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The Energy Transition in the Visegrad Group Countries

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Abstract: The aim of the research is to analyse the energy transition in the Visegrad Group countries, because they depend on the production of energy from the burning of fossil fuels, and transition is a huge challenge for them. The diversity of the energy transformation in the V4 countries was examined by using two qualitative methods, including literature analysis and comparative analysis. The timeframe of the study was set for the period from 2020 to 2030, as these years are crucial for the implementation of the European Green Deal Programme. Four diagnostic features were taken into account in the analysis: the share of RES in final energy consumption, reduction of CO_2 emissions in the non-Emissions Trading System (ETS) sector, date of withdrawal of coal from the economy, and energy efficiency. The analysis shows that the V4 countries have different approaches and levels of energy transformation in their economies. Poland is in the most difficult situation, being the most dependent on the production of electricity from coal, as well as having the largest number of employees in the coal and around coal sector. The other countries of the group can base their transformation on nuclear energy, as each of them has at least four such power units. The increased use of biomass for energy and heat production is the most important stimulus for Renewable Energy Sources (RES) growth in the analysed countries. The ambivalent attitude of the political elite to unconventional sources in the four analysed countries significantly hinders the development of certain forms of green energy. However, it has been observed that an increasing proportion of the population, especially those living in regions of the country where there is no fossil fuel mining industry, has a positive attitude towards energy transformation. The study is the first that shows the state of involvement in the process of systemic change of the Visegrad Group countries. The results can serve as a starting point for understanding the reticence of this group of European countries towards the transformation phenomenon, as well as contributing to further research on the implementation of closed-circuit economies in the Visegrad Group countries.

Keywords: energy policy; energy transformation; the Visegrad Group

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1. Introduction

The global energy system faces a huge challenge. Climate change resulting from the burning of hydrocarbons, their rapid depletion, inequality in access to energy, and the announced fall in demand for conventional fuels, especially coal and oil, have forced the need to implement a new energy model that is based on unconventional energy sources. Its core is to be the zero-emission sources, energy saving, and energy efficient. In recent years, issues relating to climate change and the negative effects of this process have been analysed and discussed among politicians, scientists, and ordinary citizens around the world, and particularly strongly in Europe. Therefore, climate policy has become a catalyst for the development and dissemination of energy based on renewable sources of energy (RES). This, in turn, has resulted in faster development of technology and it has significantly accelerated the implementation of European Union (EU) climate policy objectives.

The transition to low-emission energy sources is taking place at different speeds in individual Member States of the Community. This is the result of divergent interests in the energy security of its members, and it leads to dissonance in the energy union [1]. The

new energy strategy sets ambitious targets for the use of renewable energy. EU decision-makers have assumed that, in 2030, 32% of the Community's energy balance should come from RES [2]. Achieving this target requires reducing dependence on fossil fuels. The unbalanced perception of this issue and the different security priorities among the EU Member States mean that there is a new division of the Community along the West-East axis, thus consolidating the division that has existed since the beginning of the entry into the organisation of countries that were satellite states of the former Union of Soviet Socialist Republics (USSR) for many years [3].

It is worth adding that there is also a division that is related to energy priorities between the rich countries of northern Europe and the poorer south. The different degrees of implementation of the energy transition in the EU countries have contributed to the study of this phenomenon. This article aims to analyse the energy transformation in the Visegrad Group countries (V4), as they are largely dependent on the production of energy from burning fossil fuels and the transformation of the energy sector is a huge challenge for them. To achieve the assumed goal, it will be necessary to answer the following research questions:

1. What is the significance of the energy transformation for the security of the Visegrad Group countries?
2. What is the current state of energy security of each of the countries of the organisation under discussion?
3. What actions are taken by the V4 countries in order to comply with the requirements of the "European Green Deal"?

The methodology that is used in this manuscript is consistent with the assumed research objectives. The diversity of the energy transformation in the V4 countries was examined by using two qualitative methods, including literature analysis and comparative analysis. The first of the above-mentioned research methods allowed grouping literature sources on the basis of the adopted conceptual criteria. Comparative analysis was used to compare the studied phenomenon in the countries of the Visegrad Group, based on four diagnostic features: the share of RES in final energy consumption, reduction of CO_2 emissions in the non-ESTS sector, date of withdrawal of coal from the economy, and energy efficiency. Thanks to a critical discourse analysis, it was possible to show social problems in the context of the energy transformation in the V4 group. The timeframe of the study was set for the period from 2020 to 2030, as these years are crucial for the implementation of the European Green Deal Programme.

The article consists of five parts. The literature review of the system transformation is presented after the introduction. The third part presents the energy security system in the Czech Republic, Slovakia, Poland, and Hungary. The state of energy transition in the Visegrad countries is discussed in the fourth part. The fifth part contains a summary of the results of a comparative analysis of the energy transformation based on the basis of legislative and strategic documents of the four examined countries against the legal framework that is imposed by the EU.

2. Literature Review

Central Europe is not a region that is generously endowed by nature with energy carries, especially those that are still desirable: natural gas and oil. Moreover, the region is also not a significant energy consumer.

The complex and painful economic transformation of Central European countries has significantly transformed all sectors of the economy, including the energy sector. These countries did not attach much importance to energy policy, which is why the sector has adapted to the new market conditions, while maintaining an almost unchanged energy supply structure [4]. However, the last 15 years have been a time of fairly rapid economic growth for the Central European region, due to joining to EU [5]. In this part of Europe, one grouping that was founded in 1991 under the name of the Visegrad Group, or V4, deserves attention. It consists of four neighbouring states: the Czech Republic, Poland, Slovakia,

and Hungary, which, as a result of similar goals in foreign policy, the similarity of historical experiences and geographical proximity, have sought to strengthen cooperation. The main objective of the organisation was cooperation with the European Union and North Atlantic Treaty Organization (NATO) as part of the accession of member states to the aforesaid structures [6].

