Analysis of the Progress of the Implementation of the Europe 2020 Strategy in Respect of Climate Change and Sustainable Energy Use in Poland

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Abstract

The article presents reflections on the topic of the implementation of the Europe 2020 Strategy for Poland. The strategy covers five areas, namely research and development, education and higher education, poverty reduction and social exclusion, employment as well as energy and climate, which have been analysed in this article. Because the provisions of the strategy should already be achieved, it is necessary today to verify the progress of work, as well as to compare the achievements with the created plan. In order to be able to assess the progress of the implementation of the strategic plan, it is necessary to set indicators that will make it possible to determine whether the activities carried out facilitate the achievement of the objectives or whether they should be adjusted. In order to do it, the authors used 4 indicators. To be able to forecast when Poland would reach the set values by 2022, the authors constructed mathematical models with which the indicators values were forecast. The results obtained have been summarized and countermeasures have been identified that can help eliminate detected irregularities. The successful implementation of the strategy will have a significant impact on ensuring Poland's energy security and environmental sustainability.

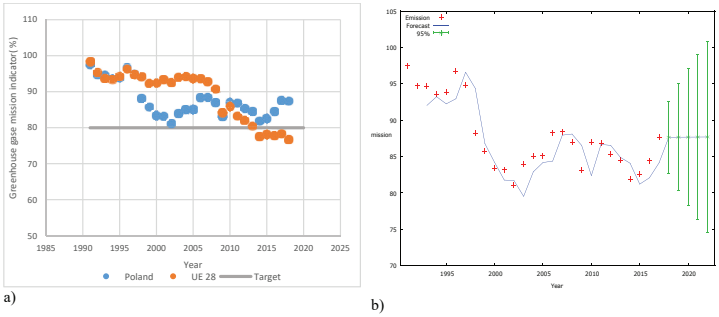
Keywords: *climate change, Europe 2020 Strategy, sustainable energy, ARIMA model*

1. Introduction

The global economic crisis that took place in 2007-2009 meant that the European Union began to search for a strategy that would not only enable it to overcome the crisis, but also would be able to direct the development of member countries on sustainable and intelligent growth (Szymańska & Zalewska, 2018; Gajewski, 2017). In order to do it, the so-called Strategy for smart and sustainable development was created with a set time horizon for implementation by 2020 (Rogge, 2019). In this article, the authors set the goal of trying to verify the progress of the implementation of tasks set by the strategy in Poland. For each of the indicators included in the document, there were defined the objectives that individual EU member states should achieve (Pavese, 2012). As the set goals should already be achieved, it is necessary to verify the progress of work and compare the already achieved results with the set target. The main postulates of the Strategy that will be analysed in this article are the increase in resource efficiency and the promotion of technology in the use of resources in an environmentally friendly manner (European Commission, 2020; Paľova & Václavíková, 2017). The indicators used for this purpose are: the level of greenhouse gas emission, share of renewable energy in gross final energy consumption, primary energy consumption, energy efficiency. The authors compared the level of these indicators set for 2020 with the values obtained thanks to the forecasts created by the authors. Thanks to this, it is possible to reliably assess the possibilities of achieving the set goals. The data used in the analysis were obtained from the Eurostat database.

2. Analysis of the implementation of the objectives of the Europe 2020 Strategy

The analysed indicators were assigned to the category Climate change and energy. The presented indicators are used to verify the progress of the implementation of the European Union policy in the scope of increasing energy efficiency by 20% by 2020 (Xavier, 2019; Yaltaa & Jenal, 2009; Yaltaa & Jenal, 2009). In addition, it was assumed that by 2030, efficiency should increase by a further 7%. Achievement of this goal will directly translate into a decrease in the value of the energy dependence indicator on imports of energy carriers, and at the same time reduce the level of greenhouse gas emission. The implementation of European Union provisions in Poland is based on the National Reform Programme (NRP). It presents the goals that Poland should achieve by 2020. The models used in the forecasts were created using the Gretl software. ARIMA time series models were used (Sen, Pal, & Roy, 2016; Yaltaa & Jenal, 2009). The reliability of each model was confirmed with information criteria AIC (Akaike criterion), Hannan Qiunn criterion, BIC (Schwarz Bayesian information criterion) (Piłatowska, 2010). The accuracy of the prediction was determined by means of the mean absolute percentage error (MAPE), the mean absolute error (MAE), average percentage error (Gruszczyński & Podgórska, 2007; Myttenaere, Rossi, Grand, & Golden, 2016). Since the shaping of the random component in the econometric model informs whether the model was built correctly, it should be confirmed that the rest of the model is white noise. In this case it is necessary to test the appropriate hypotheses. Lack of autocorrelation of residuals was confirmed by Durbin-Watson test, the occurrence of normal distribution of residues was verified by Jarque-Bera test. The estimation was carried out using the Kalman filter.



