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Polish-Hungarian Cooperation for **Energy Security** in the context of **Energy Transition** and **Economy Competitiveness**

IGNACY ŁUKASIEWICZ INSTITUTE for ENERGY POLICY

WACŁAW FELCZAK POLISH-HUNGARIAN COOPERATION INSTITUTE

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PREFACE

Poland and Hungary share a common history, both countries are allies of the United States, members of the North Atlantic Alliance (NATO) and the European Union (EU), as well as founders and members of the Visegrád Group. Above all, however, the strengthening of common interests is realised in the economic sphere through geographical proximity, mutually attractive markets and cultural proximity.

Polish-Hungarian trade is growing year by year. More Polish companies are still entering the Hungarian market. Poland is Hungary's fourth trading partner and third supplier of goods. The biggest part of the exchange consists of products of the electrical-machine, chemical and metallurgical industries. Also from the Hungarian point of view, Poland is a promising market, especially for the largest Hungarian industries, such as pharmaceuticals, plastics, construction and tourism. The most important Hungarian products exported to Poland are machinery and equipment, electrical equipment, vehicles and transport equipment, chemical products including mainly medicines and pharmaceutical products, plastics, and food industry products. Bilateral trade turnover reached more than 10 billion Euros in 2019 [1]. The level of Hungarian direct investment in Poland at the end of 2019 reached €1.325 billion. Polish direct investments in Hungary at the same time amounted to €1.223 billion. At the end of 2018, 126 entities with Hungarian capital were operating in Poland. In the same period, 50 companies from Hungary were present on the Polish market with investments exceeding USD 1 million [2]. At the same time, the two countries are also competing economically for end-customers in third countries. A key role is played by the energy sector, which contributes to raising or lowering the level of competitiveness of final products.

The prosperous trade exchange between Hungary and Poland motivates the governments of both countries to seek further opportunities for the development of interstate economic cooperation. One challenge has been the global coronavirus pandemic, which last year led for the first time in the modern history of Polish-Hungarian relations to a decline in the volume of trade by about 8% [2]. One of the areas of the economy that can contribute to post-pandemic economic recovery, further strengthening of Polish-Hungarian cooperation, and additionally increasing the security of both countries is the energy sector. A strategic assessment of the energy policy vectors of Poland and Hungary to date indicates certain differences in the approach of the two countries to these issues. It is, however, possible to find a common denominator in the actions of both countries and to set it in the existing political and strategic realities in such a way as to indicate the scope for closer cooperation between Poland and Hungary. This issue is energy transition, which is inextricably linked with building economic competitiveness.

In Poland, the share of renewable energy in the energy mix is about 12%. The Polish energy mix is dominated by coal, of which a significant part is also imported – in 2020 it was almost 13%. Despite this, Poland's hard coal reserves are among the largest in Europe, and natural gas production covers domestic household demand. Meanwhile, Hungary is poor in fossil energy sources – oil and natural gas production supply only 10% and just over 15% of domestic demand respectively. On the other hand, Hungary is one of the 11 EU member states that already met their 2020 targets in 2018, even though the country's renewable energy share has been declining since 2013. The main differences in the characteristics of the energy sectors of the two countries relate to their natural conditions. Hungary has a large potential for solar energy production, while for Poland the dominant potential lies in wind energy.

Among renewable energy sources in Hungary, biomass is the largest. Hungary has some of the best geothermal resources in the EU, providing hot water – mainly used in spas, usually without heat recovery. Since 32% of final energy consumption takes place in the residential sector, energy efficiency of buildings is a central sector of climate policy in Hungary. This sector presents a significant potential for energy savings, which overall could reach up to 150 PJ. This is because a significant part of the building stock in Hungary is technically outdated, lacking adequate insulation or efficient heating systems. This is especially true for the single-family homes that make up ⅔ of buildings. For these reasons, household energy costs are higher than the EU average as a share of total household expenditure.

In Poland, the overall share of renewable energy sources remains at over 12%. Meeting EU climate and energy policy targets by 2030 may be a challenge for Poland. The share of hard coal and lignite in Poland's energy mix is to decrease by nearly 20% by 2030. It is important to note that Poland has huge wind potential due to its geographical location, and with the current capacity of 5.8 GW it is the seventh country in the EU in terms of energy production from this source. The dynamic development in this sector was interrupted in 2016 when the government introduced a similar spatial regulation as in Hungary. However, new projects are now emerging, primarily involving offshore wind energy. In terms of wind energy, Poland is in a very good position compared to the countries of the region and can easily double its current capacity to 12 GW, according to experts, while Hungary could develop its wind power capacity to approx. 1-3 GW.

Both Poland and Hungary have a number of different support programmes for energy transition, including the development of renewable energy sources. In Hungary, operational programmes offer 100% subsidies for the renovation of public buildings. “The Warm Homes Programme” aims to increase energy efficiency and the use of renewable energy sources in households. In support of electromobility, the "Jedlik Ányos Terv" programme was established. The “METÁR” system, on the other hand, offers different types of subsidies to solar energy producers of different sizes. In Poland, too, there is a range of renewable energy support programmes. The "Clean Air" programme co-finances replacement of heat sources and thermo-modernisation of buildings. The "My Electricity Plus" programme is designed to subsidise photovoltaic micro-installations. The "My Water" programme supports installations allowing rainwater and snowmelt to be managed. The "Agroenergia Plus" programme, on the other hand, supports the development of prosumer energy in rural areas by supporting the purchase and installation of renewable energy sources on farms.

However, support for developing the share of renewable energy does not have to involve public money, but should provide a stable legislative and institutional framework, driven by political will. It should also ensure that renewable technologies have a level playing field in the energy market. One of the problems is network infrastructure. The network, which is more or less financed by new renewable projects, must be developed accordingly. Capital requirements to upgrade renewable energy investments in a given country are also evident. Engineers are able to provide solutions to these problems if given a clear signal from the state (legislation, financial framework). A signal must also be given to the companies that are ultimately responsible for solving the practical aspects of this problem. Compared to Western European countries, the legislation in the Visegrád Group countries appears to be rather hostile towards renewable energy sources and quite unstable. It happens that in a short period of time a completely new legal situation is created, which is unacceptable from an investor's perspective, and banks are reluctant to finance even good projects. Even if they are willing to commit capital, higher interest rates will create a competitive disadvantage compared to investing in Western Europe.

As can be seen from the above statements, the reference to the energy transition includes an analysis of the political, economic and social changes in Europe, which significantly affect the energy security and development of Poland and Hungary. Meeting the EU's climate targets is a challenge for both countries, which are struggling with problems of air pollution and the high energy intensity of their economies. These challenging topics are addressed in this book.

The first chapter is devoted to energy security issues on NATO's Eastern Flank, of which Poland and Hungary are a part. Given the level and directions of critical energy fuel imports to these countries, it is in their strong interest to strengthen their eastern flank. The expansion of the NATO Pipeline System creates significant energy security potential, but also puts these countries in a new negotiating position for fuel supply contracts.

The second chapter attempts to trace the evolution of the energy and climate policy of the European Union – an extremely important issue from the perspective of Poland and Hungary. The chapter also shows some of the paradoxes of EU policy in this area, the consequences of which have to be dealt with by Member States.

The next chapter examines the possibilities for Polish-Hungarian cooperation in three energy sectors important for both countries: nuclear, coal and gas. The potential of these countries and the opportunities for development in these sectors are analysed, taking into account the changing external conditions, dictated, among other things, by membership of the European Union.

The fourth chapter concerns an assessment of the significance of natural gas in the energy policy of Poland and Hungary. In addition to the characteristics of the gas sector and a comparison of key indicators, the analysis examines natural gas prices and their impact on the competitiveness of the economies of both countries. Issues related to gas infrastructure, the policy of diversification of natural gas supply sources, and the projection of gas infrastructure development in this part of Europe are important elements of the chapter.

The fifth chapter corresponds in a way with the first, by taking up the issue of energy security but analysing it from the perspective of the Three Seas Initiative. This initiative creates specific conditions for natural gas imports to Poland and Hungary, especially as regards the possibility to diversify supply directions.

In turn, the sixth chapter is refers to the issues raised in chapters two and three. The reader will find here a case study of the Paks nuclear power plant in the context of Hungary's attitude towards the European Green Deal. The chapter points to the clash of different perspectives of Eastern and Western European countries, which the European Commission has to reconcile in its efforts to achieve environmentally friendly energy.

The next chapter, the seventh, analyses the potential of renewable energy sources and supporting energy transition policies in the face of economic initiatives for Poland and Hungary. The analysis is based on the resource potential model, which allows the impact of renewable energy sources on the economic and market potential of countries to be isolated.

The final chapter eight focuses on the economic and energy consequences of coal use in Poland and Hungary. Although Poland and Hungary have significantly different conditions in terms of coal production and consumption, this area illustrates well the similarities between the energy transition paths of the two countries.

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Chapter 1

Enhancing energy security on NATO's eastern flank: the case of the NATO Pipeline System

Dominik P. Jankowski

1. Introduction: NATO and energy security

Over the last decade, energy security has become a permanent element of NATO's strategic thinking, integrated into numerous NATO policies and activities. There is no single, comprehensive definition of energy security – including in NATO – that does justice to its multi-dimensional and complex nature. The more productive way to approach this definitional problem is to distinguish clearly between the differing ways in which the concept is applied in practice. According to Roland Dannreuther, three distinctions are particularly relevant in this regard.

The first is to "recognise that the meaning and definition of energy security differs significantly whether applied to the perceived risks and threats that come from deliberate, intentional acts as against those that are more indirect, unintentional and complex. In practice, this is less of a binary distinction and more of a continuum from one extreme to the other [1]." The second distinction involves the recognition that when analysing energy security the important point of reference are specific sources of energy. "There are, though, significant differences in how the concept of energy security is applied relative to the particular energy source being considered. There is, firstly, the particularity of the energy source itself, whether it be oil, gas, coal, nuclear or the different forms of renewable energy. There are, secondly, the ways, in which energy security is applied in different ways according to the particular activities along the global value chain. These typically extend from exploration to production, transportation, processing and consumption. A third element is the actual value of the source whether defined in terms of its market price or in terms of economic rent [1]." The third distinction to be made is between energy security as applied to energy fuels, such as oil and gas, and as applied to the services that these energy sources support. "In a sense, this could reasonably be argued to be a more legitimate focus for concerns over energy security as energy resources are not inherently valuable in themselves but are valuable for the services and benefits that they offer. These services include most of the advances in prosperity and well-being of our modern industrial civilisation – services such as heating, transportation, communications, food, consumer products and housing. In a modern society, the enormous increases to the collective social well-being that these services provide are ultimately underpinned by, and would not be possible without, the modern energy systems on which they depend [1].”

John S. Duffield, in his book “Fuels Paradise. Seeking Energy Security in Europe, Japan, and the United States”, defines four key dimensions of energy security. “The first dimension is adequacy or sufficiency: is the total volume of energy supplies enough to meet reasonable present and future needs? To this should be added enough energy to satisfy the energy requirements of a state’s military forces. The second dimension is reliability or certainty: are energy supplies potentially subject to disruptions and interruptions of a significant magnitude of duration? Here we see that energy security also includes an important element of risk. The third dimension is economic affordability: are energy supplies available at reasonable prices? The challenge here is to distinguish such threats from more quotidian concerns about the effects of energy prices on the standard of living and economic competitiveness. The fourth dimension is the most difficult to summarise but captures all the other ways in which dependence on external energy supplies might threaten a state’s national security. Thus, for example, energy supplies must be adequate, reliable, and economically affordable without involving the acceptance of political conditions that might compromise a state’s political independence and freedom of action [2].”

As for international organisations, the International Energy Agency defines energy security as the uninterrupted availability of energy sources at an affordable price [3]. NATO has not agreed its own definition, as for many years Allies have struggled to clearly define NATO’s role in energy security. Hence, for the purpose of this article the following definition of energy security will be used: “a stable and reliable energy supply, the diversification of routes, suppliers, and energy resources, including the integration of sustainable energy sources, and the interconnectivity of energy networks, are all of critical importance and increase our resilience against political and economic pressure [4].”

In fact, rebuilding energy security prominence in the Alliance was not easy, especially as this policy was considered primarily a question of national security in the post-Cold War era. It was only at the 2008 Bucharest Summit that NATO was given a dedicated, yet limited, mandate to work in this field. The mandate, based on a set of principles and guidelines, included information and intelligence sharing, projecting stability, cooperation on consequence management, and support to the protection of critical energy infrastructure. In 2010 NATO’s Strategic Concept, Allies underlined that they “will ensure that NATO has the full range of capabilities necessary to deter and defend against any threat to the safety and security of our populations. Therefore, [they] will develop the capacity to contribute to energy security, including protection of critical energy infrastructure and transit areas and lines, cooperation with partners, and consultations among Allies on the basis of strategic assessments and contingency planning [5]. " For the first time, energy security was clearly linked with NATO's core business, i.e. deterrence and defence.

The NATO work on energy security covered several areas over the last decade. "First, NATO follows the energy trends and aims to enhance its strategic awareness and that of the Allies of the energy field. Second, NATO provides an arena in which its Members can exchange information, intelligence, best practices and consult on energy developments that could have security implications, including at the highest levels in the framework of the North Atlantic Council. Third, the Alliance also supports critical energy infrastructure protection. While the protection of energy infrastructure remains mainly a national prerogative and responsibility, NATO provides training and support to the Allies and partners. Fourth, NATO draws on its maritime security capabilities to provide surveillance of maritime routes and choke points that are crucial for the transport of fuel. Last but not least, NATO paid in the last decade increasing attention to issues of green defence trying to make its operations more energy efficient and more environmentally friendly [6]."

