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Energy Consumption and Energy Efficiency trends in the EU, 2000-2020

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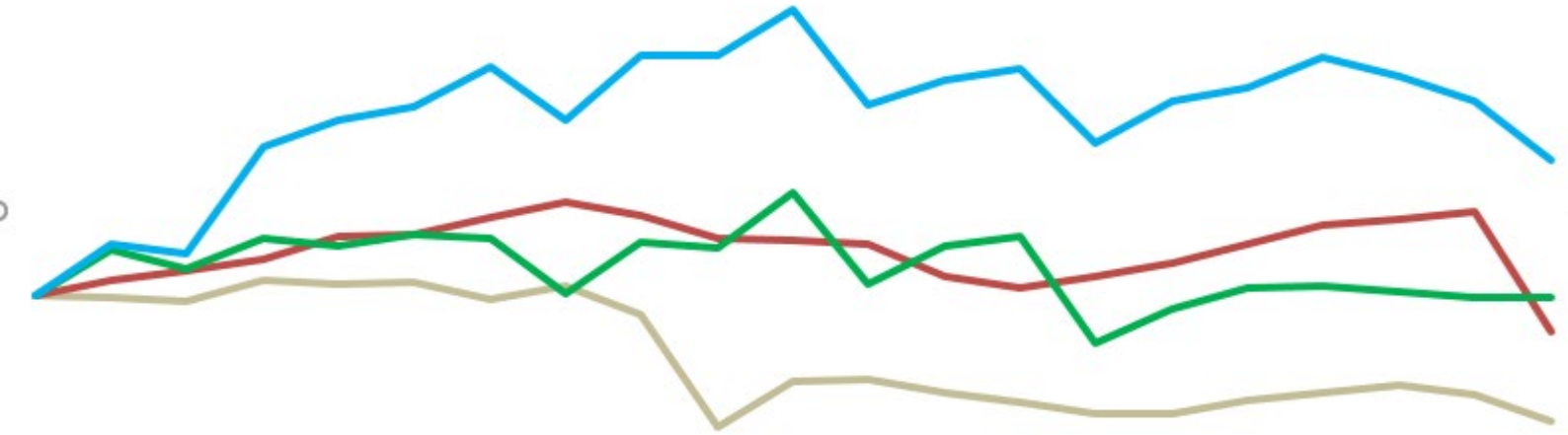

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Contents

Abstract

This report discusses the latest status of energy consumption trends in the EU, in the four main energy-consuming sectors: residential, tertiary, transport and industry. During the last years, there were 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 2020 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.

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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, tertiary, transport and industry. The main horizontal policies implemented at European level during the studied period 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 CO_2 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 2020, the European Union achieved a reduction in its total energy consumption by 11.5% in primary energy and 7.4% in final energy. This decrease was 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 as 2020 targets set in the EED were achieved in terms of primary and final energy in 2020[1], we have to consider the COVID-19 effect and the adopted measures like lockdowns and increase of teleworking that affected significantly the energy values. Final consumption decreased by 8.1% of 2020 in comparison to 2019 and primary energy consumption[2] decreased by 8.7% compared to 2019 achieving the 2020 primary target. In both cases (primary and final energy consumption), the highest levels in the studied period were registered in 2006 and the lowest ones in 2020. The financial and economic crises as well as the COVID-19 pandemic caused remarkable changes in the dynamics and consumption rates of the different economic sectors in the EU Member States. In contrast to other economic sectors[3], tertiary sector increased its final energy consumption over the analysed period (by 15.9%). The residential energy consumption declined by 0.1%, the transport consumption reduced by 4.2% and the industrial consumption reduced more significantly (by 14.7%). 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 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. COVID-19 pandemic and the adopted measures to face it (i.e. lockdown measures, increase of teleworking) as well as the economic recession caused by pandemic influenced importantly the trends in these sectors in 2020. On the other hand, the declining trend in industry was 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 was an important penetration of renewable energies during the analysed period. On the

[1] Due to changes in methodology in energy balances of Eurostat, the indicator "Final Consumption – energy use" (FC_E) 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) was 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.

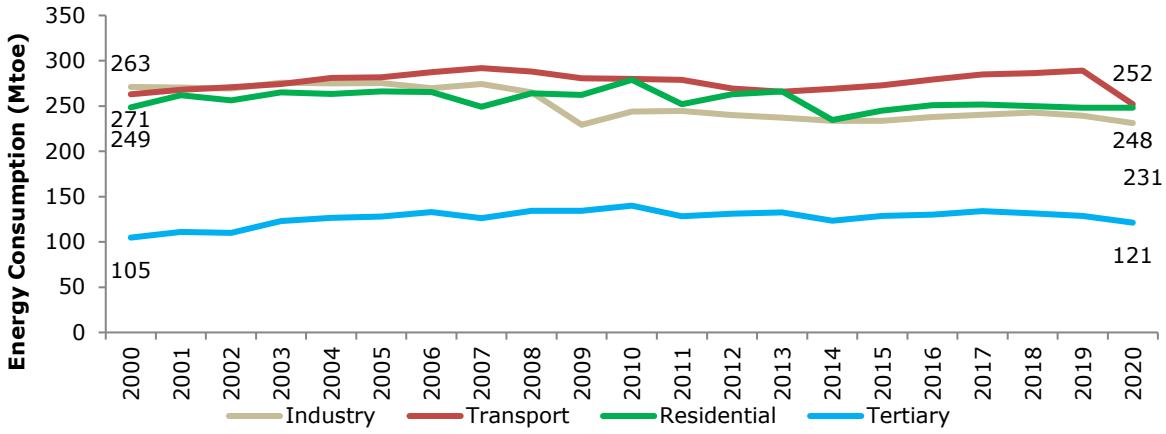
[2] In the same context with the previous note, the indicator "Primary energy consumption (Europe 2020-2030)" (PEC2020-2030) was used in this analysis. This indicator reflects on the definition given in Article 2 of the Directive 2012/27/EU as well as the methodology of energy balances in place at the 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 were analysed using the old methodology Eurostat tables in order to be comparable with the EU 2020 targets.

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 2000 to 2020, the lowest level of final energy consumption was observed in 2020. From 2015 onwards, we observed a rise in consumption that continued in 2016, 2017 and 2018. The trend begun to change in and dropped significantly in 2020 affected by COVID-19 crisis. When analysing the overall EU energy consumption trends, the individual consumption rates of the EU-27 Member States may not be representative. Four Member States (i.e. Germany, France, Italy and Spain) consumed over 50% of the final energy consumption (56.0%) and 13 Member States (half of the European Union States) consumed less than 10% (9.6%) of the total final energy consumption in 2020. Residential sectors registered an almost negligible slight increase (by 0.01%) in final energy consumption in 2020 compared to 2019, in contrast to the transport, industry and tertiary sectors which registered a drop of 12.8%, 3.4% and 5.6% respectively.



More analytically, in residential sector, final energy consumption remained stable in 2020 compared to 2019 and 2020 is one of the 3 years with the lowest final energy consumption values registered over the analysed period (2000-2020). From 2008 to 2019, the tertiary sector registered the highest energy consumption values for the period 2000-2019; with the exceptions of 2011 and 2014. However, the drop in 2020 make final energy consumption of the sector to return in levels of 2002-2003. From 2014 and onwards, transport 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 until 2019. The value in 2020 was clearly the result of limitations in transport activities as a measure to face COVID-19 pandemic. 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 2020 even though diesel and gasoline remain the main fuel types to date. The industrial final energy consumption was reduced in 2020.

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 updates on an annual. In the future, a more thorough analysis of each analysed economic sector and case studies of the EU 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, tertiary, transport and industry) in the EU for the period from 2000 to 2020. When 2020 data are not available, the most recent data (usually 2019) are instead discussed. The year 2010 was selected to divide the whole studied period in two equal sub periods (2000-2010, 2010-2020). 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 were efforts by the European Union to reduce energy consumption, and improve energy efficiency. However, the

effect of COVID-19 pandemic and the measures imposed to restrict it affected significantly the energy consumption trends in 2020. Despite this, this analysis is needed in order to evaluate whether and how the collective policy actions have influenced energy consumption in the context of 2020 EU energy targets.

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 to permit the comparison with 2020 targets (i.e. final and primary energy consumption 2030-2030 indicator). In these cases, these indicators were 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 were 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 growth[4].

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 consumption[5].

The EU has also set climate and energy targets for 2030[6][7]:

- 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 scenario[8]

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*[9] 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.[10] 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. In July 2021, European Commission presented the Fit for 55 Package that will enable the European Union to reduce its net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels and to achieve climate neutrality in 2050.

Many important EU directives and regulations to promote energy efficiency were 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 Less[11], where it was indicated the cost-effective potential supported by several studies.

In 2006, the Action Plan for Energy Efficiency[12] 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] European Commission proposes to revise this target based on Fit for 55 Package as follows: 55% reduction emissions, 40%, RES share, 36-39% energy efficiency target

[8] Business as Usual scenario modelled with Primes in 2007.

[9] COM(2010) 639

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

[11] COM(2005) 265

[12] COM(2006) 545

The Energy End-use Efficiency and Energy Services Directive[13] (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 was 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 NEEAP[14] 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 Directive[15] (EED), which was adopted in December 2012 and repealed the previous ESD. The EED contains a set of binding measures such as legal obligations to establish energy saving schemes in Member States, public sector to lead by example, energy audits, energy services, energy efficiency funds, efficient CHP, metering and billing information, consumer behaviour, etc.

One of the key articles of the Directive is Article 3, setting the target values for 2020 in terms of energy consumption: the Union's 2020 energy consumption has to be no more than 1,483 Mtoe of primary energy or no more than 1,086 Mtoe of final energy[16]. 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.

Energy Efficiency Directive is going to be revised again[17][18] to strengthen the efforts for achieving the 2030 target. European Commission proposed a revision in 2021 as part of the package "Delivering on the European Green Deal". The proposal gives emphasis in the 'energy efficiency first' principle of EU energy policy.

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 others the amendment of Energy Performance in Buildings and Energy Efficiency Directive[19]. 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.

[13] Directive 2006/32/EC
[14] The evaluation of the quality of NEEAPs and the saving reported is not in the scope of the present report.
[15] Directive 2012/27/EU
[16] 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.
[17] Source: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en
[18] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0558
[19] Source: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans

More analytically, the Clean Energy Package includes the new amended Directive on Energy Efficiency[20] 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 Action[21] 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 union[22] (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 Directive[23] (EPBD), which was introduced firstly in 2002 and then recast in 2010[24] and in 2018[25]. 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 also implemented other measures and instruments such as financial incentives to promote stimulate efficiency improvements in buildings. In 2018, the EPBD was amended[26]. 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. EPBD is going to be revised again[27] (a proposal was set by European Commission in 2021) with the aim of increasing the ambition in the context of Green Deal and 2050 goals for climate neutral EU. In addition, the Renovation Wave[28], as art of this strategy, will set a framework with regulatory and financial tools to reinforce building renovation.

Another important energy efficiency policy action at EU level was the introduction of minimum efficiency requirements for products. The Eco-design Directive[29] is the EU framework legislation that allows the introduction of energy efficiency requirements for energy related products such as residential appliances, lamps, consumer electronics, ICT equipment, etc. Since the first Eco-design Directive[30] was introduced a number of implementing Regulations were 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 others[31]. Efficiency requirements were complemented by mandatory energy labelling[32] as established in the Energy Labelling Regulation[33]. Energy labelling of residential equipment was first introduced in 1992[34], with the first energy label introduced in 1994 for refrigerators. Energy label contributed to enlarge the market for

[20] Directive (EU) 2018/2002
[21] Regulation (EU) 2018/1999
[22] More information on: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/building-energy-union
[23] Directive 2002/91/EC
[24] Directive 2010/31/EU
[25] Directive (EU) 2018/844
[26] Source: https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings
[27] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021PC0802
[28] Source: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en
[29] Directive 2009/125/EC
[30] Directive 2005/32/EC
[31] 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
[32] 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_enegy_labelling_measures.pdf
[33] Regulation (EU) 2017/1369
[34] Council Directive 92/75/EEC

efficient appliances[35] [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-27 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-27 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.

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

2 Gross, Primary and Final Energy Consumption in EU-27

Gross inland consumption[36] 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 consumption[37]. 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.[38] This report focuses 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[39]. 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.[40]

This chapter covers the gross inland, primary and final energy consumption in the EU-27 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 consumption rates in the EU-27 along the covered period.

2.1 Gross inland energy consumption

Gross inland consumption[41] in the EU-27declined from 1,498 Mtoe in 2000 to 1,326 Mtoe in 2020. Figure 1 shows how gross inland consumption and final energy consumption have evolved from 2000 onwards. It can be seen that both declined. Final energy consumption (907 Mtoe) represented the 68.4% of the gross inland consumption in 2020. That means that a large share of energy equal to 31.6% is consumed during the process of the energy transformation and delivery to end-users. This share slightly dropped compared to 2000, when it was 34.6%. Looking at these data is important for understanding the efficiency of the entire energy system.

The gross inland consumption in the EU-27 reached a maximum of 1,616 Mtoe in year 2006. A significant drop of 5.9% took place in 2009 in comparison with 2008, followed by a rise of in 2010. From 2010 to 2014, a decreasing trend can be observed (Figure 2). This was inversed until 2017 and since then gross inland consumption continuously decreased. In 2020, the gross inland consumption fell by 8.2% compared to 2019.

[36] 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)

[37] 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)

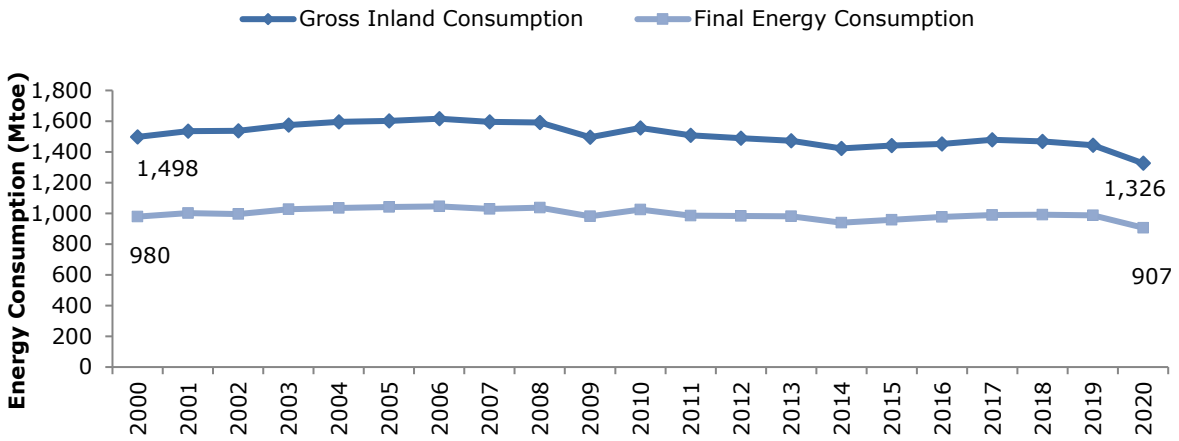
[38] Definition provided by Eurostat. Final energy consumption also excludes fuel transformed in the electrical power stations of industrial auto-producers and coke transformed into blast-furnace gas where this is not part of overall industrial consumption but of the transformation sector. (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Gloss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

[39] Definition included in Energy Efficiency Directive, Article 2, Paragraph 2

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

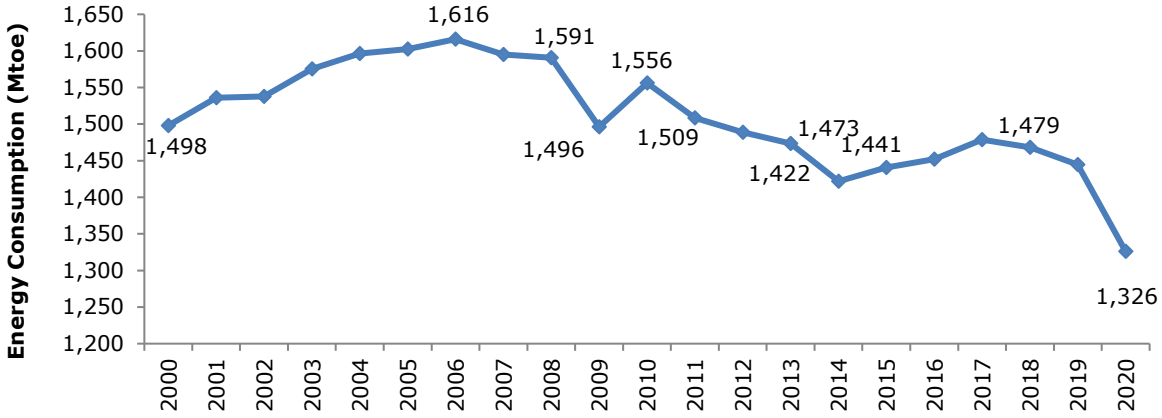
[41] In the same context with primary and final energy consumption, the indicator "Gross inland consumption (Europe 2020-2030)" (GIC2020-2030) was used in this analysis. This indicator estimates Gross inland consumption as calculated under the old Eurostat methodology – the methodology in place at the 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-27, 2000-2020



Source: Eurostat

Figure 2: Gross inland consumption in the EU-27, 2000-220

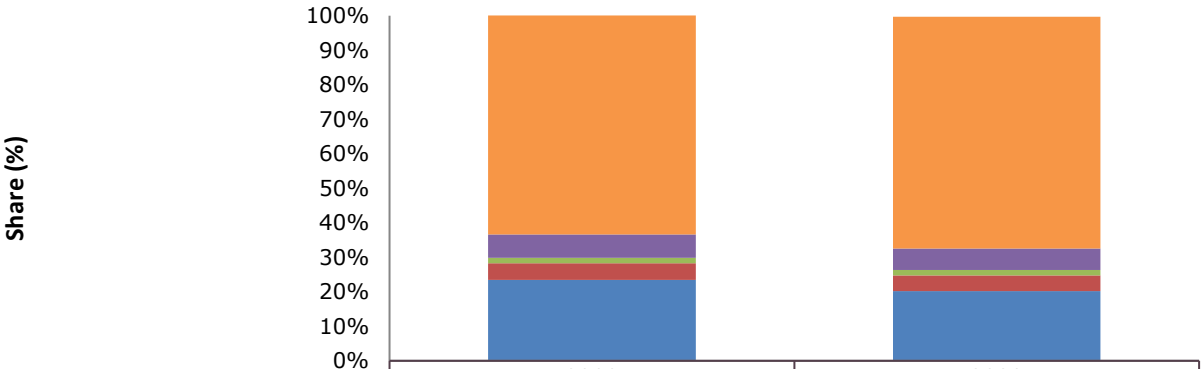


Source: Eurostat

In 2020, the difference between gross inland and final energy consumption is due to transformation losses (20.2%), consumption in the energy sector (4.5%), final non-energy consumption (6.2%) and distribution losses (1.6%)[42] (Figure 3). Compared to 2000, there was a slight increase (+3.0%) of the ratio of the final energy to gross inland consumption. This is the result of the reduction of the shares of all the other components, especially of the transformation losses. However, these changes are very small and the main consumption patterns remained the same.

[42] Gross inland consumption breakdown was 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-27, 2000 and 2020



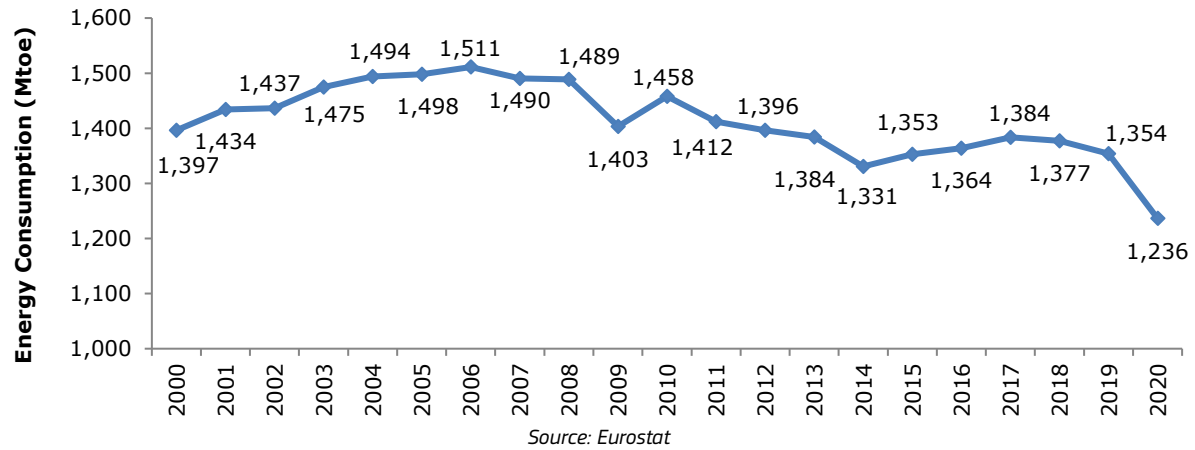
	2000	2020
Final Energy Consumption	63.71%	67.19%
Final Non-energy Consumption	6.77%	6.22%
Distribution Losses	1.56%	1.55%
Consumption in Energy Sector	4.78%	4.54%
Transformation Losses	23.48%	20.20%

Source: Eurostat

2.2 Primary energy consumption

Primary energy consumption in the EU-27 declined from 1,397 Mtoe in 2000 to 1,236 Mtoe in 2020; representing a drop of 11.5 % over this period (Figure 4). 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 (1,511 Mtoe). In 2009, a large change in the annual rate was observed; when the primary energy consumption dropped by 5.8% in comparison to the year 2008. In 2014, the EU primary energy consumption registered the second lowest value over the analysed period (1,331 Mtoe). From 2015 to 2017, the consumption increased again. In 2018, the primary energy consumption decreased with a reduction rate of 0.5% in comparison with 2017, but still above the EU 2020 target. In 2020, the lowest value over the studied period was observed (1,236 Mtoe) with a reduction rate of 8.9% compared to 2019. This was possibly the result of COVID-19 pandemic.

Figure 4: Primary energy consumption in the EU-27, 2000-2020

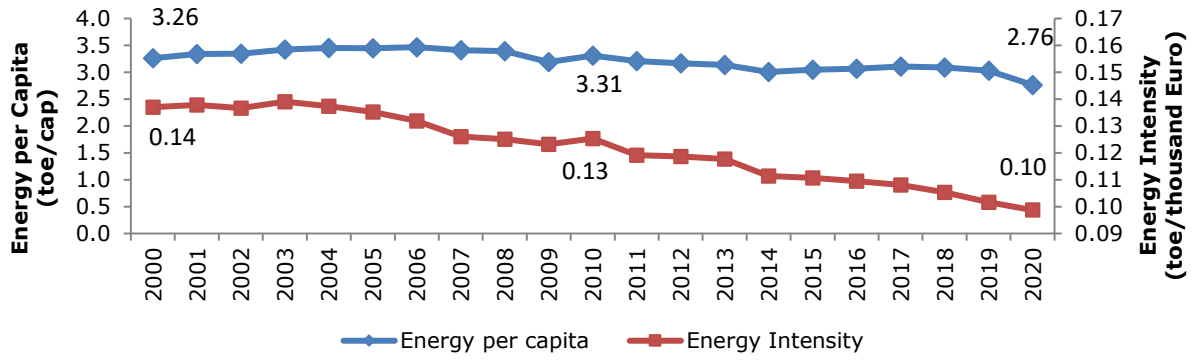


Source: Eurostat

Looking at other representative energy indicators such as energy intensity[43] and energy per capita, it can be observed that primary energy intensity declined from 0.14 to 0.10 toe/thousand Euro in the period 2000-2020. From 2000 onwards, there was a continuous gradual decrease of this indicator, with the exceptions of 2003 and of some periods that remained almost stable (i.e. 2007-2010, 2011-2013) (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 at both European and national level. In 2020 a decrease of 2.9% was registered compared to 2019.

Energy per capita decreased by 0.5 toe/cap during the analysed period. It peaked in 2006 (3.50 toe/cap) and dropped to the lowest value in 2020 (2.76 toe/cap). During the period 2014-2019, a modest increasing trend was observed. Primary energy consumption per capita increased by 0.9% from 2014 to 2019, while it decreased by 8.9% from 2019 to 2020. Both, the EU population growth (Figure 33, Page 32) and gross inland energy consumption drop led to the overall reduction of this indicator from 2000 to 2020. The deep fall in 2020 was probably due to the exceptional event of the pandemic, which led in general to reduced activities and energy needs.

Figure 5: Energy indicators for primary energy consumption: energy per capita and energy intensity[44] in the EU-27, 2000-2020



Source: Eurostat

2.3 Final energy consumption in end-users sectors

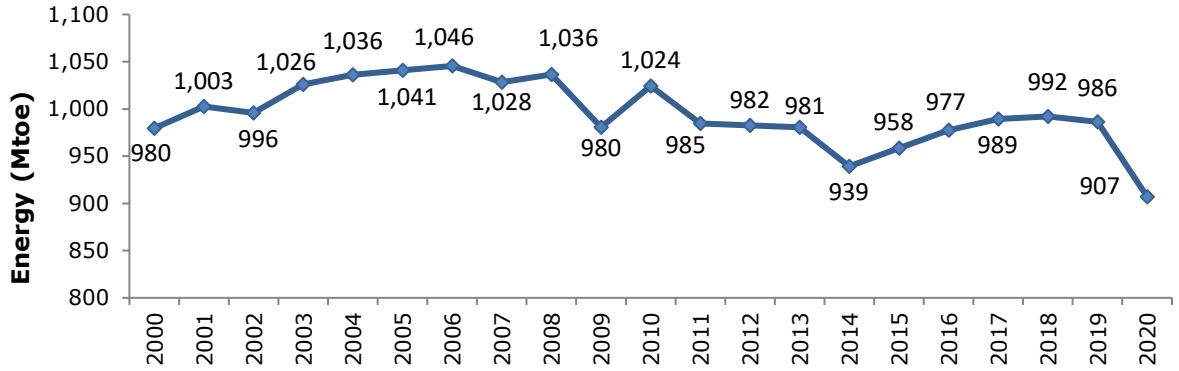
In 2020 total final energy consumption in EU-27 was 907 Mtoe. In comparison to 2019, final energy consumption dropped significantly (by 8.1%).

The EU final energy consumption decline of 7.4% was not gradual for the period 2000-2020. Until 2014, final energy consumption was always above that of 2000 (Figure 6). From 2003 to 2006, there was a constant growth reaching a maximum in 2006 with 1,046 Mtoe. After the recovery from the economic crisis in 2010, the final energy consumption decreased until 2014, when it registered the second lowest value of the studied period (939 Mtoe). After three following years of continuous increase, it remained almost stable from 2017 to 2019, but still above the 2020 EU target. In 2020, it recorded a significant drop by 8.1% reaching the value of 907 Mtoe, the lowest value over the studied period, and achieving the 2020 EU energy target of 959 Mtoe. This value was- to a great extend- the result of COVID-19 pandemic.

[43] 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.

[44] GDP values at market prices were considered to calculate the energy intensity values reported in the graph. Unit of measure: chain linked volumes (2015)

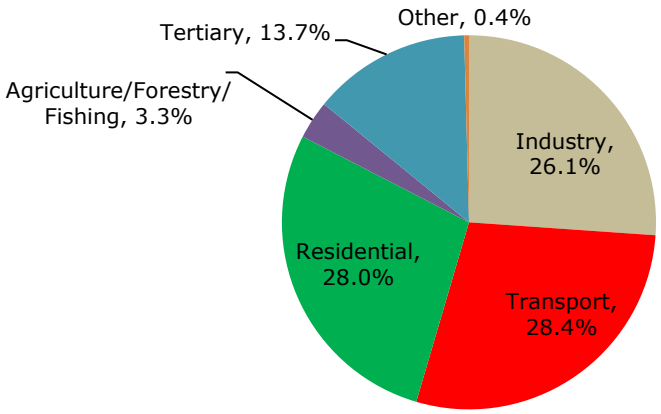
Figure 6: Final energy consumption in the EU-27, 2000-2020



Source: Eurostat

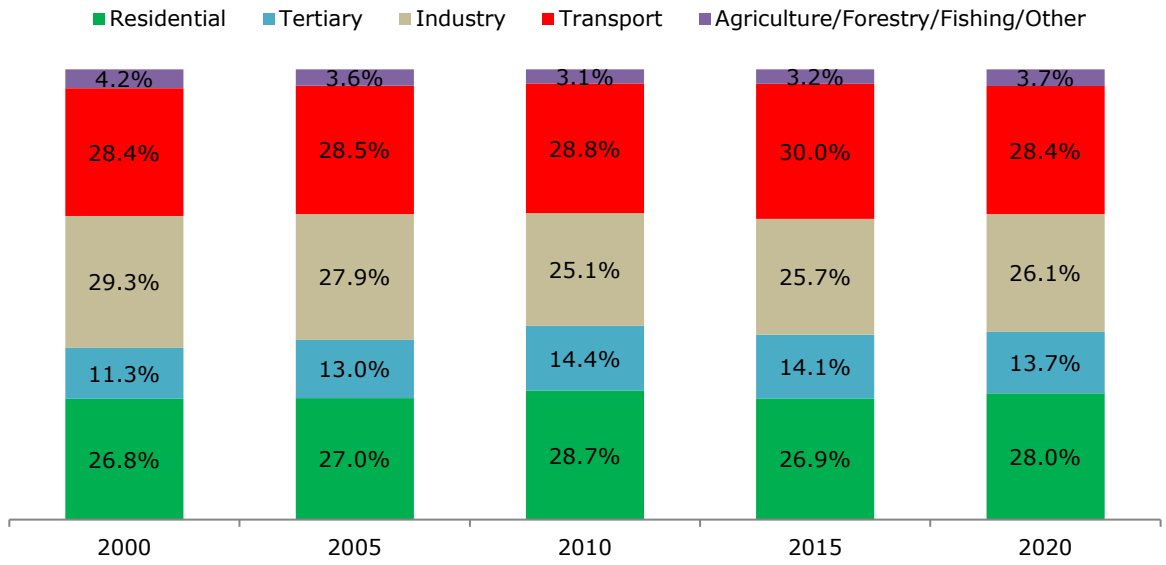
In total, 96.3% of the final energy was consumed by industry, residential, transport and tertiary sectors (Figure 7). In 2020, the sector with the largest share of final energy consumption was the transport sector, which consumed 28.4% of the total final energy consumption. The second largest was the residential sector, consuming 28.0%, followed by industry sector with a share of 26.1%. The least consuming is the tertiary sector, with a share of 13.7%. The breakdown of the final energy consumption by sector for five different years (i.e. 2000, 2005, 2010, 2015 and 2020) is shown in Figure 8. It can be observed that the shares have slightly changed during the period; residential and tertiary sector enlarged their shares while industry and agriculture/forestry/fishing reduced their shares over the years. The share of the transport sector in total final energy consumption increased over the studied period, while in 2020 it returned to 2000 figures.

Figure 7: Final energy consumption breakdown into sectors in the EU-27, 2020



Source: Eurostat

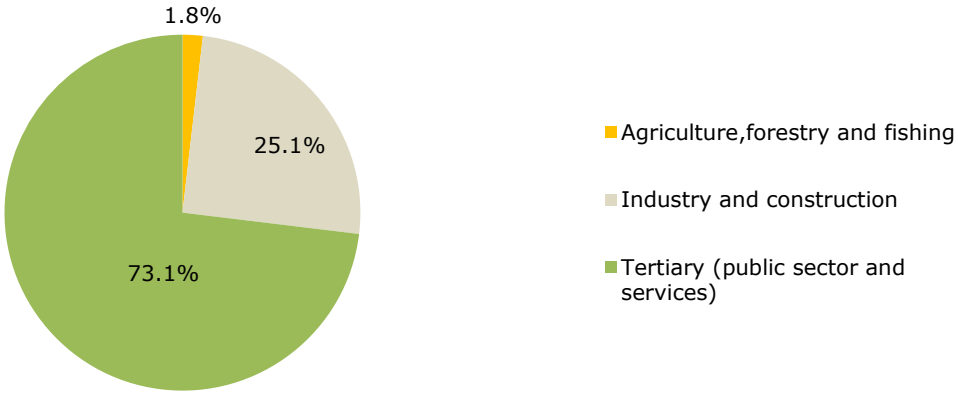
Figure 8: Final energy consumption shares by sector in the EU-27, 2000, 2005, 2010, 2015 and 2020



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 Value Added[45] of the main economic sectors. The tertiary sector[46] (including public sector) is the largest contributor of GVA with a total share of 73.1% for the year 2020 while it has the smallest share in total final energy consumption, after agriculture/forestry/fishing and non-specified consumption. Industry (including construction) has also an important share of GVA (25.1%) 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-27, 2020



Source: Eurostat

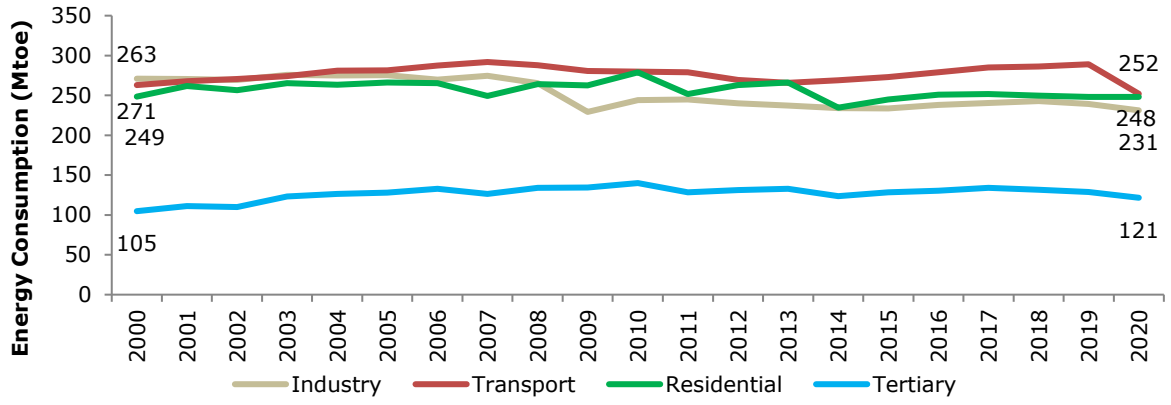
Figure 10 shows the final energy consumption breakdown by sector from 2000 to 2020. Final energy consumption of the industrial and residential sectors varied notably throughout different years (e.g. between 2008 and 2009 for the industrial sector and between 2013 and 2014 for the residential one), while final energy of transport and tertiary showed increasing trends (excluding year 2020 for transport). The increasing trends of tertiary sector the decreasing trends of industry might be representative of an on-going

[45] Unit of measure for GVA: chain linked volumes (2015), million euro

[46] Tertiary sector includes: 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.

tertiarization process in the European Union. In 2020, however, final energy consumption decreased in all the sectors except the residential sector, most probably because of COVID-19 pandemic and of the measures to confront it, like lockdowns and teleworking.

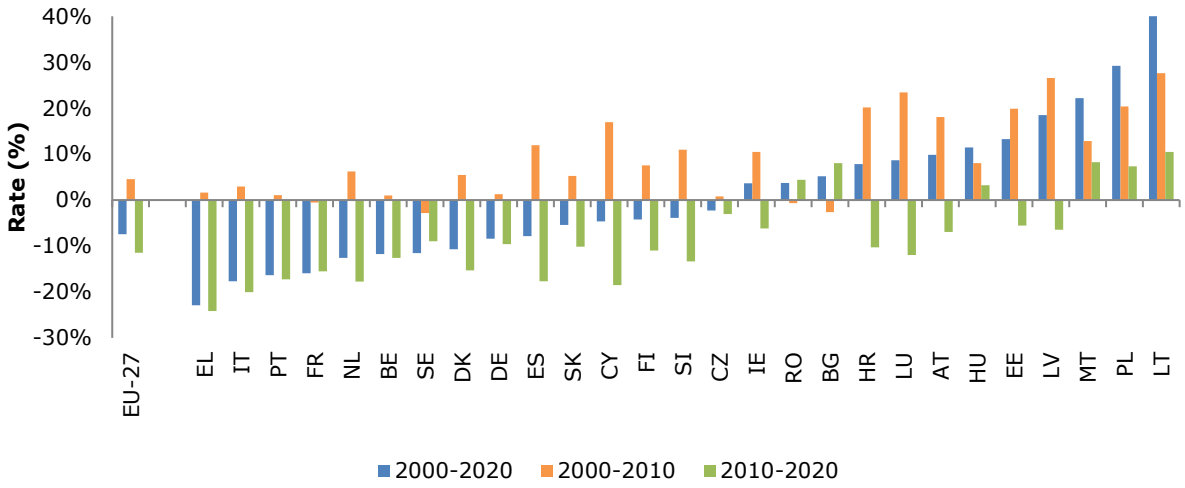
Figure 10: Final energy consumption dynamics through main sectors in the EU-27, 2000-2020



Source: Eurostat

Figure 11 shows the changes of final energy consumption per Member State. As regards the analysed period, final energy consumption rate varied considerably among the Member States of the European Union. As a whole, the EU-27 countries experienced a reduction rate of -7.4% from 2000 to 2020.

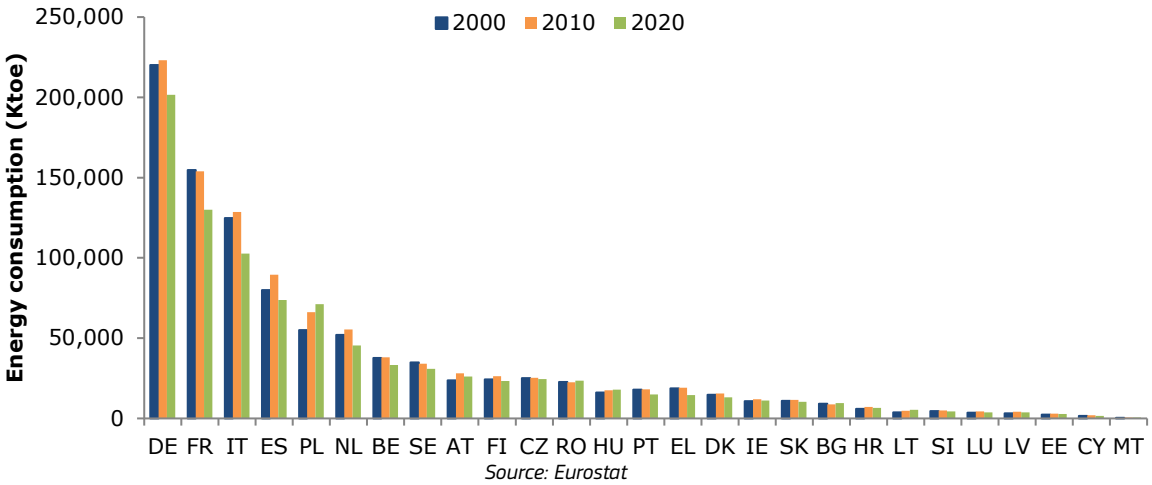
Figure 11: Final energy consumption rates by EU-27 Member States; 2000-2020, 2000-2010 and 2010-2020



Source: Eurostat

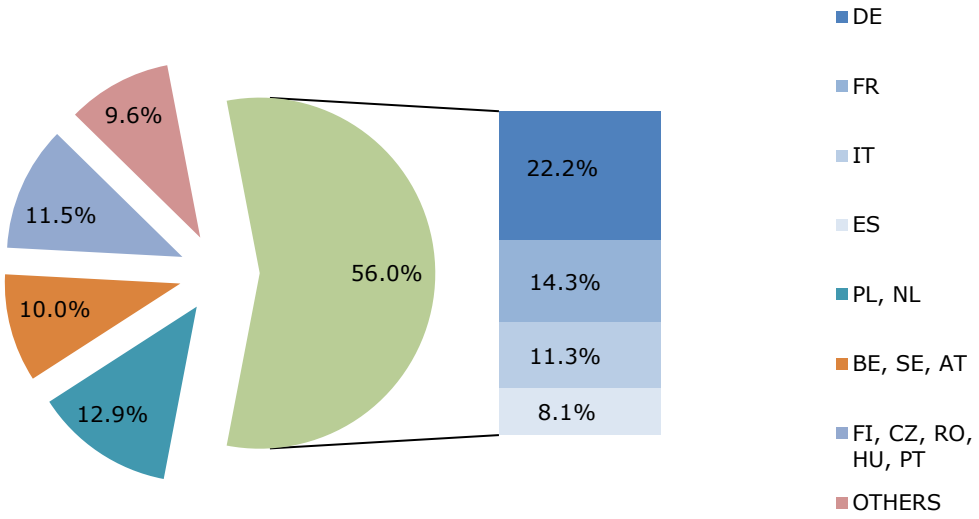
In the period 2000-2020, ten Member States were associated with larger reduction rates than the EU average. The highest reduction rate was observed in Greece (-22.9%), followed by Italy (-17.7%) and Portugal (-16.4%). In contrast, Lithuania (41.0%), Poland (29.2%) and Malta (22.2%) were the countries with the highest relative increase in final energy consumption compared to 2000. In 2020, Germany had the largest final energy consumption (201.7 Mtoe), which represented a 22.2% of the total EU final energy consumption. Together with France (130.1 Mtoe; 14.3%), Italy (102.7.7 Mtoe; 11.3%) and Spain (73.8 Mtoe; 8.1%), these countries accounted for more than 55% of the EU final energy consumption. Figure 13 shows that thirteen Member States consumed less than 10% of the total energy consumption.

Figure 12: Final energy consumption per Member State in the EU-27, 2000, 2010 and 2020



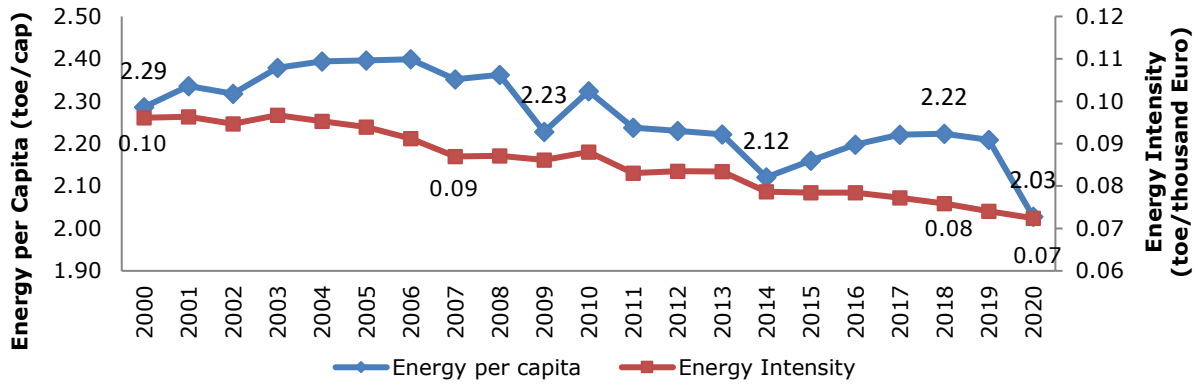
Source: Eurostat

Figure 13: Shares of EU-27 Member States to final energy consumption, 2020



Source: Eurostat

Figure 14: Energy indicators for final energy consumption: energy per capita and energy intensity[47] in the EU-27, 2000-2020



Source: Eurostat

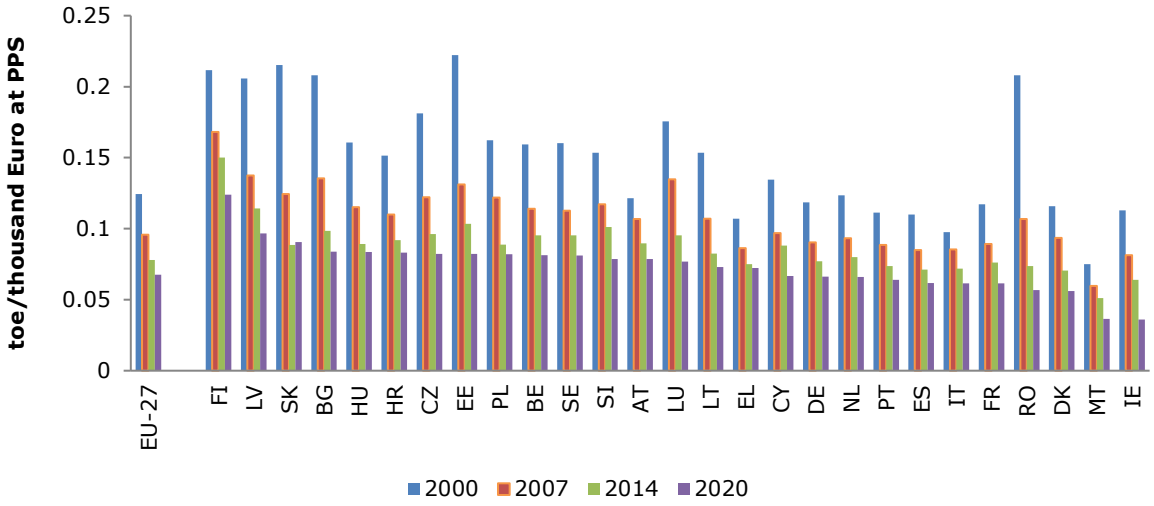
Final Energy intensity (EI) and final energy per capita are depicted in Figure 14. From 2000 to 2020, the EU-27 energy intensity fell by almost 0.03 toe/thousand Euro, reaching a value of 0.07 toe/thousand Euro in 2020. Energy per capita reached the lowest value in 2020 over the analysed period (2.03 toe/capita). Energy per capita is mainly influenced by the dynamics of final energy more than changes in population, which only increased by 4.4%. Final energy consumption per capita trends are especially important for the residential sector consumption analysis. On the contrary, 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. However, it is 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 at Purchasing Power Standard (PPS) it is possible to notice that in 2020 the Member State with the lowest energy intensity was Ireland (0.036 toe/thousand Euro), followed by Malta (0.037 toe/thousand Euro) and Denmark (0.056 toe/thousand Euro). On the other hand, the Member States with the highest energy intensity in the same year were Finland (0.124 toe/thousand Euro), Latvia (0.097 toe/thousand Euro) and Slovakia (0.091 toe/thousand Euro). For eleven European countries, energy intensity was below EU average in 2020 (<0.067 toe/thousand Euro).

The highest energy intensity drops during the 21-year period from 2000 to 2020 are found in Romania (-72.7%), Ireland (-68.2%) and Estonia (-63.0%). Greece, Austria and Italy are the countries whose energy intensity reduced the least during this period (-32.4%, -35.3% and -36.8% respectively). The overall European EI trends can reflect the interest and efforts made by the EU Member States to increase their levels of competitiveness, as the EU reduction rate was -45.6% (2000-2020).

[47] GDP values at market prices were considered to calculate the energy intensity values reported in the graph. Unit of measure: chain linked volumes (2015)

Figure 15: Final Energy intensity[48] at PPS in the EU-27 2000, 2007, 2014 and 2020



Source: Eurostat

Table 1 presents an overview of the EU-27 final energy consumption changes. It provides data about the main consuming sectors, as well as consumption rates expressed in percentage with respect to year 2000 and the previous year. Looking at the consumption rate with respect to 2000 it can be observed that, the highest reduction compared to the baseline year happened in 2020 for final energy consumption. Specific insights about the main consuming sectors are given in each of the subsequent chapters.

[48] GDP values at market prices were considered to calculate the energy intensity values reported in the graph. Unit of measure: Current prices, million purchasing power standard (PPS, EU27 from 2020)

Table 1: Overview of final energy consumption changes for different sub-sectors, EU-27

Final Energy Consumption per Sector, EU-27											
(Mtoe)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total	980	1003	996	1026	1036	1041	1046	1028	1036	980	1024
Industry	271	271	269	276	275	275	270	274	265	229	244
Transport	263	268	271	274	281	282	287	292	288	281	280
Residential	249	262	256	265	263	266	265	249	264	262	279
Tertiary	105	111	110	123	126	128	133	126	134	134	140
(Mtoe)	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	
Total	985	982	981	939	958	977	989	992	986	907	
Industry	245	240	237	234	234	238	240	243	239	231	
Transport	279	269	266	269	273	279	285	286	289	252	
Residential	252	263	266	235	245	251	252	250	248	248	
Tertiary	128	131	133	123	129	130	134	132	129	121	
% Rate to year 2000											
(%)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total		2.3%	1.7%	4.7%	5.8%	6.3%	6.7%	5.0%	5.8%	0.1%	4.6%
Industry		-0.2%	-0.6%	1.8%	1.5%	1.6%	-0.5%	1.3%	-2.1%	-15.4%	-10.0%
Transport		1.8%	2.9%	4.4%	6.9%	7.1%	9.3%	11.0%	9.5%	6.7%	6.5%
Residential		5.3%	3.1%	6.7%	5.9%	7.1%	6.8%	0.3%	6.3%	5.5%	12.2%
Tertiary		6.1%	5.0%	17.6%	20.7%	22.2%	27.0%	20.6%	28.1%	28.2%	33.7%
(%)	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	
Total	0.5%	-2.0%	-1.5%	-8.4%	-7.5%	-6.1%	-5.4%	-3.5%	-4.8%	-7.5%	
Industry	-9.7%	-11.3%	-12.0%	-15.2%	-15.0%	-13.5%	-10.9%	-11.5%	-9.7%	0.9%	
Transport	6.1%	0.5%	-1.8%	-1.9%	-3.0%	-0.9%	-0.8%	-1.9%	0.4%	-10.2%	
Residential	1.3%	0.4%	3.8%	-11.5%	-6.9%	-5.8%	-5.1%	0.2%	-6.0%	-5.4%	
Tertiary	22.5%	18.0%	20.7%	0.2%	1.7%	1.8%	0.7%	4.3%	-4.1%	-9.6%	
% Rate to previous year											
(%)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total		2.3%	-0.7%	3.0%	1.0%	0.5%	0.4%	-1.7%	0.8%	-5.4%	4.5%
Industry		-0.2%	-0.4%	2.3%	-0.2%	0.1%	-2.0%	1.8%	-3.3%	-13.6%	6.4%
Transport		1.8%	1.1%	1.4%	2.5%	0.2%	2.0%	1.6%	-1.4%	-2.5%	-0.2%
Residential		5.3%	-2.1%	3.5%	-0.7%	1.1%	-0.3%	-6.1%	6.0%	-0.7%	6.3%
Tertiary		6.1%	-1.1%	12.0%	2.6%	1.2%	3.9%	-5.0%	6.2%	0.1%	4.2%
(%)	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	
Total	-3.9%	-0.2%	-0.2%	-4.2%	2.0%	2.0%	1.2%	0.3%	-0.6%	-8.0%	
Industry	0.3%	-1.9%	-1.2%	-1.4%	0.0%	1.8%	1.0%	1.0%	-1.4%	-3.4%	
Transport	-0.4%	-3.5%	-1.3%	1.3%	1.4%	2.3%	2.0%	0.5%	1.0%	-12.8%	
Residential	-9.7%	4.4%	1.2%	-11.8%	4.4%	2.4%	0.3%	-0.8%	-0.6%	0.0%	
Tertiary	-8.4%	2.2%	1.2%	-7.0%	4.2%	1.3%	2.9%	-1.7%	-2.3%	-5.6%	

Source: Eurostat

2.4 Final energy consumption per fuel type

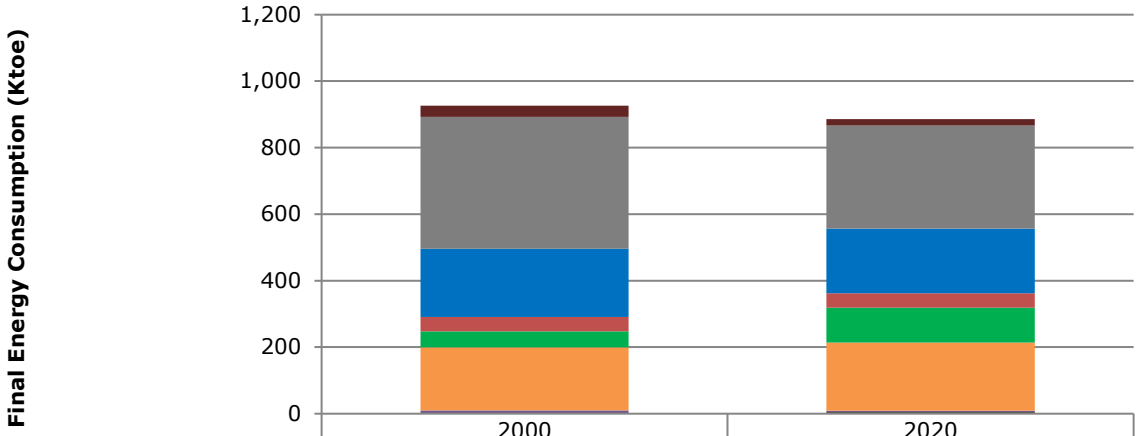
The main energy fuels are petroleum products, electricity and natural gas, which provide the 35.0%, 23.2% and 21.9% of the final energy consumption[49] in 2020 respectively (Figure 16).

Renewables, solid fossil fuels and heat, have a total share of around 15%. 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 2000-2020, there were 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 were increases in non-renewable waste, electricity, renewables and biofuels, and heat. This shows that the drop in final energy consumption from 2000 to 2020 is the combined result of diverse changes in the energy mix. For instance, the energy gap due to a decline of 11.2 Mtoe in natural gas, in 86.4 Mtoe in petroleum and in 14.5 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 its demand, 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, as renewable energy sources are integrated into electrical grids once generated in renewable power plants such as hydroelectric power plants, wind farms or PV power stations. Moreover, the electricity demand will also increase with the high growth of ICT sector, the development of big data centres and the extended use of heat pumps and household electrical appliances and devices with advanced features in buildings. All those elements point to a significant change in the end-users' consumption behaviour patterns and may rise the trend of electrification, especially in residential and service sector.

[49] 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 type in the EU-27, 2000 and 2020



	2000	2020
Solid Fossil Fuels	33,445	18,959
Oil and Petroleum Products (excluding biofuel portion)	396,719	310,314
Natural Gas	205,119	193,931
Heat	42,894	43,992
Renewable and Biofuels	48,806	104,250
Electricity	189,003	205,061
Manufactured gases	8,312	3,891
Peat and peat products	659	379
Oil shale and oil sands	60	1
Waste (non renewable)	994	4,986

Source: Eurostat

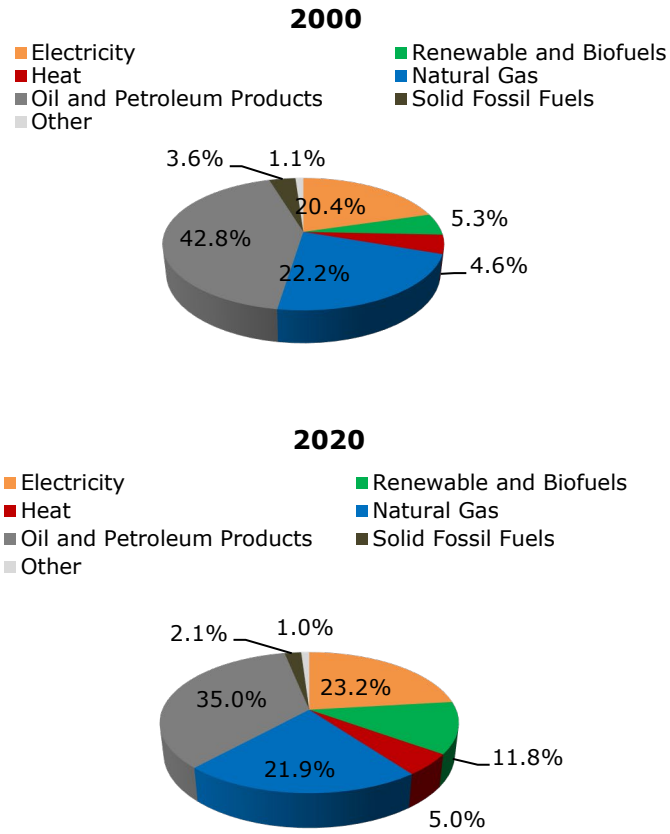
With regard to different energy source shares from 2000 to 2020 (figure 17), the electricity raised its share by 3%. The share of renewable energy sources notably augmented (more than doubled), heat, natural gas and other sources[50] shares remained almost stable, while the shares of solid fuels, petroleum and oil product decreased by 1.5% and 7.8%, respectively.

