Analysis of energy consumption in the industrial sector in the European Union

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Abstract. The European Union (EU) pursues a coherent policy to reduce the carbon footprint of human impact on the climate, with one of the main strategies being to reduce the use of energy resources. On the other hand, the EU is the world’s largest importer of energy and making it highly energy dependent which is reduced the competitiveness of Member States’ economies. Reducing the energy resources used leads to political, economic, social and environmental benefits. All this explains the EU’s motivation to make energy efficiency a key goal in development policy for the Union. At the level of the European Union a number of normative documents have been adopted, related to increasing the energy efficiency of the two largest areas of energy consumption - buildings and manufacturing systems. In the share of energy consumption in the EU, manufacturing production has a significant share, which represents the potential for increasing energy efficiency. This article analyses the dynamics of energy intensity of the European economy and consumption of energy in the manufacturing sector of the EU member states, compares the situation in Bulgaria. The efficiency of the undertaken measures for stimulating the increase of the energy efficiency in the sector is analysed. Conclusions from the study are formulated

1. Introduction

The Energy Efficiency Directive 2012/27 / EU sets the EU target for energy efficiency by 2020, which required a reduction of primary or final energy consumption by 20%, compared to the projected levels for 2020 according to the baseline scenario of the European Commission since 2007. In December 2018, the European Parliament and the Council of the European Union adopted the revised Energy Efficiency Directive (EED) [1]. The revised EED sets that the energy efficiency target for the EU should be a minimum of 32.5% till 2030. In this document, the energy efficiency is identified as a strong driver for achieving climate goals. Reducing energy consumption is set as a key building block in the Commission's proposal for an "European strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy", presented in November 2018 [2].

As a result of the EU’s consistent policy between 1990 and 2016, energy consumption was reduced by almost 2%, greenhouse gas emissions by 22%, while GDP increased by 54% [3]. However, the achieved results are not sufficient to meet the objectives set in the adopted strategic documents. Unstable momentum to improve energy efficiency is a matter of serious concern. The analysis of the available data shows that the improvements in the energy intensity of the global economy are slowing
- the improvement of 1.2% in 2018 is about half of the average observed since 2010. This supposes to make greater efforts to an intensification of the existing measures.

The analysis of primary and final energy consumption shows that for 2018 primary energy consumption for the EU was 4.9% above the target of efficiency energy for 2020 and 22.0% above the 2030 target and final energy consumption for the EU was 3.2% above the efficiency target for 2020 and 17.0% above from the 2030 target [4]. One of the sectors with a large share in energy consumption is an industry.

The aim of this study is to analyse the dynamics of energy consumption and energy intensity of the European economy in the manufacturing sector of the EU member states, Bulgaria as one of the major energy consumers and comparison between both.

2. Exposure
Various data points can be used as indicators for comparison and assessment of energy consumption: gross internal energy consumption, primary and final energy consumption, energy intensity, etc. Depending on the needs of the research different indicators can be used individually or in combination to clarify the existing dependencies, to highlight the regularities, and to draw conclusions about the trends.

In the present study, the main indicators used final energy consumption and energy intensity. According to the Eurostat glossary, final energy consumption is the total energy consumed by end users and it excludes energy used by the energy sector, including deliveries, and transformation. It also excludes fuel transformed in the electrical power stations of manufacturing auto-producers and coke fuel transformed into blast-furnace gas where this is not part of overall manufacturing consumption but of the transformation sector. Energy intensity is one of the indicators to measure the energy needs of an economy and is the ratio between gross domestic energy consumption (GIEC) and gross domestic product (GDP), calculated per calendar year. The GIEC is calculated as the sum of the gross domestic consumption of the five energy sources: solid fuels, oil, gas, nuclear and renewables. It is often used as an approximation of energy efficiency.

According to Eurostat, final energy consumption has been increasing slowly since 1994, reaching its highest level - 991 Mtoe in 2006 [5]. The reductions in 2011-2012 (figure 1) can be partially attributed to the reduced economic production due to the economic crisis, expressed by 0.4% contraction of real GDP in 2012, and continuing until 2014 reduction - of meteorological conditions. After 2014, the trend changed as the final energy consumption in the EU again marked a positive growth, reaching 939 Mtoe in 2018, which is only 0.1% lower compared to the 2017 consumption.

![Figure 1. Final energy consumption in EU for 2010-2018, source Eurostat](image)

According to Eurostat (published on 06.06.2020), the largest final energy consumers in the EU (figure 2) are Germany, France, England, Italy (figure 2 shows the countries with annual consumption near or above 1000 ktoe) [8]. The information is summaries for the period 2009-2018 and clearly identifies the largest energy consumers in Europe.
A breakdown of energy consumption by economic sectors in the EU shows an increase in the final energy consumption, which is growing at a slower pace than GDP. This is an indicator of the relative decoupling of energy consumption from economic growth, which leads to a positive trend towards increasing the efficiency of European economies. For the period 2014 and 2017, the largest increase in energy consumption was observed in buildings (+ 8.3%), followed by transport (+ 5.8%) and industry (+ 4%). For 2018 there is a decrease in energy consumption for almost all sectors except for the Transport sector. Figure 3 shows that industry is the third largest sector in terms of energy consumption, which justifies the importance of monitoring and increasing energy efficiency in this industry. Figure 3 shows that industry is the third largest sector in terms of energy consumption after transport and households, which justifies the importance of monitoring and increasing energy efficiency in this industry.

