Elżbieta **LOREK** • Agnieszka **LOREK**

CREATING A SUSTAINABLE ENERGY SECTOR IN THE CRISIS CONDITIONS AND BUILDING A EUROPEAN GREEN DEAL

Elżbieta **Lorek** (ORCID: 0000-0002-1648-7322) – *HUMANITAS University in Sosnowiec*
Agnieszka **Lorek** (ORCID: 0000-0002-1812-9692) – *University of Economics in Katowice*

Correspondence address:
1 Maja Street 50, 40-287 Katowice, Poland
e-mail: Agnieszka.lorek@ue.katowice.pl

ABSTRACT: This article presents the concept of sustainable energy industry advancement. It also evaluates selected aspects of energy sector development in the context of current civilisation challenges, European Union policy and principles of sustainable energy generation. The primary objective of the paper is to answer the question of whether the development of the power industry in Poland and other EU countries is sustainable in selected social (the problem of energy poverty), economic (energy security issues) and environmental aspects (the development of energy based on renewable sources, including the subject of bioenergy). The research method applied in the article is based on the analysis of available literature resources, thematic reports, statistical data, and legal acts. The analysis of the problems selected for the article indicates that these issues still remain unresolved barriers to the implementation of sustainable development, and the currently escalating crisis phenomena (energy and economic crisis related to the Covid-19 pandemic and the war in Ukraine) are not conducive to their effective and rapid elimination. Based on the above considerations, recommendations in relation to sustainability in the energy sector in Poland and the EU were deduced.

KEYWORDS: sustainable energy, social, environmental and economic dimension of energy sustainability, energy poverty, energy security, renewable energy sources

Introduction

Today's global development is driven chiefly by the use of energy minerals, whose resources are limited and non-renewable, and therefore, it is not based on sustainable foundations. If global development in economic, environmental, and social terms is to be sustainable, the existing strategy for obtaining energy should be systematically changed. Voices in favour of such a change point not only to the finite and non-renewable nature of resources but, above all, to the enormous environmental costs associated with the exploitation and combustion of fossil fuels. The current trend is to introduce changes in energy systems guided by the principles of sustainability. Sustainable energy policy, in general terms, is an effort to improve the well-being of society by maintaining a balance between energy security, meeting social needs, economic competitiveness and environmental protection. The global transformation of energy policy toward sustainable energy will take time, but a gradual increase in the use of renewable resources, which are far more abundant than non-renewable resources, will be a real move towards the implementation of the idea of sustainable development.

Nevertheless, it should be borne in mind that even the use of renewable resources has its barriers and can negatively affect the environment, and in the process of sustainable development, it is also necessary to take into account and balance it in the social and economic spheres. The main purpose of the article is to answer the question: is energy development in Poland and other EU countries sustainable in selected social, economic, and environmental aspects?

Thus, the article presents the concept of sustainable energy industry development and evaluates selected aspects of energy development in the context of current civilisation challenges (climate and energy crisis), European Union policy and principles of sustainable energy generation.

Research methods

The major research method was a systematic review of available literature on the subject, thematic reports, statistical data, and legal acts pertaining to the research problem and objective formulated in the introduction. Subsequent steps included organising and analysing the available material and cause-and-effect inferences based on the information obtained.

Taking into consideration the fact that sustainable energy policy aims to improve the long-term well-being of society by striving for a balance between energy security, the satisfaction of social needs, the competitiveness of the

DOI: 10.34659/eis.2023.86.3.559

economy, and environmental protection, the basic problems to be solved have been determined, which will be analysed in the following paper. These are:

1. In the social dimension: energy poverty,
2. In the economic dimension: the security of energy supply as a key factor in economic development, including dependence on external supplies,
3. In the environmental dimension: the development of energy based on renewable sources, including the particular problem of bioenergy.

The authors of the article, based on many years of experience in this field, have considered the above issues as crucial problems to be solved in the European and national dimensions and in the context of sustainable development.

The article was prepared on the basis of a paper presented during the conference "POLISH WAY OF (UN)SUSTAINABLE DEVELOPMENT. Conditions and directions of development of the Polish economy in the perspective of current environmental requirements", Poznań, 21-23.09.2022 and concerns the period until September 2022. The article presents the latest statistical data that was available to the authors.

The concept of sustainable energy development – a review of documents and literature on the subject

The concept of sustainable development and its most widely used definition was first proposed in 1987 in the UN report Our Common Future, generally referred to as the Brundtland Report (United Nations, 1987). This report recognises and appreciates the role of energy in achieving sustainable development, yet the authors of the report indicate that the means of achieving sustainability are not clear. Agenda 21, adopted in 1992, outlined strategic goals for sustainable and balanced development for the global community, including sustainable access and energy generation (United Nations, 1992). Since the adoption of Agenda 21, sustainable development has been a vital policy goal at global, national, and local levels. Nonetheless, the guidelines contained in Agenda 21 have been implemented to a small extent. The provisions contained in this document in their entirety were upheld at the Second World Summit in Johannesburg in 2002 (United Nations, 2002). According to the UN, the guidelines contained in Agenda 21 should be considered as a long-term vision for the implementation of sustainable and balanced development. The implementation of sustainable energy is considered to be one of the most relevant problems to be tackled alongside issues such as poverty alleviation, health care, biodiversity preservation or food economy. However, as the authors of the study (Gunnarsdottir et al., 2021) "Sustainable energy

