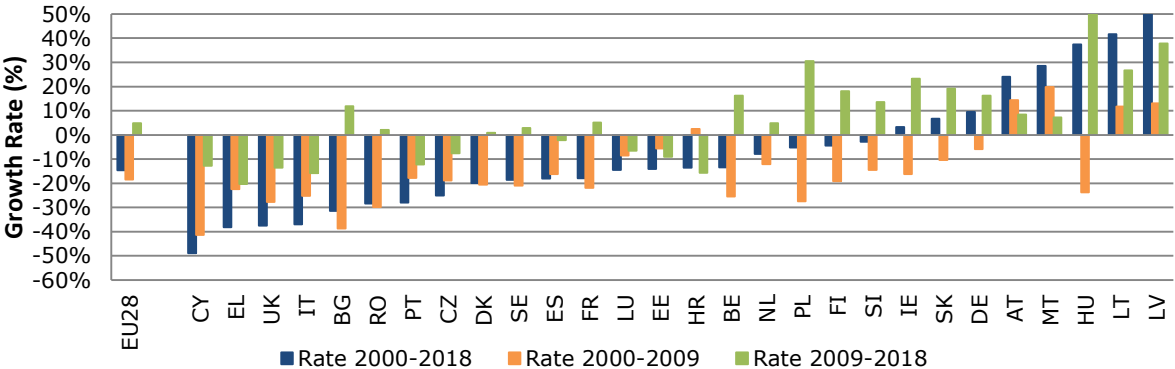
Figure 139: Industry sector: final energy consumption annual growth rates in the EU-28, 2000-2018



Source: Eurostat

By looking at the final energy consumption growth rates across the EU-28 Member States, it can be observed that only eight Member States have registered a positive growth rate from 2000 to 2018. These are: Latvia, Lithuania, Hungary, Malta, Austria, Germany, Slovakia and Ireland. The highest growth rate has been observed in Latvia (55.7%), Lithuania (41.6%) and Hungary (37.5%). Twelve EU-28 Member States have consumption negative growth rates below the EU-28 value (-14.6%). The impact of the crisis on the industry manufacturing and production rates is evident. Five Member States have increased their consumption in the period 2000-2009. These are Latvia, Lithuania, Croatia, Austria and Malta. The highest reduction rates over the period 2000-2018 have been observed in Cyprus (-48.8%), in Greece (-38.2%) and in the United Kingdom (-37.5%).

Figure 140: Industry sector: final energy consumption growth rates in the EU-28 Member States; 2000-2018, 2000-2009 and 2009-2018



Source: Eurostat

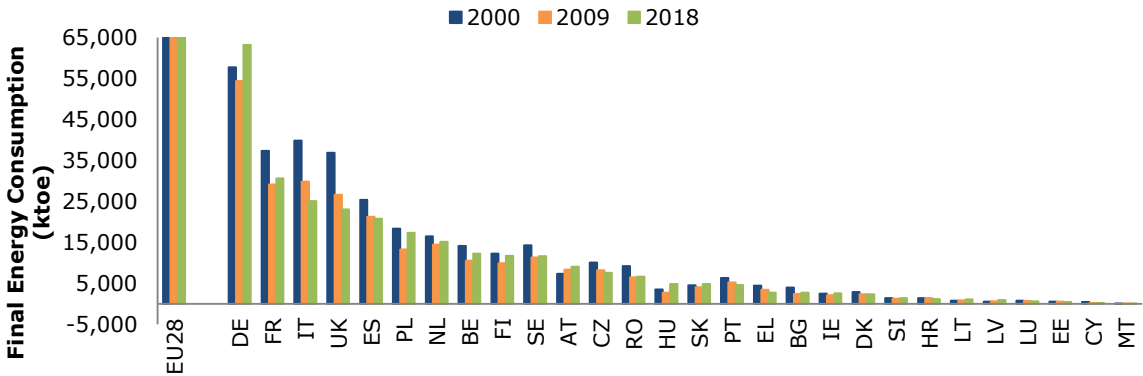
In 2018, the Member State with the highest consumption in the industry sector was Germany (63.2 Mtoe), followed by France (30.7 Mtoe) and Italy (25.1 Mtoe). In 2000 and 2009, German industry was already the first energy consumer, followed by Italy and France. In 2018 Germany is still in the first position, but France is in the second and Italy is in the third.

Four Member States consumed more than 49% 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 2018 (Figure 142).

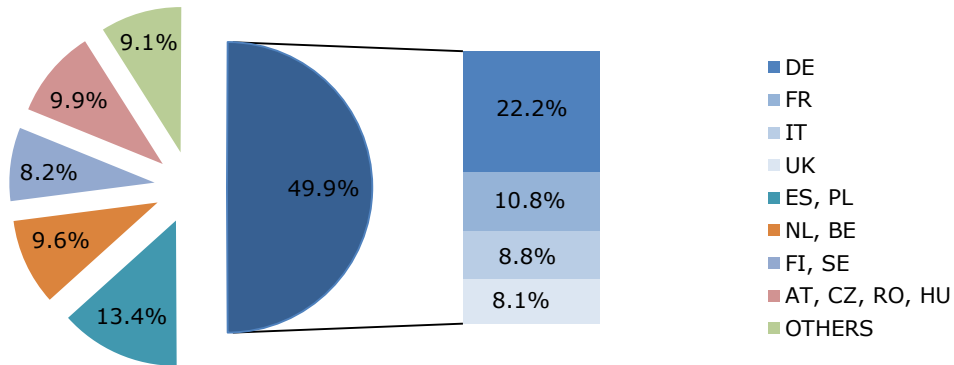
The European global energy consumption trend is therefore highly influenced by the consumption of a limited number of countries.

Figure 141: Industry Sector: Final industrial energy consumption in the EU-28 Member States, 2000, 2009 and 2018



Source: Eurostat

Figure 142: Shares of EU-28 Member States to final industrial energy consumption, 2018



Source: Eurostat

In 2018, natural gas and electricity were the main contributors to the energy mix¹⁴² in the industry sector with 83.3 Mtoe and 90.3 Mtoe respectively. These fuels represented over 65% of the energy mix; electricity accounted for 34.2% and natural gas for 31.6% of the total consumption. The rest of the energy mix was constituted by oil and petroleum products (10.3%), renewable energies and biofuels (8.9%), derived heat (6.0%), solid fossil fuels (5.2%), and other¹⁴³ (3.8%).

There are several differences in the ranking of the energy fuels compared to 2000. For example natural gas and electricity were the main contributors during the whole analysed period but they swapped their ranking positions for the first time in 2006. Consequently, from 2006 to 2018 electrical energy was the main energy source used in industry sector. Oil and petroleum products were in the third position during the studied period. Solid fossil fuels and renewables and biofuels also swapped their 4rd and 5th positions in 2009.

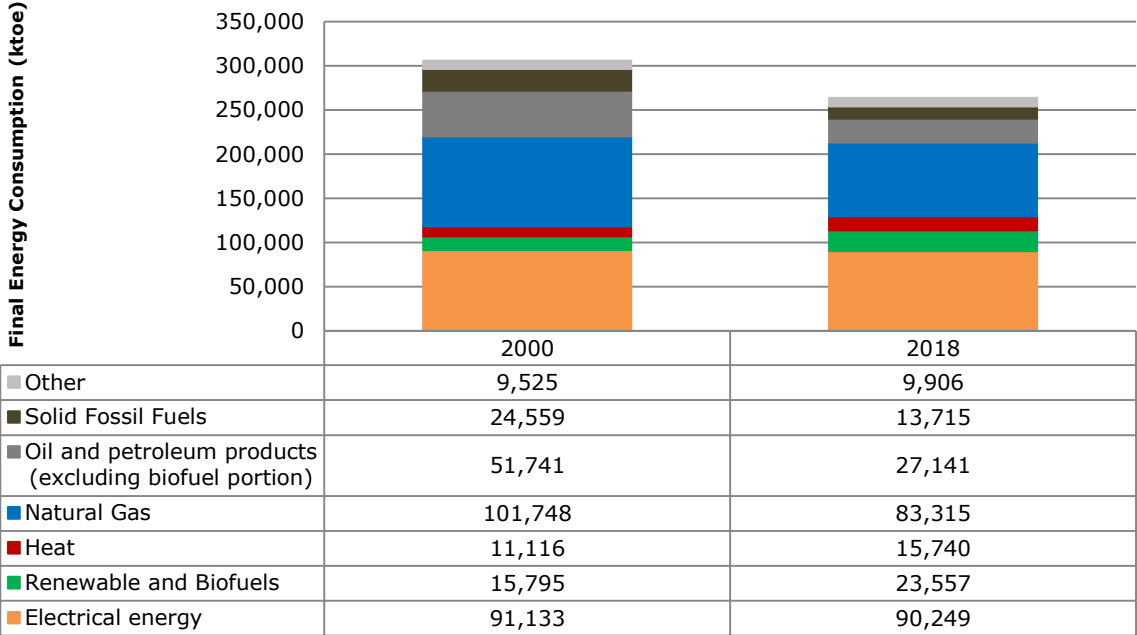
¹⁴² The analysis of industrial energy consumption per fuel type uses the new methodology Eurostat tables for energy balances based on the availability of the data.

¹⁴³ Peat and peat products, non-renewable waste, manufactured gases and oil shale and oil sands are included

Consequently from 2009 to 2018, renewables and biofuels were in the fourth ranking position.

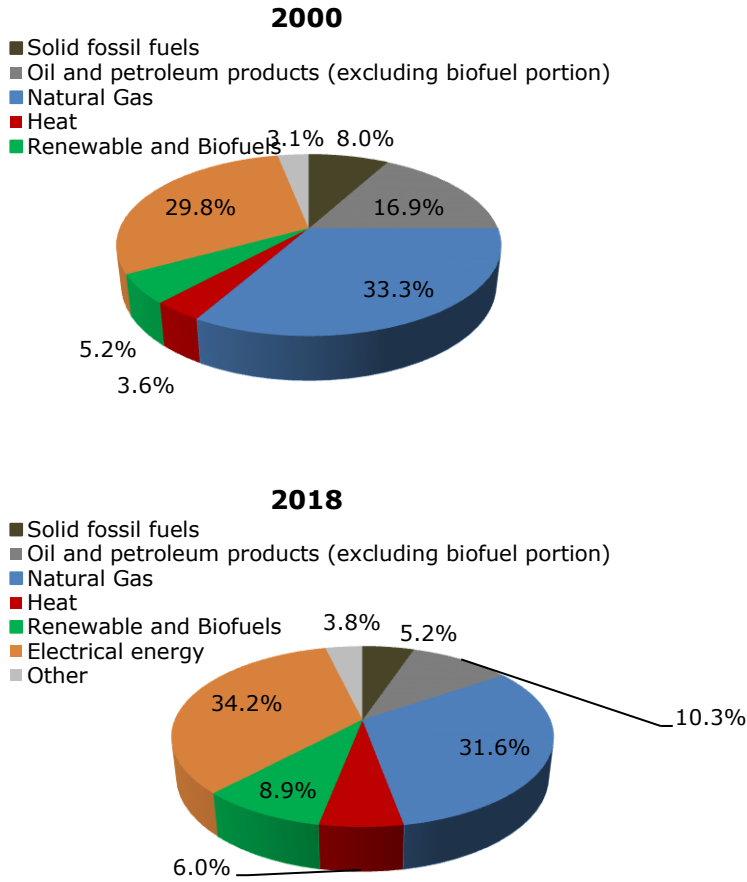
The usage of oil and petroleum products fell by 47.5% (around 25 Mtoe). Renewables and biofuels and heat have enlarged their contributions in absolute value. On the other hand, oil and petroleum products, electrical energy, natural gas and solid fossil fuels and other have reduced the absolute value of their contributions as illustrated in Figure 143. Overall, electricity, renewables and biofuels, heat and other have grown in percentage, whilst the shares of solid fossil fuels, natural gas and oil and petroleum products have decreased.