EU is now pointing to a vision of a green Europe, free of coal and other fossil fuels, on its members. However, the positions of the members of the community with regard to energy security differ and influence the decisions taken by them through joint initiatives due to their different geographical location, natural resources, history, and political traditions. For this reason, the differences in the progress of the energy transition reflect the divergent interests of individual countries in terms of energy security. The deepening division of the Union into western and eastern countries reflects a different approach to energy security [3]. The eastern cluster of the divided EU includes, among others, the Visegrad Group states. The history of belonging to the Eastern bloc and heritage of the socialist energy system is their common feature. These countries were the most important importers of Russian energy resources during the entire period of socialism. After the collapse of the USSR, the V4 countries still depended almost completely on Russian imports for about 20 years [7]. It was only in the last decade that work began on changing energy dependence on the Russian superpower. The still less developed infrastructure, which is in need of modernisation in many countries, makes the markets in this part of Europe less resistant to possible disruptions in the supply of fossil fuels. The hard coal and lignite industry is an important branch of industry in Central European countries (Poland, the Czech Republic, and Slovakia); hence, a large number of people are employed in the mining sector, and coal is a strategic hydrocarbon on whose resources the economy in these countries is based. For this reason, the transition to renewable energy is associated with much higher costs than in Western Europe. The standard of living in this part of Europe is lower than in the countries of Western Europe; therefore, the citizens of these countries are more sensitive to energy price increases [8].

Recently, V4 countries have openly expressed their concerns and preferences regarding the future of energy security both in their own country and in the region as a whole. Measures taken in relation to this, including further support for the development of nuclear energy, the implementation of natural gas diversification projects, or criticism of the far-reaching strategy of the European Green Deal, are proof of the individual approach of these countries to the changes imposed by the European Union [9].

At present, the most important objective of the V4 group is to strengthen cooperation, particularly by agreeing on a common strategy for energy security and regional emergency planning for natural gas supplies [10], as well as to promote the concept of a fair transition in climate policy, which, while striving for better use of non-traditional energy sources, will preserve jobs and take the social consequences of the changes that are to take place in the economy into account, especially those relating to living standards and electricity prices [11].

3. Brief Description of the State of Energy Security in the Visegrad Countries

3.1. The Czech Republic

The Czech Republic is one of the most developed and industrialized economies in Central Europe. Its strategic position in Europe, the good condition of economy, and its well-functioning legal and political environment attract the inflow of foreign capital, by attracting foreign capital inflows.

The Czech Republic, like other Visegrad countries, is a meaningful producer of solid fuels, mainly hard coal and brown coal in Europe. Lignite has the most significant energy potential for the Czech economy, whose resources are estimated at approximately 8.8 billion, of which 2.2 billion tonnes is economically viable [12]. The mining of this raw material has been gradually decreasing over the last 20 years. Hard coal is another hydrocarbon that is

playing a much smaller role in electricity production in this country. The production of both hard coal and brown coal is also in decline. [13].

Nuclear energy is one of the most important elements of modern Czech energy policy. Six commercial reactors are in operation in this country of ten-million inhabitants, and the authorities intend to build additional nuclear units within 15 years. In addition, the Czechs plan to build more power units in both existing power plants extend the life of the existing power units at the Dukovany power plant by 10 years to even 60 years. In the long term, nuclear energy may account for more than 50% of electricity production, replacing a large part of the energy that is obtained from coal sources. Therefore, the Czech Republic is engaged in nuclear energy, despite the current trends in energy policy, both regional and European, which clearly favour renewable or conventional (natural gas) energy sources [14].

Other energy sources are of rather marginal importance, because the country is completely dependent on imports of oil and natural gas. The shortage of the former is based on supplies from Russia and a marginal amount from Norway, while, in the case of the latter, small domestic production is supplemented by imports from Russia and Azerbaijan [14].

The new energy strategy of the Czech Republic that was adopted by the Czech Parliament in May 2015 provides for the reduction of coal in the energy mix, from the current 41% to 21% in the coming years. All hard coal for energy is to be imported. The decrease in electricity production from coal is to be compensated for by a reduction in electricity exports. The production of nuclear energy puts the Czech Republic in fourth place in the ranking of the largest energy producers in the EU. Thanks to the energy that is derived from the atom, the Czech Republic is the fourth largest exporter of electricity in the EU [15].

At present, the Czech energy mix is largely based on coal, which accounts for 44%; another important pillar of Czech energy is the atom, 34%; the remaining sources are only complementary so far: gas and oil sources-around 9% and 12.5% of RES [16]. According to the government's assumptions, green sources are to be the second largest source of energy production in the Czech Republic after nuclear energy by 2040, but their share in total energy production will be lower than in most EU countries [17].

It is worth adding that Czech politicians, unlike the majority of the population, consider the use of coal to be an important comparative advantage of the Czech Republic, ensuring an appropriate level of energy security. On the other hand, renewable energy sources are seen as a risky investment that distorts the status quo in the energy sector [17]. However, the Czech Republic may reduce the installed capacity of coal-fired power plants from 9500 MW to 2500 MW in the next decade and at the same time develop renewable energy without the risk of losing system stability, as evidenced by studies that were carried out by an independent consulting company Energynautics [18].

3.2. The Slovak Republic

Slovakia, thanks to its location, binds the V4 group together, as it is the only country that shares a border with all of its members. Slovakia has started work on changing its energy architecture, the core of which is to be: energy self-sufficiency, diversification of the energy mix, and increasing electricity generation using low-carbon technologies.