DOI: 10.34659/eis.2023.86.3.559

development: History of the concept and emerging themes" note, at that time, the concept of sustainable energy sector development had not yet emerged. The energy was perceived as a necessity for sustainable development, although it was mainly linked to climate issues, energy security and scarcity of fossil fuel resources. Topics such as renewable energy sources, energy efficiency, the environmental impact of energy generation (other than atmospheric emissions) and the role of energy in promoting human progress were discussed. However, the concept of comprehensive sustainable energy development has not yet been proposed. For instance, renewable energy sources have been used for millions of years; however, the concept of sustainable use and management of these resources is relatively new.

During the 2030 Agenda for Sustainable Development Summit, which took place in 2015 in New York, a document entitled "Transforming our World: The 2030 Agenda for Sustainable Development". It contains 17 goals and 169 related tasks. Goal 7 – "ensuring access to stable, sustainable and modern energy at an affordable price for all" is of crucial importance. The basic operational objectives in this document include (United Nations, 2015):

- ensuring universal access to affordable, reliable, and modern energy services,
- significantly increasing the share of renewable energy sources in the global energy mix,
- doubling the growth index in global energy efficiency,
- increasing international cooperation to facilitate access to clean energy and technologies in the areas of renewable energy, energy efficiency advanced research and cleaner fossil fuel technologies and promoting investments in energy infrastructure and clean energy technologies,
- expanding infrastructure and upgrading technologies to enable access to modern and sustainable energy services for all people in developing countries, in particular least developed countries (LDCs), small island developing states (SIDS) and landlocked countries, in accordance with their development programmes.

The concept of sustainable energy development also appears in the documents of many international institutions. One example is the International Energy Agency (IEA), cooperating in the development of the power sector and operating within the OECD framework, which defines sustainable energy as a power industry with a long-term global vision of development that ensures competitiveness and economic efficiency, social responsibility, and environmental protection (IEA, 2001).

An extended definition of sustainable energy, considering the three basic orders (i.e., economic, social, and environmental), is presented by L.G Action, an organisation of local governments working for sustainable energy. The definition emphasises the problem of sustainability and the use of energy

DOI: 10.34659/eis.2023.86.3.559

sources that do not cause harm to the environment and human health, which should rather be considered a difficult issue to implement (LG Action, 2018). Applying the definition of sustainable energy in strategy building, a sustainable energy system should be defined as one that converts primary energy into electricity and heat and supplies it to the consumer in a way that meets the needs of present and future generations (Mitchel, 2010).

The concept of sustainable energy is also put forward by various scientific communities. As with sustainability, there is no single basic definition that is universally accepted. Authors such as Lemaire (2010) and Tester et al. (2005) present the view that the concept of sustainable energy should be grounded on the Brundtland definition, i.e. energy consumption and supply should be based on our needs without compromising the satisfaction of needs for future generations. According to Prandecki (2014), sustainable and environmentally sound access to electricity should be achieved through measures aimed at increasing efficiency and saving energy. He believes that nowadays, the concept of sustainable energy should be considered as a theoretical concept, treated as striving for the least environmentally harmful methods of energy conversion or distribution, taking into account the social and economic needs of the present and future generations. In relation to energy sources and their role in building a sustainable energy industry, the following sources are proposed to be used (Boyle et al., 2004):

- those that are not significantly depleted by continued use,
- sources that do not cause emissions of pollutants,
- sources whose use is not associated with significant health risks.

Graczyk (2017), on the other hand, defines sustainable energy development as the process of sustainably, safely, and efficiently providing energy for sustainable development. A broad approach to the issue of defining sustainable energy is presented by Graczyk (2020), who considers sustainable energy to be about management in society in the economy-environment macro system. She believes that the scope of sustainable energy should be considered broadly, i.e. in terms of conversion, generation, transport, distribution and consumption. This author indicates that the sustainable energy paradigm sets the direction of energy management and is central to contemporary social processes in environmental protection and in the policy and institutional sphere. The sustainable energy paradigm is based on intra- and intergenerational equity, a moderately strong principle of sustainability, and the quintessence of the sustainable energy paradigm is the new concept of the human energy manager – homo energeticus (Graczyk, 2019a; Graczyk, 2019b).

Another key initiative shaping the concept has been the development of sustainable energy indicators. Indicators can provide greater clarity and a deeper understanding of the concept and the underlying themes and link-

DOI: 10.34659/eis.2023.86.3.559

ages (IAEA, 2005). It is believed that indicators at the European level, based on data from Eurostat, do not provide sufficient information, especially regarding the social dimension of sustainable energy. According to Graczyk (2017), the most comprehensive knowledge of sustainable energy implementation is provided by the International Atomic Energy Agency (IAEA, 2005) indicators.

In the conditions of the Polish economy, there are no comprehensive studies on sustainable energy development. The strategies for Responsible Development or the Polish Deal lack a comprehensive presentation of indicators showing the sustainable development of the energy sector. Also, the Polish statistics presented by the Central Statistical Office (GUS) do not contain the studies needed to assess sustainable energy development. The lack of information on sustainable energy development from both the EU and Poland should be remedied, as monitoring the process of sustainable and secure energy supply will allow the goals set in the energy, climate, and environmental policies to be achieved more quickly.