a) b)

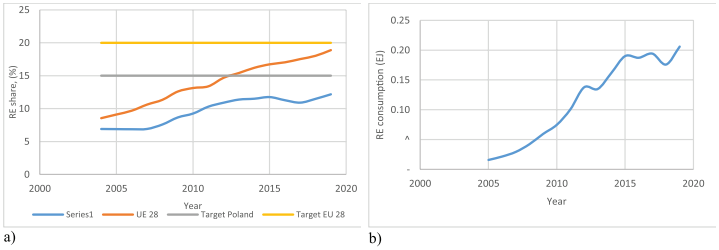
Fig. 1. Greenhouse gas emission rate in the years 1990-2018 (a), forecast till 2022, ARIMA (0,1,1) (b). Source: own study

Rys. 1. Tempo emisji gazów cieplarnianych w latach 1990-2018 (a), prognoza do 2022 r., ARIMA (0,1,1) (b). Źródło: opracowanie własne

Tab. 1. Error values and information criterion for the ARIMA model (0,2,1). Source: own study

Tab. 1. Wartości błędów i kryterium informacyjne dla modelu ARIMA (0,2,1). Źródło: opracowanie własne

Parameter	Value
MAPE	2,40
MAE	2,01
ME	0,59
Akaike	123,16
BIC	125,6
Hannan-Quinn	123,83



a) b)

Fig. 2. Share of renewable energy in gross final energy consumption in the years 2004–2019 (a), renewable energy consumption in Poland in the years 2005–2019. Source: own study

Rys. 2. Udział energii odnawialnej w końcowym zużyciu energii brutto w latach 2004–2019 (a), zużycie energii odnawialnej w Polsce w latach 2005–2019. Źródło: opracowanie własne

2.1 Greenhouse gas emission

The amount of greenhouse gas emission in Poland tended to increase until 1989. The economic transformation that began in the early 90s resulted in many of the enterprises that had been created in the People's Republic of Poland being liquidated (Żółtkowski, Karpiński, Soroka, & Paradysz, 2013). They were not adapted to functioning on the free market. Thanks to this (despite serious social effects) it was possible to reduce the level of greenhouse gas emission. The renewed economic growth that took place after 1995 caused another surge in energy demand, thereby increasing the level of green emission (Farhani & Rejeb, 2012). Such a situation occurs periodically. Figure 1a shows time series of the greenhouse gas emission index determined as the ratio of emission in a given year to the base year in accordance with the Kyoto Protocol, i.e. in 1990. It includes such greenhouse gases as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), as well as so-called F gases (fluorocarbons, perfluorocarbons, nitrogen trifluoride (NF3) and sulphur hexafluoride (SF6)) (Mayerhofer, et al., 2002; Vuuren, et al., 2007).

The EU as a whole was committed to achieving at least a 20% reduction in greenhouse gas emission by 2020 compared to the base year (1990). Already in 2017, the emission level for EU-28 reached the set goal, as the indicator was at the level of 78%. Its value for Poland is still 87%. Although CO_2 emission constitutes about 80% of all greenhouse gas emission in our country, and its level has long been lowered in accordance with the requirements imposed by the Kyoto Protocol, for the entire greenhouse gas package this situation is quite different. The NRP document assumes that due to the downward trend in the emission in the years 2005-2015 it will be possible to achieve a 20% decrease in emission. However, after 2015, greenhouse gas emission began to increase. A moving average model was created that is going to be used to make the forecast (figure 1b). It indicates that reaching the assumed 20% level in the coming years will be very difficult. If the factors affecting the time series do not change, one should take into account the stabilisation of the indicator at the level of 87% in the coming years. The factor that may currently affect the level of emissions are the restrictions related to the COVID-19 pandemic. Table 1 presents the values of the information criterion and the error of the constructed model. The model is very accurate because the error does not exceed 3%.