Figure 143: Industry sector: final energy mix, 2000 and 2018



Source: Eurostat

Figure 144: Industry sector: final energy mix by percentage, 2000 and 2018



Source: Eurostat

Electricity consumption

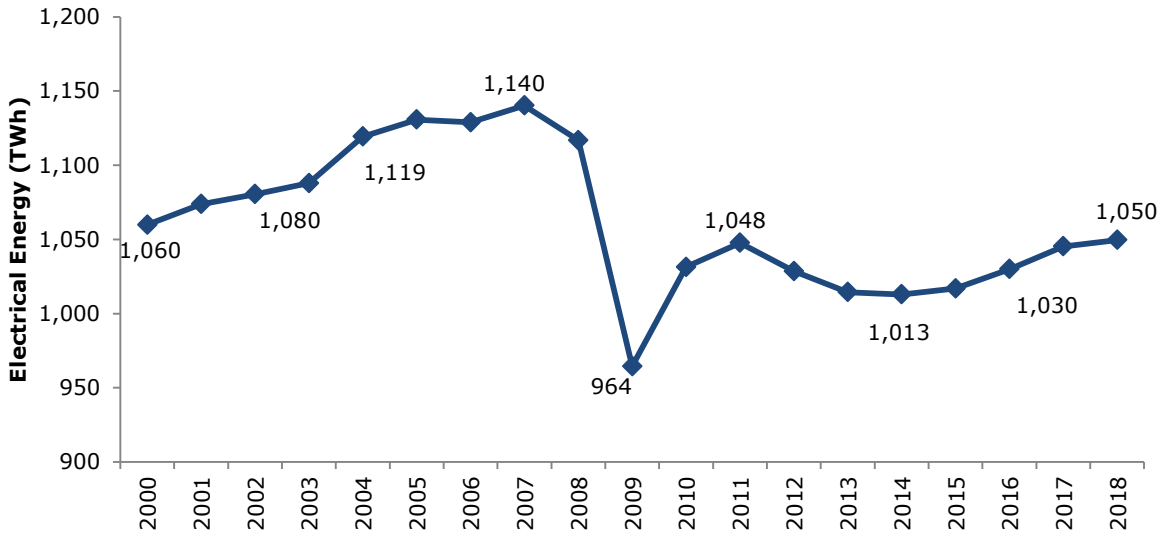
The industry sector consumed 37.3% of the final electricity consumption of the EU-28 in 2018 this confirming industry as the main electricity consumer sector in Europe (Figure 20).

When it comes to the energy mix, as mentioned in the previous section, electricity accounted for 34.2% of the total final energy consumption in 2018, making it the main final energy type consumed in the industry sector.

The final industrial electricity consumption in the EU-28¹⁴⁴ has fallen by 1.0% in the 19-year period from 2000 to 2018. The maximum consumption over the period considered took place in the year 2007 (1,140 TWh). The minimum value in the period 2000-2018 occurred in 2009 when the final electricity consumption dropped to 965 TWh as illustrated in Figure 145. Electricity consumption remained almost stable from 2017 to 2018 (increased by 0.4%).

¹⁴⁴ The analysis of industrial electricity consumption uses the new methodology Eurostat tables for energy balances based on the availability of the data.

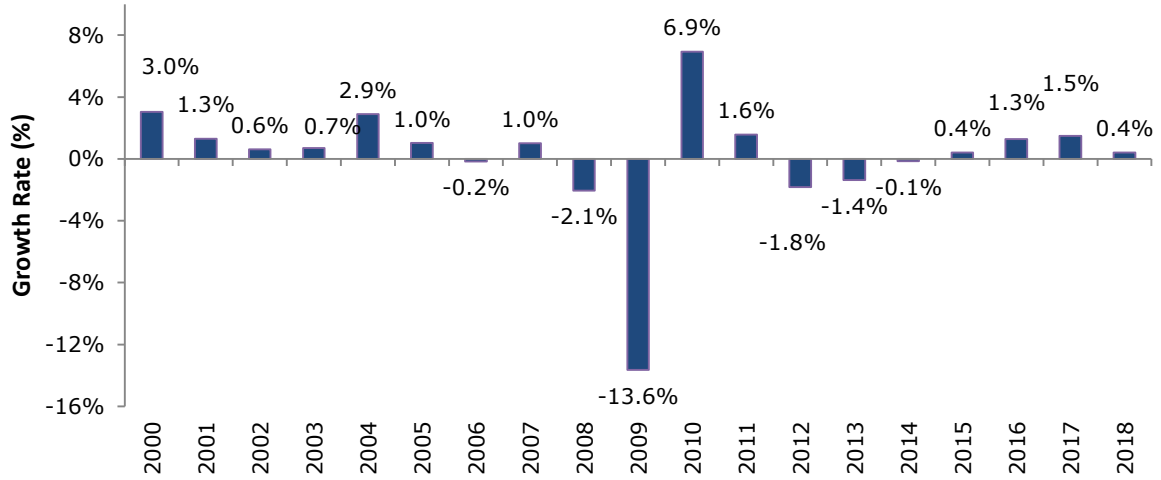
Figure 145: Industry sector: final electricity consumption in the EU-28, 2000-2018



Source: Eurostat

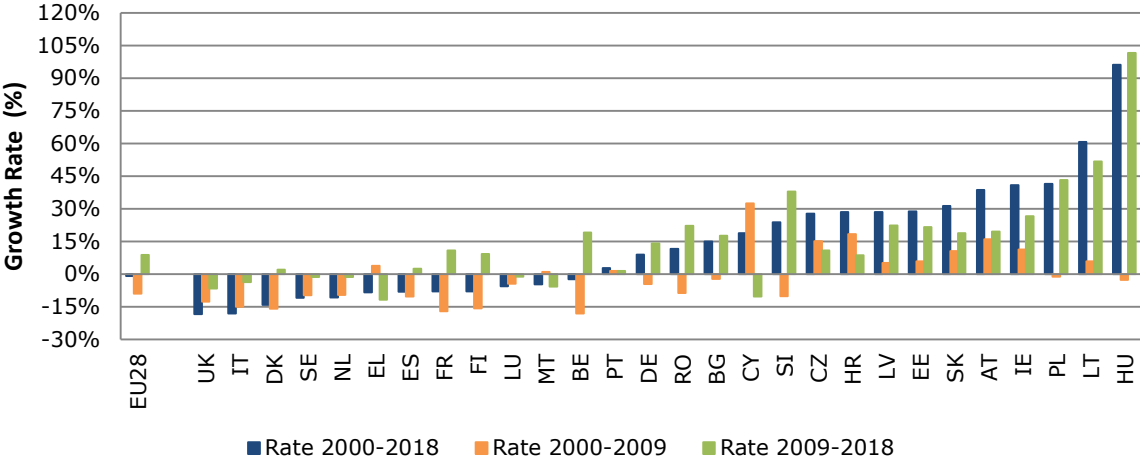
A continuous growth in the industry final electricity consumption can be substantially observed until 2007 except for the minor reduction registered in the year 2006 (-0.2% in comparison to the previous year). During years 2008 and 2009 the industry sector reduced its final electricity consumption (and its total final energy consumption) mainly for the impact of the financial and economic crisis on the sector's activity [18]. The two following years (2010 and 2011) reported an increase in the consumption in comparison to the previous years (by 6.9% and 1.6% respectively). From 2012 to 2014 a decreasing trend has been registered, although the negative growth rate was smoother year after year. From 2015 to 2018 electricity consumption registered positive growth rates as shown in Figure 146. An increase by 0.4% has been registered in 2018 compared to 2017.

Figure 146: Industry sector: annual final electricity consumption growth rates, 2000-2018



Source: Eurostat

Figure 147: Industry sector: annual final electricity consumption growth rates in the EU-28; 2000-2018, 2000-2009 and 2009-2018



Source: Eurostat

The countries with the highest growth rates in final electricity consumption between 2000 and 2018 were Hungary (96.1%), Lithuania (60.7%) and Poland (41.5%). In the same period, the Member States with the highest reduction rates were the United Kingdom (-18.4%), Italy (-18.2%), and Denmark (-14.2%). Twelve Member States have registered negative growth rates lower than the EU-28 reduction rate (-1.0%) during the mentioned 19-year period. In the period from 2000 to 2009, sixteen states underwent a negative growth rate possibly as a result of economic crisis. In the period 2009-2018 the influence of the economic crisis has been moderated as only eight Member States registered a negative growth rate.

Natural gas consumption

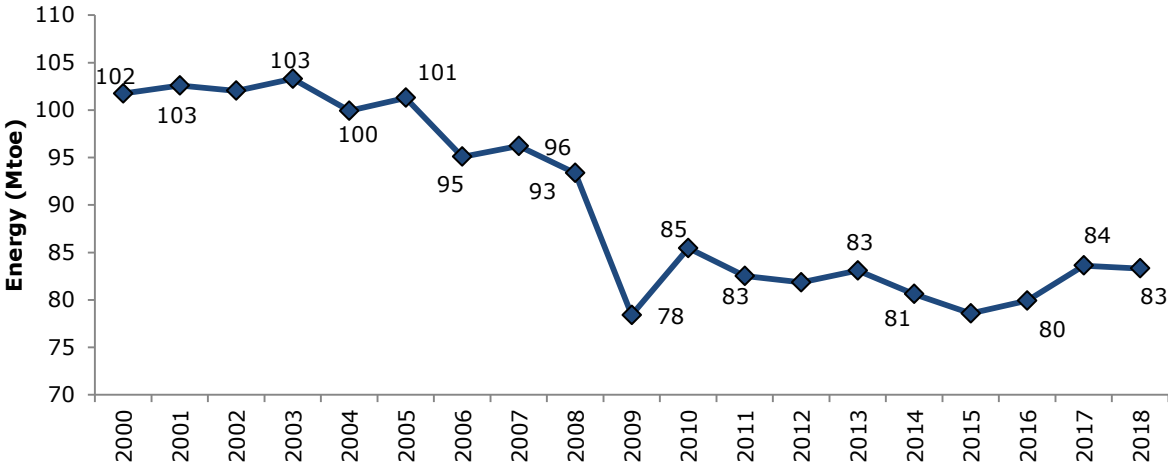
The industry sector consumed 34.7% of the final natural gas consumption of the EU-28 in 2018, representing the second natural gas consumer after the residential sector (42.8%). As in the case of final electricity consumption, natural gas consumption is primarily associated with three sectors. The residential sector is the highest consumer of gas with 42.8%, followed by industry sector with 34.7% and service sector which accounts for 19.3% of total final gas consumption. The three sectors together cover almost the 97% of the gas consumption of the European Union, as illustrated in Figure 26.

When focusing on the industrial sector energy mix, natural gas accounted for 31.6% of the total final energy consumption in 2018, making it the second final energy type consumed in the industry sector, after electricity (Figure 143).

Industry final natural gas consumption has fallen by 18.1%¹⁴⁵ in the EU-28 during the period from 2000 to 2018. The maximum consumption over the analysed period took place in the year 2003 (103 Mtoe). The minimum value in the period 2000-2018 occurred in 2009 when the final natural gas consumption dropped to 78 Mtoe as illustrated in Figure 148. Since 2009, the EU has been registering the lowest values of industry final gas consumption for the 29-year period between 1990 and 2018 (with the exception of the years 1992-1993). In 2018, natural gas consumption remained almost stable compared to 2017 (decreased by only 0.4%).

¹⁴⁵ The analysis of industrial natural gas consumption uses the new methodology Eurostat tables for energy balances based on the availability of the data.

