J. Bokajło, *Polish energy strategy – in the quest for economy. Reflections on the Polish energy policy in the perspective of endogenous growth theory and global trends within the context of Visegrad cooperation*, „Rocznik Instytutu Europy Środkowo-Wschodniej" 18(2020), z. 1, s. 117-139, DOI: https://doi.org/10.36874/RIESW.2020.1.7.

Justyna Bokajło*

Polish energy strategy – in the quest for economy. Reflections on the Polish energy policy in the perspective of endogenous growth theory and global trends within the context of Visegrad cooperation

Polska strategia energetyczna – w pogoni za ekonomią. Refleksje nad polską polityką energetyczną w perspektywie teorii wzrostu endogenicznego i globalnych trendów w kontekście współpracy wyszehradzkiej

Harvard University is not Harvard University because of its crimson logo. The value of Harvard University is in its human capital. Human capital includes the knowledge base of the employees and is often measured by the quality of the product. It also refers to the network of the employee base and the general level of influence they have on the industry.[1]

Abstract: Strategies are usually long-term plans. However, many problems appear if they are considered essential issues of social life and economic security, especially considering the need to make choices concerning conditions of limited resources. Another issue is the dilemma of achieving individual goals in the conditions of global interdependencies. One of the key requirements of nation-states is to ensure energy security; therefore, governments are strongly focused on establishing a stable, enduring, and useful energy strategy. Therefore, the point of importance is factors that will be able to ensure energy efficiency, economic stability, security, and in parallel, sustainable development

* Justyna Bokajło, PhD, University of Wroclaw, Poland, ORCID ID: https://orcid.org/0000-0002-4953-6039, e-mail: justyna.bokajlo@uwr.edu.pl.

1 Ch. Majski, 'Human Capital vs. Physical Capital: What's the Difference?', Investopedia, https://www.investopedia.com/ask/answers/062616/human-capital-vs-physical-capital-what-difference.asp [2020-08-20].

both on the national and global levels. Drawing from the above, this study investigates the reasons for the indispensability to carry out an energy market systemic reform in Poland with consideration of economic argumentation. The theories of economic growth, especially of endogenous kind, is taken into consideration. It is also argued that to achieve sustainable economic growth and social development in the long run, it would be reasonable to simultaneously concentrate on human capital and technologies. More advantages will be gained through intergovernmental cooperation, within regional groups such as the Visegrad Group and at the supranational EU level. This conviction is motivated by the principles of public choice theory.
Keywords: Energy, endogenous economic growth, sustainability, economic policy, Poland, Visegrad cooperation
Streszczenie: Strategie to zazwyczaj plany długoterminowe. Problemy pojawiają się jednak, gdy dotyczą one najbardziej istotnych kwestii życia społecznego czy bezpieczeństwa ekonomicznego, zwłaszcza w kontekście konieczności dokonywania wyborów w warunkach ograniczonych zasobów. Inną kwestię stanowią dylematy związane z realizacją celów indywidualnych w warunkach globalnej współzależności. Jedną z kluczowych potrzeb państw narodowych jest zapewnienie bezpieczeństwa energetycznego, dlatego rządy silnie koncentrują się na ustanowieniu stabilnej, trwałej i użytecznej strategii ekonomicznej. W tym wypadku istotne są czynniki, które będą w stanie zapewnić efektywność energetyczną, stabilność gospodarczą i bezpieczeństwo, a jednocześnie zrównoważony rozwój na arenie zarówno krajowej, jak i globalnej.
W związku z powyższym w niniejszym opracowaniu analizowane są przyczyny konieczności przeprowadzenia reformy systemowej rynku energii w Polsce z uwzględnieniem argumentacji ekonomicznej. Szczególną uwagę poświęca się przy tym teoriom wzrostu gospodarczego, zwłaszcza endogenicznego, argumentując jednocześnie, że aby osiągnąć zrównoważony wzrost gospodarczy i rozwój społeczny w długim okresie, rozsądne byłoby jednoczesne skoncentrowanie się w większym stopniu na kapitale ludzkim i technologiach. Poza tym więcej korzyści przyniesie współpraca międzyrządowa w ramach grup regionalnych, takich jak Grupa Wyszehradzka, oraz na poziomie ponadnarodowym, unijnym. To przekonanie jest motywowane pryncypiami teorii wyboru publicznego.
Słowa kluczowe: energia, wzrost gospodarczy endogeniczny, zrównoważony rozwój, polityka ekonomiczna, Polska, współpraca wyszehradzka

Introduction

Energy and climate policy are the most significant strategic challenges the world is facing. The evidence that they are closely related to cultural, political, institutional, and socio-economic aspects constitutes an important element of economic growth and welfare. Moreover, energy governance has become a bone of national, local, regional, and global contention. The desire to maintain energy sovereignty is often contrary to global challenges and recommendations by international institutions. By including energy resources in certain categories in the national context, these can be considered as non-rivalrous, so-called

club goods and public goods, while from the national and international perspectives they are considered as common resources. In the first case, the final products, such as electricity, serve society but the failure to pay for electricity excludes access to consumption. Electricity used for street lighting is a public good since society profits from it and its use is not competitive. In this paper, the energy resources will be considered common resources, and public access to their consumption is difficult to limit. At the same time, the exploitation of common resources reduces the amount of a specific resource, which deepens the scarcity of goods. In times of strong global ties, this trend is even stronger due to the growing, inverse correlation between, the increasing consumption of natural resources or energy services and their demand, as well as a noticeable decline in domestic production. On the other hand, their excessive exploitation, including coal combustion and other fossil fuels in a given country, leads to a suboptimal Pareto result on the international (but also national) level in the context of lowering the natural environment's quality, increasing costs to improve it, and leading to the lowering of social welfare. Therefore, we are dealing with the "tragedy of the commons", popularized in 1968 by Garrett Hardin, where the particularization of interests is more popular (although seemingly profitable only in a short period) than voluntary cooperation, assuming full rationality of entities and optimal allocation within the free market, in the understanding of Pareto. However, reality shows that these two assumptions are not met. Therefore, it is necessary to introduce the management of common goods (natural resources)[2] by institutions such as the government while bearing in mind the common interest both locally and globally, for example, in terms of sustainable and relatively balanced development. There is no evidence that is currently the case, due to the contradiction between national policy and international or subnational goals.