In the recent years, NATO's energy security agenda has become even more structured and coherent, focusing on three major areas: enhancing strategic awareness of the security implications of energy developments, supporting the protection of critical energy infrastructure, and enhancing energy efficiency in the military. However, a true game changer for NATO's energy security agenda was the Russian-Ukrainian conflict, which became a catalyst for the long-term military adaptation of the Alliance. It triggered a more ambitious Allied approach to enhancing national resilience, including energy supplies [7]. At the same time, a serious discussion about the military aspects of NATO's role in energy security started, including in the context of collective defence. In short, a crucial question emerged: whether NATO forces – adapted since 2014 in terms of quantity, quality and readiness – can be supplied with the necessary fuel at all times throughout the entire SACEUR's Area of Responsibility (AOR). In this context, Allies rediscovered a forgotten defence asset: the NATO Pipeline System (NPS) which consists of nine separate pipeline and storage facilities running through the territories of thirteen Allies. An extension of the NPS network would likely contribute to the energy security of NATO as a whole with respect to military preparedness and mobility, economic benefit advantages for host nations, including Poland and Hungary, and long-term environmental benefits.

2. The NATO Pipeline System (NPS)

2.1. NPS past: from PLUTO to CEPS

The NATO Pipeline System, which was set up during the Cold War, can be considered as the distant heir of PLUTO (Pipe-Lines Under The Ocean), a single-product pipeline lying on the seabed, constructed by the Western Allies during World War II. A reliable supply of fuel for the advancing Allied forces, following the invasion of Normandy, was of the highest priority. Planners knew that this would be the largest amphibious landing in history and without adequate and reliable supplies of fuel, any advance would at best slow down, and at worst, grind to a halt. Conventional oil tankers and "ship to shore" did not constitute a credible solution as they were in danger of cluttering up the beaches as well as obstructing the movement of soldiers, armaments and materials. Conventional oil tankers could be also easily slowed down by bad weather and changing sea conditions. In fact, operation PLUTO, which ultimately ceased in 1945, was an innovative solution which helped to create vital arteries enabling movement of Allied forces.

NATO started its work on a dedicated pipeline system in the 1950s. In 1954, the North Atlantic Council (NAC) set up a Working Group in charge of studying the Supervision, Operation and Maintenance of the NATO Pipeline System. In 1955, this Working Group decided to entrust the organisation of the pipeline system for the Central Europe area to an ad hoc working group made up of representatives from the countries concerned. A second working group, composed of representatives from the host nations and user nations located in the north and south command zones, was tasked with examining the question of how to organise the system for the north and south European regions.

In 1955, the North Atlantic Council approved the Working Group's report together with its two main recommendations. First, the pipeline networks must be capable of meeting military requirements at all times. Second, it was proposed to structure the NATO system as follows:

- Central Europe region – NATO Pipeline Committee – Central Europe Pipeline Policy Committee – Central Europe Pipeline Office – Central Europe Operating Agency;
- North and South European regions – NATO Pipeline Committee – national pipeline agencies (made up of representatives from the NATO nation hosting a particular pipeline system).

In 1956, when the Working Group in charge of studying the Supervision, Operation and Maintenance of the NATO Pipeline System was disbanded, an Ad Hoc Working Group on Pipelines was created. Its purpose was to examine the proposals submitted by the French Delegation seeking a revision of the already agreed documents in connection with the Central Europe area. France felt that it was necessary to decentralise the NATO Pipeline System as much as possible in order to ensure that it operated smoothly. With this in mind, it suggested that a national pipeline operating agency be set up in each user nation. The Working Group prepared a report which contained a specific project for the organisation of the NATO Pipeline System in the central European region. The Council approved the document and decided to recommend that interested countries immediately establish the proposed organisation.

It became apparent that NATO needed a permanent structure to manage the pipelines and fuel issues. In 1956, the NAC decided to set up the NATO Pipeline Committee[1], which was tasked to act on its behalf, in close cooperation with NATO military authorities and other competent bodies (such as the Central Europe Pipeline Office), on all matters pertaining to the supervision, operation and maintenance of the infrastructure of pipelines of likely interest to NATO as a whole.

All this work, including the two reports by the Working Groups, laid the ground for the establishment of the Central Europe Pipeline System (CEPS). The CEPS was officially created in 1958 as a joint project between NATO and originally eight nations[2] for coordinating and interconnecting national facilities. The military mission of the CEPS was clear: to satisfy the operational requirements during peace, crisis and war for the transport, storage and delivery of fuel in the central European region. It was funded from the NATO Common Infrastructure Programme. Progressive expansion of CEPS resulted in lines stretching into Germany to serve the Allied forces. Since the 1960s, following the approval by the NAC in 1959 of the principle of commercial use for non-military purposes of the NPS, the transport, storage and delivery capability of the CEPS has also been offered to non-military clients.

After over 60 years of operations, the Central Europe Pipeline System still remains the largest element of the NATO Pipeline System. The CEPS currently consists of 5,279 kilometres of pipelines and 1.2 million m^3 of jet fuel storage. It is connected to six sea entry points, nine storage facilities, 12 refineries and three civil pipeline systems. The CEPS helps to transport over 12 million m^3 of fuel per year for both military and non-military purposes, including jet fuel as well as point-to-point transport of diesel, gasoline and naphtha.

[1] The committee still exists. It was renamed the NATO Petroleum Committee in March 2008 to better reflect its wider role and responsibilities. Its present name – the Petroleum Committee – was adopted in June 2010 after a review of NATO committees aimed at introducing more flexibility and efficiency into working procedures. At that time the Petroleum Committee also came under the Logistics Committee.

[2] Belgium, Canada, France, Germany, Luxemburg, the Netherlands, the United Kingdom, the United States. Canada and the UK no longer partici-pate.

Figure 1. The Central Europe Pipeline System

Source: NATO Support and Procurement Agency

2.2. NPS today: why it still matters

The Central Europe Pipeline System, although the best known, is only one of nine elements of the whole NPS. The other eight include:

- the Greek Pipeline System (GRPS; 783 km);
- the Icelandic Pipeline System (ICPS);
- the North European Pipeline System located in Denmark and Germany (NEPS; 676 km);
- the Northern Italy Pipeline System (NIPS; 797 km);
- the Norwegian Pipeline System (NOPS; 99 km);
- the Portuguese Pipeline System (POPS; 123 km);
- the Turkish Pipeline System (TUPS; 3,204 km), comprising two separate pipeline systems known as the Western Turkey Pipeline System and the Eastern Turkey Pipeline System.

In total, the NPS is almost 11,000 kilometres long and provides 4.2 million m^3 of fuel storage. Yet, until at least 2016 the NPS was undergoing a stark restructuring with an aim to deactivate the installations no longer in use, rationalise the layout of the system and generate cost reductions. The emphasis has also shifted away from static pipeline infrastructure to modular concepts in support of NATO's out-of-area activities, such as operations in Afghanistan and Libya. These trends had a severe impact on the NPS and the perception of its importance. In 2015, this led, inter alia, to the sale of the UK Government Pipeline and Storage System (UKGPSS; ca. 2500 km), previously an element of the NPS, to the Spanish Compañía Logística de Hidrocarburos [8].

Nevertheless, the NPS still matters. In fact, three main arguments should be taken into consideration.

Firstly, the military dimension remains key[3]. On the one hand, the NPS has already proven to be a reliable logistics asset in support of NATO operations in Bosnia, Kosovo, Afghanistan and Libya[4]. On the other hand, Russia's posture and its continued military build-up, large-scale, no-notice snap exercises and the growing number of exercises with a nuclear dimension triggered a military adaptation response from NATO. As a result, the Alliance has placed renewed emphasis on deterrence and collective defence. The four subsequent NATO summits in Newport (2014), Warsaw (2016), and twice in Brussels (2018 and 2021) significantly changed the deterrence and defence posture of the Alliance. In fact, the enhanced NATO Response Force (eNRF) as well as the newly created Very High Readiness Joint Task Force (VJTF) and Forward Presence (both enhanced Forward Presence

[3] The CEPS is directly connected to over 20 military airbases, including the U.S. airbases in Germany (Ramstein and Spangdahlem).

[4] In 2018, the military volumes transported by the CEPS reached 715,000 million m^3 of fuel. In 1996 (operation in Bosnia), 1999 (operation in Koso-vo) and 2003 (operation in Afghanistan) they exceeded 1.5 million m^3 of fuel. In 2011 (operation in Libya) they exceeded 1 million m^3 of fuel.

and tailored Forward Presence) coupled with the reinvigoration of the culture of NATO readiness and responsiveness require adequate logistical support, including reliable access to energy supplies. As confirmed at the 2021 NATO Summit, Allies "will continue to give high priority, both nationally and in the Alliance, to ensuring enablement of SACEUR's Area of Responsibility to improve our ability to support the deployment and sustainment of Allied forces into, across, and from the entire Alliance territory. These efforts include taking forward our work on fuel supply distribution arrangements [9]." In fact, the NATO Pipeline System can help to ensure the Allies' ability to provide fuel to their military forces in support of Article 5 operations. The NPS, if properly enhanced, can also play a vital role in the enablement of the entire SACEUR AOR.

Secondly, the economic dimension continues to frame the discussion. The NATO Pipeline System is in peacetime an important commercial endeavour. The non-crisis capacity of the NPS has been made available to the civil market. The commercial use of the system helps in meeting the maintenance and storage requirements as well as resulting in well-trained and proficient system operators. The revenues generated contribute to lowering the operational costs. For example, the CEPS is the main supplier of fuel to major European airports, including direct connection to Schiphol-Amsterdam, Frankfurt, Köln-Bonn, Brussels-Zaventem, Bierset-Liège and Findel-Luxemburg. At the same time, the business cases cannot impede the functioning of the NPS in the times of war. Therefore, from the NATO perspective, the "military priority clause" remains essential as it assures priority for the armed forces and helps the NPS to fulfil its core mission.

Thirdly, the environmental dimension is becoming more significant. NATO is not the first responder to climate change, but has a role to play [10]. The NATO Pipeline System also considerably contributes to the reduction of the Allied ecological impact. Pipelines are less energy consuming than rail, road and water transport. In fact, when it comes to transporting oil, pipelines are the least greenhouse gas (GHG) intensive way to do so. Pipelines reduce the GHG emissions by anywhere between 61 to 77 per cent versus rail for transporting oil over long distances [11]. Moreover, the NATO pipelines are also all buried underground and require substantially less land to build in comparison with the construction of highways or railways. In fact, the CEPS transports the daily equivalent of approximately 1,100 trucks on the roads on an average distance of 400 kilometres. Transport of fuel by truck over long distances should, therefore, be assessed as a non-viable option due to both traffic but also environmental constraints. In short, the NATO Pipeline System significantly improves NATO's "green" profile.

2.3. NPS future: enhancing NATO's eastern flank

All three arguments are vital in keeping the NPS operational in the future. At the same time, it cannot be denied that the current structure and existing locations of the NATO Pipeline System reflect Cold War realities and do not take into account either NATO's enlargements or the present complexity and size of SACEUR's AOR. The entire NATO eastern flank[5], but in fact also half of the territory of Germany, remain a white spot on the NPS map. In this context, the extension of the NATO Pipeline System should be considered as an important element of NATO's further military adaptation to enhance security on NATO's eastern flank. Three components remain key in any further assessments.

Firstly, there is a clear political need to continue to bridge the infrastructural discrepancies between different strategic directions of the Alliance. The number of NATO military facilities on the territory of the eastern flank has been steadily growing. Yet, a significant imbalance still exists to the detriment of the eastern flank Allies. Pipelines should be viewed as an essential element of critical infrastructure that could help to permanently rebalance the current state of affairs.

Secondly, the military circumstances have considerably changed on the eastern flank. Due to Russia's aggressive actions, NATO has increased the number of troops stationed in the region. Moreover, additional forces regularly rotate throughout the region for exercise purposes. Therefore, the fuel requirements are currently substantially higher. At the same time, Russia has significantly enhanced its military capabilities in the Western and Southern Military Districts, including the Anti Access/Area Denial (A2/AD) systems. In fact, the Kaliningrad Oblast and illegally annexed Crimea have become A2/AD bubbles. The Russian military, bearing in mind its capabilities and strategic objectives, is capable of disrupting the Allied fuel supply chain, including blocking the sea port terminals and hampering the functioning of road and rail operations. Such a scenario would have a negative impact on the logistics both for the forces already in theatre as well as the follow-on-forces. Finally, transporting fuel using road and train could be hampered due, inter alia, to lack of available rail tankers which can be primarily contracted from private companies, traffic disruptions, or limitations to the freedom of movement. The COVID-19 pandemic has clearly shown that NATO's ability to move can be hindered by non-military factors. Therefore, pipelines on the eastern flank would not only enhance the credibility of NATO's deterrence and defence posture, but also contribute to improving military mobility [12].

Thirdly, there are vital economic arguments. In the current circumstances, most of the eastern flank nations remain dependent on Russian fuel as well as Russian owned fuel distribution capabilities. In fact, several Allies have already undertaken measures to diminish this dependence. New pipelines could help to strengthen the ongoing diversification efforts and considerably diminish Russian economic and political leverage over the region which Moscow has tried to gain through Nord Stream 1 and 2 projects [13]. Moreover, the ongoing dynamic development of the civilian airport infrastructure on NATO's eastern flank, including the planned Solidarity Transport Hub in Poland and the recently announced

[5] For the purpose of this article, the following countries are being considered as part of NATO's eastern flank: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia.

large-scale airport development project in Hungary, with plans to build 4 to 5 international airports and a dozen runways around the country, will offer additional business opportunities and commercial sustainability for the potential extension for the NATO Pipeline System.