Several changes in the ranking of energy sources occurred from 2000 to 2020. Total petroleum products remained in the first position during the analysed period, while solid fossil fuels continued in the last one (if 'other sources' are not counted). Electricity replaced natural gas as the second most consumed energy source.

No significant changes in ranking and shares of the different energy sources occurred from 2019 to 2020. All the energy sources except oil and petroleum products -that slightly decreased their share -remained almost stable (minor increases).

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

Figure 17: Share of energy source to final energy consumption in the EU-27, 2000, 2020



Source: Eurostat

2.5 Final electricity and natural gas consumption in different sectors

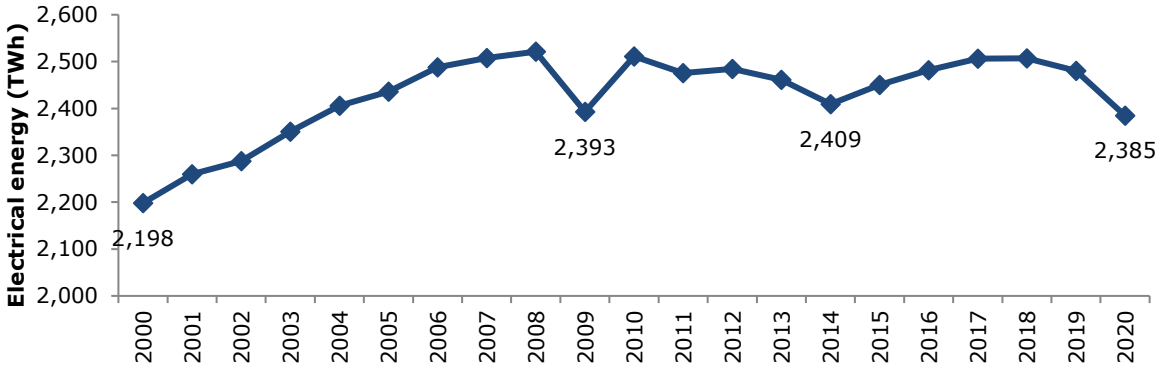
This subchapter covers the analysis of electricity and gas consumptions in different sectors over the period 2000-2020 in the 27 countries of the European Union.

Final Electricity consumption

In 2020, total electricity consumption[51] across the EU-27 countries was 2,385 TWh. It corresponds to an increase of 8.5% compared to 2000, when the electricity consumption was 2,198 TWh. In 2008, electricity consumption reached its maximum level (2,521 TWh), while the minimum value was registered in 2000. A drop of 5.1% interrupted the increasing trend observed from 2000 to 2008 (Figure 18). A decreasing trend was also observed from 2010 to 2014 (with the exception of the year 2012) and from 2018 to 2020. In 2020, final electricity consumption decreased by 3.9% compared to 2019.

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

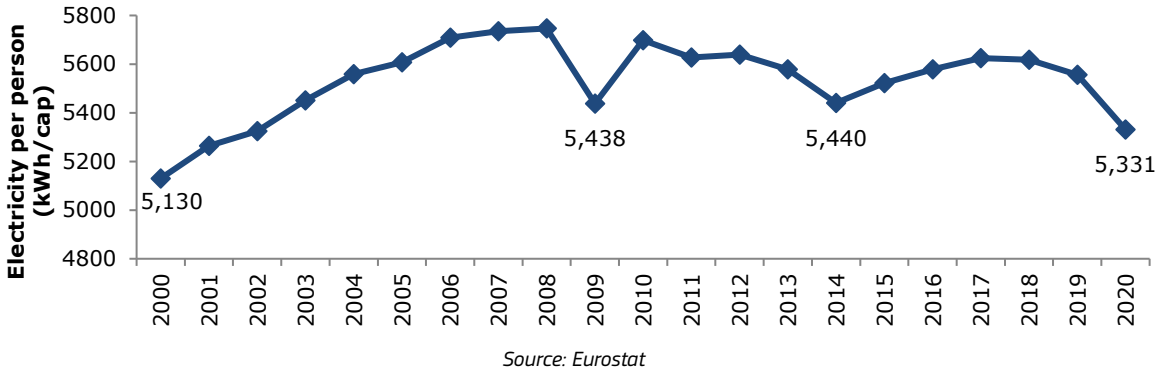
Figure 18: Final electricity consumption in the EU-27, 2000-2020



Source: Eurostat

In 2020, final electricity per capita consumption was 5,331 kWh/cap. This value represents a rise of 3.9% in comparison to 2000. From 2019 to 2020, it recorded a reduction rate of -4.0% (Figure 19).

Figure 19: Final electricity per capita consumption in the EU-27, 2000-2020

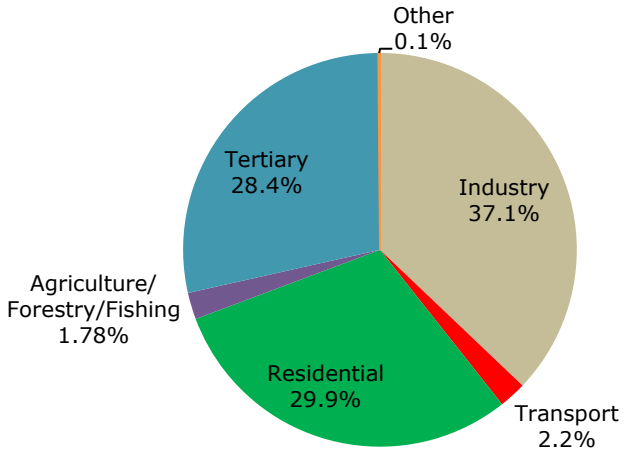


Source: Eurostat

Three sectors account for more of 95% of the electricity consumption[52] in EU-27. A total 37.1% of the electricity is consumed in the industry sector, 29.9% in the residential sector and 28.4% in tertiary (Figure 20).

[52] Sectoral analysis of electricity consumption was studied using the new methodology Eurostat tables for energy balances based on the availability of the data.

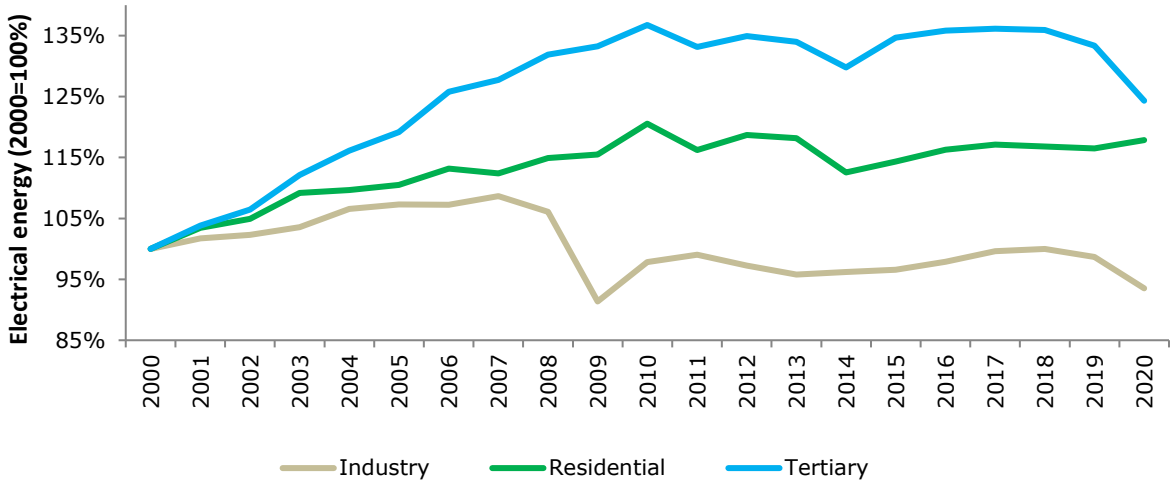
Figure 20: Electricity consumption breakdown into sectors in the EU-27, 2020



Source: Eurostat

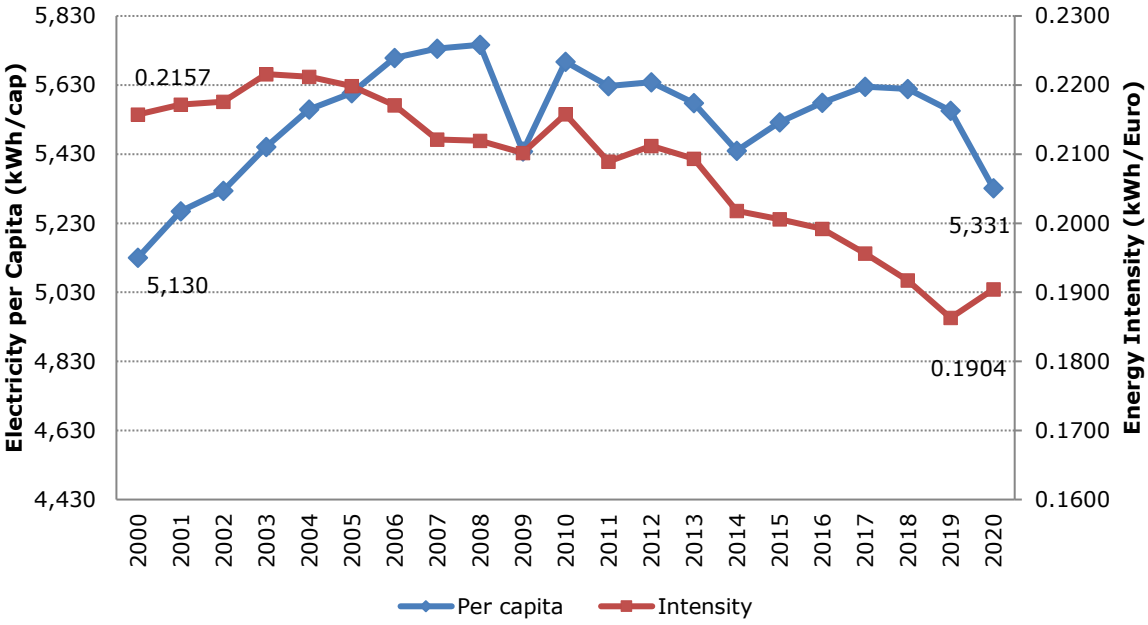
In the period 2000-2020, the industry sector was always the sector with the highest electricity consumption, reaching a maximum of 1,028 TWh in 2007. For the same sector, a pronounced drop of 13.9% in the electricity consumption took place between 2008 and 2009, because of the impact of the financial crisis. The industrial electric consumption experienced two other smoother decreasing trends in the studied period, from 2011 to 2013 and from 2018 to 2020. The electricity consumption in both residential and tertiary sectors recorded the highest values in 2010, and then they followed relatively similar trends until 2019. In 2020, the teleworking effect was visible as residential electricity increased and tertiary electricity decreased contrary to previous years (Figure 21).

Figure 21: Final electricity Consumption trends of main consuming sectors in the EU-27, 2000-2020 (2000=100%)



Source: Eurostat

Figure 22: Energy indicators for final electricity consumption: electricity per capita and electrical energy intensity[53] in the EU-27, 2000-2020



Source: Eurostat

Figure 22 describes the trends of the energy intensity of the final electricity consumption and of final electricity consumption per capita. In 2020, the energy intensity of the final electricity consumption was 0.19 kWh/Euro, the second lowest value over the analysed 21-year period after 2019. This corresponds to a drop by 11.7% compared to 2000. In the period 2000-2020, the final electrical energy consumption per capita has grown by 201 kWh/cap. This indicator reached a maximum in 2008 with 5,747 kWh/cap, followed by a fall of 309 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 185 kWh/cap. From 2018 onwards, it decreased again to reach the value of 5,331 kWh/cap in 2020.

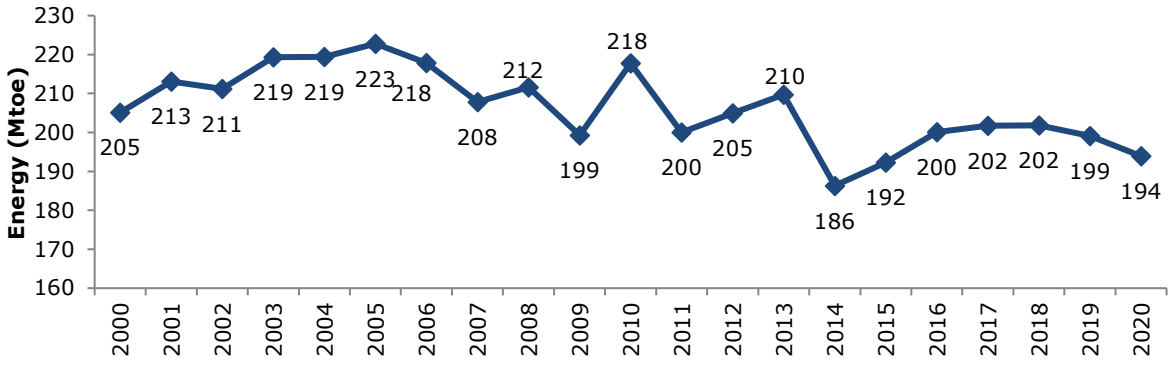
Final Natural Gas Consumption

In 2020, the total natural gas consumption[54] of the EU-27 countries reached 194 Mtoe. This established a drop of 5.5% in comparison to the level of year 2000 when the consumed gas was equal to 205 Mtoe. During the studied period, several fluctuating trends can be observed (Figure 23). The maximum value was registered in 2005 (223 Mtoe) while the minimum value was registered in 2014 (186 Mtoe). A continuous increasing trend was observed from 2014 to 2018. In 2020, it decreased compared to 2019 (by 2.6%).

[53] GDP values at market prices were considered to calculate the energy intensity values reported in the graph. Unit of measure: chain linked volumes (2015)

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

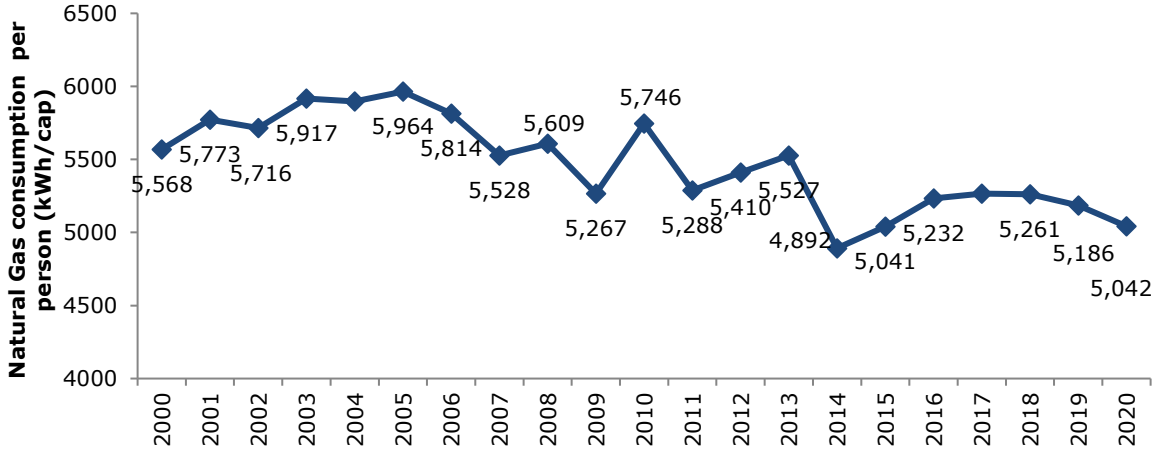
Figure 23: Final natural gas consumption trends in the EU-27, 2000-2020



Source: Eurostat

In 2020, the final natural gas consumption per capita in the EU-27 was 5,042 kWh/cap. This value represents a drop of 9.4% in comparison to the year 2000. From 2019 to 2020 it dropped by 2.8% (Figure 24).

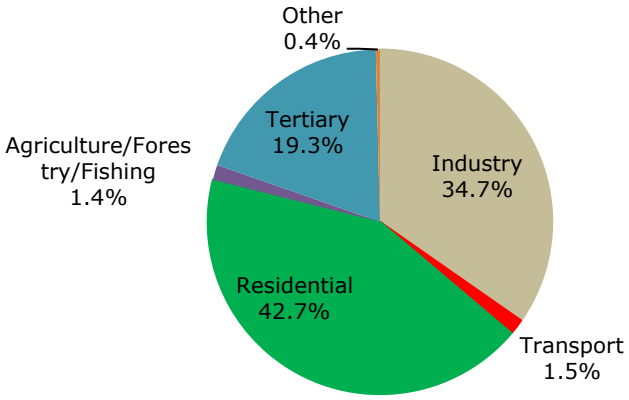
Figure 24: Final natural gas per capita consumption trend in the EU-27, 2000-2020



Source: Eurostat

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 42.7%, followed by industry sector with 34.7% and tertiary sector, which accounts for 19.3% of total final gas consumption. The three sectors together cover more than 95% of the gas consumption of the European Union (Figure 25).

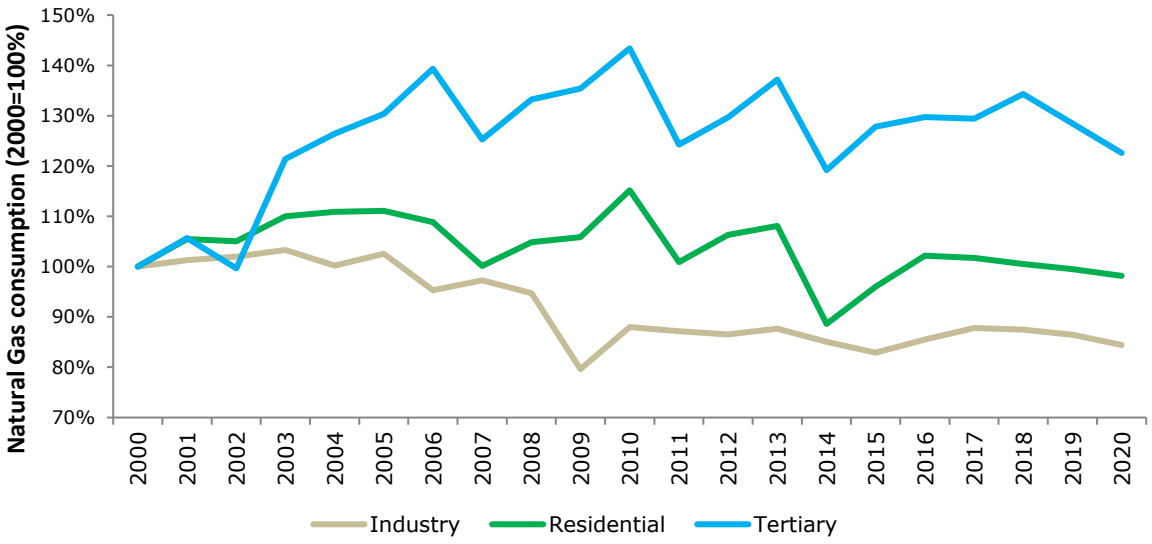
Figure 25: Natural gas consumption breakdown into sectors in the EU-27, 2020



Source: Eurostat

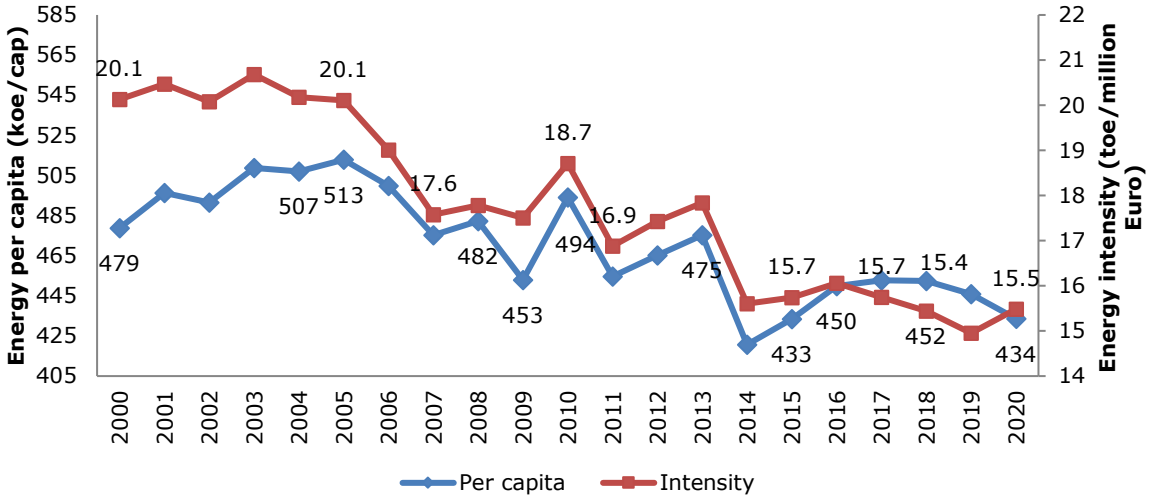
Figure 26 shows the natural gas consumption trend for the period 2000-2020 for the three aforementioned sectors. In 2000, the residential and industry sectors had the highest shares of consumption of natural gas, 78,583 ktoe (40.5%) and 73,905 ktoe (38.1%), respectively. Both sectors have occasionally experienced significant changes in consecutive years, e.g. between 2008 and 2009 the consumption of natural gas in industry sector declined by 15.9% and between 2010 and 2011 it dropped by 12.4% in the residential sector. Overall, industry experienced a reduction in natural gas consumption (-14%); tertiary sector experienced a gradually rising trend (28%), while residential sector experienced an overall decrease of -1% from 2000 to 2019. From 2019 to 2020, natural gas consumption reduced in all the three sectors.

Figure 26: Final natural gas consumption dynamics through main consuming sectors in the EU-27, 2000-2020 (2000=100%)



Source: Eurostat

Figure 27: Energy indicators for final natural gas consumption: gas consumption per capita and gas energy intensity[55] in the EU-27, 2000-2020



Source: Eurostat

Figure 27 describes the trend of the energy intensity of the final natural gas consumption and the trend of final natural gas consumption per capita. In 2020, the final energy intensity for natural gas consumption was 15.5 toe/million Euro, the third lowest value over the analysed 21-year period, after 2019 and 2018. In 2020, the energy intensity increased by 3.6% compared to 2019. In the period from 2000 to 2020, the energy intensity of the final natural gas consumption dropped by 4.7 toe/Euro. As for the final natural gas energy consumption per capita, it decreased by 45.2 koe/cap (9.4%) from 2000 to 2020, partially due to the population growth and the energy efficiency policies implemented during the analysed period. This indicator reached its maximum in 2005 at 512.8 koe/cap and its minimum in 2014 at 433 koe/cap. Since 2008, it registered a fluctuating trend, slightly decreasing since 2017 and achieving an annual reduction rate of 2.8% in 2020.

[55] GDP values at market prices were considered to calculate the energy intensity values reported in the graph. Unit of measure: chain linked volumes (2015). Natural gas consumption values were taken from new methodology Eurostat databases based on the availability of data.

3 Energy Consumption and Energy Efficiency Trends in the Residential Sector

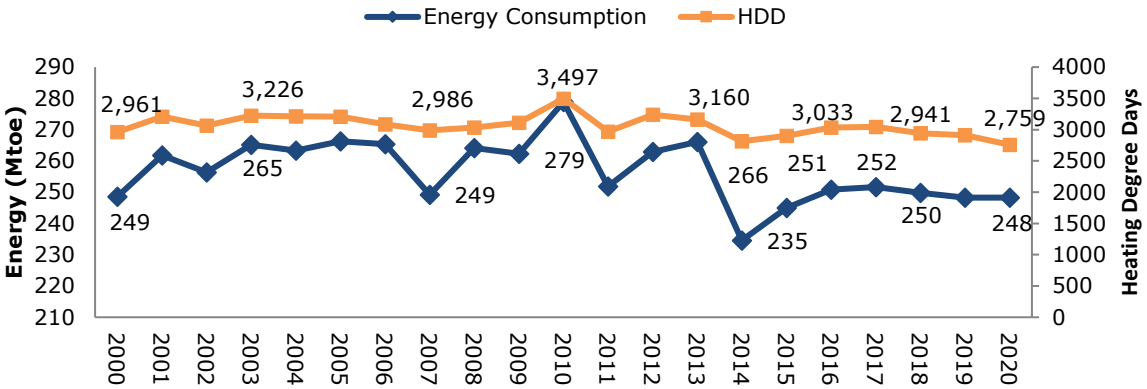
This chapter covers energy efficiency and energy consumption trends in the residential sector, with a focus on electricity and natural gas consumption. Consumption related data are presented together with data regarding some main energy consumption drivers such as economic growth, population growth, 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 trends for the period 2000-2020. Influencing factors in the energy consumption such as economic development and weather conditions are qualitatively analysed. In 2020, the residential sector represented 28% of the final energy consumption in the EU, being the second most consuming sector after transport (28.4%). By analysing the data concerning the residential consumption, it is possible to observe that it followed fluctuating dynamics, with significant decreases in 2007, 2011 and 2014 of 6.1%, 9.7 and 11.8%, respectively.

Figure 28 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 (278.9 Mtoe), the energy consumption reached its minimum in 2014 (234.6 Mtoe). During the period 2000-2020, the final residential energy consumption in the EU-27_2020 was reduced by only by 0.1%, from 248.5 Mtoe to 248.2 Mtoe while it was almost equal to the value of 2019.

Figure 28: Final residential energy consumption in the EU-27, 2000-2020



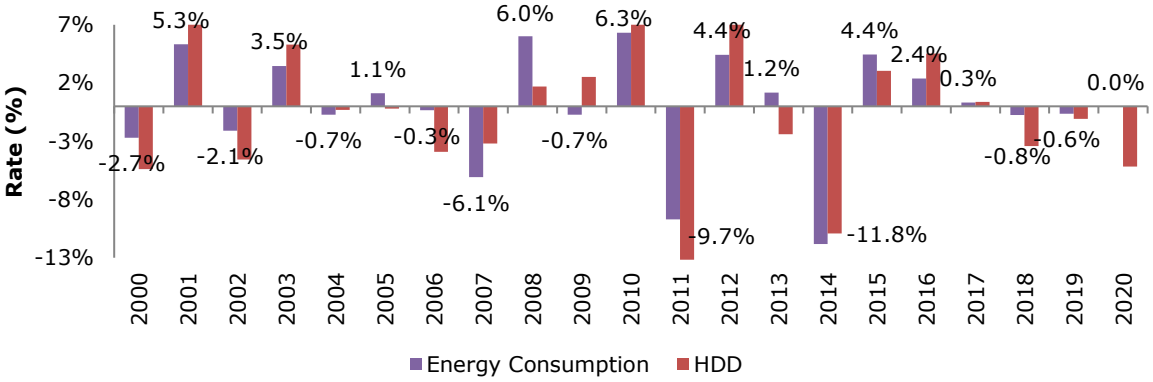
Source: Eurostat

Figure 28 also shows the relationship between weather conditions and final energy consumption in residential sector. 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 that can be related to the heating and cooling needs are the so-called Heating Degree Day (HDD)[56] and Cooling Degree Day (CDD). As shown in Figures 28 and 29, the final residential energy consumption trend follows that of the Heating Degree Days with the exception of years 2009, 2013 and 2020. This indicates that there is a strong correlation between the two indicators. The differences in trends registered for 2009, 2013 and 2020 might be explained by the influence of other factors, probably of economic and behavioural nature. In 2009, the society's concern about the crisis 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 consumption increased in 2013 despite a reduction of HDD, probably because of new positive outlook for the European economy. In 2020, the lockdowns due to COVID-19 pandemic increased the teleworking by home hours. This exceptional event prevented the reduction of energy consumption in the residential sector.

[56] 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 18ºC. Thus, HDD and CDD are the number of degrees that a day's average temperature is below/above 18ºC which is the outside temperature below which buildings need to be heated or cooled [Source: EEA].

Figure 29 complements the previous figure by providing a visualisation of the yearly consumption rates over the period 2000-2020. In this way, it is possible to have an idea about the magnitude of the variation across years. It can be observed that from 2007 to 2015, the final residential energy consumption registered an almost continuous fluctuation.

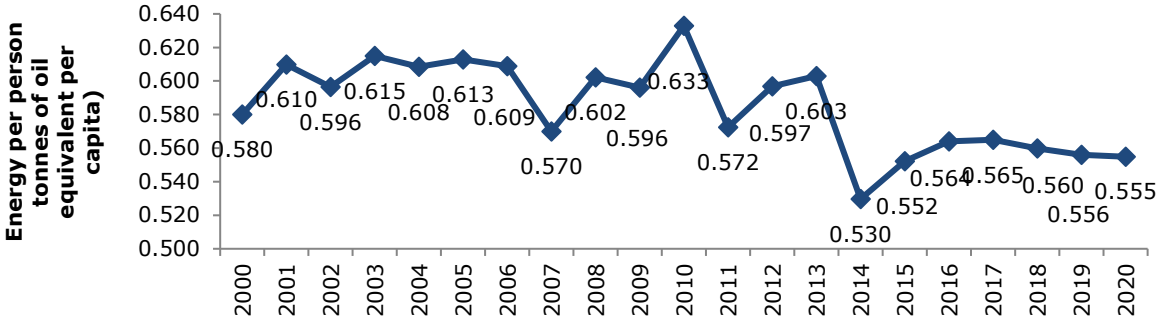
Figure 29: Final residential energy consumption and Heating Degree Days annual consumption rates in the EU-27, 2000-2020



Source: Eurostat

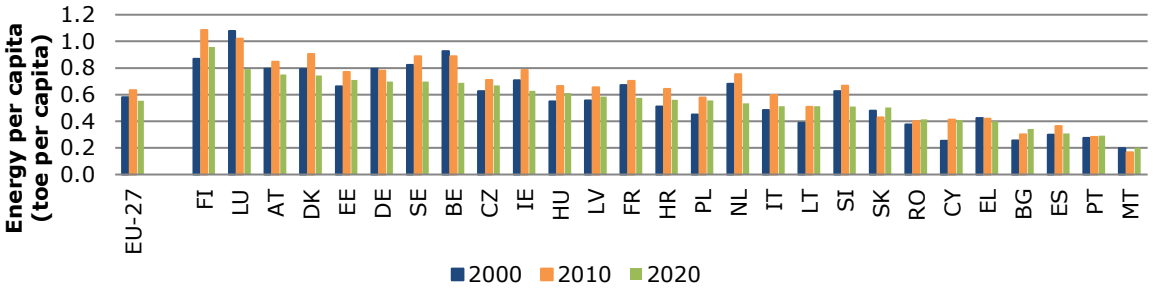
Per capita final energy consumption in the residential sector (Figure 30) lowered by 25.0 koe/cap at European level from 2000 to 2020, meaning a drop of 4.3%. The trend of this indicator mainly follows that of the final residential energy consumption, as the changes in the population rates were much less sharp than the energy consumption changes. Therefore, despite the fact that the EU population was continuously growing (it increased by 4.4% from 2000 to 2020), its influence on the final residential energy consumption changes is quite limited.

Figure 30: Final residential energy consumption per capita in the EU-27, 2000-2020



Source: Eurostat

Figure 31: Final residential energy consumption per capita by EU-27 Member State, comparison 2000, 2010 and 2020

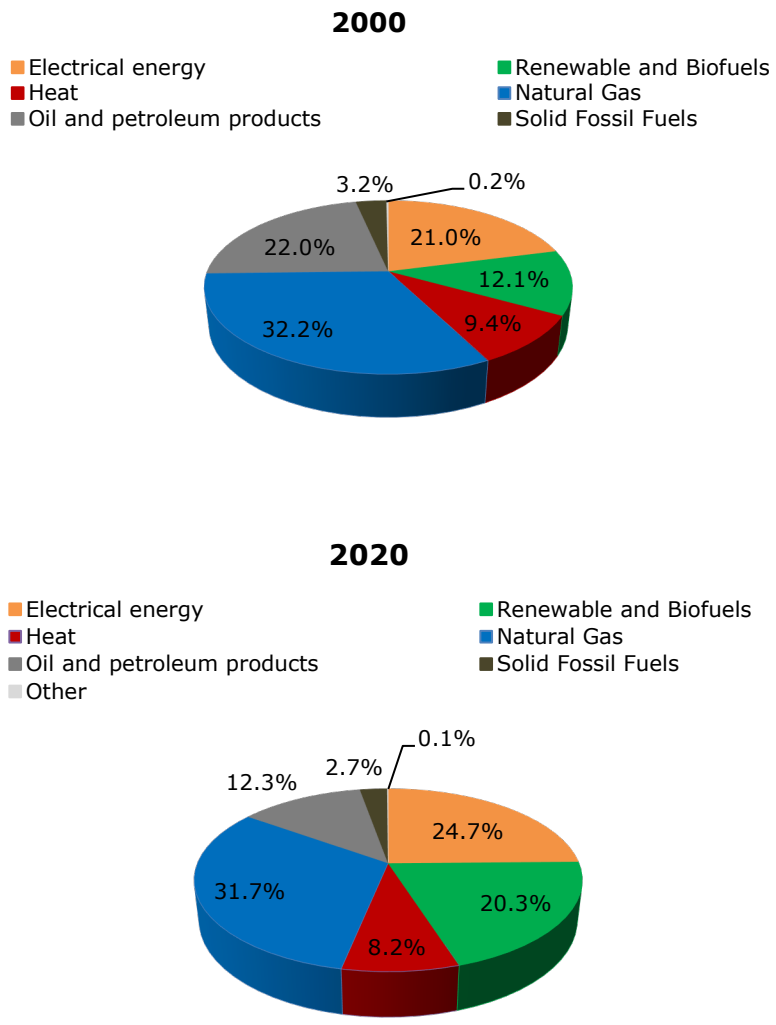


Source: Eurostat

When analysing the final residential energy per capita by Member State (Figure 31), it is observed that in 2020 the countries with highest consumption are Finland with 0.96 toe/cap, followed by Luxembourg (0.70 toe/cap) and Austria (0.75 toe/cap). In contrast, Malta, Portugal and Spain have the lowest rate with 0.20, 0.29 and 0.31 toe/cap respectively.

Twelve countries, registered a final energy consumption per capita below the value of EU-27 (< 0.55 toe/cap) in 2020. 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 except the Netherlands belong to the Eastern European area (Bulgaria, Slovakia, Romania, Slovenia, and Lithuania). This indicates that also cultural habits may influence the residential consumptions.

Figure 32: Share of fuel types to final residential energy consumption in the EU-27, 2000 and 2020



Source: Eurostat

Figure 32 shows the shares of each fuel type to final residential energy consumption. In 2020, natural gas has accounted for 31.7% of the consumption, followed by electrical energy (24.7%) and renewable energies and biofuels (20.3%). Compared to the year 2000, there are several changes in the ranking and the share of energy sources. For example, natural gas reduced its share but maintains the first ranking position also in the residential consumption in 2020. Electricity increased its share from 21.0% to 24.7% and maintained the second ranking position in both studied years. The share of renewable energies also increased from 12.1% to 20.3%, becoming the third contributor, while it was the fourth one in 2000. On the other hand, oil and

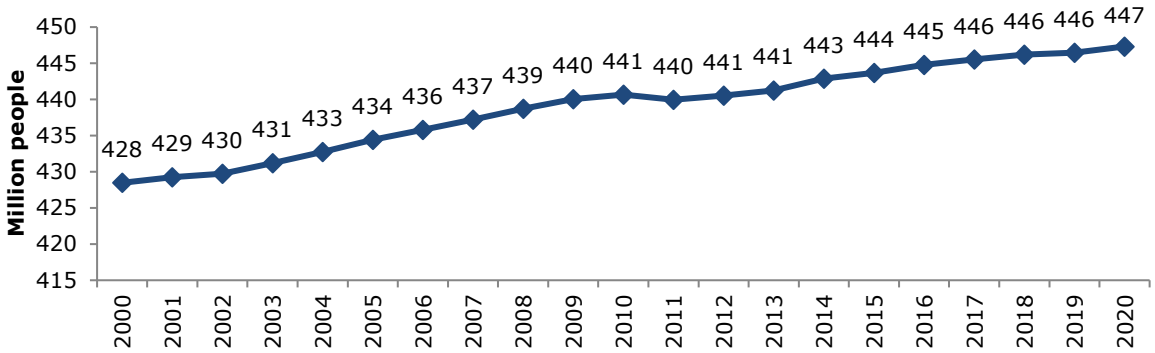
petroleum products reduced their share from 22.0% in 2000 to 12.3% in 2020. From 2019 to 2020, there are no changes in the ranking of energy sources and slight changes in their shares.

Natural gas and electricity are the main energy sources for the residential sector, their consumption trends were analysed independently later in this chapter. However, there are notable examples of Member States that do not 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. Heat is used for warming spaces 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 is equal to zero in these Member States.

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 (heating degree days), number of dwellings, average number of persons per household, average size of dwellings. Considering the influence of these factors can provide a better understanding of the relation between energy consumption and efficiency trends in the residential sector.

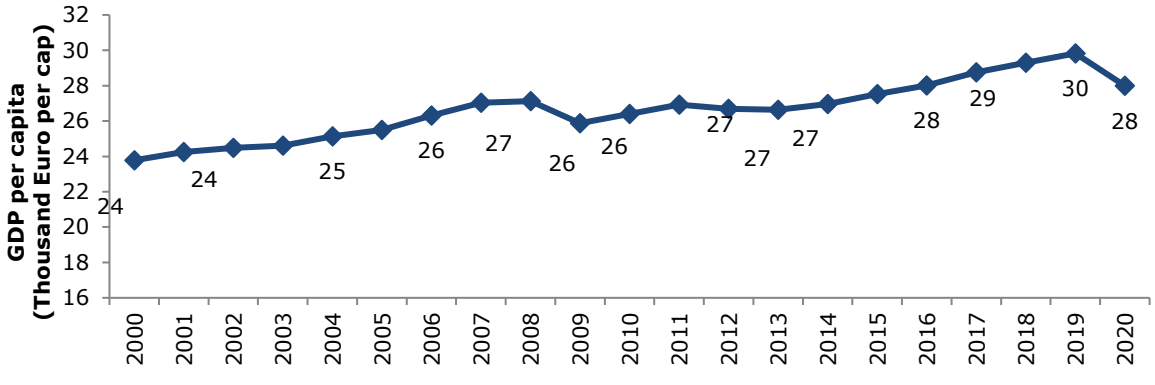
Figure 33: Population in the EU-27, 2000-2020



Source: Eurostat

Between 2000 and 2020, the population in the EU-27 grew by 4.4% (Figure 33). In the same period the residential final energy consumption dropped by 0.1%.

Figure 34: Gross Domestic Product per capita at market prices, chain linked volumes (2015), in the EU-27, 2000-2020



Source: Eurostat

Other factors that can influence the energy consumption are the economic development and the economic situation of the countries. GDP per capita in the EU-27 (Figure 34) was almost continuously increasing between 2000 and 2020 with a fall in 2009 due to the economic and financial crisis worldwide, two slight falls in 2012 and 2013 and an important fall in 2020. Between 2014 and 2019, the GDP per capita increased again by an annual average rate of 1.9% in the EU-27. GDP per capita reduction rate in 2020 was equal to 6.1% after six consecutive years of increases.

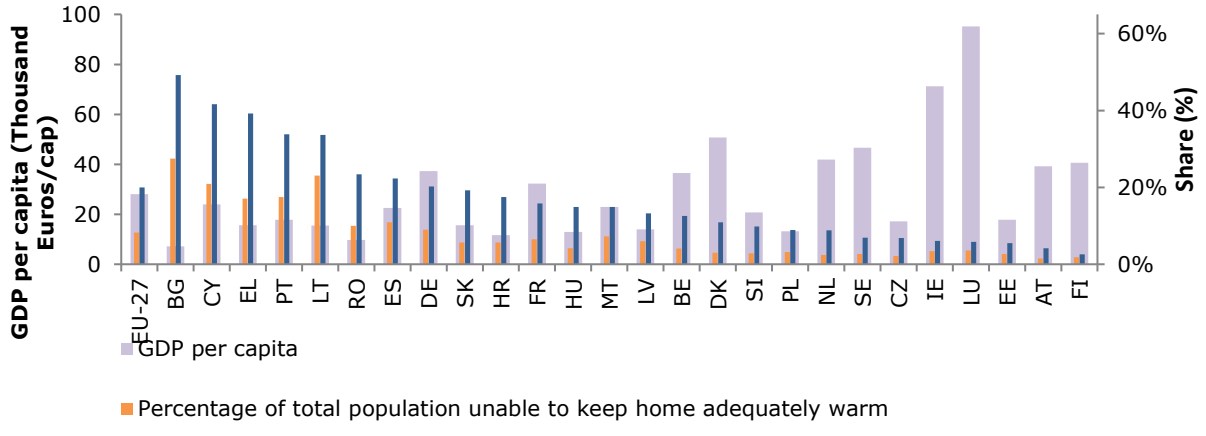
The GDP per capita in current market prices across countries[57] in the EU-27 for the year 2020 results largely dispersed (Figure 35). In 2020, it was EUR 7,128 in Bulgaria whereas it was EUR 95,178 in Luxembourg. In EU-27, the average GDP per capita in current market prices was EUR 27,998. While GDP per capita over the period 2000-2020 increased by 17.7%, final residential energy consumption per capita fell by 6.9% in the same period.

Given the large dispersion in GDP per capita in the EU-27, it is interesting to look at the disaggregated data per country for per capita final residential consumption (Figure 31). Finland, Luxembourg and Austria, which are the countries with highest consumption per capita, also have above EU-27 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 [8].

Indeed, Figure 35[58] shows that many Member States with GDP per capita levels below EU-27 and low final residential energy consumption values registered high percentages of people with inability to keep home adequately warm in both total and low-income population. For example, more than 20% of the population was unable to keep home adequately warm in Bulgaria and Romania (27.5% and 23.1%, respectively), while the percentages in population below the 60% of median equivalised income were above 30% (49.2% and 33.6%, respectively). On the other hand, Luxemburg and Finland, with high values of final residential energy consumption and of GDP per capita, registered low percentages of people not able to ensure the energy required for heating needs in both total (3.6% and 1.8%, respectively) and low income population (5.8% and 2.6%, respectively).

Figure 35: Gross Domestic Product per capita at market prices (chain linked volumes, 2015) and percentage of total and of below the 60% of median equivalised income population unable to keep home adequately warm in the EU-27 Member States, 2020



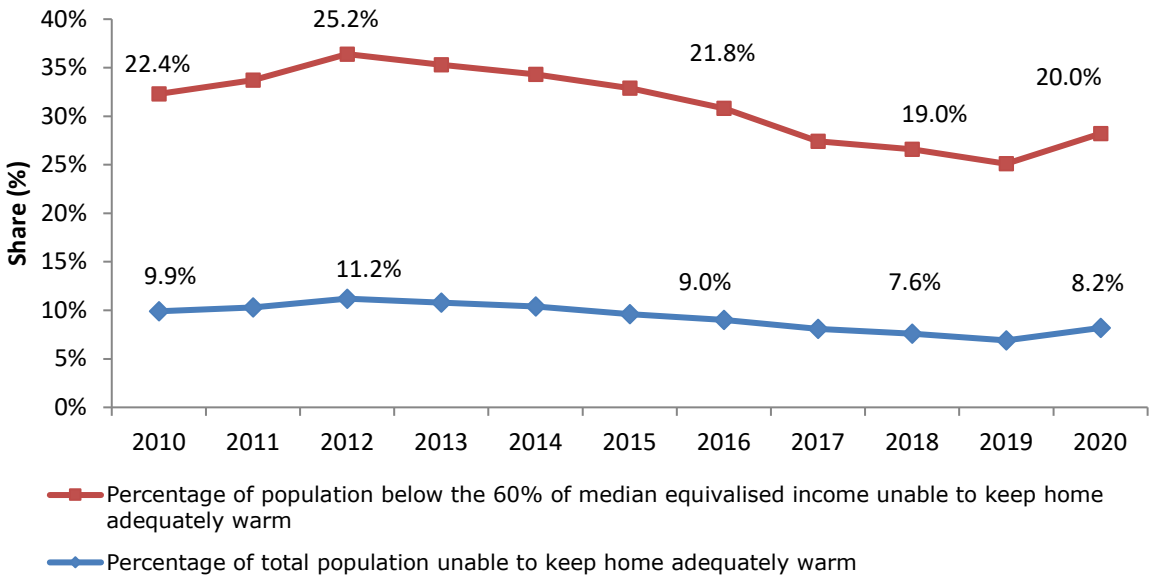
Source: Eurostat

[57] GDP at market prices, chain linked volumes (2015)

[58] Data for this indicator were 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.

Overall, the shares of people not able to keep home warm in total and low-income population decreased in EU-27 from 2010 to 2020 (Figure 36).

Figure 36: Percentage of total and of below the 60% of median equivalised income population unable to keep home adequately warm in the EU-27, 2010-2020



Source: Eurostat

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

It is clear that economic development is positively correlated with total final energy consumption. However, especially in the residential sector, economic growth in the EU can be accompanied by a more efficient usage of energy, due to the adoption of more efficient appliances and systems and better insulated buildings resulting in lower energy consumption levels. 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.

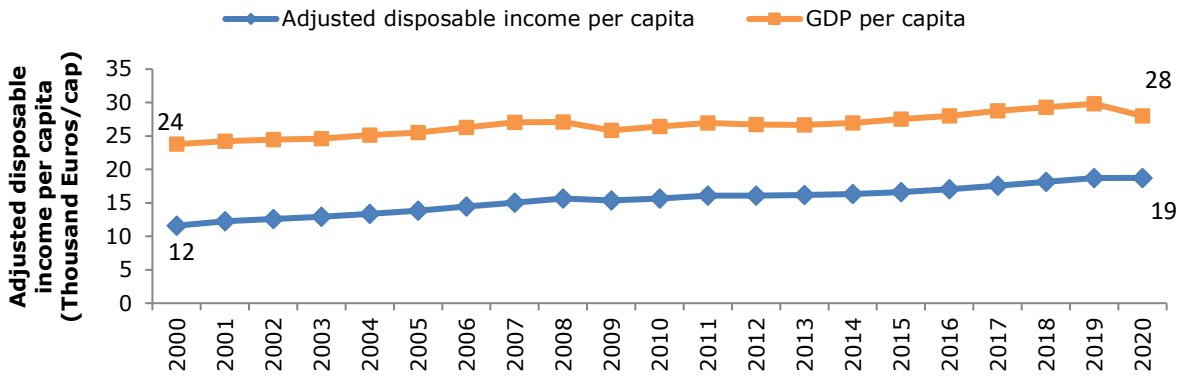
Although Gross Domestic Product is largely and traditionally used in energy statistics for obtaining key indicators such as energy intensity, the disposable income of households, or adjusted gross disposable income, which can represent a more interesting economic indicator for the analysis of residential 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 [9]. Figure 37 shows the trend-line comparison of both adjusted disposable income per

capita and GDP per capita for the 21-year period between 2000 and 2020. It can be observed that there is a notable difference between these two variables; in 2020, the difference reached EUR 9,259. Thus, the GDP, although largely used, can become an unfavourable indicator for end-users if adopted in the analysis of the residential sector, as it does not reflect the real purchasing power of the inhabitants.

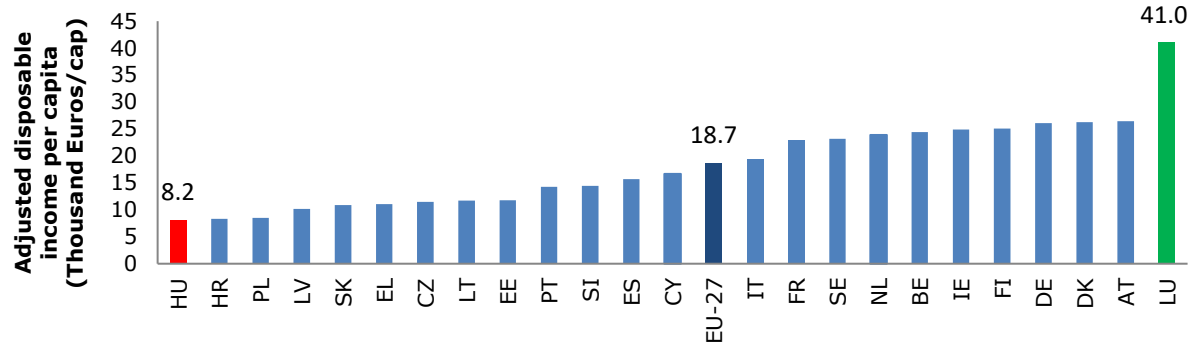
Figure 37: Adjusted disposable income per capita and GDP per capita at current market prices in the EU-27, 2000-2020



Source: Eurostat

Figure 38 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 2020. This may indicate that there is an important correlation between final residential energy consumption per capita and adjusted disposable income.

Figure 38: Adjusted disposable income per capita in the EU-27[59], year 2020

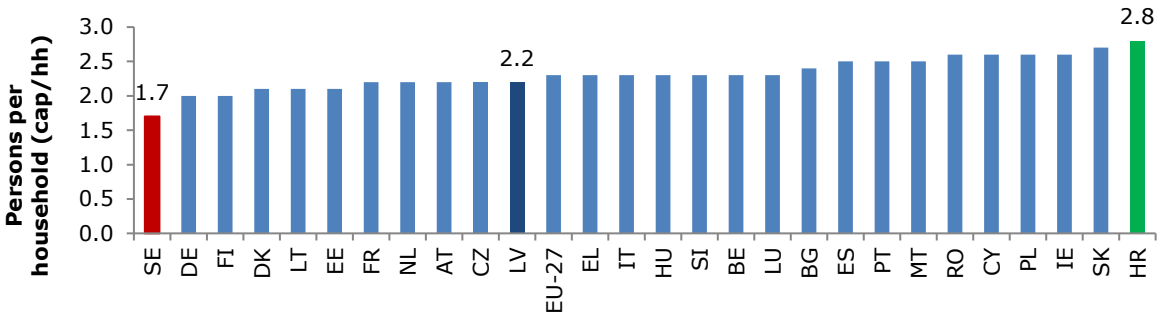


Source: Eurostat

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-27 was 2.3 in the year 2020. Sweden has the lowest average number of persons per household (1.7) and Croatia the highest (2.8) (Figure 39). The overall trend in Europe is an increase in population accompanied by an increase in the number of smaller households as – based on Eurostat data - the average number of people per household decreased from 2.4 to 2.3 during the period 2009-2020. In general, this may lead to a rise in the total final residential energy consumption.

[59] Provisional data are included. BG, RO, MT data are not available.

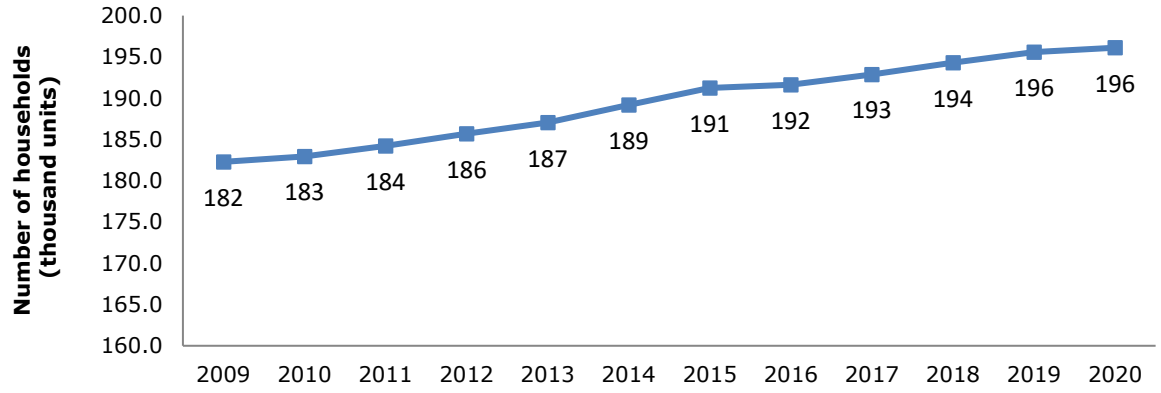
Figure 39: Persons per household in the EU-27 Member States, year 2020



Source: Eurostat

Although the number of private households in the EU-27 was continuously growing since 2009[60] and the size of houses in terms of persons per household slightly decreased, the final residential energy consumption follows a decreasing trend.

Figure 40: Number of private households (in thousands) in the EU-27, 2009-2020

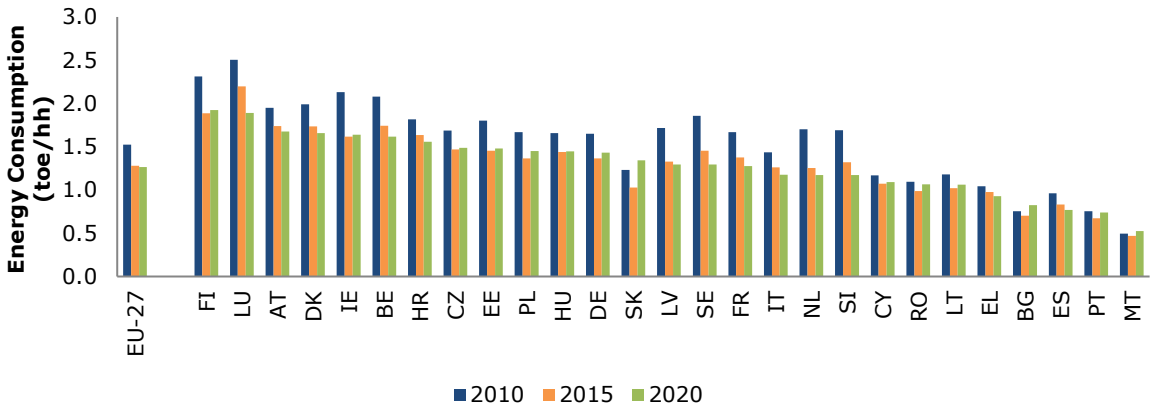


Source: Eurostat

Looking at the residential energy consumption per household in 2020 (Figure 41), it is possible to observe that Malta was the country with lowest energy consumption per household with 0.53 toe/hh, followed by Portugal (0.74 toe/hh) and Spain (0.77 toe/hh). In contrast, Finland (1.92 toe/hh), Luxembourg (1.89 toe/hh) and Austria (1.68 toe/hh) were the Member States with the highest residential energy consumption per household. Eleven of the Member States have residential energy consumption per household below the EU-27 value (1.27 toe/hh). Only Slovakia, Malta and Bulgaria increased their consumption in the 11-year period comprised between 2010 and 2020. The EU-27 energy consumption value per household dropped by 17.0% for the 11-year period between 2010 and 2020.

[60] Not available data before 2009

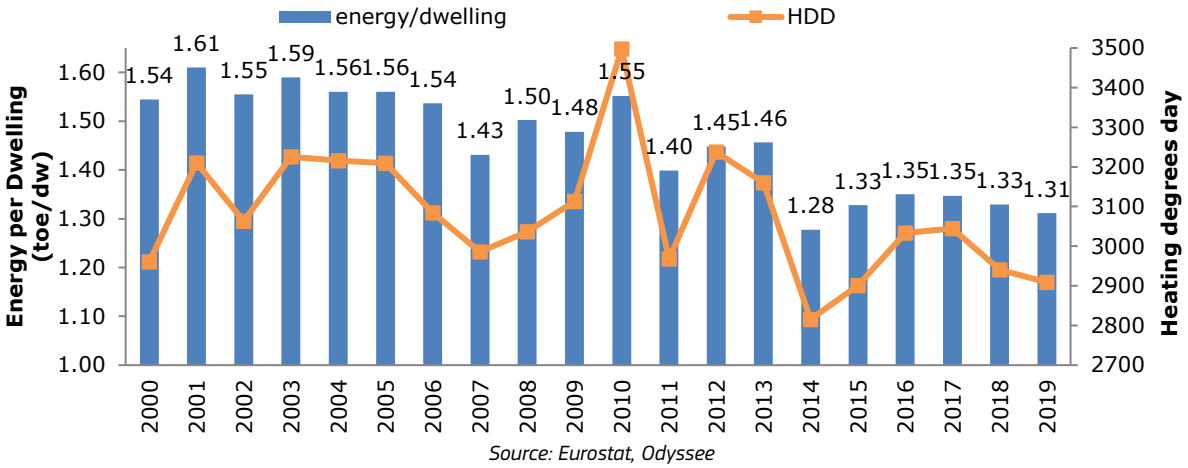
Figure 41: Final Residential energy consumption trends per household in the EU-27 Member States, 2010, 2015 and 2020



Source: Eurostat

The final residential energy consumption per dwelling also decreased during the 20-year period from 2000 to 2019 in the EU-27. In 2000, the residential consumption per dwelling was 1.54 toe/dw. In 2019, the consumption is 1.31 toe per dwelling, meaning a decrease of 15.1%. This may indicate an existing correlation between the energy consumption per dwelling and climatic conditions (heating degree days) (Figure 42). The final energy consumption per dwelling follows the HDDs with exception of year 2009, 2013 and 2017.