The main issue examined in this study provides arguments for the indispensability to carry out an energy market reform in Poland, which will be based, to a greater extent, on economic grounds and setting

2 Nobel Prize Winner in Economics, Elinor Ostrom, in her work from 1990 *Governing the Commons: The Evolution of Institutions for Collective Action proposed seven characteristics of effective shared resource management*. See: M. Jakubowski, 'Public goods and common goods', in: *Teoria wyboru publicznego. Główne nurty i zastosowania*, ed. J. Wilkin, Warszawa: Scholar, 2012, pp. 57-58.

a framework for the future energy model. It is argued that the prevalent direction of transformation, aimed at increasing the country's economic and energy security, should be criticized.

Thus, the guiding hypothesis is that an effective energy policy influences economic growth, while in the case of Poland, it does not seem to be sustainable in the long term. The reason is an insufficient emphasis on the development of human capital and technologies that are undoubtedly an immanent element of energy efficiency, which is in line with the endogenous growth theory. In this regard, there is no optimized way of governance, and energy policy seems to be far from the theoretical economic assumptions. The lack of politically sustainable action is also one of the reasons for the inefficiency in this area. Secondly, immense interdependence, which is a consequence of globalization processes; dependence on the import of hydrocarbons; limitations resulting from natural resources' availability, all require governance improvement. This can be achieved through intergovernmental cooperation, within regional groups such as the Visegrad Group (V4), and at the supranational EU level. Unfortunately, there is a significant divergence between Poland and the priorities of the EU energy transformation. Simultaneously, the lack of institutionalized activities within the V4 member states is not a premise for the effectiveness of collaboration. According to the assumptions of the theory of scale economies and the theory of public choice, the lack of cooperation limits economic and energy efficiency and does not maximize long-term economic and social profits.

The article is structured as follows, the first part focuses on presenting the methodological and theoretical framework of the research; the second part is based on a comparative and critical analysis of Poland's energy strategy towards EU's goals and its position in the Visegrad Group structure; finally, conclusions are presented. The entire analysis is based on a qualitative and interdisciplinary approach.

1. Factors affecting the energy and economic sustainability – methodological and theoretical approach

A comparative analysis of Polish energy transformation's strategic documents leads to the following conclusions: the transition to a clean energy mix is still ineffective in the face of constant domination of the

"carbon culture" and there is a lack or low efficiency of instruments and infrastructure supporting the growing share of renewable energy sources (RES). In terms of energy, the Polish goals are not fully synchronized with the EU guidelines and vision of energy transformation or the Paris Agreement's assumptions. Guidelines to improve energy efficiency are vague; there are no real solutions to reduce the energy intensity of the country's economy, thus, decreasing the dynamics of economic growth's dependence on the expansiveness of energy consumption. Moreover, the two essential elements that may contribute to this, namely the development of technology and the complementary development of human capital with increased democratization of decision-making processes, seem to be undervalued. Initiatives are not focused on long-term results, and the dominant strategy is rather the maximization of short-term profits. Considering the cooperation within the V4 Group, which could increase the countries' energy security in the region and strengthen their position in the EU, they are weakly exposed. Additionally, there is still no increased market integration, and national interests are dominating. It is mostly political factors that determine the issues of energy and economic security. In contrast, economic theories, which would undoubtedly optimize the strategic perspective, seem not to be taken into account. It is appropriate to bridge the gaps and embed considerations regarding the transformation, or rather the need to carry out systemic reforms, of Poland's energy market, in economic theories. From a research perspective, this approach contributes to interdisciplinarity and abandons, in this case, political determinism. Hence, the methodological basis of the present investigation is an endogenous concept of economic growth, while elements of the public choice theory are also introduced.

The debates conducted does not evade normative judgments, but quantitative forecasts or econometric equations are omitted. We begin our interpretation of these issues by identifying the factors influencing the sustainability of economic growth. Then we will show their correlation with energy efficiency while at the same time extracting the factors that can provide this efficiency. This will constitute the theoretical basis for the implementation of the study's aim, namely setting the structure, for the future model of Poland's energy.

The process of globalization and the related industrialization and technologization lead to increasingly negative pressure on the natu-

ral environment. As practice shows, the consequence of maximizing profits in the form of constant striving to increase economic growth measured by GDP is the over-exploitation of resources. According to classical theorists, such as Adam Smith, David Ricardo, John B. Say, and Thomas Malthus, this fact was connected to the argument that the country's wealth depended on natural resources. They defined the green economy issue based on the law of diminishing marginal productivity of land inputs, the general feature of resource scarcity, or changes in the factors of human impact on the environment. The relationship between energy generated from land capital and growth and, recently, greenhouse gas emissions is an important topic of scientific and public debates, determining the importance of energy security in the socio-economic order. The example of these assumptions shows the visible connection between economic growth and energy, which are the basic elements of the country's economic security.

The question is, what particular factors have the most significant impact on the convergence of long-term economic growth and energy efficiency? It should be remembered that the diminishing returns (decreasing land productivity), which means that an increase in the input of one factor, with the other factors unchanged, leads – as David Ricardo or Alvin Hansen would interpret – to secular stagnation.

The most popular factor analysis of economic growth was carried out in the 1950s by Robert Solow by introducing the possibility of substituting production inputs but taking into account technological progress. However, Solow's model did not indicate the sources of this progress and was an exogenous component.[3] Its modification was applied by N. Gregory Mankiw, David Romer, and David N. Weil, who, in the Cobb-Douglas production function, considered the increase in human capital as endogenous, but still maintaining the exogenous nature of technology.[4] Basing research on economic growth on the production function is correct as it is possible to indicate a correlation between the demand for specific inputs of production factors and the need for their efficiency and the potential production volume. On the

3 J. Fagerberg, 'Technology and International Differences in Growth Rates', *Journal of Economic Literature*, vol. 32, issue 3, 1994, pp. 1148-1150.