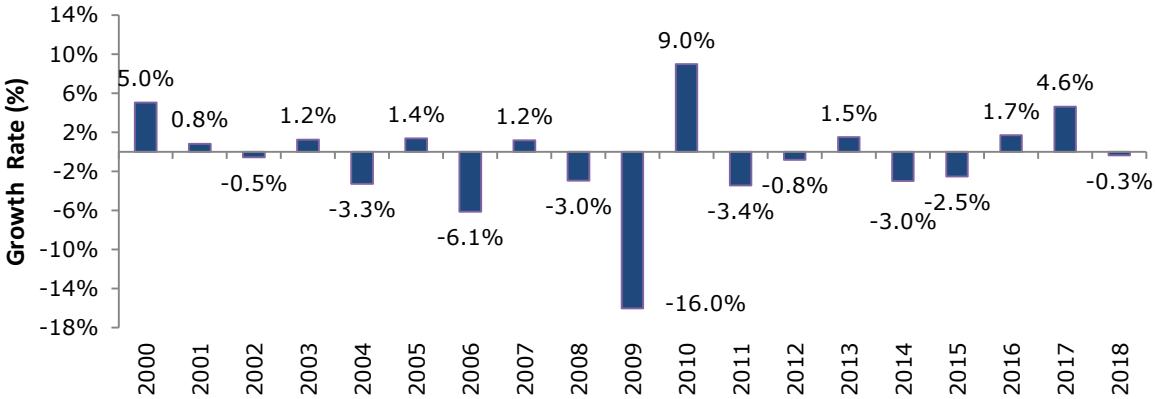
Figure 148: Industry sector: final natural gas consumption in the EU-28, 2000-2018



Source: Eurostat

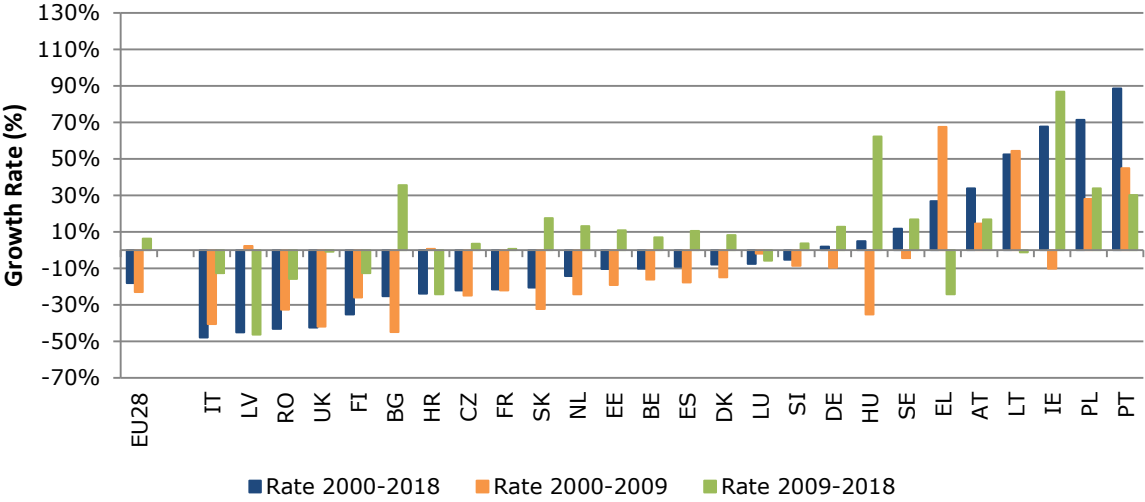
It can be observed fluctuating decreasing trends during the whole analysed period. From 2001 to 2009 the annual growth rates are either negative or with rises in comparison to previous years less than 2%. The minimum value during the analysed period registered in 2009, when a drop of 16.02% has taken place in comparison to the year 2008. From 2010 to 2017, the values have been fluctuating. The value of 83.3 Mtoe registered in 2018 represented a decrease by 0.35% after two continuous years with positive growth rates.

Figure 149: Industry sector: annual final natural gas consumption growth rates, 2000-2018



Source: Eurostat

Figure 150: Industry sector: final natural gas consumption growth rates in the EU-28¹⁴⁶; 2000-2018, 2000-2009 and 2009-2018



Source: Eurostat

From 2000 to 2018, the industry final natural gas consumption has dropped by 18.80% in the EU-28. Ten Member States have registered a decrease rate below the average European decrease rate (18.1%). The Member States with the highest growth rates are Portugal (88.5%), Poland (71.34%) and Ireland (67.7%). On the other hand, the EU-28 countries with the highest reduction rates are: Italy (-48.0%), Latvia (-45.1%), and Romania (-43.2%).

Across the EU-28 Member States, decreasing trends have been registered by nine countries in the period 2009-2018. The countries with highest reduction rates are: Latvia (-46.3%), Croatia (-24.3%) and Greece (-24.2%). To be noted the case of Greece that went from a large positive growth rate in 2000-2009 and turn to a negative growth rate in 2009-2018, possibly because of the economic crisis. In contrast, some Member States (i.e. BG, HU, IE, SK) registered significant increases during the same period possibly due to economic growth or increase of the production. EU average has also registered a positive growth rate (+6.2%).

6.2 Industry subsectors

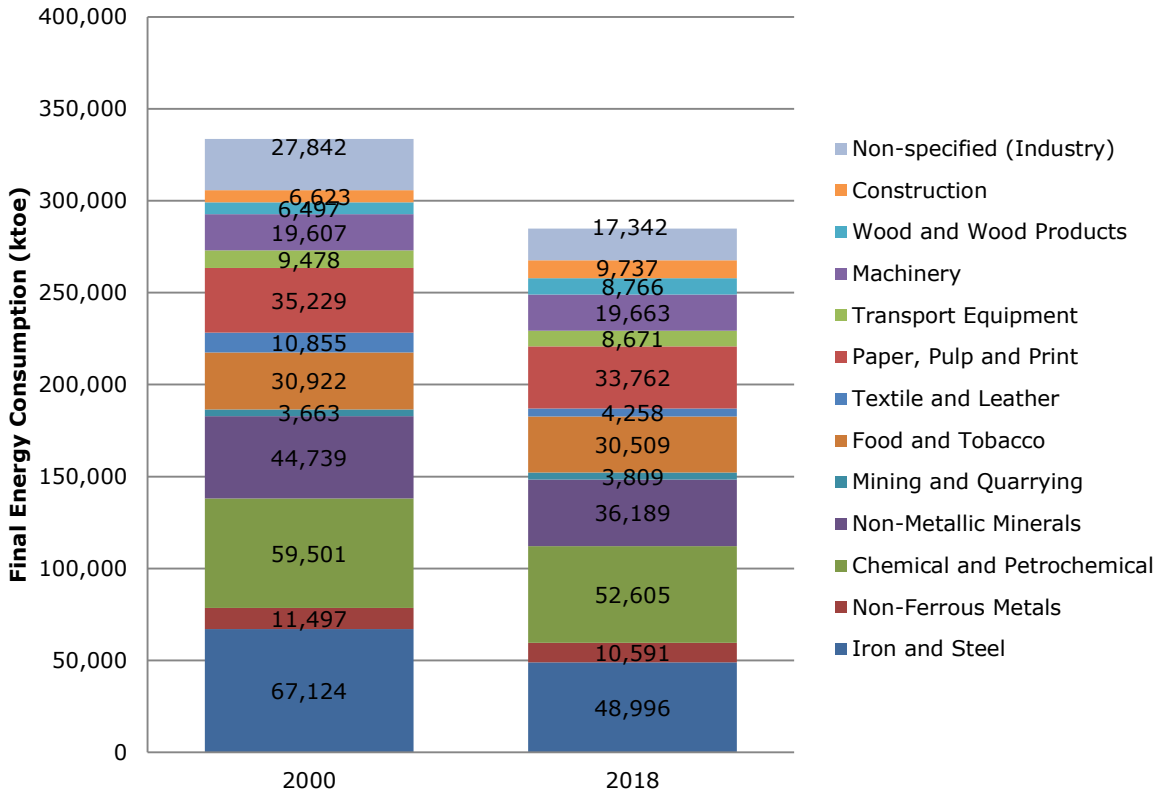
In this section, the final energy consumption in the industry sector is broken-down into different industry subsectors. The industry subsectors according to Eurostat can be mainly divided into Construction, Mining and Quarrying and Manufacturing. Manufacturing, in turn, can be split into eleven subsectors: 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 Industries¹⁴⁷.

The industry final energy consumption per subsector is reported in Figure 151 and Figure 152.

¹⁴⁶ MT, CY: consumption equal to 0

¹⁴⁷ Energy consumption data regarding industry subsectors are provided by Eurostat and Odyssee Databases. In Odyssee Database the industry subsectors are divided in: Construction, Mining, Energy and Manufacturing. The manufacturing subsectors are divided in: Primary metals, Chemical, Non-metallic minerals, Food and Tobacco, Textile and Leather, Paper and Printing, Pulp and Paper, Transport Equipment, Machinery, Rubber and Plastics, Other Industries

Figure 151: Industry sector: final energy consumption by subsectors, 2000 and 2018



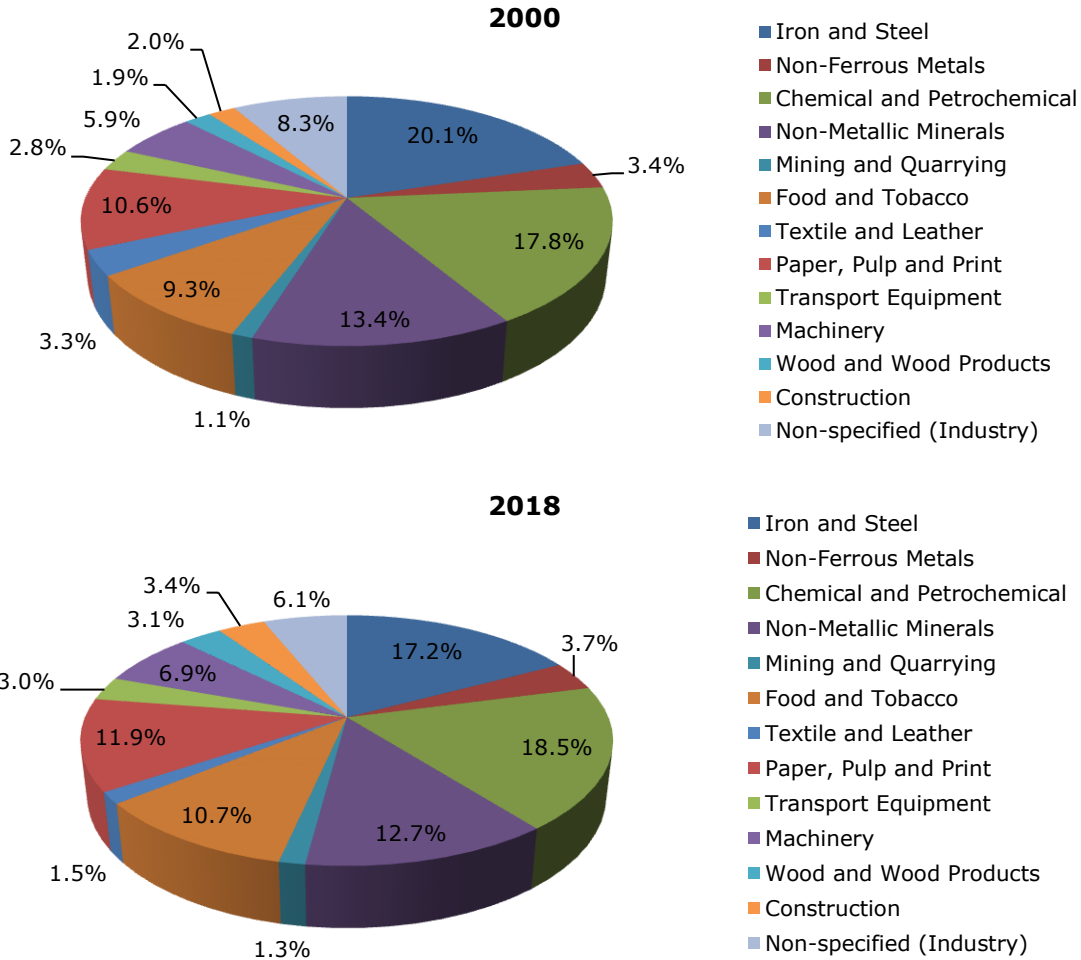
Source: Eurostat

In 2018, the industry subsector with the highest energy consumption¹⁴⁸ was the Chemical and Petrochemical subsector which accounted for 18.5% (52,605 ktoe) of the total final industrial energy consumption, followed by Iron and Steel (17.2%; 48,996 ktoe), Non-metallic Minerals (12.7%; 36,189 ktoe) and Paper, Pulp and Print (11.9%; 33,762 ktoe). The layout is completed by Food and Tobacco (10.7%; 30,509 ktoe), Machinery (6.9%; 19,663 ktoe), Non-specified (Industry) (6.1%; 17,342 ktoe), Non-Ferrous Metals (3.7%; 10,591 ktoe), Construction (3.4%; 9,737 ktoe), Wood and wood products (3.1%; 8,766 ktoe), Transport Equipment (3.0%; 8,671 ktoe), Textile and Leather (1.5%; 4,258 ktoe) and Mining and Quarrying (1.3%; 3,809 ktoe).