2.2 Renewable energy

The share of renewable energy in gross final energy consumption is another indicator included in the SE2020 strategy. Figure 2a presents the time series of the indicator in 2004–2019. Several periods can be clearly distinguished (in the case of Poland). The years 2004–2007, when the indicator remained practically unchanged at just under 7%, a period of gradual increase until 2015, when it reached 11.7% and the last two observations (2016–2019), when the indicator began to fall again. This was mainly due to the increase in gross final energy consumption.

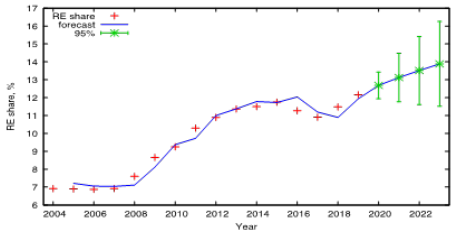


Fig. 3. The share of renewable energy in gross final energy consumption together with a forecast for the year 2022. Source: own study
Rys. 3. Udział energii odnawialnej w końcowym zużyciu energii brutto wraz z prognozą na rok 2022. Źródło: opracowanie własne

Tab. 2. Error values and information criterion for the ARIMA (1,1,0) model. Source: own study
Tab. 2. Wartości błędów i kryterium informacyjne dla modelu ARIMA (1,1,0). Źródło: opracowanie własne

Parameter	Value
MAPE	3,23
MAE	0,31
ME	0,01
Akaike	20
BIC	22,13
Hannan-Quinn	19,98

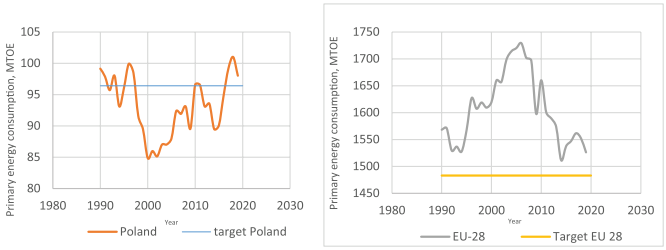


Fig. 4. Primary energy consumption in the years 1991–2019. Source: own study
Rys. 4. Zużycie energii pierwotnej w latach 1991–2019. Źródło: opracowanie własne

Despite numerous turbulences around renewable energy that took place in the last few years, RES consumption did not start to fall until 2018, as shown in Figure 2b. In 2019, another amendment to the Act on renewable energy sources was made. It contains many of the renewable energy industry's postulates and aims at compliance of the provisions of the Europe 2020 strategy. NRP assumed that achieving the set level of participation, i.e. 15%, would be possible. However, despite the upward trend of the share of renewable energy, which appeared again in 2018, the 15% share will not be reached even by 2022. It should also be remembered that without the support of the State, the development of renewable energy sources will not be viable. It is necessary to encourage investors as well as financial support for renewable energy sources and the use of support mechanisms, e.g. excise tax exemption (Laganowska, 2012).The share of renewable energy in Poland increased in 2005-2019 by 76 percentage points, in case of EU-28 it was an increase of 107 percentage points. In case of the EU-28 group, the share of renewable energy is systematically increasing. This was also possible thanks to the Directive 2009/28/EC, which emphasizes the promotion of renewable energy sources. EU-28 is on its way to achieving its goal (Figure 3). The countries that are definitely ahead in the use of renewable energy sources are Sweden, where more than half of the energy comes from renewable sources as well as Finland and Latvia. The created forecast supports the hypothesis put forward. It is presented in Figure 3. The ARIMA (1,1,0) model was used to predict future values of the time series. Table 2 presents information criterion values and model errors. It should be noted that the error does not exceed 3,5% in this case. The forecast indicates that until 2022 the share of renewable energy in gross final energy consumption will remain at around 13% if no decisive action is taken. It is also necessary to intensify activities in this regard in relation to the target set for 2030. At present, it is a 21% share, however, the European Commission will most likely be pushing for the target to be moved towards 25%.

