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## **MECHANISMS TO IMPROVE ENERGY EFFICIENCY IN THE CONTEXT OF THE OBJECTIVES OF CLIMATE AND ENERGY PACKAGE – POLISH CASE**

The climate and energy package includes targets to be met by 2020. The presented paper presents the course of action adopted by the European Union in order to improve the energy efficiency. Final and primary energy savings indicate whether the applied mechanisms play their role. The improvement of energy efficiency in Poland from 2000 to 2013 has also been analyzed. The article points out the implementation of existing measures in Poland and the European Union. Their knowledge is an integral part of finding an area with the greatest potential for energy savings. The discussed data will help to create new instruments aimed at improving the energy efficiency and meeting the current and future targets of the climate and energy package by 2020 and 2030, respectively. In addition, the article presents an overview of the most important directives and European documents, which give the legal framework for the energy policy in terms of improving the energy efficiency. They indicate the directions of activities and quantitative targets for all Member States. They are the foundation for decision-making at national level. In addition, the aim of this work is to indicate the mechanisms for improving the energy efficiency when it comes to reducing final and primary energy consumption. The following sectors: transport, industry, and households analyzed were subjected to a detailed analysis regarding the energy consumption. The conclusion resulting from this study is the answer to the question whether increasing the energy efficiency by 20% by 2020 is realistic.

**Keywords:** energy efficiency, energy consumption, climate and energy package.

### **1. INTRODUCTION**

The energy policy of the European Union is based on the following grounds: ensuring the security of energy supply and functioning of the energy market, supporting the development of renewable energy sources, mutual connections between energy networks, energy efficiency, and energy savings. The activities undertaken by the European Union are related to the problems and challenges it is facing. The dependence on energy imports and demand for energy on a global scale are increasing, which is followed by climate change. There is still insufficient diversification of energy sources, as the European Union lacks integration, interconnections and transparent energy market. Europe is facing many challenges in the

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energy sector. It should be noted that ensuring sustainable development and the energy security is crucial in implementing the energy policy. An important aspect to be taken into account in the above considerations is the energy efficiency. The improvement of energy efficiency of the energy systems can significantly reduce the demand for new energy sources<sup>3</sup>. This can be considered as one of the possibilities to save energy. Developed countries are an example that a strong correlation between the energy consumption and the growth rate of GDP (gross domestic product), an indicator of economic development, ceases to exist. The reasons for the described phenomenon are primarily technological development, the increase in energy prices, environmental regulations, and new technical standards<sup>4,5</sup>.

In 2007, the climate and energy package of the European Union has set three main objectives for the member states: to reduce greenhouse gas emissions by 20% compared to 1990 levels, to increase the share of renewable energy in total energy consumption in the European Union and to improve the energy efficiency by 20%. As a result of negotiations at national level, quantitative targets for individual Member States, which together will fulfill the objectives of the European Union, have been agreed. In addition, as a result of negotiations, selected countries were granted the right to choose a different base year for the reduction of greenhouse gas emissions. This is due to differences between developed and developing countries. In the case of developing countries, the industry sector has a higher share in the national economy and, as a result, is emitting more greenhouse gases into the atmosphere. Imposing identical requirements on both developing and developed countries could inhibit the economic development of the currently developing countries. Assumptions of the climate and energy package are at the same time the main objectives of the Europe 2020 growth strategy for smart, sustainable and inclusive growth<sup>6</sup>. To achieve the mentioned objectives, the European Union undertakes actions in many areas. The first area is a Emission Trading Scheme (ETS). It is the key instrument of the European Union for reducing greenhouse gas emissions from industrial installations, transport and large power plants. ETS applies to 45% of greenhouse gases emitted in the European Union. According to the „Europe 2020” growth strategy, the aforementioned emissions should be reduced by 21% by 2020 compared to 2005. The year 2005 was adopted as a base year. The remaining 55% of greenhouse gases are emitted by the housing sector, agriculture and waste management. In order to reduce these emissions, the national emission reduction targets have been set. Their range varies depending on the level of economic development of a country and its wealth. Most developed countries are committed to a 20% reduction in greenhouse gas emissions by 2020, while less developed countries can increase emissions up to 20%. Another action taken by the European Union is supporting the energy production from the renewable energy sources. Also in this area the objectives were adjusted to the capabilities of the member states to produce energy from renewable sources and depending on their

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<sup>3</sup> R. Szczerbowski, *Bezpieczeństwo energetyczne Polski –mix energetyczny i efektywność energetyczna*, „Polityka Energetyczna”, t. 16, z. 4, Kraków 2013, s. 35–47.