Sustainable energy development in economic, social, and environmental dimensions – a discussion of key issues

As noted above, the concept of sustainable energy has emerged since the inception of the concept of sustainable development. The individual elements of this concept have evolved, as has the overall concept of sustainability, but the general principles remain unchanged. The main core of the sustainable energy approach is the joint consideration of economic, social, and environmental dimensions. These three dimensions are closely interlinked, and sustainability requires the simultaneous support of each of them in an integrated manner.

Social dimension

The social dimension of energy sustainability involves many aspects, including:

- energy availability, which has a direct impact on employment opportunities and poverty. Access to energy is one of the key determinants of quality of life, affecting opportunities for personal development, education, work, and mobility. In particular, relatively expensive energy strains household budgets and is a disincentive to investment and entrepreneurship,
- way of generating and using energy, as well as its use, which affects health, in particular due to environmental pollution. The quality and

DOI: 10.34659/eis.2023.86.3.559

availability of energy also have an indirect impact on educational opportunities, a sense of security and social inclusion or exclusion. The social aspect also stands for job security.

The incidence of energy poverty is a particularly unfavourable phenomenon for the sustainability of energy development. Energy poverty is a culturally sensitive, multidimensional concept that changes over time and from place to place, and it is therefore not easily captured by a single indicator and definition (Day et al., 2016; Middlemiss, 2020; Bouzarovski, 2014; Szamrej-Baran & Baran, 2014; Bouzarovski & Petrova, 2015; Großmann & Kahlheber, 2017; Thomson et al., 2017). Reducing energy poverty is key to addressing some of the main challenges of sustainable development.

Table 1. Household expenditure on electricity, gas and other fuels, European Union, 2020 [as % of total expenditure]

Country	%	Country	%
Slovakia	9.2	Finland	4.2
Poland	**7.2**	Hungary	4.1
Czechia	6.2	Austria	3.9
Croatia	5.9	Spain	3.4
Slovenia	5.8	Italy	3.8
Bulgaria	5.4	Lithuania	3.4
Sveden	5.0	Romania	3.4
Greece	4.8	Portugal	3.3
Denmark	4.7	Irleand	3.2
Belgium	4.6	Netherlands	3.2
France	4.5	Cyprus	3.0
Latvia	4.5	Malta	2.6
Germany	4.2	Iceland	2.2
Estonia	4.2	Louxembourg	2.2
UE 27: 4.3			

Source: authors' work based on Eurostat [28-10-2022].

According to the IBS Research Report (Sałach & Lewandowski, 2018), in 2016, 12.2% of the population in Poland was affected by energy poverty. In absolute terms, this meant 4.6 million people living in 1.3 million households. Within the energy-poor group, a slight majority (2.5 million) of people were at the same time income-poor, while 2.1 million experienced energy poverty, although they were not income-poor. Currently (in 2022), due to the infla-

DOI: 10.34659/eis.2023.86.3.559

tionary phenomena that we can observe in the economy and the increase in the prices of energy carriers, it can be forecast that the scale of this phenomenon will deepen. Already in 2020, expenditure on electricity, gas and other fuels accounted for 7.2% of household expenditure in Poland. This was the second highest level in the entire European Union after Slovakia (9.2%). These data are illustrated in Table 1. These expenditures have an increasing trend. According to the Central Statistical Office (GUS), in 2021, expenditure on energy carriers increased to 11% of monthly household expenditure (GUS, 2021).

On a European scale, an estimated 50 million households in the European Union live in energy poverty and experience an insufficient level of basic energy services (Chlechowitz & Reuter, 2021), which is currently a significant threat to sustainability in this area.

The economic dimension

A significant part of the Polish economy, including the power sector, is at the beginning or in the phase of deep restructuring changes. Membership in the European Union requires companies from this sector not only to identify and overcome barriers in terms of technology, or organisation, but also economics and legal regulations. The European Commission has introduced elements of environmental protection and sustainable development into its sectoral policies. Sustainable development is determined by many factors, the most important of which is the use of the laws of ecology and economics in decision-making processes. Poland's energy use is less efficient than in other EU countries. Inefficient energy management translates directly into higher energy consumption per unit of GDP. This is contrary to the principles of sustainable and balanced development and has a negative impact on environmental protection in our country. Poland's energy policy until 2040 assumed a massive energy transition from coal to gas, which was to result in a doubling of gas demand by the end of the decade. These 2020 assumptions are no longer valid. The plans contained in the government's strategic documents will be subject to ongoing review due to changing geopolitical and market conditions, including factors arising from the Russian invasion of Ukraine. Apart from gas savings, a temporary renaissance of coal-fired power generation is planned for the coming 2023-24 period. In June 2022, some countries – including Germany, Italy, Austria, and the Netherlands – have already announced that coal-fired power plants could help the EU get through the gas crisis caused by Russia's reduced gas supply.