2.3 Primary energy consumption

Increasing the level of energy efficiency in the European Union was possible mainly due to the introduction of energy-saving technologies and devices. It was also influenced by the elimination of energy-intensive industries. Figure 4 shows primary energy consumption in Poland and in the EU-28 countries. In case of Poland, a decrease in energy consumption should be noted in the early 1990s. Since 2000, primary energy consumption has begun to increase again. This was related to the economic development of the country, development of industry and creation of new companies (Asafu-Adjaye, 2000).This is also indicated by GDP growth. In Poland, this increase is still heavily dependent on energy consumption. In 2017, primary energy consumption again exceeded the consumption reduction ceiling. The target has not yet been reached for EU-28 countries. In spite the fact that comparing to the base year (2005) to 2017, consumption dropped by more than 9 percentage. In 2018, energy consumption increased in many EU countries, mainly Spain, Italy, Hungary, Portugal and Romania. This is mainly due to economic growth as well as the increasing demand for cooling and heat. In 2019, however, there was a decrease in energy consumption, but it still does not match the set target.

In this case, the ARIMA (1,1,1) model was used to create the forecast. The forecast of primary energy consumption

Tab. 3. Error values and information criterion for the ARIMA (1,1,1) model. Source: own study

Tab. 3. Wartości błędów i kryterium informacyjne dla modelu ARIMA (1,1,1). Źródło: opracowanie własne

Parameter	Value
MAPE	2,75
MAE	2,55
ME	0,40
Akaike	145,88
BIC	149,77
Hannan-Quinn	147,04

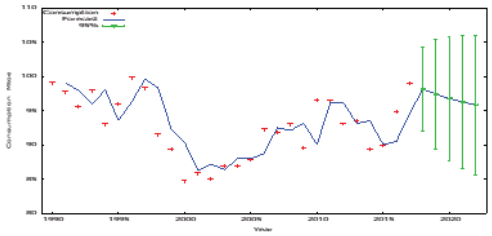


Fig. 5. Primary energy consumption with forecast until the year 2022. Source: own study

Rys. 5. Zużycie energii pierwotnej wraz z prognozą do roku 2022. Źródło: opracowanie własne

(Figure 5, Table 3) created by the authors indicates that a decline in primary energy consumption should be expected by 2020. NRP specifies that primary energy consumption should be limited to 96 Mtoe per year in terms of climate change and sustainable energy use. This figure is in line with the EU target. It is assumed that by 2020 this consumption will be 96.4 Mtoe. Basing on the results of the obtained forecast, it should be stated that it is possible to reduce consumption to the specified level. The predicted value for the time series for 2020 is 96.81 Mtoe. The forecast error was less than 3%. 2020, however, may not be representative due to the so far unique changes taking place as a result of the COVID-19 pandemic.

2.4 Energy productivity

Due to the fact that energy efficiency is measured by the level of primary energy consumption, the article additionally presents the level of the so-called energy productivity index determined according to the following formula:

$$E_p = GDP/E_c \quad (1)$$

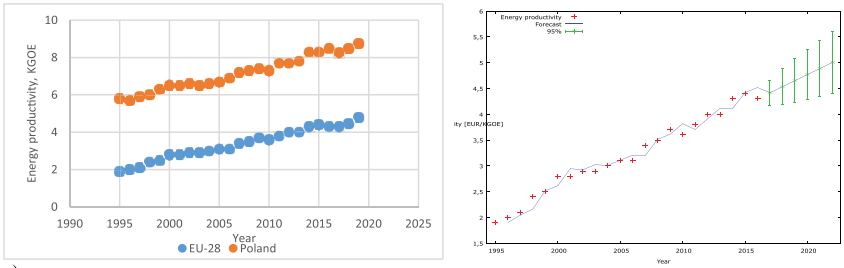
where:
E_p – energy productivity,
E_c – energy consumption.