4 N.G. Mankiw, D. Romer, D.N. Weil, 'A Contribution to the Empirics of Economic Growth', *The Quarterly Journal of Economics*, vol. 107, issue 2, 1992, pp. 407-437.

other hand, the assumption that the accumulation of physical capital is insufficient to ensure sustainable economic growth and stable development has become crucial for the inclusion of human capital in endogenous theories. This attitude was popularized by Paul Romer, who attached particular importance to the analysis of the so-called aggregate capital, a combination of physical capital with human capital and a long time perspective.[5] Human capital strongly influences the growth rate, also through the accumulation of the technological factor and physical capital, and is significant in structural changes.[6] Institutional economists added another element, namely the role of informal institutions, shaping social capital, which like other resources, has a strong and productive potential (both in terms of innovation and physical equity); this is important in shaping group relations, which contributes to creating a cooperative situation.[7] Paul Romer, approaching the long-term growth, highlighted the potential of intangible capital – the human factor – in the transfer of knowledge, orientation to investments and innovation (R & D sector), production development, and, finally, prosperity for future generations (sustainable development).[8] As a growth factor, human capital considered in the long term is a source of new ideas and know-how[9] with an advantage over natural resources. The ideas not competitive; they are not subject to the principle of limitation (which is one of the barriers to growth); they constitute a common resource (although not a public good). They are not considered models, i.e., taking into account the existence of a perfect competition environment, on the contrary; this makes their application in factor analysis closer to reality.

Another issue is the lower cost of the idea's iterative implementation, given the economies of scale. Although introducing new ideas in the short term generates high fixed costs, referring to them is as-

5 P.M. Romer, 'Human Capital and Growth: Theory and Evidence', *Working Paper*, no. 3173, prepared for the April 1989 Carnegie-Rochester Conference.

6 Ł. Jabłoński, 'Ewolucja poglądów na temat konwergencji w ekonomii rozwoju', *Gospodarka Narodowa*, no. 5-6, 2008, p. 28.

7 Ibidem, pp. 29-30.

8 P.M. Romer, 'Human Capital and Growth…'

9 W. Nonneman, P. Vanhoudt, 'A Further Augmentation of the Solow Model and the Empirics of Economic Growth for OECD Countries', *Quarterly Journal of Economics*, vol. 111, issue 3, 1996, pp. 943-953.

sociated with minimal marginal costs. Besides, their accumulation makes positive external and internal effects, eliminating further potential growth and development barriers.[10] William D. Nordhaus introduced another variable into the endogenous path, namely energy, in relation to contemporary climate challenges. He considered the burning of fossil fuels, especially carbon emissions and their concentration, to be a socio-economic barrier, and "climate change to be the greatest market failure". This threat has been included in the dynamic models, known as Integrated Assessment Models and Dynamic Integrated Climate-Economy.[11]

Based on Nordhaus' thought, many different studies have been carried out on the impact of energy consumption on economic growth. Most often, they are conducted based on cointegration tests, regression techniques, and time-series analysis, with additional variables such as energy prices or other production inputs. Simultaneously, they point out a strong correlation between energy consumption (mainly for supplying physical capital necessary for production) and GDP growth.[12] John Kraft and Arthur Kraft have demonstrated a Granger causal relationship between gross energy inputs and GNP,[13] although, as Kais Saidi and Sami Hammami note, interaction is not the same in all countries or regions over time. However, they agree that excessive fossil fuel consumption, leading to carbon dioxide and methane emissions, negatively affects social growth and welfare.[14] These studies have been confirmed by Kais Saidi, Mohammad Mafizur Rahman, and

10 B.Z. Liberda, E. Maj, *Idee i nowoczesny wzrost*, http://www.aig.pte.pl/pliki/o/247/B_Liberda_E_Maj_Idee%20_i_wzrost.pdf, pp. 2-3 and so on [2020-09-01].

11 The Committee for the Prize in Economic Sciences in Memory of Alfred Nobel, *Economic Growth, Technological Change, and Climate Change*, The Royal Swedish Academy Of Sciences, 2018, pp. 1-4 and so on.

12 D.I. Stern, C.J. Cleveland, 'Energy and Economic Growth', *Rensselaer Working Paper in Economics*, Troy: Rensselaer Polytechnic Institute, Department of Economics, 2004, pp. 2-41; M. Toman, B. Jemelkova, 'Energy and Economic Development: An Assessment of the State of Knowledge', *The Energy Journal*, no. 24, issue 4, 2003, pp. 93-112.

13 J. Kraft, A. Kraft, 'On the relationship between energy and GNP', *Journal of Energy and Development*, vol. 3, 1978, pp. 401-403.

14 K. Saidi, S. Hammami, 'Economic growth, energy consumption and carbone dioxide emissions: recent evidence from panel data analysis for 58 countries', *Quality and Quantity*, vol. 50, issue 1, 2016, pp. 361-383.

Hooman Abdollahi.[15] Moreover, they proved the existence of feedback between increasing GDP and the spreading of environmental pollution. In response to this negative correlation, the most recent research focuses on detecting the presence of two or one-way Granger causality, considering renewable energy in final energy consumption and its impact on economic growth. Empirical results for all 28 EU countries (the study was conducted before Brexit) also proved this positive correlation.[16] Despite the apparent decline in primary energy production since 2008, 2018 shows that in absolute terms, 14 out of 27 countries (excluding Great Britain – although it ranks 4th in terms of consumption) still record an increase in energy production.[17]

Nevertheless, there is a tendency for reducing primary energy consumption: since the beginning of 2019 is a noticeable decrease in coal energy production throughout Europe;[18] in the EU by 19% (especially in Germany and Ireland).[19] Many countries, including Poland, a leader among Central and Eastern European countries in consumption, especially hard coal,[20] benefit from these practices. Therefore, if the increase of RES directly translates into GDP growth and is an additional factor eliminating the negative impact of the so-called dirty energy on global climate change without leading to negative economic growth, why do market participants (governments) not optimize their choices by shifting from the individual consumer and utilitarian wel-

15 H. Abdollahi, 'Investigating Energy Use, Environment Pollution, and Economic Growth in Developing Countries', *Environmental and Climate Technologies*, no. 24, 2020, pp. 275-293.

16 G. Soava, A. Mehedintu, M. Sterpu et al., 'Impact of renewable energy consumption on economic growth: evidence from European Union countries', *Technological and Economic Development of Economy*, vol. 24, issue 3, 2018, pp. 914-932. About Great Britain's EU withdrawal consequences see: M. Dahl, Y. Skomorokhova, 'The Balance of Power in the European Union after Brexit', *Studia Universitatis Babes-Bolyai Sociologia*, vol. 62, issue 3, 2017, pp. 267-282.

17 Eurostat, 'Production of primary energy decreased between 2008 and 2018' https://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_production_and_imports#Production_of_primary_energy_decreased_between_2008_and_2018 [2020-08-11].

18 Ch. Edmond, 'Chart of the day: Is 2019 the beginning of the end for coal in Europe?', weforum.org, https://www.weforum.org/agenda/2019/07/coal-generation-production-europe-2019-fall-renewable-lignite/ [2020-08-11].