<sup>4</sup> J. Malko, *Efektywność energetyczna i strategia ograniczania zmian klimatycznych*, „Polityka Energetyczna” t. 15, z. 2, Kraków 2012, s. 5–13.

<sup>5</sup> J. Paska, T. Surma, Wpływ polityki Unii Europejskiej na funkcjonowanie przedsiębiorstw energetycznych w Polsce, „Rynek Energii” 2(123)/2016, Lublin, s. 17–26.

<sup>6</sup> Dyrektywa 2006/32/WE Parlamentu Europejskiego i Rady z dnia 5 kwietnia 2006 r. w sprawie efektywności końcowego wykorzystania energii i usług energetycznych, L 114/64, 27.04.2006.

starting position. The lowest share of renewable energy in the national balance sheet is 10% (Malta). The highest is almost 50% (Sweden). The last, but not less important area supported by the European Union is energy efficiency. Mechanisms aimed at increasing energy efficiency are set out in the Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012<sup>7</sup>.

This paper focuses on the possibility of achieving one of the objectives of the climate and energy package, that is the improvement of energy efficiency by 20% by 2020. A 20% reduction in final and primary energy consumption compared to estimations from 2007 is expected. Final energy consumption in the European Union in 2020 can not be higher than 1078 Mtoe, and primary energy consumption must not exceed 1,474 Mtoe<sup>6</sup>.

## **2. DIRECTIVE ON ENERGY EFFICIENCY AND MECHANISMS TO IMPROVE ENERGY EFFICIENCY IN THE EUROPEAN UNION**

Directive 2012/27/EU is the basis of the energy efficiency policy of the European Union. The basic assumption of the Directive is the recognition of the improvement of energy efficiency as one of the best ways to meet the challenges Europe is facing today. The increasing dependence on energy imports, limited energy resources, and the need to limit climate change are the main problems of the European Union. The improvement of energy efficiency should be seen as an opportunity for energy savings, allowing reducing the energy demand in European countries, which will contribute to the reduction of primary energy consumption and the reduction of imports. Previous documents of the European Parliament and the Council were aimed at the reduction of the final energy consumption. The most recent Directive adopts an integrated approach to fully use the potential of energy savings – from energy production to its use by the final customer. The document has obliged Member States to set indicative national targets in terms of improving the energy efficiency by 2020. In addition, the rules that apply to energy suppliers and end users have been established. Member States are obliged to ensure that a minimum of 3% of the total floor area of buildings owned and occupied by government is renovated each year. Government institutions should also serve as a role model for society. They were obliged to purchase the most energy-efficient products and services. In addition, new buildings owned and occupied by the government must meet certain technical conditions. European Union Member States should establish their own strategies and instruments to improve energy efficiency, in order to provide end-users with energy savings at a level of 1.5% each year. The national action plans should promote investments in the renovation of residential and commercial buildings aimed at reducing their energy demand. Energy efficiency certificates accompanying the sale and rental of buildings should be mandatory. The Directive obliges large companies to conduct energy audits at least every four years. Enterprises that are implementing an energy or environmental management system shall be exempted from the aforementioned requirement. Final customers should have a means to control their own individual consumption and to save energy. The information on the actual and historical consumption of final customers should be available. The solution may be the use of intelligent metering systems or smart meters. Member states are required to assess the potential for the application of high-efficiency cogeneration and efficient district heating and cooling. In addition, the European

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<sup>7</sup> Dyrektywa 2012/27/UE Parlamentu Europejskiego i Rady z dnia 25 października 2012 r. w sprawie efektywności energetycznej, L 315/1, 14.11.2012.

Union has adopted the minimum energy efficiency standards and labelling for a variety of products including boilers, household appliances, lighting and televisions<sup>8</sup>.

The inhabitants of the European Union can significantly reduce their bills through more efficient use of final energy which also reduces the dependence on external suppliers of energy resources and protects the environment, indirectly contributing to climate change mitigation. Energy efficiency must be increased at all stages of the energy chain, from the production, through processing, storage, transmission to the use by the final customer. This means that we should process primary energy from fossil fuels in an efficient and environmentally friendly way, ensure efficient supply of final energy to the customers, and utilize final energy in a rational way. At the same time, it must be ensured that the benefits of energy efficiency exceed costs. Therefore, measures aimed at improving the energy efficiency of the European Union are focused on those sectors where the potential savings are greatest.