In the Slovak energy mix, there is a balanced share of fossil fuels and nuclear energy in electricity consumption, which is as follows: nuclear 24%, natural gas 24%, oil 20%, coal 20%, RES 12% [19]. It is worth adding that almost 60% of energy is produced in nuclear power plants, while the production of biofuels and bio-waste has largely replaced coal in the production of heat and energy, which has allowed the country to maintain a relatively high rate of energy self-sufficiency.

Hard coal mining has been suspended by Slovakia; hence, it is fully imported, mainly from Russia and Ukraine. Lignite, similarly to the Czech Republic, is a significant hydrocarbon that has been extracted in Slovakia for 200 years. The domestic reserves of this hydrocarbon are large, amounting to 83 million tonnes. It is worth adding that the

specific geological structure of Slovakia means that lignite mining takes place underground and it encounters various difficulties, which increases production costs, which are higher than in neighbouring countries. Slovak mining, as in Central European countries, is in a downward trend [19]. This is the main reason for the closure of unprofitable mines. However, the government wants to maintain lignite production, with various support mechanisms (including a guaranteed purchase price) for this energy sector.

Slovak oil and natural gas deposits are small and practically exploited. Production covers approximately 1.5% of demand for oil and 2% of demand for natural gas. The only supplier of oil to Slovak refineries is Russia (5.8 million tonnes). Similarly, natural gas supplies are mainly made from Russia (87%) [20]. Slovakia plays the role of a transit country in the region through which Russian gas is transported to the neighbouring Czech Republic and Hungary, but also to Western European countries: Germany, Austria, France, and Southern Europe: Slovenia, Croatia, and Italy.

Nuclear energy is another very significant energy source in Slovakia. In this small country, located without access to the sea, there have been two nuclear power plants in operation for 50 years: Bohunice and Mochovce, each of which has two WWER 440 type reactors. It should be added that more than half of the electricity that is consumed in Slovakia comes from these power plants. In addition, the Slovaks have been building two more power units at Mochovce Power Station for a decade, their commissioning is constantly postponed, and the construction costs significantly exceeded the original cost estimate. [21].

The Slovak authorities have made it a priority to increase the share of RES in electricity consumption. Slovakia has easily achieved the Union's target of 14%, thanks to hydropower and biomass energy. Slovakia's hydropower potential is evenly distributed throughout the country and it enables energy production based on large hydropower plants as well as small hydroelectric power plants (SHPs), the development of which is stimulated by subsidies. Currently, 70% of the technical hydropower potential is used. Another significant source of renewable energy in Slovakia is biomass, which has the highest energy potential of 120 PJ [22]. Wind farms or photovoltaic installations are not a priority area for Slovakia and, therefore, the financial support mechanisms will be gradually phased out. It is worth adding that the government is subsidising unprofitable coal-fired power stations in order to protect jobs. As a result, current policies and the regulation of electricity prices have led to their highest level for industry in the region [20].

3.3. Poland

Poland, like other countries in the region, has fossil resources. Coal, which has been used in the Polish power industry for over a century, supports the country's economy (60%). Other types of primary fuels are only a complement to the energy balance. Poland ranks ninth in the world in terms of hard coal mining (approximately 64 million tonnes per year) [23]. A downward trend characterizes the mining of this energy resource; in the years 1990–2017, it decreased by 90 million from about 152 to 64 million tonnes [24]. Lignite is the second important primary energy carrier. Mining of this energy carrier in the last year recorded a strong decline and it currently amounts to 52 million tonnes [25]. It is worth adding that Poland is in the top ten of its world producers. In Poland, as in other V4 countries, there are no significant oil reserves. Domestic mining is small and it satisfies around 5% of demand; the remaining part of demand is supplemented by imports from Russia and Saudi Arabia [26]. Poland is also a transit country, with the international 'Friendship' pipeline running through its territory, the Polish section of which plays a significant role in Russian oil exports. At present, 30% of this raw material exported by Russia flows through it, but only part of the oil remains in Polish refineries, and the remaining quantity goes to German consumers.

Natural gas begins to play an increasingly important role in the Polish energy balance. This upward trend is related to the implementation of new investments and the modernization of industrial plants, which are moving away from traditional methods of supply.

The domestic production of natural gas in Poland is small and it amounts to 3.8 billion m^3 (2019), which allows for meeting one-fifth of the total demand for this raw material, hence the shortage must be supplemented with imports [27]. It is worth noting that imports of natural gas from the east are systematically decreasing in favour of supplies of liquefied gas from Qatar, Norway or the USA [28].

Another component of Poland's energy balance is renewable energy sources. They are not yet used on a large scale and are not economically competitive with energy obtained from fossil fuels, but their importance in Poland's energy mix is steadily growing (13.5% at the end of 2017). In individual regions of the country, the RES potential varies, which results from geographical and climate differences. Currently, energy from renewable sources is primarily used in the local power industry to increase local energy security, and especially to improve energy supply in areas with poorly developed energy infrastructure [29].

Poland is the only country of the Visegrad Group not having nuclear energy in its energy balance. For many years, the concept of nuclear energy has been raised. However, changes on the Polish political scene and in the attitude of many countries to this form of energy generation, as well as problems with finding a strategic investor, have caused delays in work. The current government has announced that the first power unit will not be built until after 2030 [30].

The Polish energy sector is facing a great challenge. The new EU regulations introduced to limit climate change force the decarbonisation of the economy, which is an extremely difficult task for Poland, especially due to its dependence on coal in the process of electricity production. At the same time, the energy sector will have to meet the rapidly growing demand for energy, while most of the infrastructure facilities that are used for the production of heat and electricity require modernization.