19 F. Simon, 'European coal power output sees 'unprecedented' decline', *Euractiv*, https://www.euractiv.com/section/emissions-trading-scheme/news/european-coal-power-output-saw-unprecedented-drop-in-2019/ [2020-08-11].

20 Statista, 'Electricity production from hard coal in Central and Eastern European countries in 2019', Statista, https://www.statista.com/statistics/1094556/cee-power-production-from-hard-coal/ [2020-08-11].

fare function to the social welfare function?[21] Francis M. Bator answers this question in the context of market failure. Also, Garrett Hardin in the "tragedy of the commons", and John Nash in the game known as "the prisoner's dilemma," argue that "the best strategy to maximize the objective function of an economic entity generates suboptimal solutions due to the maximization of the utilitarian welfare function". Elinor Orstom's postulate is significant in this context, involving the government as an entity that guarantees the maintenance of the appropriate quality of the common resource and taking into account the role of informal institutions in the form of educated social norms that can stop the destruction of the shared resource, which is the climate. [22] The above exemplifications confirm that the assumptions of the Kyoto Protocol (1997), the Paris Agreement (2015), and the EU strategies for reducing greenhouse gas emissions (i.e., Intelligent Energy Europe Programme) are justified. Saidi and Rahman recommend incorporating cooperation (regional and global) and mutual coordination of natural resource governance into energy transformation to ensure sustainable and qualitative growth. They emphasize that increasing energy efficiency by among others expenditure on technology and increasing public awareness are a prerequisite for achieving sustainable growth.[23] In contrast, Coen Teulings and Richard Baldwin, in the context of secular stagnation, performed a factor analysis, extracting those factors that affect the long-term economic growth rate. The potential decline of growth is due to the low level of innovation and knowledge of possible combinations by using the inputs' production capacity.[24] These aspects are important when answering the question about the possibility of separating (particularly dirty) energy from economic growth.[25] Along with that, another factor is the possible substitution

21 W. Giza, *Zawodność rynku. Powstanie i rozwój idei*, Kraków: Wydawnictwo Uniwersytetu Ekonomicznego, 2013, pp. 48-54.

22 Ibidem, pp. 60-62.

23 K. Saidi, M. Mafizur Rahman, 'The link between environmental quality, economic growth, and energy use: new evidence from five OPEC countries', *Environment Systems and Decisions*, March 2020, https://link-1springer-1com-10000b58308a4.han.buw.uw.edu.pl/article/10.1007/s10669-020-09762-3 [2020-06-11].

24 E. Hein, 'Secular Stagnation or Stagnation Policy? Steindl after Summers', *The Levy Economics Institute Working Paper*, no. 846, 2015, pp. 2-4.

25 Based on the assumptions of A. Smith, an interesting proof is conducted by: S. Mair, *Capital, Capitalism, and Climate in Adam Smith's Growth Theory*, Geneva: Centre for the Understanding

of fossil fuels by RES. Although such an option seems rather doubtful in the coming years, increasing the RES in energy mix will definitely relieve the share of primary energy in production and consumption processes based on complementarity.

2. Poland does not use all advantages to increase their energy efficiency and socio-economic sustainability – a critical analysis of short-termism

Global reality has shown a number of uncertainties and exhibits dynamism and changeability. These elements should be taken into account when planning energy activities and strategies, as they are the global reality's context, further they are a part of the New Economy approach.

Table 1. Characteristic features for the New Economy approach

Essential issues	Features
General economic	
Markets	Dynamics
Competition	Global
Potential Geographic Mobility of Business	High
Industry	
Organization of Production	Flexibility
Key Factor of Production	Innovation/Knowledge
Key Technology Driver	Digitization
Source of Competitive Advantage	Innovation, Quality, Time to Market, and Cost
Importance of Research/Innovation	High
Relations with Other Firms	Alliances and Collaboration
Workforce	
Skills	Broad Skills, Cross-Training
Requisite Education	Lifelong Learning
Labor-Management Relations	Collaborative

of Sustainable Prosperity, 2018.

Government	
Business-Government Relations	Assist Firms' Innovation and Growth
Regulation	Market Tools, Flexibility

Source: R.D. Atkinson, R.H. Court, J.M. Ward, *The State New Economy Index. Benchmarking Economic Transformation in the States*, Progressive Policy Institute Technology & New Economy Project, 1999, http://www2.itif.org/1999-state-new-economy-index.pdf, p. 5.

In addition to the above profile, it should be mentioned that some crucial features, which so far seemed to be highly theoretical, are currently personally experienced by every single market participant. Goods are limited (e.g., clean air, freshwater resources, which means that free goods become scarce, natural resources, including oil) and common resources are liable to increase competition, which is problematic for their optimal (in the Pareto sense) consumption to maximize the utilitarian welfare function. Moreover, the market does not optimally allocate public goods and therefore, the government must be responsible for providing them. Having regard to all the above, it is worth considering to what extent Poland implements the New Economy's features, in its energy strategy. Is Poland effectively heading towards the systemic reform of the energy market, or towards the minimal but necessary changes as determined by the EU environmental and global trends, or creating new yet little contribution to legal acts or amendments to existing ones? What factors could be more exposed to make the long-term growth trend sustainable and long-lasting?

In the previous section, we indicated the need to use energy to implement economic growth and development tasks. The growth target is mostly based on the consumption of fossil fuels: in the global energy mix, coal accounts for 29.3%, oil products for 29%, and gas for 22.3%.[26] The so-called dirty energy causes carbon dioxide emissions, which results in negative climate change, inhibiting social development in the long term. The EU is a world leader in the struggle against this practice, and the Treaty on the Functioning of the EU (TFEU) has already introduced certain areas of energy policy into shared competences, signaling the transition to its communitization. However, member states remain in power to determine the conditions for the