Figure 42: Final residential energy consumption per dwelling[61] and Heating Degree Days in the EU-27, 2000-2019

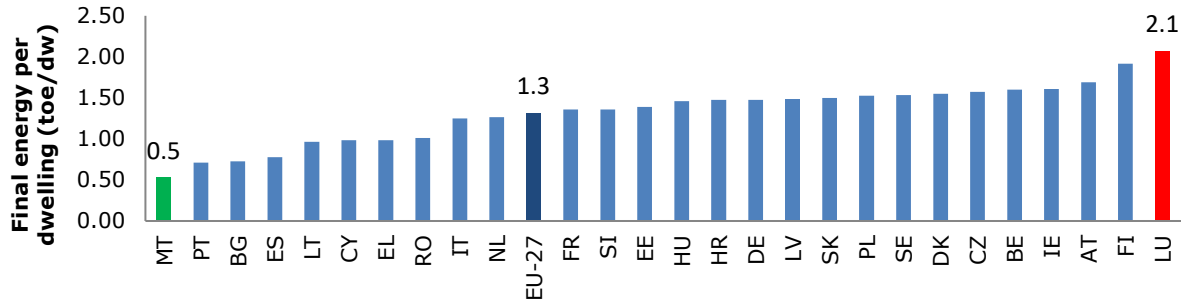


Source: Eurostat, Odyssee

The average final residential energy consumption per dwelling in the EU-27 varied among the Member States in 2019 (Figure 43). Among the Member States with available data, Luxembourg registered the highest consumption (2.1 toe/dw) and Malta (0.5 to/dwe) the lowest.

[61] Final residential energy consumption per dwelling was calculated by the report authors as the ratio between the final residential energy consumption and the stock of permanently occupied dwellings in the EU-27 as made available by Odyssee.

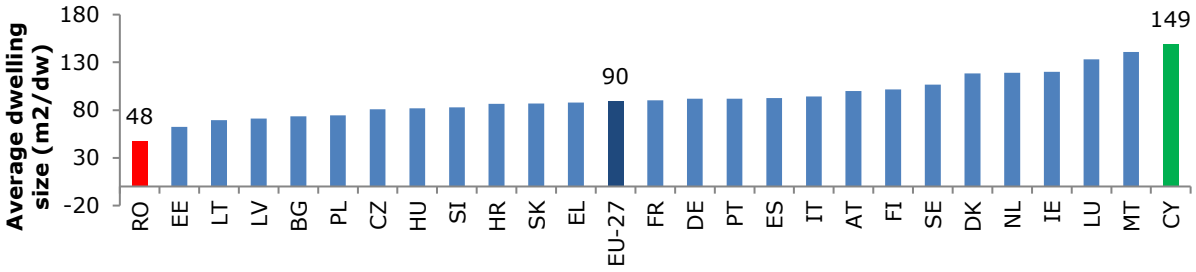
Figure 43: Final residential energy consumption per dwelling in the countries with available data year 2019[62]



Source: JRC calculation based on Eurostat and Odyssee

In addition to the number of people per household, the actual size in square metres of dwellings is another interesting driver of households' energy consumption (Figure 44). 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. Cyprus, Malta and Luxemburg are the Member States with the largest average size of dwellings.

Figure 44: Average size of dwellings for countries with available data in the EU-27, year 2019[63]

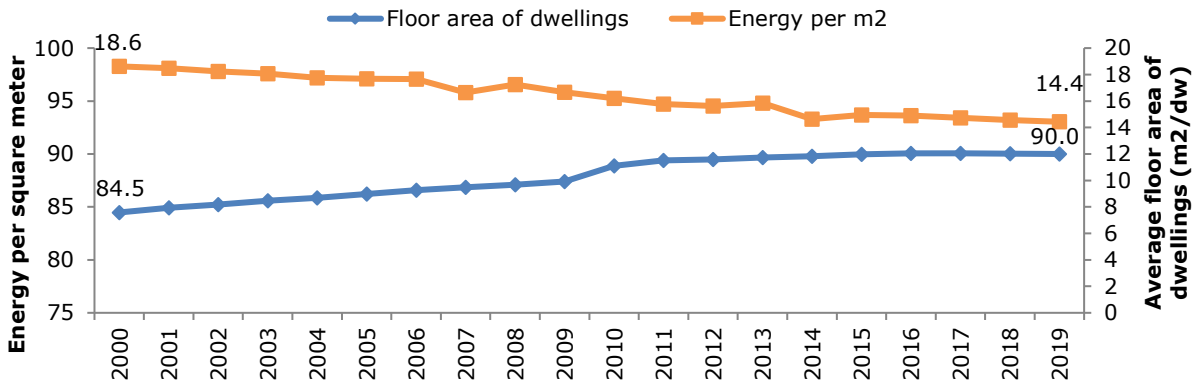


Source: Odyssee data

However, the average size of dwelling did not considerably change between 2000 and 2019: it increased by 5.5 m^2 in the whole period as shown in Figure 45. The decrease in the consumption per dwelling during the same period can thus not be explained by smaller dwellings, and it may be the result of higher share of more efficient equipment and appliances and other improvements in building elements, for example better building's envelopes.

[62] Incomplete data for more recent years
[63] Incomplete data for more recent years

Figure 45: Average energy per unit of area[64] a year and floor size in the EU-27, 2000-2019



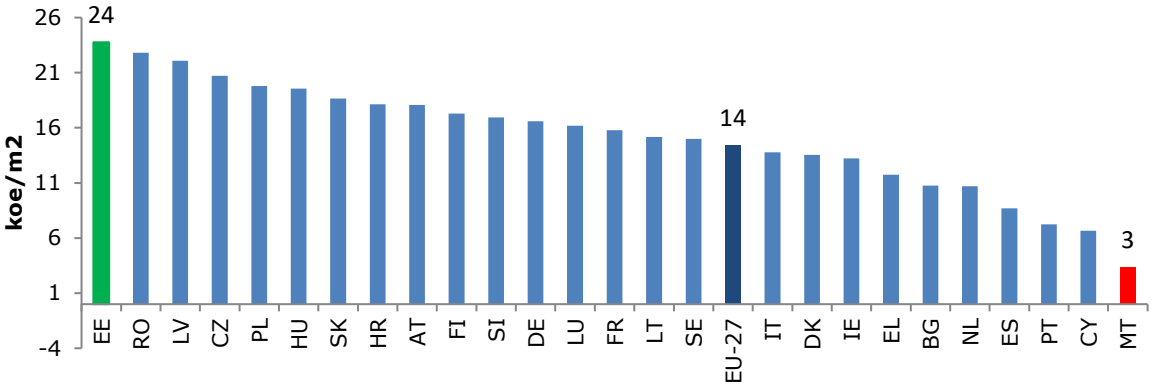
Source: Odyssee

The average energy per unit of area at EU-27 level was 14.4 koe/m^2 in 2019 (Figure 45). This represents a drop of 22.5% compared to 2000. 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-27 Member States for the year 2019 (figure 46).

In 2019, Member States with the highest residential energy consumption per floor area were Estonia and Romania (23.8 and 22.8 koe/m^2 respectively). On the other hand, the Member States with the lowest values were Malta and Cyprus (3.4 and 6.7 koe/m^2 respectively).

Figure 46: Average residential energy consumption per floor area in the countries with available data, 2019



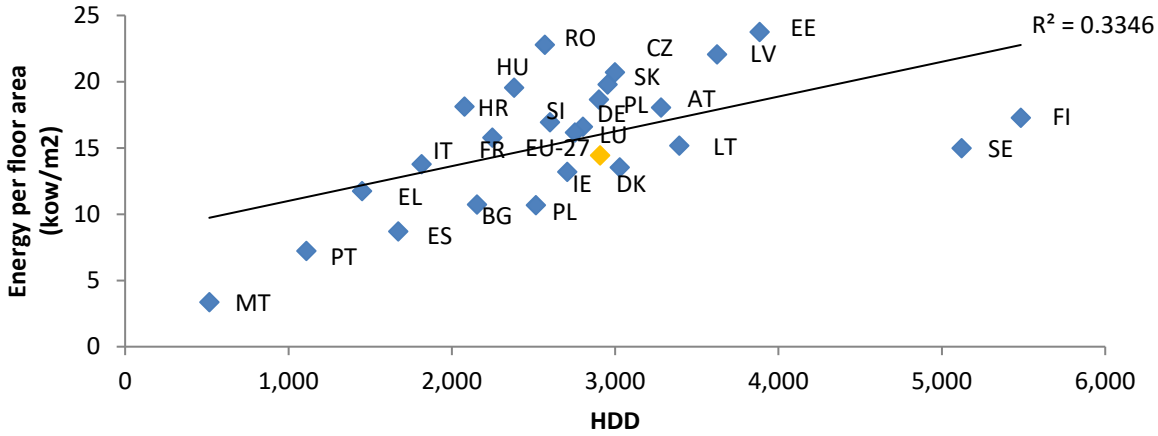
Source: Odyssee[65]

The correlation between climatic conditions and energy consumption per square metre is also presented in Figure 47. 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 47, 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 more efficient 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.

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

[65] 2020: incomplete data

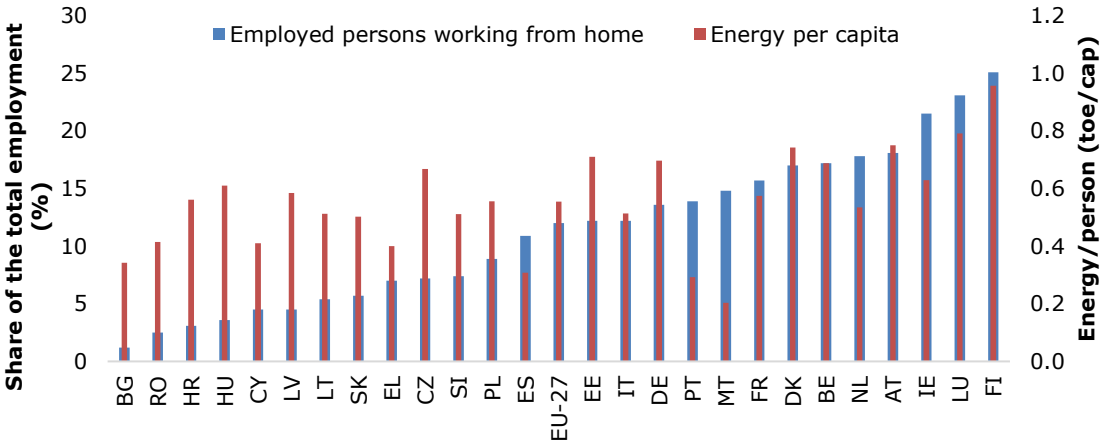
Figure 47: Average energy per unit area climatic corrected[66] vs heating degree days in the EU-27 Member States[67], year 2019



Source: Eurostat (HDD), Odyssee (energy per floor are)

Teleworking from home was a common measure adopted by national authorities in 2020 to confront COVID-19 pandemic. The increased teleworking activities probably could lead to increase of energy consumption in residential sector. The following figure compares the residential final energy consumption per capita in 2020 with the persons working from home[68] as a percentage of the total employment in the same year. Finland and Luxembourg had the highest values of energy per capita in the residential sector as well as the highest percentages of persons that teleworked.

Figure 48: Average residential energy consumption per capita and persons working from home as a percentage of the total employment in the EU-27 Member States, 2020



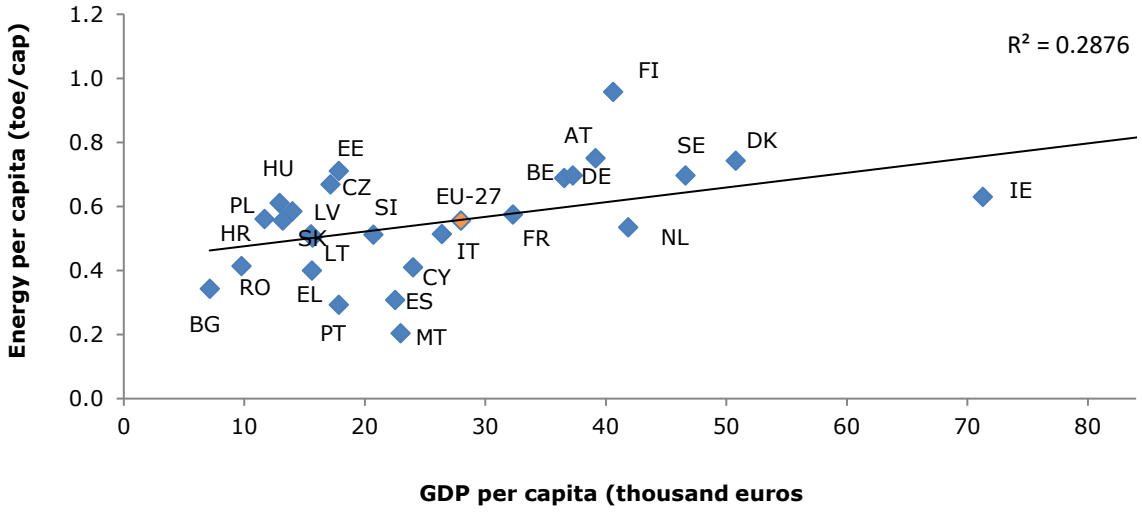
Source: Eurostat

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 value[69] of the Figure 49 ca not lead to a clear conclusion regarding the correlation between residential energy consumption and GDP. However, it is 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 higher correlation between GDP per

[66] Unit consumption per m2 (koe/m2): Calculated by Odyssee. It relies on the energy consumption of dwellings (climate corrected) to the average size of dwelling (m2).
[67] BE, CY: not available data for 2019. Incomplete data for more recent years
[68] Employed person from 15 to 64 years
[69] 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.

capita and energy consumption. Moreover, there are countries registering relatively low levels of energy per capita (below the 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 sources' and improved buildings characteristics.

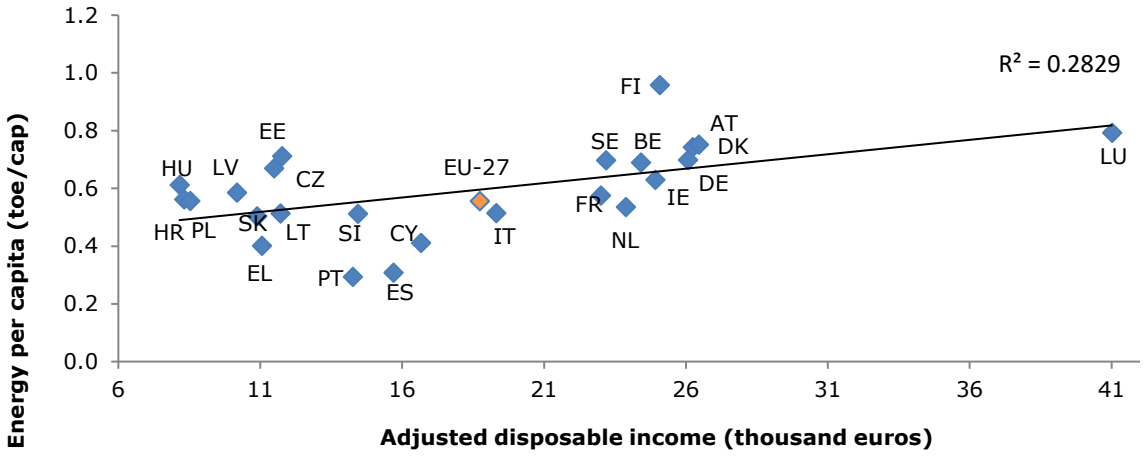
Figure 49: Residential energy per capita and GDP per capita[70] for EU Member States, Year 2020



Source: Eurostat

In the case of adjusted disposable income, the correlation seems to be 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.

Figure 50: Residential energy per capita and adjusted disposable income in euros for EU Member States[71], Year 2020

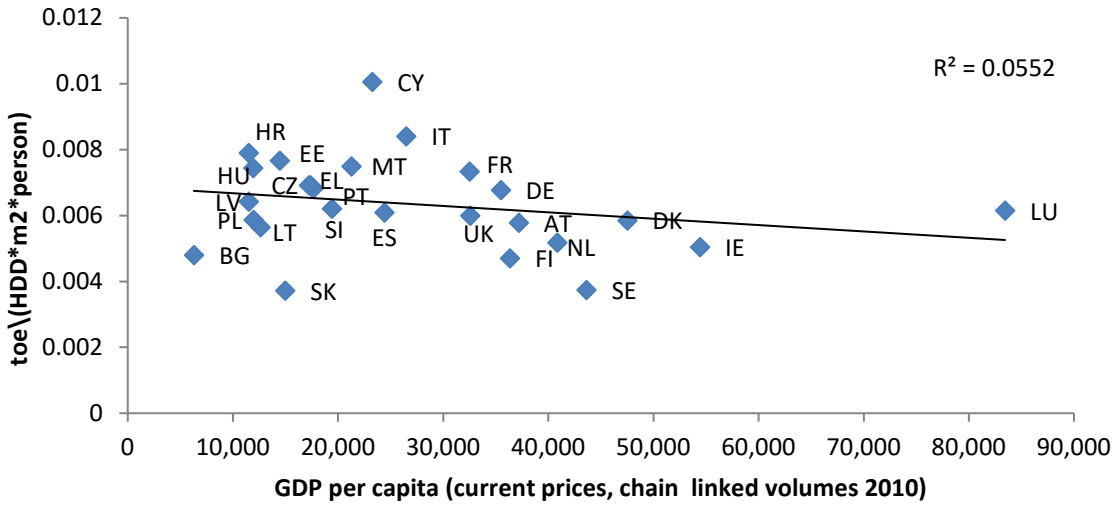


Source: Eurostat

Finally, Figure 51 shows that there is a low degree of negative correlation between climatic corrected residential final energy consumption per capita and per average floor area (toe/(HDD*m^2*pop) and GDP per capita (current market prices, chain linked volumes 2015).

[70] GDP at market prices, current prices, chain linked volumes (2015)
[71] MT, BG and RO excluded due to incomplete data. Estimated data are included

Figure 51: Residential energy normalized by HDD[72], $m^{2,}$ and population, and GDP per capita for EU Member States[73], Year 2019[74]



Source: Eurostat, Odyssee

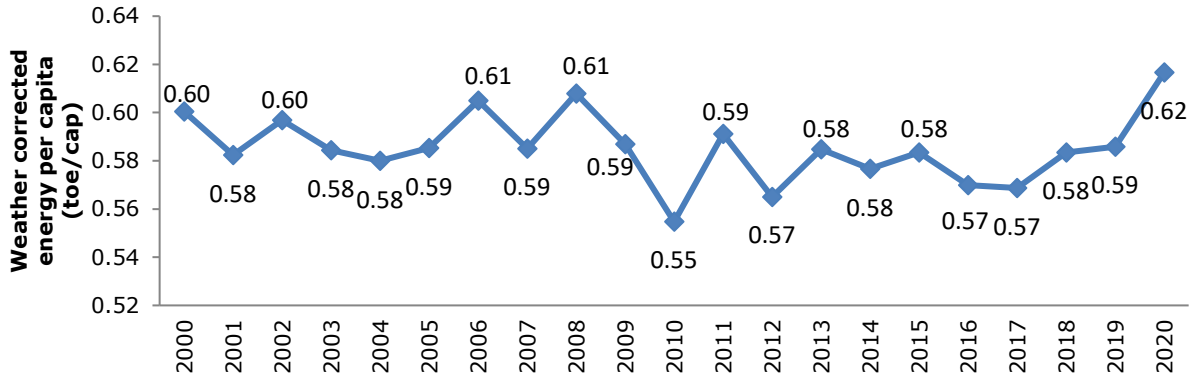
Residential consumption per capita climatic corrected[75] in EU-27 increased slightly by 2.7% from 2000 to 2020, while it increased by 5.2% in 2020 compared to 2019. (Figure 52)

Figure 53 shows that residential consumption per capita normalized by GDP per capita (energy intensity of residential sector) decreased by 41.3% during the 21-year analysed period while it recorded an increase of 4.6% in 2020 compared to 2019.

Figure 54 shows that residential energy consumption per capita normalized by HDD, GDP per capita and average floor area decreased by 46.4% from 2000 to 2019[76]. The trend is mainly bound to the growing trends of income levels (GDP) and the average size of dwellings in terms of square meter per person. The alterations in the trend may be explained by the influence of the factors. For instance, in 2007, a mild winter and the rise of GDP per capita led to lower normalized energy consumption. Opposite occurred in 2009, despite the fact of not being a severe winter, the GDP reduction due to the impact of the financial and economic crisis made the normalized value rise by 1.1% 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. Figure 54 showed that, if the final residential energy consumption is isolated from the climatic conditions, the economic growth (increase of GDP per capita) and the increase in the population and in the average floor area, it has experienced a gradual decrease in the analysed period, related to efficiency improvements.

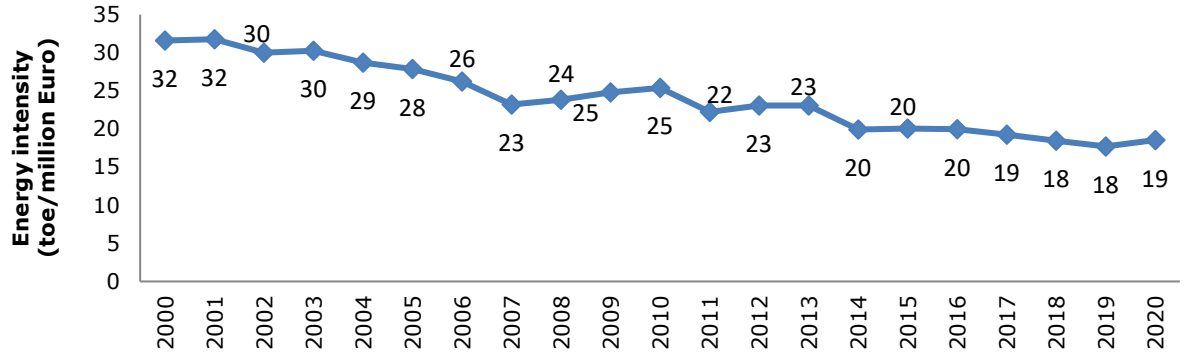
[72] HDD normalization: HDD of Member State/mean HDD of EU-27 Member States for 2019
[73] BE excluded due to incomplete data.
[74] Incomplete data for 2020
[75] Climatic correction: EU-27 HDD/ EU-27 Mean HDD of reference period 2000-2020
[76] Incomplete data for 2020

Figure 52: Residential final energy consumption per capita climate corrected in EU-27, 2000-2020



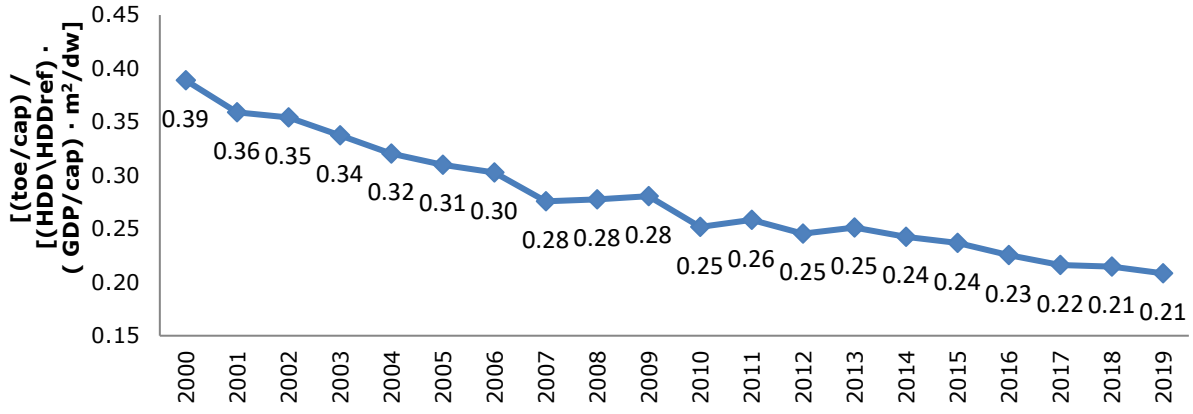
Source: Eurostat

Figure 53: Residential final energy consumption per capita normalized by GDP per capita (energy intensity of residential sector)[77] in EU-27, 2000-2020



Source: Eurostat

Figure 54: Residential energy per capita, normalized by HDD[78], GDP per capita[79] and average floor area in the EU-27, 2000-2020



Source: Odyssee, Eurostat

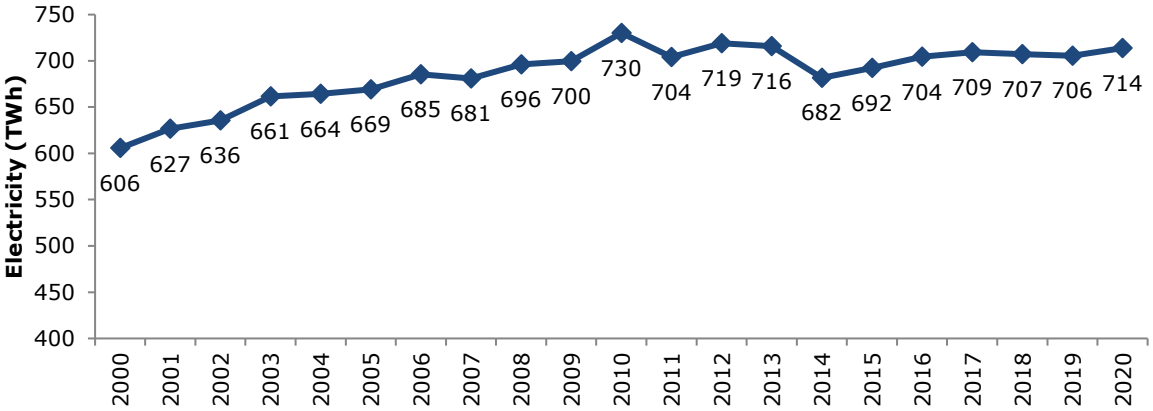
[77] GDP at current market prices, chain linked volumes (2015)
[78] HDD normalization: HDD of year/mean HDD of the period 2000-2020
[79] GDP at current market prices, chain linked volumes (2015)

3.2 Electricity consumption trends in the residential sector

Electricity accounted for 24.7% of the final residential energy consumption in the EU-27 in 2020. This is the second highest share after natural gas consumption share (31.7%). The final residential electricity consumption in the EU-27 grew by 17.8% in the period between 2000 and 2020. The electricity consumption reached 713.7 TWh in 2020.

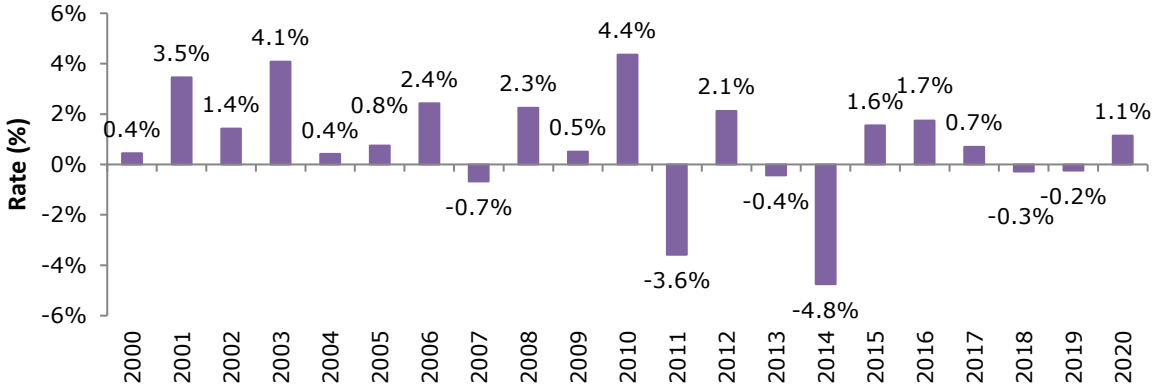
The highest consumption level during the analysed period was registered in 2010, when the final electricity consumed grew up to 730.2 TWh (Figure 55). Between 2000 and 2010, the final electricity consumption in the residential sector was continuously increasing (with the only exception of year 2007). After the peak in 2010 the consumption started to fluctuate, registering the most significant drops in 2011 (-3.6%) and 2014 (-4.8%). In 2020, it increased by 1.1%.

Figure 55: Final residential electricity consumption in the EU-27, 2000-2020



Source: Eurostat

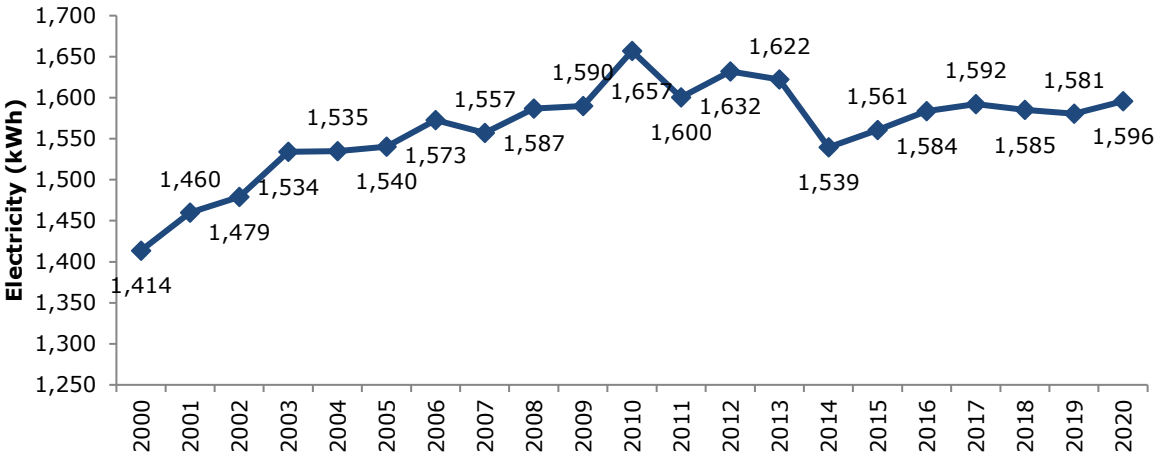
Figure 56: Final residential electrical energy consumption annual consumption rates in the EU-27, 2000-2020



Source: Eurostat

The final residential electricity consumption per capita in the EU-27 grew by 12.9% between 2000 and 2020 (Figure 57). The average per capita electricity consumption in the residential sector was 1,596 kWh in 2020.

Figure 57: Final residential electricity consumption per capita in the EU-27, 2000-2020

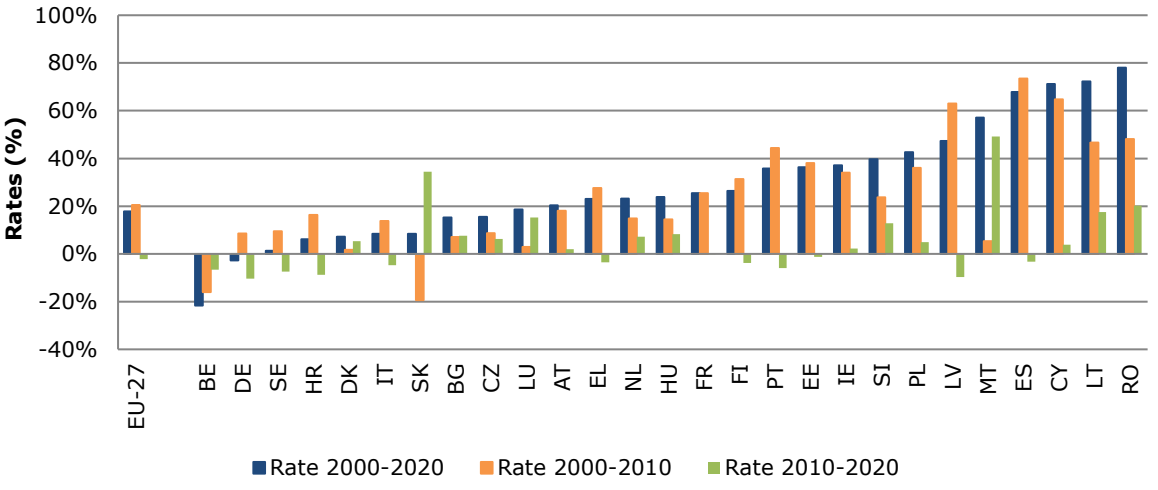


Source: Eurostat

Concerning final residential electricity consumption rates across the EU-27 Member States for the period 2000-2020, it can be observed that nine Member States registered rates below the EU-27 growth rate (17.8%).

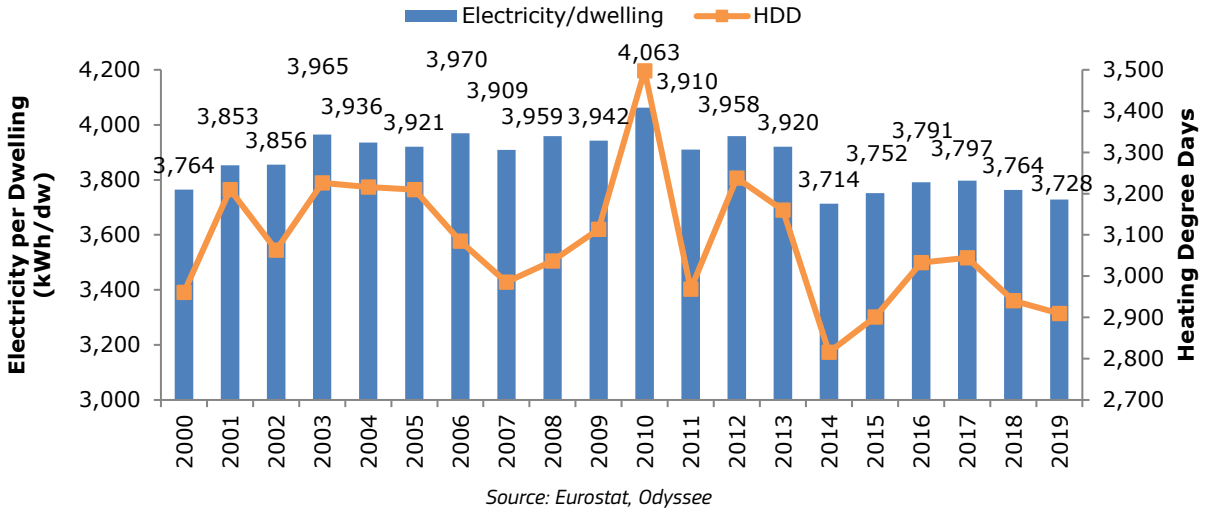
The Member State with the highest reduction rate was Belgium with -21.7%, followed by Germany (-2.7%) and the lowest growth rate was found in Sweden (1.3%). The Member States with the highest growth rates were Romania (77.8%), Lithuania (72.3%), and Cyprus (71.2%). It is important to note that the majority of the countries with Mediterranean climate (Spain, Cyprus, Greece, Portugal, and Malta) registered growth rates above the one EU-27 for the period 2000-2020. This may was the result of climate change leading to the increase of the cooling needs. Figure 58 shows the rates for three different periods. It can be noticed that in some cases 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 73.5% for the period 2000-2010 to a decreasing trend of 3.2% for the period 2010-2020. Sixteen countries experienced a growth rate in the period 2010-2020. The highest growth rate in that period took place in Malta (49.2%).

Figure 58: Final residential electricity consumption rates in the EU-27 by Member State; 2000-2020, 2000-2010 and 2010-2020



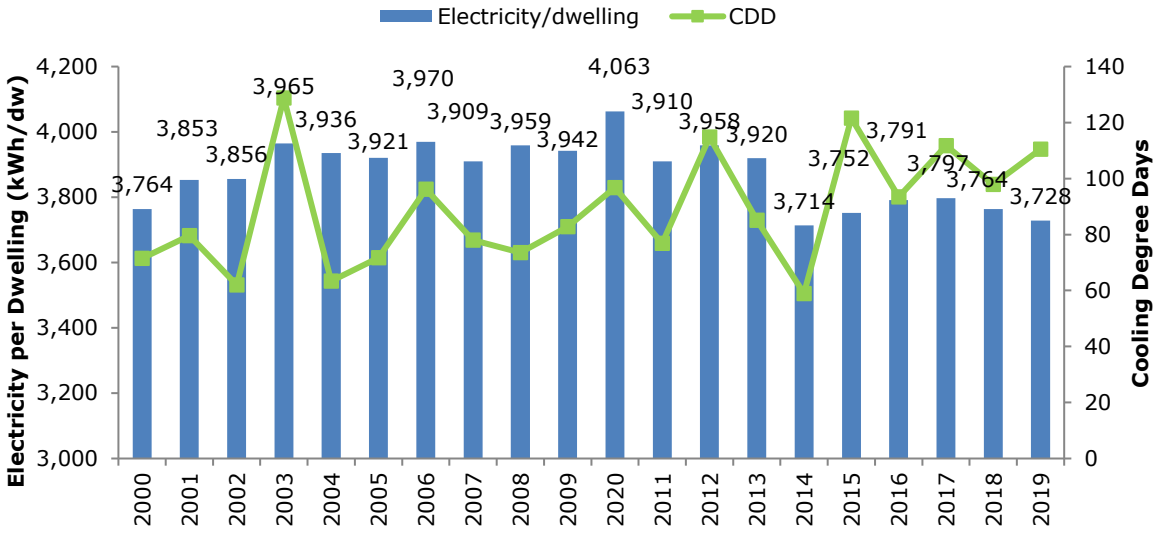
Source: Eurostat

Figure 59: Residential electricity consumption per dwelling[80] and heating degree days in the EU-27, 2000-2019



Source: Eurostat, Odyssee

Figure 60: Residential electricity consumption per dwelling[81] and cooling degree days in the EU-27, 2000-2019



Source: Eurostat, Odyssee

The residential electricity consumption per dwelling was 3,728 kWh/dw in 2019, the second lowest value registered during the period 2000-2019 after year 2014 (3,714 kWh/dw). Over the period 2000-2019, this value reduced by 0.9% (Figure 59). This trend was inversed several times during the whole 20-year period. It is observed a positive correlation between the consumption per dwelling and the heating degree days with exceptions of the years 2006 and 2009. This highlight the impact of other factors on consumption trends, as the 2009 figures could be related to an income effect as GDP drop significantly that year.

Figure 60 shows that there is also a positive correlation between residential electricity consumption per dwelling and the Cooling Degree Days with the exceptions of years 2005, 2008, 2009, 2016 and 2019. This indicates that an important amount of electricity is used for space cooling. Moreover, it could also explain the consumption growth in 2006 despite lower HDD, as the highest CDD figure was registered that year.

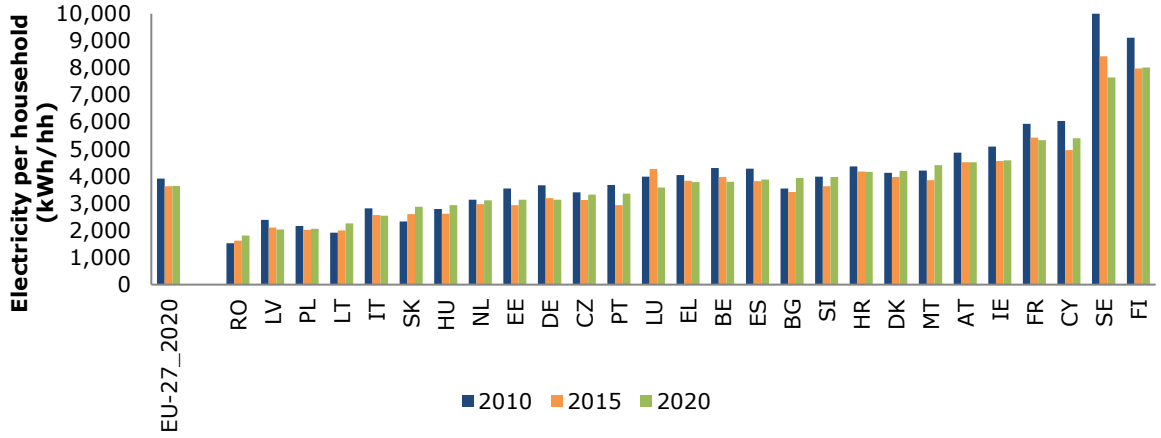
Looking at the electricity consumption per household in 2020 (Figure 61), it is possible to observe that Romania was the country with lowest electricity consumption per household with 1,812 kWh, followed by

[80] Residential electricity consumption per dwelling was calculated by the report authors as the ratio between the final residential energy consumption and the stock of permanently occupied dwellings) in the EU-27 as made available by Odyssee.

[81] Residential electricity consumption per dwelling was calculated by the report authors as the ratio between the final residential energy consumption and the stock of permanently occupied dwellings) in the EU-27 as made available by Odyssee.

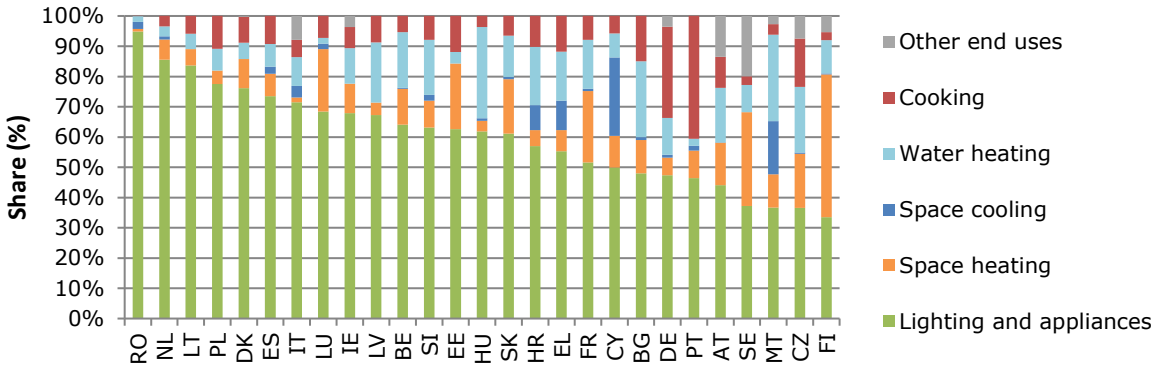
Latvia (2,033 kWh) and Poland (2,061 kWh). In contrast, Finland (8,018 kWh), Sweden (7,652 kWh) and Cyprus (5,406 kWh) were the Member States with the highest residential electricity consumption per household. Thirteen of the Member States have residential electrical energy consumption per household below the EU-27 value. Only four Member States have increased their consumption in the 11-year period comprised between 2010 and 2020 (Romania, Hungary, Slovakia and Bulgaria).

Figure 61: Residential electricity consumption trends per household by Member State in the EU-27; 2010, 2015 and 2020



Source: Eurostat

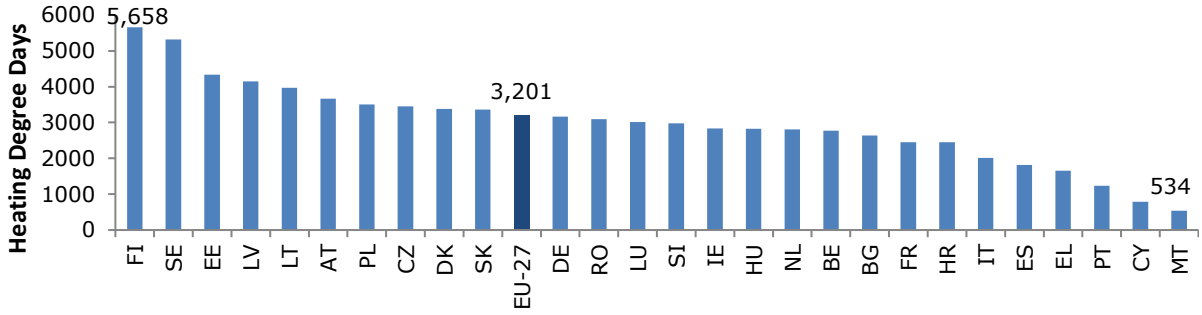
Figure 62: Residential electricity consumption by type of end-use in the EU-27 Member States, 2018



Source: Eurostat

Figure 62 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 consumed a relevant part of electricity for space heating. Germany and Portugal consumed over 30% of electricity for cooking while Hungary consumed more than 30% for water heating. Finally, some Member States with Mediterranean climate like Malta and Cyprus, consumed a notable share for space cooling needs (up to 26% in Cyprus).

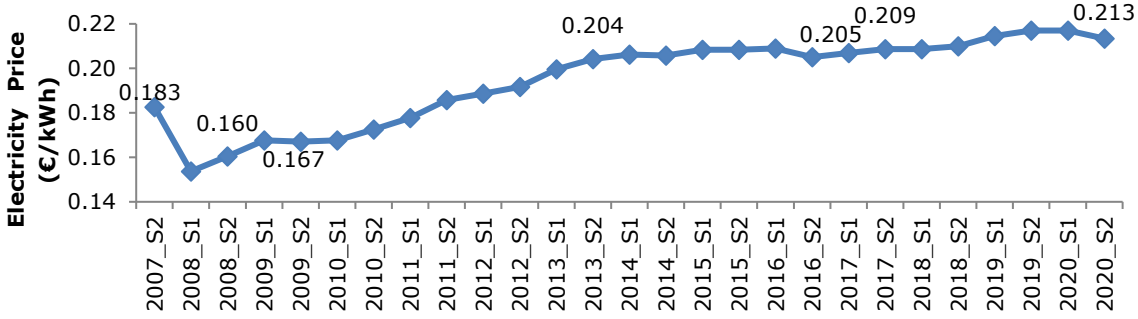
Figure 63: Mean Heating Degree days (1980-2020) in the EU-27 by Member State



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 63 shows the mean heating degree days in the EU-27 by Member State between 1980 and 2020. The EU-27 Member States with the highest values are Finland, Sweden and Estonia, corresponding to those with the highest heating shares in their electricity consumption.

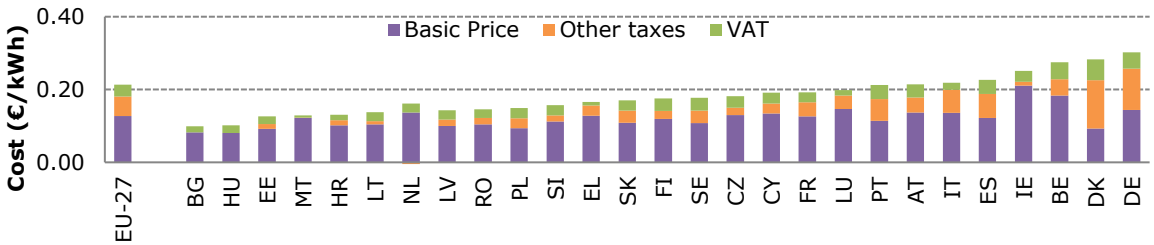
Figure 64: Electricity prices for household consumers in the EU-27 by semesters, band DC - all taxes and levies included, 2007S2-2020S2



Source: Eurostat

Electricity expenses are a cost to consider. In 2020, the average EU-27 expenses per household for electricity were EUR 776.7[82]. The electricity price for household consumers has continuously grew during the last years (Figure 64) with the exception of the years 2008, when prices drop to EUR 0.154/kWh in the first semester and the minor decreases 2009_S2, 2015_S2, 2014_S2, 2016_S2 and 2020_S2. The electricity prices in the EU-27 increased by 16.9% between the second semester of 2007 and that of 2020, rising from EUR 0.183/kWh to EUR 0.213/kWh.

Figure 65: Electricity prices for household consumers in the EU-27 Member States, band DC, 2020

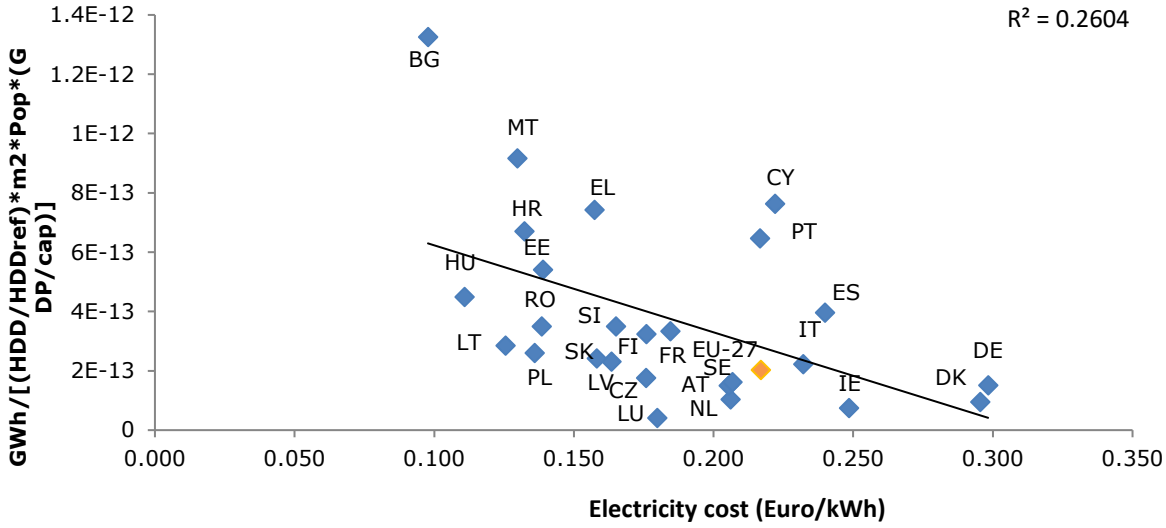


Source: Eurostat

[82] This value was calculated from the average total electricity price for household consumers (band DC) multiplied by residential electricity consumption per household.

Looking at the electricity prices across the EU-27 Member States for the year 2020 (Figure 65), Germany has the highest electricity price (EUR 0.303/kWh) followed by Denmark (EUR 0.283/kWh) and Belgium (EUR 0.275/kWh). The lowest electricity prices are found in Bulgaria (EUR 0.099/kWh), Hungary (EUR 0.102/kWh) and Estonia (EUR 0.126/kWh). To be noted that Denmark and Germany registered the highest shares of taxes and levies in the total electricity price (67.0% and 52.4% respectively). The respective EU-27 percentage of taxes and levies was 37.3% in year 2020.

Figure 66: Electricity consumption normalized by HDD[83], m², population and GDP per capita[84] vs electricity prices[85] for EU Member States[86] , Year 2019



Source: Eurostat, Odyssee

The trend-line of the Figure 66 shows the correlation between the electricity price and the electricity consumption of the residential sector adjusted to take into account population, floor area of dwellings, climatic and economic factors. As expected, electricity consumption decreases if the 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-27 Member States. It provides with electricity consumption at residential sector for years 2000, 2010 and 2020, as well as with the rates over different periods. The data have been already introduced and analysed along the chapter.

Table 2: Overview of final residential electricity consumption in the EU-27 Member States, 2000-2020

	2000 (GWh)	2010 (GWh)	2020 (GWh)	2000-2020 (%)	2000-2010 (%)	2010-2020 (%)
EU-27	605,719	730,178	713,739	17.8%	20.5%	-2.3%
BE	23,738	19,925	18,597	-21.7%	-16.1%	-6.7%
BG	9,858	10,559	11,356	15.2%	7.1%	7.5%
CZ	13,822	15,028	15,972	15.6%	8.7%	6.3%
DK	10,215	10,389	10,946	7.2%	1.7%	5.4%
DE	130,500	141,700	127,032	-2.7%	8.6%	-10.4%
EE	1,466	2,023	1,998	36.3%	38.0%	-1.2%
IE	6,375	8,546	8,738	37.1%	34.1%	2.2%
EL	14,207	18,130	17,486	23.1%	27.6%	-3.6%

[83] HDD normalization: HDD of Member State/mean HDD of EU-27 Member States for 2019
[84] GDP at current market prices, chain linked volumes (2015)
[85] Includes all taxes and levies
[86] Excludes BE due to incomplete data

ES	43,619	75,679	73,224	67.9%	73.5%	-3.2%
FR	128,720	161,520	161,499	25.5%	25.5%	0.0%
HR	5,729	6,664	6,077	6.1%	16.3%	-8.8%
IT	61,112	69,550	66,212	8.3%	13.8%	-4.8%
CY	1,055	1,738	1,806	71.2%	64.7%	3.9%
LV	1,189	1,938	1,751	47.3%	63.0%	-9.6%
LT	1,767	2,590	3,044	72.3%	46.6%	17.5%
LU	792	815	940	18.6%	2.9%	15.3%
HU	9,792	11,202	12,129	23.9%	14.4%	8.3%
MT	559	589	878	57.2%	5.4%	49.1%
NL	20,019	22,994	24,645	23.1%	14.9%	7.2%
AT	14,962	17,657	18,006	20.3%	18.0%	2.0%
PL	21,034	28,615	30,006	42.7%	36.0%	4.9%
PT	10,056	14,522	13,656	35.8%	44.4%	-6.0%
RO	7,652	11,329	13,620	78.0%	48.1%	20.2%
SI	2,601	3,219	3,634	39.7%	23.8%	12.9%
SK	5,419	4,370	5,874	8.4%	-19.4%	34.4%
FI	17,441	22,904	22,040	26.4%	31.3%	-3.8%
SE	42,020	45,982	42,573	1.3%	9.4%	-7.4%

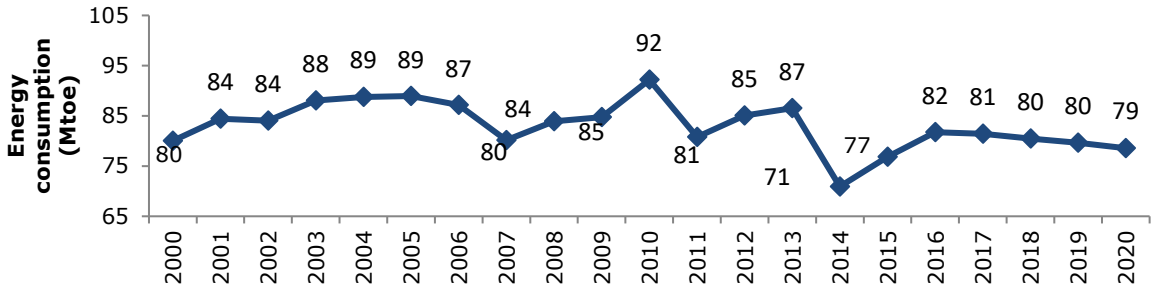
Source: Eurostat

3.3 Natural gas consumption trends in the residential sector

Natural gas consumption accounted for 31.7% of the final residential energy consumption in the EU-270 in 2020, confirming it as the main source of final energy in the residential sector. The residential natural gas consumption in the EU-27 (Figure 67) dropped by 1.8% in the 21-year period between 2000 and 2020 and by 1.3 from 2019 and 2020. The gas consumption reached 78.6 Mtoe in 2020.