3.4. Hungary

Hungary is a country with the smallest potential for energy resources in the region. Domestic energy production amounts to 45% of the total primary energy supply, so this small country is becoming increasingly dependent on imports. Natural gas and crude oil are the largest sources of primary energy, while nuclear power has the largest share in electricity generation. Brown coal is an important source of indigenous primary energy, which can be activated in an energy crisis. In the early 1990s, as a result of a systemic change, hard coal production was phase out, thus making Hungary dependent on imports of this raw material, mainly from USA. Lignite mining currently amounts to 9.3 million tonnes per year, which makes the country self-sufficient in terms of energy production [31]. It is worth noting that further use of coal is an important part of the national energy strategy until 2030.

Natural gas is Hungary's largest primary energy source. Its domestic extraction has been steadily decreasing for thirty years and it currently amounts to two billion m3 per year. This amount makes it possible to cover approximately one-fifth of total demand for this raw material. The missing quantity is compensated by imports from Russia [31]. Crude oil is the second largest source of primary energy after natural gas. The production of black gold in Hungary is small and decreasing every year, meeting 12% of demand. The most important supplier of this energy source is Russia (75%) and Iraq (15%) [31].

The Hungarian economy has been based on nuclear energy for over 30 years. Nuclear energy supplies more than half (52%) of the country's electricity production. Hungary has one Paks nuclear power plant with 4 PWR (pressurized water reactors) with a capacity of 500 MW each. Electricity that is generated at the Paks power plant provides Hungary with energy security while reducing carbon dioxide emissions. The National Energy Strategy 2030 envisages that nuclear energy will remain an important part of the national energy sector for a long time. The Hungarian Government decided to extend the operation of existing units and build two new power units at the Paks power plant. The construction of the new units is considered to be the government's priority project. The modernisation programme for the old units will allow them to operate for another 20 years until the

new units become operational. It should be noted that the new units will be put into operation before the closure of the existing ones, which will lead to a temporary increase in the production of energy from a nuclear source, compensating for some time for energy imports. In this way, Hungary is trying to prevent energy shortages that would await them after the closure of the Paks power plant [21].

The share of renewable energy sources in the Hungarian energy sector has been slightly increasing for several years. Biomass is the most important source of RES growth. Geothermal energy is another source with significant potential. Hungary has some of the best geothermal resources in the EU. High sunshine makes solar energy the fastest growing energy source in recent years, although energy production from this source is still low [31]. Because of legislation issued in 2016, which was inconvenient for investors, wind energy has stopped developing and the government is not interested in developing this form of green energy. The degree of use of hydropower has remained low for years, apart from small installations in small water basins, the potential use of large rivers to produce hydropower is unlikely.

Hungary's National Energy Strategy to 2030 stipulates that 54% nuclear energy and 30% natural gas will be the country's main energy carrier. Subsequently, energy will come from renewable energy sources (16%) and from coal (5%) [32].

4. Results: Energy Transformation in V4 Countries

Energy and climate policy is always shaped by many political, economic, social, security, and environmental issues. The multidimensional nature of energy policy is evident in Central Europe due to the source of energy imports and Russia's role in the European energy mix. The Central and Eastern European region also acts as an intermediary in the distribution of Russian fossil fuels to Western Europe. The existing conviction that local production and combustion of fossil fuels will guarantee cheap energy for households means that the policy of adapting to climate change in Central European countries lags behind the rest of Europe.

Current energy situation in the Visegrad countries is presented in Table 1. In the energy mix of Poland and the Czech Republic, coal ranks first, while in Slovakia and Hungary the dominant source of energy is nuclear energy. Imported gas consumption is growing in all V4 countries. RES constitute a small part of the energy balance of the analyzed group.

Table 1. Structure of net electricity generation in the Visegrad countries in 2019, Developed from [33].

Energy Carrier	Czech Republic	Slovakia	Poland	Hungary
Coal	44.2%	8.5%	73.9%	11.6%
Natural gas	6.8%	10.2%	9.3%	25.1%
Atom	34.6%	54.0%	0%	48.2%
Other sources	1.7%	4.0%	1.2%	1.2%
RES:	12.7%	23.3%	15.6%	13.9%
-Biofuels	5.8%	3.0%	4.2%	6.1%
-Hydroelectricity	2.7%	17.6%	1.4%	0.7%
-Photovoltaics	3.4%	2.6%	0.5%	4.9%
-Wind energy	0.8%	0%	9.4%	2.2%

All of the analysed countries have, over the last decade, transposed EU legislative standards on green energy sources into their strategic documents and legislation. Each Member State of the European Community has committed itself in the EU Renewable Energy Directive (2009/28/EC) to achieving a specific share of energy from renewable

sources in the gross final consumption of energy by 2020. The Czech Republic and Hungary have committed themselves to achieve a 13% share of RES in gross final energy consumption, while Slovakia and Poland have committed themselves to achieve 14% and 15%, respectively, in the designated period, according to the National RES Action Plans [34].

The Czechs and Hungarians have done best in the implementation of EU law, as evidenced by the rapid achievement of the RES targets set for 2020. This was made possible by the appropriate legal framework and the financing of projects using green energy, unfortunately, mainly from external sources (EU funds). When external funding is reduced, it may prove difficult to find national sources of support for this technology, due to the ambivalent attitude of the political elite to unconventional sources [35].

Poland has, to a certain point in time, achieved its objective in accordance with the indicative course set out in the EU RES Directive. At that time, two main RES technologies were developed thanks to support in the green certificate system: co-firing of biomass in existing coal units and onshore wind power. Unfortunately, the changes that were introduced in 2016 in legal regulations concerning support for RES, consisting mainly in the transition from the green certificate system to the auction system, made it impossible for Poland to achieve the assumed 20% by 2020. Failure to meet the EU target means that it is necessary to make up for the lack of green energy through statistical transfers, involving the purchase of 'virtual' energy from RES from Member States that have developed a surplus of this energy as part of their targets. In the case of Poland, the costs of such a transfer may amount to as much as PLN eight billion [36].