In 2000, the most energy consuming subsector was iron and steel (20.1%), followed by chemical and petrochemical (17.8%). The most significant change is the decrease of the share of Textile and Leather subsector that remained less than the half from 2000 to 2018.

¹⁴⁸ Industry energy consumption trends by industry subsector have been analysed using the old methodology Eurostat tables in order to be comparable with the EU 2020 targets.

Figure 152: Industry sector: final energy consumption percentage by subsectors, 2000 and 2018



Source: Eurostat

Table 8 provides an overview of the variations in the final energy consumption in the different energy subsectors between years 2000 and 2018. 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 was the only subsector registered a final energy consumption drop (by 16.1%). The Mining and Quarrying subsector has registered an increase of 4.0% in the period 2000-2018. Construction also has increased its demand of final energy by 47.0%. Among the manufacturing subsectors, the only positive growth rates are found in Wood and Wood Products (by 34.9%) and Machinery (0.3%). The rest of the manufacturing subsectors have registered negative growth rates. The highest reduction rates have been observed in Textile and Leather (-60.8%), Non-Specified Industry (-37.7%) and Iron and Steel (-27.0%). Some of these reduction trends are possibly the result of reduced production (Figure 158).

Table 8: Growth rates and energy consumption shares in industry subsectors, 2000 and 2018

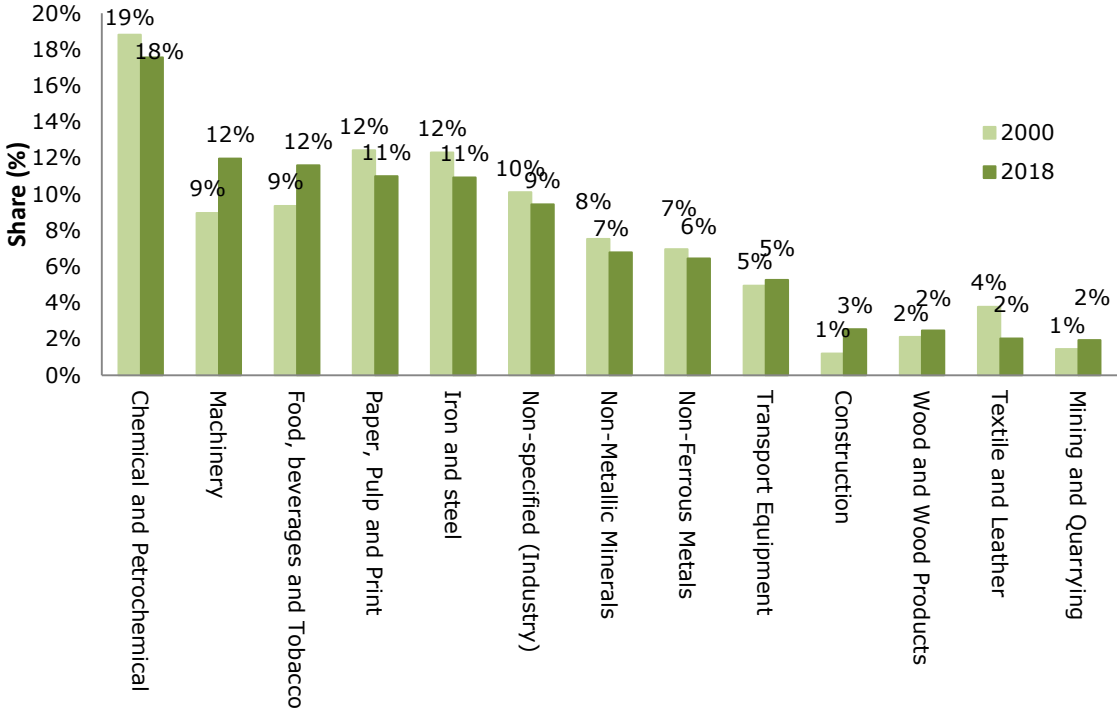
	Final Energy (ktoe)		Growth Rate (%)	Share in %		Change of shares
	2000	2018	2000-2018	2000	2018	2000-2018
Manufacturing	323,291	271,352	-16.1%	96.9%	95.3%	-1.7%
Iron and Steel	67,124	48,996	-27.0%	20.1%	17.2%	-2.9%
Non-Ferrous Metals	11,497	10,591	-7.9%	3.5%	3.7%	0.3%
Chemical and Petrochemical	59,501	52,605	-11.6%	17.8%	18.5%	0.6%
Non-Metallic Minerals	44,739	36,189	-19.1%	13.4%	12.7%	-0.7%
Food and Tobacco	30,922	30,509	-1.3%	9.3%	10.7%	1.4%
Textile and Leather	10,855	4,258	-60.8%	3.3%	1.5%	-1.8%
Paper, Pulp and Print	35,229	33,762	-4.2%	10.6%	11.9%	1.3%
Transport Equipment	9,478	8,671	-8.5%	2.8%	3.0%	0.2%
Machinery	19,607	19,663	0.3%	5.9%	6.9%	1.0%
Wood and Wood Products	6,497	8,766	34.9%	2.0%	3.1%	1.1%
Other industries (Rubber, Plastics)	27,842	17,342	-37.7%	8.4%	6.1%	-2.3%
Mining and Quarrying	3,663	3,809	4.0%	1.1%	1.3%	0.2%
Construction	6,623	9,737	47.0%	2.0%	3.4%	1.4%
Industry Total	333,576	284,897	-14.6%			

Source: Eurostat

Figure 153 and Figure 154 analyse electricity and natural gas consumptions¹⁴⁹ in the different industry subsectors. Chemical and Petrochemical registered the highest electricity consumption in 2018 with a consumption of 184 TWh accounting for 17.6% of the industry final electricity consumption. It was followed by Machinery (126 TWh; 12.0%), Food, beverages and Tobacco (122 TWh 11.6%) and Paper, Pulp and Print (116 TWh; 11.0%). In 2000, Chemical and Petrochemical was the main electricity consumer (200 TWh), followed by Paper, Pulp and Print (132 TWh), and Iron and Steel (130 TWh).

¹⁴⁹ Electricity and natural gas consumption per industry subsector have been studied using the new methodology Eurostat tables for energy balances based on the availability of the data.

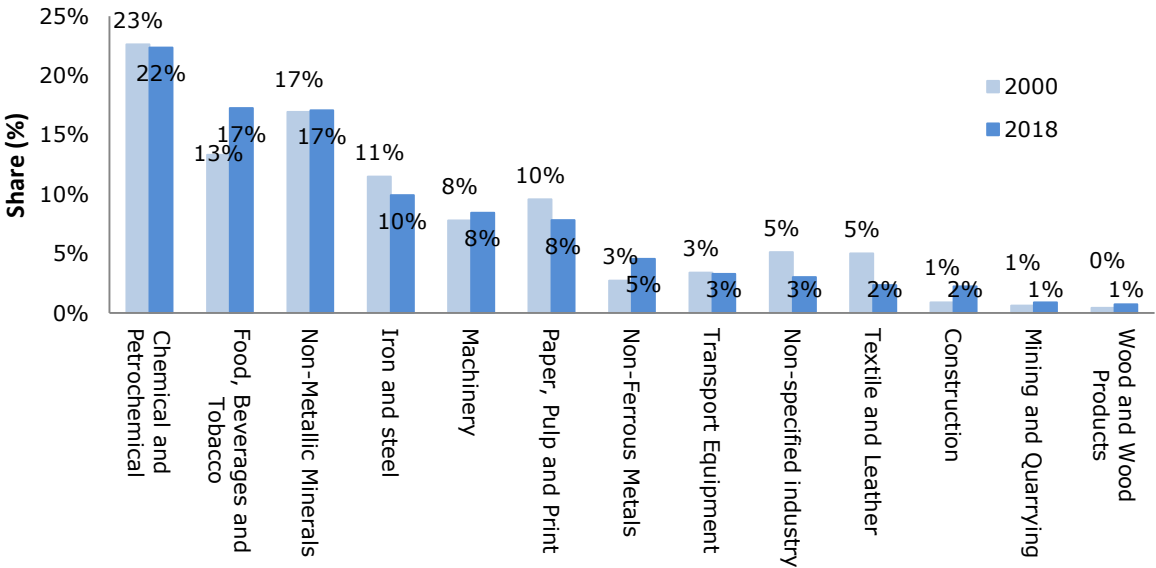
Figure 153: Industry sector: share of electricity consumption by industry subsectors, 2000 and 2018



Source: Eurostat

In 2018, the Chemical and Petrochemical manufacturing subsector was the main natural gas consumer with 22.4% (18,619 ktoe) of the share over the total final natural gas consumption. Food, beverages and Tobacco was the second natural gas consuming subsector (17.3%; 14,382 ktoe) followed by Non-Metallic minerals (16.1%; 14,215 ktoe), and Iron and Steel (9.9%; 8,265 ktoe).

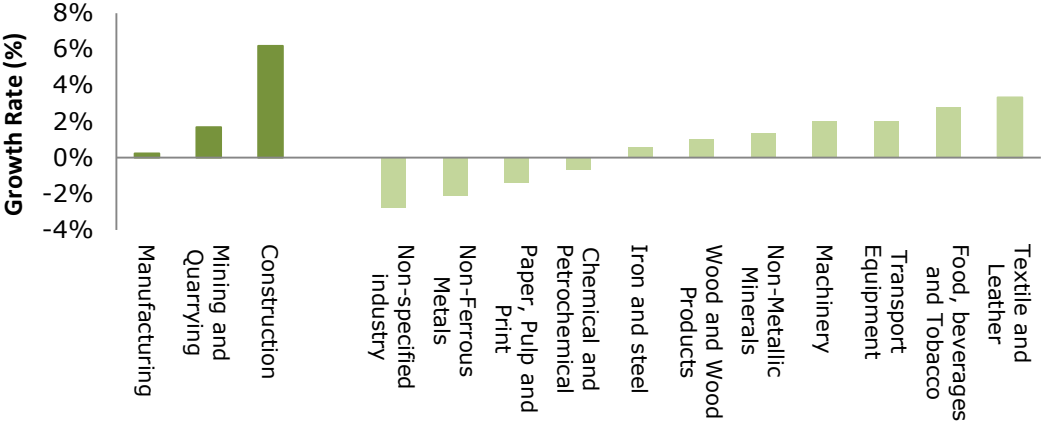
Figure 154: Industry sector: share of natural gas consumption by industry subsectors, 2000 and 2018



Source: Eurostat

Figures 155 shows the electricity consumption growth rates in the industrial and manufacturing subsectors for the last two years analysed in the report (2017 and 2018). Four subsectors registered decreases in 2018. Non-specified industry registered the highest reduction rate (- 2.8%). Textile and leather registered the largest increase (by 3.3%) among the manufacturing subsectors while Construction registered the largest increase (by 6.2%) among the overall industrial subsectors.