26 World energy mix 2020, *The Economist Intelligence Unit*, http://www.eiu.com/industry/energy [2020-08-11].

consumption of energy resources (TFEU Art. 194 (2)), taking into account a high dependence on hydrocarbon imports, especially from Russia. This group of countries includes all V4 members, therefore in 2004, they expressed their will for deepened cooperation in the implementation of the EU energy goals. The V4 states declared that regional cohesion should be achieved mainly by ensuring energy security, increasing the efficiency of the EU energy market (thus recognizing the problem of resource scarcity and the need to maximize the use of shared resources), as well as "diversification of routes, sources, and suppliers of energy carriers and the development of energy infrastructure."[27] The intention is that the goals of regional cooperation (which is part of the Alliances and Collaboration feature) would be consistent with the EU's plans to implement the energy and climate union's framework strategy. The relevant document, entitled "Roadmap for the Energy Union for Europe", was presented to the European Commission by the then Polish Prime Minister, Donald Tusk, in April 2014. Two months later, the European Council signed the plan as part of the European Energy Security Strategy. Despite the promises and potential resulting from solidarity and unity, the current balance records numerous difficulties in working out a common position. The terms "polarization" and "incoherence" dominate the international discourse in this respect. Ladislav Cabada expresses doubts concerning the effectiveness of Visegrad synergy. In his opinion, the cooperation of the fourth countries was significant through historical coincidence and temporal interests unity, dealing with the process of accession to the EU and the North Atlantic Alliance. However, in the long term, there is visible dissension and selection of political configurations, increasing the domestic entities' dominance.[28] It is often said that the V4 Group occurs in a "two plus two" constellation with Slovakia and the Czech Republic as pro-EU and Poland and Hungary as more Eurosceptic.[29] An example of different attitudes is the inconsistent po-

27 The Bratislava Declaration of the Prime Ministers of the Czech Republic, the Republic of Hungary, the Republic of Poland and the Slovak Republic on the occasion of the 20th anniversary of the Visegrad Group, Bratislava, 15 February 2011.

28 L. Cabada, 'The Visegrad Cooperation in the Context of Other Central European Cooperation Formats', *Politics in Central Europe*, vol. 14, no. 2, pp. 165-167.

29 'Visegrad Group: A new economic heart of Europe?', *Deutsche Welle,* https://www.dw.com/en/visegrad-group-a-new-economic-heart-of-europe/a-49483505 [2020-04-27].

sition of Poland, Hungary, but also the Czech Republic, towards the EC's narrative, striving to achieve climate neutrality by 2050 (a net-zero level by 2050),[30] showing the differences in the interests of the V4, the rest of the Central and Eastern European region and other EU members. The way of thinking based on the conventional energy industry, as confirmed by the National Energy and Climate Plans, does not address structural changes and decomposition of public policies towards institutional and social innovation. On the contrary, in January 2020, Hungary unexpectedly decided to endorse the sustainable development strategy, the European Green Deal, popularized by Ursula von der Leyen and Frans Timmermans. What is worrying is that the main determinants of Polish electricity production are still hard coal and lignite (78.3% in 2018), which means that Poland remains the largest hard coal producer in Europe.[31] After Germany and the United Kingdom (before Brexit, in 2018), Poland is the third largest emitter of greenhouse gases in the EU.[32] On the other hand, the latest data from the Ember think-tank climate report suggests that Poland took first place in the production of electricity from coal, ahead of Germany. This is equivalent to coal-based power generation in the entire EU, except for Germany, and its dependence on coal is the greatest among all 27 member states.[33] Furthermore, Poland is the largest emitter of greenhouse gases in the V4, followed by the Czech Republic and Hungary, while Slovakia is the lowest emitter.[34] When it comes to the Polish Government's role, the centralization of activities is still dominant, and the presented tactics implement a planning task rather than a strategic and development assignment. In pursu-

30 S. Morgan, 'Poland stokes dispute over net-zero emissions price and meaning', *Euractiv*, https://www.euractiv.com/section/energy-environment/news/poland-stokes-dispute-over-net-zero-emissions-price-and-meaning/ [2020-04-27].

31 'The voice of coal in Europe', Euracoal, https://euracoal.eu/info/country-profiles/poland/ [2020-04-27].

32 M. Jamet, S. Amiel, 'EU still among top 3 world CO_2 emitters, new data shows', EuroNews, https://www.euronews.com/2019/12/05/eu-still-among-top-3-world-co2-emitters-new-data-shows [2020-04-28].

33 J. Bretan, 'Poland overtakes Germany as EU's biggest coal generator', *Notes from Poland*, https://notesfrompoland.com/2020/07/23/poland-overtakes-germany-as-eus-biggest-generator-of-electricity-from-coal/ [2020-08-12].

34 Infografika: *Emisje gazów cieplarnianych w Unii Europejskiej*, Parlament Europejski, https://www.europarl.europa.eu/news/pl/headlines/society/20180301STO98928/infografika-emisje-gazow-cieplarnianych-w-unii-europejskiej [2020-04-28].

ing the "coal policy", political leaders only see short-term individual benefits, ignoring the factors that would maximize social welfare in the aspect of a sustainable, national economy. Therefore, insufficient efforts are directed towards decarbonization, taking into account decentralization, digitization (as guidelines of the New Economy), as well as energy democratization, increasing social control and stricter cross-sector partnership (the so-called 4D strategy). [35]

Analyzing the strategic documents of the Polish energy modus operandi such as the National Energy and Climate Plan for 2021-2030 (NECP) and Poland's Energy Policy until 2040, as well as the tasks set by Poland, which took over the presidency of the V4 Group in July 2020, it is necessary to define them as an ambitious declarative phase. They are moving towards increasing energy security (including gas supplies and routes)[36] and reducing the economy's energy intensity. There are also assumptions for increasing the percentage of renewable energy sources in the production and consumption of energy, the development of low-emission projects leading to the reduction of greenhouse gas emissions, and the modernization and development of infrastructures. It is about investments, attracting private investors or capital (especially financial ones) open to cooperation in the field of green energy to support the Green European Deal, as well as the elimination of the so-called bottlenecks in the area of infrastructure, especially gas infrastructure. This would translate into increased security of energy supply, reduce risk, improve cost-effectiveness, and increase the system's resilience at the European level. Finally, the aspect of technology potential and research and development projects, especially in low-carbon emission, removes barriers to the flow and exchange of information in the field of good practices and knowledge transfer. As far as the operational phase is concerned, the authori-

35 J. Bozuwa, *Energy democracy: taking back power*, The Next System Project 2019, https://thenextsystem.org/sites/default/files/2019-03/EnergyDemocracy-2-star-Final.pdf; J. Jędrzejowski, 'Jaka powinna być polska energetyka przyszłości', Rzeczpospolita, https://energia.rp.pl/akcje-specjalne/walka-o-klimat/18903-jaka-powinna-byc-polska-energetyka-przyszlosci [2020-09-01].