Each member state shall prepare National Energy Efficiency Action Plan. It obliges both the distribution and sales sectors to the overall objective of energy savings by 2020. The alternative to this system is the implementation of other measures aimed at improving the energy efficiency, allowing achieving the imposed targets in terms of energy savings of the end-user. The aforementioned measures that can be used in the field of energy efficiency policy include:

- Energy or CO<sub>2</sub> taxes that have the effect of reducing end-use energy consumption,
- Financing schemes and instruments or fiscal incentives that lead to the application of energy-efficient technology or techniques and have the effect of reducing end-use energy consumption,
- Regulations or voluntary agreements that lead to the application of energy-efficient technology or techniques and have the effect of reducing end-use energy consumption,
- Standards and norms that aim at improving the energy efficiency of products and services, including buildings and vehicles,
- Energy labelling schemes,
- Training and education, including energy advisory programmes, that lead to the application of energy-efficient technology or techniques and have the effect of reducing end-use energy consumption.

The Directive obliges Member States to presenting the measures taken and reporting of the obtained results in improving energy efficiency.

### **3. PRIMARY AND FINAL ENERGY CONSUMPTION IN THE EUROPEAN UNION**

The effectiveness of energy efficiency improvement measures in the Member States of the European Union can be seen by comparing the consumption of primary and final energy over several years. In this article, this comparison was conducted from 2000 to 2014. Changes in the total primary energy consumption (Fig. 1) and the total final energy consumption have been analyzed (Fig. 2). Particular attention was paid to the analysis of final

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<sup>8</sup> Dyrektywa 2012/27/UE Parlamentu Europejskiego i Rady z dnia 25 października 2012 r. w sprawie efektywności energetycznej.

energy consumption, broken down into the three most energy consuming sectors: households (Fig. 3), industry (Fig. 4), and transport (Fig. 5).

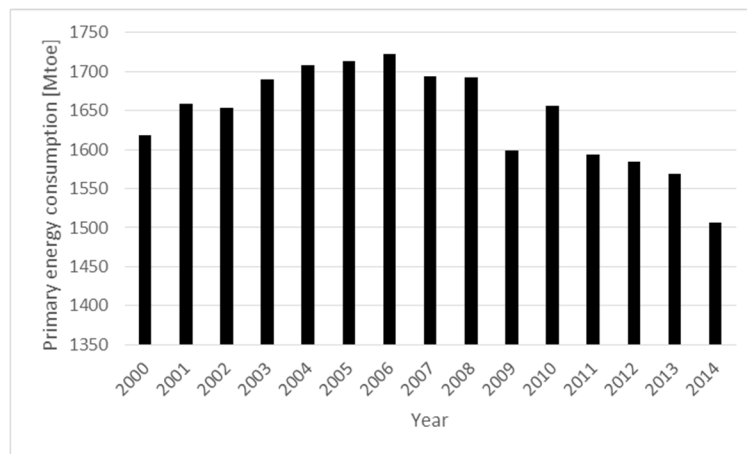


Fig. 1. Primary energy consumption in the years 2000-2014 in the European Union

Source: own work based on Eurostat: Primary energy consumption, <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdcc120>, dostę: 17.04.2016 r.

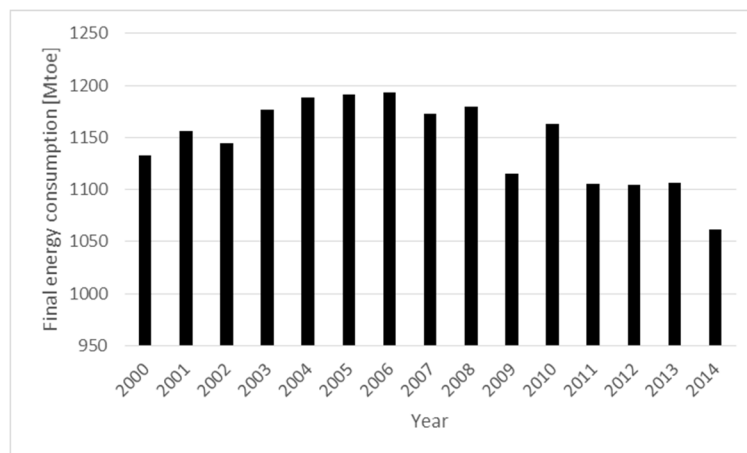


Fig. 2. Final energy consumption in the years 2000-2014 in the European Union

Source: own work based on Eurostat: Final energy consumption by sector, <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdpc320>, dostę: 17.04.2016 r.