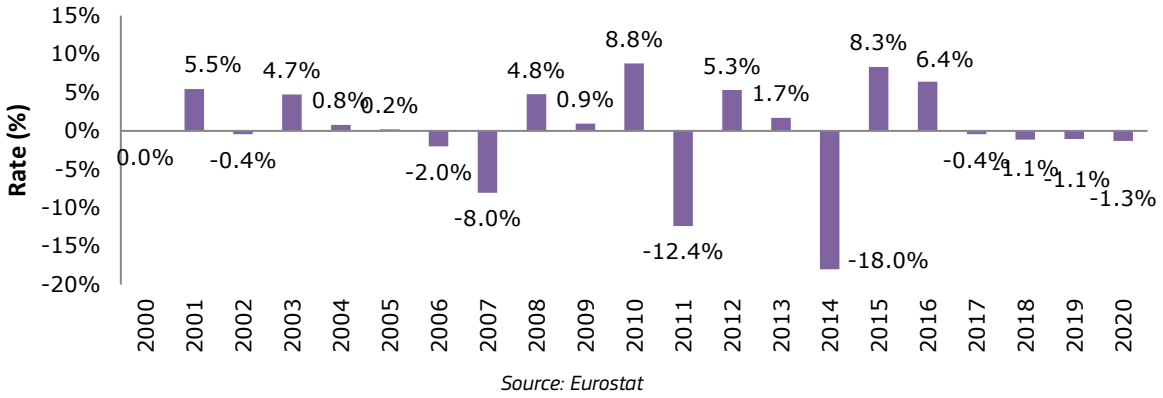
The highest consumption during the period 2000- 2020 occurred in 2010 when it reached 92.2 Mtoe. In the same year, the price registered the highest growth rate compared to the previous year (8.8%). In contrast, the highest drops occurred in 2011 and 2014 when gas consumption decreased by 12.4% and 18.0% compared to previous years (Figure 68).

Figure 67: Final residential natural gas consumption trends in the EU-27, 2000-2020



Source: Eurostat

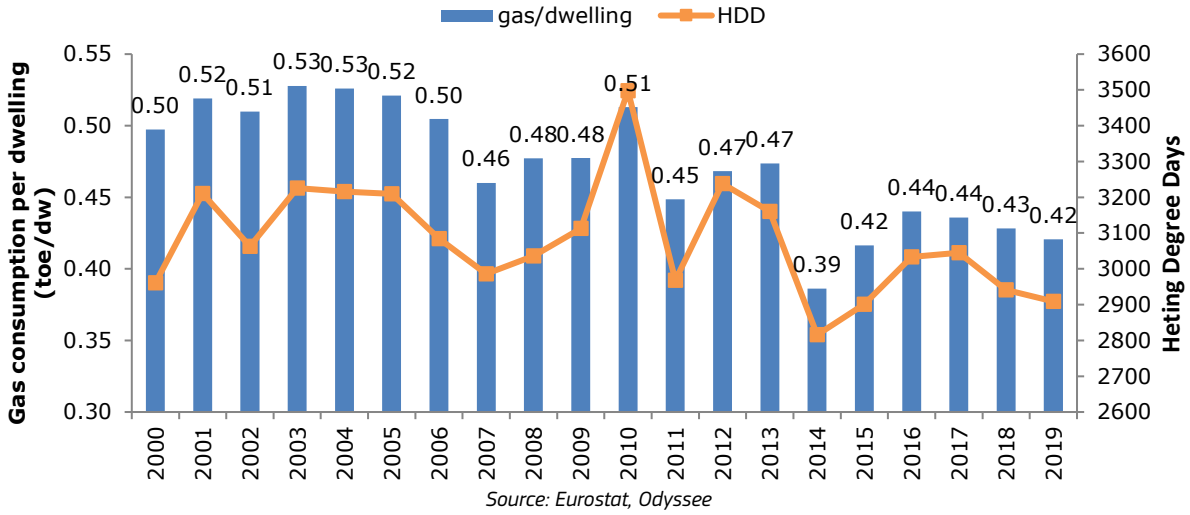
Figure 68: Final residential natural gas consumption annual rates in the EU-27, 2000-2020



Source: Eurostat

The residential consumption of natural gas per dwelling in the EU-27 reached 0.42 toe/dw in 2019, which represents a drop of 15.4% in comparison to the 2000 level. This trend fluctuated several times during the whole studied period, however the lowest values were registered the last six years (from 2014 to 2019). It is observed a positive correlation between the consumption per dwelling and the heating degree days with exception of years 2009, 2013 and 2017. This was probably a result of other factors such as economic changes.

Figure 69: Final residential gas consumption per dwelling[87] and heating degree days in the EU-27, 2000-2019

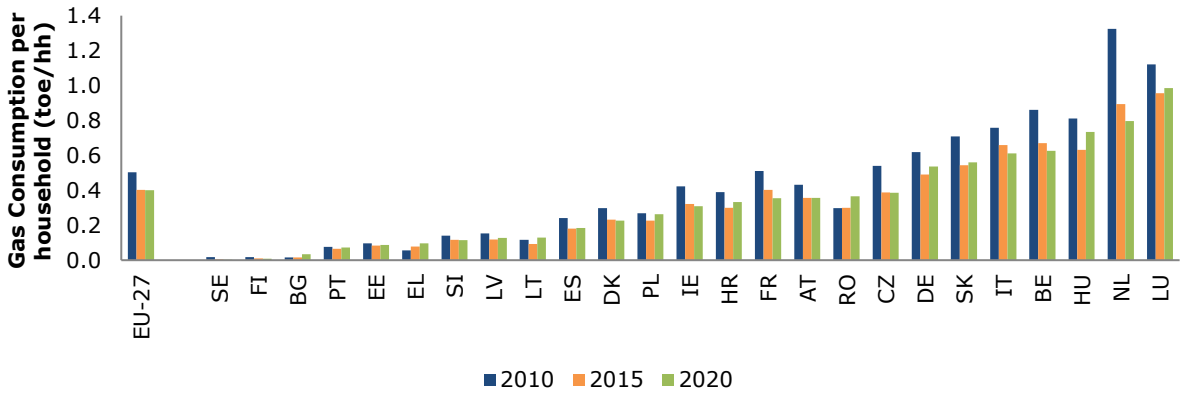


Source: Eurostat, Odyssee

Looking at the residential gas consumption per household across the EU-27 Member States (Figure 70), it can be observed that eighteen Member States had natural gas consumption values below the European one in 2020 (0.401/hh). Malta and Cyprus were excluded from these figures as in both cases residential natural gas consumption was equal to zero. The Member State with the highest residential natural gas consumption per household was Luxembourg (0.986 toe/hh), followed by the Netherlands (0.797 toe/hh) and Hungary (0.734 toe/hh). In contrast the lowest natural gas consumption per household occurred in Sweden (0.003 toe/hh), Finland (0.009 toe/hh) and Bulgaria (0.033 toe/hh). The lowest values of natural gas consumption achieved by Sweden and Finland, despite their high heating degree days, might be explained by the use of other energy sources such as electricity, biomass or district heating plants for 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, Lithuania and Romania decreased their consumption in comparison to the year 2010.

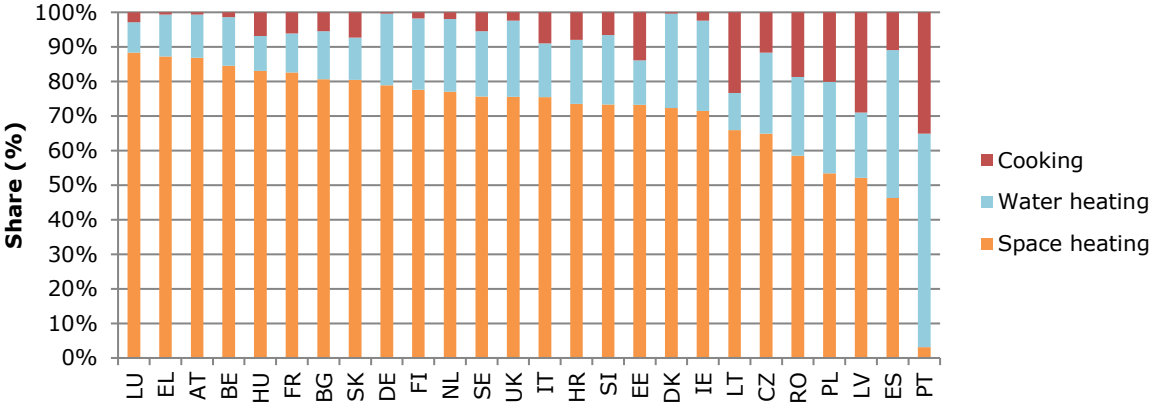
[87] Residential electricity consumption per dwelling was calculated by the report authors as the ratio between the final residential energy consumption and the stock of permanently occupied dwellings) in the EU-27 as made available by Odyssee.

Figure 70: Residential natural gas consumption trends per household in the EU-27 Member States, 2010, 2015 and 2020



Source: Eurostat

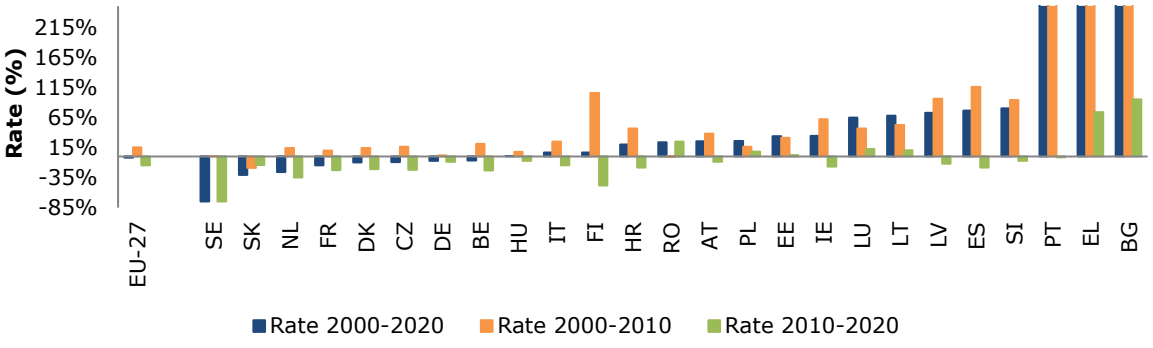
Figure 71: Residential natural gas consumption by type of end-use in the EU-27 Member States[88], 2018



Source: Eurostat

Figure 71 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 consumed more than 40% for water heating while Portugal, Lithuania and Latvia and Poland consumed more than 20% for cooking.

Figure 72: Final residential natural gas consumption rates in the EU-27 per Member State; 2000-2020, 2000-2010 and 2010-2020

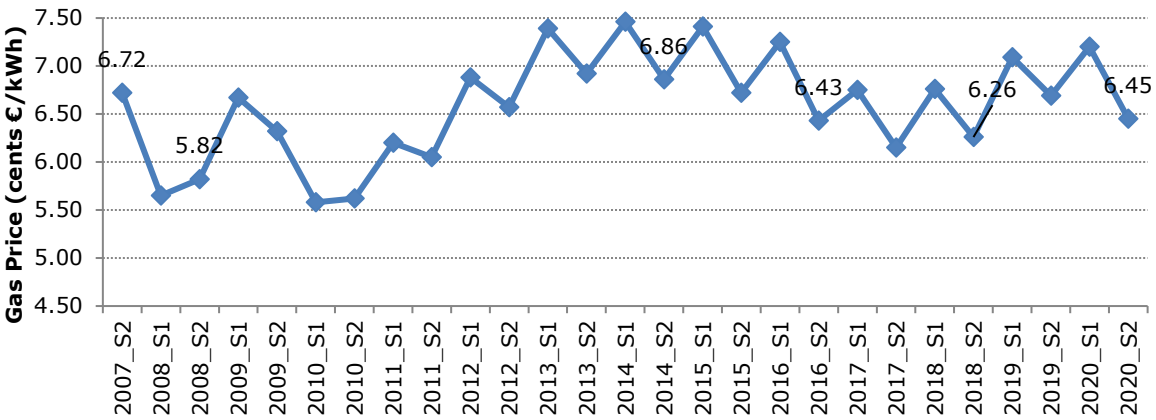


Source: Eurostat

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

The residential natural gas consumption decreased by 1.8% in the period between 2000 and 2020. The Member States with the highest growth rate was Bulgaria with an increase in the consumption over the period equal to 49,676.7%, followed by Greece (8,998.2%) and Portugal (302.6%). These extremely high 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 occurred in Sweden (-74.9%), Slovakia (-30.4%), and the Netherlands (-25.7%). Overall, it can be observed a significant change in the consumption trend can be observed from 2010 onwards, (Figure 72). To be noted the cases of Bulgaria, Greece and Portugal, where the rates sharply changed between the periods 2000-2010 and 2010-2020, most probably because the natural gas networks had already been developed in the second decade and no important changes took place.

Figure 73: Natural gas prices for household consumers in the EU-27 by semesters, band D2 - all taxes and levies included, 2007S2-2020S2

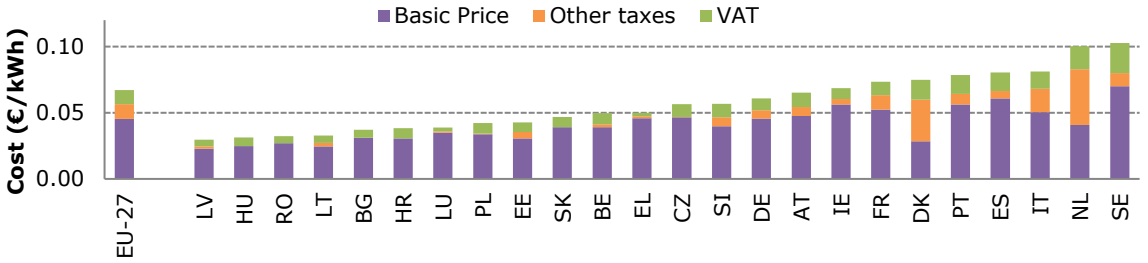


Source: Eurostat

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 2020, the average EU-27 expenses per household for natural gas were EUR 312.9[89]. Despite its considerable fluctuations, the average EU-27 natural gas price for households experienced a fall of 4.0% between the second semester of 2007 and the second semester of 2020, when prices were EUR 0.067/kWh and EUR 0.065/kWh respectively (Figure 73). The highest price level (EUR 0.052/kWh) was reached during the second half of 2014.

Looking at the natural gas prices across the EU-27 Member States for the year 2020 (Figure 74), it is possible to notice that Sweden has the highest gas price (EUR 0.103/kWh) followed by the Netherlands (EUR 0.100/kWh) and Italy (EUR 0.081/kWh). In contrast, the lowest natural gas prices are found in Latvia (EUR 0.030/kWh), Hungary (EUR 0.031/kWh) and Romania (EUR 0.032/kWh). As for electricity prices, Denmark has the highest percentage (61.9%) of taxes and levies. The EU-27 percentage of taxes and levies in 2020 was equal to 32.5%.

Figure 74: Natural Gas prices for household consumers in the EU-27[90], band D2, 2020

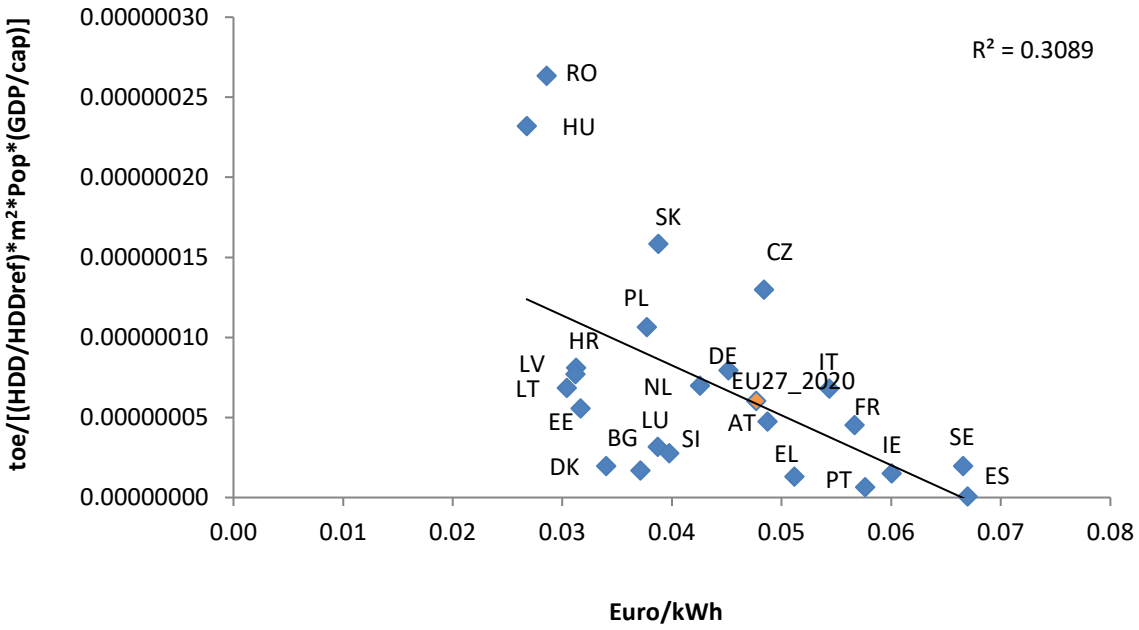


Source: Eurostat

[89] This value was calculated from the average natural gas total price for household consumers (band D2) multiplied by residential gas consumption per household in kWh.

[90] Data are not available for Finland. Malta and Cyprus: natural gas consumption equal to zero

Figure 75: Natural gas consumption normalized by HDD[91], m², population, GDP per capita[92] and natural gas prices[93] for EU-27 Member States[94], Year 2019



Source: Eurostat, Odyssee

The trend-line of the Figure 75 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-27 Member States. It summarizes data about gas consumption in the residential sector for years 2000, 2010 and 2020, as well as the rates over different periods. The data have been already introduced and analysed along the chapter.

Table 3: Overview of final residential gas consumption in the EU-27 Member States, 2000-2020

	2000 (ktoe)	2010 (ktoe)	2020 (ktoe)	2000-2020(%)	2000-2010 (%)	2010-2020 (%)
EU-27	80,035	92,180	78,583	-1.8%	15.2%	-14.8%
BE	3,293	3,986	3,072	-6.7%	21.0%	-22.9%
BG	0	49	96	49676.7%	25461.7%	94.7%
CZ	2,049	2,382	1,856	-9.4%	16.3%	-22.1%
DK	658	751	592	-10.1%	14.1%	-21.2%
DE	23,431	23,907	21,746	-7.2%	2.0%	-9.0%
EE	42	55	56	34.0%	31.0%	2.3%
IE	438	708	589	34.4%	61.8%	-16.9%
EL	5	255	442	8998.2%	5141.2%	73.6%
ES	1,972	4,255	3,474	76.2%	115.7%	-18.3%
FR	12,642	13,871	10,753	-14.9%	9.7%	-22.5%
HR	406	595	486	19.7%	46.7%	-18.4%

[91] HDD normalization: HDD of Member State/mean HDD of EU-27 Member States for 2019
[92] GDP per capita at current market prices, chain linked volumes (2015)
[93] Includes all taxes and levies
[94] Excludes FI, BE due to incomplete data
CY, MT zero consumption

IT	14,971	18,698	15,933	6.4%	24.9%	-14.8%
LV	64	124	110	72.6%	96.0%	-11.9%
LT	104	158	174	67.6%	52.2%	10.1%
LU	157	229	258	64.9%	46.4%	12.6%
HU	3,025	3,260	3,027	0.0%	7.7%	-7.2%
NL	8,509	9,715	6,323	-25.7%	14.2%	-34.9%
AT	1,134	1,564	1,423	25.5%	37.9%	-9.0%
PL	3,048	3,545	3,841	26.0%	16.3%	8.4%
PT	73	299	295	302.6%	308.6%	-1.5%
RO	2,217	2,206	2,746	23.9%	-0.5%	24.5%
SI	59	114	106	80.2%	94.1%	-7.1%
SK	1,642	1,332	1,143	-30.4%	-18.9%	-14.2%
FI	22	46	24	6.8%	105.4%	-48.0%
SE	76	76	19	-74.9%	0.3%	-75.0%

(1) CY, MT – Gas consumption equal to 0

Source: Eurostat

3.4 Overview – Residential sector

The residential sector accounted for more than one quarter of the EU-27 total final energy consumption in 2020 and it is the second most energy-consuming sector after transport.

The final residential energy consumption in the EU-27 shows a very slight reduction from 2000 to 2020 (-0.1%) and an almost negligible increase from 2019 to 2020. The COVID-19 effect and the increase of teleworking interrupted the decreasing trend of the two previous years in the residential sector. The EU-27 final residential energy per capita decreased notably compared to the year 2000 (-4.3% in 2020).

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

Between 2000 and 2020, the population in the EU-27 grew by 4.4%. This was accompanied by a higher increase in the number of households that resulted in smaller households (2.3 people per household in 2020). Moreover, the average dwelling size increased by 6.5%. Despite these indicators could lead to a rise in the consumption, the efficiency improvement allowed for the reduction of residential energy use.

Per capita residential energy consumption is highly influenced by the economic situation. Countries with high per capita consumption, such as Luxembourg and Finland, also registered high GDP per capita values. This suggests that higher wealth may indeed lead to more equipped houses and more energy consumption. On the other hand, Bulgaria and Romania, which were the Member States with the lowest GDP per capita, were countries with low residential energy consumption per capita. Thus, lower GDP levels may lead to energy poverty due to their inability to ensure the required levels of energy at home.

GDP per capita in the EU-27 has been continuously increasing between 2000 and 2020 (by 17.7%), only interrupted in 2009 due to the economic crisis, in 2012 and 2013, and in 2020 due to the pandemic. However, the final residential energy consumption per capita fell by 4.3% in the same period, hence achieving the decoupling of the economic and energy consumption growths.

Nevertheless, energy indicators and ratios based on GDP values might not be as representative in the residential sector, since others based on the disposable income of households or in the adjusted gross disposable income can better reflect the purchasing power of the inhabitants.

Furthermore, residential trends are affected by climate conditions, which are responsible for annual fluctuations. A positive correlation is observed between the residential energy consumption (final energy, electricity and gas consumptions) and heating degree days, while cooling degree days are more related to the electricity consumption only.

Final residential energy consumption is corrected to isolate the trend from climatic conditions, economic and population growth and changes in the dwelling characteristics. The analysis shows a gradual decrease in the analysed period, suggesting the efficiency improvement of the sector and the effectiveness of the energy policies.

In terms of the residential energy mix, the main fuel types contributing to the final residential energy consumption in the EU-27 in 2020 were natural gas, electrical energy and biofuels and renewables.

As for the main fuel types, the final residential electricity consumption grew in the period 2000-2020 in the EU-27 while the natural gas consumption dropped. However, the consumption of both energy sources per dwelling and per household decreased over the studied period.

The energy mixes are greatly dependent of the country so the differences across EU-27 Member States are notable.

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-27expenses per household for electricity were EUR 776.7 EUR while for natural gas were EUR 312.9 in 2020.

The electricity price for households has risen significantly in the period between 2007_S2 and 2020_S2. The price of natural gas for household consumers has registered fluctuating growth rates but overall it had decreased in the same period.

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4 Energy Consumption Trends in the Tertiary Sector

In this report, the definition of tertiary sector includes public sector, professional, scientific and technical activities, services and commerce[95]. 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. 73.1% of the total gross value added was generated by this sector in 2020 (Figure 8, Page 14). 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 [10].

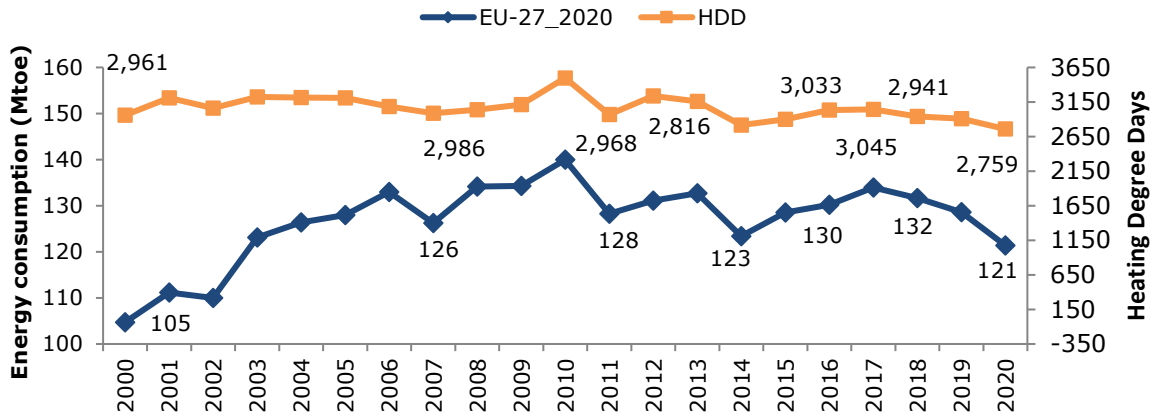
Furthermore, employment rates registered in the recent years show changes that provided opportunities for increased productivity in knowledge-intensive sectors, leading to additional possibilities for labour re-allocation and employment growth in certain sectors. However, manual workers – in particular in manufacturing and agriculture – are relocated to services in the automation process [11].

Final energy consumption trends in the tertiary sector

The tertiary sector accounted for 13.7% of total final energy consumption in the year 2020. Its value added share is relatively low compared to other sectors, e.g. the industry sector. This latter sector consumed 26.1% of total final energy but with a contribution of just 25.3%[96] to the total value added in 2020.

The final tertiary energy consumption in the EU-27 risen by 15.9% in the period from 2000 to 2020. The consumption peak was reached in the year 2010 (140.0 Mtoe), as illustrated in Figure 76. From 2019 to 2020, tertiary final energy consumption decreased by 5.6% perhaps as a consequence of increased teleworking to restrict COVID-19 pandemic which led to reduced use of tertiary sector buildings.

Figure 76: Final tertiary energy consumption in the EU-27, 2000-2020



Source: Eurostat

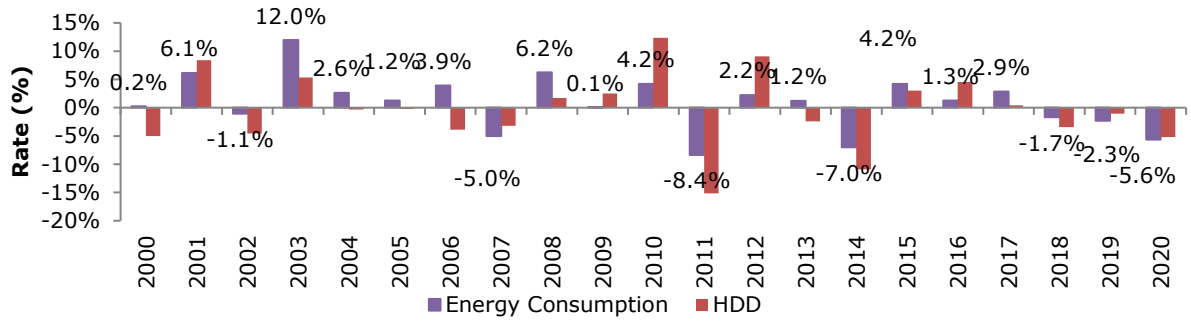
Moreover, in Figures 76 and 77 it is studied if there is a correlation between weather conditions and final energy consumption in tertiary sector. As shown in these figures, the final tertiary energy consumption trends are similar to the Heating Degree Days ones, with the exception of years 2004, 2006, 2009, 2013 and 2017. This indicates a potential correlation between the two indicators; however, energy consumption may be also affected by other factors, such as the number of employees. A further analysis on which is the most influencing factor in tertiary sector energy consumption is going to be presented in this chapter (Figures 80-82).

Looking at the consumption rates along the same period (Figure 77), a general growing trend can be observed between 2000 and 2010 with the exception of the years 2002 and 2007. Notably, an increase of 12.0% was

[95] This category is also known as the "commercial sector" and represents non-residential buildings in the tertiary sector.
[96] Construction sector is included – see Figure 9.

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 the opposite directions. To be noted that the decreases seen in 2011 and 2014 brought back the final tertiary energy consumption close to 2007 levels. A new increasing trend started in 2015 and continued in 2016 and 2017. From 2018 to 2020, tertiary energy consumption recorded negative growth rates. In 2020, the reduction rate was -5.6%, and the lowest value of the latest 10 studied years was registered.

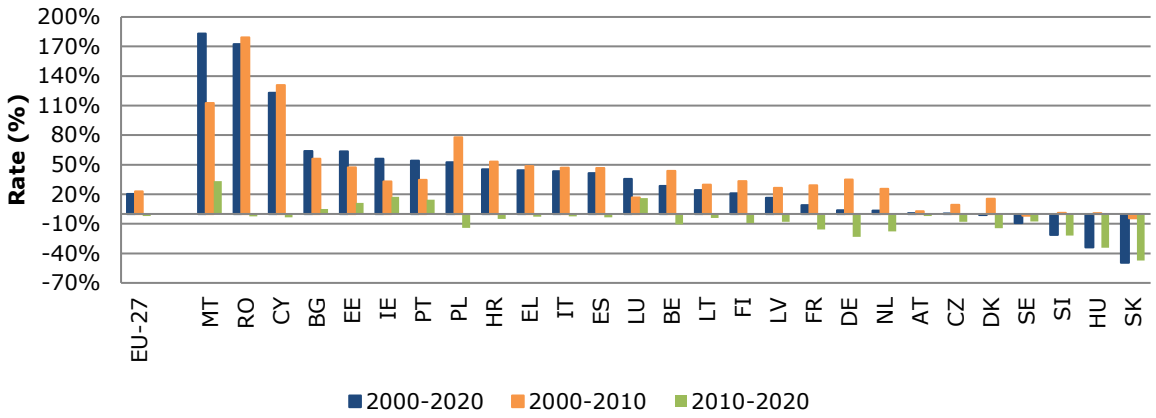
Figure 77: Tertiary final energy consumption and Heating Degree Days annual consumption rates in the EU-27, 2000-2020



Source: Eurostat

As previously mentioned, the EU-27 final tertiary energy consumption grew by 15.9% in the 21 years studied. Nevertheless, the consumption rates are markedly different before and after 2010 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 -49.6%, followed by Hungary (-33.9%) and Slovenia (-21.2%). %). In contrast, Member States that experienced the highest growth rates in energy consumption in the tertiary sector were Malta (183.1%), Romania (172.4%) and Cyprus (123.0%).

Figure 78: Final tertiary energy consumption rates by Member State in the EU-27; 2000-2020, 2000-2010 and 2010-2020

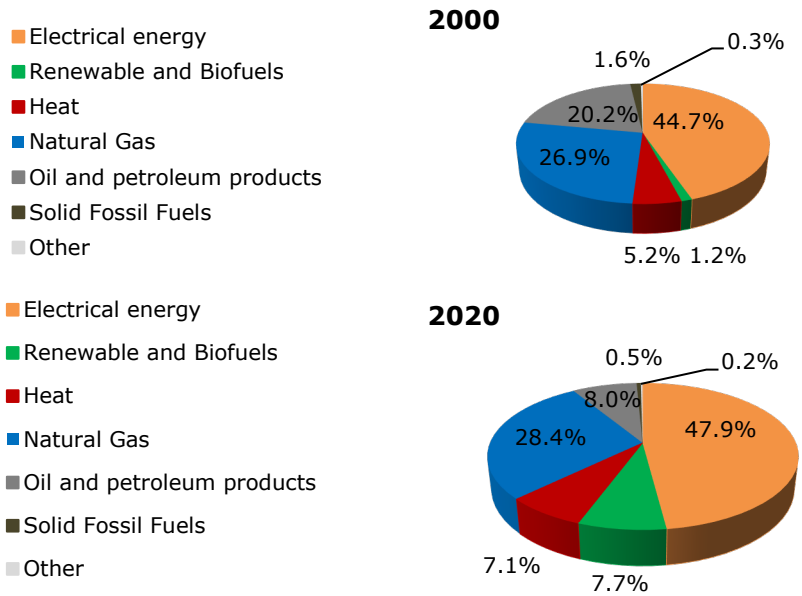


Source: Eurostat

To be noted the significant change in the consumption rates across different sub-periods in Romania, Cyprus, Poland, Croatia, Greece, Italy, Spain and Belgium. In particular, in Romania, the rate passed from +179.3% in the period 2000-2010, to -2.5% in 2010-2020 period. At the same time, a positive rate during the first sub-period made way for a negative one in the second sub-period the rest of mentioned countries.

The final energy mix in the tertiary sector of EU-27 was mainly composed of three energy sources, which accounted for almost the 85% of the total final energy consumption in 2020. Electricity had the highest share (47.9%), followed by natural gas (28.4%) and oil and petroleum products (8.0%). Other contributors to the energy mix were renewable energies and biofuels (7.7%), heat (7.1%), solid fossil fuels (0.5%) and other not already mentioned sources[97] (0.2%). Changes compared to the 2000 scenario are mainly due to a reduction in the share of petroleum products to less than the half in 2020 and to the great increase of renewable energies and biofuels, (their share was multiplied increased by more than 6 six times in 2020). There are no significant changes in the shares of energy sources used in tertiary sector in 2020 compared to the year 2019. The ranking also remained the same.

Figure 79: Final energy mix in the tertiary sector in the EU-27, 2000 and 2020

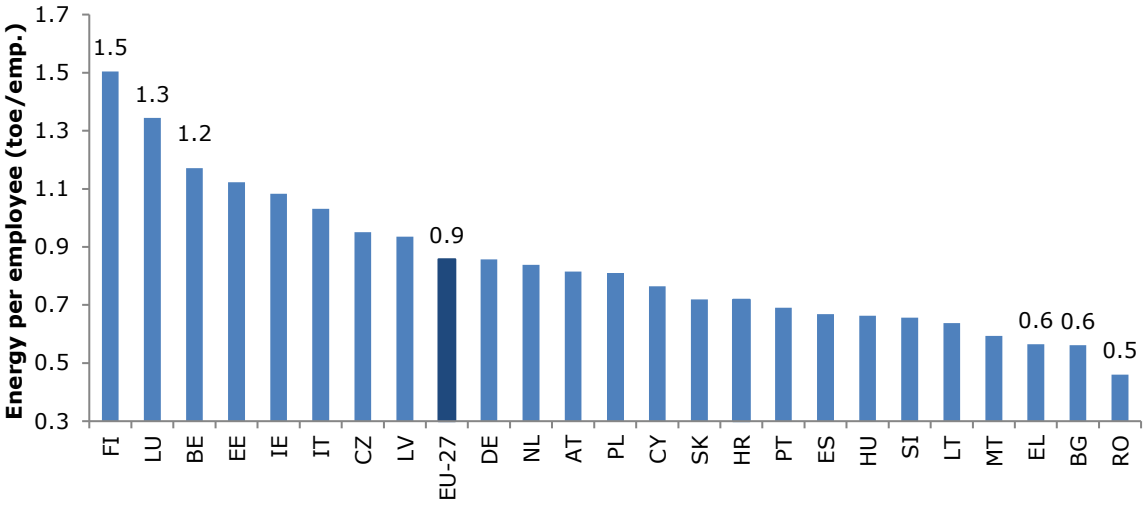


Source: Eurostat

[97] Peat and peat products, manufactured gases and non-renewable waste are included.

An interesting indicator to consider in the analysis of the tertiary energy trends is the energy consumption per employee. The value of this indicator was equal to 0.9 toe per employee in 2020 (Figure 80).

Figure 80: Final energy consumption per employee[98] in the tertiary sector in the EU-27 Member States[99], 2020



Source: Eurostat

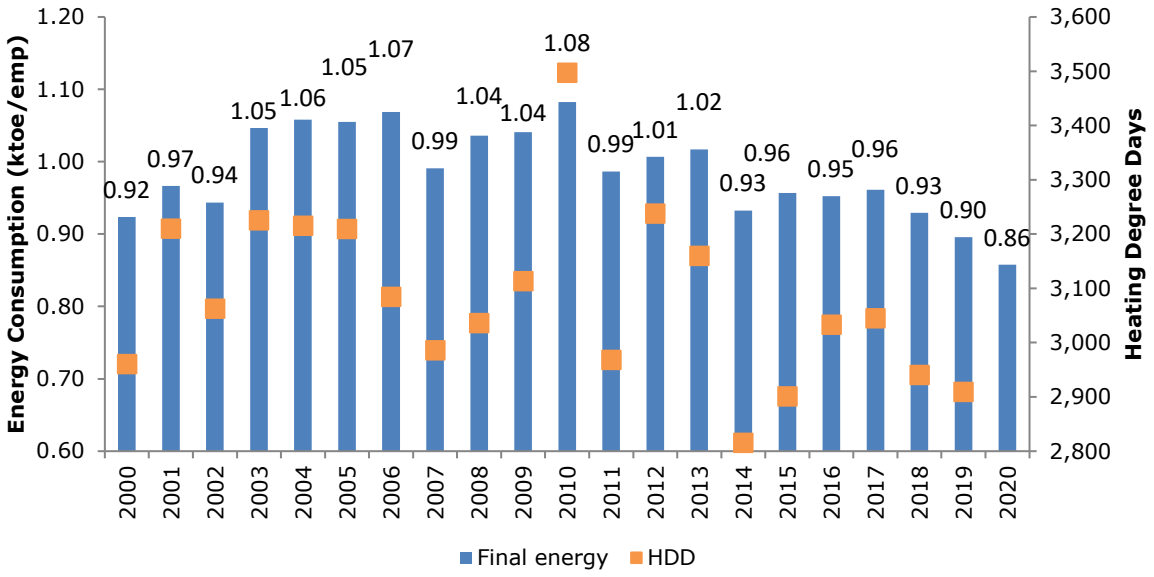
In 2020, the Member States with the highest energy consumption per employee were Finland (1.5 toe/emp.), Luxembourg (1.3 toe/emp.), and Belgium (1.2 toe/emp.). On the other hand, Romania (0.5 toe/emp.), Bulgaria and Greece (0.6 toe/emp. both) were the Member States with the lowest final tertiary energy consumption per employee.

Looking at the trend of this indicator over the period 2000-2020 (Figure 81) it is possible to notice that 2020 registered the lowest value at EU-27 level (0.86 toe/emp.). The maximum value was reached in 2010 (1.08 toe/emp.). In 2020, its value decreased by 4.3% compared to 2019 and by 7.2% compared to 2000).

[98] 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

[99] France, Denmark and Sweden excluded due to incomplete data

Figure 81: Final energy consumption per employee in the tertiary sector and Heating Degree Days in the EU-27, 2000-2020



Source: Eurostat

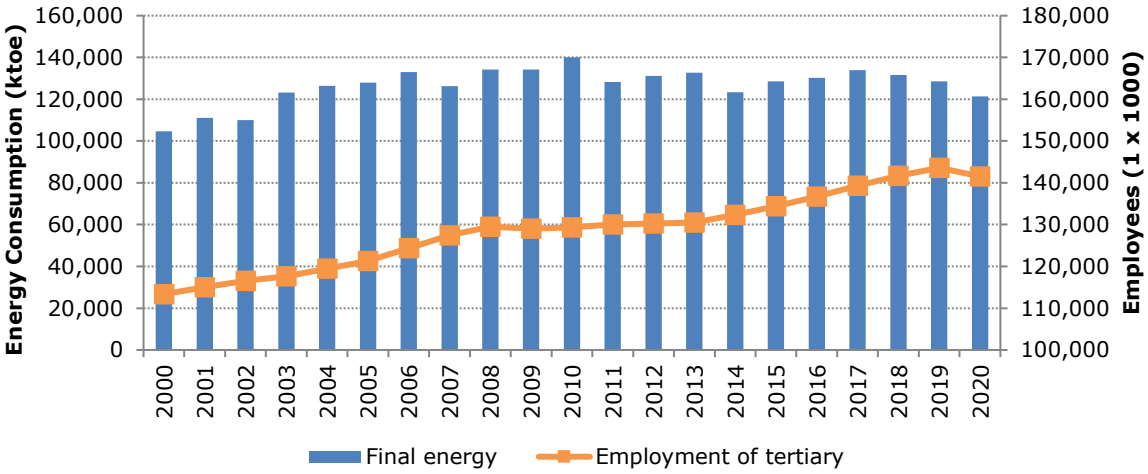
Trends of the energy consumption per employee is interesting to be analysed in parallel with the trends s some influencing factors such as weather and climate conditions and employment values in the tertiary sector. The tertiary sector created 28.2 million employees in the period from 2000 to 2020, with a growth rate of 24.9%. A slowdown in the employees growth rates was observed between 2008-2012 because of the economic crisis. Despite this, from 2013 to 2019, the tertiary sector continued to increase rapidly in terms of number of employees in the EU. In 2020 the number of tertiary sector employees decreased by 1.4% due to the COVID-19 crisis.

Given the nature of the tertiary sector that 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 81 shows the heating degree days together with the final energy consumption per employee. A certain degree of correlation between the two trends can be inferred by this figure.

Figure 82 shows the trend of employment together with the final energy consumption in the tertiary sector. This graph, as the previous one, helps in analysing the influence of external factors, related to weather and population dynamics, on energy consumption.

Figure 82: Final energy consumption and employment rates in the tertiary sector in the EU-27, 2000-2020



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-27 Member States

	Final Tertiary Energy Consumption in the EU-27 Member States (ktoe)													Consumption Rate
	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2000-2020 (% year)
EU-27	**104,722**	**127,946**	**139,970**	**128,250**	**131,127**	**132,700**	**123,386**	**128,548**	**130,204**	**133,919**	**131,642**	**128,624**	**121,376**	**15.9%**
BE	3,476	4,686	4,998	4,412	4,625	4,914	4,246	4,619	4,645	4,645	4,661	4,607	4,470	**28.6%**
BG	658	841	1,027	1,090	1,070	1,030	992	1,079	1,157	1,167	1,231	1,268	1,080	**64.0%**
CZ	2,972	3,137	3,249	3,133	3,040	3,010	2,923	2,977	3,091	3,181	3,128	3,192	2,987	**0.5%**
DK	1,843	2,002	2,128	1,948	1,979	1,964	1,847	1,896	1,947	1,991	1,983	1,917	1,822	**-1.1%**
DE	25,820	33,712	34,807	30,736	32,028	33,550	30,766	32,290	31,866	31,838	28,893	27,534	26,772	**3.7%**
EE	288	389	424	402	424	418	458	465	498	467	490	467	471	**63.6%**
IE	1,172	1,413	1,557	1,508	1,562	1,594	1,504	1,608	1,646	1,643	1,765	1,818	1,829	**56.1%**
EL	1,318	1,953	1,957	1,870	1,941	1,821	1,714	1,875	2,038	2,192	2,093	2,135	1,903	**44.5%**
ES	6,679	8,314	9,786	10,228	10,111	9,675	8,942	9,521	9,841	10,145	10,263	10,311	9,451	**41.5%**
FR	18,658	20,967	24,103	21,059	22,625	23,398	21,471	22,283	22,407	22,757	22,338	21,910	20,341	**9.0%**
HR	521	721	797	786	758	741	693	763	780	818	833	835	757	**45.5%**
IT	11,542	15,053	16,979	15,751	15,931	15,847	14,667	15,391	15,440	18,242	19,002	18,192	16,558	**43.4%**
CY	108	161	248	236	223	203	200	207	221	229	270	281	240	**123.03%**
LV	473	595	598	557	623	600	609	586	592	607	592	569	550	**16.43%**
LT	463	562	601	584	610	593	586	575	603	634	651	627	576	**24.3%**
LU	363	367	424	340	384	400	353	397	400	449	461	519	493	**35.8%**
HU	3,026	3,501	3,049	3,054	2,354	2,337	2,115	2,204	2,191	2,154	2,099	2,050	2,000	**-33.9%**
MT	43	63	92	88	100	104	111	121	118	128	121	128	123	**183.1%**
NL	6,245	6,943	7,847	6,989	7,239	7,268	6,412	6,738	6,781	6,932	6,916	6,771	6,466	**3.6%**
AT	2,552	3,014	2,626	2,555	2,553	2,539	2,424	2,479	2,435	2,638	2,579	2,648	2,570	**0.7%**
PL	4,966	6,730	8,837	8,430	8,364	8,079	7,788	7,842	8,503	8,044	7,929	7,808	7,580	**52.6%**
PT	1,400	2,200	1,884	1,856	1,843	1,787	2,285	2,356	2,290	2,301	2,381	2,359	2,159	**54.2%**
RO	673	1,670	1,881	1,774	1,763	1,785	1,768	1,762	1,806	1,858	1,976	1,962	1,834	**172.4%**
SI	527	476	533	531	453	468	427	455	492	481	474	452	415	**-21.2%**
SK	2,200	1,751	2,105	1,602	1,451	1,711	1,233	1,300	1,308	1,427	1,315	1,222	1,108	**-49.6%**
FI	2,326	2,619	3,100	2,866	3,030	2,907	2,890	2,737	2,890	2,960	3,078	3,015	2,810	**20.8%**
SE	4,409	4,105	4,334	3,865	4,046	3,959	3,960	4,022	4,217	3,991	4,121	4,025	4,008	**-9.10%**

Source: Eurostat

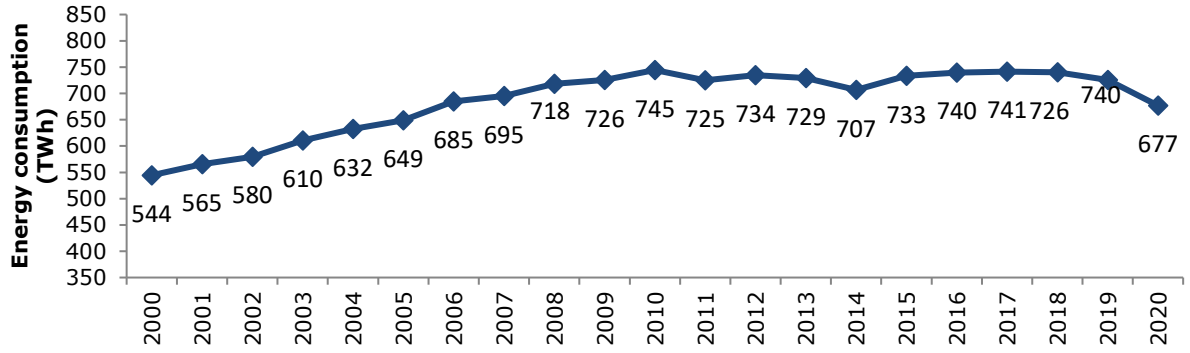
4.1 Electricity consumption trends in the tertiary sector

In 2020, the tertiary sector accounted for 23.4% of the final electricity consumption. It had the largest share of consumption after the industry sector (37.1%) and residential sector (29.9%) (Figure 20, Page 24).

Turning to the tertiary sector energy mix, electricity accounted for 47.9% in 2020, representing the highest share among the different energy types.

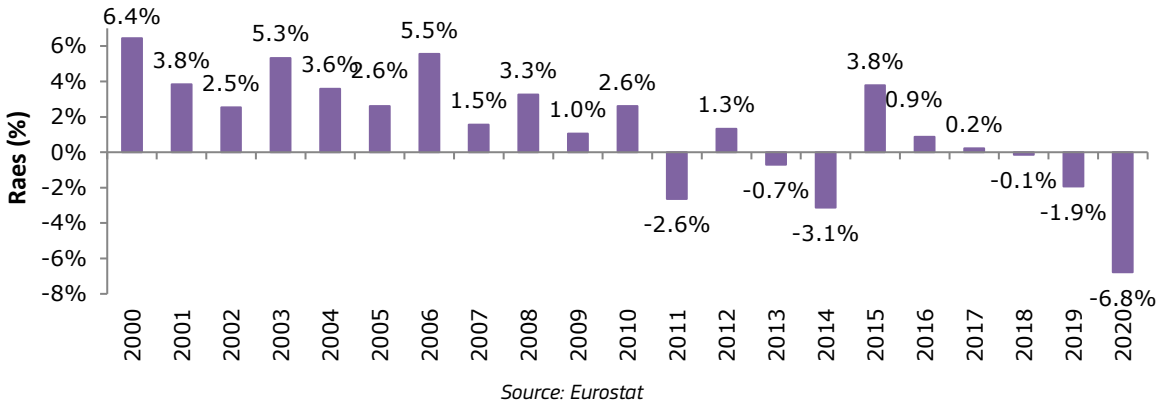
The total final electricity consumption increased by 24.3% during the period from 2000 to 2020. In 2020, the EU-27 electricity consumption reached 676.7 TWh. A continuous increase with an average growth rate above 3% per year can be observed between 2000 and 2010 in the EU-27. In 2010, electricity consumption in the sector reached its maximum level (744.5 TWh). From 2011 to 2014, fluctuating trends were registered, whereas from 2015 to 2017 it is possible to observe a new increasing trend in the final tertiary electricity consumption. In 2020, the total final electricity consumption of the tertiary sector decreased by the highest reduction rate over the studied period (by 6.8%) possibly as a result of increased

Figure 83: Final tertiary electricity consumption in the EU-27, 2000-2020



Source: Eurostat

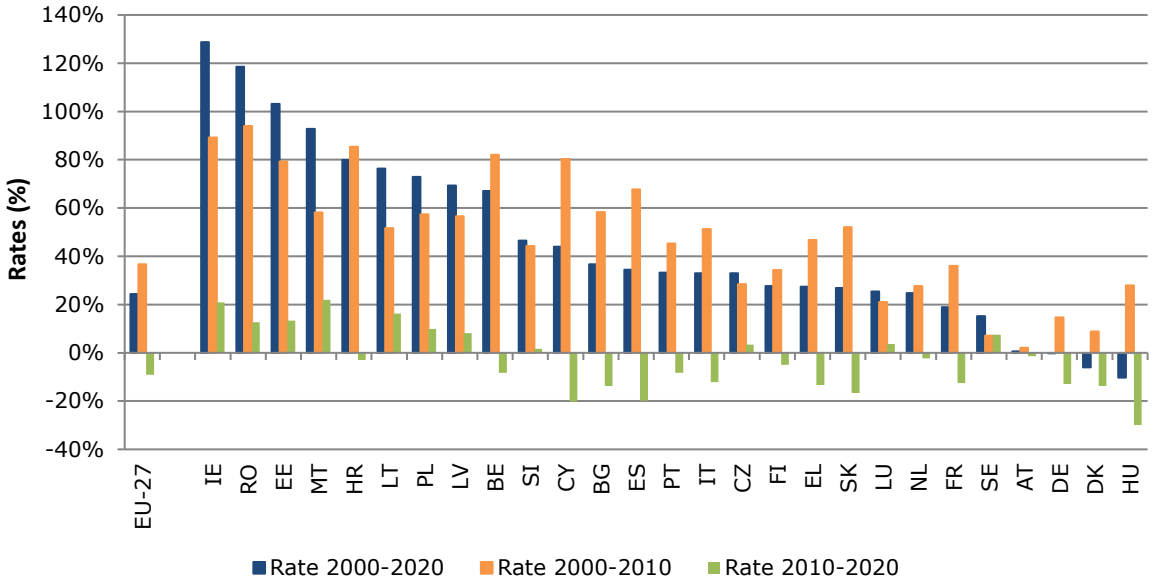
Figure 84: Tertiary electricity consumption annual rates in the EU-27, 2000-2020



Source: Eurostat

Looking at the rates of the different Member States (Figure 85), six of them registered a rate below the EU-27_2020 growth rate (Hungary, Denmark, Germany, Austria, Sweden, France). During the period 2000-2020, the Member States with the highest growth rates were Ireland (128.8%), Romania (118.58%) and Estonia (103.1%). In contrast, Member States with the highest reduction rates were Hungary (-10.3%), Denmark (-6.1%) and Germany (-0.1%). All Member States showed a positive rate in the period from 2000 to 2010. During this latter time period, the highest growth rates were found in Romania (94%), Ireland (89.3%) and Croatia (85.3%). From 2010 to 2020, fifteen EU-27_2020 countries reversed their rate trends and turned them into negative ones. The highest growth rates occurred in Malta (21.9%), Ireland (20.9%) and Lithuania (16.3%) whereas the highest reduction rates took place in Hungary (-29.8%), Spain (-19.9%) and Slovakia (-16.6%).

Figure 85: Final tertiary electricity consumption rates by Member State in the EU-27; 2000-2020, 2000-2010 and 2010-2020



Source: Eurostat

The EU-27 annual electricity consumption per employee was 4,781 kWh/emp in 2020 (Figure 86). Thirteen Member States had above EU-27 electricity consumption per employee where Finland (9,081 kWh/emp), Ireland (7,570 kWh/emp) and Estonia (6,779 kWh/emp) were the Member States with the highest consumption per employee. On the other hand, the countries with the lowest electricity consumptions per employee were Romania (2,141 kWh/emp), Hungary (2,641 kWh/emp) and Bulgaria (3,637 kWh/emp).

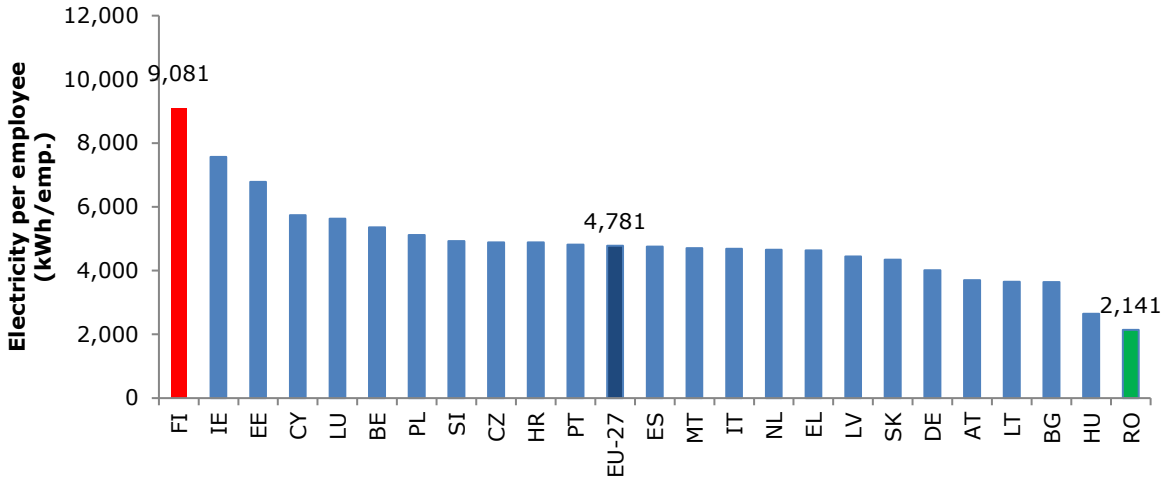
Weather and climatic conditions cannot explain the large differences in per employee electricity consumption observed e.g. between Finland and Lithuania (around 148.7%), as both countries are ranked as first and fifth respectively in the value of Mean Heating Degree days (Figure 63). The difference may be explained not even by referring only to GDP influence, because for example Germany and Finland have similar values of GDP per capita (Figure 35). Factors that could explain this difference in electricity per employee are:

- The installation of more energy efficient technologies in the tertiary sector
- Cultural and social habits
- Energy consumption patterns of different energy types
- Measures adopted by national authorities to confront COVID-19 pandemic in 2020
- Structural differences in the national economies

For example, looking at the energy consumption values per employee in Finland and Cyprus, these countries rely more on electricity than natural gas as energy type (Figure 90). Other Member States, such as Lithuania or Latvia, have consumption levels per employee below the EU-27 value for both electricity and natural gas. In these countries District Heating serves a high percentage of citizens and

.