Energy productivity is calculated as the total value of goods and services produced in the country expressed in money from a unit consumed at the same time of primary energy. The indicator measures the efficiency of energy consumption and determines the degree of independence of GDP growth from energy consumption. Eurostat sets the value of the energy productivity index using for this purpose the gross domestic product (GDP) and the gross inland consumption of energy (for a given calendar year). Gross domestic energy consumption is the total of gross domestic energy consumption based on renewable energy sources, coal, natural gas and crude oil. Energy productivity takes more factors into account than energy efficiency. This indicator does only include energy efficiency, but also additional ways to reduce energy costs. It might be, among others, a change of energy carrier, the use of renewable energy sources, storage of energy from renewable energy sources, a change of energy supplier. Without energy storage, renewable sources must be supported by conventional power plants that meet energy demand during a period of lower renewable energy production. Figure 6a presents energy productivity in the years 1995–2016 in Poland and the European Union. Figure 6b shows productivity in Poland with a forecast until 2022. Energy productivity was not included in the indicators enabling verification of the degree of implementation of the Europe 2020 strategy. However, due to the importance of this indicator, it was included in the article by the authors. Energy efficiency in Poland in 2005-2016 increased by 39%, in the EU by 28%, and over the years 1995-2017 it is on average twice higher for the EU than for Poland.

Taking into account the target set for energy efficiency at the level of 20% in the said period, the increase in productivity in Poland is almost twice as large. The forecast obtained indicates that further increases in energy productivity should be expected in Poland. In 2020, compared to the base year 2005, an increase of approximately 55 percentage points was calculated basing on the ARIMA model (1,1,1). Energy productivity means more production with the same or a smaller amount of energy used. This is important from the point of view of the country's economic efficiency. By using fewer resources, it is possible to achieve the effect of reducing the cost of producing goods and reducing the negative impact on the environment. Energy efficiency can also be determined basing on final energy consumption. Thanks to this, energy losses in the power supply system and deficiencies arising during transport are excluded.

3. Conclusion

Europe 2020 is a strategy adopted on 03.03.2010 by the European Commission. The provisions contained in the document are to stimulate the EU's economic development. This stimulation should support the so-called intelligent development, i.e. economy based on innovation, knowledge and sustainable growth, i.e. activities focused on the most optimal and effective use of resources, the use of modern technologies, and care for environmental protection. Control over the correct course of actions aimed at achieving the set goals is conducted basing on the set indicators. Since the deadline for implementing the strategy has expired, the authors decided to analyse the stage of completion of the actions taken to imple-



a) b)

Fig. 6. Energy productivity in the years 1995–2019 (a), forecast for the year 2022 (b). Source: own study
Rys. 6. Produktywność energetyczna w latach 1995–2019 (a), prognoza na rok 2022 (b). Źródło: opracowanie własne

Tab. 4. Error values and information criterion for the ARIMA (1,1,1) model. Source: own study
Tab. 4. Wartości błędów i kryterium informacyjne dla modelu ARIMA (1,1,1). Źródło: opracowanie własne

Parameter	Value
MAPE	3,40
MAE	0,11
ME	0,11
Akaike	-19,31
BIC	-16,18
Hannan-Quinn	-18,63