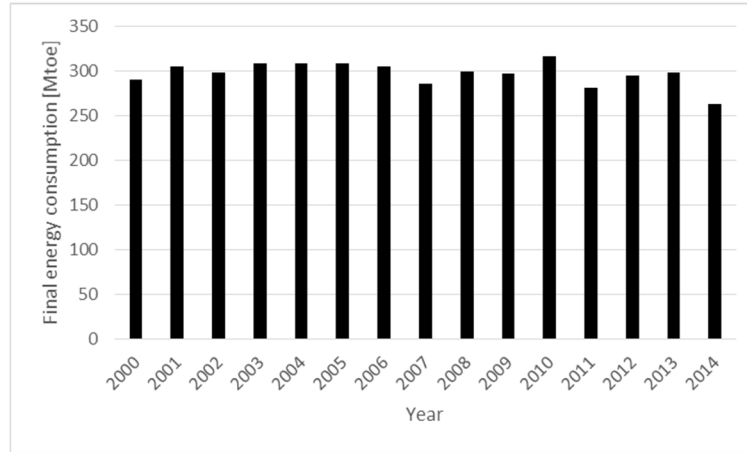


Fig. 3. Final energy consumption in the household sector over the 2000-2014 period in the European Union

Source: own work based on Eurostat: Final energy consumption by sector, <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdpc320>, dostępi: 17.04.2016 r.

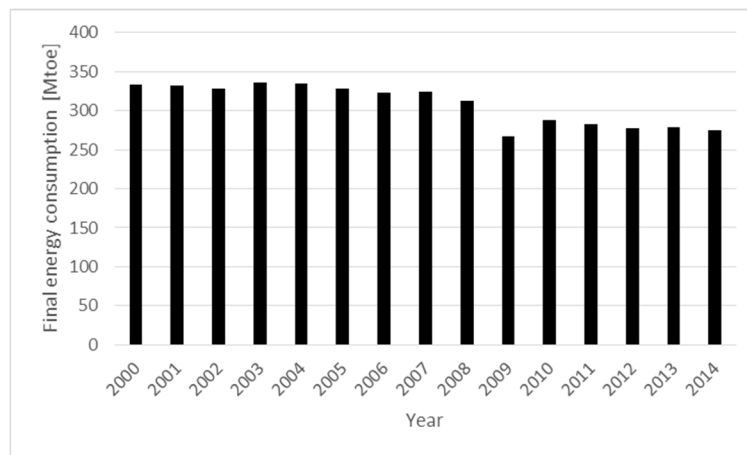


Fig. 4. Final energy consumption in the industrial sector in the years 2000-2014 in the European Union

Source: own work based on Eurostat: Final energy consumption by sector, <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdpc320>, dostępi: 17.04.2016 r.

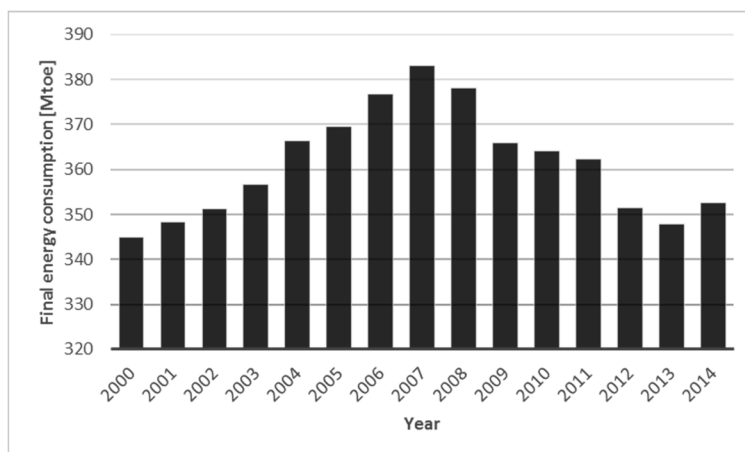


Fig. 5. Final energy consumption in the transport sector in the years 2000-2014 in the European Union

Source: own work based on Eurostat: Final energy consumption by sector, <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdpc320>, dostep: 17.04.2016 r.