36 This aspect was emphasized during the Hungarian Presidency and the V4 countries declared cooperation in the region in the construction of a common gas market and cooperation with countries such as Croatia, Ukraine and Romania. OWC Außenwirtschaft, *Visegrád-Länder wollen Energiesicherheit*, https://legacy.owc.de/2013/10/21/visegrad-laender-wollen-energiesicherheit/ [2020-04-05].

ties' attitude is more conservative and insufficiently consistent with the EU priorities; especially with regard to implementation of carbon dioxide reduction and the share of renewable energy sources in final energy consumption in the V4 countries. The EU's goal is to achieve the share of RES at 20% by 2020, but individual countries have lowered this target. The table below shows that only the Czech Republic exceeded the set individual target in 2018, while other countries, especially Poland, are far short of reaching 20%. The comparison takes into account Germany, which in the first months of 2020 produced half of the total energy from renewable sources.[37]

Table 2. Percentage of renewable energy in the gross final energy consumption of Germany and V4 (in %)

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	Target
EU – 28	13,1	13,4	14,6	15,3	16,2	16,7	16,9	17,4	17,8	20
Germany	11,6	12,4	13,5	13,7	14,3	14,9	14,8	15,4	16,4	18
Czechia	10,5	10,9	12,8	13,9	15,0	15,0	14,9	14,8	15,1	13
Hungary	12,7	13,9	15,5	16,2	14,6	14,4	14,3	13,5	12,4	13
Poland	9,2	10,2	10,8	11,3	11,4	11,7	11,2	10,9	11,2	15
Slovakia	9,0	10,3	10,4	10,1	11,7	12,8	12,0	11,4	11,8	14

Source: Profile elaboration based on the Eurostat, *Share of renewable energy in gross final energy consumption*, https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020_31&plugin=1 [2020-04-08].

According to the EC recommendations, the share of energy production from RES by 2030 is 25%; in the National Plan for Energy and Climate 2021-2030 (KPEIK) assumptions, we read that Poland sets the level of 21%+2 in the reduction of carbon dioxide by 2030. The EU plan is to reduce carbon dioxide by 40%, and the Polish by 29%.

Meanwhile, a question arises about the specific instruments assigned to specific stages, which require flexible adaptation to be economic and social dynamics in terms of focusing on competitiveness, knowledge, skills, innovation, and progressiveness (using life-long learning ploy) and changing the approach from quantitative to qualitative. The last aspect is particularly a part of the endogenous growth

37 R. Waldholz, 'Germany marks first ever quarter with more than 50 pct renewable electricity', *Journalism for the Energy Transition*, https://www.cleanenergywire.org/news/germany-marks-first-ever-quarter-more-50-pct-renewable-electricity [2020-05-01].

theory's assumptions, which have been completely isolated. When transforming the energy sector, one should take into account the limited resources, a change, which assumes climate neutrality (until 2050), i.e., a complete abandonment of coal, but also other primary sources, and the costs considering continuous energy production, which translates into growth and development balanced. The role of the government should be supportive (assumption of market allocation imperfection). Currently, these priorities seem to be postponed, and an example is the modest level of advancement of Poland in the implementation of expenditure on research and development activities. In 2010 the EU adopted the EUROPE 2020 strategy, which pointed out that the spending would constitute 3% of GDP. In Poland and other V4 countries, it remains at a much lower level despite the continuous growth.

Table 3. Expenditure of the Visegrad Group countries in the R & D sector in 2017 and 2018 (% of GDP)

Country	Year	
	2017	2018
Poland	1.03	1,21
Czechia	1,79	1,93
Slovakia	1,88	0,83
Hungary	1,21	1,53

Source: Own elaboration based on: Eurostat, *R+D expenditure*, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R_%26_D_expenditure#R_.26_D_expenditure_by_sector_of_performance; OECD, *Gross domestic spending on R & D*, https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm [2020-08-12].

In the 2017 profile, Poland was in the last place, and a year later, it was in the third, but it is still 1.79% less than the EU target, while the Czech Republic is the leader. Regarding sectors that support R & D, the enterprise sectors in all the V4 countries are the most involved. In Poland, the higher education branch is most concerned with R & D, followed by the Czech Republic. On the contrary, in these two countries, the government sector shows the least initiative, and Hungary plays the most supporting role.[38] Actual results show that Polish de-

38 Eurostat, *R+D expenditure*, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R_%26_D_expenditure#R_.26_D_expenditure_by_sector_of_performance [2020-08-05].

cision-makers do not strive for systemic reform of the energy market but only apply the necessary energy mix correction. At the same time, the main development factor is the financial capital, especially from the European Just Transition Fund. Insufficient consideration of the expenditure of technology and human capital (with all advantages, as new ideas and know-how) stands in opposition to the theory of growth and pure economic logic. Human capital especially plays a catalytic role in promoting a sustainable approach and economic efficiency. It reduces aggregate energy consumption, but according to the Environmental Kuznets Curve, it replaces dirty energy consumption with an increase in clean energy consumption, leading to a rise in energy production and national income.[39] On the other hand, technological progress is a consequence of the accumulation of human capital. In addition, social capital has a psychological effect, i.e., increased awareness of climate change, associated with the transition to environmentally optimized solutions and improving social welfare. In conclusion, human and technological capital is complementary (R & D), and their increase causes an increase in production.[40] An input in only one of the factors causes a decrease in marginal productivity as its consumption grows and, as a result, an increase in energy and economic production is not sustainable. Similarly, building an energy strategy based on the domination of financial capital will not cause a substitution effect in relation to other inputs, leading to decreased efficiency.

The research hypothesis' last issue refers to insufficiently politically balanced activities, which are the cause of low energy and economic efficiency. This has already been partially verified based on the government's operational analysis to rely on economic theories and achieve the current climate goals. Optimizing energy security, translating into sustainable growth and social progress, requires, as we have already stated, the complementarity of technological and human capital. Most of the authors referred to in this study prove that the increase in human capital expenditure has a positive effect on the energy mix and the

39 Y. Yao, K. Ivanovski, J. Inekwe et al., 'Human capital and energy consumption: Evidence from OECD countries', *Energy Economics*, vol. 84, 2019, pp. 5-6.