Slovakia has also easily achieved the Union's target for the production of green energy. Thanks to the launch of the "Greenery for Households" program, which supports the production of heat and electricity from small, household renewable energy systems, this form of energy generation has developed at both the regional and local level. Energy from renewable sources is promoted through a feed-in tariff. Energy companies are obliged to purchase energy from RES. Other sources of green energy are of marginal importance in energy production. It is worth adding that, while neighbouring countries are investing in wind energy, in Slovakia the development of wind energy was stalled in 2009, when investors were unable to obtain permission from the network operator to join into it. The Slovak government considers wind energy to be unstable, with large fluctuations in production and not worth the investment [22].

Until recently, the V4 countries did not want to hear about the decarbonisation of the economy. Today, the situation has changed. Hard coal mines are being closed due to low raw material prices and strong foreign competition, and lignite mines are also being closed due to emission regulations and pollution charges. Both in the Czech Republic, Slovakia and Hungary, national strategic plans have been drawn up to help the coal regions to switch to other activities.

The Czech Government has introduced the RESTART programme, which aims to stimulate the development of three mining regions in the country [37]. The mining regions are among the least developed in the country and the cause of these problems is seen in mining. Too much pollution, the flight of secondary and higher education graduates from these regions, as well as poor support for business development and limited supply on the labour market prevent the development of small and medium-sized enterprises. Low skills characterise local industry, so low added value means that purchasing power is not increasing in this region [37]. The financial support of the RESTART programme amounts to EUR 1.5 billion until 2030 and it includes a large part of national and EU funds [38].

Slovak climate policy was defined in the studies "Environmental Strategy-Greener Slovakia" that was published in 2018 and in Low-Carbon Development Strategy of the Slovak Republic until 2030 with a View to 2050. Among other things, it includes adaptation measures for the coal region of Slovakia, called Upper Nitra, which, like Polish Silesia, is a very economically developed area with a high density of industrial sector. It is worth adding that this region was qualified in 2017 for a pilot EU programme supporting the transformation of coal mining regions. Slovakia was one of the first countries in the V4

group to give a specific date for the end of coal mining, 2023 and announced the gradual phasing out of the production of electricity and heat from this energy source [39,40]. Review of energy transformation goals for 2030 in V4 countries is shown in Table 2.

Poland has also created its action plan as part of the energy transformation. The assumptions and objectives of the energy policy are included in the "National Energy and Climate Plan for 2021–2030". The document sets out the climate and energy objectives to be achieved by Poland in the next 10 years. The most important issue for this country is to reduce the share of coal in electricity production. Poland is to reduce energy production from coal by 56–60% by 2030, according to the provisions contained in the above document. The share of coal-fired power plants will be systematically reduced as a result of the phasing out of old, worn-out conventional generation sources that do not meet environmental pollution requirements. Gas will be a very important energy carrier in the transition period, in both the power industry and in heating [41]. Poland will be one of the few countries to close down its coal sector as the last one, according to the latest announcements of the Polish government, in 2049 [42].

Table 2. Energy transformation goals for 2030 in V4 countries, [14,20,39,43–45].

Targets for 2030	Czech Republic	Hungary	Poland	Slovakia	EU
Share of RES in final energy consumption	22%	21%	21–23%	19.2%	32%
Reduction of CO_2 emissions in the non-ESTS sector	−14%	−7%	−7%	−20%	−30%
Date of withdrawal from coal	2030/2040	2030	2049	2023	2040
Energy efficiency	8%/84 PJ	10%	23%	30.3%	32.5%

The high level of environmental pollution from the emission of harmful greenhouse gases into the atmosphere is one of the biggest problems of the countries under discussion. All countries of the Visegrad Group have taken appropriate measures to reduce their emissions. Poland is the largest emitter in the region, followed by the Czech Republic, Hungary, and Slovakia. The Polish government has announced that, in the next decade, it will work to reduce emissions by at least 7% in sectors that are not covered by the ECTS programme when compared to 2005 [45]. Similar positions are held by Hungarians, Czechs (14% reduction as compared to 2005) [46], and Slovaks (12% reduction as compared to 2005) [47].

The development of RES is another element of the energy transformation (Figure 1). All four examined countries have announced a significant increase in the share of this clean form of energy. The Czech Republic, thanks to the development of hydroelectric power plants and biomass, is expected to reach 22% in gross final energy consumption in 2030. A similar level was set by Poles (21–23%), who are developing wind energy both at sea and on land and photovoltaics. Hungarians assume that, in less than a decade, they will achieve 21%, mainly due to solar energy, biomass, and geothermal energy, while Slovaks will achieve their target of 19.2% thanks to small hydroelectric and biomass plants [31,32,39,46].