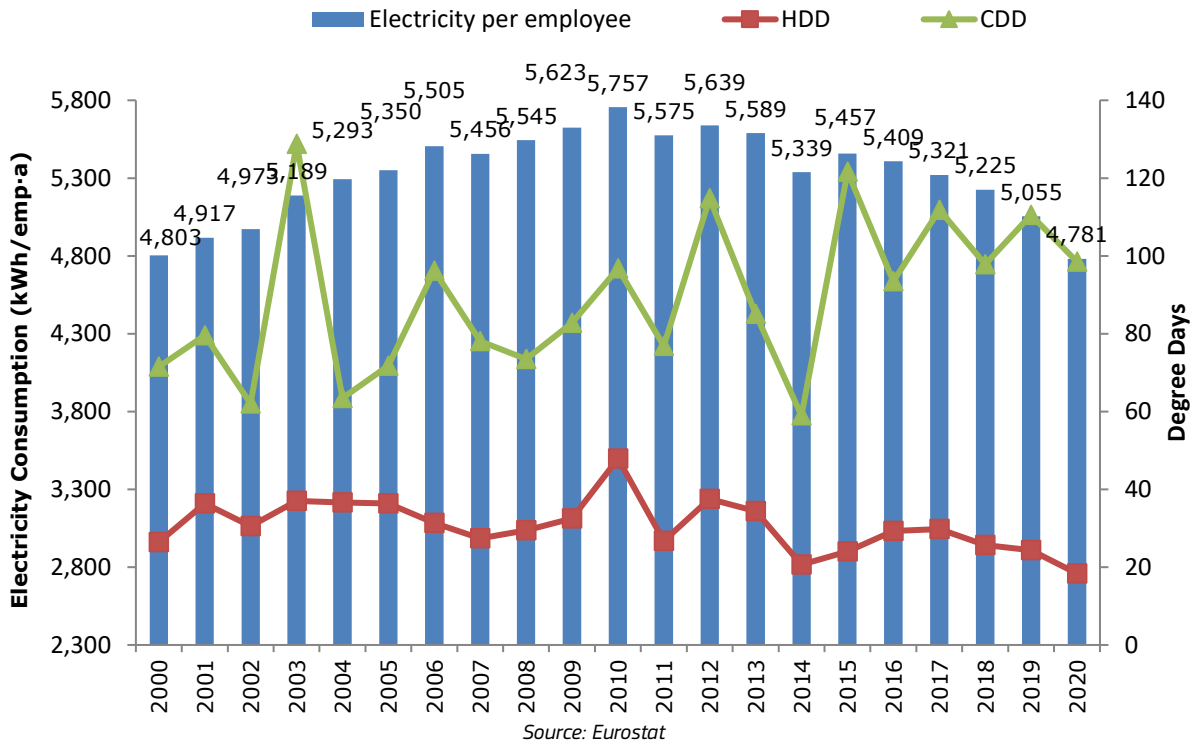
Figure 86: Annual electricity consumption per employee in the tertiary sector in the EU-27, 2020



Source: Eurostat

The European electricity consumption per employee decreased by 0.5% in the period from 2000 to 2020. A growing trend was experienced until 2010, then a decreasing one until 2020 (Figure 87). The maximum value in the time period considered was registered in 2010, when the electricity consumption per employee reached 5,757 kWh/emp. The highest values of electricity consumptions per employee were registered in the period from 2008-2013, when the consumption remained steadily above 5,500 kWh/emp. In 2020, the electricity consumption per employee decreased by 5.4% compared to 2019 and remained below the threshold of 5,000 kWh/emp (4,781 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 87: Annual electricity consumption per employee in the EU-27 tertiary sector, 2000-2020



Source: Eurostat

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

Table 5: Final tertiary electricity consumption in the EU-27 Member States

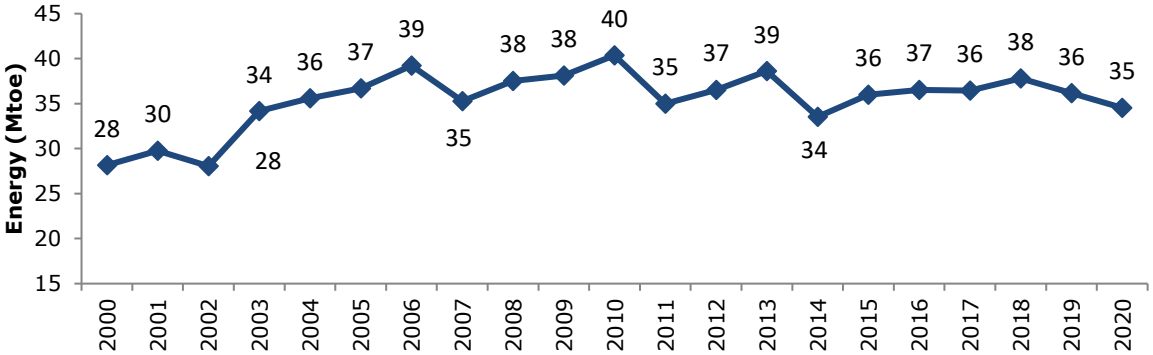
GWh	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2000-2020 (% year)
EU-27	544,460	648,814	744,516	724,873	734,486	729,375	706,556	733,264	739,607	741,166	740,155	725,907	676,733	**24.3%**
BE	12,236	20,787	22,283	21,591	21,839	22,206	21,146	21,442	21,589	21,686	21,757	21,605	20,443	**67.1%**
BG	5,115	6,143	8,101	8,437	8,170	7,954	7,831	8,076	8,505	8,434	8,470	8,754	6,992	**36.7%**
CZ	11,559	12,911	14,851	14,471	14,469	14,809	14,464	14,875	15,327	15,618	16,027	16,135	15,363	**32.9%**
DK	9,954	10,472	10,835	10,656	10,481	10,227	10,288	10,087	10,213	10,465	10,356	10,000	9,352	**-6.1%**
DE	125,453	137,410	143,862	136,306	139,210	142,062	131,515	140,736	141,585	138,755	133,470	129,974	125,353	**-0.1%**
EE	1,401	1,929	2,511	2,378	2,536	2,530	2,795	2,813	2,971	2,715	2,933	2,921	2,846	**103.1%**
IE	5,590	8,584	10,580	10,215	10,558	10,605	10,004	10,913	11,216	11,271	12,142	12,727	12,787	**128.8%**
EL	12,260	16,479	18,000	16,839	18,470	17,008	16,802	17,926	19,448	19,243	17,807	17,914	15,612	**27.3%**
ES	50,023	63,823	83,892	81,825	80,752	76,302	70,562	74,108	73,388	75,307	74,513	74,626	67,233	**34.4%**
FR	106,313	125,188	144,664	137,706	143,911	144,158	137,962	141,359	141,875	141,399	140,491	136,609	126,482	**19.0%**
HR	2,863	4,343	5,306	5,435	5,437	5,311	5,136	5,326	5,352	5,697	5,859	5915.042	5150.1	**79.9%**
IT	56,595	73,875	85,619	86,912	90,279	88,982	88,489	92,085	91,736	93,492	94,489	89,215	75,259	**33.0%**
CY	1,251	1,786	2,256	2,138	2,000	1,786	1,838	1,886	2,065	2,097	2,174	2,171	1,801	**44.0%**
LV	1,546	2,142	2,420	2,487	2,798	2,703	2,882	2,725	2,733	2,765	2,856	2,848	2,618	**69.3%**
LT	1,872	2,686	2,839	2,953	3,114	3,130	3,218	3,110	3,280	3,307	3,436	3,543	3,301	**76.3%**
LU	1,647	1,751	1,994	1,881	1,946	1,992	1,925	1,913	1,786	2,241	2,172	2,292	2,066	**25.5%**
HU	8,880	9,931	11,355	11,466	7,817	7,507	7,647	7,937	8,045	8,323	8,540	8,557	7,967	**-10.3%**
MT	504	563	797	829	888	896	943	1,002	992	1,094	1,069	1,088	971	**92.8%**
NL	28,796	33,698	36,766	36,911	36,130	36,283	35,590	36,261	36,217	36,690	37,037	36,556	35,916	**24.7%**
AT	11,586	12,319	11,825	11,715	12,182	12,350	12,277	12,357	11,757	12,351	12,580	12,589	11,662	**0.7%**
PL	27,756	33,357	43,669	44,190	44,378	43,130	45,171	45,443	47,800	47,019	49,441	49,088	47,988	**72.9%**
PT	11,288	14,407	16,397	16,270	16,007	15,707	16,756	17,193	16,457	16,370	16,749	16,443	15,038	**33.2%**
RO	3,908	4,000	7,581	7,869	7,897	7,961	8,223	8,407	8,581	8,548	8,752	8,826	8,538	**118.5%**
SI	2,126	2,421	3,066	3,261	3,169	3,218	3,141	3,232	3,365	3,524	3,595	3,520	3,115	**46.5%**
SK	5,268	6,151	8,014	8,232	6,450	7,549	6,145	6,866	6,946	7,674	7,218	6,654	6,684	**26.9%**
FI	13,287	15,523	17,846	17,263	17,857	17,505	17,459	17,450	17,645	17,520	18,200	17,867	16,964	**27.7%**
SE	25,383	26,135	27,187	24,636	25,741	25,504	26,347	27,736	28,733	27,563	28,012	27,459	29,227	**15.1%**

Source: Eurostat

4.2 Natural gas consumption trends in the tertiary sector

In 2020, 13.7% of the total final natural gas energy consumption of the EU-27 was generated in the tertiary sector, this being the third highest share after those of the industry sector (42.7%) and residential (39.0%) (Figure 25, Page 27). When focusing on the tertiary sector energy mix, natural gas accounted for 28.4% of total final consumption in 2020, representing the second highest share among the different energy types after electricity.

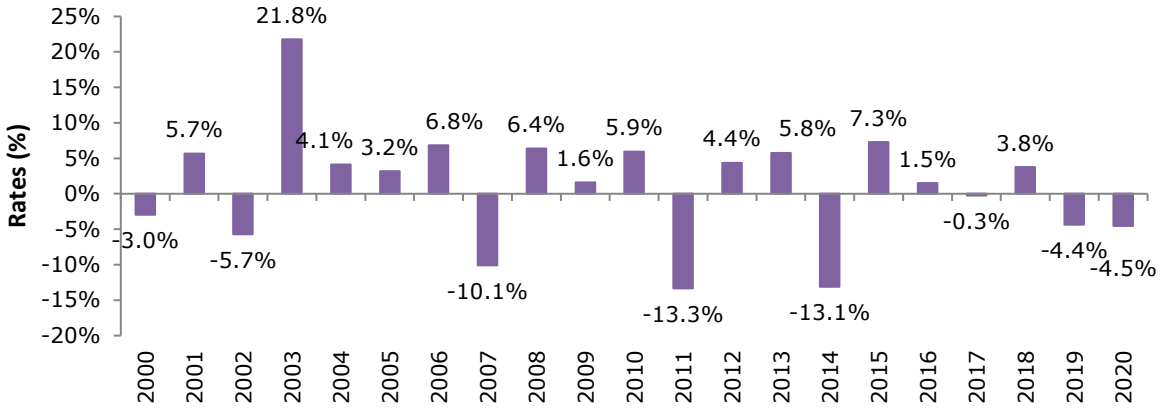
Figure 88: Final tertiary natural gas consumption in the EU-27, 2000-2020



Source: Eurostat

The final tertiary natural gas consumption in the EU-27 grew by 22.6% in the period between 2000 and 2020. In 2020, the EU-27_2020 tertiary natural gas consumption reached 34.5 Mtoe. From 2000 to 2010 an increasing trend in the consumption was registered (leading to an overall increase of 43.3%) with the exception of years 2002 and 2007. The maximum consumption was reached in 2010 (40.4 Mtoe). After an annual decrease by -13.3% occurred in 2011, there was a rise of 10.4% in the period 2011-2013. In 2014, the tertiary natural gas consumption was reduced again by -13.1% in comparison to 2013 and returned to the 2007 levels. A new increase (8.9%) was registered in the period 2014-2016. In 2018, natural gas consumption of service sector increased by 3.8% approximately approaching the levels of 2013. The last two studied years it recorded declines, in particular, in 2020 it reduced by 4.5% compared to 2019.

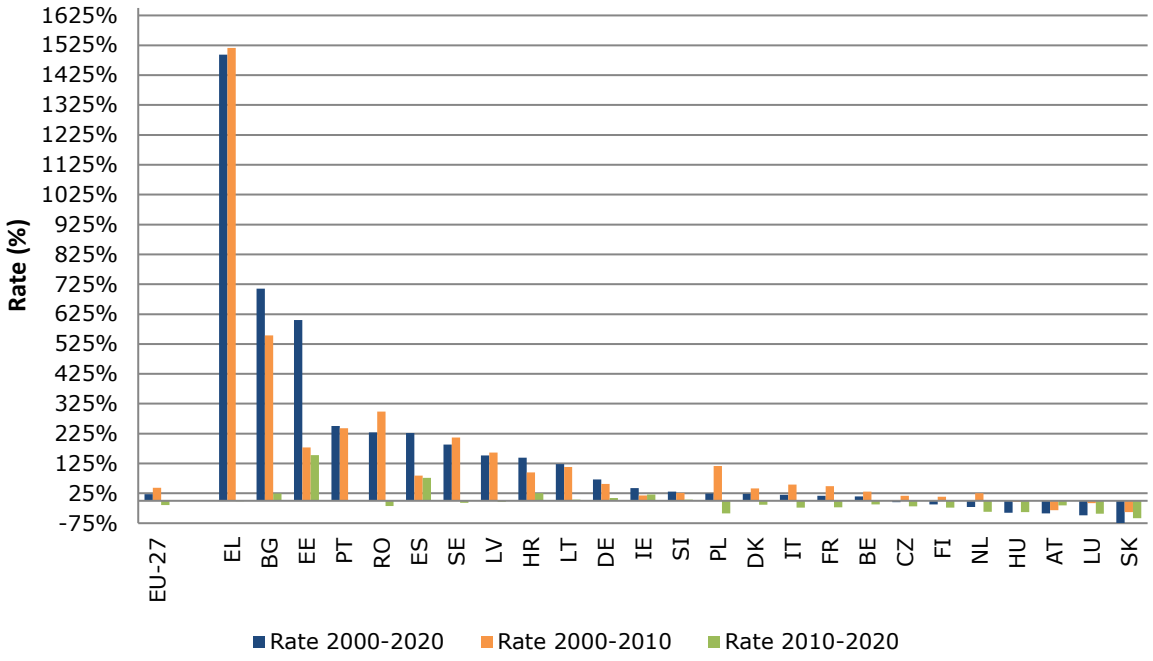
Figure 89: Annual tertiary natural gas consumption rates in the EU-27, 2000-2020



Source: Eurostat

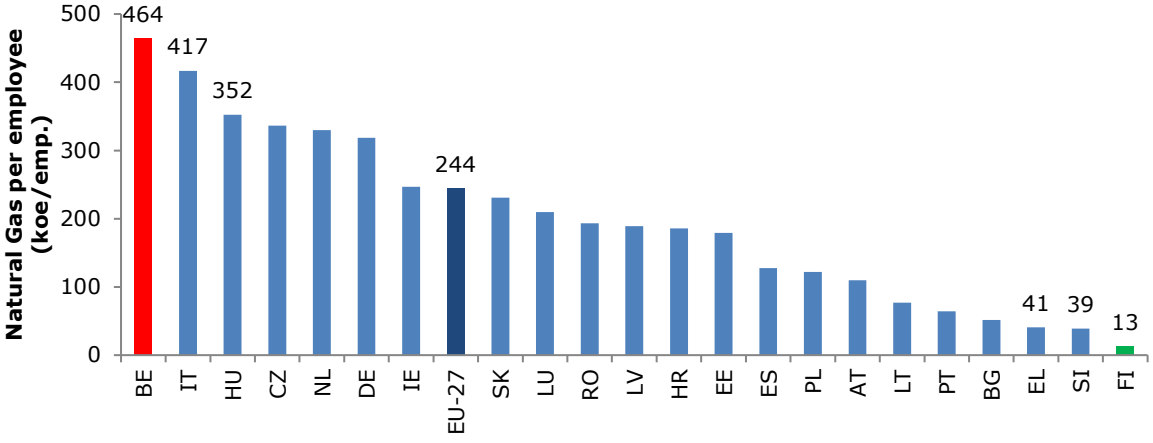
There are remarkable differences across the EU-27 Member States regarding the natural gas consumption rates during the period 2000-2020. In Figure 90, it can be observed that countries such as Greece, Bulgaria and Estonia experienced a very large increase in their consumption over this period (+1493.2%, +710.7% and +605.1% 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. However, individual case studies and further research would be needed in order to explain these high growth rates. Ten Member States registered a rate below the European average growth rate (22.6%) for the same period. The recent financial and economic crisis affected less on total EU-27 tertiary natural gas consumption compared to the impact on in other economic sectors. This is confirmed although it totally reversed the tendencies in countries such as Romania (it went from an increase of 298.8% between 2000-2010 to a decrease of 17.6% in 2010-2020) or Latvia (passed from 161.4% in 2000-2010 to –3.7% in 2010-2020) (Figure 90).

Figure 90: Final tertiary natural gas consumption rates by Member State[100] in the EU-27; 2000-2020, 2000-2010 and 2010-2020



Source: Eurostat

Figure 91: Annual final natural gas consumption per employee101 in the tertiary sector in the EU-27 Member States, 2020

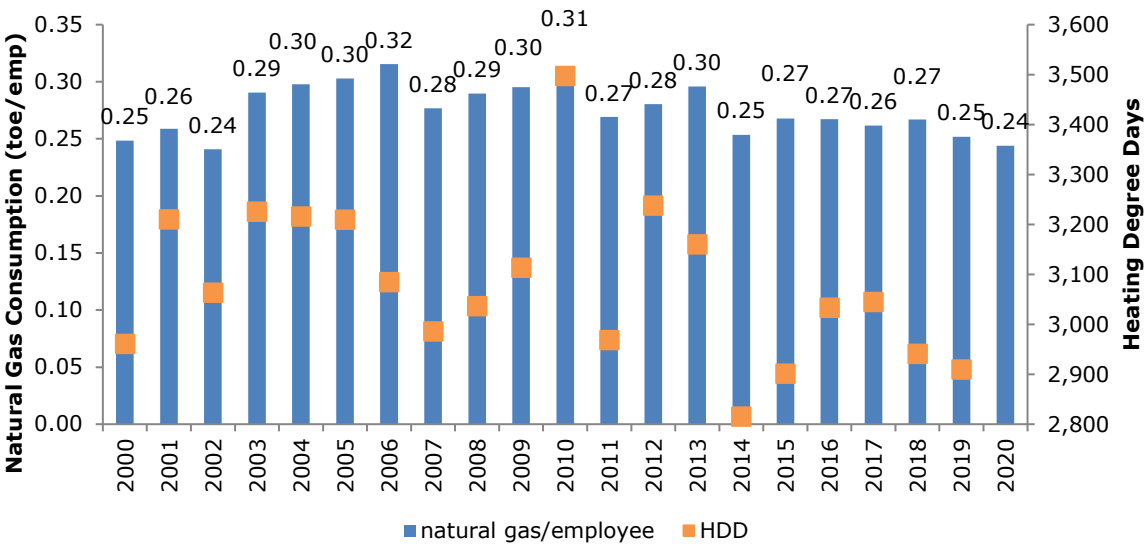


Source: Eurostat

The natural gas consumption per employee in the EU-27 in the tertiary sector was 243.8koe/emp. in 2020. Differences among Member States are remarkable. The European country with the lowest natural gas consumption per employee was Finland which registered 12.7 koe/emp., followed by Slovenia (38.8 koe/emp.) and Greece (40.6 koe/emp.). On the other hand, the Member State with the highest consumption was Belgium (463.7 koe/emp.), followed by Italy (416.6 koe/emp.) and Hungary (352.2 koe/emp.). Overall, seven countries registered consumption levels above EU-27_2020 level (Figure 91).

[100] CY and MT eliminated in the final graphics
[101] Data for Cyprus and Malta equal zero.
Denmark, Sweden, France : incomplete data

Figure 92: Annual final natural gas consumption per employee in the tertiary sector in the EU-27, 2000-2020



Source: Eurostat

Unlike electricity, which can be used for other purposes, natural gas is used mainly for heating purposes. Therefore, the correlation between natural gas consumption per employee in the tertiary sector and the weather conditions is crucial in this case. Figure 92 shows heating degree days and gas consumption per employee in the EU-27 from 2000 to 2020. During this period, the natural gas consumption per employee in the EU-27 reduced by 1.8%. The maximum value was reached in 2006 (0.32 toe/emp.).

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-27 Member States

ktoe	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2000-2020 (% year)
EU-27	28,153	36,710	40,368	34,987	36,513	38,616	33,544	35,993	36,531	36,438	37,805	36,157	34,517	**22.6%**
BE	1,545	1,591	2,014	1,641	1,832	1,984	1,587	1,777	1,880	1,874	1,896	1,898	1,770	**14.6%**
BG	12	44	80	83	82	78	83	89	90	95	98	90	99	**710.7 %**
CZ	1,104	1,274	1,291	1,241	1,149	1,106	1,082	1,078	1,128	1,190	1,106	1,172	1,058	**-4.2%**
DK	160	221	228	178	198	207	154	172	178	195	188	201	198	**23.7%**
DE	5,804	9,228	9,102	8,062	8,290	9,934	9,085	9,620	9,553	9,579	10,713	9,468	9,945	**71.3%**
EE	11	46	30	31	35	43	67	70	79	71	76	73	75	**605.1 %**
IE	293	290	344	348	377	360	339	364	367	368	406	409	416	**42.3%**
EL	9	74	139	165	138	125	125	166	148	151	144	153	137	**1493.2 %**
ES	552	579	1,018	1,725	1,629	1,492	1,409	1,763	1,803	1,844	1,893	1,946	1,803	**226.8 %**
FR	4,539	5,610	6,749	5,211	5,957	6,405	5,501	5,849	5,949	6,149	6,059	5,980	5,301	**16.8%**
HR	80	122	156	141	132	136	132	169	181	192	202	209	196	**144.3 %**
IT	5,572	7,434	8,614	7,254	7,276	7,259	6,012	6,499	6,542	6,590	7,250	7,086	6,690	**20.1%**
LV	44	94	116	104	98	84	91	86	94	101	105	110	111	**151.6 %**
LT	31	51	66	60	63	63	54	62	65	69	73	73	69	**122.9 %**
LU	149	98	136	69	108	107	90	104	117	89	100	107	77	**- 48.2%**
HU	1,773	2,281	1,715	1,726	1,387	1,408	1,243	1,261	1,233	1,170	1,102	1,059	1,062	**- 40.1%**

NL	3,227	3,523	4,035	3,222	3,633	3,646	2,888	3,101	3,111	3,111	3,004	2,787	2,546	**-21.1%**
AT	597	553	410	356	401	404	338	362	341	359	339	363	346	**-42.0%**
PL	921	1,634	1,993	1,870	1,932	1,827	1,611	1,715	1,934	1,452	1,345	1,349	1,144	**24.2%**
PT	57	136	196	218	218	219	216	234	253	255	263	248	201	**250.5%**
RO	235	782	936	756	764	785	776	751	762	830	822	819	771	**228.5%**
SI	19	26	24	39	13	32	37	50	65	49	26	30	25	**31.1%**
SK	1,360	901	843	357	644	772	493	526	533	571	489	399	356	**-73.9%**
FI	27	32	31	37	34	35	30	28	29	29	26	27	24	**-12.3%**
SE	33	88	103	94	122	106	101	95	96	54	78	102	95	**188.8%**

(1)Data for CY and MT equal zero

Source: Eurostat

4.3 Overview – Tertiary sector

The tertiary sector represented about more than 73% of the EU-27 GVA in the year 2020 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, information and communication, public administration, education, defence, human health and social works, arts, transport, accommodation and food service, financial and insurance, wholesale, retail, real estate. These activities caused a significant increase in employment during the period from 2010 to 2020.

The final energy consumption of the tertiary sector increased significantly from 2000 to 2020 (+15.9%). The maximum level of consumption was reached in the year 2010. In 2020, tertiary final energy consumption registered decrease (by 5.6%) as a result to the increase of teleworking due to COVID-19 pandemic, which led to reduction of use of tertiary sector buildings.

Heterogeneous final energy consumption rates were registered across the EU-27_2020 Member States in tertiary sector. From 2000 to 2020, the Member States with the highest reduction rates of final tertiary energy consumption were Slovakia, Hungary and Slovenia. The Member States with the highest consumption growth rates were Malta, Romania and Cyprus. Some significant changes in the growth rates across different sub-periods were observed in some Member States.

In 2020, the final energy mix in the tertiary sector of EU-27 was mainly formed by three energy sources that accounted for almost the 85% of the total final energy consumption i.e. electricity, natural gas and oil and petroleum products. However, renewable energies and biofuels multiplied by more than six times their share compared to year 2000, whereas oil and petroleum products share was decreased to less than half.

Weather and climate conditions, energy prices, teleworking activities as well as economic and employment growth can be factors affecting energy consumption in the tertiary sector. Given the nature of this sector, that includes different sub-sectors, comfort conditions (e.g. temperature or humidity levels) play a key role in the evaluation of the energy consumption. Regarding the employment creation during the period 2000-2020, the sector increased significantly. In this direction, an interesting indicator to consider in the energy trends analysis is the energy consumed per employee. The EU-27 final average energy consumption per employee in 2020 decreased slightly compared to 2000 (-7.2%). The Member States with the highest energy consumption per employee were Finland and Luxembourg, whereas Romania, Bulgaria and Greece showed the lowest final tertiary energy consumption per employee.

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

Tertiary sector (commercial and public services) accounted for almost one third of the final electrical energy consumption, the largest share after the industry and residential sector.

Both final electricity and natural gas consumption trends in the tertiary sector show an important increase in the consumption during the period from 2000 to 2020. Concerning the growth rates of the different Member States over this period, it is observed that six Member States registered a rate below the EU-27 value for

electricity and ten for natural gas. The Member States with the highest growth rates were Ireland for electricity and Greece for natural gas. The highest reduction rates were 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 EU-27 electricity and natural gas consumption per employee in 2020 decreased compared to 2000. Eleven Member States had above EU-27_2020 electricity consumption per employee and seven had above EU-27_2020 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 one with the lowest natural gas consumption per employee was Finland.

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

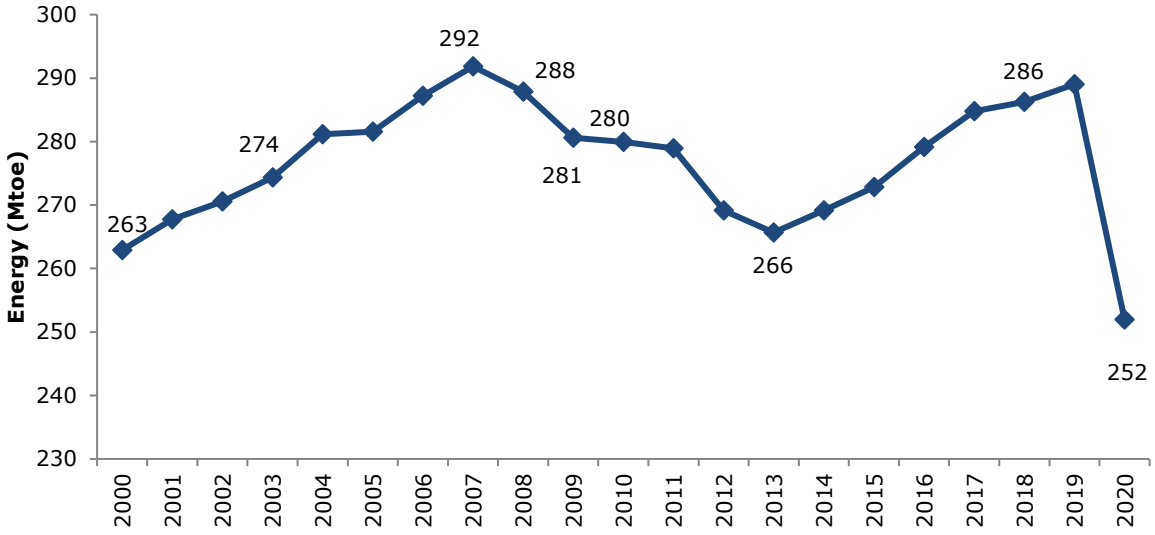
5 Energy Consumption Trends in the Transport Sector

This chapter covers the energy consumption trends in the transport sector including rail, road, 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 28.5% of the total final energy consumption in the year 2020 (Figure 7, Page 13), the largest share of final energy consumption. The final energy consumption in the EU-27 transport sector decreased by 4.2% in the 21-year period from 2000 to 2020. The EU-27 consumption reached a peak in the year 2007 (291.8 Mtoe); the lowest consumption was registered in the year 2020 (252.0 Mtoe). The increasing trend was reversed after 2007 and until 2013 and from 2013 to 2019, it was reversed again (Figure 93). The profound reduction in 2020 was a result of COVID-19 Pandemic and of the lockdown measures that restricted importantly the transport activities. Energy consumption data of 2020 in transport were influenced mainly by the exceptional event of COVID-19 and may be no representative for the trends of the studied period. Indeed, if we look at the period from 2000 to 2019, an increase by 9.9% is observed. However, even if transport sector restricted significantly the energy consumption in 2020, it is still consuming the most among the end-use sectors. This means that policies related to transport sector should be reinforced in the following years.

Figure 93: Final energy consumption in the transport sector in the EU-27, 2000-2020

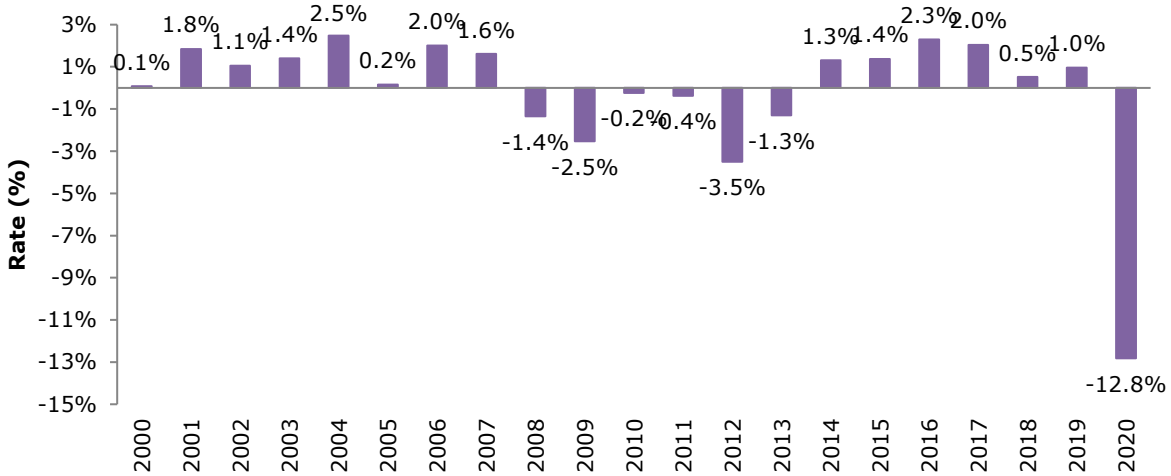


Source: Eurostat

During the period 2000-2007, the highest growth rate occurred in 2004 (by 2.5% 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 slowed down after 2007, driven by the fall in traffic and the less efficient operation of the vehicle fleet as shown by the lower load factors[102]. From 2013 to 2019, an increasing trend in transport energy consumption is observed. This probably was the result of economic recovery taken place during this period. However, the highest decreased occurred in 2020 due to the exceptional event of COVID-19, (-12.8% less compared to the previous year).

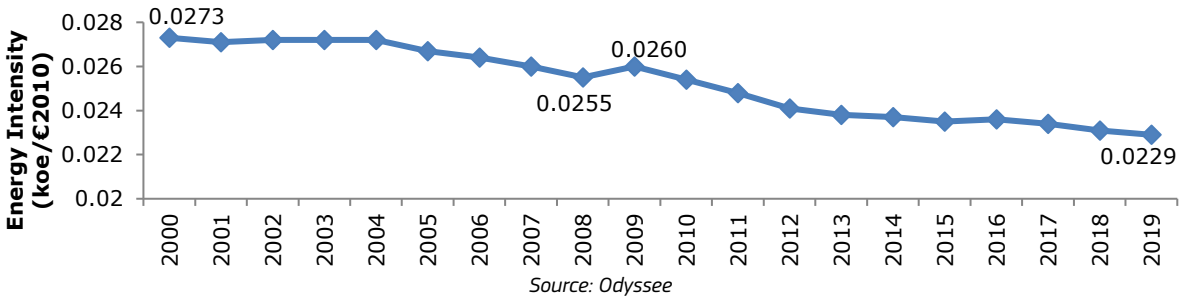
[102] Odyssee-Mure (2015): Trends and policies for energy savings and emissions in transport (available at: http://www.odyssee-mure.eu/publications/br/energy-efficiency-in-transport.html)

Figure 94: Annual energy consumption rates in the EU-27 transport sector, 2000-2020



Source: Eurostat

Figure 95: Energy intensity of transport sector in the EU-27, 2000-2019



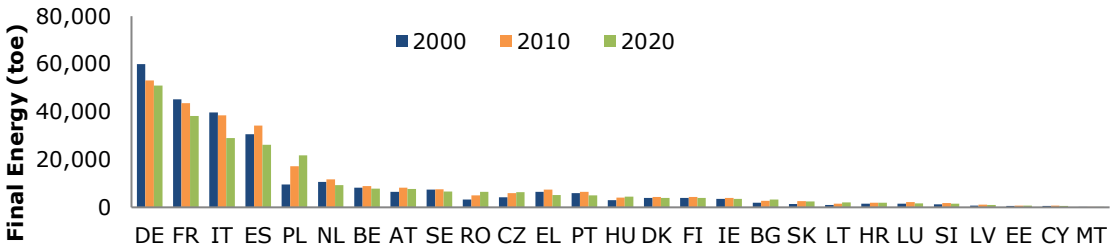
Source: Odyssee

During the period from 2000 to 2019, the energy intensity in the transport sector decreased by 16.1% reaching 0.023 ktoe/€ in 2019. The decreasing trend along the period was interrupted in 2009 and then from 2016 by rises of 2.0% and 0.4% respectively compared to the previous year. In 2009, it may was 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 2019, it reduced slightly compared to 2018.

In 2020, the Member State with the highest consumption in the transport sector was Germany (51.0 Mtoe), followed by the France (38.2 Mtoe) and Italy (29.0 Mtoe) (Figure 96). It is worth noticing that in the years 2000, 2010 and 2020 these three countries occupied the same positions in the ranking in terms of final energy consumption in transport.

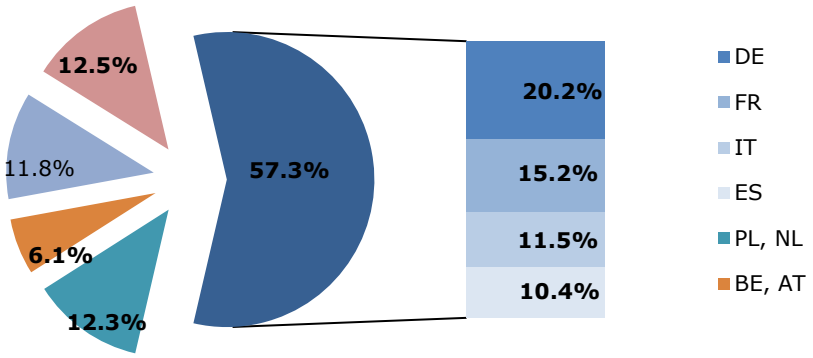
The four Member States together with Spain accounted for more than 55% of the final energy consumption in the sector. If also Poland and Netherlands are added, the share reaches almost the 70% of the final energy consumption. Fourteen Member States accounted for less than 13% of the final energy consumption in 2020 (Figure 97).

Figure 96: Final energy consumption at transport sector in the EU-27 Member States, 2000, 2010 and 2020



Source: Eurostat

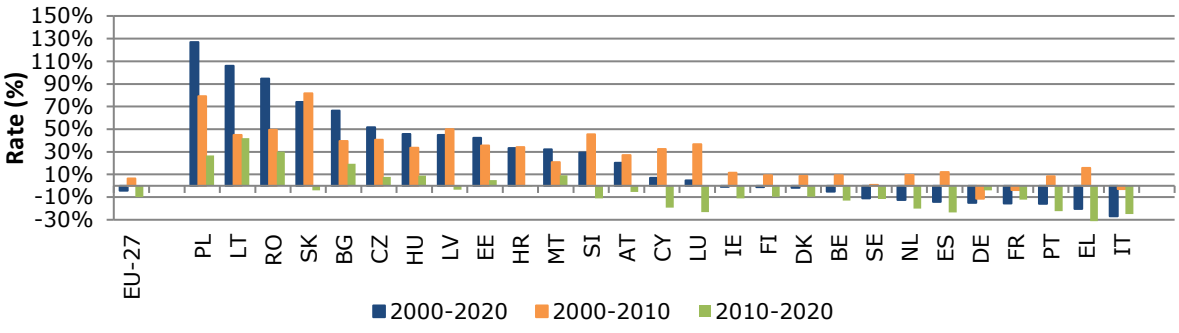
Figure 97: Shares of EU-27 Member States to final transport energy consumption, 2020



Source: Eurostat

Figure 98 shows the 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 2020 were Poland (127.0%), Lithuania (105.9%) and Romania (94.5%), while the Member States with highest decreases in terms of reduction rates were Italy (-27.0%), Greece (-20.4%) and Portugal (-16.0%). Nine EU-27 countries registered consumption values below the European rate (-4.2%). In the period 2000-2010, only four Member States registered a decrease in their final energy consumption. The European growth rate was 6.5% during this period. On the contrary, all but eight Member States transport consumption reduced from 2010 to 2020. No clear results from transport policies could be extracted from this, as once again the COVID-19 effect influenced the general trends.

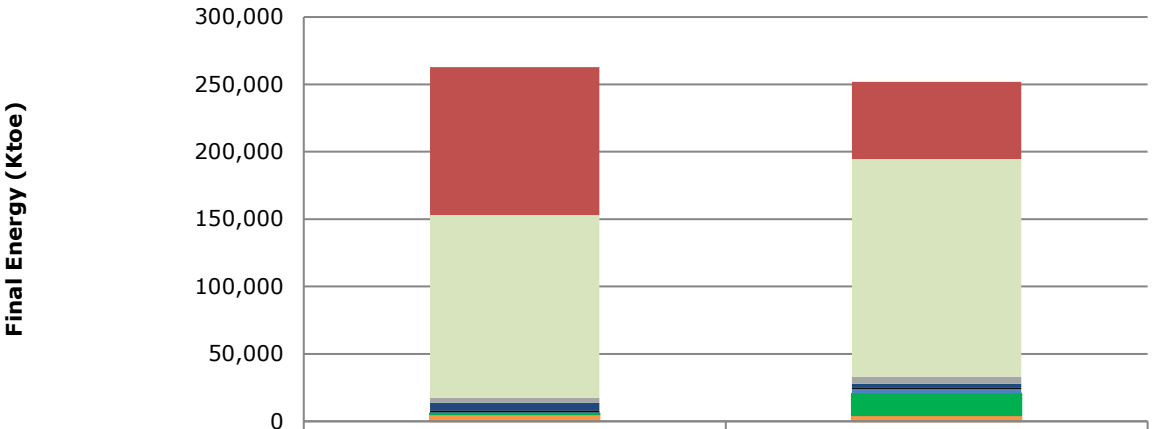
Figure 98: Final energy consumption rates in the transport sector in the EU-27 Member States; 2000-2020, 2000-2010 and 2010-2020



Source: Eurostat

In terms of the energy mix (Figure 99) oil and petroleum products provide the largest share of the final energy consumption in transport. Petroleum products represented 90.6% (228,206 ktoe) of the final energy demand in 2020. However, the share was reduced relative to 2000 (97.4%; 256,026 ktoe).

Figure 99: Final energy mix in the transport sector in the EU-27 (absolute numbers), 2000 and 2020



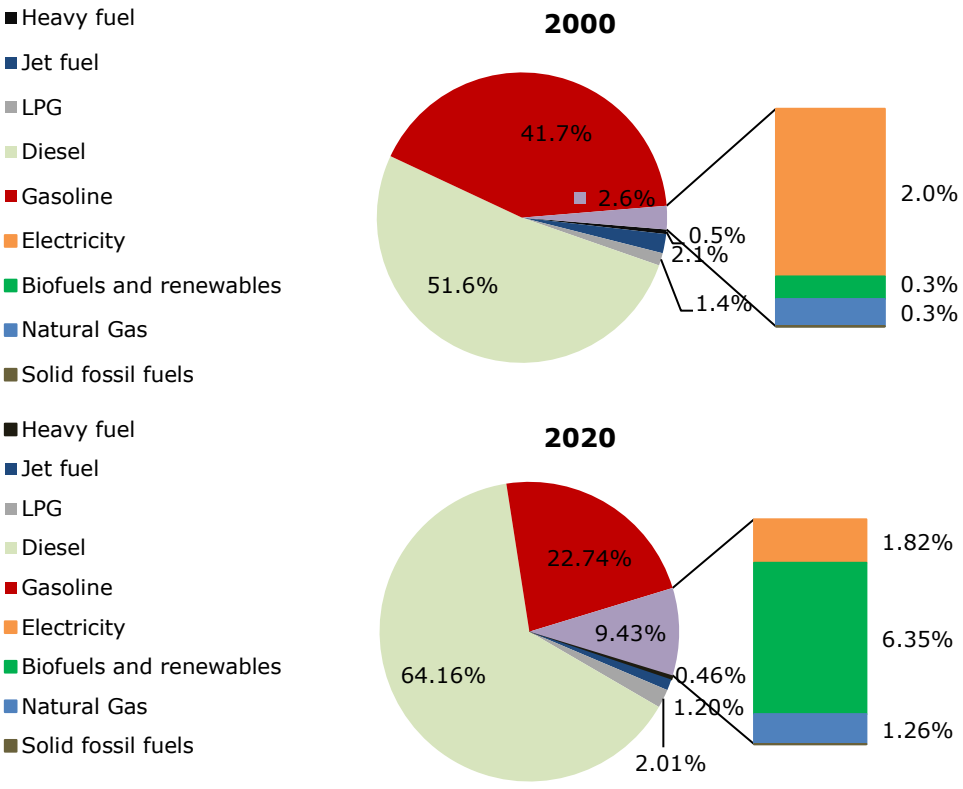
	2000	2020
Gasoline	109603	57262.2
Diesel	135716	161655.4
LPG	3657	5059.7
Jet fuel	5608	3033.8
Heavy fuel	1337	1147.6
Natural Gas	855	3162.2
Biofuels and renewables	712	16003.3
Electricity	5283	4598.3
Solids fossil fuels	10	0

Source: Eurostat

Among the petroleum products, diesel and gasoline provide the largest share (Figure 100). In 2020, diesel accounted for 64.2% (161,655 ktoe) of the final energy demand and gasoline for 22.7% (57,309 ktoe). Other fuels and energy carriers showed lower shares in the energy mix: biofuels and renewables (6.4%; 16,003 ktoe), LPG (2.0%; 5,060 ktoe), electricity (1.8%; 4,598 ktoe), natural gas (1.3%; 3,162 ktoe), jet fuel (1.3%; 3,034 ktoe), and heavy fuel (0.5%; 1148 ktoe). Solid fuels represented a negligible share in the final energy mix.

The gasoline share decreased from 41.7% in 2000 to 22.7% in 2020. The share of diesel increased from 51.6% in 2000 to 64.2% in 2020. The share of biofuels and renewables increased from 0.3% in 2000 to 6.4% in 2020. These were the most significant changes in the final energy mix during 2000-2020.

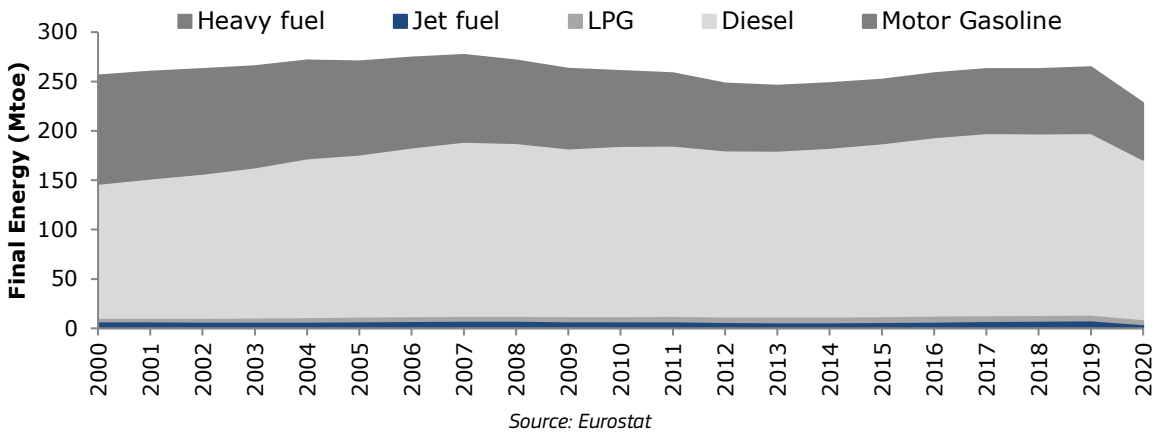
Figure 100: Final energy mix in the transport sector in the EU-27 (shares), 2000 and 2020



Source: Eurostat

From 2000 to 2020, the oil and petroleum products consumption increased by 10.9%. During this period diesel gradually increased its presence. Diesel's consumption increased by 19.1%, while gasoline declined by 47.8%. However, in 2020 diesel consumption decreased by 12.1% compared to 2019. Heavy fuel registered a decrease by 14.2% and jet fuel by 45.9% from 2000 to 2020. The changes in the petroleum products consumption occurred gradually during the analysed 20-year period (Figure 101).

Figure 101: Final energy consumption of oil and petroleum products in the EU-27 transport sector, 2000-2020

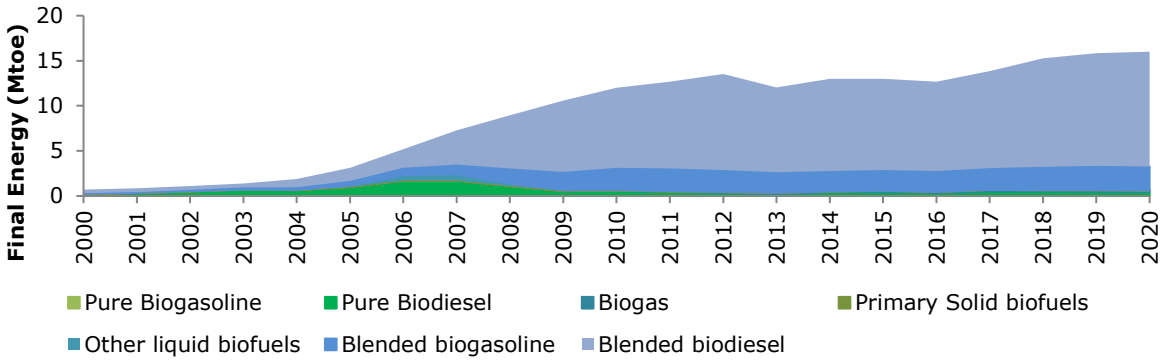


Source: Eurostat

Although the petroleum products dominate the fuel mix in the transport sector, biofuels and renewables significantly increased their share between 2000 and 2020, driven by the Renewable Energy Directives[103].

[103] 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)

Figure 102: Final energy consumption of biofuels in the EU-27 transport sector, 2000-2020



Source: Eurostat

A significant increase in the consumption of biofuels took place especially between 2005 and 2010 when the consumption rose by almost four times (from 3,140 ktoe to 12,011 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 82.3% of biofuels.

Biogasoline is the second highest consumed type of biofuel. Pure and blended biogasoline represent the 16.6% of biofuels. From 2000 to 2020, they increased from 59 ktoe to 2656 ktoe (4425.4%). Biogas represented 19 ktoe in 2008 and increased significantly by 2020, when it reached 178 ktoe. This corresponds to an increase of increase of 835.2%. The energy consumption of other liquid biofuels[104] was more limited. Solid biofuels consumption was negligible (below 1 ktoe per year).

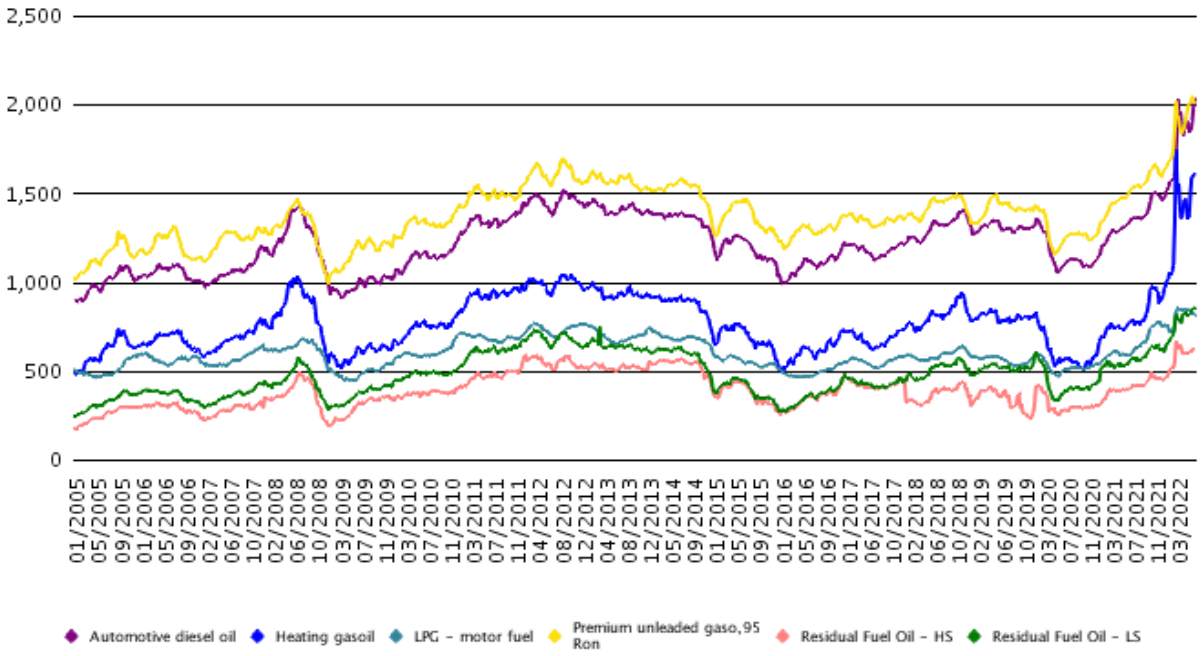
Fuel prices

According to the weekly oil bulletin of DG-Energy [12], 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. Since then some drop falls were recorded: in January 2015, January 2016, and March 2020 while the peak of the whole period from 2005 to 2022 was registered at the end of 2021-beginning of 2022.

The evolution of crude oil prices was driven by many factors such as the weakening of global demand, a significant shift in OPEC[105] policy, some geopolitical risks or the appreciation of the U.S. dollar [13], [14].

[104] 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.
[105] Organization of the Petroleum Exporting Countries

Figure 103: Consumer prices of petroleum products inclusive of duties and taxes - Eurozone weighted average, January 2005 – March 2022



Source: EC DG-ENER

5.2 Final energy demand by transport mode

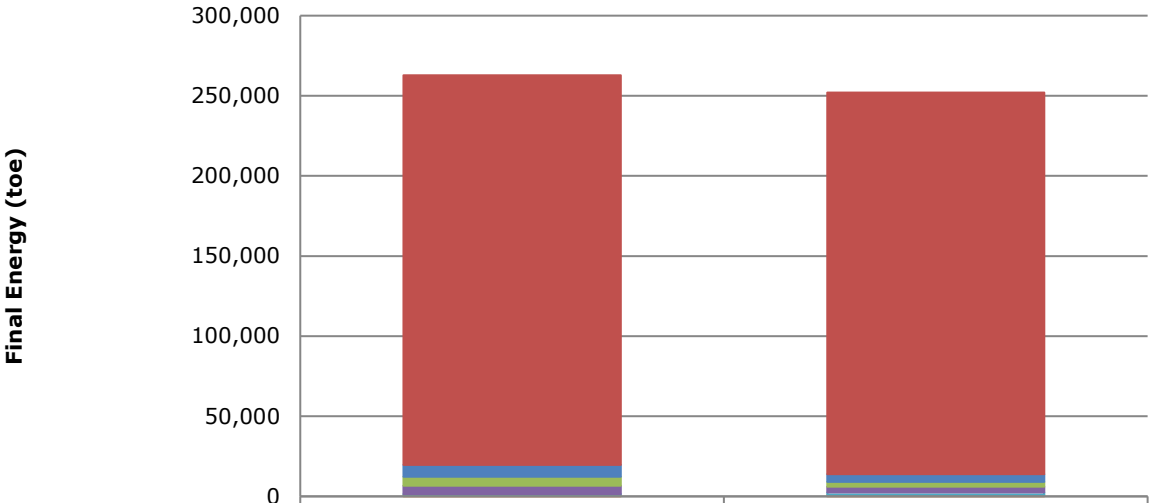
In this section, final energy consumption in the transport sector is broken down by mode: road, rail, domestic aviation, domestic navigation, pipeline transport[106], and other transports. Domestic aviation and domestic navigation include the activity taken place within the Member States[107]. Other transportation[108] 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 transport (Figure 104).

[106] Pipeline transport is the long-distance transportation of a liquid or gas through a system of pipes—a pipeline—typically to a market area for consumption

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

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

Figure 104: Final energy consumption in the EU-27 by transport mode, 2000 and 2020

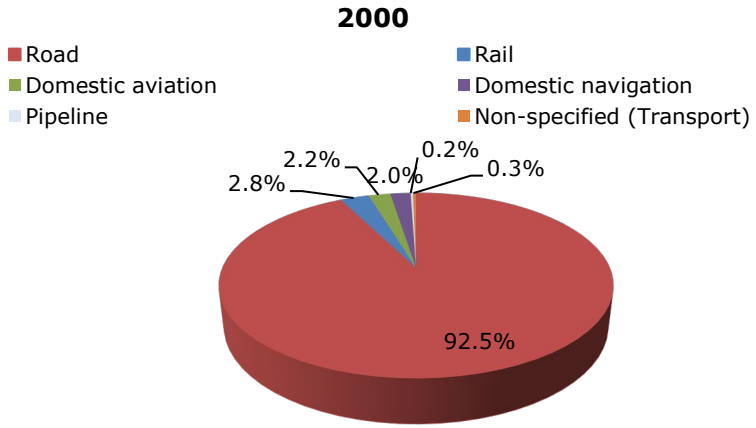


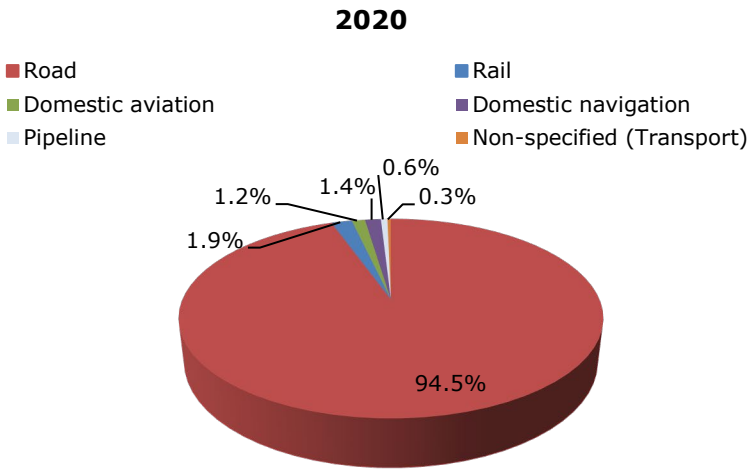
	2000	2020
Road	243,159	238,218
Rail	7,384	4,717
Domestic aviation	5,715	3,081
Domestic navigation	5,214	3,645
Pipeline	581	1,503
Non-specified Transport	833	926

Source: Eurostat

Road transport is extensively the main energy-consuming mode of transport. It represented 94.5% (238.2 Mtoe) of the transport final energy share in 2020. In the same year, rail ranked second in the terms of energy consumption (1.9%; 4.7 Mtoe), followed by domestic navigation (1.5%; 3.7 Mtoe), domestic aviation (1.2%; 3.1 Mtoe), pipeline transport (0.6%; 1.5 Mtoe) and other non-specified transport (0.3%; 0.9 Mtoe). The most remarkable change compared to the year 2000 scenario is the energy consumption of pipeline transport that increased by almost three times (from 581 ktoe to 1,503 ktoe). In comparison to the year 2000 rail, domestic aviation, domestic navigation reduced their shares, while the rest of transport modes (i.e. road, pipeline and non-specified transport) increased their shares (Figure 105).