40 Y. Yao, K. Ivanovski, J. Inekwe et al., 'Human capital and…', pp. 6 and so on; M. Malaczewski, 'Complementarity between energy and physical capital in a simple model of economic growth', *Economic Research – Ekonomska Istraživanja*, vol. 31, 2018, pp. 1169-1184.

reduction of marginal costs in the long run, having no impact in the short period. This can explain Polish decision-makers' political slowness and short-sightedness of efforts, without taking into account the factors that require higher expenditure at the implementation stage. The political maximization of profits is the acquisition and maintenance of power, while the Polish nature of the rule is rather short-term. Conducting long-term, socially, and economically beneficial projects involve savings, responsibility, diligence, and civic activity, and this requires the introduction of instruments that are often socially unpopular, therefore, unprofitable for those in power. In countries where the positive effects of the energy reform, which translate into growth and sustainable development, are visible and felt, such as Switzerland, Sweden, or Germany, the government is ruled with political continuity. From 1990 to 2020, Sweden had five prime ministers, but apart from Frederik Keinfeldt, all came from the same Swedish Social Democratic Workers' Party. Likewise, over this period, Switzerland had five chancellors, most of them from the Christian Democratic People's Party, not to mention Germany, where since 1949, the chancellor has been replaced only nine times, with the political continuity still dominated by the Christian Democratic Union party up to this day. To compare, since the times of the Republic, Slovakia has been represented by seven prime ministers, the Czech Republic by twelve, and Hungary by nine. In Poland, the change of ruling political parties since August 1989 up until now has occurred nineteen times, with Donald Tusk assuming the office for the longest time during the PO-PSL coalition.

Conclusions

The article revises the Polish strategy of energy transformation towards the efficiency of plans, the use of instruments, taking into account the technological factor and human capital, and the progress made so far in its implementation. A critical analysis was applied in terms of insufficient adjustment of Poland's energy policy to economic theories, including the nature of the New Economy and the theory of endogenous growth, which includes independent variables, such as the complementarity of human and technological capital. Thus, the Polish energy strategy is, to a greater extent, dominated by a political approach without considering the economic dimension. The ineffi-

ciency of instruments and the direction of current actions taken so far in the systemic reform of the energy market was mentioned. In this context, it would be important to consider the following arguments:

- to have regard to the law of diminishing revenues from land inputs (natural resources) and their exhaustiveness, and ensure long-term, sustainable energy security through at least partial substitutability of RES;
- to eliminate Poland's dependence on imported fossil fuels, which it can be recalled that even in the 1990s, Poland was a net exporter of this raw material, but is now forced to import particularly hard coal from Russia.[41] Moreover, compared to other V4 countries, the production of nuclear energy reduces its energy mix);
- to increase the chances of replacing dirty energy with clean energy, which will first reduce the consumption of aggregate energy by reducing the share of primary energy; increasing the consumption of clean energy translates into long-term, sustainable convergence of economic growth with social progress. This will also reduce the "tragedy of the commons" issue by the socio-economic improvement of the Pareto optimization results, which concerns reducing the negative impact on climate change. Moreover, it will open the possibility of reducing the dependence of economic growth on energy consumption;
- to fully incorporate the "4D" strategy with an emphasis on energy democratization, taking into account the potential for innovation, new ideas, and social capital. It can be defined as a necessity to adapt to EU and global challenges and guidelines.

It is recommended to strengthen regional cooperation and use the V4 Group's potential to maximize interests in the EU arena and also to balance energy security. Collaborative solutions and market integration and their openness are more efficient and, in the long run,

41 The Lena Coal Basin in Siberia is considered to be the largest in terms of hard coal and lignite mining, with an area of 600,000 km2. The largest Russian coal importer to Poland is the SUEK group, which for over 10 years has been supplying over 2.5 million tons per year from the Siberian regions of Khakassia, Buryatia and Kabarovsk. See: Państwowy Instytut Geologiczny, *Występowanie, zasoby i złoża węgla brunatnego w Polsce*, https://www.pgi.gov.pl/psg-1/psg-2/informacja-i-szkolenia/wiadomosci-surowcowe/10421-wystepowanie-zasoby-i-zloza-wegla-brunatnego-w-polsce.html [2018-06-10]; T. Wójcik, *W 2018 roku Polskę zasypią tony węgla ze Wschodu*, BiznesAlert, http://biznesalert.pl/wegiel-polska-rosja/ [2018-06-10].

alleviate political and economic transaction costs. It should also be remembered that changes in the energy strategy and their effects are considered in the long term; hence, continuity, decision-making, and operational consistency are important. On the other hand, the issue of sustainable development should be approached not through the prism of short-term, particularistic financial maximization but the socio-global utilitarian welfare function.

References

Abdollahi, H., 'Investigating Energy Use, Environment Pollution, and Economic Growth in Developing Countries', *Environmental and Climate Technologies*, no. 24, 2020, https://doi.org/10.24193/subbeuropaea.2017.3.12.

Atkinson, R.D., Court, R.H., Ward, J.M., *The State New Economy Index. Benchmarking Economic Transformation in the States*, Progressive Policy Institute Technology & New Economy Project, 1999, http://www2.itif.org/1999-state-new-economy-index.pdf.

Bozuwa, J., *Energy democracy: taking back power*, The Next System Project 2019, https://thenextsystem.org/sites/default/files/2019-03/EnergyDemocracy-2-star-Final.pdf.

Bretan, J., 'Poland overtakes Germany as EU's biggest coal generator', Notes from Poland,, https://notesfrompoland.com/2020/07/23/poland-overtakes-germany-as-eus-biggest-generator-of-electricity-from-coal/.

Cabada, L., 'The Visegrad Cooperation in the Context of Other Central European Cooperation Formats', *Politics in Central Europe*, vol. 14, no. 2, 2018.

Dahl, M., Skomorokhova Y., 'The Balance of Power in the European Union after Brexit', *Studia Universitatis Babes-Bolyai Sociologia*, vol. 62, issue 3, 2017.

Edmond, Ch., 'Chart of the day: Is 2019 the beginning of the end for coal in Europe?', weforum.org, https://www.weforum.org/agenda/2019/07/coal-generation-production-europe-2019-fall-renewable-lignite/.

'The voice of coal in Europe', Euracoal, https://euracoal.eu/info/country-profiles/poland/.

Eurostat, *Production of primary energy decreased between 2008 and 2018*, https://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_production_and_imports#Production_of_primary_energy_decreased_between_2008_and_2018.

Eurostat, *Share of renewable energy in gross final energy consumption*, https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020_31&plugin=1.

Eurostat, *R+D expenditure*, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R_%26_D_expenditure#R_.26_D_expenditure_by_sector_of_performance.