ment the SE2020 strategy. The strategy has been devoted to five areas of activity such as research and development, education and higher education, reduction of poverty and social exclusion, employment as well as energy and climate. The article focuses on analysing the state of implementation of the provisions of the last of the presented areas. The following indicators were analysed: the level of greenhouse gas emission, the share of renewable energy in gross final energy consumption, primary energy consumption and energy efficiency. In addition, the authors analysed energy productivity due to the universality and information that the indicator brings. The authors came to the following conclusions: with reference to the greenhouse gas emission rate - from 2015 the value of the indicator is moving away from the desired level of 80%. This is due to economic growth, production volume is increasing, and more and more cars are being bought in the country. At the same time, the goal has already been achieved for EU-28. In case of the share of renewable energy in gross final energy consumption, reaching the target of 15% share of energy from renewable sources by 2020 was very difficult due to the slow pace of development in previous years. The forecast has shown that in the coming years this indicator will remain at the level of around 11%. If the target is not met, Poland will have to make the so-called statistical transfer of renewable energy from those EU countries in which a surplus has been achieved. This unfavourable situation was caused, primarily, by the lack of consistency of the Polish State regarding the development of renewable energy, an unfriendly legal environment, tardiness in the preparation of implementing regulations and thus the lack of predictability of further development of renewable energy in Poland. Primary energy consumption - the world's energy consumption is steadily rising. This is related to the civilizational development, population growth and the desire to raise the standard of living. All these activities require access to energy carriers. Observing the time series of primary energy consumption in Poland, several periods can be distinguished: an increase in energy consumption until 1990, a decrease in consumption until 2000, and a period of re-growth after 2000. These changes were caused by the political and economic transformation of Poland. Economic development requires access to energy, while coal is the basic energy carrier in Poland. Coal burning has a negative impact on the environment. Therefore, it is necessary to use technologies aimed at reducing greenhouse gas emission, but also those that will improve energy efficiency as well as enable economical management of available fuels and energy obtained on their basis. Energy efficiency is a great way to increase energy security. The authors additionally presented the energy productivity index in the article. It is not only an excellent source of information on the energy efficiency of the economy, but also the degree of independence of GDP growth from energy consumption. Energy productivity should therefore be seen as an energy source from which the European Union ca benefit in the near future. The beginnings of the implementation of the Europe 2020 strategy coincided with the period of the economic crisis which went through the European Community. Problems related to it resulted in development activities being pushed into the background in most EU countries. The success of implementing SE 2020 is obviously of economic importance, but it would also have a positive impact on the opinion of the Union as a community capable of close cooperation and capable of achieving common goals, especially after the failures of the Lisbon Strategy. Summing up, the analysis presented in the article, according to the authors, indicates that in the area of climate change strategy and sustainable energy use, the goals designated for year 2020 has not been fully achieved especially in case of reducing greenhouse gas emission and achieving a 15% share of renewable energy gross final energy consumption. Since the time horizon up to 2020 does not provide the opportunity to apply appropriate countermeasures, it is necessary to extend the deadline for implementing SE 2020 and possibly revise the goals. Therefore, a new strategy and goals for the EU until 2030 have been set. These are mainly: at least 32.5% improvement in energy efficiency, at least 40% cuts in greenhouse gas emissions (from 1990 levels), at least 32% share for renewable energy. To successfully implement SE 2020, it is necessary to build the foundations of an innovative economy. The indicator proving the level of development

of a modern economy is the financing of the R&D sphere. Limited financing of research and development in Poland is typical for the area analysed in the article. Financial support in the field of development of renewable energy sources, clean coal technologies and solutions increasing energy efficiency would certainly speed up and enable compliance with the strategy's provisions. For the EU, the share of internal expenditure on research and development in GDP was set at 3%, for Poland it is 1.7%. Achievement of the goal will be possible in the event of member states fulfilling the obligations they took on. In 2017, the share of internal expenditure on research and development in GDP in Poland was 1.03%. Achieving the 3% level for the Community will be very difficult because in 2017 the highest level of the indicator was reached in Sweden and amounted to 3.4%. Without an increase in funding for R&D in a turbulent and uncertain environment and in the context of globalization, the European Union will not be able to become a leader and compete with the economies of other developed countries (Greene, 2001; Gupta & Grubb, 2000). Due to the current situation, the trends shaping the analyzed indicators may be distorted. During the pandemic, the lockdowns mainly reduced greenhouse gas emissions, as well as primary energy consumption. The mobility of citizens of many countries has been limited, the level of production in some industries has been temporarily limited, and the demand for services has decreased. However, the downward trends observed are unlikely to be sustained. After the pandemic, emissions and energy consumption are likely to return to their previous levels or increase due to the need to rebuild the economy and compensate the incurred losses.