Figure 105: Share of transport modes in final energy consumption, 2000 and 2020

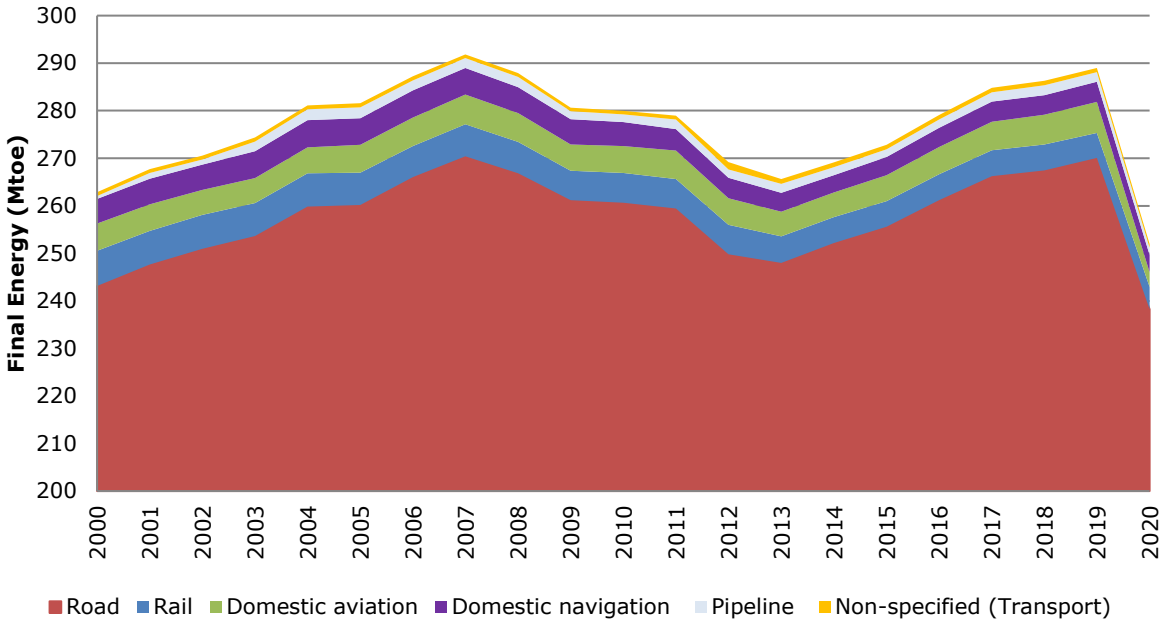




Source: Eurostat

The contribution of the different transport modes to the aggregate energy consumption for the period 2000-2020 (Figure 106). During this period, the total final energy consumption in the sector decreased by 4.2%. However, this increase did not take place in all transport modes. Domestic aviation was the sector where consumption declined the most (by 46.0%). Rail and domestic navigation decreased their energy consumption by 36.1% and 30.1% respectively. Road transport and non-specified transport reduced slightly their consumptions by 2.0% and 3.2% respectively. In contrast, pipeline transport is the only subsectors that registered an increase in their consumption in comparison to the year 2000 by 158.7%.

Figure 106: Final energy consumption in the EU-27 by transport mode, 2000-2020



Source: Eurostat

Table 7 provides an overview of the final energy consumption and rates by transport mode from 2000 to 2020.

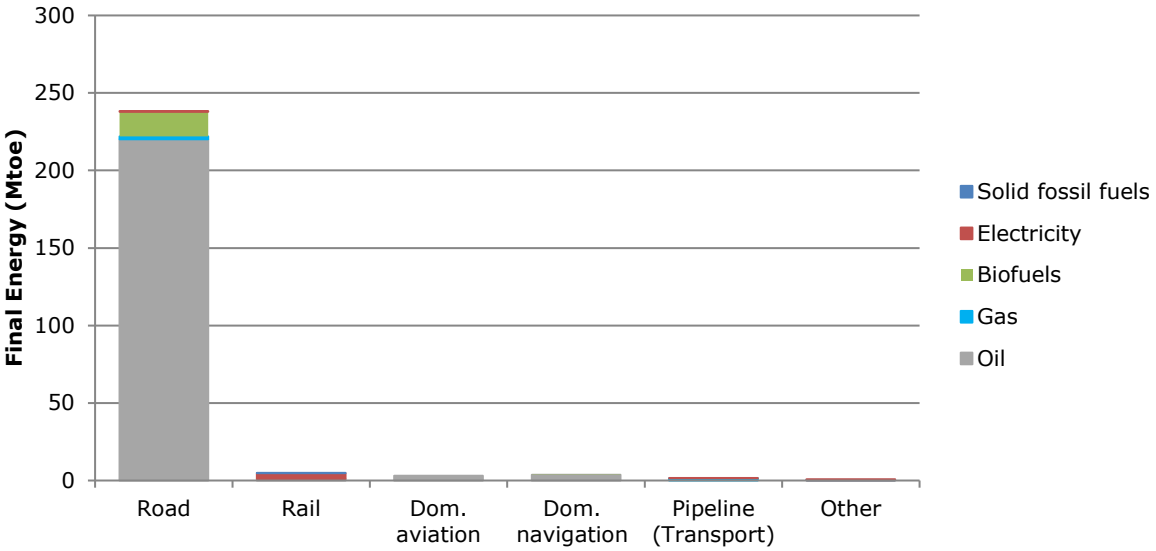
Table 7: Rates of energy consumption and transport modes, 2000 and 2020

	Final Energy (toe)		Rate (%)	Share in %		Change of shares
	2000	2020	2000-2020	2000	2020	2000-2020
Transport	262886	251970	-4.2%			
Rail	7384	4717	-36.1%	2.8%	1.9%	-0.9%
Road	243159	238218	-2.0%	92.5%	94.5%	2.0%
Domestic aviation	5715	3081	-46.1%	2.2%	1.2%	-1.0%
Domestic Navigation	5214	3645	-30.1%	2.0%	1.4%	-0.5%
Consumption in Pipeline	581	1503	158.6%	0.2%	0.6%	0.4%
Other transports	833	806	-3.2%	0.3%	0.3%	0.0%

Source: Eurostat

Figures 107 and 108 show the energy mix by transport mode for the year 2020 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 99.5% of energy use in domestic navigation and 92.4% of the energy use in road transport.

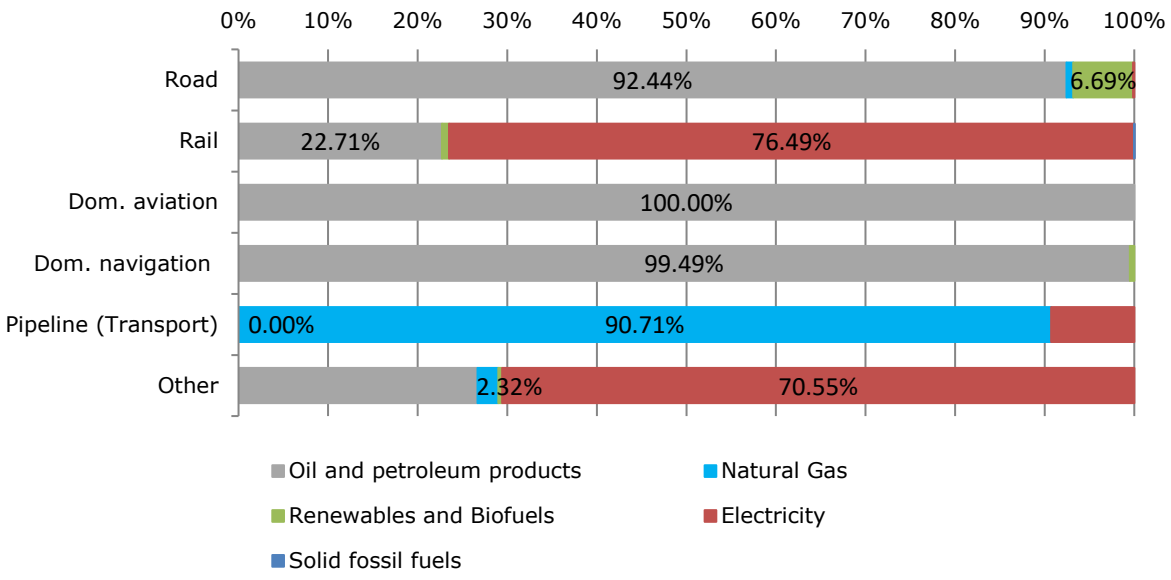
Figure 107: Final energy per fuel type and transport mode in the EU-27, 2020



Source: Eurostat

In 2020, electricity represented the main energy type used in rail (76.5%) and other transports (70.6%). In terms of shares, natural gas represented 90.7% of the energy use in pipeline transport. Renewables Biofuels provided about 6.7% of the energy use in road transport, 0.8% for rail transport, 0.5% for other transport, and 0.5% for domestic navigation.

Figure 108: Share of fuel type and transport modes in the EU-27, 2020



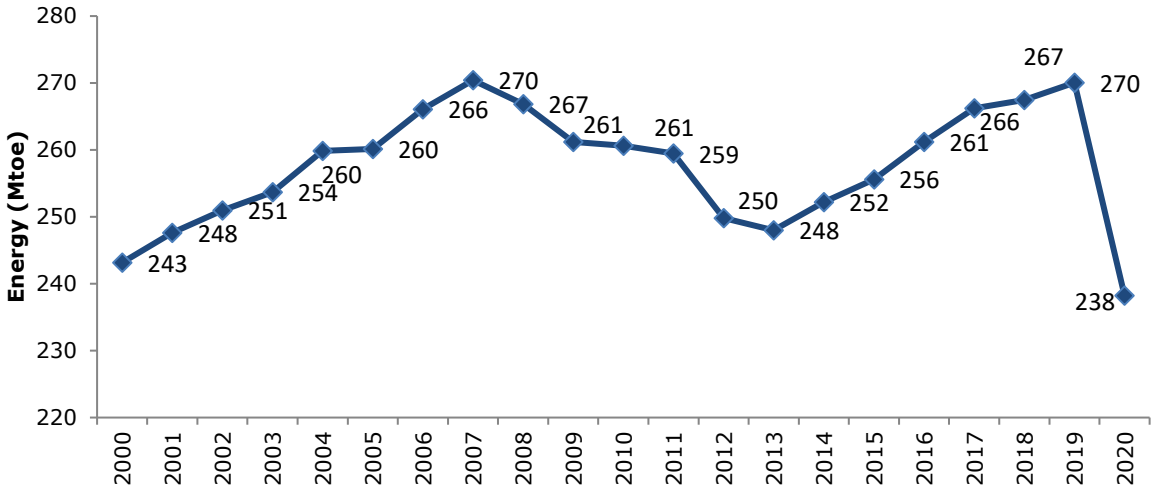
Source: Eurostat

As road transport provides the highest share of final energy demand in transport (94.5%), it is further analysed in the section below.

5.3 Final energy demand in road transport sector

The final energy consumption in the road transport has decreased by 2.0% in the period from 2000 to 2020. Hover it has increased by 11.1% in the period 2000-2019, while it has decreased significantly (by 11.8%) from 2019 to 2020 (Figure 109), mainly due the COVID-19 pandemic.

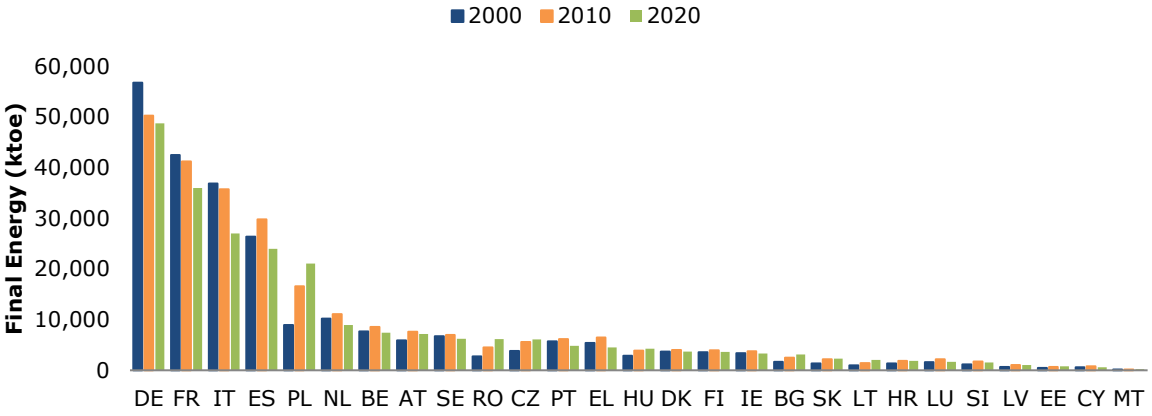
Figure 109: Final energy consumption in the EU-27 road transport, 2000-2020



Source: Eurostat

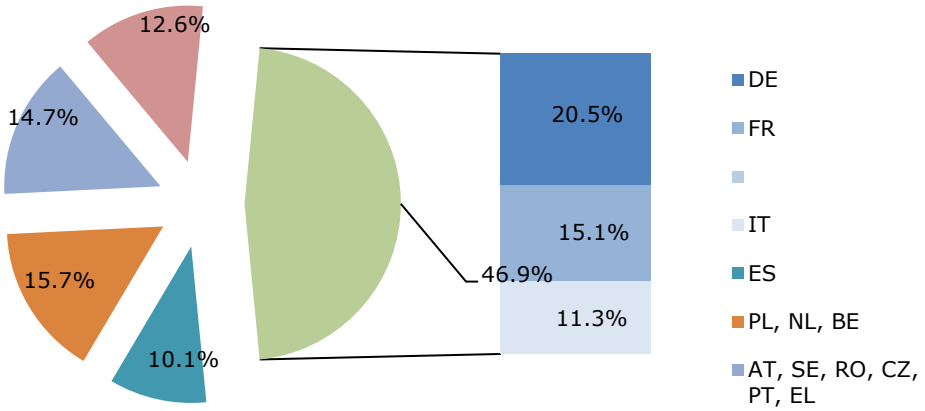
Across the EU-27 Member States, there are remarkable differences in the final energy consumption (Figure 110). In 2020, the countries with the highest road transport energy consumption were Germany (56.8 Mtoe), France (42.5 Mtoe), Italy (36.9 Mtoe) and Spain (26.4 Mtoe). These four countries accounted for more than 55% of the total final energy consumption in the road transport. In the same year, fourteen Member States consumed less than 13% of the final energy consumption in the road transport (Figure 111).

Figure 110: Final energy consumption in road transport per Member State in the EU-27, 2000, 2010 and 2020



Source: Eurostat

Figure 111: Shares of EU-27 Member States to final road transport energy consumption, 2020

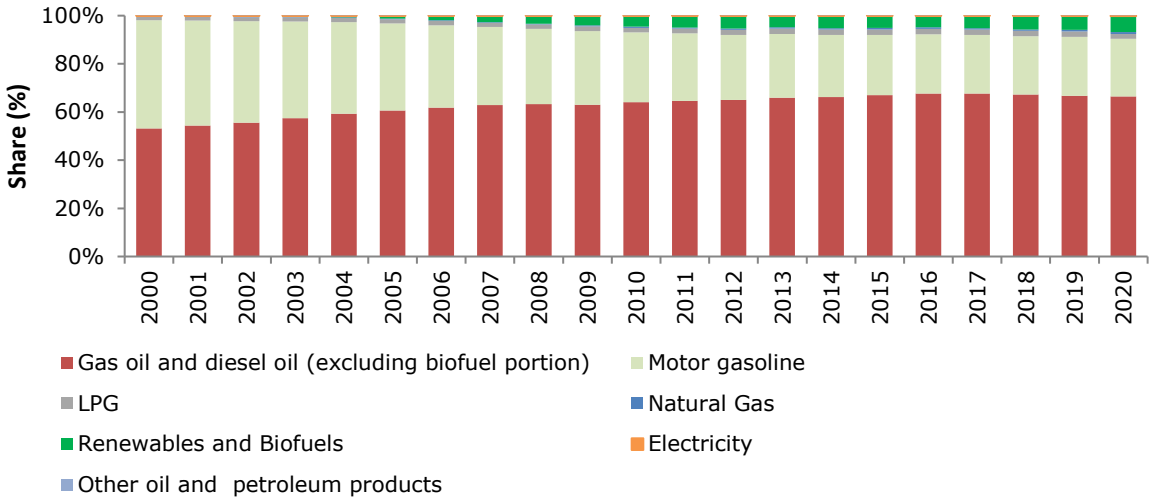


Source: Eurostat

With regard to the energy mix in the road transport, petroleum products (i.e. diesel, gasoline, LPG) are main fuel types used. In 2020, diesel represented 66.5% of the energy use in road transport, followed by motor gasoline (23.9%), renewables and biofuels (6.7%), LPG (2.1%), natural gas (0.8%), electricity (0.1%) and other oil and petroleum products, which accounted for negligible shares of the final energy consumption.

Figure 112 displays the energy mix for the period 2000-2020. It shows the gradual reduction of gasoline consumption and the increase in the consumption of diesel and biofuels. LPG, natural gas and electricity slightly increased their shares in energy consumption. Renewables and biofuels share was increasing continuously during the studied period while diesel share slightly decreased from 2019 to 2020.

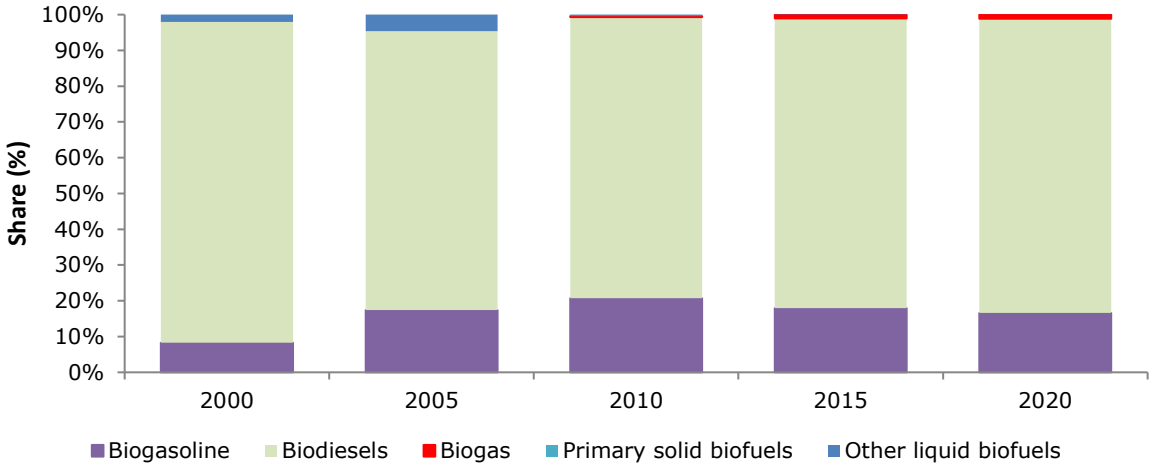
Figure 112: Final energy mix in the EU-27 road transport, 2000-2020



Source: Eurostat

Biodiesel was the main type of biofuel used during 2000-2020. Already in 2000, biodiesel (pure and blended) accounted for 89.7% of the total consumption of biofuels in the road sector, followed by biogasoline (pure and blended) (8.3%) and other liquid biofuels (2.0%). In 2020, after 21 years, biodiesel still provided 82.2% of the total consumption of biofuels. Biogasoline increased its share to 16.6%. The uptake of biogas started after 2008 reaching 1.1% of the total liquid and gaseous biofuels in 2020 (Figure 113).

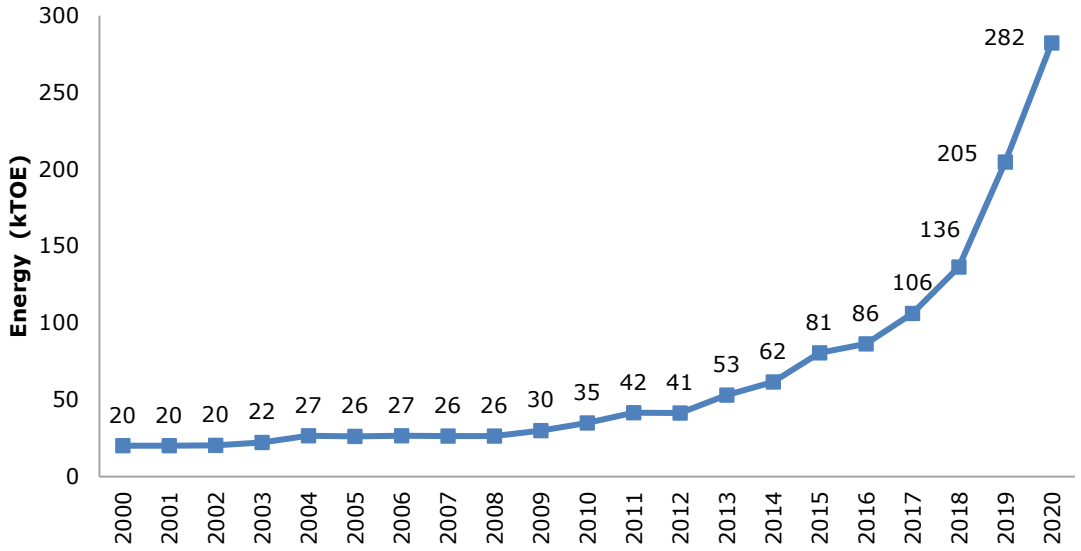
Figure 113: Liquid and gaseous biofuels mix in the EU-27 road transport, years 2000, 2005, 2010, 2015 and 2020



Source: Eurostat

Figure 114 shows that electricity use in road transport has increased significantly during the studied period (by 13%) most probably as a result of penetration of electric vehicles to the total road vehicle fleet and of the provided incentives for the purchase or use of them.

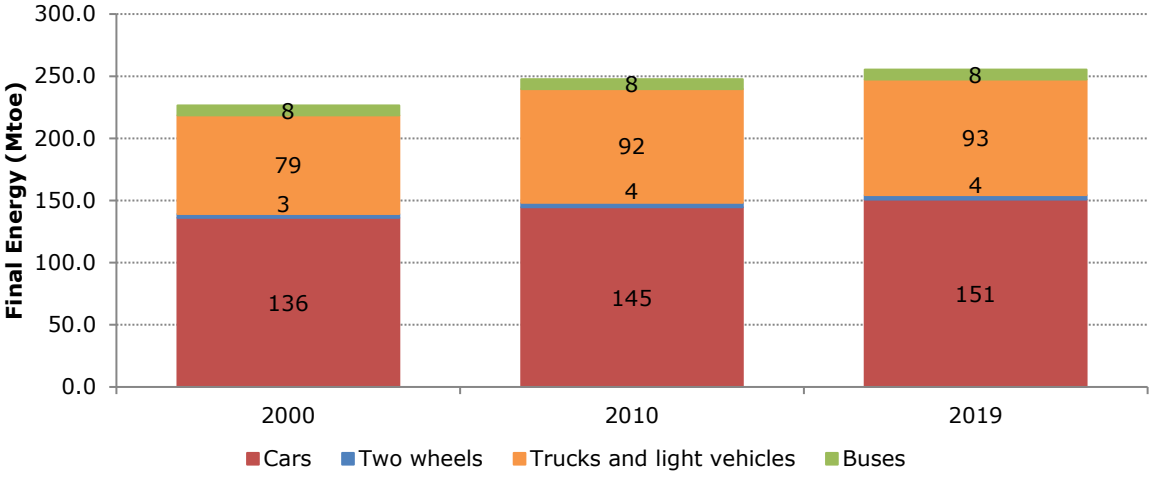
Figure 114: Electricity in the EU-27 road transport, 2000-2020



Source: Eurostat

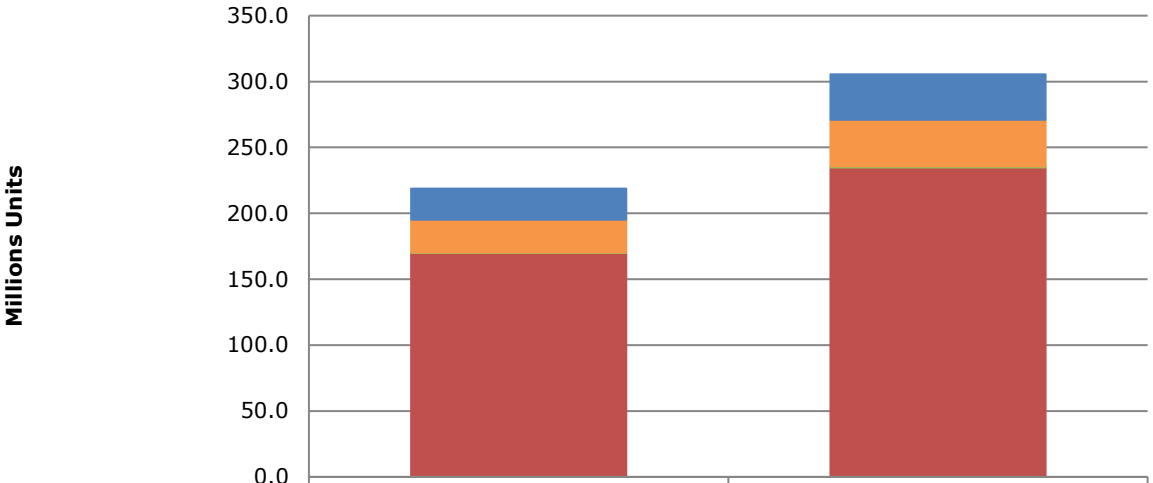
Among the different vehicle types, cars are estimated to provide the highest share of road transport energy consumption. According to Odyssee database (Figure 115), in 2019, cars accounted for 59.0% (150.8 Mtoe) of the energy consumption in road transport, followed by trucks and light vehicles (36.5%; 93.1 Mtoe), buses (3.1%; 7.9 Mtoe) and powered two wheelers (1.3%; 3.5 Mtoe). There were not remarkable differences between 2000 and 2019 within these indicators. Nevertheless, during this period, increases in the consumption have been registered, due to the grow of energy demand coming from cars, trucks and light vehicles.

Figure 115: Road energy consumption per vehicle type in the EU-27, 2000, 2010 and 2019



Source: Odyssee

Figure 116: Number of vehicles in the EU-27, 2000 and 2019



	2000	2019
Two wheels	23.7	34.5
Trucks and light vehicles	24.7	35.3
Buses	0.7	0.7
Cars	169.8	234.9

Source: Odyssee

According to Odyssee database (Figure 116), in 2019, there were 234.9 million of cars registered in Europe, 35.4 million trucks and light vehicles[109], 34.5 million powered two wheelers and 741.1 thousand buses. In comparison with the year 2000, the total stock of vehicles increased by 39.5%. All the vehicle types increased their stock. Two wheels are the vehicle types, which experienced the highest growth rate, (45.2% or 10.7 million units). The stock of trucks and light vehicles increased by 43.3% (10.7 million units). Cars and buses incremented their stock numbers by 38.3% and 12.7% respectively.

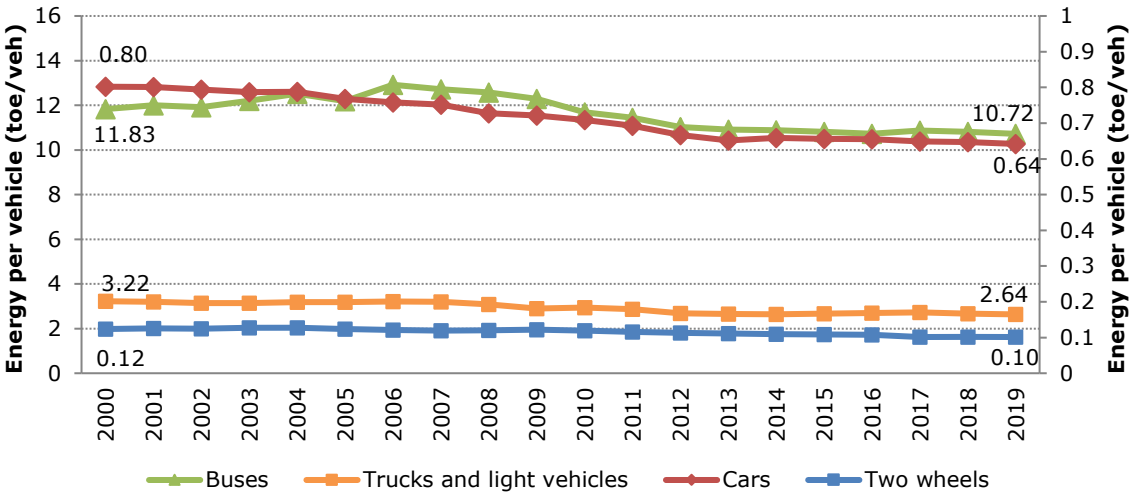
Buses have the largest energy consumption per vehicle (Figure 117). This is easily understandable due to the average size of this kind of vehicles and due to the kind of their journeys. In 2019, the average energy consumption per bus in EU-27 was 10.7 toe/veh. In the same year trucks and light vehicles consumed 2.6 toe/veh, cars 0.64 toe/veh and two wheels 0.101 toe/veh. In comparison to year 2000, cars' energy consumption decreased by 20.0%, two wheels by 17.5%, trucks, and light vehicles[110] by 18.2%. Buses registered a decrease by 9.3%.

To be noted that buses are the only vehicle type that reduced the least energy consumption per unit during the period 2000-2019. 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, 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 Europeans regions in both private- and public-operated buses.

[109] 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 [15]

[110] 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 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. [15]

Figure 117: Energy consumption per vehicle type (toe/veh) in the EU-27, 2000-2019



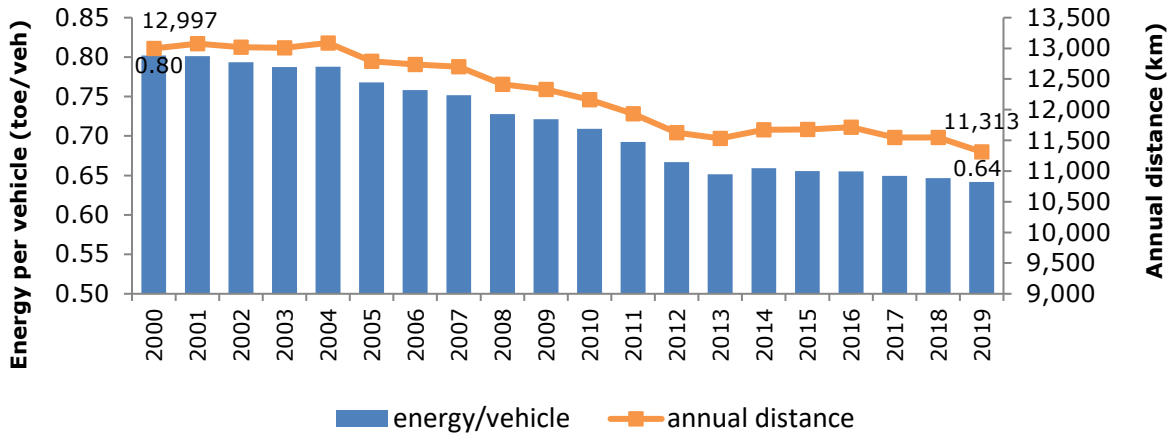
Source: Odyssee

5.3.1 Passenger cars

According to Odyssee database, cars represented the 76.9% of the stock of vehicles and the 59.0% of the final road energy consumption in 2019. 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-27 registered the value of 0.80 toe per vehicle. During the period from 2000 to 2019, a gradual decreasing trend was observed (a 20.0% drop during the period).

Figure 118 shows the energy consumption per car, together with the average annual distance travelled by car in the EU-27 during the same period (2000-2019). The average annual distance travelled by car decreased by 1,684 km during the 20-year period (from 12,977 km to 11,313 km). The lowest distance travelled was registered in 2019. 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.

Figure 118: Annual energy consumption and annual distance travelled per car in the EU-27, 2000-2019

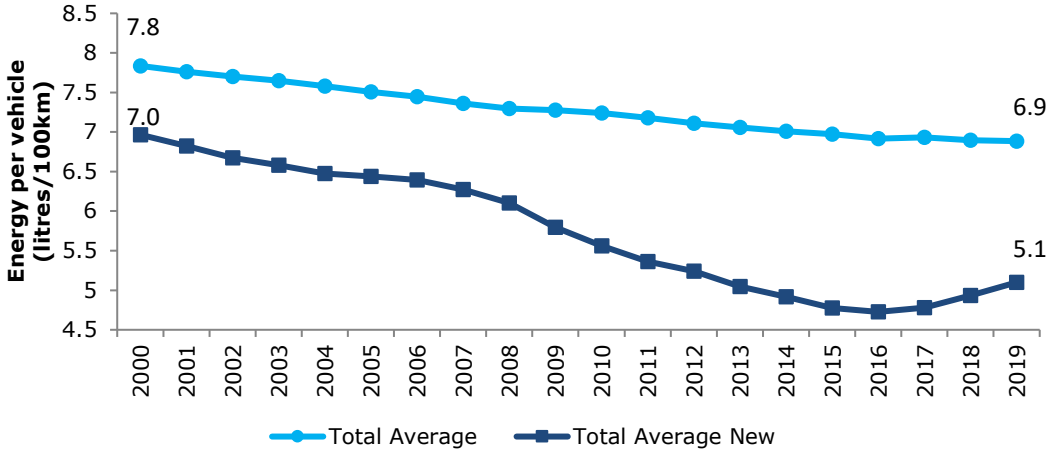


Source: Odyssee

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 cycle[111]. Figure 119 shows that in both cases (i.e. average consumption calculated from data and those based on test cycle) there is a decline since 2000. The average consumption of registered cars in the market declined by 12.1%, while the consumption of new cars entering the market (tagged as 'new') is even larger at 26.8%. Specific consumption for total average registered an almost continuous decreasing trend from 2000 to 2019 while for new cars a slight increasing trend was started in 2016.

It is important to note that after 2009 and until 2016, the rate of decline in the consumption of new cars increased, driven by the regulations on CO2 emissions from light-duty vehicles. The increase observed from 2017 to 2019 in new cars is maybe a result of increase in the average size of new cars compared to previous years.

Figure 119: Average specific consumption per car engine technology in the EU-27, 2000-2010

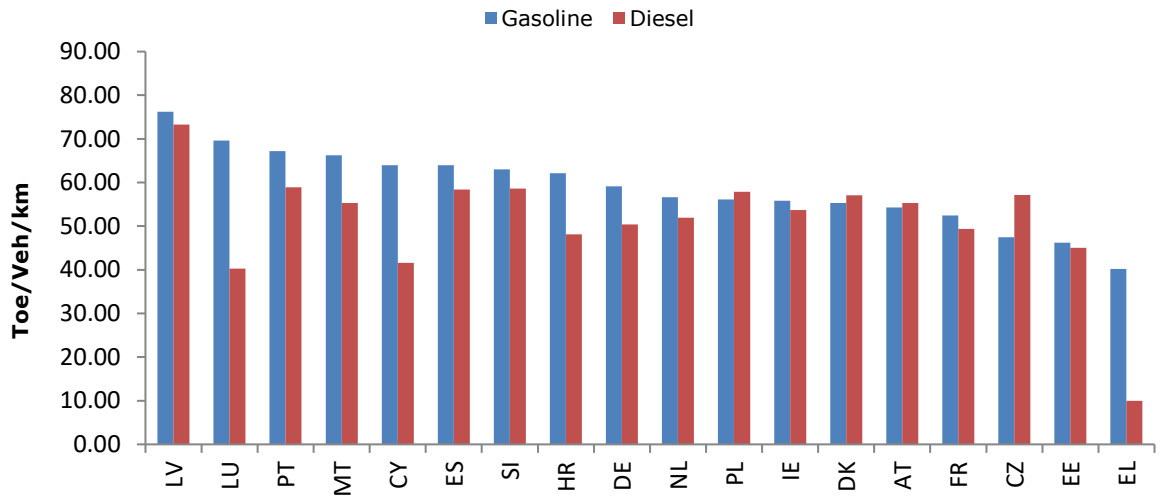


Source: Odyssee

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.

[111] Definition of energy efficiency indicators can be found in Odyssee database.

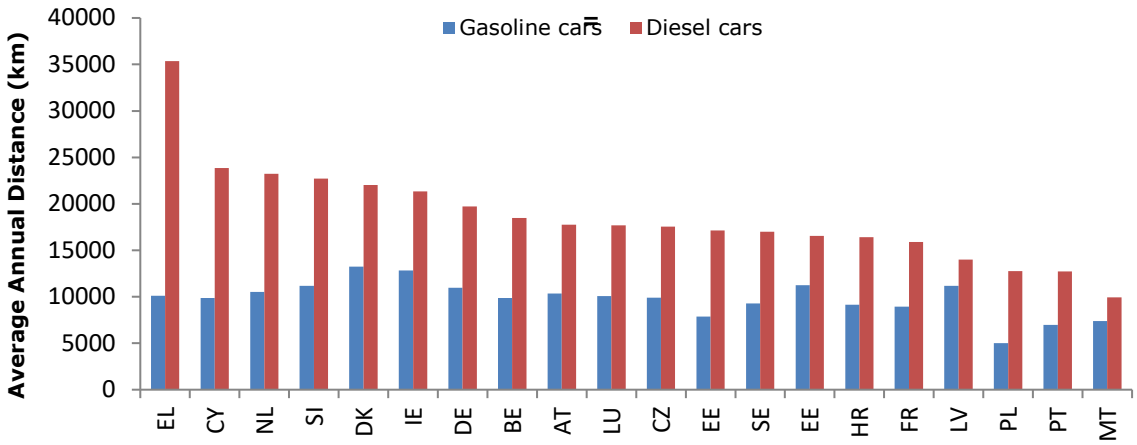
Figure 120: Energy consumption per vehicle and per average annual distance in the Member States with available data, 2019



Source: Odyssee

Figure 121 shows the average annual distance per vehicle travelled by diesel and gasoline cars in 2019 for 18 Member States. For all them, on average, diesel cars realised longer distances than gasoline cars.

Figure 121: Average annual distance travelled by car per fuel in the Member States with available data, 2019



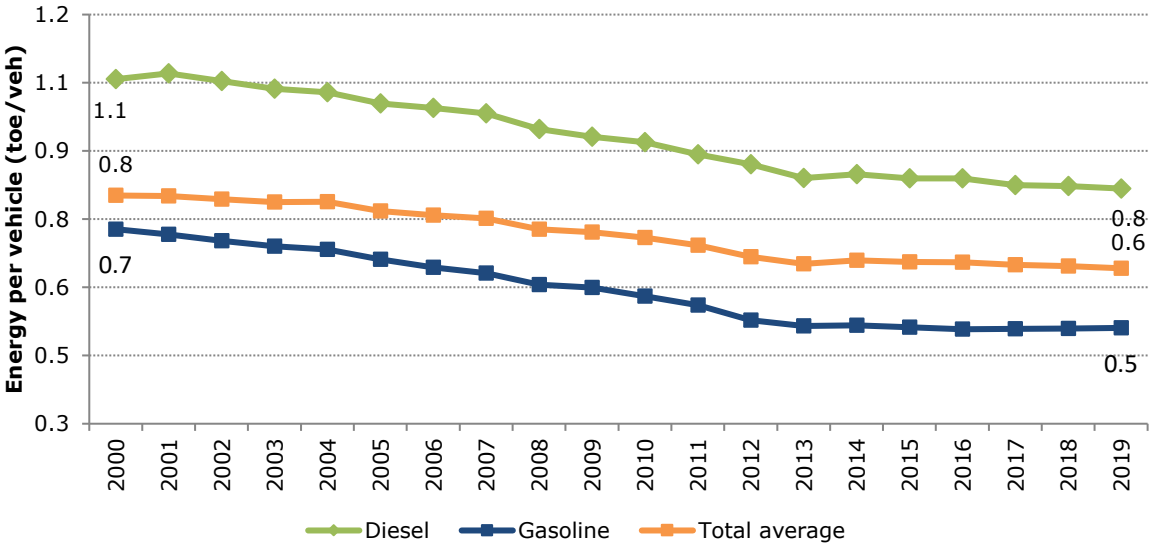
Source: Odyssee

All the figures presented above show that diesel cars tend to consume less energy adjusted per km. 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 perform. Another factor that may contributed to the relatively higher values of diesel consumption per vehicle is the diesel fuel prices that may worked as an incentive for longer travels. (Figure 123)

The reduction in total average energy consumption per vehicle registered during the period 2000-2019 was -20.0% while the reduction registered from 2000 to 2019 was -29.9% in gasoline-fuelled cars and -22.8% in diesel-fuelled cars. Overall, a decreasing trend was experienced by the cars despite the engine technologies adopted. This is mainly due to energy efficiency performance improvements. The decreasing trend was more

intense during the first half of the studied period, while the trend tends to become more stable in the most recent years.

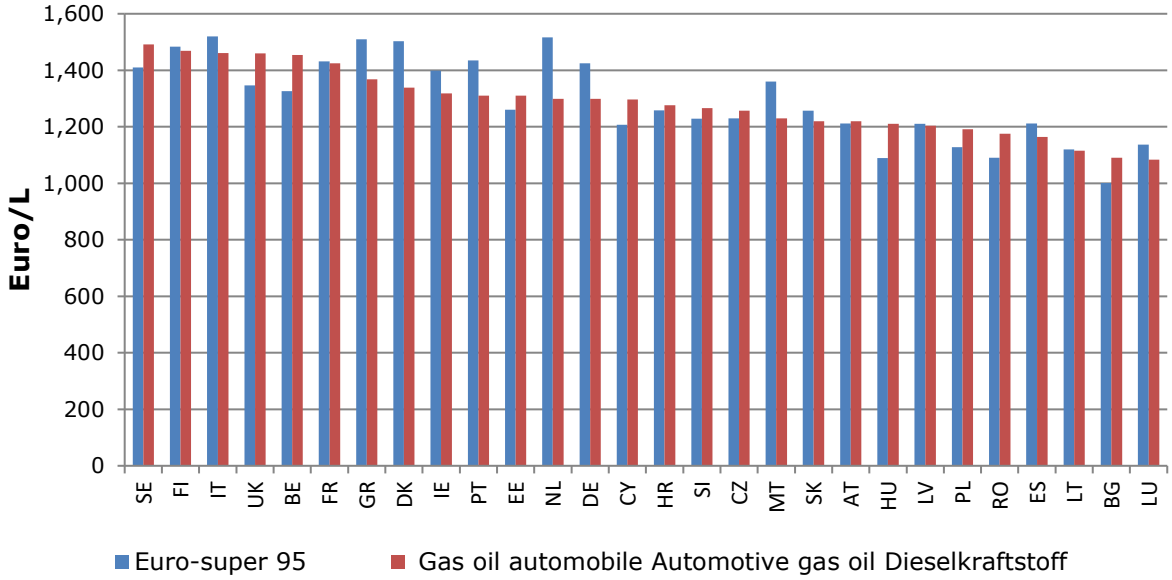
Figure 122: Average energy consumption per car engine technology[112] in the EU-27, 2000-2019



Source: Odyssee

[112] 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.

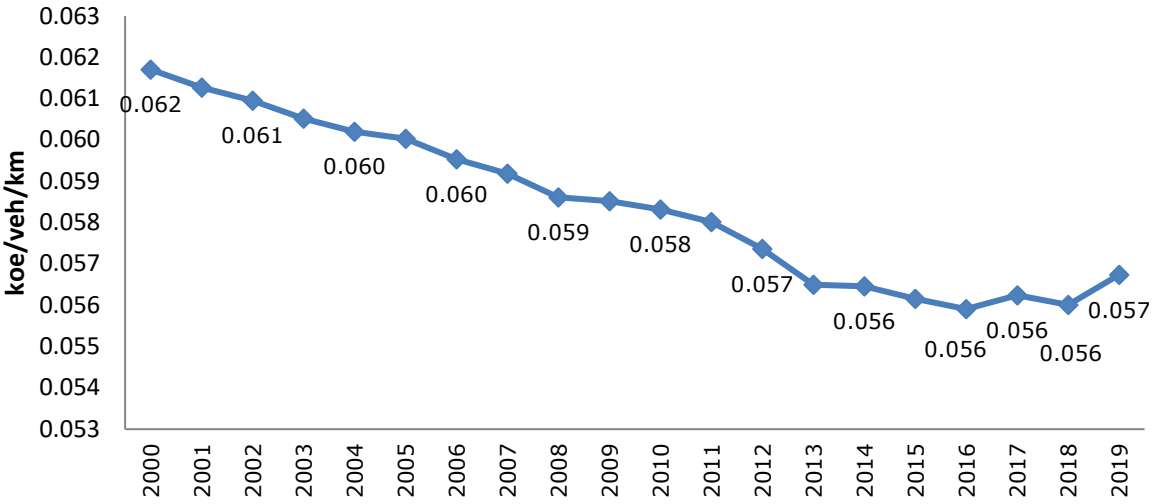
Figure 123: Consumer prices of petroleum products inclusive of duties and taxes on 21/12/2020 in the EU-27 Member States



Source: EC DG-ENER

Figure 124 shows the total car energy consumption per km for one car in the EU-27. From 2000 to 2019, there was a total reduction of 8.1% 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-27, 2000-2017[113]



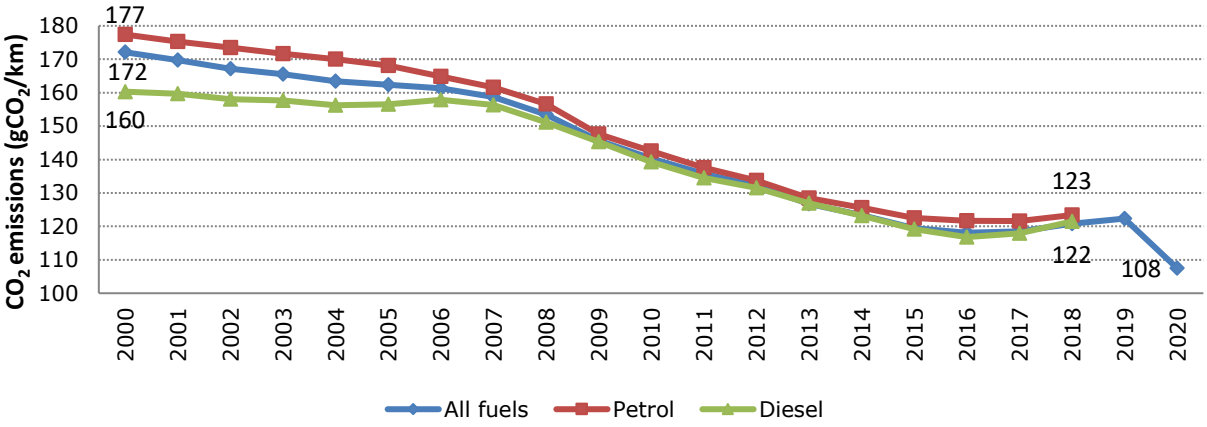
Source: Odyssee, EC DG-MOVE, own calculation

Figure 125 shows the average carbon dioxide emissions of new passenger cars for the period from 2000 to 2020. The EU level of carbon dioxide emissions was 107.5 g CO_2/km in 2020; it represents a drop of 37.5% in comparison with the year 2000 and a drop of 12.1% compared to 2019. The significant drop in 2020 was the result of COVID-19 crisis and of the very important increase of the share of electric vehicles. The figure shows that there are no remarkable differences in the average CO_2 emissions of petrol and diesel fuelled passenger

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

cars in the recent years (from 2009 onwards). Passenger cars fuelled by gasoline (petrol) registered an average level of CO_2 emissions of 123.4 g CO_2/km in 2018; while passenger cars diesel-fuelled registered 1.9 g CO_2/km less (121.5 g CO_2/km) in the same year. Petrol-fuelled vehicles CO2 emissions dropped by 30.4% during 2000-2018 while diesel-fuelled vehicles dropped by 24.2% during the same period maybe as a result of strengthening the regulations and the standards in the EU legislation during this period. Compared to 2017, both vehicle types increased slightly their emissions by 1.5% and 3.1% respectively.

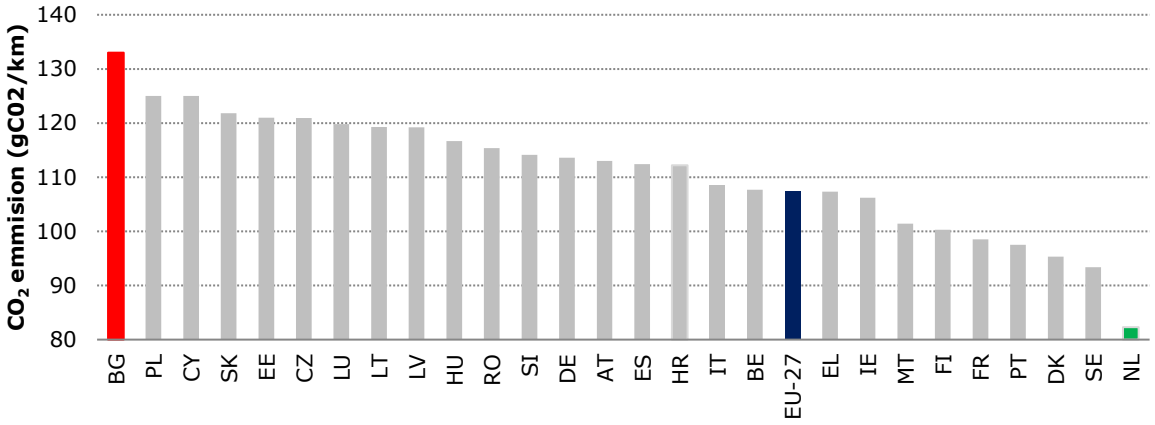
Figure 125: European average CO_2 emissions per kilometre of new passenger cars, 2000-2020



Source: EEA

Across the EU-27 Member States, Bulgaria (133 g CO_2/km), Poland and Cyprus (125 g CO_2/km) were the countries with the highest average emissions of the new car fleet in 2020. In contrast, the Netherlands (82 g CO_2/km), Sweden (93 g CO_2/km), and Denmark (95 g CO_2/km) registered the lowest average emissions of new cars in the same year (Figure 126). This is possibly the result of specific policies adopted by these Member States incentivising the purchase of hybrid/EV vehicles.

Figure 126: Average CO_2 emissions per kilometre of new passenger cars in the EU-27, 2020

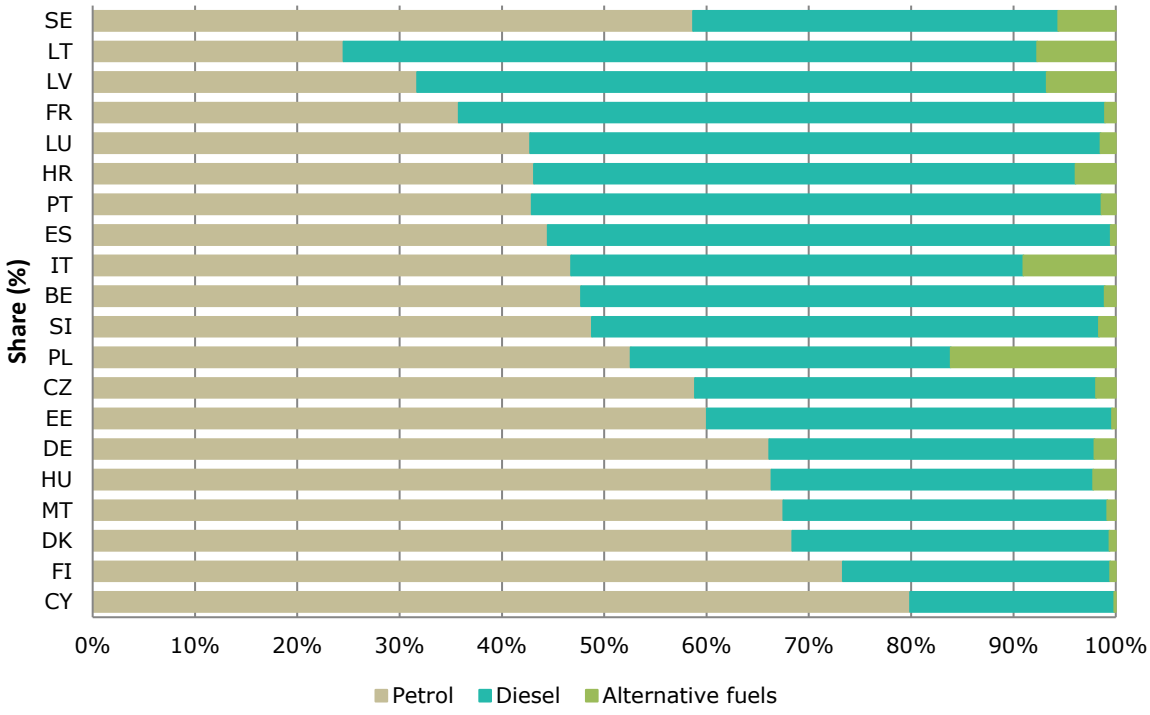


Source: EEA

Across the EU-27 Member States in 2020, the countries with the highest percentage of petrol (gasoline) fuelled passenger cars were Cyprus (79.9%), Finland (73.3%), and Denmark (68.4%). The States with the highest presence of diesel-fuelled passenger cars were Lithuania (67.8%), France (63.2%), and Latvia

(61.5%). Poland (16.1%), Italy (9.0%) and Lithuania (7.7%) were the European countries where alternative-fuelled engines[114] reached the largest shares (Figure 127).

Figure 127: Passenger cars by type of engine fuel, 2019 (% of all passenger cars)[115]



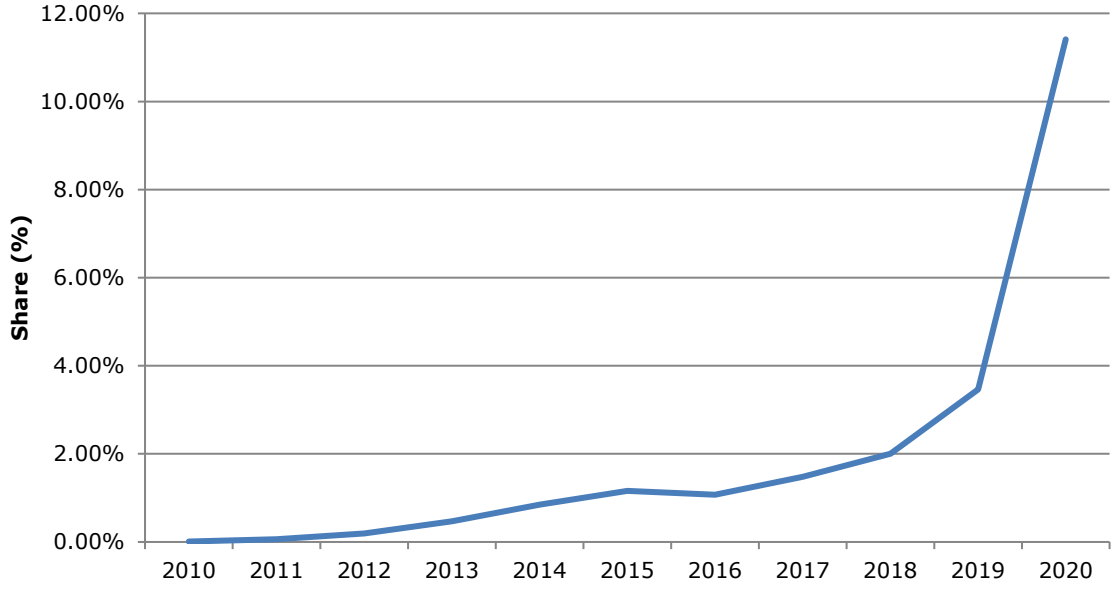
Source: Eurostat

Figure 128 shows the evolution of share of new-registered alternative-fuel passenger cars in total cars fleet from 2010 to 2020 in the EU-27. The major part of alternative-fuel passenger cars were registered in 2020 (11.4%). Overall, there is an increasing trend in the registration of the passenger cars working with alternative fuels, interrupted in 2016 and restarted again in 2017.

[114] 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.