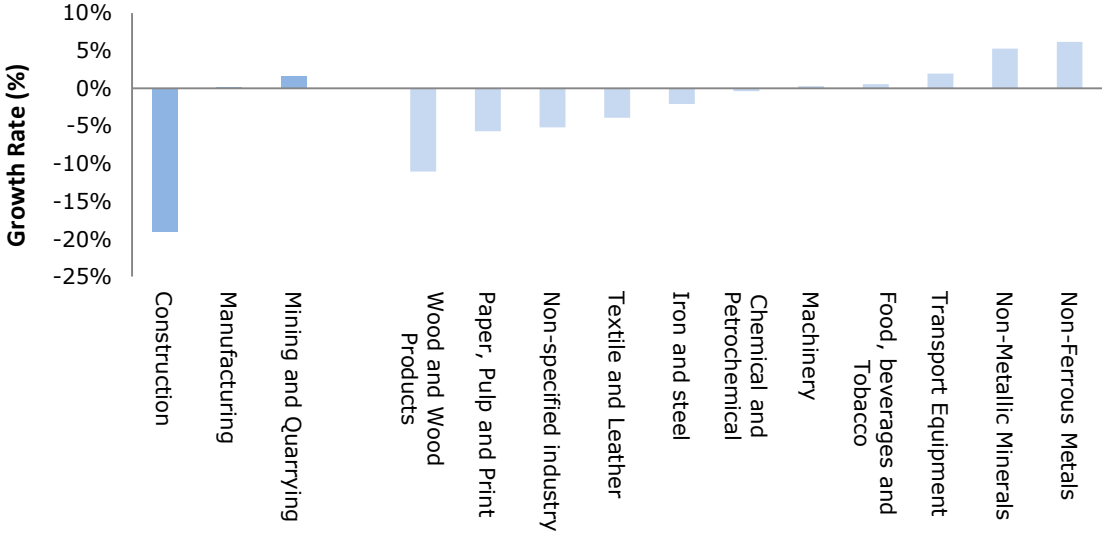
Figure 155: Growth rates in industrial and manufacturing subsectors in the EU-28, 2017 and 2018



Source: Eurostat

Figure 156 shows the natural gas consumption growth rates in the industrial and manufacturing subsectors in the two-year period 2017-2018. All the industrial subsectors registered increases in 2018 except Construction which experienced a decrease by 19.08%. Among the industrial subsectors the Mining and Quarrying subsector recorded the largest increase (by 1.6%) while Manufacturing subsector remained almost stable (increased by 0.2%). As regards the Manufacturing subsectors, the largest increase is observed in Non-ferrous metals (6.1%) while the highest reduction rate is observed in Wood and Wood Products (11.1%).

Figure 156: Final natural gas consumption in Construction and Mining and Quarrying in the EU-28, 2017 and 2018



Source: Eurostat

Table 9 provides an overview of the changes between years 2000 and 2018 regarding the final electricity and natural gas consumption in the different industry subsectors.

Absolute values of final natural gas and electricity consumption are also presented for both years.

Manufacturing, among the three main subsectors, is the only subsector which has registered decreases in electricity consumption (-2.8%) and in natural gas consumption (-19.5%) over the period 2000-2018. Among the manufacturing subsectors, Textile and Leather has registered the highest reduction rates for electricity and natural gas (-47.0% and -61.6% respectively). To be noted the increases of 108.5% and 101.9% in the electricity and natural gas consumptions respectively in the Construction subsector during the period 2000-2018.

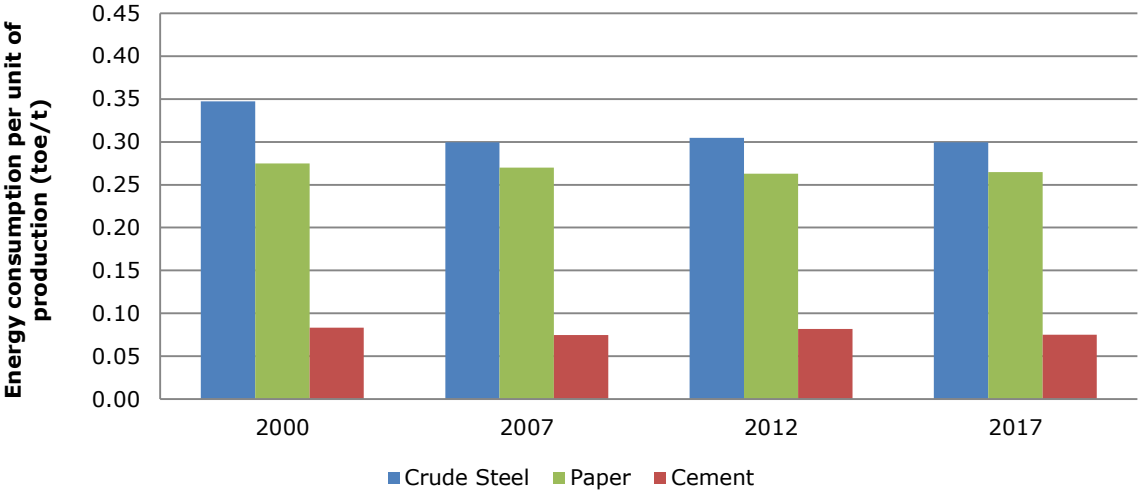
Table 9: Growth rates of final electricity and natural gas consumptions in industry subsectors, 2000 and 2018

	Final Electricity (GWh)		Growth Rate (%)	Final Natural Gas (ktoe)		Growth Rate (%)
	2000	2018	2000-2018	2000	2018	2000-2018
Manufacturing	1,031,725	1,002,458	-2.8%	100,193	80,702	-19.5%
Iron and Steel	130,373	114,737	-12.0%	11,681	8,265	-29.3%
Non-Ferrous Metals	73,815	67,701	-8.3%	2,771	3,814	37.64%
Chemical and Petrochemical	199,455	184,311	-7.6%	23,009	18,619	-19.1%
Non-Metallic Minerals	79,809	71,201	-10.8%	17,220	14,215	-17.5%
Food and Tobacco	99,119	121,802	22.9%	13,559	14,382	6.1%
Textile and Leather	40,157	21,266	-47.0%	5,118	1,966	-61.6%
Paper, Pulp and Print	131,760	115,459	-12.4%	9,752	6,515	-33.2%
Transport Equipment	52,551	55,219	5.1%	3,466	2,743	-20.9%
Machinery	95,008	125,698	32.3%	7,927	7,040	-11.2%
Wood and Wood Products	22,398	25,999	16.1%	456	611	33.8%
Other Industries	107,281	99,067	-7.7%	5,232	2,532	-51.6%
Mining and Quarrying	15,368	20,480	33.3%	630	746	18.4%
Construction	12,787	26,659	108.5%	925	1,867	101.9%
Industry Total	1,059,880	1,049,597	-1.0%	101,748	83,31	-18.1%

Source: Eurostat

An indicator commonly 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 indicator is calculated by Odyssee Database. This ratio is shown for three main industrial products in EU-28 based on the availability of data: steel, cement and paper. Overall, this parameter shows decreased values for the studied years with the largest decrease observed in crude steel (decreased by 13.8% from 2000 to 2017) reaching the value of 0.230 toe/t. In 2017, the energy consumption per ton of paper was 0.265 toe/t, representing a drop of 3.8% in comparison to the year 2000. Among the three analysed products, paper showed the highest ratio over the whole period, as illustrated in Figure 157. In 2017, the production of one tonne of cement consumed 0.075 toe/t on average in EU-28. It has reduced its ratio of energy consumed per unit of production by 9.74% during the analysed period.

Figure 157: Average energy consumption per tonne of produced crude steel, cement and paper in EU-28, 2000, 2007, 2012, 2017



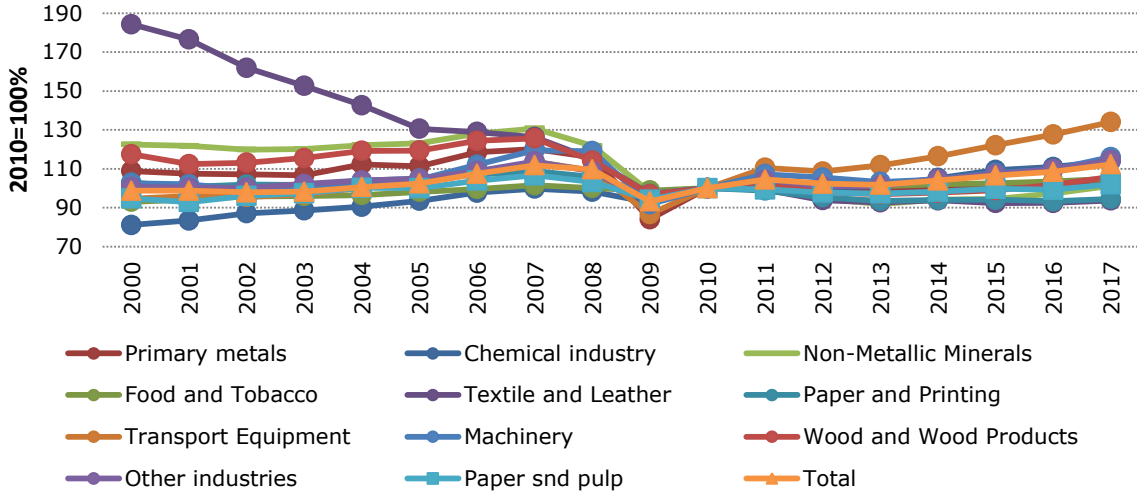
Source: Odyssee

Industrial Production Indexes (IPIs)¹⁵⁰ allow measuring changes in the industry's output. Figure 158 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 almost continuously decreasing since 2000 and has accumulated a 49.2% drop till 2017. The most stable manufacturing subsector is Food and Tobacco with yearly growth rates between -0.5% and 2.3%. To note, that all the manufacturing industries present positive annual growth rates from 2016 to 2017, with the highest one registered in machinery (5.8%) while the lowest one in food and tobacco (1.2%).

¹⁵⁰ The production index by sub-sector is the most common indicator used to measure the industrial output; it is usually measured in relation to a base year (e.g. index base 100 in 2005 for instance) or in relation to the previous year. It is well covered in national statistics. This index usually measures the changes in the volume of physical production: it is calculated from index of change in physical production at a very detailed level (4 to 5 digits) measured with different units (e.g. number of litres of milk processed, of tons of meat produced for the food industry) and aggregated at the branch level (e.g. food) into a production index on the basis of the weight of each sub-branch in the value added of the branch in the base year (2005).