Both total primary energy and final energy consumption have shown an upward trend until 2007 and rapidly declined thereafter. It should be noted that this is not related to the introduction of energy efficiency measures but is a result of the economic crisis, which began in Europe in 2008. The graphs presented above illustrate the Europe's struggle with the economic crisis.

The impact of the measures aimed at improving the energy efficiency can be seen from the year 2012 on, following the introduction of Directive 2012/27 / EU. In most European Union countries there has been a reduction in final energy consumption in the household sector. However, in the context of the entire European Union this phenomenon is not as noticeable. The countries that joined the EU later are characterized by a high level of final energy consumption in this sector. The final energy consumption in the industrial sector in 2000-2007 remained stable, and gradually decreased since then. As a result, the energy consumption by the industry sector in 2014 was almost 18% lower than in the year 2000 and accounted for 25% of the energy consumed by end-users, which is 4% less than in 2000. This is mainly due to the reduction of energy-intensive production while only 25% of the abovementioned reduction is due to the energy savings and the introduction of new, more energy-efficient technologies. In the transport sector, a rapid decrease in the energy consumption has started since 2007. More than 70% of the reduction is due to the onset of the economic crisis, leading to a decrease in freight transport. The remaining 30% decrease in energy consumption in transport is due to the introduction of EU regulations and emission standards. The improvement of energy efficiency in this sector has been observed mainly in the road and airplane transport. It is worth noting that the average fuel consumption per

100 km in the EU car improved from 8.1 liters in the 90s, to 6.8 l. in 2012. Truck transport has made the slowest progress in improving the energy efficiency<sup>9</sup>.

#### 4. MECHANISMS TO IMPROVE ENERGY EFFICIENCY IN POLAND

Poland, as a member of the European Union, is obliged to submit National Energy Efficiency Action Plans, containing information about the adopted or planned measures to improve energy efficiency, to the European Commission. The National Energy Efficiency Action Plan for Poland determines instruments to be used to improve the energy efficiency broken down into sectors of final energy consumption<sup>10</sup>. They are listed in Table 1, along with the division into sectors in which they are used.

Table 1. Mechanisms to Improve Energy Efficiency in Poland determined in the National Energy Efficiency Action Plan for Poland

The area of use of the energy efficiency improvement measures	Mechanisms to Improve Energy Efficiency
Horizontal measures	The energy efficiency obligation (i.e. white certificates)
	Energy audits and energy management systems (i.e. DSM <sup>11</sup> )
	Energy Meters and billing information
	Programmes to raise awareness among customers through appropriate advice services
	Qualification, accreditation and certification schemes
	The market for energy services
Buildings	The strategy of building renovation
	Thermal & Refurbishment Fund
	Green Investment Scheme
	Loan subsidies for building energy-efficient houses
	Funds for the so-called complex thermal efficiency improvement
Public institutions	Promoting energy efficiency, intelligent power management and the use of renewable energy sources under Operational Programme Infrastructure and Environment 2014-2020
	Promoting energy efficiency, intelligent power management and the use of renewable energy sources under Regional Operational Programmes for 2014-2020
Enterprises (industry and small and medium-sized enterprises)	Energy audits of companies
	Rewarding low carbon investments and resource-efficient economy
	Energy-saving investments in small and medium-sized enterprises

<sup>9</sup> Synthesis: Energy Efficiency Trends and Policies in the UE, ODYSSEE-MURE 2015

<sup>10</sup> Krajowy Plan Działań dotyczący efektywności energetycznej dla Polski, Warszawa 2014.

<sup>11</sup> T. Olkusi, E. Ciesielka, A. Szurlej, *Programy zarządzania popytem odbiorcy energii elektrycznej*, „Rynek Energii” nr 2, Lublin 2015, s. 3–9.



Table 1 (cd.)