[115] BG, EL, NL, RO, SK, IE, AT incomplete data

Figure 128: New registrations of alternative-fuel passenger cars in the EU-27, 2010-2020

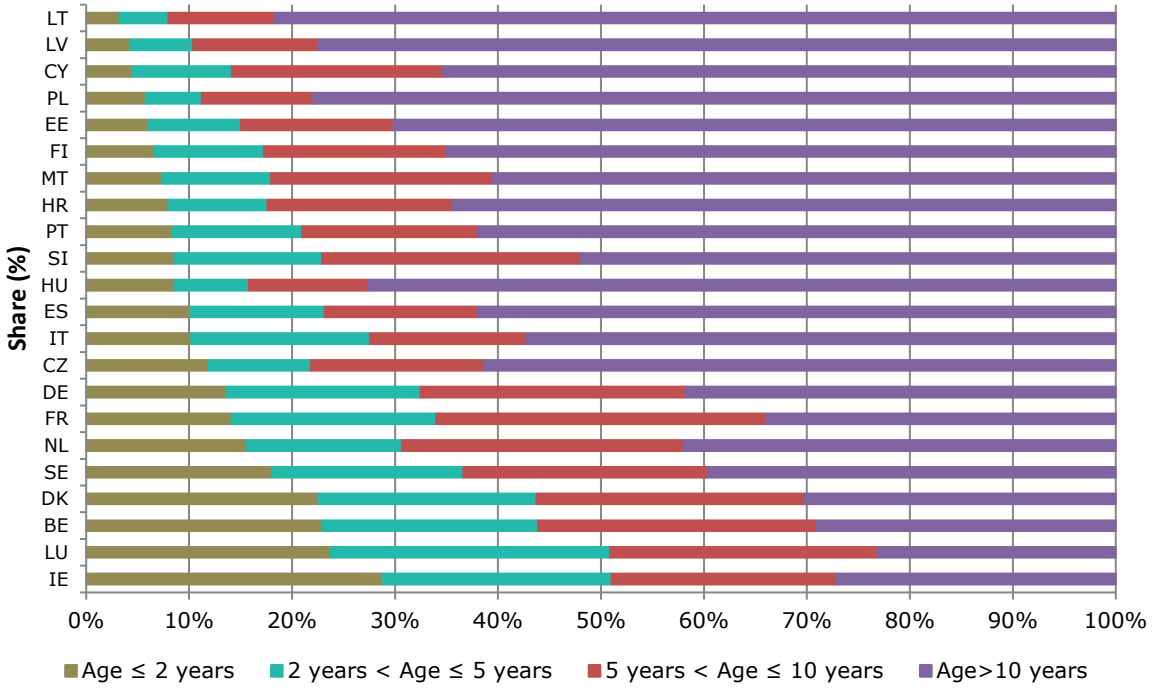


Source: EEA

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 some exceptions –Figure 118, Page 89), it is possible to see that the lower is the average age of the vehicles, the lower the average energy consumption per vehicle. In 2019 (Figure 129), the EU-27 Member State with the newest fleet of passenger cars was Ireland with 28.8% of its passenger cars below or equal 2 years old, followed by Luxemburg (23.7%) and Denmark (22.6%)._In contrast, the oldest fleet of passenger cars (older than 10 years) were registered in Lithuania (81.7%), Poland (78.0%) and Latvia (77.5%) as illustrated in Figure 129. The highest share of passenger cars between 2 and 5 years old was found in Luxembourg (27.2%), Ireland (22.3%) and Belgium (21.0%), while the highest number of passenger cars between 5 and 10 years was registered in France (32.1%), the Netherlands (27.3%) and Belgium (27.0%).

Overall, Luxembourg, Ireland, Belgium and Denmark have the newest fleet of passenger cars (these Member States have the lowest share of above 10 years old passenger cars). This is most likely the result of National vehicle scrappage scheme and. as already mentioned, this could lead to lower energy consumption in the road transport in the short-term or mid-term future.

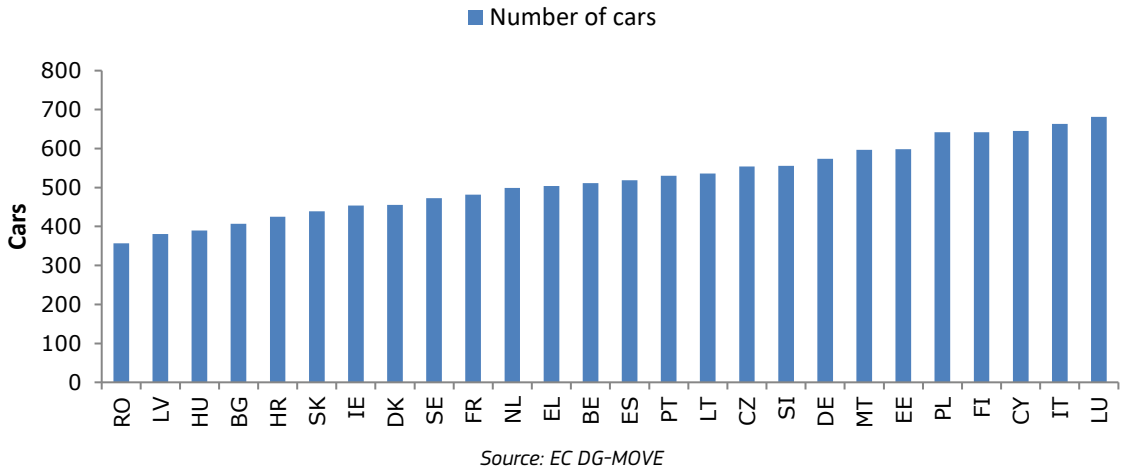
Figure 129: Passenger cars by age, 2019 (% of all passenger cars)[116]



Source: Eurostat

In 2019, the Member State with the highest number of passenger cars per 1,000 inhabitants was Luxembourg (681 cars); the second was Italy (663 cars) and the third Cyrus (645 cars). In contrast, the lowest number of passenger cars per thousand inhabitants was registered in Romania (357 cars), Latvia (381 cars) and Hungary (390 cars) for the same year as illustrated in Figure 130.

Figure 130: Number of passenger cars per 1,000 inhabitants, 2019[117]



Source: EC DG-MOVE

5.4 Passenger and freight transport

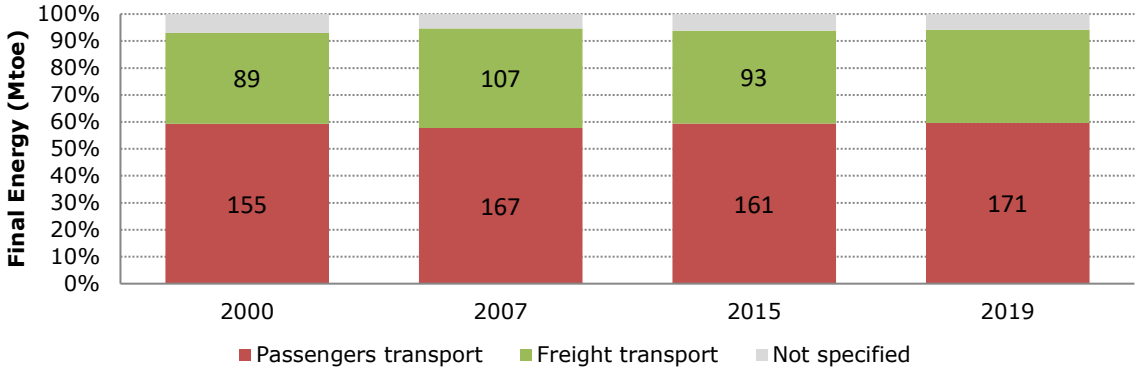
Most of the energy used in the transport sector is for domestic transportation, which consists mainly of passenger and freight transport. According to Odyssee database, passenger transport accounted for the

[116] BG, EL, RO, SK, AT: incomplete data

[117] AT: no available data

59.6% of the domestic transport in 2019. In 2015, the consumption shares were 59.4% for passenger and 35.4% for freight transport while not-specified transport accounted for the 6.2% of the domestic transport. Overall, domestic transport increased by 25 Mtoe or 7.3% between 2000 and 2019 (from 262 Mtoe to 287 Mtoe) (Figure 131).

Figure 131: Final energy consumption by passenger and freight domestic transport in the EU-27, 2000, 2007, 2015 and 2019

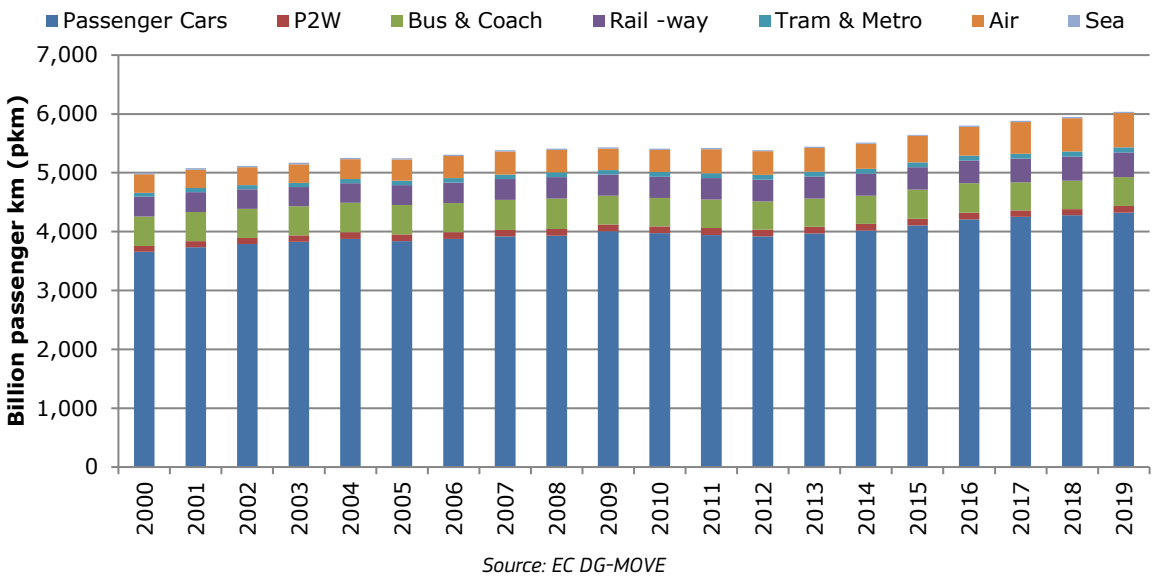


Source: Odyssee

5.4.1 Passenger traffic

The passenger transport volume risen by 20.8% in the period from 2000 to 2019. In 2019, the value registered 6,038 billion pkm[118], the maximum passenger volume registered during the period 2000-2019.

Figure 132: Passenger transport volume and modal split in the EU-27[119], 2000-2019



Source: EC DG-MOVE

Passenger cars provide the highest share of passengers transport activity (Figure 133). Passenger cars activity was equal to 4,325 pkm (71.6% of the total) in 2019, which corresponds to an increase of 18.2% in comparison with 2000. Between the years 2000 and 2019 domestic and intra-EU air transport increased by

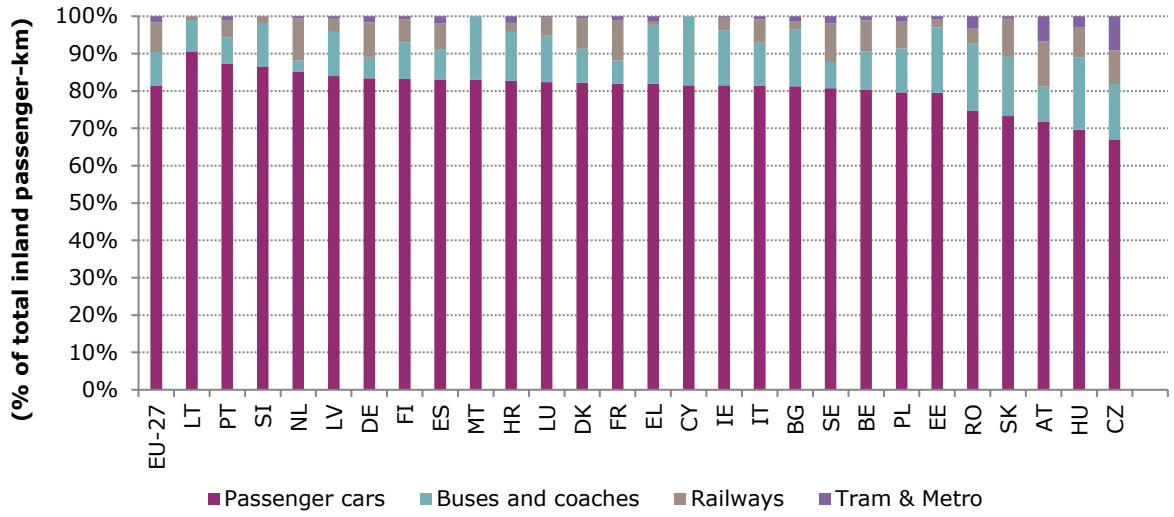
[118] A passenger-kilometre, abbreviated as pkm, is the unit of measurement representing the transport of one passenger by a defined mode of transport (road, rail, air, sea, inland waterways etc.) over one kilometr

[119] Air and Sea: only domestic and intra-EU-27 transport; provisional estimates. P2W: Powered two-wheelers

86.0%, tram and metro by 28.2%, powered 2-wheelers by 15.1% and rail transport by 24.5%. In contrast, buses and coaches dropped by 2.0% and sea transportation by 14.5% 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-27 Member States, in 2019, Lithuania was the European country with the highest estimated activity of passenger cars in pkm (90.6%), followed by Portugal (87.3%), and Slovenia (86.6%). In contrast, in the same year, Czech Republic (67.0%), Hungary (69.6%) and Austria (71.7%) were the Member States with the lowest percentage of cars activity in the inland passenger transport. Ten Member States registered a share of passenger cars activity in 2019 below the European average (<81.3%). The relative importance of buses and coaches activity approached one fifth of inland passenger transport activity only in Hungary (19.5%). This share was between 10.0% and 20.0% in 17 other Member States while the lowest share for buses and coaches activity was registered in the Netherlands (3.0%). Regarding to railways, the highest share of rail activity in transport activity by land was registered in the Austria (12.2%), the Netherlands (11.2%) and France (10.6%). The highest share of tram & metro activity was registered in Czechia (9.2%), Austria (6.7%) and Romania (3.3%).

Figure 133: Modal split of inland passenger transport in the EU-27 Member States, 2019[120]



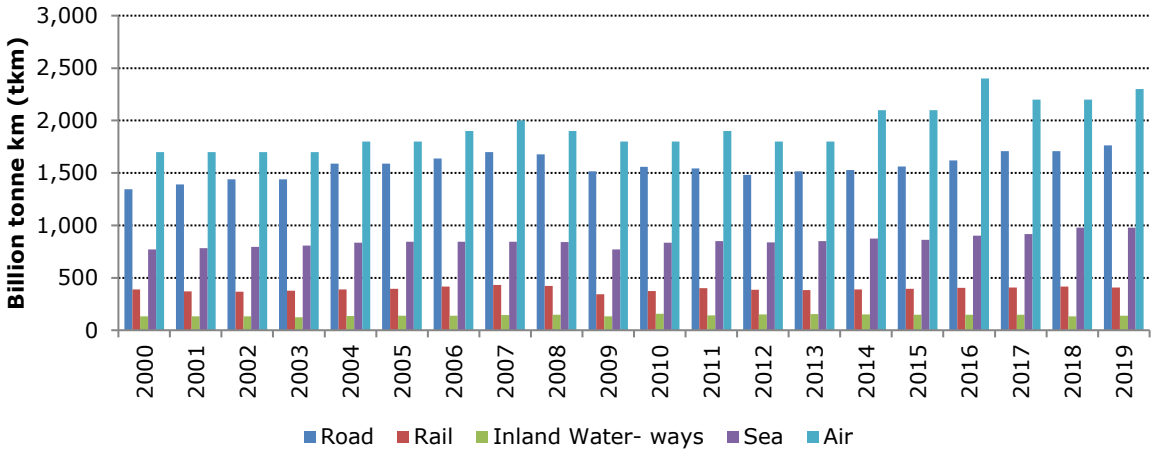
Source: EC DG-MOVE

5.4.2 Freight traffic

Total inland freight transport in the EU-27, including also pipelines, is estimated to be 3,392 tonne-kilometres (tkm) in 2019 (Figure 134). In the period from 2000 to 2019, the total freight traffic increased by 23.2% (639 tkm). Road transport and air transport are the modes of transport which increased the most during these years (by 31.3% and 35.3% respectively), followed by national and intra-EU maritime (27.2%), rail (4.8%) and inland waterways (4.5%). Pipeline transport decreased by 12.7% during the period.

[120] 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.

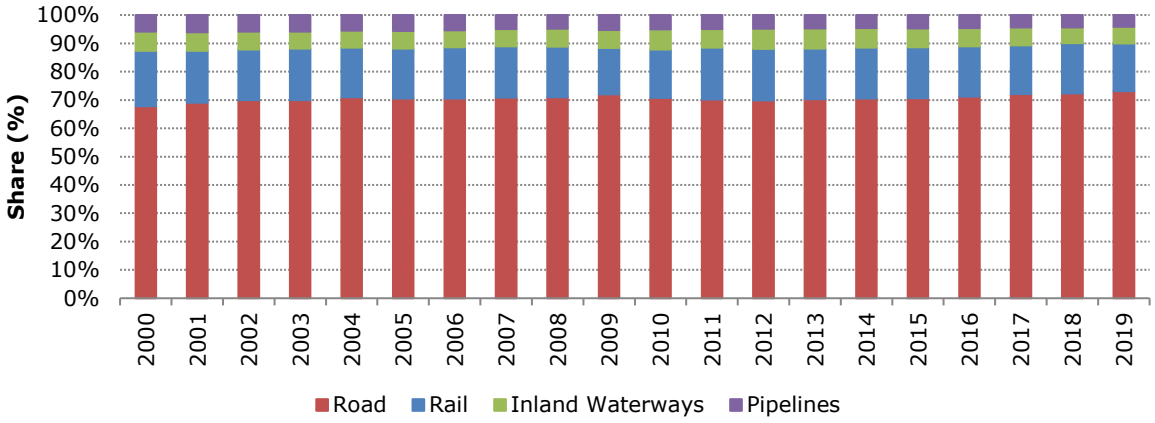
Figure 134: Freight transport traffic (billion tkm) breakdown into conveyances in the EU-27, 2000-2019[121]



Source: EC DG-MOVE

Analysing the inland transport modes Figure 135), road registered 73.1% of the freight traffic in 2019, the highest share of all modes. Rail was the second freight transport mode with a share of 16.9% in inland transport activity in 2019. In 2019, the share of road transport was larger relative to 2000.

Figure 135: Freight transport in the EU-27: modal split of inland transport modes (% of total tonne-kilometres), 2000-2019

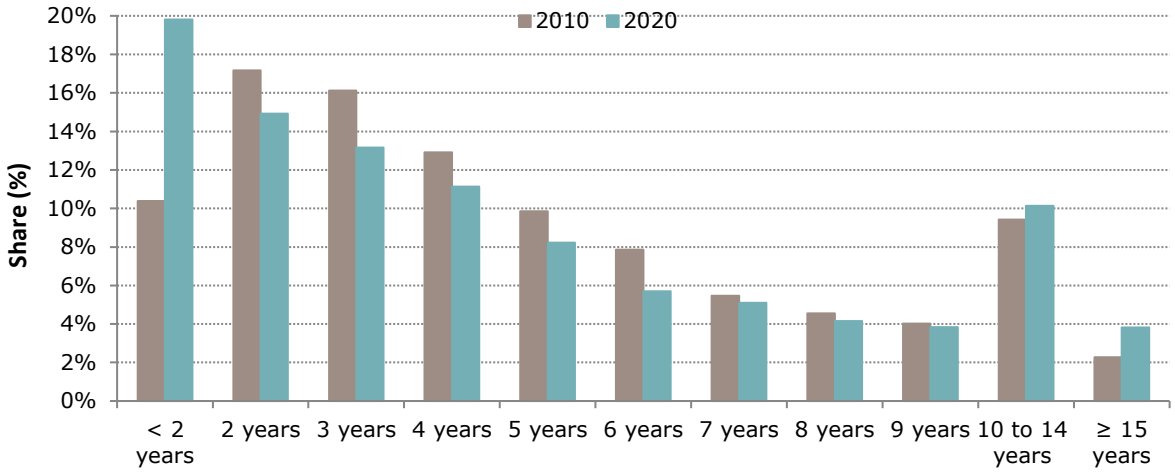


Source: EC DG-MOVE

Regarding the age of the vehicles used for the road goods transport (Figure 136), it can be observed that over 59% of the total tonne-km transport was done by vehicles 4 years or younger in 2020. In the same year, the 19.8% 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 increased by 10.4%. Overall, the share of activity performed by vehicles up to 3 years of age increased slightly (43.7% in 2010 vs 47.9% in 2020).

[121] 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.

Figure 136: Road goods transport in the EU-27 by age of vehicle, 2010 and 2020 (% of total tonne-kilometres) [122]

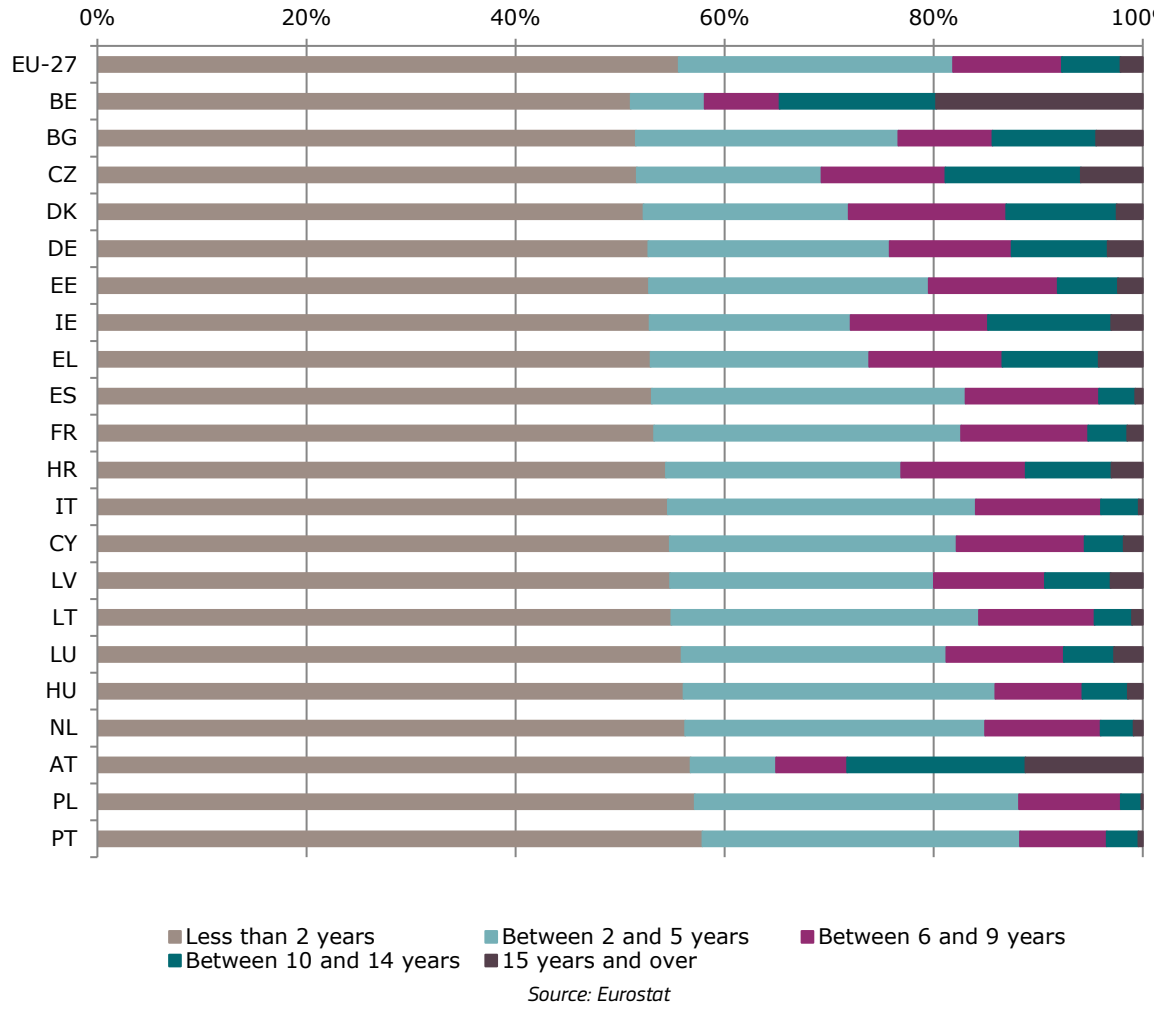


Source: Eurostat

Analysing the age of vehicles used in road goods transport across the EU-27 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 Czechia, Greece and Cyprus. The highest percentage of new cars (less than 2 years) is observed in Germany (42.3%) while the lowest in Czechia (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%).

[122] Total tonne kilometres do not include the tonne kilometres transferred by vehicles of unknown age.

Figure 137: Road goods transport in the EU-27 Member States[123] by age of vehicle, 2019 (% of total tonne-kilometres)



Source: Eurostat

5.5 Overview – Transport sector

The transport sector was the most consuming among the end-use sectors in 2020 in the EU-27. The energy consumption in transport decreased (by -4.2%) during the 2000-2020 period (second largest decrease after industry among the analysed sectors) due to the notable decrease in 2020 value compared to 2019. From 2000 to 2019, instead transport sector final energy consumption increased by almost 10%. The maximum consumption during this period was registered in 2007, while the minimum in 2020 affected by COVID-19 situation. Energy consumption 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 before the COVID-19 crisis in 2020, which made the final values decrease again importantly.

The energy intensity in the transport sector decreased significantly during the period from 2000 to 2019 (-16.1%). The decreasing trend along the period was interrupted in 2009 and in 2016. In the first case it may was 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 2019, it reduced slightly compared to 2018.

In 2020, 14 Member States accounted for less than 13% of the final energy consumption and 4 Member States (Germany, Spain, France and Italy) accounted for more than 55% of the final energy consumption in the sector. Between 2000 and 2020, Poland, Lithuania and Romania were the EU-27 Member States with the

[123] Excludes IT due to incomplete data

highest growth rates in the final energy consumption in the transport sector. In contrast, Italy, Greece and Portugal 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 2020, 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 2022 at the end of 2021-beginning of 2022.

Among the transport modes, road transport is the main energy-consuming mode of transport. It provided by far the highest final energy share in 2020, followed by rail, domestic navigation, domestic aviation, pipeline transport and other non-specified transport. Domestic aviation was the sector where consumption declined the most during the 2000-2020 period, while pipeline is the sector where consumption increased the most. In 2020, petroleum products are the only fuel types in the domestic 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. Biofuels also occupied a share in some transport modes.

Focusing on road transport, the final energy consumption reduced in the period from 2000 to 2020 (-2.0%). It decreased sharply from 2019 to 2020 -11.8%). 14 Member States consumed less than 13% of the final energy of the sector in 2020 and 4 Member States (Germany, France, Spain and Italy) consumed almost the 57% 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 occurred during 2000-2020. LPG, natural gas and electricity slightly increased their shares in energy consumption. As regards the biofuels, biodiesel had the largest share by far followed by biogasoline in 2020.

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 increased their stock. Two wheels are the vehicle types, which experienced the highest growth rate.

During the period from 2000 to 2019, a gradual decreasing trend was observed in the average energy consumption per car in the EU-27 (-20.0%). 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 2019, cars already in the market and new cars registered a reduction in their average specific consumptions.

Car energy consumption per vehicle in stock and annual distance indicator also experienced a reduction from 2000 to 2019 (-8.1%) 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 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 contributed to the relatively higher values of diesel consumption per vehicle is the diesel prices that may worked as an incentive for longer travels.

With regard to the EU average level of CO_2 emissions from new passenger cars, there was registered a significant reduction during 2000-2020 (-37.5%) due to the COVID-19 crisis and the important increase of electric vehicles registration. The Member State with the highest average emissions of new car fleets in 2019 was Bulgaria, while the Netherlands registered the lowest average emissions of new cars in the same year.

The countries with the highest percentage of petrol fuelled passenger cars in 2019 were Cyprus, Finland and Denmark. The States with the highest presence of diesel-fuelled passenger cars were Lithuania, France and Latvia. Poland, Italy and Lithuania were the European countries where alternative-fuelled engines reached the largest shares.

In 2019, the highest share of newest passenger cars was found in Ireland, Luxemburg and Denmark. The oldest fleet of passenger cars were registered in Lithuania, Poland and Latvia. Luxembourg was the Member State with the highest number of passenger cars per 1,000 inhabitants in 2019. The lowest number of passenger cars per 1000 inhabitants was registered in Romania.

The passenger transport volume risen notably in the period from 2000 to 2019 (+20.8%). The value registered in 2019 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 2019, 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, Czechia, 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 approached one fifth of inland passenger transport. Regarding to railways, the highest share of train transport were recorded in Austria. The highest share of tram & metro activity was registered in Czechia.

In the period from 2000 to 2019, the total freight traffic increased (+23.2%). Road registered the highest share of the freight traffic in 2019, 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-27 freight traffic. In 2019, over 59% of the total tonne-km performance was done by vehicles younger than 4 years or below. In the same year, the 19.8% 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.

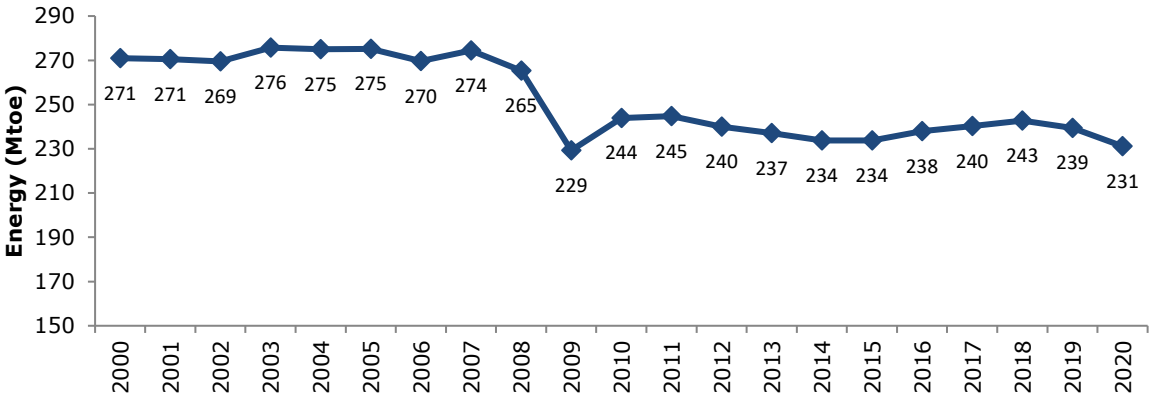
6 Energy Consumption Trends and Energy Efficiency trends in the Industry Sector

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 26.1% of the EU-27 total final energy consumption in the year 2020. This sets the industry sector at the third place after the transport sector (28.5%) and residential sector (28.0%) in the ranking of the most energy consuming economy sectors. Industry final energy consumption in the EU-27 fallen by 14.7% in the period 2000-2020. It is the sector that registered the highest fall in final energy consumption from 2000 to 2020 among the four analysed sectors. In 2020, industry final energy consumption reached 231.2 Mtoe. It corresponds to a 3.4% decrease compared to 2019. The maximum annual consumption over the 2000-2020 period took place in the year 2003 when it reached 275.7 Mtoe, while the minimum occurred in 2009 when the final energy consumption decreased to 229.2 Mtoe, (Figures 138 and 139). This probably was due to the impact of the financial and economic crisis [16].

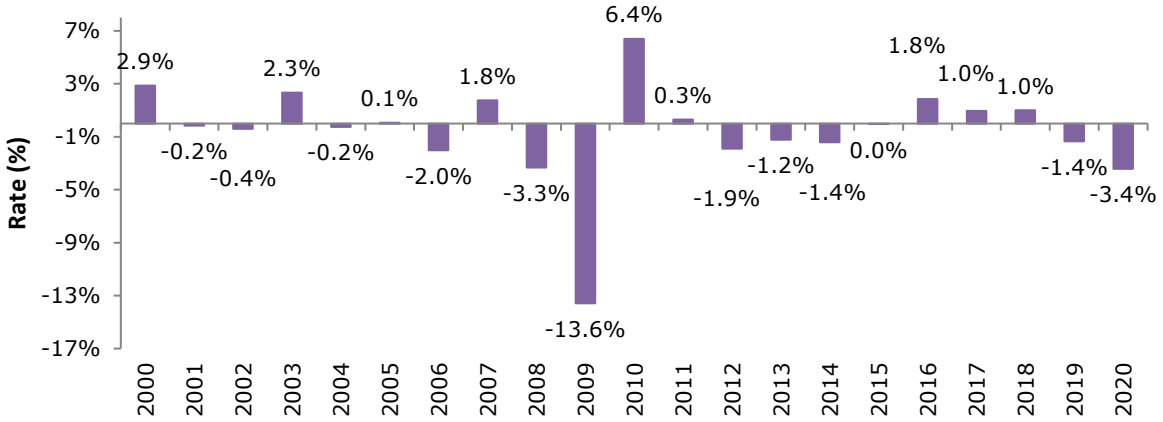
Figure 138: Industry sector: final energy consumption in the EU-27, 2000-2020



Source: Eurostat

A decreasing trend in the final energy consumption was registered during the last 21-year period with some exceptions, such as the year 2003 when a 2.3% rise occurred, the year 2007 an increase of 1.8% was registered and the year 2010 when the consumption rebounded from the drop of 13.6% in year 2009 (Figure 139). From 2011 to 2015, the decreasing trend continued. From 2016 to 2018, a slight increasing trend was observed while it was again inversed reaching in 2020 the second lowest value over the period 2000-2020. In general, energy consumption in industry could probably keep an overall decreasing trend, at least in the short and medium-term, 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.

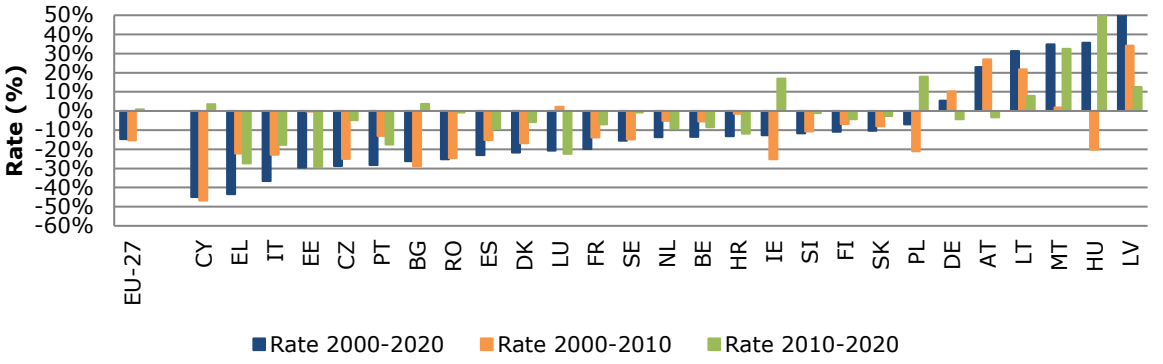
Figure 139: Industry sector: final energy consumption annual rates in the EU-27, 2000-2020



Source: Eurostat

Looking at the final energy consumption rates across the EU-27 Member States, it can be observed that only six Member States registered a growth rate from 2000 to 2020. These are Latvia, Lithuania, Hungary, Malta, Austria and Germany. The highest growth rate was registered by Latvia (51.1%), Hungary (35.7%) and Malta (34.8%). Thirteen Member States experienced negative consumption rates below the EU-27 value (-14.7%) (Figure 140). The impact of the economic and financial crisis on the industry sector is evident. Six Member States increased their consumption in the period 2000-2010, i.e. Luxembourg, Germany, Latvia, Lithuania, Austria and Malta. The highest reduction rates over the period 2000-2020 were observed in Cyprus (-45.0%), in Greece (-43.5%) and in the Italy (-36.5%).

Figure 140: Industry sector: final energy consumption rates in the EU-27 Member States; 2000-2020, 2000-2010 and 2010-2020



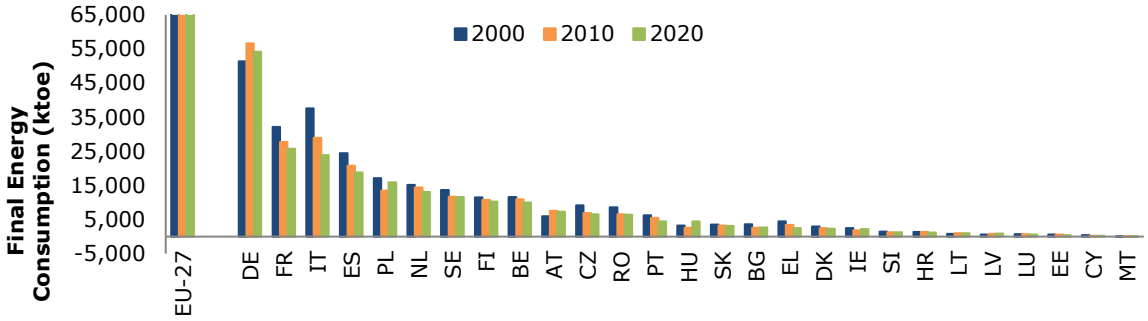
Source: Eurostat

In 2020, the Member State with the highest consumption in the industry sector was Germany (54.2 Mtoe), followed by France (25.8 Mtoe) and Italy (23.9 Mtoe) (Figure 141). In 2000 and 2010, German industry was already the first energy consumer, followed by Italy and France. In 2020 Germany is still in the first position, whereas France rose to second place and Italy drop in third.

Four Member States consumed more than 53% of the total final energy consumption in the industry sector in Europe: Germany, France, Italy and Spain. More than half of the EU-27 Member States (14 countries) generated less than 10% of European industry final energy consumption in 2020 (Figure 142).

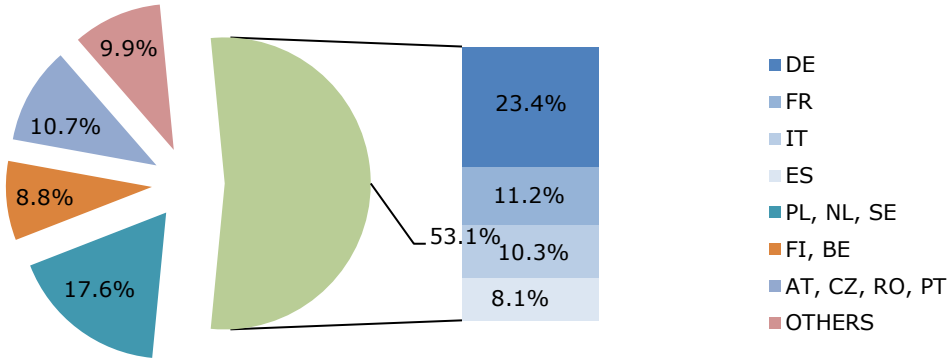
The European global energy consumption trend is therefore highly influenced by the consumption of a limited number of countries.

Figure 141: Industry Sector: Final industrial energy consumption in the EU-27 Member States, 2000, 2010 and 2020



Source: Eurostat

Figure 142: Shares of EU-27 Member States to final industrial energy consumption, year 2020



Source: Eurostat

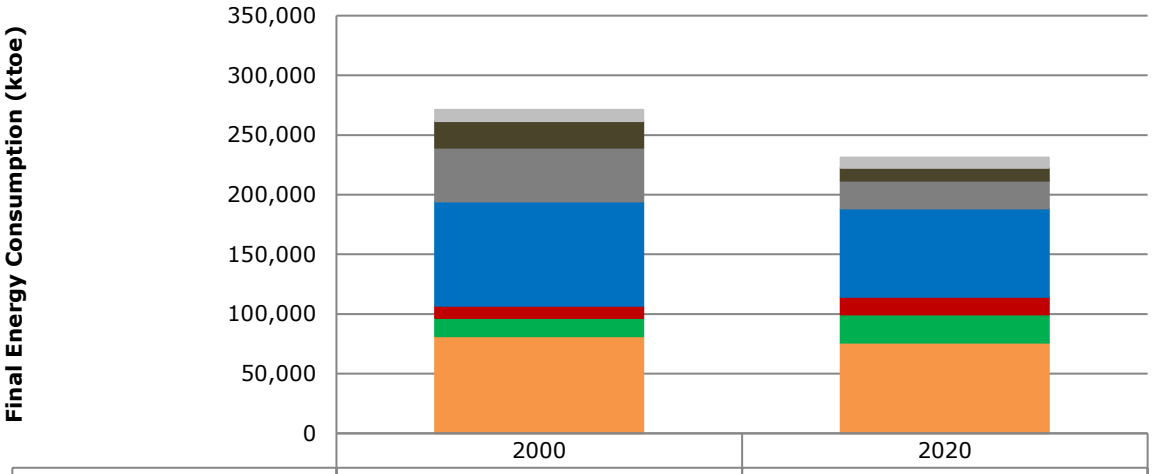
In 2020, electricity and natural gas were the main contributors to the energy mix in the industry sector with 76.1 Mtoe and 73.9 Mtoe respectively. These fuels represent almost the 65% of the European energy mix, with electricity accounted for 32.9% and natural gas for 32.0% of the total consumption. The rest of the energy mix is constituted by renewable energies and biofuels (10.2%), oil and petroleum products (10.1%), derived heat (6.03%), solid fossil fuels (4.6%), and other[124] (3.8%).

There are several differences in the 2020 energy mix compared to 2000. For example, natural gas and electricity are the main contributors for the entire analysed period but they swapped their ranking positions. 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 in 2000 but they dropped in fourth position in 2020 due to the increased use of biofuels and renewables. Consequently, biofuels and renewables are in the third position in 2020.

The consumption of oil and petroleum products fell by 48.0% (around 21.6 Mtoe). Renewables and biofuels and heat enlarged their contributions in absolute value. Electrical energy, natural gas and solid fossil fuels and other reduced the absolute value of their contributions (Figure 143).

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

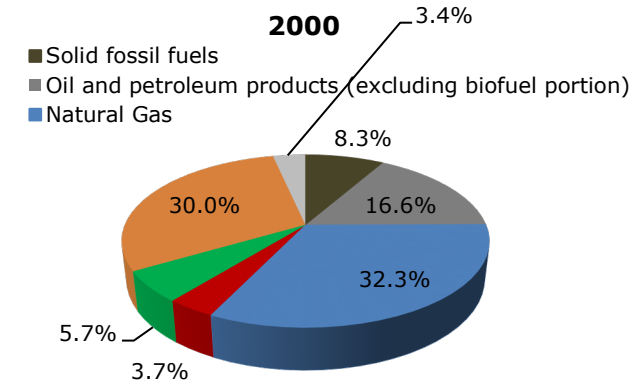
Figure 143: Industry sector: final energy mix, 2000 and 2020

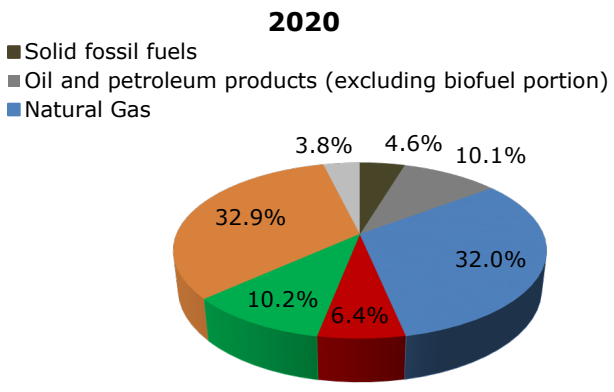


	2000	2020
Other	9,243	8,746
Solid Fossil Fuels	22,438	10,713
Oil and petroleum products (excluding biofuel portion)	44,922	23,360
Natural Gas	87,552	73,904
Heat	9,982	14,725
Renewable and Biofuels	15,514	23,689
Electrical energy	81,321	76,074

Source: Eurostat

Figure 144: Industry sector: final energy mix by percentage, 2000 and 2020





Source: Eurostat

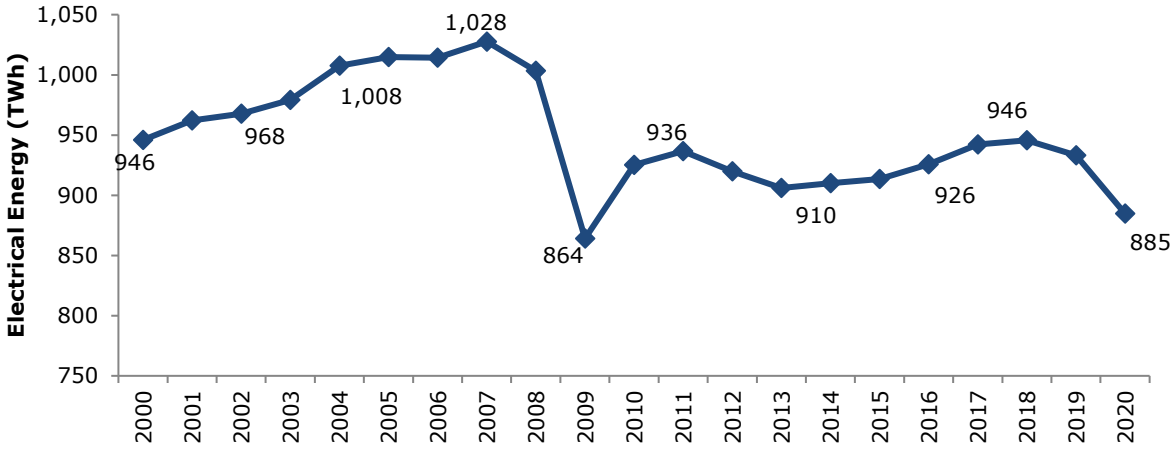
Electricity consumption

The industry sector consumed 37.1% of the EU-27 final electricity consumption in 2020, confirming industry as the main electricity consumer sector in Europe (Figure 20, Page 24).

When it comes to the energy mix, as mentioned in the previous section, electricity accounted for 32.9% of the total final energy consumption in 2020, making it the main energy source consumed in the industry sector.

The industrial electricity consumption in the EU-27 fallen by 6.5% in the period from 2000 to 2020. The maximum consumption over the period considered took place in the year 2007 (1,028 TWh), whereas the minimum occurred in 2009 when the final electricity consumption dropped to 864 TWh (Figure 145). Moreover, electricity consumption declined by 5.2% from 2019 to 2020.

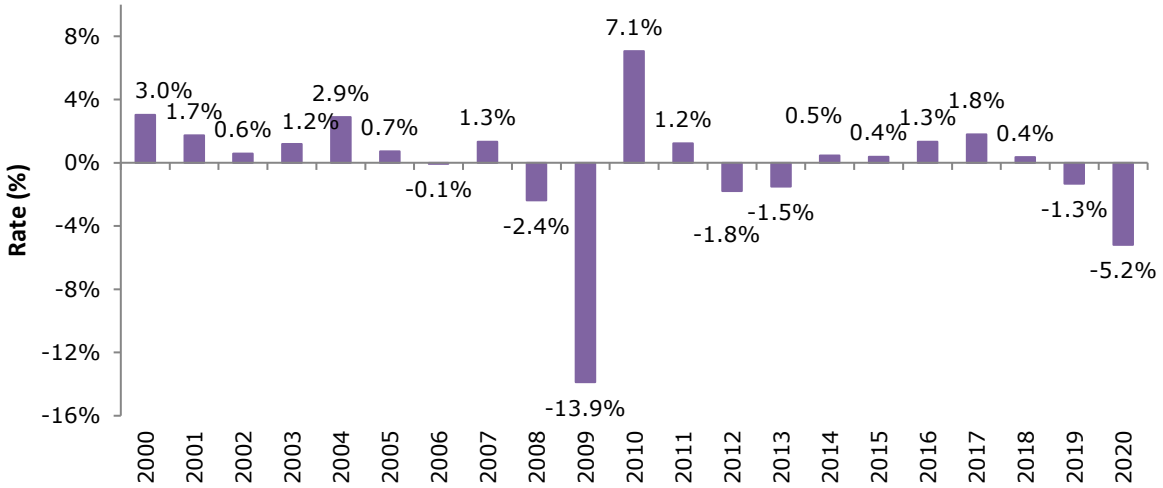
Figure 145: Industry sector: final electricity consumption in the EU-27, 2000-2020



Source: Eurostat

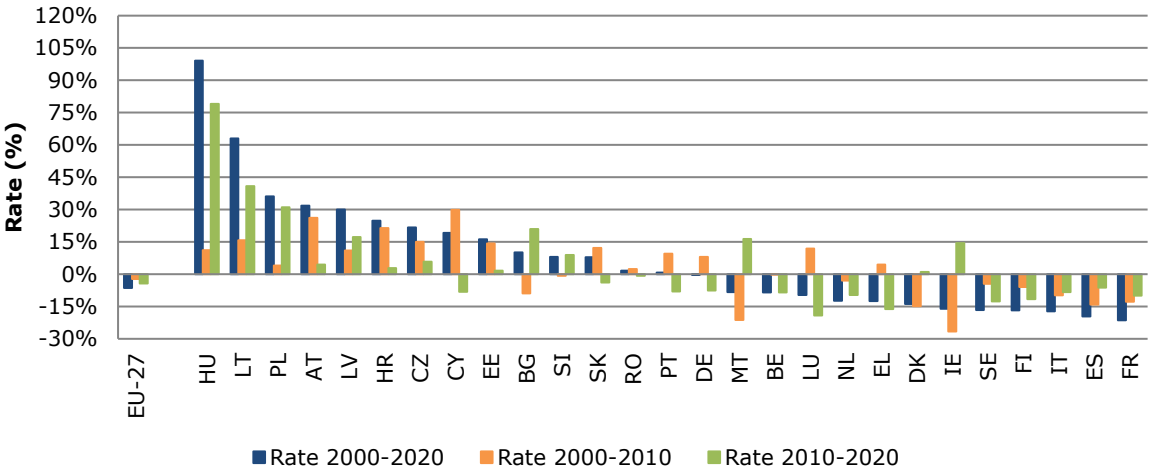
A continuous growth in the industry final electricity consumption can be observed until 2007. During the years 2008 and 2009 the industry sector reduced its final electricity consumption (and its total final energy consumption) mainly for the impact of the financial and economic crisis on the sector's activity [17]. On the contrary, the two following years (2010 and 2011) reported an increase in the consumption with respect to the previous years (by 7.1% and 1.2% respectively). In 2012 and 2013, a decreasing trend was registered, although the negative rate was smoother year after year. From 2015 to 2018 electricity consumption registered growth rates. A new decreasing trend started in the last two studied years while the negative rate was more profound from 2019 to 2020 (-5.2%) (Figure 146).

Figure 146: Industry sector: annual final electricity consumption rates, 2000-2020



Source: Eurostat

Figure 147: Industry sector: annual final electricity consumption rates in the EU-27; 2000-2020, 2000-2010 and 2010-2020



Source: Eurostat

The countries with the highest growth rates in final electricity consumption between 2000 and 2020 were Hungary (99.1%), Lithuania (63.0%) and Poland (36.2%). In the same period, the Member States with the highest reduction rates were France (-21.4%), Spain (-19.6%), and Italy (-17.3%). Twelve Member States registered negative rates lower than the EU-27 reduction rate (-6.5%) during the examined time period. From 2000 to 2010, twelve Member States show a negative consumption rate possibly as a result of the economic crisis. In the period 2010-2020, the consequences of these instable economic conditions were maintained. Moreover, the influence of deindustrialization and COVID-19 pandemic lead several Member States to register negative electricity consumption rates.

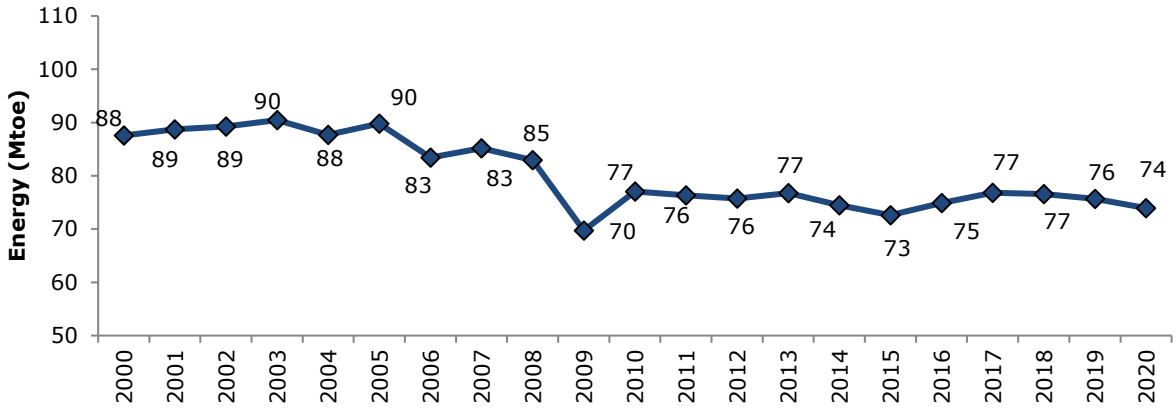
Natural gas consumption

In 2020, the industry sector consumed 38.1% of the final natural gas consumption of the EU-27. 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 40.5%, followed by industry sector with 38.1% and tertiary sector, which accounts for 17.8% of total final gas consumption. The three sectors together cover almost the 97% of the gas consumption of the European Union, (Figure 25, Page 27).

When focusing on the industrial sector energy mix, natural gas accounted for 32.0% of the total final energy consumption in 2020, making it the second final energy type consumed in the industry sector, after electricity (Figure 143, Page 107).

Industry final natural gas consumption fallen by 15.6% in the EU-27 during the period from 2000 to 2020. The maximum consumption over the analysed period took place in the year 2003 (90.5 Mtoe). The minimum value occurred in 2009 when the consumption dropped to 69.7 Mtoe (Figure 148). In 2009, the EU was registering the lowest values of industry final gas consumption for the 21-year period between 2000 and 2020. In 2020, natural gas consumption reduced compared to 2019 (2.4%).

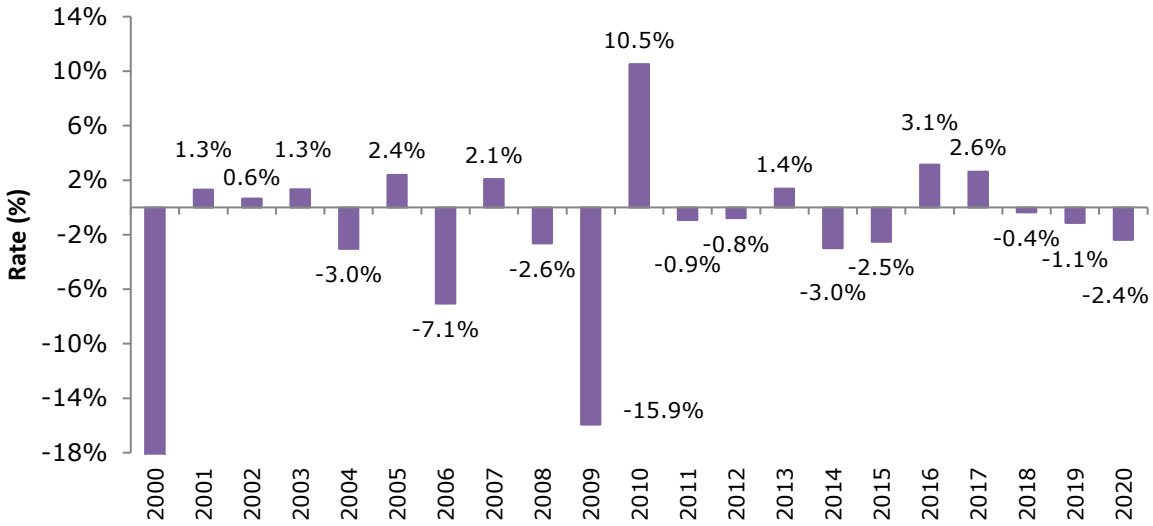
Figure 148: Industry sector: final natural gas consumption in the EU-27, 2000-2020



Source: Eurostat

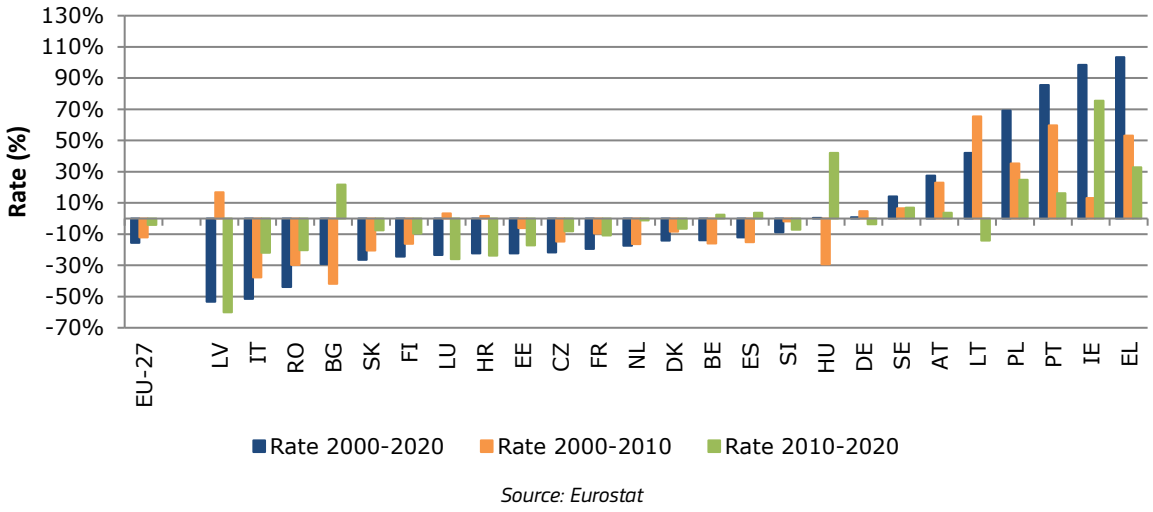
A decreasing trend can be observed during the whole analysed period. From 2001 to 2009, the annual consumption rates are either negative or very low (less than 2.5%). From 2010 to 2017, the values were fluctuating. From 2017 to 2020, the energy consumption recorded a decreasing trend.