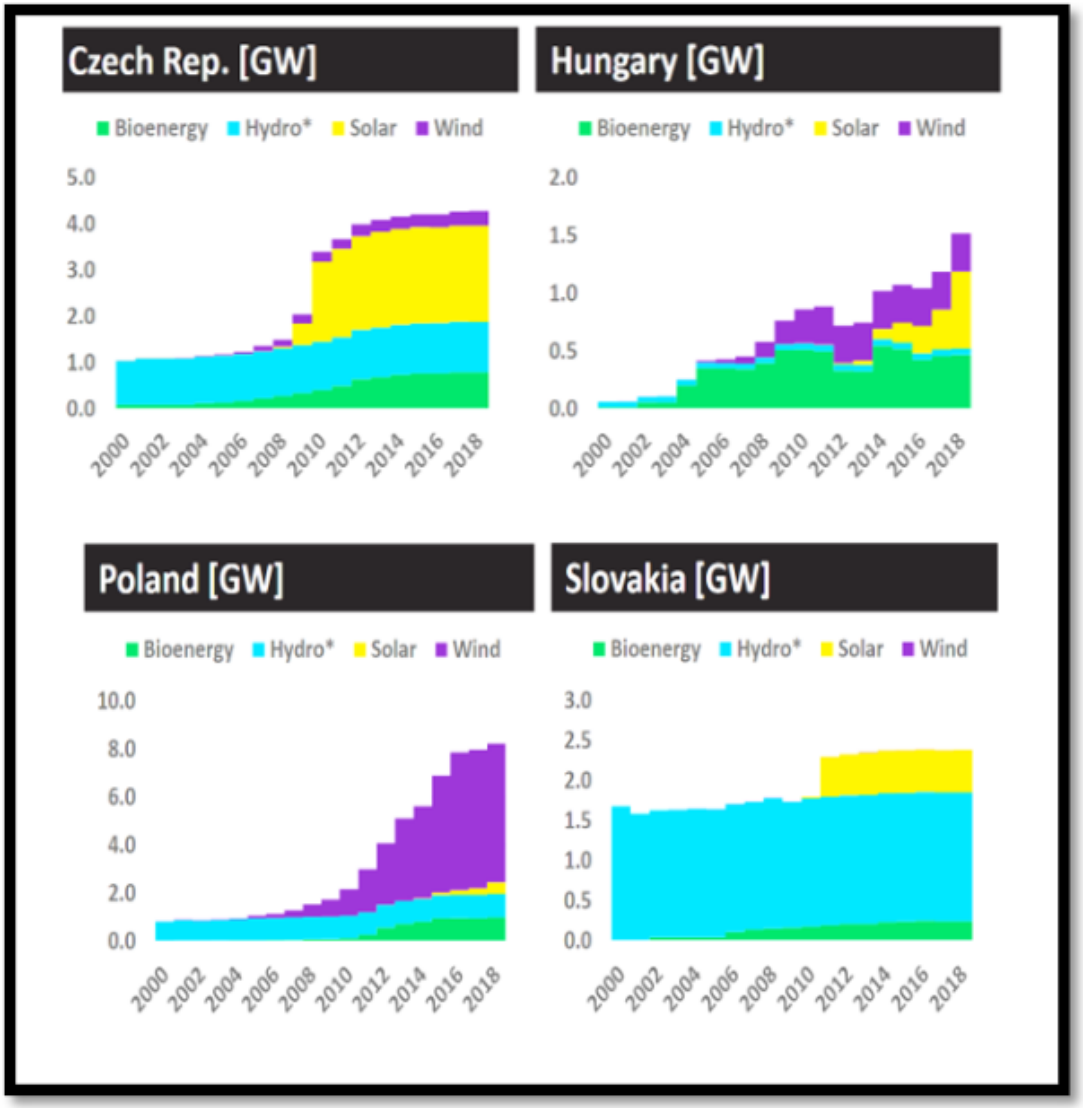

Figure 1. Development of renewable sources of energy (RES) by installed power in V4 countries, as of 2019. Adapted from [47].

The phasing out of the coal sector in the Visegrad countries will create a large number of unemployed people (90,000 in Poland and 20,000 in the Czech Republic), and it is also worth adding that the sectors providing services for mines and power plants employ four times as many workers, so the transformation in these countries should be carried out at a moderate pace [48]. Poland is in the worst situation when compared to other EU countries, because of its different starting point, economic, energy and technological conditions, reduction potential, and financial capacity. Therefore, the costs of the energy transformation will be the highest of all members of the community [41]. According to preliminary estimates of Polish government representatives, they will amount to EUR 240 billion and will be twice as high as the EU average. For this reason, Poland draws attention to the need for further financing of gas projects, which, in its case, as in the case of Hungary, will be the most effective and fastest way to reduce CO_2 emissions, and will become a transitional solution to the full achievement of climate targets [49]. The Czechs, on the other hand, are seeking, in the forum of the European Community, to classify nuclear energy as a green energy source. Such a change in the provisions would enable the three V4 countries to receive funds for developing the nuclear sector [49].

The energy infrastructure, especially the electricity system, is another problem arising during the system change. The electricity networks of the Visegrad countries and their

system interconnections with neighbouring countries have been designed, so that they are based on the energy produced from coal or an atom distributed from specific production sites to other regions of the country. When coal is removed from the energy mix, it will be necessary to redesign the entire energy infrastructure in each of these countries. Poland will have to redesign its entire electricity grid, because both offshore wind and nuclear energy are to be located in the northern part of the country, in contrast to the current location of generation sources in the south of the country [50].

It is also worth adding that all V4 countries continue to support the coal sector, regardless of the ageing, inefficient infrastructure, and the collapsing European coal sector. The actions of the governments of Poland and the Czech Republic, in particular, are aimed at maintaining the ideological significance of coal, because it plays an important role in the economy and appears to be an important element of sustainable prosperity. Over the decade in Poland by 2030, the government is expected to provide about PLN 150 billion for the coal sector [51], while, in the Czech Republic, subsidies for fossil fuels are not given separately, but are rather determined together with the costs of the transformation, which will amount to CZK 1–5 billion [52]. Slovakia allocates about EUR 100 million annually to the coal sector [19].

The politicians of the countries in this region consider the use of coal to be their significant comparative advantage, which ensures that they maintain an optimum level of energy security. Unconventional sources, on the other hand, are seen as a risky investment with a low rate of return in terms of energy security. It is worth adding that society (especially its younger generations) is increasingly often protesting against the continuation of coal policy, demanding the rapid implementation of the principles of the European Green Deal.

5. Conclusions

Energy transformation aims at economic prosperity through the creation of new jobs, greater energy independence, and CO_2 reduction. The transformation of the current system requires fundamental changes in the energy sector.