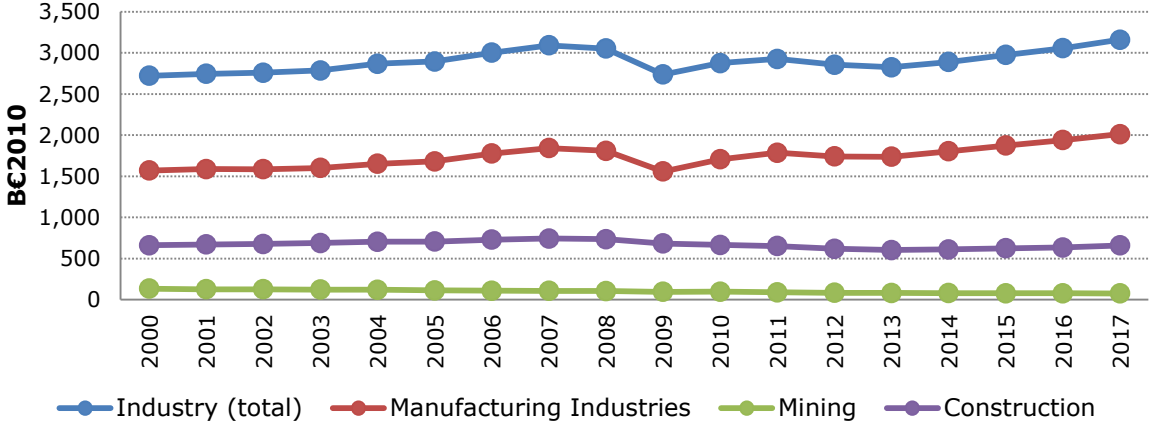
Definition by Odyssee [16]

Figure 158: Industrial Production Indices of Manufacturing Industries, (2010=100%), 2000-2017



Source: Odyssee

Figure 159: Added value per industrial subsector, in the EU-28, 2000-2017

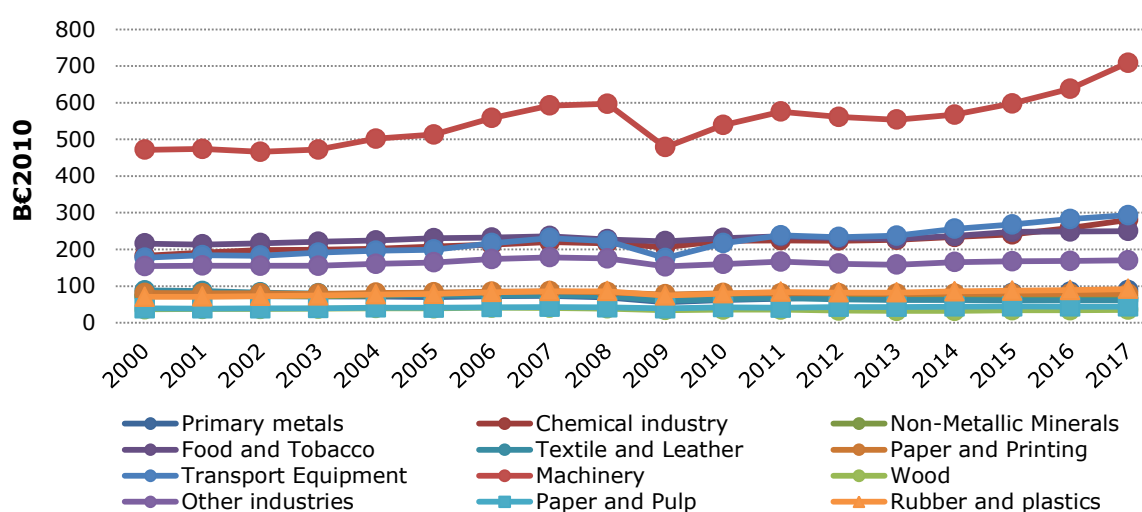


Source: Odyssee

According to Odyssee Database, the industry sector added value to GDP has risen by 16.1% in the period 2000-2017. This figure includes Manufacturing Industries, Mining, Construction and Energy sector. Among the analysed industry subsectors¹⁵¹, Manufacturing industries have increased their added value by 28.1%, while Construction and Mining industries have decreased their contribution by 0.4% and 43.4% respectively in the previously mentioned time period. Within manufacturing industries the highest growth rates in the value added are found in Transport Equipment (65.6%), Chemical (53.8%), and Machinery (50.3%). On the other hand, the manufacturing industries with the highest reduction rates are Textile and Leather (-30.6%) and Wood (-4.3%). Machinery subsector is the largest contributor to the GDP added value among the manufacturing industries. Its contribution (708,750 M€) more than doubles the second ranked industry subsector (Transport Equipment) which contributes with 293,128 M€.

¹⁵¹ Energy subsector is not analysed as an industrial subsector in this report.

Figure 160: Added value per manufacturing subsector in the EU-28, 2000-2017



Source: Odyssee

Table 10 provides an overview of the industrial production indices and value added to GDP for the different industry subsectors for years 2000 and 2017.

Table 10: Industrial Production Indices and Value Added to GDP for Industry Subsectors,¹⁵² 2000 and 2018

	Industrial Production Index (2010=100%)		Change of Production Index	Value Added to GDP (MC2010)		Change of shares
	2000	2017	2000-2017	2000	2017	2000-2017
Manufacturing	99	108	9.8%	1,569,570	2,010,778	28.1%
Primary metals	109	104	-4.9%	72,228	88,532	22.6%
Chemical industry	81	114	40.6%	182,259	280,351	53.8%
Non-Metallic Minerals	123	101	-17.4%	72,365	69,990	-3.3%
Food and Tobacco	93	105	12.7%	216,135	250,002	15.7%
Textile and Leather	184	94	-49.2%	88,285	61,313	-30.6%
Paper and Print	103	95	-8.1%	81,312	79,127	-2.7%
Transport Equipment	95	134	41.7%	177,040	293,128	65.6%
Machinery	103	116	13.1%	471,589	708,750	50.3%
Wood	118	106	-9.9%	36,804	35,230	-4.3%
Paper and Pulp	95	102	7.6%	39,193	44,006	12.3%
Rubber and plastics	na	na		70,648	91,821	30.0%
Other industries	101	114	13.6%	154,649	169,958	9.9%
Mining	137	77	-44.2%	135,584	76,779	-43.4%
Construction	102	101	-0.7%	662,800	660,199	-0.4%
Industry Total	99	107	7.3%	2,721,114	3,158,806	16.1%

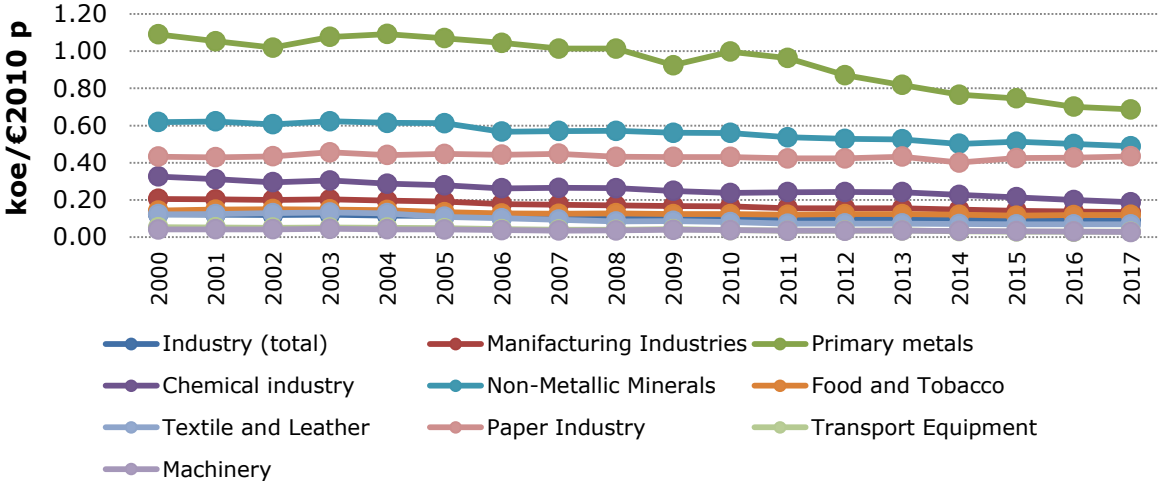
Source: Odyssee

Table 10 shows that the Textile and Leather manufacturing subsector is the subsector with the highest decrease in the industrial production index (-49.2%)¹⁵³. This is probably

¹⁵² Total industry includes also energy industries.

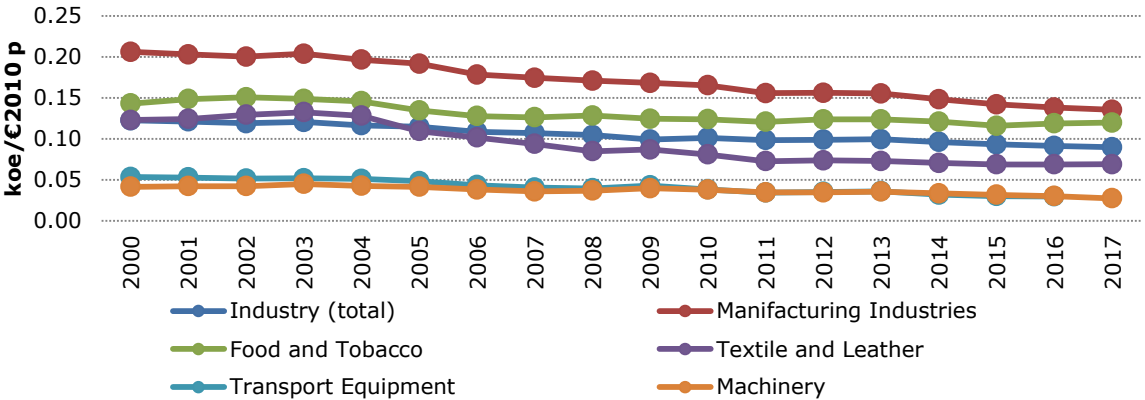
mostly due to the European textiles and clothing industry outsourcing and delocalization of production in non-EU countries, in the last years. Lower wages, together with a high proportion of entry-level jobs for unskilled personnel, ease of transport and relatively low investment costs are probably the main drivers of these decisions.

Figure 161: Energy intensity¹⁵⁴ per industry subsector in the EU-28 (GDP at purchasing power parities), 2000-2017



Source: Odyssee

Figure 162: Energy intensity per industry subsector in the EU-28 (GDP at purchasing power parities), 2000-2017 (expanded)



Source: Odyssee

Energy Intensity of the industry sector was 0.090 koe/€2010 in 2017, representing a drop of 26.8% in the period 2000-2017. The overall trend is a decreasing trend for all the industry subsectors during the mentioned period with the exception of Paper Industry which remain almost stable (with a growth rate of 0.2%). It can be observed that Textile and Leather and Transport Equipment are the subsectors where the biggest changes have taken place as they have reduced their energy intensity by 43.7% (from 0.123

¹⁵³ 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 [19]:

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

¹⁵⁴ The energy intensity of industry is the ratio between the final energy consumption and the value added at constant price in purchasing power parities. [16]

koe/€2010 in 2000 to 0.069 koe/€2010 in 2017) and 44.5% (from 0.054 koe/€2010 in 2000 to 0.030 koe/€2010 in 2017) respectively.

6.3 Overview – Industry sector

The industry sector accounted for around the one quarter of the EU-28 total final energy consumption in the year 2018. It was the second energy consuming sector after transport.

Industry final energy consumption has experienced a notable decrease during the studied period (-14.6%), the largest among the studied end-use sectors. The maximum annual consumption of this period took place in the year 2003 while the minimum occurred in 2009. Although the overall decreasing trend, some low positive annual growth rates have been observed during the last three studied years.

The highest growth rates have been observed in Latvia, Lithuania and Hungary. The highest reduction rates over the period 2000-2018 have been observed in Cyprus, in Greece and in the United Kingdom.

In 2018, the Member State with the highest consumption in the industry sector was Germany followed by France and Italy. These three States together with the United Kingdom accounted for more than 49% 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, natural gas and electricity were the main energy types consumed in 2018. These two fuel types represented together over 65% of the total final energy consumption in EU-28. However, renewables and biofuels and heat have enlarged their contributions in absolute value compared to 2000. On the other hand, oil and petroleum products, electrical energy, natural gas and solid fossil fuels and other have reduced the absolute value of their contributions.

Industry sector was the main electricity consumer and the second natural gas consumer in 2018.

The industry electricity consumption in the EU-28 has fallen very slightly from 2000 to 2018 (-1.0%). However, from 2015 to 2018 slight but a continuous increase has been registered. The highest electricity consumption growth rate over the period 2000-2018 have been experienced by Hungary. The Member State with the highest reduction rate was the United Kingdom.