Figure 149: Industry sector: annual final natural gas consumption rates, 2000-2020



Source: Eurostat

Figure 150: Industry sector: final natural gas consumption rates in the EU-27125; 2000-2020, 2000-2010 and 2010-2020



Source: Eurostat

Twelve Member States registered a higher decrease rate compared to the European average rate. Among them the Member States with the highest reduction rates are Latvia (-53.4%), Italy (-51.4%), and Romania (-44.0%). On the contrary, the Member States with the highest growth rates are Greece (103.5%), Ireland (98.6%) and Portugal (85.6%).

Decreasing trends were registered by fourteen countries in the period 2010-2020. The countries with highest reduction rates are Bulgaria (-41.8%), Italy (-37.7%) and Romania (-29.8%). To be noted the case of Latvia that went from a large positive rate in 2000-2010 and turn to a negative rate in 2010-2020, possibly because of the economic crisis.

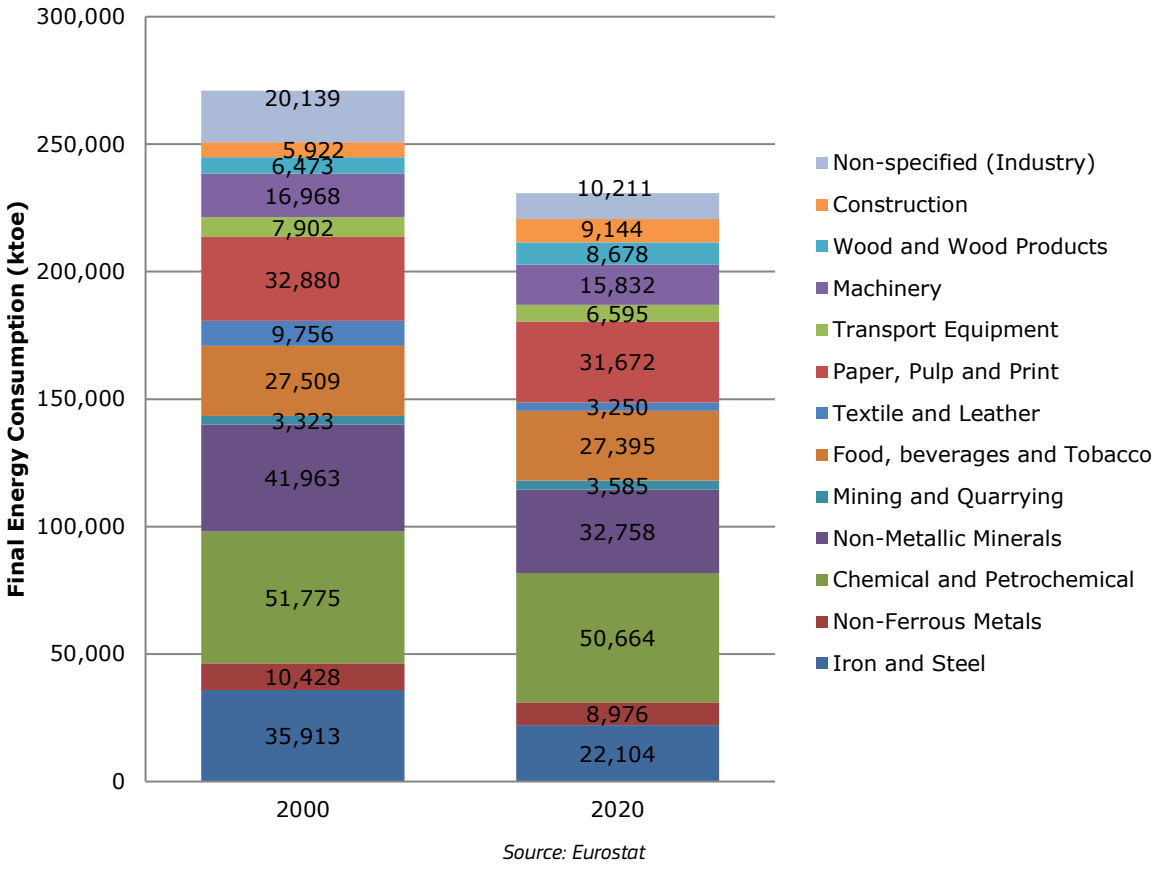
[125] MT, CY: consumption equal to 0

6.2 Industry subsectors

In this section, the final energy consumption of 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 divided into eleven subsectors: iron and steel; non-ferrous metals; chemical and petrochemical; non-metallic minerals; food, beverages and tobacco; textile and leather; paper, pulp and print; transport equipment; machinery; wood and wood products; and other industries[126].

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

Figure 151: Industry sector: final energy consumption by subsectors, 2000 and 2020



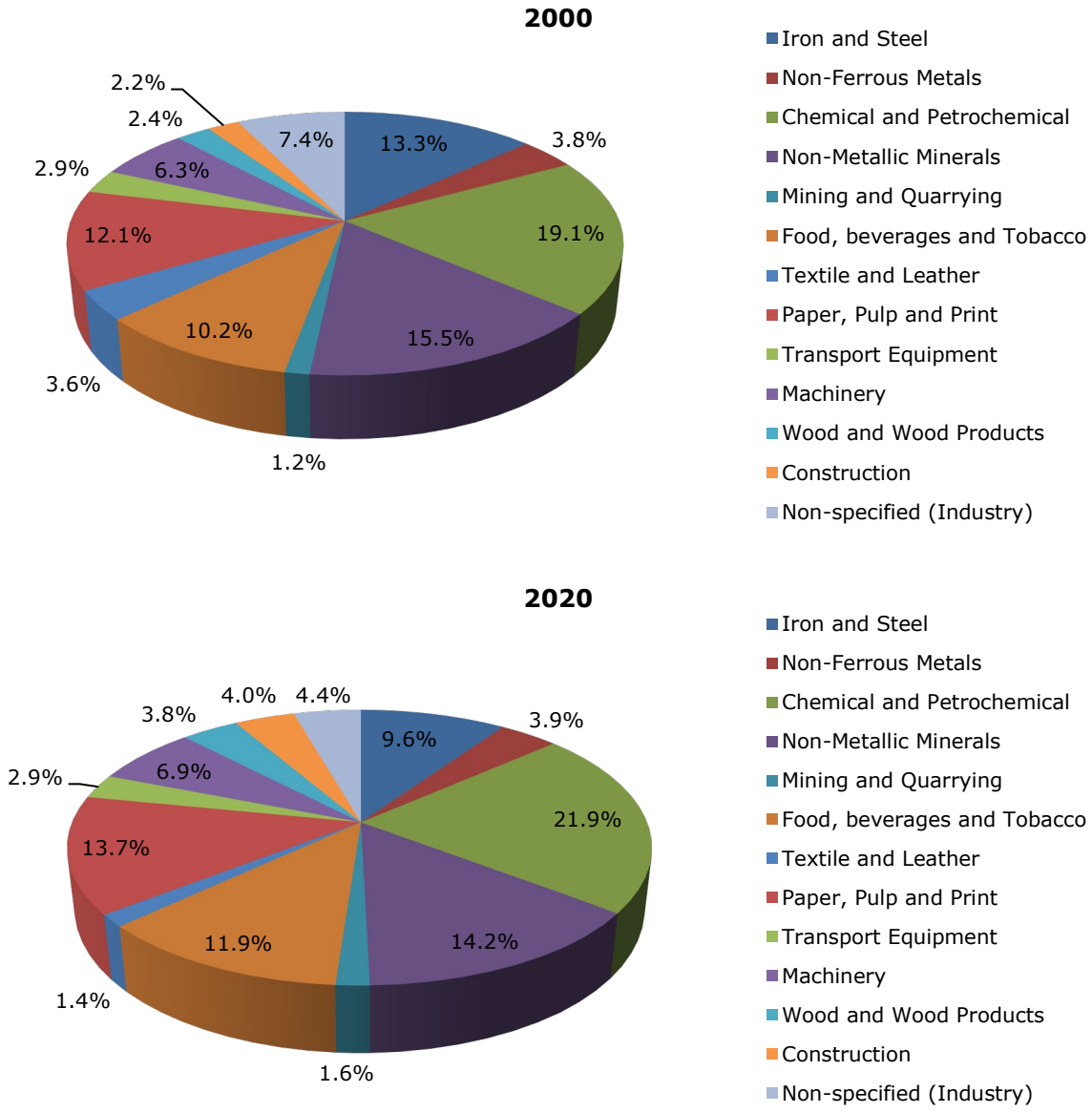
Source: Eurostat

In 2020, the Chemical and Petrochemical was the industry subsector with the highest energy consumption which accounted for 22.0% (50,664 ktoe) of the total final industrial energy consumption, followed by Non-metallic Minerals (14.2%; 32,758 ktoe), and Paper, Pulp and Print (13.7%; 31,672 ktoe). The layout is completed by Food, Beverages and Tobacco (11.9%; 27,395 ktoe), Iron and Steel (9.6%, 22,104 ktoe), Machinery (6.9%; 15,832 ktoe), Non-specified (Industry) (4.4%; 10,211 ktoe), Construction (4.0%; 9,144 ktoe), Non-Ferrous Metals (3.9%; 8,976 ktoe), Wood and wood products (3.8%; 8,678 ktoe), Transport Equipment (2.9%; 6,595 ktoe), Mining and Quarrying (1,6%; 3,585 ktoe) and Textile and Leather (1.4%; 3,250 ktoe).

In 2000, the most energy-consuming subsector was Non-metallic Minerals (15.5%), followed by Iron and Steel (13.3%). The most significant change is the decrease of the share of Textile and Leather subsector that accounted less than the half from 2000 to 2020.

[126] 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 152: Industry sector: final energy consumption percentage by subsectors, 2000 and 2020



Source: Eurostat

Table 8 provides an overview of the variations in the final energy consumption in the different energy subsectors between years 2000 and 2020. 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 one registering a drop in the final energy consumption (16.7%). The Mining and Quarrying subsector registered an increase of 7.9% in the same period. Construction also increased its final energy demand by 54.4%. Within the manufacturing subsectors, the only positive rate is found in Wood and Wood Products (34.1%). The remaining subsectors show a negative consumption rates. The highest reduction rates were observed in Textile and Leather (-66.7%), Non-Specified Industry (-49.3%) and Iron and Steel (-38.5%). Some of these reduction trends are possibly the result of reduced production (Figure 158).

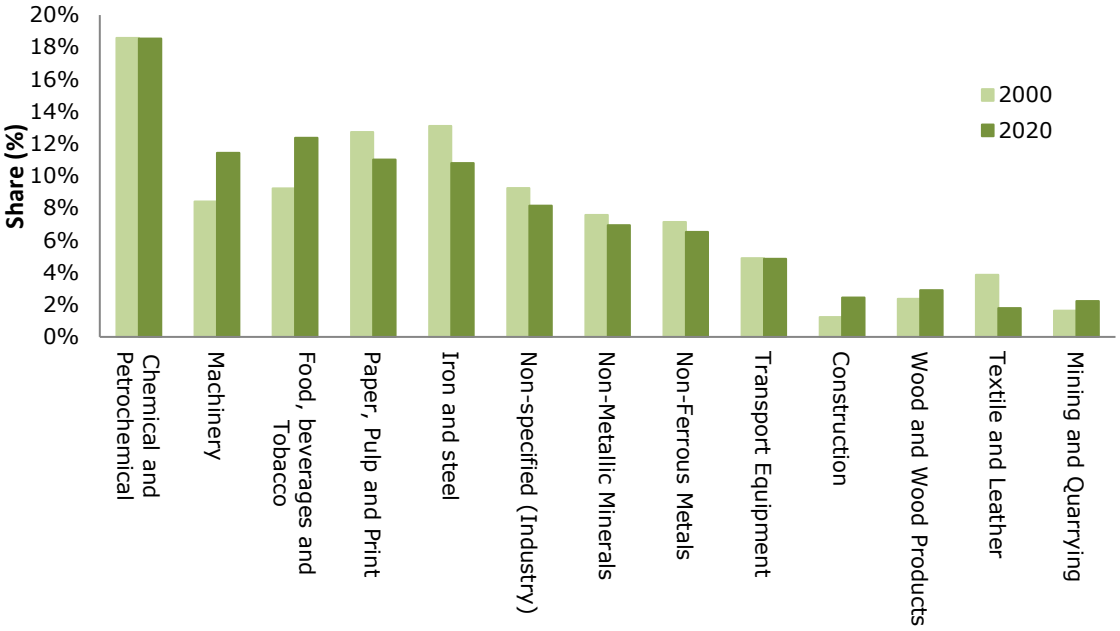
Table 8: Rates and energy consumption shares in industry subsectors, 2000 and 2020

	Final Energy (ktoe)		Rate (%)	Share in %		Change of shares
	2000	2010	2000-2020	2000	2020	2000-2020
Manufacturing	261,706	218,135	-16.6%	96.6%	94.5%	-2.1%
Iron and Steel	35,913	22,104	-38.5%	13.3%	9.6%	-3.7%
Non-Ferrous Metals	10,428	8,976	-13.9%	3.8%	3.9%	0.0%
Chemical and Petrochemical	51,775	50,664	-2.1%	19.1%	21.9%	2.8%
Non-Metallic Minerals	41,963	32,758	-21.9%	15.5%	14.2%	-1.3%
Food, Beverages and Tobacco	27,509	27,395	-0.4%	10.2%	11.9%	1.7%
Textile and Leather	9,756	3,250	-66.7%	3.6%	1.4%	-2.2%
Paper, Pulp and Print	32,880	31,672	-3.7%	12.1%	13.7%	1.6%
Transport Equipment	7,902	6,595	-16.5%	2.9%	2.9%	-0.1%
Machinery	16,968	15,832	-6.7%	6.3%	6.9%	0.6%
Wood and Wood Products	6,473	8,678	34.1%	2.4%	3.8%	1.4%
Other industries (Rubber, Plastics)	20,139	10,211	-49.3%	7.4%	4.4%	-3.0%
Mining and Quarrying	3,323	3,585	7.9%	1.2%	1.6%	0.3%
Construction	5,922	9,144	54.4%	2.2%	4.0%	1.8%
Industry Total	270,951	230,864	-14.8%			

Source: Eurostat

Figure 153 and Figure 154 analyse electricity and natural gas consumptions in the different industry subsectors. Chemical and Petrochemical registered the highest electricity consumption in 2020 with a consumption of 164 TWh accounting for 18.5% of the industry final electricity consumption. It was followed by Food, Beverages and Tobacco (109 TWh; 11.0%), Machinery (101 TWh 11.4%) and Paper, Pulp and Print (98 TWh; 11.0%). In 2000, Chemical and Petrochemical was the main electricity consumer (200 TWh; 18.6%), followed by Iron and Steel (124 TWh; 13.1%), and Paper, Pulp and Print (120 TWh; 12.7%).

Figure 153: Industry sector: share of electricity consumption by industry subsectors, 2000 and 2020

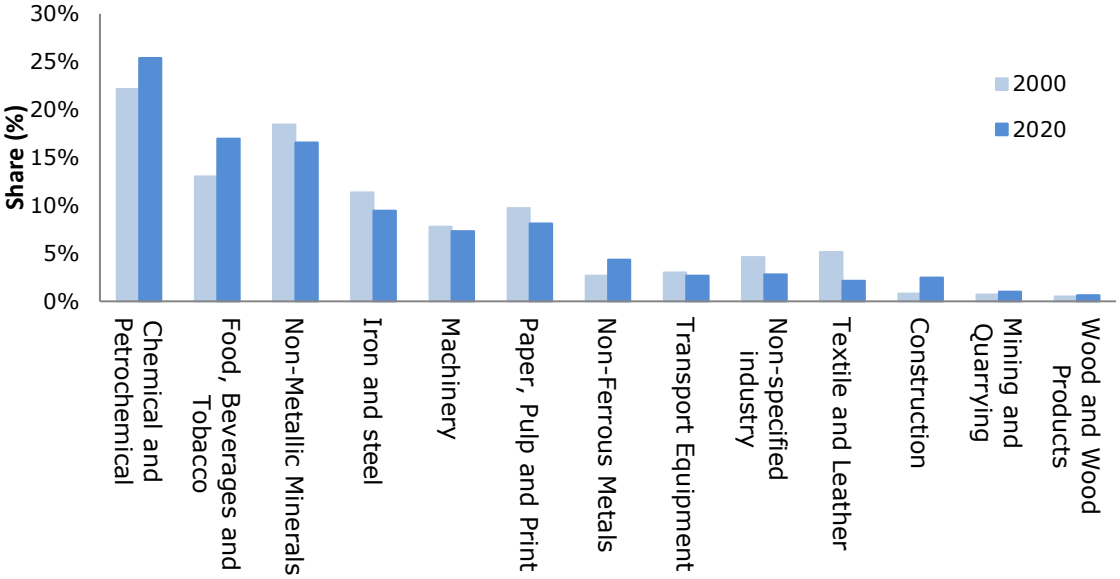


Source: Eurostat

In 2020, the Chemical and Petrochemical manufacturing subsector was the main natural gas consumer with 25.4% (18,774 ktoe) of the share over the total final natural gas consumption. Food, beverages and Tobacco

was the second natural gas consuming subsector (17.0%; 12,556 ktoe) followed by Non-Metallic minerals (16.6%; 12,250 ktoe), and Iron and Steel (9.5%; 6,983 ktoe).

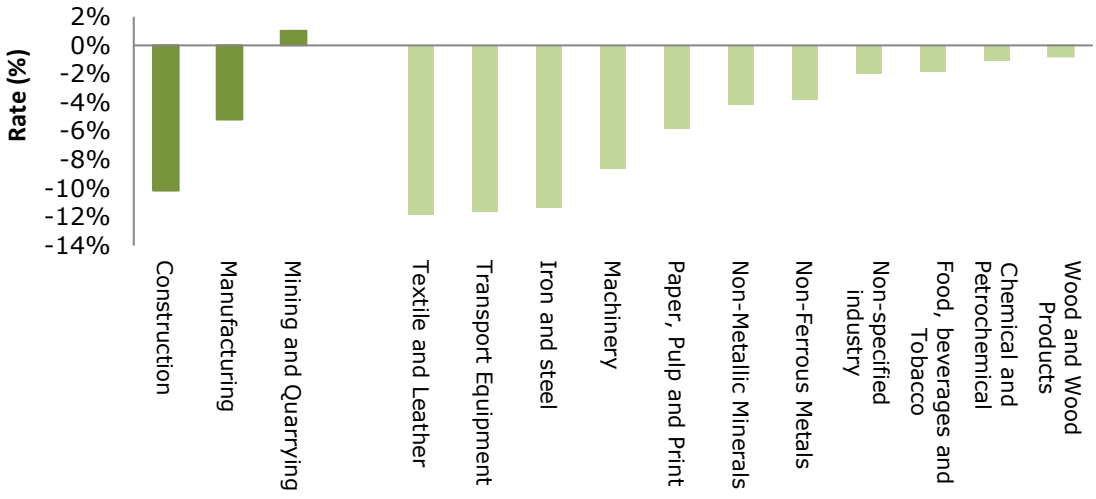
Figure 154: Industry sector: share of natural gas consumption by industry subsectors, 2000 and 2020



Source: Eurostat

Figures 155 shows the electricity consumption rates in the industrial and manufacturing subsectors for the last two years analysed in the report (2019 and 2020). All subsectors excluding Mining and Quarrying registered decreases in 2020. Textile and Leather registered the highest reduction rate (-11.9%) among the manufacturing subsectors.

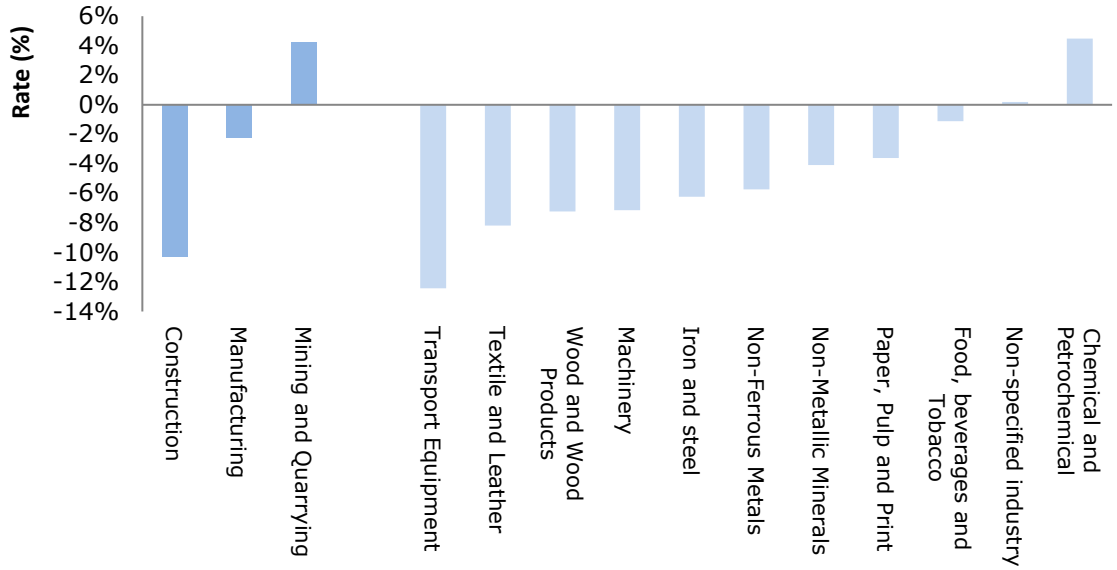
Figure 155: Electricity rates in industrial and manufacturing subsectors in the EU-27, 2019 and 2020



Source: Eurostat

Figure 156 shows the natural gas consumption rates in the industrial and manufacturing subsectors in the two-year period 2019-2020. All the industrial subsectors registered decreases in 2020 except Mining and Quarrying, which experienced an increase of 4.2%. As regards the Manufacturing subsectors, the largest increase is observed in Chemical and Petrochemical (4.5%) while the highest reduction rate is observed in Transport Equipment (-12.4%).

Figure 156: Final natural gas consumption in Construction, Mining and Quarrying and Manufacturing subsectors in the EU-27, 2019 and 2020



Source: Eurostat

Table 9 provides an overview of the changes between years 2000 and 2020 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 registered decrease in electricity consumption (-8.2%) and in natural gas consumption (-17.3%) over the period 2000-2020. Within manufacturing subsectors, Textile and Leather registered the highest reduction rates for electricity and natural gas (-56.5% and -64.8% respectively). To be noted the increases of 85.8% and 165.4% in the electricity and natural gas consumptions respectively in the Construction during the period 2000-2020.

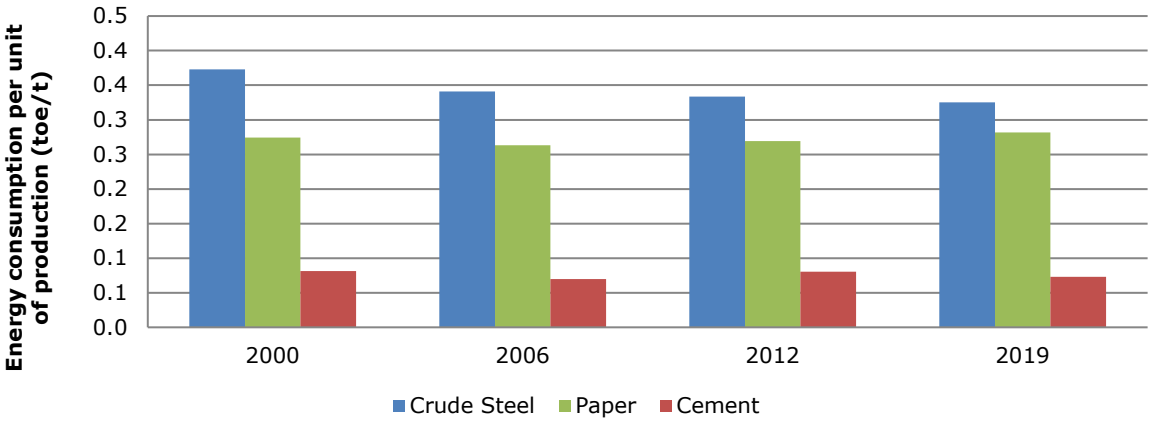
Table 9: Rates of final electricity and natural gas consumptions in industry subsectors, 2000 and 2020

	Final Electricity (GWh)		Rate (%)	Final Natural Gas (ktoe)		Rate (%)
	2000	2020	2000-2020	2000	2020	2000-2020
Manufacturing	918,823	843,481	-8.2%	86,227	71,316	-17.3%
Iron and Steel	124,024	95,522	-23.0%	9,936	6,983	-29.7%
Non-Ferrous Metals	67,631	57,788	-14.6%	2,348	3,223	37.2%
Chemical and Petrochemical	175,643	163,967	-6.6%	19,406	18,774	-3.3%
Non-Metallic Minerals	71,665	61,348	-14.4%	16,145	12,250	-24.1%
Food and Tobacco	87,286	109,396	25.3%	11,424	12,556	9.9%
Textile and Leather	36,546	15,908	-56.5%	4,518	1,591	-64.8%
Paper, Pulp and Print	120,325	97,558	-18.9%	8,507	5,992	-29.6%
Transport Equipment	46,228	42,927	-7.1%	2,629	1,979	-24.7%
Machinery	79,639	101,118	27.0%	6,807	5,412	-20.5%
Wood and Wood Products	22,377	25,707	14.9%	456	477	4.6%
Other Industries	87,458	72,240	-17.4%	4,050	2,079	-48.7%
Mining and Quarrying	15,341	19,694	28.4%	630	746	18.3%
Construction	11,605	21,561	85.8%	694	1,843	165.4%
Industry Total	945,768	884,735	-6.5%	87,552	73,904	-15.6%

Source: Eurostat

An indicator commonly used in the manufacturing industry as benchmark for analysing the energy efficiency levels 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-27 based on data availability: steel, cement and paper. Overall, except from paper, this parameter shows decreased values for the studied years with the largest decrease observed in crude steel (decreased by 12.8% from 2000 to 2019) reaching the value of 0.325 toe/t. In 2019, the energy consumption per ton of paper was 0.282 toe/t, representing a rise of 2.8% in comparison to the year 2000. In 2019, the production of one tonne of cement consumed 0.073 toe/t on average in EU-27. It reduced its ratio of energy consumed per unit of production by 10.1% during the analysed period.

Figure 157: Average energy consumption per tonne of produced crude steel, cement and paper in EU-27, years 2000, 2006, 2012, 2019

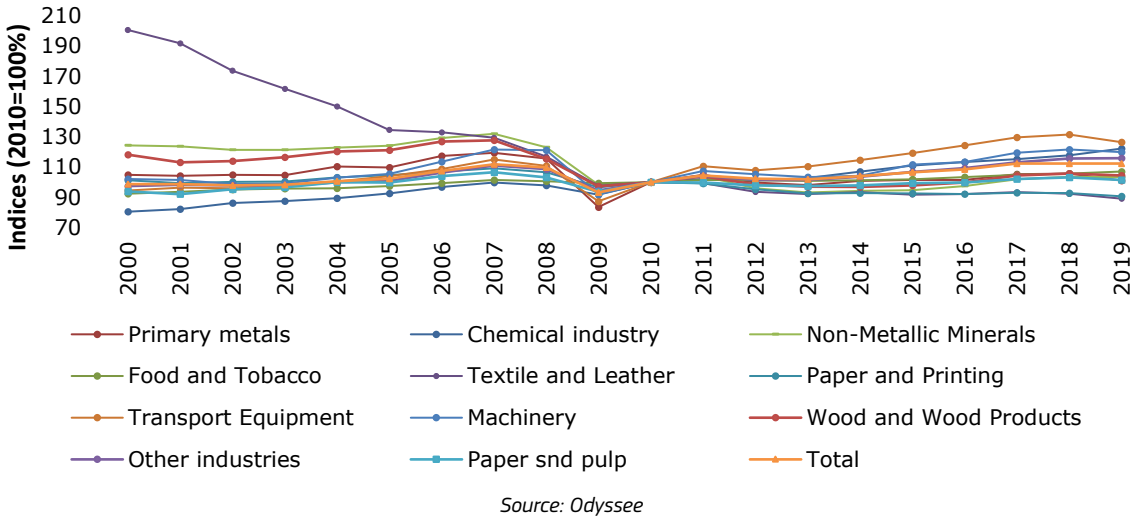


Source: Odyssee

Industrial Production Indexes (IPIs)[127] 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 was almost continuously decreasing with some exceptions, and has accumulated a 55.6% drop until 2019 compared to 2000. To note, among the manufacturing industries the highest rate from 2018 to 2019 was registered in Chemical (3.8%) while the lowest one in Primary Metals (-4.3%).

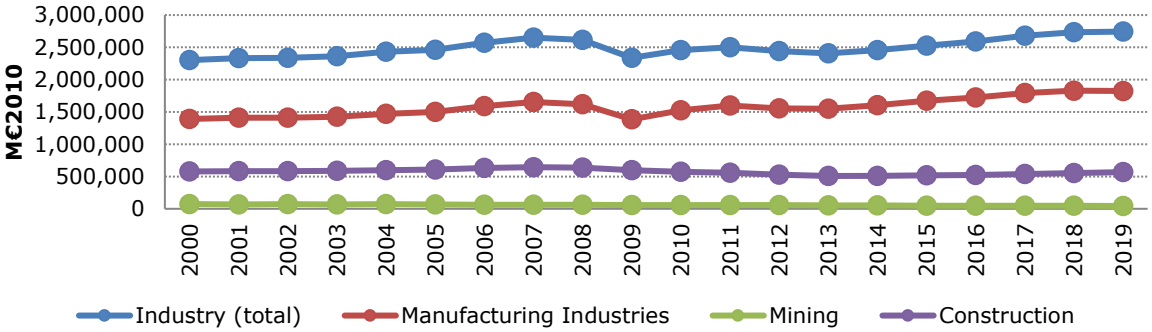
[127] The production index by sub-sector is the most common indicator used to measure the industrial output; it is usually measured in relation to a base year (e.g. index base 100 in 2005 for instance) or in relation to the previous year. It is well covered in national statistics. This index usually 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 [15]

Figure 158: Industrial Production Indices of Manufacturing Industries, (2010=100%), 2000-2019



Source: Odyssee

Figure 159: Added value per industrial subsector, in the EU-27, 2000-2019

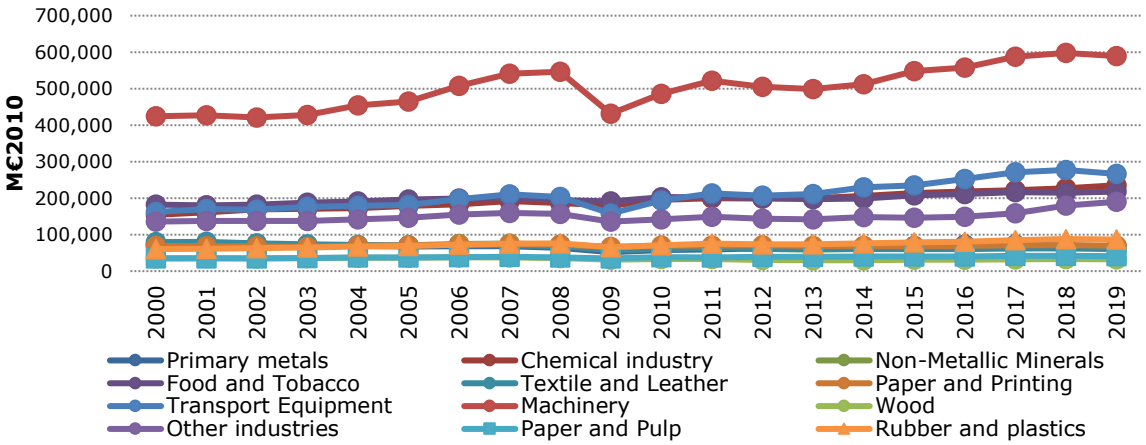


Source: Odyssee

According to Odyssee Database, the industry sector added value to GDP risen by 19.2% in the period 2000-2019. This figure includes Manufacturing Industries, Mining, Construction and Energy sector. Among the analysed industry subsectors[128], Manufacturing industries increased their added value by 31.1%, while Construction and Mining industries decreased their contribution by 1.9% and 41.4% respectively in the previously mentioned time period. Within manufacturing industries, the highest growth rates in the value added are found in Transport Equipment (63.9%), Chemical (52.6%), and Machinery (39.0%). On the other hand, the manufacturing industries with the highest reduction rates are Textile and Leather (-24.8%) and Primary Metals (-7%). Machinery subsector is the largest contributor to the GDP added value among the manufacturing industries. Its contribution (589,636 M€) more than doubles the second ranked industry subsector (Transport Equipment) which contributes with 266,352 M€.

[128] Energy subsector is not analysed as an industrial subsector in this report.

Figure 160: Added value per manufacturing subsector in the EU-27, 2000-2019



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 2019.

Table 10: Industrial Production Indices and Value Added to GDP for Industry Subsectors,[129] 2000 and 2019

	Industrial Production Index (2010=100%)		Change of Production Index	Value Added to GDP (M€2010)		Change of shares
	2000	2019	2000-2019	2000	2019	2000-2019
Manufacturing	97	97	**0.0%**	1,391,649	1,824,450	**31.1%**
Primary metals	105	101	**-3.6%**	72,656	67,570	**-7.0%**
Chemical industry	80	122	**51.8%**	154,196	235,237	**52.6%**
Non-Metallic Minerals	124	103	**-16.8%**	69,104	66,938	**-3.1%**
Food and Tobacco	92	107	**15.9%**	182,528	217,851	**19.4%**
Textile and Leather	201	89	**-55.6%**	79,726	59,979	**-24.8%**
Paper and Print	101	91	**-10.5%**	69,242	69,554	**0.5%**
Transport Equipment	95	134	**41.8%**	162,500	266,352	**63.9%**
Machinery	102	120	**17.6%**	424,215	589,636	**39.0%**
Wood	118	104	**-11.6%**	34,841	32,510	**-6.7%**
Paper and Pulp	94	101	**8.1%**	34,852	41,201	**18.2%**
Rubber and plastics	na	na		60,547	87,020	**43.7%**
Other industries	97	116	**18.9%**	136,151	189,978	**39.5%**
Mining	117	117	**0.0%**	73,354	43,024	**-41.3%**
Construction	102	102	**0.0%**	578,515	567,684	**-1.9%**
Industry Total	97	107	**9.4%**	2,302,894	2,743,951	**19.2%**

Source: Odyssee

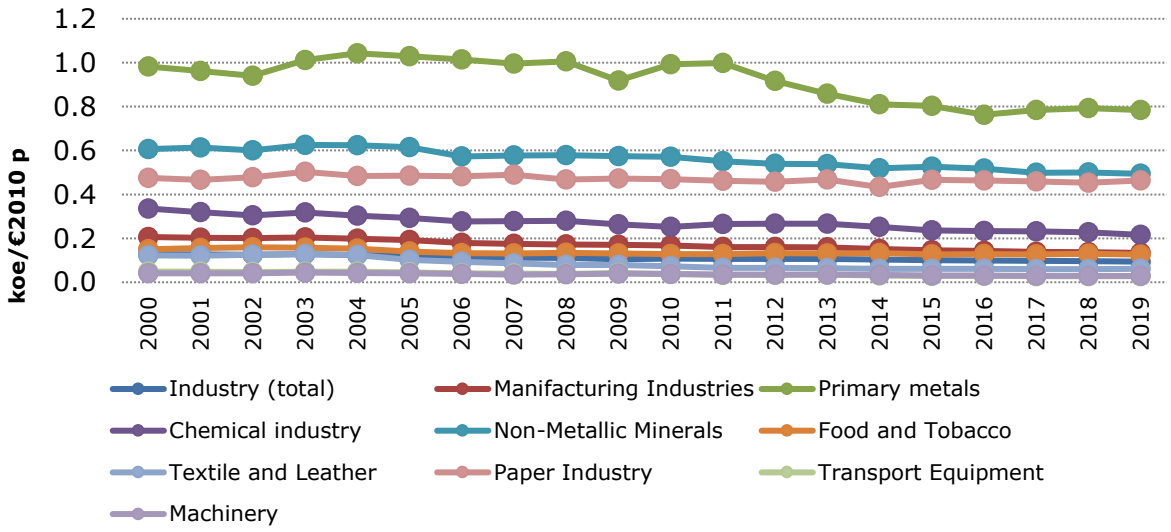
Table 10 shows that the Textile and Leather manufacturing subsector is the subsector with the highest decrease in the industrial production index (-55.6%)[130]. This is probably mostly due to the European textiles and clothing industry outsourcing and delocalization of production in non-EU countries, in the last years.

[129] Total industry includes also energy industries.

[130] 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 [18]:
-Relocation of production and activities to low-cost countries;
-Development of added-value activities in the higher end of the value chain.

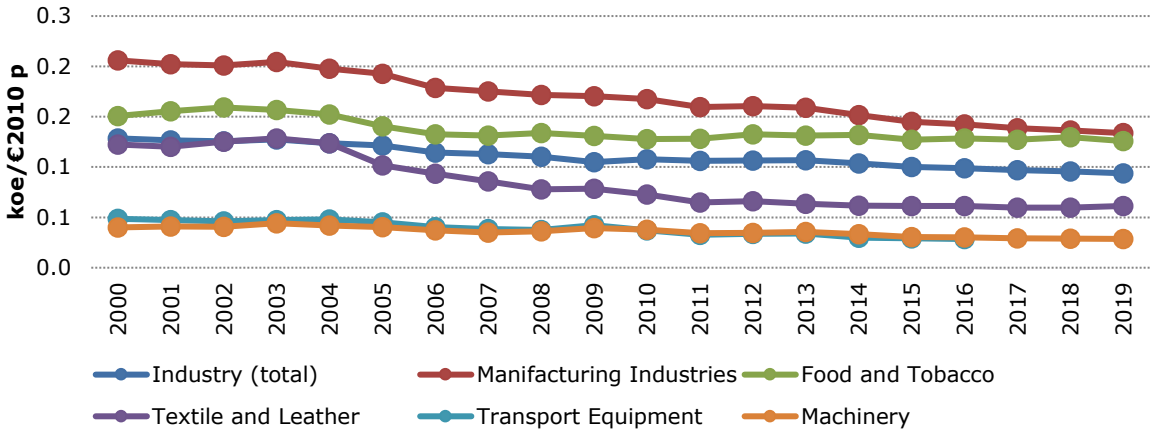
Lower wages, together with a high proportion of entry-level jobs for unskilled personnel, ease of transportation and relatively low investment costs are probably the main drivers of these decisions.

Figure 161: Energy intensity[131] per industry subsector in the EU-27 (GDP at purchasing power parities), 2000-2019



Source: Odyssee

Figure 162: Energy intensity per industry subsector in the EU-27 (GDP at purchasing power parities), 2000-2019 (expanded)



Source: Odyssee

The industry energy intensity was 0.094 koe/€2010 in 2019, showing a drop of 27.0% in the period 2000-2019. The overall trend is decreasing for all the industry subsectors during the mentioned period. It can be observed that Textile and Leather and Transport Equipment are the subsectors where the biggest changes took place as they reduced their energy intensity by 50.0% and 42.4% respectively.

6.3 Overview – Industry sector

The industry sector accounted for more than one quarter of the EU-27 total final energy consumption in the year 2020. It was the third energy-consuming sector after transport and households.

[131] The energy intensity of industry is the ratio between the final energy consumption and the value added at constant price in purchasing power parities. [15]

Industry final energy consumption experienced a notable decrease during the studied period (-14.7%), 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. The annual reduction recorded in 2020 led to values almost similar to 2009 levels.
The highest growth rates were observed in Latvia, Hungary and Malta. The highest reduction rates over the period 2000-2018 were observed in Cyprus, in Greece and in Italy.

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 Spain accounted for more than 53% of the total European final energy consumption in the sector. More than half of the EU-27 Member States (14 countries) consumed less than 10% of the EU-27 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 2020. These two fuel types represented together almost the 65% of the total final energy consumption in EU-27. However, renewables and biofuels enlarged their contributions both in absolute values and shares compared to 2000. On the other hand, oil and petroleum products, electrical energy, natural gas and solid fossil fuels and other reduced the absolute value and the shares of their contributions.

Industry sector was the main electricity consumer and the second natural gas consumer in 2020.

The industry electricity consumption in the EU-27 fallen from 2000 to 2020 (-6.5%). The highest electricity consumption rate over the period 2000-2020 was experienced by Hungary. The Member State with the highest reduction rate was France.

EU-27 natural gas consumption in industry fallen significantly in the period 2000-2018 (-15.6%) while it fallen to a less extent from 2019 to 2020 (by -2.4%). The Member State with the highest growth rates was Greece. On the other hand, the EU-7_2020 country with the highest reduction rates was Latvia.

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, Beverages 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 2000-202 (-16.7%). Among the Manufacturing subsectors, the highest final energy consumption in 2020 was registered in the Chemical and Petrochemical subsector followed by Paper, Pulp and Print and Iron and Steel.

The manufacturing subsector with the highest and the only positive rate for the period 2000-2020 was Wood and Wood Products (+34.1%) while the manufacturing subsector with the highest reduction rate for the same period was Textile and Leather(-66.7%).
In 2020, 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 2019, 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 was almost continuously decreasing since 2000 and has accumulated a very significant drop until 2019 (-55.6%). The most stable manufacturing subsector is Primary Metals.

The industry sector added value to GDP risen importantly in the period 2000-2019 (+19.2%). Among the industry subsectors, in the same period, Manufacturing industries increased their added value while Construction and Mining Industries 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 instead dropped remarkably in the period 2000-2019 (-27.0%). Overall, we observe a decreasing trend in all the industry subsectors during the mentioned period. Textile and Leather and Transport Equipment are the subsectors where the biggest changes took place.

7 Conclusions

This report described and analysed the energy consumption patterns in the EU-27 for the period 2000-2020. 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 declined from 2000 by 11.5%, 11.5%, and 7.4% 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 (-14.7%), followed by the transport sector (-4.2%). Residential sector, on the other hand, registered a slight decrease in consumption (0.1%), whilst the tertiary sector experienced a growth of 15.9%. Energy indicators such as energy intensity of final energy and final energy per capita dropped during the analysed period, by 24.7% and 11.3% 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-27, 2000-2020

	2000		2020		Rate 2000-2020 (%)
Inland Gross Energy Consumption (Mtoe)	1,498		1,326		-11.5%
Primary Energy Consumption (Mtoe)	1,397		1,236		-11.5%
Total Primary Energy Consumption per capita (toe/cap)	3.3		2.8		-15.2%
Energy Intensity - Primary Energy (toe/1,000 Euro)	0.1		0.1		-28.0%
Final Energy Consumption (Mtoe)	980		907		-7.4%
Final Energy Consumption per capita (toe/cap)	2.3		2.0		-11.3%
Energy Intensity - Final Energy (toe/1,000 Euro)	0.1		0.1		-24.7%
	2000		2020		Rate 2000-2020 (%)
	FEC (ktoe)	Share (%)	FEC (ktoe)	Share (%)	
Residential Sector	248,525	28.0%	248,243	29.1%	-0.1%
Tertiary Sector	104,722	11.8%	121,376	14.2%	15.9%
Transport Sector	262,886	29.6%	251,970	29.5%	-4.2%
Industry Sector	270,973	30.5%	231,212	27.1%	-14.7%

Source: EC DG-JRC

The main findings and results of the report for the period from 2000 to 2020 are:

In 2020, the EU-27 **final energy consumption remained reduced by 8.1% compared to the previous year**, by registering a value of 907 Mtoe. As a result, the final energy consumption in 2020 achieved the 2020 EU-27 target (959 Mtoe). However, this value is probably influenced by the COVID-19 pandemic and the adopted measures.

In 2020 **primary energy consumption decreased by 8.7% compared to the previous year**, registering a value of 1,236 Mtoe. Consequently, it achieved the 2020 target (1,312 Mtoe).

Extending the timeline to 2030, the 2020 gap to the future 2030 targets are +9.6% for primary energy consumption and +7.2% for the final energy consumption, highlighting the need of intensified policy and technological efforts in the next decade.

The tertiary sector experienced a growth in final energy consumption over the analysed period while final energy consumption in the transport and industry sectors declined. Residential sector remained almost stable (experienced a very slight decrease). The adopted lockdown measures in 2020 led to an important decrease in transport sector energy consumption while the increase of teleworking activities in the same year restricted the decreasing trend of residential final energy consumption and keep the final consumption of tertiary sector in lower levels than previous years.

EU reduced its final energy intensity by 24.7% over the period 2000-2020 by reaching a value 0.07 toe/thousand Euro in 2020. Energy consumption per capita reduced by 11.3% from 2000 to 2020, reflecting the dynamics of final energy consumption.

Overall, final energy consumption trends over the studied period showed that the financial and economic crisis (which started in 2007 and peaked in 2008) and the COVID-19 pandemic strongly affected dynamics and rates of the different economic sectors and Member States.

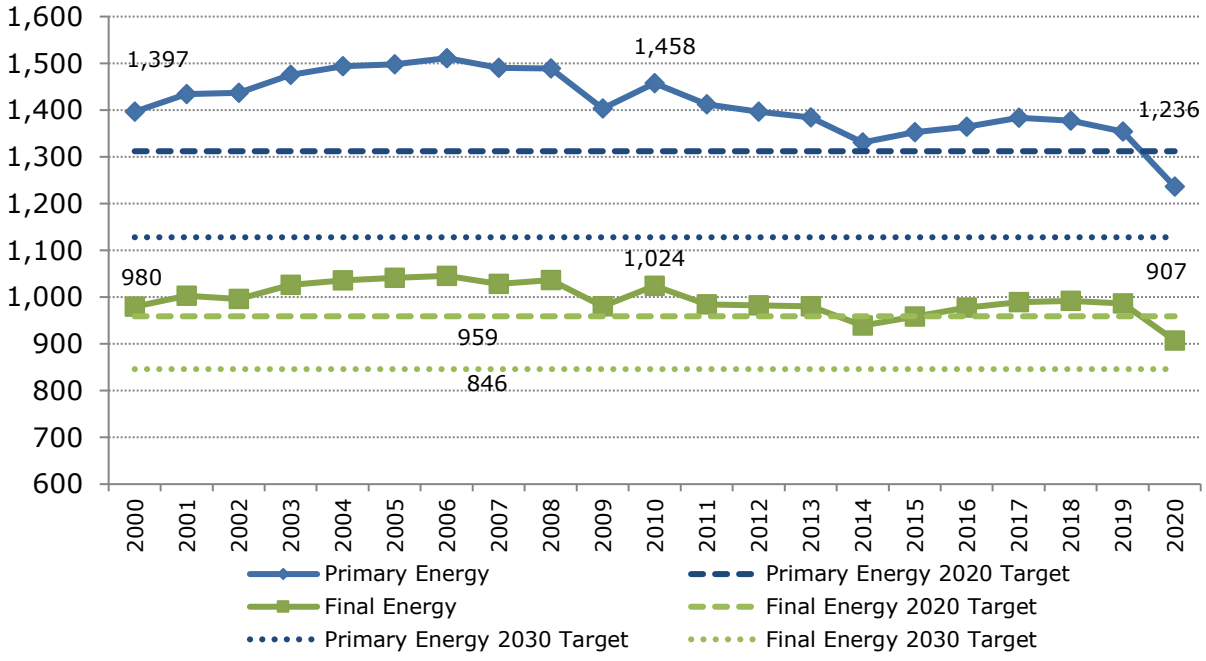
The climatic conditions is an important factor influencing the final energy consumption values especially in residential and tertiary sectors, that's why climatic corrected data was used in the report.

Despite the economic growth (GDP per capita, adjusted disposable income increase in the studied period), the climatic conditions and the increase of population, final energy consumption achieved the 2020 target and is below the 2000 levels. However, we have also to consider the exceptional event of COVID-19 pandemic that took place in 2020, reduced the end-use activities and consequently influenced importantly the final values.

Four Member States (i.e. Germany, France, Italy and Spain) consumed over 56% of the final energy consumption and thirteen Member States (almost half of the EU Member States) consumed less than 10% of the total final energy consumption in 2020. Different energy consumption 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 tertiary 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-27 energy targets, 2000-2020



Source: Eurostat

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

Residential Sector

The residential sector registered a very slight decrease in the final energy consumption by 0.1% in the period from 2000 to 2020.

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. The GDP is an important variable to consider as it grew 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 experienced a gradual decrease in the analysed period. Increased teleworking activities in 2020 due to COVID-19 situation possibly slowed down the decreasing trends of these indicators.

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

In 2020, the residential sector represented 28.0% of the final energy consumption in the EU, being the third consuming sector after transport sector.

After the lowest value (over the period 2000-2020) registered in 2014, from 2015 to 2017 final residential energy consumption values increased compared to the previous years. This trend stopped in 2017 when consumption started to decrease until 2019. In 2020 remained stable.

The energy mix in the residential sector is mainly formed by natural gas (31.7%) and electricity (20.3%) consumption.

The final residential electricity consumption increased by 17.8% in the EU-27 during the 21-year period 2000-2020. 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 1.8% between 2000 and 2020.

The residential sector was the second electricity consumer (29.9%) and the main natural gas consumer (40.5%) among the analysed sectors in 2020.

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 was 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.

In the EU, there was a declining trend in the size of the households in terms of persons per household over the period 2009-2020, 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.

Electricity prices went up in the EU (grew by 16.9%-up to EUR 0.213/kWh). Natural gas prices decreased by 4.0% (to EUR 0.065/kWh) between the second semester of 2007 and the second semester of 2020.

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 15.9% in the period from 2000 to 2020.

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

The final energy consumption decreased in 2020 (by 5.6% compared to 2019). 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 recorded negative growth rated in the last studied years.

The energy mix in the tertiary sector is mainly formed by electricity (47.9%), natural gas (28.4%) and oil and petroleum products (8.0%) consumption. Renewables and biofuels increased their shares compared to 2000 to 7.7%.

The final tertiary electricity consumption grew (by 24.3%) in the EU-27 during the 21-year period 2000-2020. 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 increased (by 22.6%) between 2000 and 2018, following the development of the sector and the final energy consumption trends.

The tertiary sector was the third electricity consumer (28.4%) and the third natural gas consumer (17.8%) among the analysed sectors in 2020.

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 is the only sector registered a positive rate among the analysed sectors over the analysed period, but it also accounts for the largest share of gross value added in EU-27 in 2020 (73.1%).

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 a decrease in the final energy consumption by 4.2% in the period from 2000 to 2020 mainly due to significant reduction in 2020.

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 28.5% in the year 2020.

Energy consumption increased during 2000-2007, followed by a decrease until 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 2020 it decreased significantly (by 12.8%) due to COVID-19 pandemic which restricted the transport activities.

Petroleum products represented about 90.6% of final energy demand in the transport sector in 2020.

Electricity only contributed 1.8% of the energy demand and natural gas 1.3%. Renewables and biofuels contributed 6.4% 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 (94.5% in 2020). Road transport is highly dependent on petroleum products, and diesel represented about 66.5% of the energy use in 2020 in the road transport.

Biofuels use steadily increased between 2000 and 2020. Biodiesel (pure and blended) represented around 82.2% of the total biofuels consumption in 2020, followed by biogasoline (pure and blended) (16.6%) and biogas (1.1%).

Energy consumption per car declined by 20.0% from 2000 to 2019. The average annual distance travelled by car also experienced a decreasing trend during the same period. Cars were estimated to account for about 59.0% of the road transport energy consumption in 2019.

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 14.7% in the period from 2000 to 2020.

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

The industry is the third in the ranking of the most energy consuming economy sectors, accounting for 26.1% of the EU-27 total final energy consumption in 2020.

Since 2008, industry registered the lowest energy consumption levels in the 21-year period from 2000 to 2020. This may be result of financial and economic crisis as well as of the continuing deindustrialization.

The industry sector was the main electricity consumer (37.1%) and the second natural gas consumer (38.1%) among the analysed economic sectors in 2020.

The energy mix in the industry sector was mainly and evenly formed by electricity (32.9%) and natural gas (32.0%) in 2020.

Overall, the industry sector reduced its final energy consumption due to a contraction of production. For instance, final energy consumption of non-metallic minerals (the highest energy consuming subsector in 2000) decreased by 21.9% and the decreased industrial production index (IPI) by 16.8% during the period 2000-2019.

The financial and economic crisis 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 2019 registered a growth of 9.4% and 19.2%, respectively.

The IPI reduction was not evenly registered across the industry subsectors. For instance, IPI of textile and leather subsectors was almost continuously decreasing since 2000 and has accumulated a 55.6% drop until 2019.

Among the manufacturing subsectors chemical and petrochemical was the main final energy, electricity and gas consumer in 2020. Despite a negative rate in energy consumption (-11.6% from 2000 to 2018) it registered an increase in IPI (51.8%) and in the share of value added to GDP (52.6%) over the period 2000-2019.

The machinery subsector was the largest contributor to the GDP among the manufacturing subsector in 2019.

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List of abbreviations

AT	Austria
BE	Belgium
BG	Bulgaria
Cap	Per capita
CDD	Cooling Degree Days
CY	Cyprus
CZ	Czechia
DK	Denmark
DE	Germany
Dw	dwelling
EL	Greece
Emp	per employee
ES	Spain
EE	Estonia
EU-27	European Union Member States after the withdrawal of UK
EU-28	European Union Member States until January 2020
FI	Finland
FR	France
GDP	Gross Domestic Product
Gwh	Gigawatt hour
HDD	Heating Degree Days
HH	Households
HR	Croatia
HU	Hungary
IE	Ireland
IPI	Industrial Production Index
IT	Italy

KOE	Kg of Oil Equivalent
kTOE	Thousand Tonnes of Oil Equivalent
kwh	Kilowatt hour
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
MTOE	Million Tonnes of Oil Equivalent
NL	Netherlands
Pkm	passenger kilometre
PL	Poland
Pop	population
PPS	Purchasing Power Standard
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
SE	Sweden
Tkm	Tonne kilometre
TOE	Tonnes of Oil Equivalent
Twh	Terawatt hour
UK	United Kingdom
Veh	per vehicle

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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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