Consequently, energy security has been identified as a key factor in the economic dimension of sustainable development. Energy security is a complex concept with implications in many spheres: political, economic, environ-

DOI: 10.34659/eis.2023.86.3.559

mental, social, technical, etc. For example, according to the definition contained in the Energy Law, the term should be understood as a state of the economy that makes it possible to cover the current and prospective demand of consumers for fuels and energy in a technically and economically justified manner, while maintaining the requirements of environmental protection. In turn, the International Energy Agency (IEA, 2001) defines energy security as the uninterrupted availability of energy sources and their affordability. At the same time, the IEA emphasises the multifaceted nature of the concept, including long-term energy security, mainly related to investments in energy infrastructure in line with economic development and environmental needs, and short-term energy security, focusing on the ability of the energy system to react quickly to sudden changes in the balance of energy supply and demand.

Today, the studies on energy security have become an interdisciplinary field. As Jakstas (2020) points out, the concept of energy security has been combined with environmental, social, political and security issues. According to the authors of the article, such an approach is still too rare in the national discussion of the energy security issue.

The experience of supplying the country with sufficient energy has shown that, in addition to the concept of energy security, the concept of energy sovereignty is also fundamental. This is a much broader concept than energy security. It departs from the typical principles of climate policy in favour of ensuring stability and reliability of energy and fuel supplies for society and the economy. The provision of clean, affordable, and secure energy and further decarbonisation of the energy system is key to achieving the 2030 and 2050 climate targets.

Table 2. Energy dependence[1] in EU countries and Norway in 1990 and 2021 [%]

Country	1990	2021	Tendency
Belgium	75.1	78.85	↑
Bulgaria	62.8	37.88	↓
Czechia	15.3	38.85	↑
Denmark	45.8	44.85	↓
Germany	46.5	63.71	↑
Estonia	44.2	18.58	↑

1 The energy dependency rate shows the proportion of energy that an economy must import. It is defined as net energy imports divided by gross available energy, expressed as a percentage. A negative dependency rate indicates a net exporter of energy while a dependency rate in excess of 100% indicates that energy products have been stocked. It can be defined for all products total as well as for individual fuels (for example: crude oil, natural gas (Eurostat, 2022c)).

DOI: 10.34659/eis.2023.86.3.559

Country	1990	2021	Tendency
Ireland	68.6	71.38	↑
Greece	62	81.41	↑
Spain	63.1	67.89	↑
France	52.4	44.46	↓
Croatia	39.8	53.58	↑
Italy	84.7	73.45	↓
Cyprus	98.3	93.87	↓
Latvia	88.9	45.48	↓
Lithuania	71.7	74.98	↑
Luxembourg	99.5	92.45	↓
Hungary	49	56.62	↑
Malta	100	97.56	↓
Netherlands	24	68.86	↑
Austria	68.5	58.32	↓
Poland	0.8	42.76	↑
Portugal	84.1	65.26	↓
Romania	34.3	28.28	↓
Slovenia	45.7	45.88	↑
Slovakia	77.5	56.32	↓
Finland	61.2	42.83	↓
Sweden	38.2	33.51	↓
Great Britain	2.4	bd	↑
Norway	-484.1	-623.85	↓
Total	**44.3**	**57.5**	↑

Source: authors' work based on Eurostat (2015; 2022a; 2022c).

In the current context of the energy crisis and the threat from Russia, making economies (both Polish and other EU countries) dependent on fossil fuels such as oil and coal (whose prices continue to rise) is unrealistic in the long term. Table 2 shows the degree of dependence of the individual EU economies and Norway on external supplies of energy raw materials over the period from 1990 to 2020. In the case of Poland, an increase in dependence from 0.8% in 1990 to over 42% in 2020 is evident. The phenomenon of dependence on external supplies is also visible in many other EU countries, e.g. Germany, the Netherlands, or Spain.

DOI: 10.34659/eis.2023.86.3.559

This is why companies in various countries, as part of their national energy market development strategies, intend to significantly increase their financial investments in new energy sources, including the development of renewable energy sources. The currently applicable energy legislation – including the "Energy Policy of Poland until 2040" – must take a new path in the new geopolitical and economic situation, as well as ensure energy security and protect consumers from excessive energy price increases and aggravation of energy poverty.

Environmental dimension

The production, distribution and use of energy put pressure on the environment. Sustainable development of the energy sector in the environmental dimension requires the following principles to be observed:

- the rate of consumption of renewable resources cannot be higher than the rate of their regeneration,
- the emission of pollutants related to the use of resources must be lower than the neutralisation potential,
- non-renewable resources cannot be used faster than the possibility of creating their substitutes.

Rational use of renewable energy sources is one of the priorities of sustainable development, bringing measurable economic, social, and ecological effects (Gielen et al., 2019; Bórawski et al., 2019; Østergaard et al., 2020; Kumar & Majid, 2020; Adenle, 2020; Clausen & Rudolph, 2020; Kirikkaleli & Adebayo, 2021; Zheng et al., 2021; Hepburn et al., 2021; Li et al., 2022). The increase in the share of renewable energy sources in the EU, as well as in the national energy balance, is expected to lead to improved efficiency in the use and saving of energy resources, but also to an improvement in the state of the environment and a reduction in the amount of waste generated. Thus, supporting the development of energy based on renewable sources has become one of the priorities of the European Union and, to some extent, of Poland, with the primary aim of combating climate change.