The extension of the NPS to NATO's eastern flank is an ambitious project which will face numerous challenges. Firstly, countries in the region, including Poland and Hungary, would have to assure the necessary financial resources to build the pipelines, as only some costs could be covered by the NATO Security Investment Programme (NSIP). Secondly, they would need to ensure long-term political and societal support for the project as its benefits would not be visible in the short term. Finally, the eastern flank countries would have to provide the necessary support to the development of the military requirements by upgrading or building logistics connections, including to sea ports and refineries.

Figure 2. Potential Eastern Europe Pipeline and Storage System (E2PS)

Source: NATO

3. Conclusions

Energy has always been a strategic input to war-fighting, but was typically viewed as the purview of logistics planners. Yet, "security, economic, and environmental factors have recently elevated energy to be considered as a system-wide strategic lever in the military, which will have lasting and positive results for war-fighting capabilities, and ultimately the civilian energy sector" [14].

For over six decades, the NATO Pipeline System has served Allies in times of crisis and peace, offering viable solutions for both missions and operations as well as to the civil market. The current security environment and NATO's renewed emphasis on deterrence and collective defence boost the importance of reliable energy supply to the Allied forces within SACEUR's AOR. In this context, the NATO Pipeline System remains an essential defence asset and its extension to the eastern flank, including to Poland and Hungary, should become an important NATO project in the coming years. This plan could be achieved by extending the existing pipelines – such as the CEPS or the NEPS – and/or by building a brand new pipeline infrastructure on NATO's eastern flank. With such an investment, the Allies would also further improve NATO's "green" profile.

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Chapter 2

Castle on sand?
The evolution of EU energy and climate policy and its potential paradoxes

Péter Rada, Attila Farkas

1. Introduction: the World in 2021

Over the last 30 years since the end of the Cold War, academia and the international relations experts have discussed how the emerging new security challenges can be managed in the frames of the existing institutions, which beyond doubt (would have) needed reform. 2020 was beyond question an unconventional year: the "Googleized", "Twitterized", or "Facebookized" international politics meant a myriad of interconnected processes, the global political awakening of people, and the emergence of new power centres paired with the forgotten challenge of an indeed global pandemic. Unfortunately, 2021 did not bring relief either, but the everyday problems should not overshadow the importance of managing existing problems, such as energy security in Central Europe and in the European Union.

When political scientists and international relations experts try to analyse certain foreign policy events, certain decisions by states, or any developments in international relations, they tend to use the conventional tools of IR. That is, international relations have been analysed by reflecting on the past. However, in years like 2020 and 2021 we cannot, or could not rely on the conventional wisdom.

In 2020 and 2021 we witnessed many challenges, which most probably will prove to be a turning point or a cornerstone in the development of international relations, and similarly in transatlantic relations. These challenges – to name only a few – were those that are widely analysed in the international political literature but convincing arguments have not yet been presented. Of course the Covid-19 global pandemic; the further problems with Russia and China; the non-decreasing number of terrorist attacks in the Western hemisphere; further environmental problems; the unsolved identity crisis in the EU – including the not properly managed Brexit, and the still pressing issues related to energy security of the EU.

In the last three decades, we had comprehensive debates about the new world order and consequently the challenges stemming from the new realities. During this period there were real changes and we witnessed events which were not or should not have been a surprise, but the common characteristics were that these events changed how we think about security challenges. Of course, the most significant were the series of systemic changes in 1989 in Central Europe and the dissolution of the Soviet Union in 1991. Later, 2001 and the simultaneous terrorist attacks in the United States woke up the world's military superpower from its strategic slumber and the global war on terror emerged as the most important priority of the Western alliance. In 2008-2009, the transatlantic allies ran out of money and the United States realised that it could not bear the burdens alone. Washington decided to pull back to moderate the American presence in Europe. 2014 is the next turning point because the Russian invasion of Ukraine called the attention to the original goal of NATO and that territorial defence is still valid. Simultaneously in 2015 the ongoing identity crisis of the EU manifested in the counterproductive political statements and dangerous steps trying to manage the illegal migration crisis. At the end of the first decade of the new century many publications tried to analyse the changes in international relations and they tried to predict the possible ways in which our world would develop. This became an even more valid question in 2020, and it is very important because if we understand our world better we can adapt to it more easily. It does not need further explanation if we think about how volatile the events can be even in a year. The 2010s began very pessimistically and continued even worse. We witnessed significant changes, which made us rethink what the new world order really is, the conclusions from 10 years before became outdated and the impetus of new analysis became stronger. We need add unfortunately that the start of the 2020s is no better, either.

The situation is even more serious because the unanswered challenges resulted in the emergence of a many new "security experts", who had specific opinions on the possible solutions without having deep understanding of the complexity of today's world. We need to accept and admit that the parallel challenges are very difficult to analyse with the conventional wisdom, and it is probably even more difficult to identify trends in their complexity. The securitised political communication is a trap for the European Union because we may lose ground in understanding and analysing the real challenges objectively. One of these challenges, or better to say threats, is the dependence of Central Europe and the European Union on energy. The energy security of Europe has never been a forgotten question, but we can honestly feel that in the myriad of other challenges we probably had less time, energy or opportunity to deal with it.

Our changing world has brought many simultaneous challenges, which have entailed serious headaches for the politicians and decision makers. It is true that even if most of these challenges were not new, the problem is their parallel existence and the EU has unsurprisingly struggled to find a real united solution. Some member states strived to follow the mainstream, whilst others tried to express their individual opinion and make their voice heard in Brussels. The two energy crises of the European Union in 2006 and 2009 are characteristic of this problem. It is a known story that Ukraine and Russia could not agree on the long term gas supply due to which Moscow decided to turn off the gas tap. Why was (is) it important for us in the European Union? Beyond doubt, the common energy policy of the European Union has been always a priority since the European Coal and Steal Community, but because of the enlargement especially after 2004 the basic characteristics of energy security as a challenge broadened. It brought to the surface the significantly different and at many times contradictory individual interests of the Member States. While some of the members have focused more on climate change and renewables, others simply could not change course due to the existing infrastructure and the dependence on external (Russian) sources. Even if there is some kind of common policy regarding energy security, we cannot forget for instance the existence of double standards in the way in which Brussels evaluates the Member States' efforts to decrease their energy dependency. The Nord Stream 1 and Nord Stream 2 projects prove that Member States still follow their own self-interests. However, before we come to an overly pessimistic conclusion too early, we should look at the evolution of the European Union's energy policy.

2. Evolution of EU energy policy

Energy policy has taken a long road since the initiation of the European Coal and Steel Community to becoming a shared competence between Member States and the EU. As of now, the limits of responsibilities between the two are defined by Article 194 of the Treaty on the Functioning of the EU.

The Treaty defines four key areas, or goals rather, which the common policy should strive for:

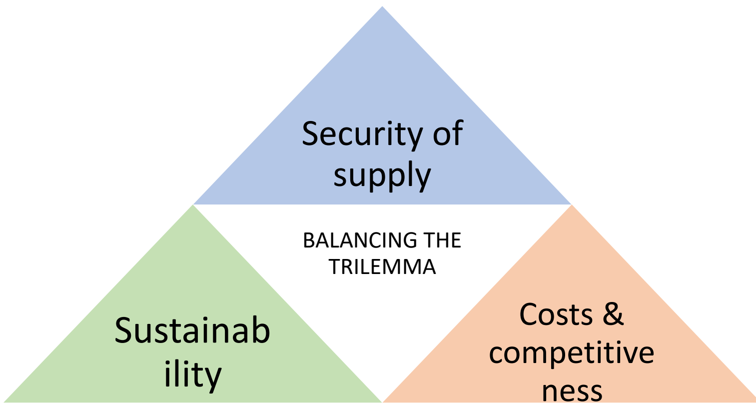
a) "ensure the functioning of the energy market;
b) ensure security of energy supply in the Union;
c) promote energy efficiency and energy saving and the development of new and renewable forms of energy; and
d) promote the interconnection of energy networks."

Although climate policy is less directly integrated into the Treaties, in Article 191 it says: "[Union policy shall contribute to pursuit of the following objectives:] promoting measures at international level to deal with regional or worldwide environmental problems, and in particular combating climate change." This reference can serve as the basis for the EU's increasing climate policy ambitions, expanding its energy policy to climate and energy policy (as the two fields are inherently linked [12].

These are the results of long development with a gradual broadening of EU coordinated areas and budgets [6]. One aspect has not changed, however: that Member States hold basically complete oversight and sovereignty over shaping their energy mix, i.e. what sources and with which technologies they produce energy[6].

The areas of the common energy policy try to cover all aspects of the well-known energy trilemma. The term was coined by the World Energy Council and refers to the three basic requirements of a modern energy system (from the perspective of the consumer): 1. Security of supply (sometimes vaguely referred to as energy security); 2. Affordability of using energy through competitive market structures; 3. Environmental sustainability of the energy system (localised pollution, GHG-emissions).

Figure 1. Energy trilemma - three basic requirements of a modern energy system



Source: Own elaboration based on World Energy Council

Ever since the Treaty of Rome, the central aim of European integration was to create an internal energy market. This process is still not finished even though significant steps have been taken in the last 15 years. The entry into force of the so-called Third Energy Package in 2009, the subsequent market design rules adopted continuously, the Winter Package in December 2016, and the regulatory changes in the Green Deal (mostly still as proposals under the Fit for 55 package)[7].

[6] As Article 194 of TFEU puts it: "[Measures taken under shared competence] shall not affect a Member State's right to determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply". Meaning that while common EU policies are possible – even desirable – a Member State's right to promote or prohibit certain technologies shall not be overridden (Szabo 2016).

[7] The Green Deal is the new framework introduced by the von der Leyen Commission that is supposed to centre EU decision-making on sustainability and climate issues. The major strategic goal is to strengthen the EU's cli-mate action to 2030 and 2050 and use this momentum to build a future-proofed green economy in Europe that can ensure competitiveness and a global leading role in the sector. To achieve this, numerous legislative doc-uments are modified, and new tools are introduced and proposed (e.g. the Carbon Border Adjustment Mechanism).

Energy security and the climate agenda (sustainability) are later additions and are more contested policy areas, as they are more politicised than the creation of the internal energy market. Following the gas supply crises of 2006 and 2009, the issue of gas supply and gas transit was securitised both by Member States and the Commission [7-8, 12, 14]. The disruption of Russian gas supplies and Ukrainian transit in early 2006 and 2009 due to political conflicts have highlighted the dependency of many (new) Member States on Russian natural gas shipped through Ukraine. The events created a window of opportunity to frame the supply security question as a common EU issue both by several Member States and the Commission. As a result, the Security of Gas Supply Regulation was accepted in 2010 establishing an EU security of supply framework, and certain EU funds were also mobilised to secure infrastructure investments like natural gas interconnectors and LNG-terminals. The Russian-Ukrainian armed conflict starting in 2014 and some subsequent energy security challenges have helped keep the issue on the agenda, as we will show later when discussing Nord Stream 2.

As the EU and several of its Member States aimed for a leading role in global climate action in the late 2000s, sustainability became an increasingly integral part of the common energy policy framework. In 2007, the Commission put forward the 2020 goals on renewable energy and GHG-emissions and the Renewable Energy Directive containing legally binding targets for Member States. After meeting the 2020 targets, and as the climate issue became more and more politicised globally and in Europe especially (see the emergence of the youth movements, the strengthening of the green political parties), the EU decided to deliver even more on climate policy. The 2030 targets were increased and by 2050 a net GHG-neutral EU was promised by the European Council in December 2020.

In terms of the legal background, however, the Lisbon Treaty is still the most defining step in the evolution of EU energy and climate policy. Although the creation of the Energy Union under the Juncker Commission, and now, the Green Deal under the von der Leyen Commission are politically significant messages and umbrellas for important legislative changes in many areas, all of them are based on Article 191 and 194[8].

Yet achieving an EU-led energy transition, the core idea behind the original concept of Energy Union, seems to be practically impossible without extending

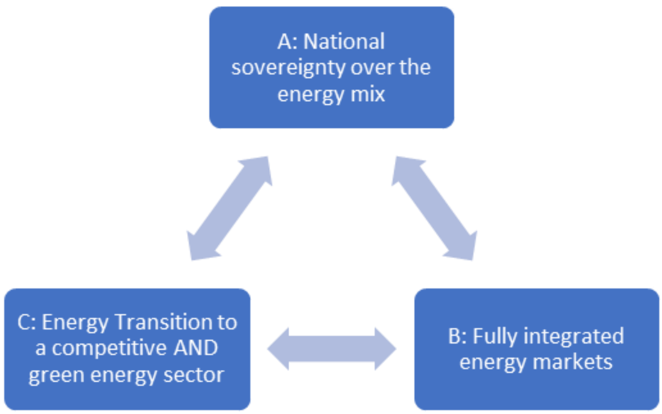
[8] The Energy Union framework divided the EU's energy and climate policy ambitions into five dimensions: 1. Diversification, energy security and soli-darity between Member States; 2. A fully integrated energy market without technical (infrastructural) or regulatory barriers; 3. Energy efficiency for se-curity and prosperity; 4. Emission reduction and global leading role in re-newables; 5. Supporting research and innovation to drive the energy transition. Alt-hough the Energy Union as a concept was not necessarily more than "being a list of all the things the Commission is currently doing, with some extra 'asks'" (Helm 2015, 4), it could still become a useful political instrument as the Commission was able to pursue the Europeanisation of a key sector while in many other areas the unity of the EU suffered blows (Brexit, migra-tion quotas, Eurozone) (Buchan and Keay 2016).

the competences and institutions of the European Union [3], even more so if we add the new drive on the climate agenda, which has even weaker foundation in the Treaties.