The area of use of the energy efficiency improvement measures	Mechanisms to Improve Energy Efficiency
Transport	Operational Programme Infrastructure and Environment 2014-2020 – the development and increased use of low-carbon urban transport
The electricity production and supply	Operational Programme Infrastructure and Environment 2014-2020 - reduction of losses in the heat/cold distribution process
	Operational Programme Infrastructure and Environment 2014-2020 – promoting the use of high-efficiency cogeneration of heat and electricity

## 5. AN INCREASE IN THE ENERGY EFFICIENCY IN POLAND AND THE EUROPEAN UNION IN THE CONTEXT OF THE CLIMATE AND ENERGY PACKAGE

An analysis of primary and final energy consumption does not allow for precise determination of the improvement of the energy efficiency over the fourteen years (2000–2014). The reason for this is the number of other factors which significantly affect the analyzed results. In order to objectively assess whether the reduction of energy consumption is the result of energy saving measures or limitation of energy-consuming processes, it is necessary to know the economic situation of the European Union. Therefore, the graphs presented below (Fig. 6, Fig. 7, Fig. 8, and Fig. 9) show the progress in improving energy efficiency for Poland and the European Union. The base year is 2000.

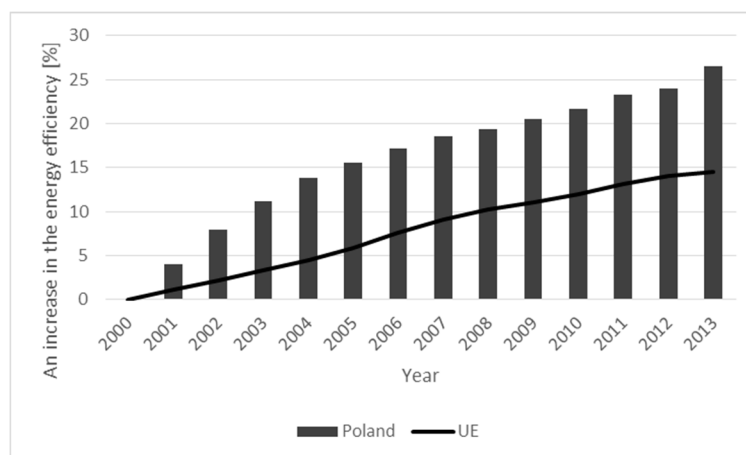


Fig. 6. An increase in the energy efficiency in Poland and in the European Union

Source: own work based on ODYSSEE-MURE: Energy Efficiency Gains since 2000, <http://www.indicators.odyssee-mure.eu/energy-indicators/efficiency-gains-in-transport-since-2000.html>, dostep: 17.04.2016 r.

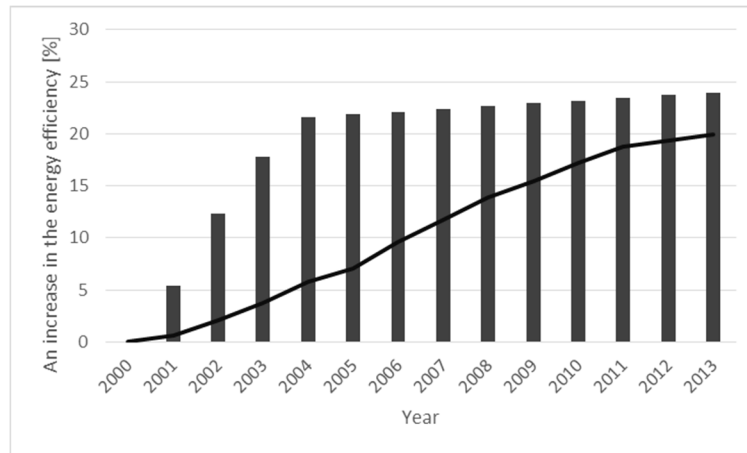


Fig. 7. An increase in the energy efficiency in the household sector in the years 2000-2013 in Poland and in the European Union

Source: own work based on ODYSSEE-MURE: Energy Efficiency Gains since 2000, <http://www.indicators.odyssee-mure.eu/energy-indicators/efficiency-gains-in-transport-since-2000.html>, dostep: 17.04.2016 r.