EU-28 natural gas consumption in industry has fallen significantly in the period 2000-2018 (-18.1%) while it remained almost stable from 2017 to 2018 (-0.4%). The Member State with the highest growth rates in was. On the other hand, the EU-28 country with the highest reduction rates was Italy.

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 Non-Specified Industry.

Manufacturing was the only subsector to register a final energy consumption drop over the period 2000-2018 (-16.1%). Among the Manufacturing subsectors, the highest final energy consumption in 2018 has been registered in the Chemical and Petrochemical subsector followed by Iron and Steel and Non-metallic minerals.

The manufacturing subsector with the highest growth rate for the period 2000-2018 was Wood and Wood Products (+34.9%) while the manufacturing subsector with the highest reduction rate for the same period was Textile and Leather(-60.8%).

In 2018, Chemical and Petrochemical manufacturing industry was the industry subsector with the highest electricity and natural gas consumptions.

When analysing the Industrial Production Indexes (IPIs) of the different manufacturing industries for the period from 2000 to 2017, 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 almost continuously decreasing since 2000 and has accumulated a very significant drop till 2017 (-49.2%). The most stable manufacturing subsector is Food and Tobacco. All the manufacturing industries present positive annual growth rates from 2016 to 2017.

The industry sector added value to GDP has risen importantly in the period 2000-2017 (+16.1%). Among the industry subsectors, in the same period, Manufacturing industries have increased their added value while Construction and Mining Industries have decreased their contributions.

Regarding the economic contribution of manufacturing industries to the GDP, Machinery subsector is the largest contributor. The second one is Transport Equipment.

The Energy Intensity of the industry sector has instead dropped remarkably in the period 2000-2017 (-26.8%). Overall we observe a decreasing trend in all the industry subsectors during the mentioned period with the exception of Paper Industry. Textile and Leather and Transport Equipment are the subsectors where the biggest changes have taken place.

7 Conclusions

This report described and analysed the energy consumption patterns in the EU-28 for the period 2000-2018. Such analysis provides insights about the impact and effectiveness of policies aimed at promoting energy efficiency in the EU. The results show that EU inland gross energy consumption, primary energy consumption, and final energy consumption have declined from 2000 by 4.7%, 4.2%, and 0.8% respectively. Looking at the individual sectors covered by the report, it was shown that the largest decline of final energy consumption was registered in industry (-14.6%), followed by the residential sector (-4.5%). Transport sector, on the other hand, registered an increase in consumption (10.8%), whilst the tertiary sector experienced the largest growth (20.2%). Energy indicators such as energy intensity of final energy and final energy per capita dropped during the analysed period, by 23.6% and 5.7% respectively. This can be interpreted as a possible sign of a higher competitiveness of the EU as a global actor.

Table 11: Overview of energy consumption in the EU-28, 2000-2018

	2000		2018		Growth Rate
					2000-2018 (%)
Inland Gross Energy Consumption (Mtoe)	1,732		1,651		-4.7%
Primary Energy Consumption (Mtoe)	1,620		1,552		-4.2%
Total Primary Energy Consumption per capita (toe/cap)	3.32		3.03		-8.9%
Energy Intensity - Primary Energy (toe/1,000 Euro)	0.15		0.11		-26.2%
Final Energy Consumption (Mtoe)	1,133		1,124		-0.8%
Final Energy Consumption per capita (toe/cap)	2.33		2.19		-5.7%
Energy Intensity - Final Energy (toe/1,000 Euro)	0.10		0.08		-23.6%
	2000		2018		Growth Rate
					2000-2018 (%)
	FEC (ktoe)	Share (%)	FEC (ktoe)	Share (%)	
Residential Sector	291,270	26.7%	278,121	25.5%	-4.5%
Tertiary Sector	121,714	11.2%	146,328	13.4%	20.2%
Transport Sector	344,320	31.6%	381,511	35.0%	10.8%
Industry Sector	333,576	30.6%	284,897	26.1%	-14.6%

Source: EC DG-JRC

The main findings and results of the report for the period from 2000 to 2018 are:

In 2018 the EU-28 **final energy consumption remained almost stable compared to the previous year**, by registering a value of 1,124 Mtoe. As a result, the final energy consumption in 2018 exceeded slightly the 2020 EU-28 target (1,086.0 Mtoe) with a gap of +3.5%. Despite this increase, the level of consumption in 2018 remained below the average of the last studied period (2000-2018).

In 2018 **primary energy consumption decreased slightly (by 0.7%) compared to the previous year**, registering a value of 1,552 Mtoe after three following years of positive growth rates. However, it remained above the 2020 target (1,483 Mtoe). The primary energy gap to the target was +4.7% in 2018 versus a gap of +5.4% in 2017.

Extending the timeline to 2030, the 2018 gap to the future 2030 targets are +21.9% for primary energy consumption and +17.6% for the final energy consumption, highlighting the need of intensified policy and technological efforts in the next decade.

The transport and the tertiary sector experienced a growth in final energy consumption over the analysed period while final energy consumption in the residential and industry sectors declined.

EU has reduced its final energy intensity by 23.6% over the period 2000-2018 by reaching a value 0.08 toe/thousand Euro in 2018. Energy consumption per capita remained stable in 2018, thereby reflecting the dynamics of final energy consumption.

Overall, the current final energy consumption trends showed 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.

A possible economic growth of the most recent years that can be proved by the increase of GDP and of adjusted disposable income, may have led to the increase in many energy consumption in the last three years (2015-2018). However the increase in energy consumption is not of the same magnitude as the economic development.

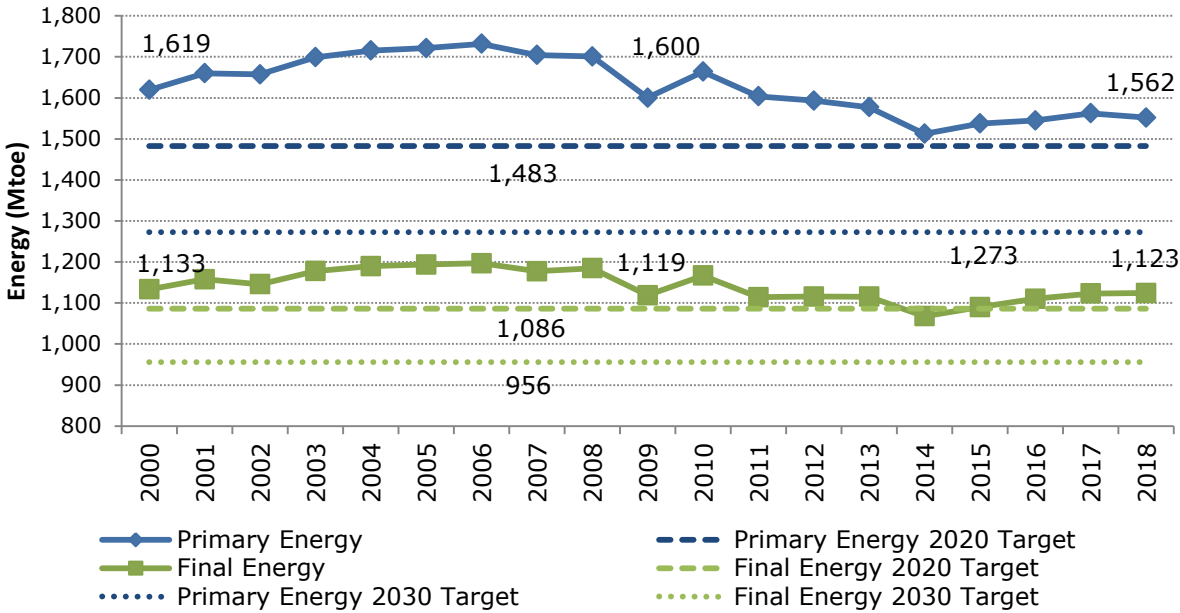
The climatic conditions is an important factor influencing the final energy consumption values especially in residential and tertiary sectors, that's why climatic corrected data has been used in the report.

Despite the economic growth (GDP per capita, adjusted disposable income increase), the climatic conditions and the increase of population, final energy consumption is still close to achieve the 2020 target and below the 2000 levels.

Four Member States (i.e. Germany, France, the United Kingdom and Italy) consumed over 54% of the final energy consumption and fourteen Member States (half of the EU Member States) consumed less than 9% of the total final energy consumption in 2018. Different energy consumption growth rates by Member States reflect national-specific energy-related scenarios and national policy efforts.

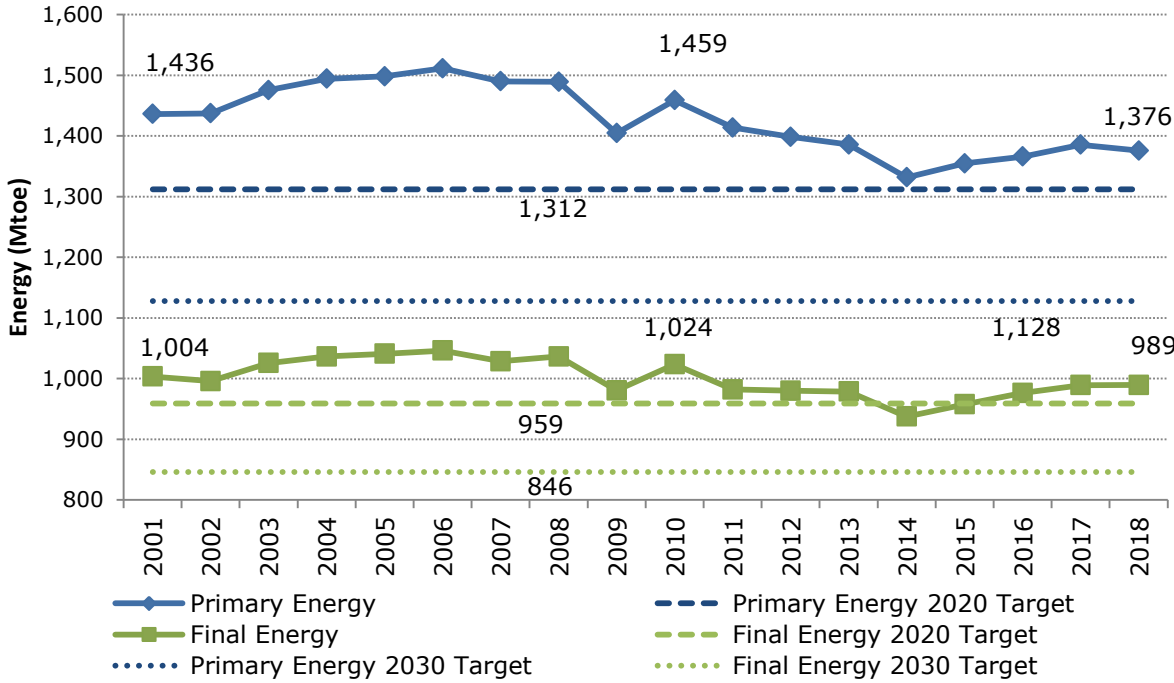
Oil and petroleum products, natural gas and electricity still represent the main energy sources. However, there is a gradual decrease in the use of petroleum products and natural gas and at the same time an increase in the use of electricity and renewables, including biofuels. The first is possibly the result of the electrification trend, especially in residential and service sectors while the second is probably the result of the implementation of European and national legislation for the promotion of the use of alternative energy sources.

Figure 163: Energy consumption trends with 2020 EU-28 energy targets, 2000-2018



Source: Eurostat

Figure 164: Energy consumption trends with 2020 EU-27 energy targets, 2000-2018



Source: Eurostat

At this stage, it is important to note that the necessary adjustment in the targets following the withdrawal of the United Kingdom from the EU. The 2018 gaps to the

revised 2020 targets¹⁵⁵ seem similar to the initial ones: +4.9% for primary energy consumption and +3.2% for final energy consumption.