3. The paradox of the current EU energy and climate policy

The notion that the EU might see a discrepancy between its ambitions in climate and energy policy and the legal foundation becomes especially problematic as the EU's goals (fully integrated and liberalised markets, a quick but economically efficient energy transition) and tools, abilities (the need to respect national sovereignty over the energy mix) do not meet; they are in a somewhat paradoxical relation to each other [15]. The paradoxical situation may be shown as an 'impossible triangle' where only two points can be achieved under the status quo, but not all three at the same time.

Figure 2. Impossible triangle



Source: Own elaboration

1. Integrated and liberalised markets + Efficient transition vs National sovereignty. Achieving energy transition with a fully integrated market would mean that economic efficiency (i.e., prices based on comparative advantages) would determine the quantity and location of various energy generating capacities and trade between Member States, and with third states. This would empty national sovereignty, as a Member State would not be able to actually decide on their domestic energy mix or maintain any desired level of domestic (backup) generation capacity without distorting the market. In this scenario, natural gas use should drop (as should of course coal too) in certain countries while remaining stable or even increase in others.

An illustrative example for this debate is that of nuclear energy[9]. Should the common market and the efficiency of the energy transition prevail over national sovereignty, it would likely become practically impossible (but at least significantly harder) to build new nuclear facilities. The renewable energy paradox states that even new renewable capacities might become 'cannibalised' by their own success and the resulting price drop [2] – nuclear investments would be especially vulnerable to this. Therefore, they would likely require state subsidies, interventions, distorting the market (and the common sustainability goals in certain countries' opinion).

2. National sovereignty + Efficient transition vs. Integrated and liberalised markets. If Member States can hold full sovereignty over their energy mix and the way to achieve it, they should be able to introduce different support schemes to increase the share of renewables or maintain nuclear or fossil capacities. These heavily distort the long-term price signals on the market. As a result, there would be a strong incentive to take protectionist steps, not to let the low prices achieved by subsidies or some comparable advantage 'leak out' of the national market. Should such 'leakage' or price diminishing occur, the neighbouring countries' energy markets could become unable to guarantee necessary investments for the national energy system and make them reliant on external import[10].

Something similar can be described in the case of the debate on the Nord Stream 2 natural gas pipeline. Germany is adamant on its (more precisely the companies') right to develop the project and meet its growing need for natural gas, despite its potential distortive effect on the common market (and of course the political consequences) [5, 15].

3. National sovereignty + Integrated and liberalised markets vs. Efficient transition. There seems to be an inherent contradiction in building a strong common market while also keeping the sovereignty over deciding on the energy mix [15]. However, should the two be prioritised over the third, it would make efficient transition harder to achieve. Different countries would follow different pathways, and market signals would not be strong enough to enforce a quick and economically efficient energy transition.

An example of such a debate could be found in the recent discussions on the EU's climate agenda and goals. Certain Member States would take a more cautious approach on new climate pledges (e.g. Poland) or on the intensity and burden-distribution of new instruments required for those pledges (e.g. the ETS expansion).

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[9] See the current debate on whether nuclear energy can be included in the EU Taxonomy for sustainable activities as a green investment.

[10] Such an advantage could be large renewable energy potential as a natural resource, or a large gas market with diversified supply options allowing for cheaper gas prices, or a large fleet of nuclear power plants operating on their marginal operational cost.

While acknowledging the right of the Member States to their energy policy decisions and avoiding putting any constraints on the market, it is hard to achieve unanimity and a truly common ambition in climate policy and energy transition.

This paradox or impossible triangle is not extreme in the sense that there is a chance of finding a compromise between the aspects with efficient market and regulatory design. The aim is to underline, it is likely not possible to "have and eat the cake", especially not all three slices of it[11]. Putting the emphasis on certain aspects will likely put pressure on others, and the current legislative framework of the EU Treaties might prove to be not supportive enough for the proposed and politically sought for EU energy and climate policy targets.

The question is whether all Member States can subscribe to such compromises, or some differentiated cooperation would likely arise to solve a political stalemate. The idea of a multi-speed development of the EU energy and climate policy is not new [9]. The energy policy predicament and development patterns of EU countries are very different, and consolidating them is no easy task [4].

4. Conclusion and strategic consequences

Despite the long and gradual development of EU energy (and climate) policy, and the political unity that was supposed to be reflected in the recent political programmes of the Energy Union and Green Deal, there remain strong divisions between Member States. There is no real and deep consensus on climate ambitions (and especially on tools), on the role and importance of free market competition, and the weight and nature of the EU's energy security challenges.

The current rapid rise in energy prices and the debate on whether and how the EU should intervene is probably the most recent example of divisions. And interestingly, this debate introduces a North-South divide into the energy policy discussions, as opposed to the 'traditional' East-West. Similar development as we witnessed during the fiscal policy debates of the new MFF. Yet the East-West division is still running strong. Not only in the differences among the countries' risk perception on energy security, but also in energy transition: while the central countries would like to gain a global competitive edge through the energy transition, the newer Member States are looking for an affordable way to modernise their energy systems.

Despite these divisions, EU energy and climate policy is gaining strength. Yet as the current EU legal framework doesn't necessarily support the increased ambitions, the new initiatives and actions might prove to be new wings in a castle

[11] Disruptive and paradigm shifting changes in technology of electricity pro-duction, distribution and consumption are possible and even forecast. Such changes could fundamentally alter the predicaments. Yet, based on the slow reaction time of the energy sector (including regulation) and the long in-vestment cycles, it is reasonable to expect no radical shifts in the following years, when answers to the paradox are likely to be offered.

built on sand. Without strong political consensus on the basics, the debates along the paradoxes presented above could erode the bold future plans and actions.

Also, in light of the many open questions in the European Union's energy policy, for us in Central and Eastern Europe the success of European integration is beyond question even though there are many challenges today. It provides still a solid basis for cooperation because there was a wide consensus in the Central European political elite that the political, economic and societal transition process needs to be designed according to the Western (EU) norms due to the unquestioned goal of the integration. However, even after joining the European Union Central Europeans still cannot completely trust the Western European allies due to the different views on fundamental questions. Furthermore, the Central Europeans have had some fears on a potential Western-Russian conciliation related to energy security questions. The Central European fears were not completely unsubstantiated which is shown for example by the Nord Stream projects, the double standards regarding South Stream, or Nabucco, or when it came to economic sanctions against Russia after the invasion of Crimea. The Central Europeans have been more affected by the sanctions, which has been mentioned several times for instance by the Hungarian government, provoking only Western criticism, while Germany or France maintained close economic ties with Russia even in strategic (energy) sectors.

Simultaneously, the challenges that the EU struggles with, the internal crisis and in general the transatlantic alliance, should make it rethink its common mission. It is more than obvious that existing international law could not follow the pace of change and that international organisations are outdated and need reform to be able to manage the challenges. The recent trends in international politics, security or economy should warn the European Union more than other "great players" of international politics. According to many expectations, Europe will fall behind the United States and China in the coming decades if it is not able to renew and to respond the existential questions. The complex constellation of security challenges let the negative spillover effects complicate the present situation even more. There is a need for a comprehensive solution in each dimension at the same time, thus providing energy security in this sense is not an independently existing challenge, but rather is interconnected to the other simultaneously existing ones.

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Chapter 3

Poland and Hungary – possible fields of cooperation in the energy sector

Paweł Turowski

It seems that the transformation of the energy sectors of Poland and Hungary is most influenced by the policies of the European Union. The energy transition announced by the Community, which is expected to reduce carbon dioxide emissions over the next thirty years, has fundamental implications for the projects planned by Warsaw and Budapest. From this perspective, it is worth tracing what cooperation might look like in sectors such as nuclear power, lignite power, the gas industry, and the renewables sector. These areas are crucial for the reconstruction of the Polish and Hungarian energy sectors, so it is worth looking to see where there is potential for cooperation.

It is worth noting the key factors that are generating a deep reconstruction in the energy sector, which will result in the implementation of new power generation technologies. It seems that these actions are the consequence of implementing new climate protection policies in the European Union. 2018 saw the transformation of existing climate and energy policies, focused directionally on carbon dioxide emission reduction, into a broad energy transition policy aimed at eliminating CO_2 emissions from as many sectors of the economy as possible. Decarbonisation, seen as the elimination of coal and lignite from electricity generation, has been extended to emission reduction policies in further sectors of the economy. In this way, the climate protection policy was named the European Green Deal to underline its fundamental importance for the Community as a whole and its permeability into all economic spheres. At the same time, the impact of climate policies has been accelerated through policy instruments. Increasing greenhouse gas reductions to 55 percent, or 14 percent over the next nine years, was adopted by the European Council in December 2020 [1]. The increase in emission targets results in a significant increase in spending on energy transformation by all EU countries. To achieve this goal, strong financial tools have been constructed to support the new policy. It has been assumed that as much as 30% of the funds of the EU's Multiannual Financial Perspective, i.e. the Community budget, are to be allocated for the implementation of climate goals. In addition, the European

Investment Bank has been obliged to restructure its lending portfolio so that in four years' time half of its lending will be for climate policy objectives. It has been assumed that the abovementioned, as well as other financial instruments, but also investment expenditures carried out by energy companies on a commercial basis, i.e. market financing, from the revenues collected from customers, would trigger a financial stream of EUR 1 trillion at the level of the economy of all the Member States of the Community to support the energy transformation, to be spent over the next 9 years [1]. Additional financial support for the Green Deal policy has been provided through a financial instrument to help EU economies overcome the recession and economic collapse caused by the COVID-19 pandemic. In February of this year, the Reconstruction Fund was approved with a budget of 723 billion Euros [2], consisting of both non-refundable grants and a joint loan taken out by the Member States. The same spending priorities were set based on the implementation of the Green Deal [3]. It can be calculated that the total funding is EUR 260 billion per year, which is equivalent to 1.5 times the EU countries' 2018 GDP [4-5]. All the measures indicated result in a significant increase in funding for energy sector reconstruction in individual Member States.

The reconstruction of the energy and heating sectors, as well as other sectors such as the transport sector, programmed at the European Union level, launches a stream of expenditure on an unprecedented scale, building the largest and most cost-intensive industrial policy of the 21st century. For the Polish state, this means the need to spend between PLN 320 billion and PLN 340 billion over the next twenty years (until 2040) on the reconstruction of the electricity generation sector – 4/5 of the indicated amount is to be spent on the construction of climate-neutral sources. The total costs of transforming the energy sector are estimated at PLN 867-890 billion, while the entire energy transformation is to cost as much as PLN 1.6 trillion, or nearly EUR 350 billion by the end of 2040. This means that in the twenty-year perspective, the cost of reconstruction of the energy sector in Poland will reach a value equivalent to 68% of the GDP of the economy in 2020 [5]. This, in simple terms, generates an annual expenditure averaged over the entire 20-year period of about 3.4 percent of Poland's national GDP in 2020. A similar scale of investment expenditure in the energy sector will take place in Hungary. The Budapest government estimates that the implementation of policies to reduce CO_2 emissions over the next thirty years will require outlays of HUF 50,000 billion, taking into account the implementation of such goals as the complete electrification of the transport system and cessation of the use of natural gas [6]. This means that the cost of transformation over the next thirty years will be about EUR 140 billion, or more than 100 percent of Hungary's 2020 GDP (amounting to over EUR 133 billion) [7]. Averaged out, this means that statistically, the average annual investment in the energy transition in Hungary will be 3.3 percent of GDP, compared to an estimated cost of 3.4 percent of GDP in Poland. Therefore, it can be seen that the costs of the energy transformation for both Hungary and Poland in real terms as a percentage of gross domestic product are at a very similar, if not the same, level. It is not impossible that due to the projected scale of expenditures, the government in Budapest has stipulated that it would be realistic in making specific commitments and that strategic decisions would be taken after thorough cost analysis. The government in Budapest believes that achieving the goal of climate neutrality is only possible with significant financial support from the European Union [6]. In its view, both climate protection and maintaining a high rate of economic growth are objectives that do not contradict each other. It points out that since 1990, Hungary has been one of over twenty countries that have managed to maintain GDP growth while cutting CO_2 emissions by almost a third and reducing energy consumption by 15%. This means that the Hungarian economy has adapted better to climate protection, reducing energy intensity, while maintaining a much higher rate of economic growth, than many countries in the Community [6]. The foundations of Hungary's energy policy are based, on the one hand, on respect for the environment, which is regarded as a heritage requiring special protection, and, on the other hand, on the implementation of an appropriate policy to achieve this objective while preserving energy sovereignty and energy security. A strategic recommendation is being made that it is only possible to build a climate-neutral economy in Hungary if nuclear energy is used [6,8].