In recent years, many different programmes and strategies to mitigate climate change and, at the same time, to adapt to EU requirements have been initiated in the group of countries surveyed. All of the documents mentioned above talk about the promotion of renewable energy sources, which translates into a reduction in the production of energy from conventional sources, and the strategies of the V4 countries also assume the reduction of dependence on oil and gas imports from Russia. The Czech Republic, Slovakia, and Hungary are focusing on increasing energy production from the atom, which correlates with the reduction of CO_2 emissions.

The conducted analysis showed that the measures proposed in the Strategies and National Ecological and Climate Plans are insufficient for ensuring the required energy transformation and achieving the long-term goal of the Paris Agreement. Out of the four analysed countries, only Slovakia significantly increased its climate goals, especially in terms of reducing CO_2 emissions. Poland, the Czech Republic, and Hungary, on the other hand, increased their contribution to the EU's 2030 renewable energy target, but still below the recommendations that were issued by the European Commission. The analysed countries only slightly increased their ambitions in terms of energy efficiency. V4 members are not interested in a sharp reduction and gradual phasing out of fossil fuel subsidies. Poland and the Czech Republic have declared that they will continue to burn coal after 2030.

Three mutually exclusive factors influence the speed of the energy transformation of the Visegrad countries: environmental factor, technical factor, and acceptability factor. The environmental factor emphasises the impact of government policies on climate change, man and their environment. The technical factor refers to using the current state of the art in ensuring energy security. The acceptability factor takes economic and political aspects into account. In this case, we are faced with a paradox, because even the best zero-emission

technology is unacceptable if it entails too high financial and political costs. In fact, these factors correspond to three basic assumptions:

(1) continuity of energy;
(2) acceptability of prices to all consumers; and,
(3) environmentally friendly energy production and consumption.

The approach of the governments of Poland and Hungary, in particular to the implementation of RES, reflects their ambition to maintain strict control over the development of energy infrastructure. The wealth of national energy carriers is concentrated in the hands of state-owned enterprises. Thus, these state ambitions hinder decentralisation, as expressed in the EU strategy and limited competition.

The energy transformation is a huge challenge for the countries concerned, but it also provides an opportunity for economic growth and brings tangible benefits in the form of diversification of the energy balance and a cleaner environment. It is necessary to review the flexibility of the electricity systems in this group of countries, as the increasing penetration of photovoltaics and wind power on the electricity market will lead to grid loading and power cuts. The prerequisite for the success of the long-term transformation process is an appropriate adaptation policy, which is supported by national and European funds.

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References

1. Zhou, S.; Matisoff, D.C.; Kingsley, A.; Brown, M. Understanding Renewable Energy Policy Adoption and Evolution in Europe: The Impact of Coercion, Normative Emulation, Competition and Learning. *Energy Res. Soc. Sci.* **2019**, *51*, 2. [CrossRef]
2. Council of the European Union. Renewable Energy: Council Confirms Deal Reached with the European Parliament 27 June 2018. Available online: https://www.consilium.europa.eu (accessed on 9 October 2020).
3. Esperanza, M.; Perez, M.; Scholten, D.; Stegen, K. The multi-speed Energy transition in Europe: Opportunities and challenges for EU Energy security. *Energy Strategy Rev.* **2019**, *26*, 2.
4. Kratochvil, P.; Mišik, M. Bad external actors and good nuclear Energy: Media discourse on Energy supplies in the Chech Republic and Slovakia. *Energy Policy* **2020**, *136*, 1. [CrossRef]
5. Jóźwik, B. Transformation and economic development in the countries of Central and Eastern Europe. *Yearb. East. Eur. Inst.* **2016**, *58*, 50–51.
6. Kużelewska, E.; Bartnicki, A.R. Visegrad Group-New security challenges and prospects for cooperation. *Yearb. East. Eur. Inst.* **2017**, *11*, 103–104.
7. Kochanek, E. Regional cooperation on gas security in Central Europe. *Energy Policy J.* **2019**, *1*, 19–38. [CrossRef]
8. *Central Europe Energy Partners Recommendations for Trilouues on the Directive on the Promotion of the Use of Energy from Renewable Sources (RED 2)*; Central Europe Energy Partners: Bruxelles, Belgium, 2018; p. 1.
9. Dyduch, J.; Skorek, A. Go South! Southern dimension of the V4 state's Energy policy strategies–An. assesment of viability and prospects. *Energy Policy* **2020**, *140*, 2. [CrossRef]
10. Ascari, S. *The Gas Target Model for the Visegrad 4 Region. Conceptual Analysis*; OSW Report: Warsaw, Poland, 2013; p. 6.
11. *Polish Presidency of the Visegrad Group*; July 2020–June 2021; Visegrad Group: Visegrad, Hungary, 2021; p. 5.
12. Czech Statistical Office. Available online: https://vdb.czso.cz (accessed on 11 October 2020).
13. *Euracoal Market. Report*; Euracoal European Association for Coal and Lignite: Bruxelles, Belgium, 2019; p. 2.
14. *State Energy Policy of the Czech. Republic*; Ministerstvo Prumyslu a Obchodu: Prague, Czech Republic, 2014; p. 14.
15. *Fossil Fuel Support. Country Note. Czech Republic*; OECD: Paris, France, 2020; p. 1. Available online: http://stats.oecd.org/wbos/fileview2.aspx?IDFile=fdb82750-aae6-473d-92e2-dffcdb832618 (accessed on 11 October 2020).
16. Czech Republic—Energy. Available online: https://www.privacyshield.gov/article?id=Czech-Republic-Energy (accessed on 12 October 2020).
17. *Energie 2020–část Uhelná Energetika*; Hnuti Duha: Brno, Czech, 2020; p. 7.
18. Polanecky, K.; Duha, H. *Climate Policy Implementation in the Czech Republic*; Visegrad Found: Bratislava, Slovakia, 2018; p. 7.
19. Furmanczuk, Z. *Climate and Energy Policy in Slovakia*; Slovak Renewable Energy Agency: Bratislava, Slovakia, 2018; p. 2.
20. *Energy Policies of IEA Countries*; The Slovak Republik, IEA: Bratislava, Slovakia, 2018; p. 58.