In 2019, the share of energy from renewable sources in total primary energy was 19.7% for Poland and 28-32.8% for the EU (GUS, 2021).

The structure of obtaining energy from renewable sources shows that the most popular source was the so-called solid biofuels (which mainly include wood), with an EU average of 40.1%. In Poland, solid biofuels are the main renewable source at the level of 73.4%. More detailed data on the structure of energy generation from renewable sources in selected EU countries can be found in Table 3.

DOI: 10.34659/eis.2023.86.3.559

Table 3. The structure of obtaining energy from renewable sources (by energy carriers) for Poland, EU-28, and selected member states in 2019 [%]

Country	Solid biofuels	Solar energy	Water energy	Wind energy	Biogas	Liquid biofuels	Geothermal energy	Renewable municipal waste	Heat pumps
Austria	45.1	3.2	33.9	6.3	2.1	3.7	0.3	1.8	3.6
Czechia	67.7	4.4	3.5	1.2	11.7	5.6	-	1.8	4.1
Finland	74.0	0.1	8.8	4.3	1.6	3.4	-	2.9	5.0
France	37.3	4.5	18.1	10.9	3.6	9.2	1.7	4.6	10.0
Netherlands	23.2	7.8	0.1	15.9	5.7	28.6	2.1	12.3	4.2
Lithuania	75.4	0.5	1.8	7.8	2.4	9.6	-	1.1	1.6
Germany	27.9	10.3	3.7	23.6	16.5	7.8	0.7	6.7	2.7
Poland	**73.4**	**1.1**	**1.4**	**10.6**	**2.4**	**8.0**	**0.2**	**0.8**	**2.1**
Slovakia	62.8	2.6	16.8	0.0	6.4	7.7	0.4	1.4	1.8
Italy	26.8	8.4	14.7	6.4	7.4	3.9	19.9	3.2	9.2
Total	**40.1**	**6.7**	**11.6**	**15.3**	**6.9**	**6.8**	**2.9**	**4.2**	**5.6**

Source: authors' work based on GUS (2021).

The energy generation process from renewable sources should accelerate in the current geopolitical environment due to the need to maintain energy security and strengthen the energy sovereignty of EU countries. Nevertheless, despite the general acceptance of the development of renewable energy sources and considering compliance with the principles of sustainable development, the authors of the paper find the extensive use of wood in co-combustion processes particularly controversial (as indicated by the data quoted in the article). This state of affairs has been heavily influenced by European Union policy. The Directive on the Promotion of the Use of Energy from Renewable Sources (RED), adopted by the European Union in 2009, was a direct stimulus for the rapid increase in the use of forest biomass for energy production in Europe. The current directive in force is the Renewable Energy Directive 2018/2001/EU, which sets consumption targets for renewable energy sources between 2021 and 2030. Although this directive introduces many changes in the area of certification for sustainable biofuel production, these can still be considered insufficient in terms of forest protection (also considering the changes regarding the use of primary woody biomass introduced on 14 September 2022, which contain many exceptions).

As the report indicates: The use of woody biomass for energy production in the EU in 2015, of all wood used in the EU (from both primary and second-

DOI: 10.34659/eis.2023.86.3.559

ary sources, either domestically sourced or imported), 63% was used for bioenergy production, of which primary wood accounted for at least 37% of the total wood used for energy. Also, in Poland, since the accession to the EU, there has been a dynamic development of the bioenergy sector. Between 2004 and 2020, the total consumption of woody biomass for energy purposes in Poland increased by 9.5 million m3, i.e. as much as 69% more (CIRE, 2022). Based on the assumptions of Poland's Energy Policy until 2040 and the National Energy and Climate Plan (NECP), we can expect further dynamic development of this sector in Poland in the next 10 years.

Investment outlays for the production of electricity from biomass alone are expected to reach nearly PLN 11 billion in the period 2021-2030.

Increasing the consumption of woody biomass on a large, industrial scale, either by co-combusting with coal or by replacing old coal-fired power plants with combusting biomass, is a very inefficient way of using wood harvested from forests. Increasing the use of bioenergy without setting appropriate safeguards at the same time has serious socio-environmental consequences – a phenomenon that is already being observed both within and outside the Union. Negative impacts include issues such as loss of biodiversity, land use change, and impacts on water, soil and air quality associated with agricultural production and forest management. Scientists and international organisations, including the Intergovernmental Panel on Climate Change (IPCC), also do not recommend replacing fossil fuels with woody biomass. In its recent sixth report of 2022, the IPCC withdrew its opinion that replacing coal with woody biomass will have climate change mitigation benefits (IPCC, 2022). Also, the authors of this article evaluate the policy as incompatible with sustainable energy development.

Conclusions and recommendations

Based on the above considerations regarding the development of the concept of sustainable energy, it can be concluded that the concept has evolved considerably over the last few decades. In the late 1980s and early 1990s, a narrow view of energy development was taken, focusing mainly on emission reduction and energy security. Moreover, energy issues were perceived in isolation and were not linked to other development issues. Over time, a broader perspective on energy development has been adopted, in which potential socio-economic impacts are taken into account.