1. The atom as key to energy transition

Hungary plans to build two new units at the Paks nuclear power plant by 2030, each with a capacity of 1,200 MW. The contractor is the Rosatom concern, and the Russians are also the organiser of the investment financing [8]. However, the expansion does not serve to transform Hungary's energy mix, but to sustain electricity production at a level similar to the current one. Nuclear energy provides about 50 percent of Hungary's electricity needs. The authorities indicate that the existing four units of the PAKS 1 power plant were commissioned in the 1970s, have been in use since then, and are therefore planned to be phased out over the years 2032-2037. Budapest has made the strategic assumption that it would manage the nuclear power plant itself, preventing an outside entity from entering. The Russian side has offered a loan of 80 percent of the implementation value of EUR 10 billion, the remaining EUR 2.5 billion will be provided by Hungary [9]. As has been made public, the construction of the new units at the Paks power plant is expected to bring tangible economic benefits – but analysts doubt Hungarian companies' ability to realise the investment with a 40% share, as well as the creation of 10,000 new jobs and an increase in Hungary's economic growth rate by 1% per year [9]. The construction of two units at the Paks 2 power plant has been delayed, changes in the Russian-Hungarian agreement regarding the financial renegotiation of the loan provided were subject to package arrangements when signing the multi-year gas contract concluded in September 2021 with the Russian partner. Russia has agreed to postpone repayment of the loan for five years [10].

Poland treats nuclear energy as the foundation of its energy security. As indicated in the government document, the construction and operation of nuclear energy will diversify the sources of electricity generation and in 2045 this energy sector will have a 20% share in the energy mix. Its importance for the stability of the electricity system will be very great, as it is supposed to be the basis of the system [8]. Construction of the first nuclear unit should begin around 2026, and by 2043 6-9 GW of capacity should be in place [8]. As indicated in Poland's Energy Policy until 2040, commissioning of the first unit (with a capacity of 1-1.6 GW) of the first nuclear power plant is planned for 2033. In the following years, five units are planned to be commissioned at intervals of 2-3 years. The deadlines planned in this way have their basis in the forecast power deficits in the national power system. Without additional investment in new energy sources, there will be further shortfalls in meeting the increase in power demand during this period due to the retirement of coal-fired power plants that have reached the end of their useful lives. At the same time, it will reduce national emissions of greenhouse gases and air pollutants [8]. Poland plans to implement its nuclear energy programme in a different way than Hungary. While in Hungary the state will be the sole owner of the entity that builds and then manages the power plant, a different assumption was made in Poland. A special purpose vehicle will be set up to implement the project, with room for two shareholders. The Polish state is to take up shares of 51 percent, the foreign shareholder – 49 percent. Investors will jointly bear the costs of realising the scheme. In Poland, as in Hungary, a broad participation of Polish entities in the project is planned in order to create value in the local supply chain and thus develop economic sectors that can benefit from the nuclear power programme. The cost of the Polish nuclear power plant construction programme has been estimated at about PLN 100-105 billion, which is more than twice the cost of the Hungarian programme [11]. However, the financial investment to be borne by the Polish State will be at a level similar to that of the Hungarian programme, since it owns only just more than half of the shares of the planned nuclear power plants. Interest in the Polish nuclear power programme has so far been expressed by America's Westinghouse, the French company EDF, and the Korean company KHNP (Korea Hydro & Nuclear Power). All these entities have declared that their reactors meet the standards of the Polish programme and that they have the necessary experience and are ready to participate as a minority shareholder in a company managing future Polish power plants.

Where is cooperation likely to occur, and where is it highly unlikely to occur? The differences are the most visible – in the choice of technology (in the case of Hungary it is the Russian Rosatom, in the case of Poland the choice has not been made but it will not be a Russian entity); the ownership and management model is different (Hungary – full ownership, Poland – a foreign investor with nearly half of the shares); the financing model is different (Hungary – a loan from a Russian investor, Poland – 51 percent of the costs will be borne by Poland, 49 percent will be provided by a foreign shareholder). The similarities, on the other hand, relate to the extensive involvement of national economic operators in the realisation of the project. Hungary declares that 40% of the investment will be carried out with the help of domestic business entities and that it will contribute to the creation of 10,000 new jobs. In Poland, on the other hand, plans exceed Hungarian assumptions. According to the authors of the Polish National Energy Policy 2040, domestic enterprises in cooperation with scientific and research centres may carry out work up to 70% of the project value. They indicate that more than 60 domestic companies have experience in the nuclear power industry over the past 10 years building foreign nuclear power plants, and another 300 companies have competencies in related industries that can be applied to the nuclear industry. Thus, by 2040 the Polish nuclear power programme may create 25,000 - 38,000 direct new jobs. The final number will depend on both the number of units and the power installed in them (whether it will be 6 or 9 GW) [8]. It is worth noting that such a broad programme of supplies from domestic entities, both Hungarian and Polish, provides a good opportunity to start cooperative ties. It seems clear that the assistance of the state administration in establishing such cooperation and association of entities would be valuable. If the Polish and Hungarian forecasts come true, then we will have a services market worth EUR 3.4 billion in Hungary and EUR 16 billion in Poland[12]. With such a large market for the supply of services, technologies and works, it is likely that both Polish and Hungarian entities will need cooperating partners. It is possible that both the scale and momentum of the planned nuclear power plant construction activities exceed existing and planned economic capacities. It appears that cooperation and collaboration between nuclear power plant subcontractors both have the potential for growth and mutual economic benefit.

Both the Polish and Hungarian nuclear power development plans create an important platform for cooperation. It is a field of diplomacy directed towards the European Commission. Their aim is to provide a long-term stable political, institutional, legal, administrative and financial framework for the development of nuclear energy. The achievement of climate neutrality by the Community is expected to lead to an increase in electricity generation through renewable energies, in particular offshore wind and to a lesser extent photovoltaics, onshore wind farms, and biomass. These technologies do not cause CO_2 emissions in electricity production and financial support from structural funds, cheap bank loans, or the European Investment Bank is planned for their development. It is worth stressing the fact that nuclear energy, although it pursues the key goal for the energy transformation policy, i.e. zero-emission energy production and climate neutrality by 2050 for EU member states, is not treated in the same way as renewable energy source technologies. In particular, the European Commission has not given its unambiguous consent to the inclusion in the so-called taxonomy, which is an index of classified technologies that may count on support from the EU budget and EU financial institutions. Given that it is not possible to build a nuclear power plant

[12] Own calculations.

in EU countries without financial support, the failure to include nuclear energy in the taxonomy would make it very difficult, if not impossible, to bring this sector of carbon-free electricity generation to a halt. As a reminder – all RES technologies are included in the taxonomy and thus can count on financial support. For these reasons, countries wishing to develop nuclear power are coordinating their actions in the EU forum. France is the leader of an informal alliance of nuclear power plant supporters; it is around France that countries interested in developing this technology are grouping together, and a joint diplomatic campaign is gaining momentum. It is difficult to assume that this will be an ad hoc coalition that will dissolve after a single success. Rather, given that the energy transition is a long-term process, it should be just as long-term to correlate the diplomatic, economic, and European activities of nuclear power plant proponents. At the beginning of October 2021, both Hungary and Poland, the Visegrád Group countries, and several other Community countries signed an open letter to defend nuclear energy and to include it in the taxonomy [12]. It is worth mentioning that the building of such an informal alliance took place within the Visegrád Group countries, in March 2021. At that time, a joint letter from the leaders of seven countries – the Czech Republic, France, Hungary, Poland, Romania, Slovakia and Slovenia – to the European Commission was published on the role of nuclear energy in EU climate and energy policy [13]. It calls for a true level playing field for nuclear energy in the EU, without excluding it from EU climate and energy policy. It underlined that half of the EU countries use or are developing nuclear energy, which provides almost half of the EU's low-carbon electricity. The signatories to the letter are concerned that the development of the nuclear sector is being questioned by a number of Member States (notably Germany and Austria) even though nuclear energy is also a source of low-carbon hydrogen, can play an important role in the integration of the energy sector, and creates many well-paid jobs, which is important in combating the recession following the COVID pandemic. The signatories to the letter directly point to the attempts by the European Commission to limit the treaty right of the Member States to independently shape their energy balance resulting from Article 194 of the Treaty on the Functioning of the European Union by excluding nuclear energy from an increasing number of Community policies [14]. The joint action goes further – the model of basing energy on renewables has come under heavy criticism, with many of the new climate-neutral technologies only reaching commercial viability after 2050 [13]. To sum up the discussion on nuclear energy, it seems that the dimension of cooperation between Poland and Hungary, together with France and other members of the club of friends of nuclear energy, requires coordination, mutual support, and, above all, work in the long term.

2. The difficult challenge is lignite

Another field of common challenges for the Polish and Hungarian energy sectors is the reconstruction of the energy sector based on lignite. The EU's energy policy poses the challenge of ending lignite mining and recultivating post-mining areas while transforming existing power plants. If we look at coal-fired power generation from the perspective of the power generation system, then we can see that the optimal solution for systemic balance is to replace the energy carrier used so far (lignite) with another fuel and to reconstruct the power generation installation. Such a solution will enable effective use of the existing transmission and distribution system and thus reduce the costs of transformation. Hungary plans to use the project to rebuild its largest power plant, which is fired by lignite. Completed more than half a century ago, the Mátra power plant has an installed capacity of 750 MW, and provides 8% of the electricity consumed in Hungary and 11% of the electricity produced. The Mátra power plant is a strategic plant for the electricity system and is also a major emitter of carbon dioxide. It accounts for nearly half of the CO_2 of the energy sector in Hungary, and nearly 14 percent of all carbon dioxide emissions in Hungary. The reorganisation of the plant has been planned – the phasing out of coal-fuelled production will be accompanied by the transition to low-emission technologies – inter alia, the construction of a natural gas-fired power generator has been planned. In addition, there will be investments in zero-emission electricity generation technologies such as a photovoltaic farm, energy storage, and energy waste recovery technology [15]. Hungary sees power generation reconstruction in a comprehensive way, not only as an implementation of the postulates to reduce emissions and the goal of climate neutrality, but also as an economic measure to ensure the preservation of jobs. For this reason, the Hungarian strategy devotes so much attention to the social impact of closing lignite mines and power plants.

In the region where the Mátra power plant is located, more than 100,000 households are supplied with heat generated from lignite. Therefore, another objective of the activities carried out is to replace the high-carbon source of heat energy for farms with clean energy and to reduce energy demand. This is to be achieved by means of photovoltaic panels, which will partially cover the local electricity demand [15]. Interestingly, the area of the former lignite mine is to find an unusual use – it will become a tourist attraction, a kind of museum presenting the cultural heritage of opencast mining, but also a reservoir. The social aspect related to the local labour market is also important. The Mátra power plant directly and indirectly generates 10,000 jobs, and together with the employees' families, this gives a total of 27,000 people whose livelihoods are ensured by the power plant and the lignite mine. It is worth mentioning that the Hungarian authorities do not rule out the possibility of using lignite in the future, and leave themselves a kind of "gap", calling these resources a strategic reserve and declaring the possibility of using them in the future [15].

In Poland, the production of electricity from lignite plays a very important role in the country's energy balance. In 2020, more than 37 TWh of electricity was produced from this type of fuel, which accounted for almost 25% of the electricity generated in the country. The decreasing trend continues – a year earlier the production of energy from this carrier reached over 41 TWh with over 26% market share [16]. The lignite-based energy industry provides many jobs; in 2016, mines, power plants, and transportation of the resource provided a total of more than 23,500 jobs in regions where the mine and power plant are the only large industrial plants that cannot be replaced by other economic sectors [17]. At the same time, the energy transition policy of the European Union means that all Polish owners of lignite-fired power plants have already made a decision or are in the process of making such a decision regarding the termination of lignite mining. This raises an important need to replace existing generation sources with new, climate-neutral ones. The closest plans to end mining are those of Zakład Energetyczny Pątnów Adamów Konin (ZE PAK), a corporation owning three open-cast lignite mines and a lignite-fired power station in central-western Poland. The company's strategy assumes that the transformation will continue over the next few years, with the aim of ceasing to generate energy from lignite at the end of the current ten-year period. To ensure that this process is not abrupt, a smooth start-up of further climate-neutral energy generation projects is planned [18]. New technologies are to use wind energy – wind farms are planned to be built on reclaimed land. It is also planned to build photovoltaic farms, and produce energy by adapting some of the coal boilers to burn biomass. In addition, production of green hydrogen by electrolysis is also to take place [18]. Poland's largest lignite-fired power plant in Bełchatów, on the other hand, plans to shut down the last unit in the plant in 2036, at which time the Bełchatów mine will also stop extracting coal. The cancellation of the plan to build the Złoczew open-cast mine, which was to provide coal fuel to replace the now depleted deposit, has been announced. In its place, renewable energy is to be developed in Bełchatów. As in the case of the Hungarian power plant and the Mátra mine, the Polska Grupa Energetyczna plans to use three climate-neutral technologies: wind farms with a capacity of about 100 MW, photovoltaic farms with a capacity of about 600 MW, and energy storage facilities with a capacity of up to 300 MW. Shutting down the Bełchatów power plant will be a major loss for the National Power System, as the total generating capacity of the plant is 5,472 MW. A simple calculation suggests that renewable energy sources will replace about one-fifth of the capacity withdrawn. Thus, unlike other lignite-fired power plants, the optimal solution will be the foundation of a large new power project. It could be a nuclear power plant, since the Bełchatów site has been proposed as the location for Poland's second nuclear power plant [19]. The last lignite mine and the associated power plant in the Turoszów Basin, at the junction of the Polish, Czech and German borders, will cease production as the latest of the listed facilities – in 2044. This power station is crucial from the point of view of the national power system as it supplies 2.3 million consumers with energy and after the commissioning of the next unit there will be an additional 1 million consumers. The power output of the power plant reaches about 2,000 MW with an annual production of approx. 14 TWh of electricity, generating about 5% of the country's electricity in 2020 [20]. It is worth mentioning that the Turów power plant has been the subject of a ruling by the Court of Justice of the European Union ordering it to halt lignite mining as a precautionary measure and fining the Polish state EUR 0.5 million per day as a result of Poland's failure to comply with the ruling [21]. The case was brought before the CJEU by the Czech Republic, which alleges that the mine causes water shortage problems on the Czech side. Regardless of the future dynamics of the dispute, its amicable conclusion or its continuation, it is increasingly evident that in the light of legal, institutional and administrative measures, the use of lignite, which emits large quantities of CO_2 when burned, will encounter ever more problems. It can be assumed that this may have a significant impact on speeding up the process of reconstruction of the generation sources of these power plants. Taking into account the fact that the conversion plans for both Hungarian and Polish lignite power stations assume extensive use of renewable energy sources, it seems that from this perspective there is an opportunity for cooperation. Exchange of experience and the selection of optimal technologies could be the field of cooperation. In this case, it seems that the Polish side has more to gain because Hungary will stop lignite mining and electricity production from this energy carrier much earlier. At present, it is difficult to say whether this cooperation will develop into a mutual economic exchange concerning potential technologies of renewable energy sources; however, it can be observed that these industries are developing dynamically both in Hungary and Poland. It is therefore not out of the question that this could build a field of trade. Another aspect of joint activity should also be noted. Poland and Hungary are applying for access to Community funding for their energy transition. From this perspective, diplomatic cooperation is important because the more effective this activity is and the more it is focused on winning allies for the purpose of achieving the goal of transforming the lignite power industry, the more effectively and efficiently this process can be carried out.