The state of the final energy consumption by sectors for Bulgaria is presented in figure 4, according to the data indicated in the Integrated Plan in the field of energy and climate of the Republic of Bulgaria 2021-2030, Annex 3, published on 21.02.2020 [7]. Thanks to the policy pursued in recent years for increasing the energy efficiency of buildings, the energy consumption in this sector is lower.
than in the industry sector, opposite to the situation in the EU. Despite the crisis that our economy has gone through, the energy consumption in the sector is growing except in 2014, when there was a sharp decline, after which it began to grow again [8]. One of the explanations for this fact is the high energy consumption of production sector, which can be clearly established by the next indicator - energy intensity. According to the latest data published by the National Statistical Institute in 2018 [9], there is a slight decline only in the transport sector, while in other sectors the upward trend.

Figure 4. Final consumption by sectors for the period 2005-2015 and a forecast for the period up to 2030 for Bulgaria.

The energy intensity shows how much energy is needed to produce a unit of GDP and thus is a good indicator for assessing energy consumption as well as for analyzing trends. In the period 1990-2018 in the EU there is a steady trend of decreasing energy intensity - 37% in total (1.7% per year). There are various reasons for the improvement in energy intensity: the general shift from industry towards a service-based economy in Europe, performing less energy-intensive activities and production methods within the industry, the closure of inefficient units, or the use of more energy-efficient appliances. According to Eurostat data (figure 5), all Member States have reduced the energy intensity in the period, including Bulgaria, although our economy ranks first in this indicator.

Figure 5. Energy intensity of the economies of the EU Member States for selected years.
The analysis of the energy intensity by sectors in the European Union shows fluctuations in the trend of the indicator but the general tendency is for its decrease (figure 6). A more gradual decline is in the Industry sector, followed by the Transport sector.

![Figure 6. Final energy intensity by sector for the EU in base year 2005, Source: European Environment Agency (EEA).](image)

According to data from Odyssee And Mure Databases [10], the two sectors of the Bulgarian economy with the highest energy intensity are the Industry and Transport sectors. Figure 6 presents a comparison of the index levels in Bulgaria and in the EU for the period 2010-2017 as the industry is the second largest sector according to the energy intensity. This determines its low economic efficiency. Regardless of a slight decline in the energy intensity of the manufacturing sector over the review period, it remains well above EU rates.

![Energy intensity of industry (at purchasing power parities) Energy intensity of transport](image)

**Figure 7.** Comparison of energy intensity in the Transport and Industry sectors in Bulgaria and the EU. **Source:** Odyssee And Mure Databases.

3. Conclusion
In the present study, the authors analysed the statistics provided by various sources in the field of energy consumption in Europe and the energy intensity of the manufacturing sector as a potential opportunity to raising the energy efficiency of the European and national economies. Some differences
in the published information in the sources were found, as well as differences in the indicators on which consumption is reported. An attempt to solve these problems was realized through the Odyssee-Mure project which is co-ordinated by ADEME with the technical support of Enerdata and Fraunhofer.

The analysis clearly shows that a constant decrease in energy consumption since 1990 is a result of a consistent long-standing EU policy to reduce energy consumption and increase energy efficiency as a part of legislative measures to improve the climate and reduce the carbon footprint on the nature. There is a difference between the current state and the historically proven dependence of increasing energy consumption and increasing economic growth. This is observed in all EU member states.

The analysis indicates that, unfortunately, the achievement of the targets for 2020 and 2030 will most likely not be met.

In terms of final energy consumption, transport and households were found to be the most energy-intensive sectors in the EU, with Industry remaining in third place. In Bulgaria, thanks to the policy for increasing energy efficiency in buildings, pursued in recent years, the Households sector is in third place.

The analysis of energy intensity shows that in the EU the main energy-intensive sectors are households and services, in Bulgaria they are transport and industry.

In summary, the Industry sector as one of the major consumers of energy has considerable potential for energy efficiency in this sector. This also outlines the direction in which efforts should be directed to improve energy efficiency in the next period 2021-2030.

As proved above, the manufacturing branch ranks as one of the major sectors with high energy consumption and high energy intensity, which make urgently legislative measures have to be taken to ensure the continuous monitoring and estimation of energy consumption in the sector, ensuring proper measures, which need to be taken towards improving the state in order to reach the 2030 targets.

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