If global development – in economic, environmental, and social terms – is to be sustainable (which is one of the hallmarks of the concept of sustainable development), the current energy strategy should be regularly updated, taking into consideration the issues of energy poverty, energy security and envi-

DOI: 10.34659/eis.2023.86.3.559

ronmental consequences. The global transition to sustainable energy will take time, but a gradual increase in the use of renewable resources, of which there are far more than non-renewable resources, will be a real incentive for sustainable development. Apart from the directly perceptible benefit of reducing atmospheric emissions, the development of renewable energy sources fits perfectly with the current problems of fuel and energy insecurity in the global market. Yet, even the generation of energy from renewable sources carries certain risks, as indicated in the article.

When assessing the current approach to energy development, it is difficult to speak of consistency in implementing the principles of sustainable development, as exemplified by the analysed problem of bioenergy from wood combustion, as well as unresolved problems related to energy poverty and ensuring security and sovereignty in the area of energy supply. These obstacles remain current barriers to the implementation of sustainable development, and the currently escalating crisis phenomena (energy and economic crisis related to the COVID-19 pandemic and the war in Ukraine) are not conducive to their effective and rapid elimination.

Based on the above considerations, recommendations for sustainability in the energy sector in Poland and the EU can be made. These concern the following actions:

1. Development and presentation of comprehensive and binding sustainability criteria for the energy sector.
2. Including environmental security issues in the discussion on energy security and sovereignty in Poland. Both the satisfaction of social needs and energy security should not be pursued at the expense of the destruction and overexploitation of environmental resources, especially forest ecosystems.
3. Better integration of energy policy measures with other Community policies, e.g. the biodiversity protection strategy. Further discussion is needed on solutions to protect biodiversity and how to implement them in practice.
4. Introducing an upper limit for the use of woody biomass for energy production. This level should ensure its sustainable use and the protection of forests. These principles should also be applied to imported non-EU woody biomass.
5. Shifting the focus to local measures, including the expansion of solar energy systems and onshore wind turbines. For this to be possible, it is necessary to accelerate the development of transmission and distribution networks. These are indispensable elements in order to reinforce energy sovereignty and security of energy supply, which guarantees a constant and reliable supply of energy and fuels for society and the economy. These measures are especially crucial for Poland, where the struc-

DOI: 10.34659/eis.2023.86.3.559

ture of energy generation from renewable sources is unfavourable and based primarily on the use of solid biomass combustion.

6. Competitive markets need to be developed for green energy, which more and more companies want to buy, for both economic and environmental reasons.
7. Development of other scenarios for Poland's energy policy until 2050, which would set priorities and directions for action. This primarily concerns reducing the energy intensity of the Polish economy, which is still very high.
8. Conducting in-depth research on the issues of energy sovereignty and energy poverty and ways of eliminating this phenomenon in European countries. The gravity of these phenomena is indicated by the current energy crisis linked to the geopolitical situation on the European continent.

The contribution of the authors

The article was written in collaboration with all authors.

References

Act of 10 April 1997. The Energy Law. Journal of Laws No 54, item 348. https://www.ure.gov.pl/download.php?s=2&id=2

Adenle, A. A. (2020). Assessment of solar energy technologies in Africa-opportunities and challenges in meeting the 2030 agenda and sustainable development goals. Energy Policy, 137, 111180. https://doi.org/10.1016/j.enpol.2019.111180

Bórawski, P., Bełdycka-Bórawska, A., Szymańska, J. E., Jankowski, K. J., Dubis, B., & Dunn, J. W. (2019). Development of renewable energy sources market and biofuels in the European Union. Journal of Cleaner Production, 228, 467-484. https://doi.org/10.1016/j.jclepro.2019.04.242

Bouzarovski, S. (2014). Energy poverty in the European Union: landscapes of vulnerability. WIREs, 3(3), 276-289. https://doi.org/10.1002/wene.89

Bouzarovski, S., & Petrova, S. (2015). The EU Energy Poverty and Vulnerability Agenda: An Emergent Domain of Transnational Action. In J. Tosun, S. Biesenbende & K. Schulze (Eds.), *Energy Policy Making in the EU. Lecture Notes in Energy* (pp. 129-144). London: Springer. https://doi.org/10.1007/978-1-4471-6645-0_7

Boyle, G., Everett, B., & Ramage, J. (2004). *Energy Systems and Sustainability. Power for a Sustainable Future*. Oxford: Oxford Uniwersity Press.

Camia, A., Giuntoli, J., Jonsson, R., Robert, N., Cazzaniga, N. E., Jasinevičius, G., Avitabile, V., Grassi, G., Barredo, J. I., & Mubareka, S. (2021). *The use of woody biomass for energy purposes in the EU.* Luxembourg: Publications Office of the European Union.

Chlechowitz, M., & Reuter, M. (2021). *Energy Poverty in the EU.* https://www.odysseemure.eu/publications/policy-brief/european-energy-poverty.html

DOI: 10.34659/eis.2023.86.3.559

CIRE – Centrum Informacji o Rynku Energii. (2022, October 15). *Rośnie ilość biomasy leśnej spalanej w energetyce.* https://www.cire.pl/artykuly/serwis-informacyjny-cire-24/rosnie-ilosc-biomasy-lesnej-spalanej-w-energetyce-mediaroom (in Polish).