3. Natural gas – distant cooperation

Another aspect of power generation relations concerns potential cooperation in the natural gas sector. What does the Hungarian gas market look like? Hungary has significantly reduced its natural gas consumption in the last decade. While it reached more than 14 billion m^3 per year in 2005, it has remained stable over the past decade, amounting to 9.7 billion m^3 of gas. Hungary, which produces approximately 1.5 billion m^3 of gas, meets 14 percent of its demand – the rest of the fuel is imported from Russia. In the last few years, Budapest has transformed itself from a gas consumer into a large-scale trader of "blue fuel". As indicated by the journal "World Gas and Renewables Review 2020" of the energy company ENI, in 2019 Hungary bought 18.65 billion m^3 (95 percent from Russia), but 9 billion m^3 or half was exported to neighbouring countries. Most gas was sold to Ukraine – almost 6.5 bcm^3, with the remainder going to Croatia [22]. Hungary, unlike Poland, has now decided to keep Russia as its key natural gas supplier. Hungary's energy strategy is based on maintaining good energy relations with Russia and aiming to diversify gas supplies. The recently signed gas contract with the Russian Federation for the next 15 years will give gas supplies from Russia a very strong position in Hungary [23]. As government documents indicate, Hungarian gas sector policy is geared towards ensuring security of supply and market integration. It seems that Hungary is planning to build a kind of a natural gas trading centre in Central Europe – for this purpose it is pursuing a pipeline policy similar to the Turkish concept – the more routes passing through Hungarian territory the better, and if these routes have no alternative the stronger Budapest's position will be. It seems that this concept is being implemented in the construction of the overland branch of the Russian Turkish Stream project, which is to bring gas along the Black Sea bed to Central Europe via Hungary and the countries of the Eastern Balkans, in order to bypass the Ukrainian transit pipelines. Another important project is the BRUA gas pipeline, which is to enable gas imports from Romanian fields initially at a volume of 1.75 billion m^3 per year, and after expansion up to 4.4 billion m^3 per year [6]. It appears that some of this raw material will be exported to Austria. This is complemented by onshore connections to Croatia to purchase gas from the LNG marine terminal on KRK Island. Hungarian entities have reserved an annual capacity of not quite 1 billion m^3 of gas until 2027. It is worth remembering that the capacity reservation is the right to use the regasification capacity of the floating LNG terminal, and not a signed contract for supply [22]. Efforts to build a regional gas trading hub are complemented by efforts to strengthen the liquidity of the Hungarian gas exchange, which has regional aspirations. In addition, the plan for providing access to the capacity of underground gas storage facilities is to support regional integration of the gas market and assist in generating revenue from the trade in blue fuel. And what does the possibility of cooperation with Poland look like in this aspect? This direction of trade seems to be of moderate importance for the Hungarians. Although an upgrade of the Slovakian-Hungarian interconnector is planned, which once connected to Poland will enable the transport of coal fuel from Poland, when the Hungarian energy system is analysed as a whole it appears that the project of a north-south gas axis from the Polish coast to the Croatian LNG terminal on Krk Island is not treated by Hungary as a priority. The efforts to build multiple gas routes from different directions, with a clear dominance of supplies from Russia, are a derivative of a planned strategy and not an effect of the spontaneous development of the gas market in Hungary. It is worth mentioning that Hungary, unlike Poland, forecasts a reduction in demand for natural gas in the future and these reductions are expected to be significant. As a result of declining gas consumption and increasing domestic gas production, gas imports for Hungary's needs will be reduced by 30 percent by 2030 and this trend will continue in the following decade. Energy efficiency measures will contribute to this. The development of renewable energy sources and new energy efficiency technologies is projected to reduce demand for natural gas in the home heating sector by 2 billion m^3 of gas per year relative to current consumption, while gas consumption in this sector could decrease by up to 50 percent [6]. Summarising the consideration of differences and similarities in the natural gas sector, it can be noted that the concepts of ensuring security of natural gas supply are different. While Poland has opted for the strategy of eliminating gas supplies from Russia, diversifying the market, ensuring competitively priced gas supplies via LNG terminals and purchasing gas from Norway, with a price close to that prevailing on the German exchange, Hungary has decided to maintain the dominance of fuel supplies from Russia with a changed, more favourable price formula. For these reasons, the possible future launch of gas supplies from Poland via Slovakia is not treated as an important objective in strategic documents. Therefore, perhaps only in the future will these relationships be rebuilt and strengthened. Since both the Hungarian and Polish power exchanges have aspirations to integrate regional markets, perhaps cooperation between these entities could become a field of possible cooperation even today.

4. Summary

Poland and Hungary will intensively rebuild their energy sectors in the coming years. These actions have their basis in the energy transition policies adopted by the European Union and entail the expenditure of large financial resources. An analysis of the three sectors shared by Poland and Hungary shows the potential for cooperation in two of them and the limited scope for cooperation in the third. There are important common goals in the nuclear power sector, where cooperation in the regulatory, administrative, political and diplomatic fields is not only desirable but necessary, while close cooperation can be established in the lignite-based energy transformation sector, the gas industry and gas supply and trade offer limited opportunities for joint action. It seems that the greatest scope for economic cooperation lies in the nuclear power sector. The construction sector is very large, companies from Poland and Hungary specialising in subcontracting may establish cooperation which may bring mutual benefits in the future.

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Chapter 4

The importance of natural gas in the energy policies of Poland and Hungary – a comparative analysis

Mariusz Ruszel

1. Introduction

Natural gas plays an important role in the structure of the Hungarian and Polish energy balance. Its price is a significant element in the building of the economic competitiveness of each country and translates into profitability of production of sectors based on this energy raw material [1]. Neither country has enough of their own resources to be energy self-sufficient in their own natural gas production, so imports are necessary. Poland extracts just under 4 bcm of natural gas annually, which makes it possible to meet over 20% of the annual demand for this fuel (19.7 bcm), while Hungary extracts nearly 1.5 bcm of gas, which makes it possible to meet over 15% of the demand (10 bcm). In recent years, the production of natural gas in both countries has declined, with the dynamics of decline in Hungary being greater, since as recently as 1985 it was producing nearly 8 billion m^3 per year [2]. However, natural gas for both countries plays an important role not only in terms of energy security and competitiveness of their economies, but also in terms of foreign policy and building their geoeconomic position in Europe. In this paper, a comparative analysis is made of the gas infrastructure of the two countries, and the price of natural gas for households and non-households as factors to characterise gas policy. The aim of the paper is to determine the importance of natural gas in the energy policies of both countries and to identify their current foreign policy priorities. Therefore, the following research questions were posed. How does natural gas contribute to the geoeconomic empowerment of both countries? Will the role of natural gas in the perspective of the coming decade increase or decrease in the structure of the energy balance of the countries analysed? How can the gas infrastructure of both countries be developed? In terms of the subject, the research analysis was focused on the state, while in terms of the object, on natural gas. The theory of geoeconomics as well as the factor analysis method proved to be useful in the analysis. The comparative analysis method and the forecasting technique were also used.

2. The importance of natural gas for economic competitiveness – a comparative analysis

Natural gas plays an important role in the structure of primary energy consumption of Poland and Hungary. In Hungary it is even higher, 38%, and in Poland 15% [3]. Both countries produce natural gas and it makes a significant contribution to meeting domestic demand and enables the price of natural gas to be reduced for end users, as the cost of domestic production is lower than the import price. However, both countries are still heavily dependent on imports of this commodity (see Table 1).

Table 1. Characteristics of the gas sector in Poland and Hungary

State	**Consumption of natural gas**	**Domestic production of natural gas**	**Imports of natural gas**	**Imports from the Russian Federation**	**Share of Russian imports in total imports**	**Long-term contracts with Gazprom**
Hungary	10.1	1.5	8.6	8.6	100%	2036
Poland	19.6	4.0	15.6	11.1	75%	2022 (PGNiG)

Source: Own calculations based on [8]

It should be noted that both countries have similar levels of energy self-sufficiency: Poland (Ws = 20%), Hungary (Ws - 18%).

$$Ws = \frac{P * 100\%}{Z_k}$$

Ws - energy self-sufficiency index
P - fuel extraction in a given year
Z_k - domestic consumption equal to the sum of volumes supplied to the domestic market of individual fuels less the balance of domestic stocks

Hungary has reduced its natural gas use to nearly 10 bcm in recent decades and plans indicate a further reduction of nearly 30% by 2030. The situation is reversed in Poland, where more than 19 bcm/year is currently used, while in the 2030 perspective, consumption may reach 30 bcm. The main consumer of natural gas in Hungary is the residential housing and house heating sector (35%), while the planned increase in energy efficiency and the spread of renewable energy sources will contribute to the reduction of demand in this sector [2]. On the other hand, as part of the energy transition process, Poland will replace coal-fired units with natural gas as an interim fuel whose role will grow in the electrification of the country. An important consumer of natural gas in both countries is industry (Hungary 21.9%, Poland 39%), which means that the price of this raw material directly affects the competitiveness of other goods manufactured from it, e.g. products from the chemical industry [1-2, 4,]. It should be noted that Hungary has one of the lowest natural gas prices for households (see Table 2) as well as for other consumers (see Table 3) in the entire European Union.

Table 2. Natural gas price for households in the first half of a given year from 2016 to 2021 (expressed in EUR / kWh)

	Households ([1])					
	2016 S1	**2017 S1**	**2018 S1**	**2019 S1**	**2020 S1**	**2021 S1**
Hungary	**0.0344**	**0.0352**	**0.0358**	**0.0346**	**0.0319**	**0.0307**
Poland	0.0392	0.0417	0.0423	0.0473	0.0425	0.0376

Source: Eurostat.
S1 - first half year
([1]) annual consumption: 5,555 kWh < consumption < 55,555 kWh (20-200 GJ).

Table 3. Natural gas price for non-households in the first half of a given year from 2016 to 2021 (expressed in EUR / kWh)

	Non-household customers ([2])					
	2016 S1	**2017 S1**	**2018 S1**	**2019 S1**	**2020 S1**	**2021 S1**
Hungary	0.0317	**0.0261**	**0.0243**	**0.0290**	**0.0266**	**0.0224**
Poland	**0.0270**	0.0273	0.0304	0.0347	0.0297	0.0281

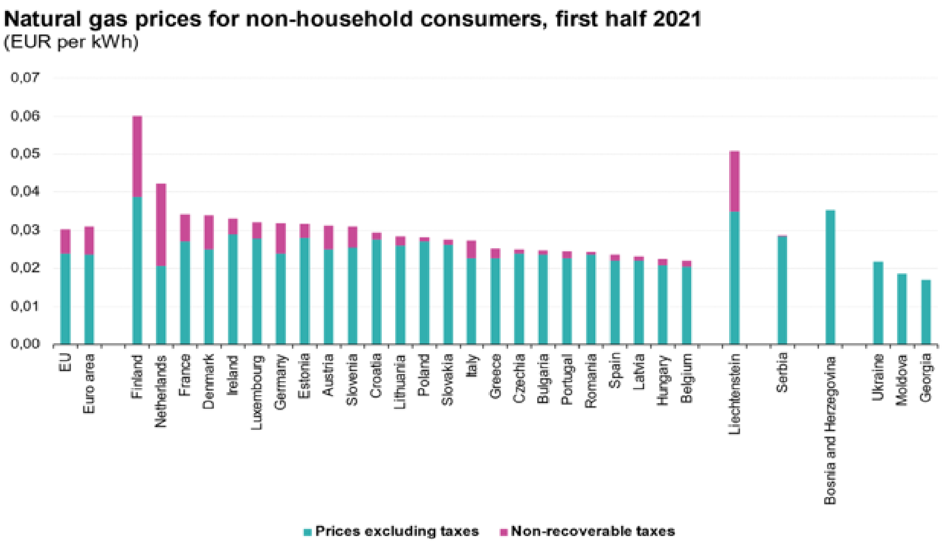
Source: Eurostat
S1 - first half year
([2]) annual consumption: 2,778 kWh < consumption < 27,778 kWh (20-200 GJ)

Comparing the prices of natural gas for households in Poland and Hungary, it is clear that the price has been lower in Hungary over the last 6 years. Particularly large price differences were seen in 2019-2020, when the price in Poland was nearly 30% higher. In the first half of 2021, the price difference was over 20%. Politicians can use low natural gas prices as an instrument to build public support among citizens. In October 2021, the entire European Union saw increases in the price of natural gas due to reduced supplies from the Russian Federation, while Hungary was the only country without a price increase and was at the lowest level in the EU [5].