21. Schneider, M. *The World Nuclear Industry. Status Report 2020*; The World Nuclear Industry: Paris, France, 2020; p. 82.
22. The Slovak Energy Transition-Decarbonization and Energy Security. Available online: https://energytransition.org (accessed on 15 October 2020).
23. Nyga-Łukaszewska, H.; Aruga, K.; Stala-Szlugaj, K. Energy Security of Poland and Coal Supply: Price Analysis. *Sustainability* **2020**, *12*, 2541. [CrossRef]
24. Brown Coal. Available online: www.geoportal.pgi.gov.pl/surowce/energetyczne/wegiel_brunatny (accessed on 19 October 2020).
25. Rybak, A.; Manowska, A. The future of crude oil and hard coal in the aspect of Poland's energy security. *Energy Policy J.* **2018**, *21*, 142–143. [CrossRef]
26. Natural Gas. Available online: www.geoportal.pgi.gov.pl/surowce/energetyczne/gaz_ziemny (accessed on 19 October 2020).
27. Ruszel, M. The significance of the Baltic Sea Region. for natural gas supplies to the V4 countries. *Energy Policy* **2020**, *142*, 5.
28. Bartczak, A.; Budziński, W.; Gołębiowska, B. Impact of beliefs about negative effects of wind turbines on preference heterogeneity regarding renewable energy development in Poland. *Resour. Conserv. Recycl.* **2021**, *169*, 3. [CrossRef]
29. Ciepiela, D. Polish Power Plant Will Be Built After 2030. Available online: https://energetyka.wnp.pl (accessed on 2 November 2020).
30. *Energy Policies of IEA Countries. Hungary Reviev 2017*; IEA: Bratislava, Slovakia, 2017; pp. 146–149.
31. Bart, I.; Csernus, D.; Safian, F. *Analysis of Climate–Energey Polices Imlementation in Hungary*; Climate Strategy 2050 Institute 2018; Elsevier: Amsterdam, The Netherlands, 2018; p. 5.
32. Eurostat. Available online: https://ec.europa.eu/eurostat (accessed on 31 March 2021).
33. Olczak, K. European Union policy in relation to renewable energy sources-legal framework. *Legal Econ. Stud.* **2016**, *50*, 94.
34. Tanil, G.; Jurek, P. Policies on renewable energy at the European and national level of governance: Assessing policy adaptation in the Czech. Republic. *Energy Rep.* **2020**, *6*, 549–550. [CrossRef]
35. *Development of the Renewable Energy Sector*; NIK Report; NIK: Warsaw, Poland, 2017; p. 11.
36. Heuer, D. *Just Transition in Czech. Republic*; Visegrad Found: Visegrad, Hungary, 2018; p. 2.
37. *RE:START-Strategy for Economic Restructuring of Czech. Coal Regions*; UE: Bruxelles, Belgium, 2019; p. 4.
38. *Low-Carbon Development Strategy of the Slovak Republic until 2030 with a View to 2050*; United Nations Climate Change: Bonn, Germany, 2020; p. 30.
39. Slovakia Coal Phase-Out. Available online: https://www.poweringpastcoal.org/members/slovakia (accessed on 30 November 2020).
40. *National Energy and Climate Plan for 2021–2030*; Ministry of State Assets: Warsaw, Poland, 2019; pp. 24–29.
41. Poland Agrees Coal Mining Phase Out with Unions by 2049. Available online: https://www.climatechangenews.com/2020/09/25/poland-agrees-coal-mining-phase-unions-2049/ (accessed on 30 November 2020).
42. *Energy Policies of the Slovak Republik*; Ministry of Economy of the Slovak Republic: Bratislava, Slovakia, 2014; p. 54.
43. *Integrovaný Národný Energetický a Klimatický Plan na Roky 2021–2030*; Ministerstvo Hospodarstva Slovenskiej Republiky: Bratislava, Slovakia, 2019; p. 41.
44. *State Environmental Policy 2030*; Ministry of Environment: Warsaw, Poland, 2019; p. 17.
45. *Climate Protection Policy of the Czech Republic*; Ministry of the Environment of the Czech Republic: Warsaw, Poland, 2017; p. 5.
46. Krupa, K.; Kowalewski, K.; Gacki, M.; Moskwik, K. *Power System Flexibility-A Pivotal Enabler of An Efficient Energy Transition. Assessment and Proposed Ways Forward for the V4 Counties*; Jagiellonian Institute: Kraków, Poland, 2020; p. 6.
47. *EU Coal Regions: Opportunities and Challenges Ahead*; European Commission: Bruxelles, Belgium, 2018; pp. 25–64.
48. Ciepiela, D. The Cost of Poland's Energy Transformation until 2030 is EUR 240 Billion. Available online: https://www.wnp.pl (accessed on 12 November 2020).
49. Ogrodnik, Ł. Czech. Republic in the Process of Climate and Energy Transformation. *PISM Bull.* **2020**, *183*, 2.
50. Szabo, J.; Fabok, M. Infrastructures and state-building: Comparing the Energy politics of the European Commission with the governments of Hungary and Poland. *Energy Policy.* **2020**, *138*, 6. [CrossRef]
51. Sielicka, U.; Śniegocki, A.; Wetmańska, Z. *Hidden Coal Bill 2017*; WiseEuropa: Warszawa, Polonia, 2017; p. 33.
52. Van der Burg, L.; Trilling, M.; Gençsü, I. *Fossil Fuel Subsidies in Draft EU National Energy and Climate Plans*; ODI: London, UK, 2019; Volume 562, p. 15.