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 4.5% in the period from 2000 to 2018.

The residential energy consumption depends on many variables: heating degree days, population, GDP, adjusted disposable income, number of dwellings, total floor area, average number of people per household, energy prices. Different combinations of these variables were used in order to assess whether the decreasing trend over the analysed period in residential energy consumption are still there after correcting for these factors. After correcting for population heating degree days together, there was still reduction in the residential consumption. The GDP is an important variable to consider as it has grown significantly over the covered period. Combinations of the effect of GDP per capita and HDD; energy consumption analysis per dwelling (per square meter); and residential consumption per capita, for HDD, GDP per capita and square meters all return similar results: although the increase in HDDs, the growth of GDP per capita values, and the raise of population, the final residential energy consumption has experienced a gradual decrease in the analysed period.

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

In 2018, the residential sector represented 24.7% of the final energy consumption in the EU, being the third consuming sector after transport sector and industry.

After the lowest value (over the period 1990-2017) registered in 2014, in 2015 and in 2016 final residential energy consumption values increased compared to the previous years. This trend stopped in 2017 when consumption decreased while it decreased even more in 2018.

In 2018, final residential energy consumption has declined by 1.6%.

The energy mix in the residential sector is mainly formed by natural gas (36.2%) and electricity (24.6%) consumption.

The final residential electricity consumption increased by 13.0% in the EU-28 during the 19-year period 2000-2018. This is possibly the result of the increase in the use and number of electric domestic appliances with more advanced features, requiring higher electricity demand.

The final residential natural gas consumption dropped by 5.6% between 2000 and 2018.

The residential sector was the third electricity consumer (28.8%) and the main natural gas consumer (42.8%) among the analysed sectors in 2018.

The weather and climatic conditions have an impact on residential energy consumption. The results show that the colder the year, the higher the energy consumption. There has been a positive correlation between the final energy consumption (also in the electricity and natural 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.

¹⁵⁵ "A technical adaptation of targets results in a primary energy consumption of no more than 1,312 Mtoe in 2020 and 1,128 Mtoe in 2030 and a final energy consumption of no more than 959 Mtoe in 2020 and 846 Mtoe in 2030." Source: Eurostat, statistics explained (https://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_saving_statistics)

In the EU, there has been a declining trend in the size of the households in terms of persons per household over the period 2009-2018, which might lead to a future increase in the residential energy consumption per capita.

Energy consumption per household and energy consumption per dwelling may be considered as reference variables to compare and analyse trends at residential level.

Energy prices went up in the EU. Electricity has grown by 38.3% (up to EUR 0.211/kWh) and natural gas by 30.9% (up to EUR 0.067/kWh) between the second semester of 2007 and the second semester of 2018.

The main use of electricity in residential sector is associated with lighting and appliances while the main use of natural gas with the space heating.

The disposable income of households or adjusted gross disposable income can represent a more appropriate economic indicator in the analysis of the residential energy consumption compared to the GDP per capita.

Tertiary Sector

The tertiary sector (commercial and public services) registered an increase in the final energy consumption by 20.2% in the period from 2000 to 2018.

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

The final energy consumption decreased in 2018 (by 1.4% compared to 2017) after three continuous years of growth. However, consumption remains enough above the 2000 levels.

Despite of the continuous increase in Gross Value Added of the tertiary sector, the final energy consumption has recorded a decrease in 2018.

The energy mix in the tertiary sector is mainly formed by electricity (47.0%), natural gas (30.5%) and oil and petroleum products (8.7%) consumption. Renewables and biofuels have increased their shares compared to 2000.

The final tertiary electricity consumption has grown (by 30.6%) in the EU-28 during the 19-year period 2000-2018. This is probably the result of the significant development of ICT sector, the big data centres and the general electrification trend observed in tertiary sector.

The final tertiary natural gas consumption has increased (by 34.5%) between 2000 and 2018, following the development of the sector and the final energy consumption trends.

The tertiary sector was the second electricity consumer (29.5%) and the third natural gas consumer (19.3%) among the analysed sectors in 2018.

The tertiary energy consumption in the tertiary sector is expected to increase in the following years as per the on-going EU tertiarization trend.

The tertiary sector registered the highest growth rate among the analysed sectors over the analysed period, but it also accounts for the largest share of gross value added in EU-28 in 2018 (74.0%).

Weather and climate conditions are an important 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 natural gas consumption) are of positive correlation, indicating the impact of comfort conditions on consumption.

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 10.8% in the period from 2000 to 2018.

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

The transport sector has the highest share in final energy consumption, accounting for 33.9% in the year 2018.

Energy consumption has increased during 2000-2007, followed by a decrease till 2013. The decline in energy consumption may be the result of the impact of the financial and economic crisis as well as higher fuel prices and more efficient vehicles.

From 2014 onwards, energy consumption started rising again in the context of higher growth of transport activity and lower fuel prices environment. In 2018 the transport energy consumption increased by 1.1% compared to 2017.

Petroleum products represented about 93.2% of final energy demand in the transport sector in 2018.

Electricity only contributed 1.4% of the energy demand and natural gas 0.9%. Renewables and biofuels contributed 4.4% of transport final energy demand (significant larger percentage compared to year 2000).

Road transport provides the highest share of final energy demand in the sector (80.4% in 2018). Road transport is highly dependent on petroleum products, and diesel represented about 66.8% of the energy use in 2018 in the road transport.

Biofuels use steadily increased between 2000 and 2018. Biodiesel represented (pure and blended) around 88.2% of the total biofuels consumption in 2018, followed by biogasoline (pure and blended) (9.5%) and biogas (2.3%).

Energy consumption per car has declined by 21.8% from 2000 to 2017¹⁴⁹. The average annual distance travelled by car also experienced a decreasing trend during the same period. Cars have been estimated to account for about 56.1% of the road transport energy consumption in 2017.

The CO₂ emissions regulation for new passenger cars and commercial duty vehicles contributed positively to the reduction in the average specific fuel consumption.

The renewal of the cars fleet will contribute to further reductions in the energy consumption as new passenger cars are more energy efficient.

Industry Sector

The industry sector registered a decrease in the final energy consumption by 14.6% in the period from 2000 to 2018.

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

The industry is the second in the ranking of the most energy consuming economy sectors, accounting for 25.3% of the EU-28 total final energy consumption in 2018.

Since 2008, industry has registered the lowest energy consumption levels in the 29-year period from 1990 to 2018. This may be result of financial and economic crisis as well as of the continuing deindustrialization.

However, in the last three years, industry experienced a slight increase in final energy consumption, with annual growth rates of just below 2.0%.

The industry sector was the main electricity consumer (37.3%) and the second natural gas consumer (34.7%) among the analysed economic sectors in 2018.

¹⁴⁹ 2018: data not available

The energy mix in the industry sector was mainly and evenly formed by electricity (29.8%) and natural gas (33.3%) in 2018.

Overall, the industry sector has reduced its final energy consumption due to a contraction of production. For instance, final energy consumption of non-metallic minerals (among the highest energy consuming subsectors in 2000) decreased by 19.1% and the decreased industrial production index (IPI) by 17.4% during the period 2000-2017.

The financial and economic crisis has further caused a drop in production output and contributed to the decrease in final energy consumption.

Overall both IPI and the industrial value added to GDP from 2000 to 2016 have registered a growth of 7.3% and 16.1%, respectively.

The IPI reduction has not been evenly registered across the industry subsectors. For instance, IPI of textile and leather subsectors has been continuously decreasing since 2000 and has accumulated a 49.2% drop till 2017. The most stable manufacturing subsector is food and tobacco.

Among the manufacturing subsectors chemical and petrochemical was the main final energy, electricity and gas consumer in 2018. Despite a negative growth rate in energy consumption (-11.6% from 2000 to 2018) it registered an increase in IPI (40.6%) and in the share of value added to GDP (53.8%)¹⁵⁷ over the period 2000-2017.

The machinery subsector has been the largest contributor to the GDP among the manufacturing subsector during the period from 2000 to 2017.

¹⁵⁷ Data for IPI and GDP have been found in Odyssee Database for "Chemical" subsector. Data for 2018 non available

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List of abbreviations

Country Codes:

BE	Belgium	LT	Lithuania
BG	Bulgaria	LU	Luxembourg
CZ	Czech Republic	HU	Hungary
DK	Denmark	MT	Malta
DE	Germany	NL	Netherlands
EE	Estonia	AT	Austria
IE	Ireland	PL	Poland
EL/GR	Greece	PT	Portugal
ES	Spain	RO	Romania
FR	France	SI	Slovenia
HR	Croatia	SK	Slovakia
IT	Italy	FI	Finland
CY	Cyprus	SE	Sweden
LV	Latvia	UK/GB	United Kingdom

EU-28: European Union Member States until January 2020

EU-27: European Union Member States after the withdrawal of UK

Unit of measures:

MTOE: Million Tonnes of Oil Equivalent

TOE: Tonnes of Oil Equivalent

kTOE: Thousand Tonnes of Oil Equivalent

KOE: Kg of Oil Equivalent

Gwh: Gigawatt hour

Twh: Terawatt hour

kwh: Kilowatt hour

Cap: per capita

Dw: dwelling

HH: Households

HDD: Heating Degree Days

CDD: Cooling Degree Days

Pop: population

Emp: per employee

Veh: per vehicle

Pkm: passenger kilometre

Tkm: Tonne kilometre

Indicators:

GDP: Gross Domestic Product

IPI: Industrial Production Index

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Annex

New methodology in energy balances of Eurostat

In order to allow comparison with Europe 2020 targets established prior to the actual methodology of energy balance, the indicators used to estimate gross inland consumption, primary and final energy consumption as well final energy consumption by sector are the ones calculated under the old methodology of Eurostat. This methodology was in place at the time of establishing the Europe 2020 targets. The old methodology indicators should be used also for tracking progress towards Europe 2030 targets.

The old methodology indicators used in this report are named as following in the current Eurostat datasets: Gross inland consumption (Europe 2020-2030), Primary energy consumption (Europe 2020-2030), Final energy consumption (Europe 2020-2030). The following arithmetic definition explained the correspondence between the old and the new methodology:

Gross inland consumption (Europe 2020-2030):

Gross inland consumption (Europe 2020-2030) [All products total] = + Gross inland consumption [All products total] – Gross inland consumption [Ambient heat (heat pumps)]

Numerically this aggregate can be also calculated in the following way:

Gross inland consumption (Europe 2020-2030) [All products total]= + Gross available energy [All products total] – Gross available energy [Ambient heat (heat pumps)] – International maritime bunkers [All products total]

This aggregate is calculated only for All products total.

Primary energy consumption (Europe 2020-2030):

This indicator reflects on the definition given in Article 2 of the Directive 2012/27/EU as well as the methodology of energy balances in place at the time of establishing the Directive and Europe 2020 targets.

Primary energy consumption (Europe 2020-2030) [All products total] = + Gross inland consumption (Europe 2020-2030) [All products total] – Final non-energy consumption [All products total]

This aggregate is calculated only for All products total.

Final energy consumption (Europe 2020-2030)

Final energy consumption (Europe 2020-2030) [All products total] = + Final energy consumption [All products total] – Final energy consumption [Ambient heat (heat pumps)] + International aviation [All products total] + Transformation input Blast furnaces [All products total] – Transformation output Blast furnaces [All products total] + Energy sector Blast furnaces [Solid fossil fuels] + Energy sector Blast furnaces [Manufactured gases] + Energy sector Blast furnaces [Peat and peat products] + Energy sector Blast furnaces [Oil shale and oil sands] + Energy sector Blast furnaces [Oil and petroleum products] + Energy sector Blast furnaces [Natural gas]

This aggregate is calculated only for All products total.

The final energy consumption breakdown by product is available only by the new methodology datasets.

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