Even more importantly, low natural gas prices for industry build up the competitiveness of the Hungarian economy and directly support industries that depend on the price of natural gas, such as the petrochemical and chemical sectors, which are the largest energy consumers in Hungary (22%) [2]. It should be noted that the OECD forecasts that gross domestic product (GDP) growth in Hungary will be

4.6% in 2021, while in 2022, 5% [6]. Economic forecasts are significantly better than for Poland, for which economic growth is estimated at 3.8% for 2022 [7]. At the same time, between 2020 and 2021 there will be an increase in Hungary's exports of goods by more than 9% [6]. Taking into account the ratio of exported goods and commodities to imports, it is projected that Hungary will be a net exporter (more goods exported than imported) in 2022 [6]. In Poland, on the other hand, the situation will be reversed and the country is projected to be a net importer in 2022 [7]. The above economic factors indicate that energy commodity and energy prices can play a key role in the context of building competitive advantages of one economy over another. They directly contribute to export growth or depreciation, as well as job creation. When analysing natural gas prices in Hungary against the backdrop of all European Union countries, it can be seen that they are among the lowest (see Chart 1).

Chart 1. Natural gas price for non-household customers in the first half of 2021 in European Union countries.



Source: Eurostat (online data codes:nrg_pc203)
Note: Data for Sweden (reference period 2021S1), Malta and Cyprus are not available

3. Characteristics of the natural gas infrastructure of Poland and Hungary

Poland and Hungary are countries where the transmission pipeline system, compressor stations, and natural gas storage facilities have been built since the 1970s and have been subordinated to the logic of natural gas supply from east to west [8-9]. This means that both countries had an important role as transit countries for the Russian Federation. When comparing the most important elements of the gas infrastructure of both countries, significant differences between them can be observed.

Firstly, Hungary has far better natural gas storage capacity than Poland. The storage capacity in Hungary in relation to the annual consumption of natural gas amounts to 63% and is decisively higher than in the case of Poland, where this indicator is at the level of 15%. Poland has seven of facilities, while Hungary has 5, but the active capacity of the facilities is better in Hungary, where it is 6.3 bcm (see Table 4). The Hungarian storage system also has a better daily offtake capacity than the Polish one, as the maximum offtake capacity is 78.6 million cubic metres per day, compared to 53.49 million cubic metres per day in Poland. This means that Hungary has better developed UGS, which secures the country more effectively in a crisis situation. Hungary has two operators of underground gas storage facilities: Hungarian Gas Storage (HGS) and MMBF Natural Gas Storage, and Poland one PGNiG Gas Storage.

Table 4. Underground natural gas storage in Poland and Hungary

State	**Number of underground gas storage facilities**	**Active capacity (bcm/year)**	**Maximum take-up capacity (mcm/d)**	**Percentage of annual gas demand satisfied**
Hungary	5	6.30	78.6	63%
Poland	7	3.17	53.49	15%

Source: Own elaboration based on [10]

An important role in the import of natural gas is played by the gas infrastructure, which allows this raw material to be received from various sources and directions. Poland has an LNG terminal in Świnoujście in the northern part of the country with a capacity of 7.5 bcm per annum, and is completing construction of the 10 bcm Baltic Pipe gas pipeline. From the western direction via Germany, deliveries are possible using physical and virtual reverse on the Yamal-Europe pipeline with a total capacity of 5.7 bcm (physical), 2.7 bcm (virtual) on the Mallnow interconnector and 1.5 bcm on the GCP Gaz-System/ONTRAS virtual point. From the southern side through the Czech Republic via the Cieszyn 0.5 bcm interconnector and from the east through Belarus using the Wysokoje 5.5 bcm interconnector, Tietierówka 0.2 bcm interconnector, as well as at the Yamal-Europe gas pipeline consumption points at Włocławek 3.1 bcm and Lwówek 2.4 bcm, and through Ukraine via the Drozdowicze 4.4 bcm interconnector [10].

Hungary, on the other hand, has the infrastructure to import and export 1.8 bcm (export) and 4.5 bcm (import) to the north via Slovakia using the Balassagyarmat/ Velké Zlievce interconnector. From the south via Romania via the Csanádpalota bi-directional interconnector 1.7 bcm (exports) and 0.1 bcm (imports);

and via Serbia via the Kiskundorozsma interconnector 4.8 bcm (exports); and Croatia via the Drávaszerdahely interconnector 2.6 bcm (exports). Imports from the western direction are possible via Austria through the unidirectional Mosonmagyaróvár interconnector 5.3 bcm (imports), and from the eastern direction via Ukraine via the reverse IP Beregdaróc/Beregovo 14.6 bcm (imports) and 6.2 bcm (exports) [10].

Analysing the energy infrastructure of the two countries, it can be seen that supplies from any source and direction are possible through the Baltic Sea basin. For this reason, the European Union has identified the North-South Gas Corridor as one of the "Projects of Common Interest" in the area of energy security to connect the Baltic Sea with the Croatian island of Krk [11]. At present, the construction of a gas interconnection between Poland and Slovakia is in its final stage. By 2022, it will enable the transmission of 4.7 bcm from Poland to Slovakia or 5.7 bcm from Slovakia to Poland. At the same time, the Velké Zlievce interconnector between Slovakia and Hungary will be expanded to 5.35 bcm (2023) in both directions. The implementation of these investments would enable Hungary to access natural gas imported through the Baltic Sea basin [10].

On the other hand, Hungary is interested in the Eastring gas pipeline, which would connect Slovakia with Hungary, Romania and Bulgaria. The investment is planned to be completed between 2022 and 2025 and is to have a capacity of 20 billion cubic metres, while in the 2030 perspective, up to 40 billion cubic metres. As part of the implementation of this project, the capacity of the Csanádpalota interconnector from Hungary to Romania will be increased from 1.7 bcm to 4.4 bcm (2022). At the same time, it should be emphasised that the construction of the bi-directional Bulgaria-Romania-Hungary-Austria gas corridor (the ROHUAT/BRUA project) is also planned, which will enable the flow of natural gas from the Black Sea basin at the level of 1.75 bcm in the first phase and 4.4 bcm in the second phase of implementation.

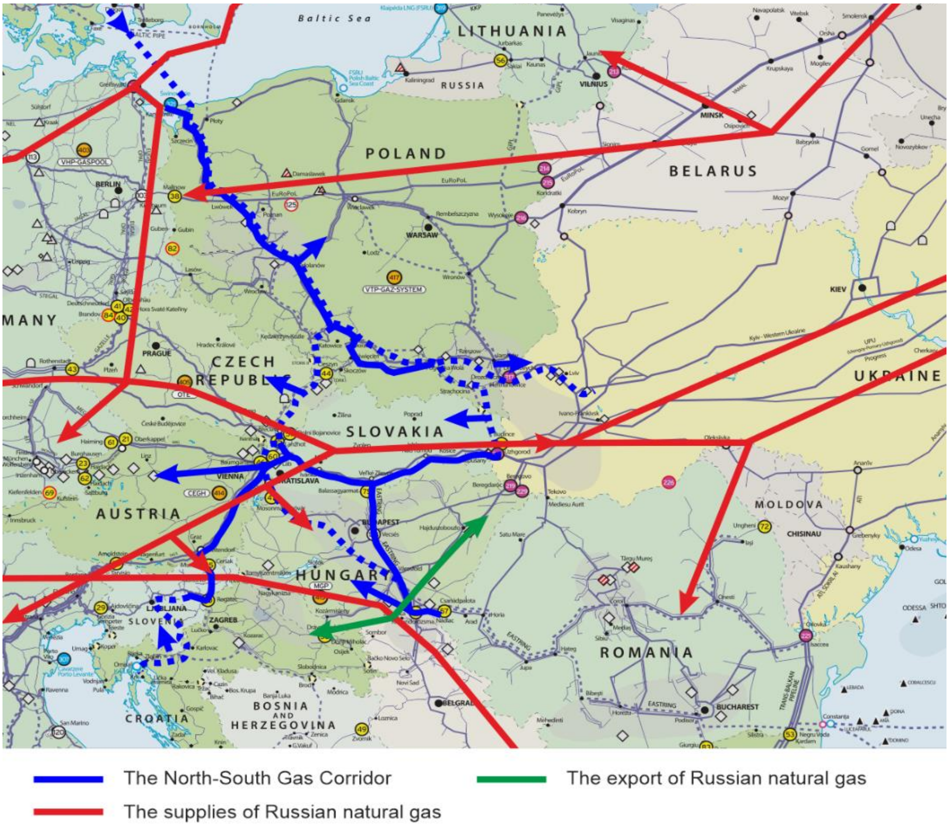
4. Policies to diversify natural gas supply sources.

Poland and Hungary are both members of the European Union and share a common energy market. The historical experiences of the two countries are similar, as the geopolitical location in Central and Eastern Europe made the countries Soviet republics [12]. This had a significant impact on the architecture of gas pipelines built in Poland and Hungary, which was subordinated to the logic of using these countries as transit points in the transmission of natural gas from the eastern direction of today's Russian Federation and the Caucasian republics to Western Europe. This logic determined the structure of transmission pipelines, their capacity, as well as the location of gas compressor stations and underground gas storage facilities. This means that the entire gas system in these countries was built from the outset with a view to importing natural gas from the East and transporting it further to the West. Thus, an important transit role of the Polish gas system (the Yamal-Europe gas pipeline) and the Hungarian one (the Brotherhood gas pipeline) was assumed. With the construction of the gas system, these countries signed long-term gas contracts and became increasingly dependent on today's Russian Federation, which has used and continues to use the supply as an instrument of political pressure [13]. However, in the last decade or so, Poland and Hungary have adopted different strategic objectives for their relations with the Russian Federation.

For the last several decades, Poland has pursued an energy policy aimed at diversification of sources and directions of supplies of energy resources, including primarily natural gas. To this end, an LNG terminal has been constructed in Świnoujście, which makes it possible to supply 7.5 billion cubic meters of natural gas annually, and also the Baltic Pipe pipeline is nearing completion, which will allow gas imports from Norway (10 bcm/year), where the Polish company also holds nearly 60 gas licences. In parallel with the execution of projects enabling supplies from other sources, the domestic gas pipeline network is being modernised and extended in order to facilitate the transmission of natural gas from the northern part of Poland to the south.

Hungary, on the other hand, has decided on a close partnership with Russia to strengthen its position as a re-exporter of Russian gas in Central and Eastern Europe. This means that the strategic objectives set by the two countries are fundamentally different, making the gas sector an area with limited scope for cooperation. Given the structure of recent long-term contracts concluded by both countries, it can be seen that this situation will not change in the coming decade. While Poland has signed a number of contracts contributing to the diversification of supply sources from Qatar and the U.S. (see Table 5), in late September 2021 Hungary signed a 15-year contract for the supply of 4.5 bcm of natural gas from the Russian Federation until 2036. [14]. The gas is to be supplied to Hungary via the Turkish Stream pipeline at the border with Serbia via the Hungarian-Serbian interconnector in the amount of 3.5 bcm and at the border with Austria in the amount of 1 bcm. At present, nearly 30% of Russian gas imported to Hungary is supplied from Austria under short-term and spot contracts [10]. This means that Hungary is consciously contributing to reducing the transit role of Ukraine, since so far most of the natural gas supplied to the country has flowed through Ukrainian territory.

Map 1. The direction of natural gas supplies to Poland and Hungary



Source: Own map based on ENTSOG

According to statements by Hungarian politicians, the Hungarian-Russian contract is more favourable in terms of price than the previous one, but the price at which the raw material will be delivered has not been made public [14]. Nevertheless, the agreement itself is becoming a geo-economic instrument of pressure on Ukraine in Russian-Ukrainian relations. This decision indicates that Hungary shows little interest in diversifying its natural gas supply sources and directions. It is in Hungary's interest to increase its role as a transit country for Russian natural gas, and to this end natural gas interconnections are being expanded to become a regional hub for Russian gas in this part of Europe. In recent years, Hungary has steadily increased the amount of natural gas it re-exports to Ukraine, in 2019 these exports amounted to 3.7 bcm through the Beregdaroc/Beregovo interconnector, by which Ukraine has so far exported gas to Hungary [15]. Hungary also exported surplus natural gas to Croatia and this was also Russian gas.