Clausen, L. T., & Rudolph, D. (2020). Renewable energy for sustainable rural development: Synergies and mismatches. Energy Policy, 138, 111289. https://doi.org/10.1016/j.enpol.2020.111289

Day, R., Walker, G., & Simcock, N. (2016). Conceptualising energy use and energy poverty using a capabilities framework. Energy Policy, 93, 255-264. https://doi.org/10.1016/j.enpol.2016.03.019

Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, Pub. L. No. 32018L2001, 328 OJ L (2018). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32018L2001

Directive 2009/28/EC of The European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, Pub. L. No. 32009L0028, 140 OJ L (2009). https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0028

Eurostat. (2015, July 20). *Energy dependence.* https://ec.europa.eu/eurostat

Eurostat. (2022a, October 18). *Energy dependence.* https://ec.europa.eu/eurostat

Eurostat. (2022b, October 28). *Household expenditure by category. European Union, 2021 (as % of total expenditure).* https://ec.europa.eu/eurostat/cache/infographs/hhexpcofog/hhexpcofog_2021/

Eurostat. (2022c, October 29). *Glossary: Energy dependency rate.* https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Energy_dependency_rate

Fudali, E., Jaroszewicz, B., Kabała, C., Kadej, M., Karaczun, Z., Koperski, P., Kossowska, M., Kotowski, W., Kujawa, K., Malinowski, Sz. P., Miścicki, S., Nowicki, P., Orczewska, A., Pijanowska, J., Reczyńska, K., Skubała, P., Stachowski, P., Stefanowicz, A., Świerkosz, K., Tarnawski, D., Tykarski, P., Walankiewicz, W., Żarska, B., Zbierska, J., & Żurek, R. (2022, October 20). *List otwarty naukowców dotyczący zrównoważonego wykorzystania biomasy leśnej w produkcji energii.* https://instytutsprawobywatelskich.pl/wp-content/uploads/2019/12/List-otwarty-naukowc%C3%B3w_ost_Bioenergia.pdf (in Polish).

Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., & Gorini, R. (2019). The role of renewable energy in the global energy transformation. Energy Strategy Reviews, 24, 38-50. https://doi.org/10.1016/j.esr.2019.01.006

Graczyk, A. (2017). Wskaźniki zrównoważonego rozwoju energetyki. Optimum. Studia Ekonomiczne, 4(88), 53-68. (in Polish).

Graczyk, A. M. (2019a). *Gospodarowanie odnawialnymi źródłami energii w ekonomii rozwoju zrównoważonego. Teoria i praktyka*. Warszawa: Wydawnictwo PWN. (in Polish).

Graczyk, A. M. (2019b). The Formulation of Fundaments and Form of Paradigm of Sustainable Energy. *Proceedings of the 34th International Business Information Management Association Conference (IBIMA),* Madrid, Spain, 12828. https://ibima.org/accepted-paper/the-formulation-of-fundaments-and-form-of-paradigm-of-sustainable-energy/

Graczyk, A. M. (2020). Sustainable Energy – Definitions, Scope, and Areas. In S. Soliman Khalid (Ed.), *Education Excellence and Innovation Management: A 2025*

Vision to Sustain Economic Development during Global Challenges (pp. 9495-9503). International Business Information Management Association (IBIMA).

Großmann, K., & Kahlheber, A. (2017). Energy poverty in an intersectional perspective. In N. Simcock, H. Thomson, S. Petrova & S. Bouzarovski (Eds.), *Energy Poverty and Vulnerability* (pp. 12-32). London: Routledge. https://doi.org/10.4324/9781315231518

Gunnarsdottir, I., Davidsdottir, B., Worrell, E., & Sigurgeirsdottir, S. (2020). Review of indicators for sustainable energy development. Renewable and Sustainable Energy Reviews, 133, 110294. https://doi.org/10.1016/j.rser.2020.110294

Gunnarsdottir, I., Davidsdottir, B., Worrell, E., & Sigurgeirsdottir, S. (2021). Sustainable energy development: History of the concept and emerging themes. Renewable and Sustainable Energy Reviews, 141, 110770.

GUS. (2021). *Energia ze źródeł odnawialnych w 2020 r.* https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/energia-ze-zrodel-odnawialnych-w-2020-roku,3,15.html (in Polish).

GUS. (2022). *Sytuacja gospodarstw domowych w 2021 r. w świetle wyników badania budżetów gospodarstw domowych*. https://stat.gov.pl/obszary-tematyczne/warunki-zycia/dochody-wydatki-i-warunki-zycia-ludnosci/sytuacja-gospodarstw-domowych-w-2021-r-w-swietle-badania-budzetow-gospodarstw-domowych,3,21.html (in Polish).