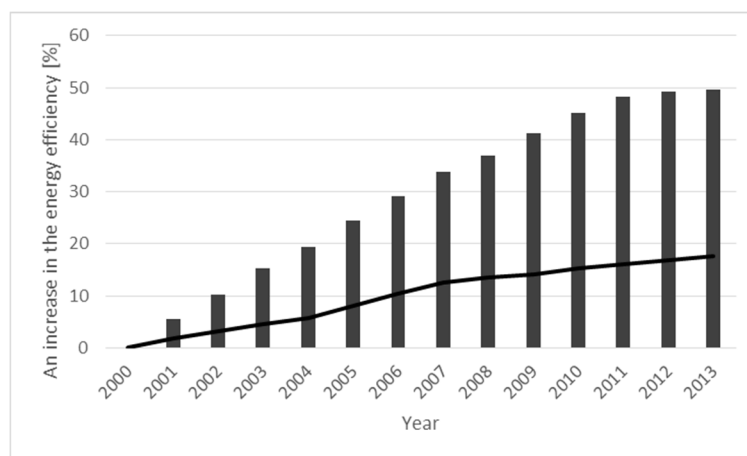


Fig. 8. An increase in the energy efficiency in the industry sector in the years 2000-2013 in Poland and in the European Union

Source: own work based on ODYSSEE-MURE: Energy Efficiency Gains since 2000, <http://www.indicators.odyssee-mure.eu/energy-indicators/efficiency-gains-in-transport-since-2000.html>, dostep: 17.04.2016 r.

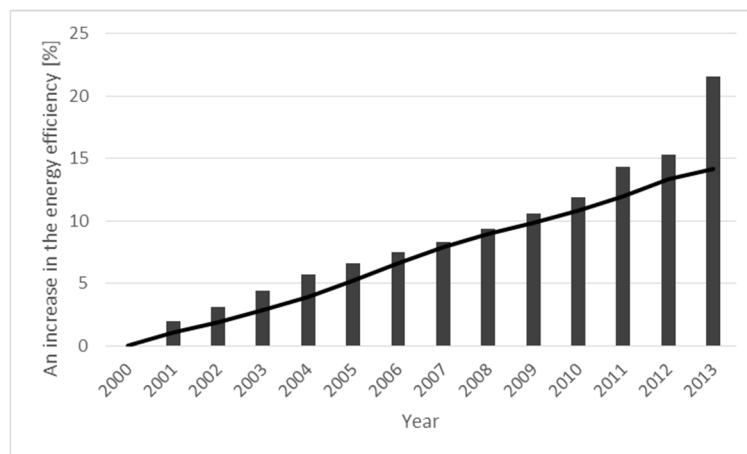


Fig. 9. An increase in the energy efficiency in the transport sector in the years 2000-2013 in Poland and in the European Union

Source: own work based on ODYSSEE-MURE: Energy Efficiency Gains since 2000, <http://www.indicators.odyssee-mure.eu/energy-indicators/efficiency-gains-in-transport-since-2000.html>, dostep: 17.04.2016 r.

A 15% increase in the energy efficiency in the European Union since the year 2000 has been observed. However, the growth rate has decreased as a result of the economic crisis from 2007. Currently, the rate of improvement of the energy efficiency in most EU countries remains stable at a level of 1% per year. In the case of six countries of the European Union, including Poland, the abovementioned growth rate is 2% per annum. A 27% increase in the energy efficiency has been reported in Poland over the analyzed thirteen years. The highest rate of improvement has been reported in Slovakia and amounts to 33.4%, while the lowest has been reported in Spain and is only 9.2%<sup>16</sup>.

The increase in energy efficiency in the household sector in the EU is 1.5% per year. This is mainly due to the improvement of heating systems (development of new, energy-efficient buildings and thermal efficiency improvement of the existing ones) and the dissemination of more efficient appliances. The share of energy for space heating in the energy of the household sector is gradually decreasing. Currently it is four percentage points lower than in the year 2000. What is more, the energy consumption for lighting has been reduced due to the use of more efficient light bulbs on a large-scale. In Poland, the improvement of energy efficiency in the housing sector is above the average of EU countries, reaching almost 24%. In the industrial sector, the improvement of energy efficiency in the European Union has been increasing at a rate of 2% per year until 2007 and at a slower rate of 1% thereafter. Ultimately, it amounted to 17.6% in 2013. In Poland, a significant increase in energy efficiency in this area has been reported, amounting to just under 50%. The use of less energy-intensive technologies and the transformation of Polish industry have significantly contributed to the abovementioned achievement. A rapid increase in the energy efficiency of road transport both in Poland and in the European Union is a result of the introduction of the EU regulations and emission performance standards.

In 2013, the energy efficiency in the European Union improved by 14.2%, while in Poland by 21.6%. This is due to technologies that contributed to the improvement of car engine efficiency.