Literatura – References

1. Asafu-Adjaye, J. (2000). The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. 22, pp. 615–625.
2. European Commission. (2020). A strategy for smart, sustainable and inclusive growth. COM (2010) 2020. Brussels.
3. Farhani, S., & Rejeb, J. (2012). Link between economic growth and energy consumption in over 90 countries. 3, pp. 282–297.
4. Gajewski, M. (2017). Policies Supporting Innovation In The European Union In The Context Of The Lisbon Strategy And The Europe 2020 Strategy. 20, pp. 109-127.
5. Greene, O. (2001). The globalization of world politics—An introduction to international relations Environmental issues. Oxford: Oxford University Press.
6. Gruszczyński, M., & Podgórska, M. (2007). Ekonometria. Warszawa: Oficyna Wydawnicza SGH.
7. Gupta, J., & Grubb, M. (2000). Climate change and European leadership—A sustainable role for Europe? 27, pp. 3-14.
8. Żółtkowski, W., Karpiński, A., Soroka, P., & Paradysz, S. (2013). Jak powstawały i jak upadały zakłady przemysłowe w Polsce (1946–2012). Warszawa: Muza.
9. Laganowska, Z. (2012). Ulgi podatkowe dla inwestycji w odnawialne źródła energii. 2, pp. 48-49.
10. Mayerhofer, P., de Vries, B., den Elzen, M., van Vuuren, D., Onigkeit , J., Posch, M., & Guardans, R. (2002). Long-term, consistent scenarios of emissions, deposition and climate change in Europe. 5, pp. 273-305.
11. Myttenaere, F., Rossi, B., Grand, B., & Golden, A. (2016). Mean Absolute Percentage Error for regression models. 192, pp. 38–48.
12. Paľova , D., & Václavíková, P. (2017). Comparison of Europe 2020 implementation process among European Union members states. 12, pp. 2376-2387.
13. Pavese, C. (2012). The contribution of the European Union to global climate change governance: Explaining the conditions for EU actorness. 55, pp. 125-143.
14. Piłatowska, M. (2010). Kryteria informacyjne w wyborze modelu ekonometrycznego. Kraków: Studia i Prace Uniwersytetu Ekonomicznego w Krakowie.
15. Rogge, N. (2019). EU countries' progress towards 'Europe 2020 strategy targets'. 41, pp. 255-272.
16. Sen, P., Pal, P., & Roy, M. (2016). Application of ARIMA for forecasting energy consumption and GHG emission: A case study of an Indian pig iron manufacturing organization. 116, pp. 1031-1038.
17. Szymańska, A., & Zalewska, E. (2018). Towards the Goals of the Europe 2020 Strategy: Convergence or Divergence of the European Union Countries? 21, pp. 67-82.
18. Vuuren, D., den Elzen , M., Lucas, P., Eickhout, B., Strengers, B., Van Ruijven, B., Van Houdt , R. (2007). Stabilizing greenhouse gas concentrations at low levels: an assessment of reduction strategies and costs. 81, pp. 119–159.
19. Xavier, A. (2019). The European Union as a Leading Environmental Player? A critical analysis on the policy and commitments towards global development and climate change. pp. 135-151.
20. Yaltaa, A., & Jenal, O. (2009). On the importance of verifying forecasting results. 25, pp. 62-73.

Analiza postępów realizacji Strategii Europa 2020 w zakresie zmian klimatu i zrównoważonego wykorzystania energii w Polsce

Artykuł przedstawia refleksje na temat realizacji Strategii Europa 2020 dla Polski. Strategia obejmuje pięć obszarów, tj. badania i rozwój, edukację i szkolnictwo wyższe, ograniczanie ubóstwa i wykluczenia społecznego, zatrudnienie oraz energię i klimat, które zostały poddane analizie w niniejszym artykule. Ponieważ zapisy strategii powinny być już zrealizowane, konieczna jest dziś weryfikacja postępu prac, a także porównanie osiągnięć z założonym planem. Aby móc ocenić postępy w realizacji planu strategicznego, konieczne jest wyznaczenie wskaźników, które pozwolą określić, czy prowadzone działania ułatwiają osiągnięcie celów, czy też należy je skorygować. W tym celu autorzy posłużyli się 4 wskaźnikami. Aby móc prognozować, kiedy Polska osiągnie wyznaczone wartości do 2022 r., autorzy skonstruowali modele matematyczne, za pomocą których prognozowano wartości wskaźników. Uzyskane wyniki zostały podsumowane i zidentyfikowano środki zaradcze, które mogą pomóc wyeliminować wykryte nieprawidłowości. Pomyślne wdrożenie strategii będzie miało znaczący wpływ na zapewnienie bezpieczeństwa energetycznego Polski i zrównoważonego rozwoju środowiska.

Słowa kluczowe: *zmiany klimatu, Europe 2020 Strategy, zrównoważona energia, model ARIMA*