Hepburn, C., Qi, Ye., Stern, N., Ward, B., Xie, Ch., & Zenghelis, D. (2021). Towards carbon neutrality and China's 14th Five-Year Plan: Clean energy transition, sustainable urban development, and investment priorities. Environmental Science and Ecotechnology, 8, 100130. https://doi.org/10.1016/j.ese.2021.100130

IAEA. (2005). *Energy indicators for sustainable development: Guidelines and Methodologies.* https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1222_web.pdf

IEA. (2001). *Towards a Sustainable Energy Future.* https://www.iea.org/reports/towards-a-sustainable-energy-future

IEA. (2022, November 5). *Areas of work*. https://www.iea.org/areas-of-work

IPCC. (2022). *Climate Change 2022: Mitigation of Climate Change.* Cambridge: Cambridge University Press. https://doi.org/10.1017/9781009157926

Jakstas, T. (2020). What does energy security mean? In M. Tvaronavičienė & B. Ślusarczyk (Eds.), *Energy Transformation Towards Sustainability* (pp. 99-112). Elsevier. https://doi.org/10.1016/B978-0-12-817688-7.00005-7

Kirikkaleli, D., & Adebayo, T. S. (2021). Do renewable energy consumption and financial development matter for environmental sustainability? New global evidence. Sustainable Development, 29(4), 583-594. https://doi.org/10.1002/sd.2159

Kumar, J. C. R., & Majid, M. A. (2020). Renewable energy for sustainable development in India: current status, future prospects, challenges, employment, and investment opportunities. Energy, Sustainability and Society, 10, 2. https://doi.org/10.1186/s13705-019-0232-1

Lemaire, X. (2010). *Glossary of Terms in Sustainable Energy Regulation.* https://www.reeep.org/sites/default/files/Glossary%20of%20Terms%20in%20Sustainable%20Energy%20Regulation.pdf

LG Action. (2018, September 18). *Project definitione of Sustainable Energy.* https://www.acrplus.org/en/activities/previous-projects/2-content/274-lg-action

Li, L., Lin, J., Wu, N., Xie, Sh., Meng, Ch., Zheng, Y., Wang, X., & Zhao, Y. (2022). Review and outlook on the international renewable energy development. Energy and Built Environment, 3(2), 139-157. https://doi.org/10.1016/j.enbenv.2020.12.002

DOI: 10.34659/eis.2023.86.3.559

Middlemiss, L. (2020). Energy poverty: Understanding and addressing systemic inequalities. In R. Galvin (Ed.), *Inequality and Energy. How Extremes of Wealth and Poverty in High Income Countries Affect CO_2 Emissions and Access to Energy* (pp. 99-114). Elsevier. https://doi.org/10.1016/C2018-0-02082-4;

Ministerstwo Klimatu i Środowiska. (2019). *Krajowy plan na rzecz energii i klimatu na lata 2021-2030. Założenia i cele oraz polityki i działania.* https://www.gov.pl/web/klimat/krajowy-plan-na-rzecz-energii-i-klimatu (in Polish).

Ministerstwo Klimatu i Środowiska. (2021). *Polityka energetyczna Polski do 2040 roku.* https://www.gov.pl/web/klimat/polityka-energetyczna-polski (in Polish).

Mitchel, C. (2010). *The Political Economy of Sustainable Energy*. Basingstoke: Palgrave Macmillan.

Østergaard, P. A., Duic, N., Noorollahi, Y., Mikulcic, H., & Kalogirou, S. (2020). Sustainable development using renewable energy technology. Renewable Energy, 146, 2430-2437. https://doi.org/10.1016/j.renene.2019.08.094

Prandecki, K. (2014). Teoretyczne podstawy zrównoważonej energetyki. Studia Ekonomiczne/ Uniwersytet Ekonomiczny w Katowicach, 166, 238-248. (in Polish).

Sałach, K., & Lewandowski, P. (2018). *Pomiar ubóstwa energetycznego na podstawie danych bbgd – metodologia i zastosowanie*. https://ibs.org.pl/app/uploads/2018/02/IBS_Research_Report_pl_01_2018.pdf (in Polish).

Szamrej-Baran, I., & Baran, P. (2014). Subiektywne i obiektywne mierniki ubóstwa energetycznego. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, 367, 332-339. https://doi.org/10.15611/pn.2014.367.36 (in Polish).

Tester, J. W., Drake, E. M., Golay, M. W., Discoll, M. J., & Peters, W. A. (2005). *Sustainable Energy, Choosing Among Options.* London: The MIT Press.

Thomson, H., Bouzarovski, S., & Snell, C. (2017). Rethinking the measurement of energy poverty in Europe: A critical analysis of indicators and data. Indoor and Built Environment, 26(7), 879-901. https://doi.org/10.1177/1420326X17699260

United Nations. (1987). Report of the World Commission on Environment and Development: Our Common Future. https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

United Nations. (1992). *Agenda 21. United Nations Sustainable Development.* https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

United Nations. (2002). *Report of the World Summit on Sustainable Development.* https://digitallibrary.un.org/record/478154

United Nations. (2015). Rezolucja Zgromadzenia Ogólnego A/RES/70/1 z dnia 25 września 2015 r. Przekształcamy nasz świat: Agenda na rzecz zrównoważonego rozwoju 2030. https://www.unic.un.org.pl/files/164/Agenda%202030_pl_2016_ostateczna.pdf (in Polish).

Vera, I., & Langlois, L. (2007). Energy indicators for sustainable development. Energy, 32(6), 875-882. https://doi.org/10.1016/j.energy.2006.08.006

Zheng, H., Song, M., & Shen, Z. (2021). The evolution of renewable energy and its impact on carbon reduction in China. Energy, 237, 121639. https://doi.org/10.1016/j.energy.2021.121639

DOI: 10.34659/eis.2023.86.3.559