Fagerberg, J., 'Technology and International Differences in Growth Rates', *Journal of Economic Literature*, vol. 32, issue 3, 1994.
Giza, W., *Zawodność rynku. Powstanie i rozwój idei*, Kraków: Wydawnictwo Uniwersytetu Ekonomicznego, 2013.
Hein, E., 'Secular Stagnation or Stagnation Policy? Steindl after Summers', *The Levy Economics Institute Working Paper*, no. 846, 2015.
Infografika: *Emisje gazów cieplarnianych w Unii Europejskiej*, Parlament Europejski, https://www.europarl.europa.eu/news/pl/headlines/society/20180301STO98928/infografika-emisje-gazow-cieplarnianych-w-unii-europejskiej, https://doi.org/10.18778/0208-6018.313.03.
Jabłoński, Ł., 'Ewolucja poglądów na temat konwergencji w ekonomii rozwoju', *Gospodarka Narodowa*, no. 5-6, 2008.
Jakubowski, M., 'Public goods and common goods', in: *Teoria wyboru publicznego. Główne nurty i zastosowania*, ed. J. Wilkin, Warszawa: Scholar, 2012.
Jamet, M., Amiel, S., 'EU still among top 3 world CO_2 emitters, new data shows', *Euronews*, https://www.euronews.com/2019/12/05/eu-still-among-top-3-world-co2-emitters-new-data-shows.
Jędrzejowski, J., ‚Jaka powinna być polska energetyka przyszłości', Rzeczpospolita, https://energia.rp.pl/akcje-specjalne/walka-o-klimat/18903-jaka-powinna-byc-polska-energetyka-przyszlosci.
Kraft, J., Kraft, A., 'On the relationship between energy and GNP', *Journal of Energy and Development*, vol. 3, 1978.
Liberda, B.Z., Maj, E., *Idee i nowoczesny wzrost*, http://www.aig.pte.pl/pliki/0/247/B_Liberda_E_Maj_Idee%20_i_wzrost.pdf.
Mair, S., *Capital, Capitalism, and Climate in Adam Smith's Growth Theory*, Geneva: Centre for the Understanding of Sustainable Prosperity, 2018.
Majski, Ch., 'Human Capital vs. Physical Capital: What's the Difference?', Investopedia, https://www.investopedia.com/ask/answers/062616/human-capital-vs-physical-capital-what-difference.asp.
Malaczewski, M., 'Complementarity between energy and physical capital in a simple model of economic growth', *Economic Research – Ekonomska Istraživanja*, vol. 31, 2018.
Mankiw, N.G., Romer, D., Weil, D.N., 'A Contribution to the Empirics of Economic Growth', *The Quarterly Journal of Economics*, vol. 107, issue 2, 1992.
Morgan, S., 'Poland stokes dispute over net-zero emissions price and meaning', Euractiv, https://www.euractiv.com/section/energy-environment/news/poland-stokes-dispute-over-net-zero-emissions-price-and-meaning/.
Nonneman, W., Vanhoudt, P., 'A Further Augmentation of the Solow Model and the Empirics of Economic Growth for OECD Countries', *Quarterly Journal of Economics*, vol. 111, issue 3, 1996.
OECD, *Gross domestic spending on R & D*, https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm.
OWC Außenwirtschaft, *Visegrád-Länder wollen Energiesicherheit*, https://legacy.owc.de/2013/10/21/visegrad-laender-wollen-energiesicherheit/.
Państwowy Instytut Geologiczny, *Występowanie, zasoby i złoża węgla brunatnego w Polsce*, https://www.pgi.gov.pl/psg-1/psg-2/informacja-i-szkolenia/

wiadomosci-surowcowe/10421-wystepowanie-zasoby-i-zloza-wegla-brunatnego-w-polsce.html.
Romer, P.M., *Human Capital and Growth: Theory and Evidence*, *Working Paper*, no. 3173, prepared for the April 1989 Carnegie-Rochester Conference.
Saidi, K., Hammami, S., 'Economic growth, energy consumption and carbone dioxide emissions: recent evidence from panel data analysis for 58 countries', *Quality and Quantity*, vol. 50, issue 1, 2016.
Saidi, K., Mafizur Rahman, M., 'The link between environmental quality, economic growth, and energy use: new evidence from five OPEC countries, Environment Systems and Decisions', *Environment Systems & Decisions*, March 2020.
Simon, F., 'European coal power output sees "unprecedented" decline', Euractiv, https://www.euractiv.com/section/emissions-trading-scheme/news/european-coal-power-output-saw-unprecedented-drop-in-2019/.
Soava, G., Mehedintu, A., Sterpu, M. et al., 'Impact of renewable energy consumption on economic growth: evidence from European Union countries', *Technological and Economic Development of Economy*, vol. 24, issue 3, 2018, https://doi.org/10.3846/tede.2018.1426.
Statista, *Electricity production from hard coal in Central and Eastern European countries in 2019*, https://www.statista.com/statistics/1094556/cee-power-production-from-hard-coal/.
Stern, D.I., Cleveland, C.J., 'Energy and Economic Growth', *Rensselaer Working Paper in Economics*, Troy: Rensselaer Polytechnic Institute, Department of Economics, 2004.
The Bratislava Declaration of the Prime Ministers of the Czech Republic, the Republic of Hungary, the Republic of Poland and the Slovak Republic on the occasion of the 20th anniversary of the Visegrad Group, Bratislava, 15 February 2011.
The Committee for the Prize in Economic Sciences in Memory of Alfred Nobel, Economic Growth, Technological Change, and Climate Change, The Royal Swedish Academy of Sciences, 2018.
Toman, M., Jemelkova, B., 'Energy and Economie Development: An Assessment of the State of Knowledge', *The Energy Journal*, no. 24, issue 4, 2003.
'Visegrad Group: A new economic heart of Europe?', Deutsche Welle, https://www.dw.com/en/visegrad-group-a-new-economic-heart-of-europe/a-49483505.
Waldholz, R., 'Germany marks first ever quarter with more than 50 pct renewable electricity', *The Committee for the Prize*, Clean Energy WIre, https://www.cleanenergywire.org/news/germany-marks-first-ever-quarter-more-50-pct-renewable-electricity.
Wójcik, T., 'W 2018 roku Polskę zasypią tony węgla ze Wschodu', BiznesAlert, http://biznesalert.pl/wegiel-polska-rosja/.
World energy mix 2020, *The Economist Intelligence Unit*, http://www.eiu.com/industry/energy.
Yao, Y., Ivanovski, K., Inekwe, J. et al., 'Human capital and energy consumption: Evidence from OECD countries', *Energy Economics*, vol. 84, 2019.