According to the climate and energy package, the improvement of energy efficiency specified in the climate and energy package requires the European Union to consume 1483 Mtoe of primary energy and 1086 Mtoe of final energy in 2020. Currently, the aforementioned consumption is at the level of 1507 Mtoe for primary energy and 1061 Mtoe for final energy. This means that the European Union has already met the targets regarding the final energy use set out by the climate and energy package. In addition, when it comes to primary energy, a downward trend has been observed in recent years. Indicative targets set for Poland are 96.4 Mtoe for primary energy consumption and 71.6 Mtoe for final energy consumption. In 2013 both objectives have already been achieved since the primary energy consumption amounted to 89.1 Mtoe and the final energy consumption to 61.6 Mtoe.

## 6. CONCLUSIONS

Mechanisms to improve energy efficiency in Poland and in the European Union achieve their goal. Both Poland and the EU have already met the targets regarding the final energy use set out by the climate and energy package. In the case of Poland, the required level of primary energy consumption has been achieved. The target of a 20% improvement in energy efficiency for primary energy in the European Union has not yet been reached. It should be borne in mind that the reduction of energy consumption after 2007 is mainly due to the economic crisis. However, as the economic crisis is ending, some of the European Union countries face the need to improve the performance of energy efficiency improvement measures. Understanding the barriers, including lack of public awareness or funds for certain projects, will allow creating mechanisms aimed at contributing to achieving climate targets set for 2030 in the future: to reduce greenhouse gas emissions by 40%, to improve the energy efficiency by 27%, and to increase the share of renewable energy sources by 27%.

The development of the construction industry and universal access to electrical devices makes households to consume more and more energy. Promoting energy-saving solutions will allow balancing the total final energy consumption. As of today, the housing sector offers the greatest potential for energy savings. The efforts on the introduction of new instruments aimed at improving the energy efficiency should be directed in this direction.

## ACKNOWLEDGEMENTS

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- [2] Dyrektywa 2009/125/WE Parlamentu Europejskiego i Rady z dnia 21 października 2009 ustanawiająca ogólne zasady ustalania wymogów dotyczących ekoprojektu dla produktów związanych z energią.
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## MECHANIZMY POPRAWY EFEKTYWNOŚCI ENERGETYCZNEJ W POLSCE W KONTEKŚCIE CELÓW PAKIETU KLIMATYCZNEGO

Pakiet klimatyczno-energetyczny obejmuje cele, których osiągnięcie zostało wyznaczone na 2020 rok. Wśród nich znajdują się cele dotyczące redukcji emisji dwutlenku węgla, poprawy efektywności energetycznej oraz wykorzystania odnawialnych źródeł energii. Cele zawarte w przedmiotowym dokumencie dotyczą Unii Europejskiej jako całości. Jednak dokument, stanowiący załącznik do omawianego dokumentu, zawiera cele dotyczące poszczególnych krajów członkowskich. Niniejszy artykuł przedstawia kierunek działań przyjęty przez Unię Europejską w zakresie poprawy efektywności energetycznej na podstawie analizy europejskich dokumentów. Wartości oszczędzonej energii finalnej oraz pierwotnej wskazują, czy obrane mechanizmy spełniają swoją rolę. Szczegółowej analizie pod kątem zużycia energii zostały poddane następujące sektory: przemysł, gospodarstwa domowe oraz transport. Analizie została również poddana poprawa efektywności energetycznej w Polsce od 2000 do 2013 roku. Następująca poprawa w zakresie oszczędzania energii również wskazuje, że stosowane mechanizmy mają pozytywny wpływ na dążenie do celów wyznaczonych w pakiecie klimatycznym. Ponadto artykuł wskazuje na bariery występujące zarówno w Polsce, jak i w Unii Europejskiej w zakresie wdrażania istniejących środków. Poznanie ich jest nieodłącznym elementem dostrzeżenia obszaru, w którym istnieje największy potencjał

oszczędności energii. Takie informacje pozwolą na stworzenie kolejnych instrumentów poprawy efektywności energetycznej i możliwość osiągnięcia zarówno obecnych celów klimatyczno-energetycznych do 2020 r., jak i nowych, wyznaczonych do roku 2030.

**Słowa kluczowe:** efektywność energetyczna, poprawa efektywności energetycznej, pakiet klimatyczno-energetyczny.

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