Table 5. Gas contracts executed by PGNiG to supply natural gas

Polish Gas Company	Importing country	Company	Period	Volume of supply (bcm/year)
PGNiG	Russian Federation	Gazprom	2022	8-10
PGNiG	Qatar	Qatargas	2009-2024	1.35
PGNiG	Qatar	Qatargas	2017-2034	1.35
PGNiG	USA	Centrica	2018-2022	9 loads of LNG 0.7 - 0.8
PGNiG	USA	Venture Global LNG	2023-2043	2.7
PGNiG	USA	Cheniere Marketing International	2019-2043	1.95
PGNiG	USA	Port Arthur LNG	2023-2043	2.7

Source: [8]

It should be remembered that Hungary is a country which, unlike Poland, in addition to its natural gas supplies from the Russian Federation, has decided to cooperate with the Russians in the development of the Paks nuclear power plant, which is currently responsible for the production of nearly 50% of its electricity needs. At the same time, this energy is cheaper than other sources and facilitates climate goals [16]. Comparing the competitiveness of the two countries' economies in terms of the structure of the energy balance, it is observable that Hungary emits less carbon dioxide per capita (4.5 tonnes) than Poland (7 tonnes), which in the long run may contribute to the greater economic competitiveness of Hungary relative to Poland [17]. Given the growing pressure for further climate restrictions, as well as record high carbon emission prices, and the discussion of further regulations related to the so-called carbon footprint. The Paks nuclear power plant plays an important role in maintaining the competitiveness of the Hungarian economy. Hungary is therefore all the more dependent on the Russian Federation, whose company Rosatom is responsible for the construction of the new reactors at the Paks nuclear power plant and will supply nuclear fuel to them. Considering the amount of electricity produced from the nuclear power plant and from burning natural gas, it is reasonable to conclude that Hungary's electricity security is dependent on political relations with the Russian Federation. This restricts the Hungarian Government from running foreign policy which runs completely counter to the Kremlin's interests. Given the above circumstances, Hungary pursues a multi-vector foreign policy, which on the one hand contributes to obtaining favourable natural gas prices from the Russian Federation, and on the other hand balances its political relations with the European Union.

5. Summary

Natural gas plays an important role in Poland's and Hungary's energy policy and its price directly contributes to the competitiveness of economic sectors dependent on natural gas. The chemical sector in Poland is the largest consumer of natural gas, while in Hungary it is the second largest sector after the automotive industry, which has a large petrochemical base and provides a large number of jobs. Comparative analysis of natural gas prices confirms that in Hungary it is the cheapest in the whole European Union. Even with the crisis of rising natural gas prices, Hungary was the only country where the price did not rise, and the coming years indicate that it will continue to benefit from cheap gas. This has a direct impact on the competitiveness of the Hungarian economy. However, the price of such a situation is heavy dependence on the Russian Federation, which has also made the Hungarians dependent on itself in the area of nuclear energy, accounting for half of the country's electricity production. This means that the priority for Hungary's foreign policy economics is the Russian Federation, while for Poland it is the transatlantic route, which is reflected in the policy of diversification of natural gas supply sources confirmed by successive gas contracts with the USA, Qatar, as well as planned deliveries from Norway. Both countries had gas infrastructure built for a similar purpose in Soviet times, when the logic was subordinated to their role as transit countries. Both countries still want to play that role. At the same time, Poland is open to the priority significance of the "North-South" gas corridor, which it is co-creating in order to strengthen the energy security of the European Union. Hungary, on the other hand, is seeking to develop its gas infrastructure in such a way as to connect to various directions of Russian gas supply and to be a further re-exporter. This limits the platform for cooperation in the gas sector between Poland and Hungary. In the perspective of the next 15 years, Hungary will be bound by a long-term gas contract with the Russian Federation, but at the same time the significance of natural gas in Hungary will steadily decrease. It is important that the gas infrastructure is developed to allow natural gas supplies from the northern direction via Poland and Slovakia. It is also important to develop connections enabling deliveries from Romania, as well as from Croatia. Poland remains the country most focused on the diversification of natural gas supply sources in the CEE region and the most secure partner for the countries in the region in this respect, as the strategic gas sector assets responsible for the implementation of this policy have not been privatised. This is a significant advantage for Poland over other countries in this part of Europe, including Hungary, which decided to sell some of its strategic assets in the energy sector. The development of infrastructure in the Baltic Sea basin, the expansion of common connections and the appropriate political will in the future may become the basis for Polish-Hungarian rapprochement in the area of natural gas and hydrogen, the significance of which in the economy will grow in the coming years.

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Chapter 5

The energy security of the Three Seas Initiative countries in the context of the directions of natural gas supplies to Poland and Hungary

Tomasz Chyła

The dynamically changing prices on global natural gas markets and the cold winter forecast by climatologists are leading to a situation where there is growing competition for natural gas supplies, including in Central Europe. The attempt to consolidate the countries of the region initiated by Poland and Croatia in 2016 was, in its assumptions, to take care of the balanced development of the member countries of the Three Seas Initiative and to ensure the energy security of the countries of the region. The security situation was intended to be achieved through joint investment in the energy sector and a common regional policy. A strong need for cooperation resulted, inter alia, from the fact that there were few gas connections (interconnectors) between the countries of the region, which in turn led to dependence on a single exporter. Russia's dominance exposes these countries to monopolistic practices and political pressure, for example by disrupting the supply of this raw material. The European Commission's antitrust proceedings against Gazprom have confirmed this. Most of the member states of the Three Seas Initiative were significantly affected by the cut-off of Russian gas supplies during the Ukraine-Russia gas dispute at the turn of 2008/09. The need to expand gas connections, mainly in the Three Seas area, was also demonstrated by the 2014 EU stress tests conducted by the European Network of Transmission System Operators for Gas (ENTSO-G), and simulating gas supply disruptions from the east. Stability of natural gas supply is one of the key elements of energy security, as it affects the existence and survival of the state and its proper functioning. Moreover, it enables the satisfaction of broad economic and social needs, as well as political aspirations, which is extremely important in the context of countries that remained dependent on the Soviet Union for many years. The following analysis will compare the current (2021) level of energy security in the Three Seasregion and the impact on this security of the natural gas supply directions imported by Poland and Hungary.

The main issue in this study is contained in the question: how may the changes of the directions of supplies on the Polish and Hungarian gas markets influence the energy security of the European countries associated around the Three Seas Initiative (3SI)? In order to solve the main problem the following specific questions have been identified:

– What is the current situation on the European (EU) gas market?
– What energy security objectives guided the establishment of the Initiative?
– What are the demand and directions of natural gas imports in member states?
– What is the economic and political context of the directions of supply of this raw material of strategic importance to Poland and Hungary?
– How can the approach of the Polish and Hungarian governments to diversification of the sources of this raw material, which is almost contradictory as far as the main direction of imports is concerned, affect energy security in associated countries?

In view of the above, the main objective of this paper is to analyse the current situation on the gas markets in the Three Seas region, in particular in Poland and Hungary, and its implications for the energy security of the member states of the Three Seas Initiative. In order to operationalise the main objective, the following specific objectives have been identified:

– The identification of factors influencing the current situation in the gas market in the European Union;
– An explanation of the organisational basis and objectives related to the establishment of the Three Seas Initiative;
– An analysis of member states' consumption levels and dependence on natural gas imports;
– A presentation of the economic and political context of the different directions of natural gas supplies to Poland and Hungary;
– An examination of the potential impact of the different supply directions in these countries on the energy security of the Three Seas countries.

The research methods that the author will use to achieve the objectives of the study will be cognitive methods, i.e. the analysis of sources (the bibliographic method), and predictive methods, i.e. inference and synthesis.

1. Factors influencing the current situation in the gas market in the European Union

The European Union, with a gross domestic product of $15.2 trillion for 2020 according to World Bank data, was the 3rd economy in the world (after the United States of America and the People's Republic of China). As a major global consumer of electricity and an important player in the global energy market, the EU is aware that the priority for energy security policy must be to secure a continuous supply of energy resources, given the increasing dependence on imports. The trend away from indigenous raw materials is progressing and is related to the decarbonisation of the energy sector. Departure from its own hard coal and lignite resources, without a bridging resource such as natural gas, makes it practically impossible to implement the ambitious plans contained in the "Fit for 55" EU package. The goal of this 2021 document passed by the European Parliament, which updates the earlier European Green Deal, is to reduce carbon emissions by at least 55 percent by 2030. It is assumed that the European Union's energy sector will be increasingly based on renewable energy, but stabilising these energy sources (biomass, solar and wind), while moving away from coal and nuclear power plants, will not be possible without plants powered by natural gas. Moreover, natural gas fits into the trend of implementing hydrogen in most energy sectors, despite many technological limitations (efficient electrolysis, storage, transmission or, finally, mixing with natural gas itself). The current situation on the natural gas market, caused mainly by such factors as strong economic recovery after the pandemic, the collapse of wind energy production, and the constantly rising prices in the EU emission trading scheme, is resulting in the rapid growth of global demand for natural gas. The implication of these factors on the European markets is an unprecedented increase in prices (05.10.2021) to the record level of USD 1,300 per 1,000 m^3 on the reference exchange in the Netherlands, which corresponds to a 550% year-on-year increase in prices. Due to the fact that the main supplier of hydrocarbons to the European market is Russia, it can be assumed that the raw material potential of that country is treated by the Kremlin authorities as a kind of foreign policy instrument. This is perfectly clear this autumn, when the action of Russia, which is reducing the volume of supplies of natural gas, will make it impossible to fill up unfilled gas storage facilities before the winter heating season, at the same time causing pressure on the European Commission to approve the newly built Nord Stream 2 gas pipeline as soon as possible. Russia seeks to play a monopolistic role in the supply of energy resources to the EU. In this situation, there is a need for an effective policy of diversification of supply sources and increased EU activity to strengthen economic relations with alternative exporters of energy resources [1].

2. The organisational background and objectives regarding the establishment of the Three Seas Initiative

The European Union, by accepting into its ranks the countries that until 1989 were "behind the Iron Curtain", has not only expanded but also consolidated. Since the fall of that curtain, Central Europe has sought to find its place in redefining the East-West balance of power, mainly through measures to secure the region from Russian influence. In 1991, a regional alliance was formed through the creation of the Visegrád Group (Poland, Hungary, Slovakia and the Czech Republic, first as V3, then as V4). Another attempt to strengthen ties in the region was the Three Seas Initiative, brought to life in 2016 by Poland with the support of Croatia and Romania. The Three Seas Initiative is to serve,in its assumptions, the strengthening of ties in the wider region of Central Europe (between the Baltic, Adriatic and Black Seas), creating a lasting basis for economic development in the field

of energy, transport, digital communications and the economy. The foundation for the implementation of these assumptions is six defined objectives of activity:
1) To stimulate economic growth and increase the prosperity of the region;
2) To attract investment;
3) To enhance energy security through a common, well-functioning energy market and the diversification of energy sources and suppliers;
4) To strengthen the articulation of geopolitical interests through the economic potential of the region as an integral part of a strong EU;
5) To use intelligent ICT technologies to create modern systems for data exchange and more efficient use of information;
6) To achieve the ambitious climate targets through the development of modern infrastructure.

The Initiative, through its third objective, in addition to reducing dependence on Russia (the Nord Stream 1,2, South Stream and Turk Stream pipelines under construction and "encircling" Central Europe), was to lead to improved competitiveness and living standards of its inhabitants (at the time of its creation, the member states represented 30% of the EU territory and 22% of its population, but generated only 10% of the EU GDP). On 25 August 2016, the twelve Three Seas countries – Austria, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia – signed a declaration on cooperation in Dubrovnik. Given the U.S. government's contribution, the Initiative was also seen as a kind of counterweight to China's increasing presence (through the implementation of the "Belt and Road" Initiative) in the region. In the context discussed in this paper, it provided for, inter alia, the development of infrastructure to create a common gas market and to increase security and competition. It was intended to strengthen a region that lacks gas infrastructure, opening the way for significant investment and, as a result, positively influencing the development of the entire European Union. The assumption of the Three Seas Initiative was to help coordinate activities and promote the interests of the region, increase energy security, and enable the development of a competitive gas market (according to forecasts, the demand for gas from these countries will continue to grow) by developing gas infrastructure, mainly on the North-South axis. This was to be achieved by such investments as those approved during the 3rd Three Seas Initiative summit held in September 2018 in Bucharest: the LNG terminal on Krk Island in Croatia (to be completed in late 2020.), connected to a pipeline connecting Hungary and Slovakia, the Poland-Lithuania gas interconnector (GIPL – a pipeline connecting Lithuania, Latvia and Estonia to the wider European gas network), and the Bulgaria-Romania-Hungary-Austria gas pipeline (BRUA – which would supply Romanian Black Sea gas to the region). After the summits which took place in Tallinn (2020) and in Sofia (2021), the list of projects, of which there are currently 90, includes 33 which are energy projects [2] and these are, inter alia:

- Launching a regional LNG terminal in Estonia (Paldiski), and Latvia (Skulte);

- A gas interconnector (HUSIT), between Slovenia and Hungary (eventually also connecting Italy), and between Poland and Slovakia within the "Baltic Energy Market Interconnection Plan";
- The "Eastring" pipeline connecting Romania, Bulgaria, Hungary and Slovakia and securing 100% of the gas demand of the Balkan countries;
- The improvement of technologies for extraction of natural gas from unconventional reservoirs by Austria, Hungary, Romania and Slovakia (and Serbia and Ukraine, invited to cooperate outside the 3SI);
- The Ionian-Adriatic (IAP) gas pipeline, connecting the gas systems of Croatia with the countries invited to cooperate: Bosnia and Herzegovina, Albania and Montenegro;
- The ROHU gas corridor (enabling transmission of gas from the Black Sea to Hungary and Central European countries);
- Expansion of the gas pipeline capacity between Hungary and Slovakia within the existing North-South Corridor (connecting the LNG Terminal in Świnoujście and the Baltic Pipe, via southern Poland, the Czech Republic, Slovakia and Hungary, with the LNG terminal in Croatia).

The number of projects seems large; however, if we analyse how many of them have obtained completed status so far, it turns out that there were very few plans transformed into real successes. This status concerns two projects, which are national and not international – the modernisation of the Croatian container terminal in the port of Rijeka and the construction of a gas compressor station within the Croatian transmission system. One aspect affecting this is undoubtedly financial. According to estimates presented in the report following the Sofia summit, the 3SI priority projects could cost as much as EUR 180.9 billion. A significant part of this amount is to come from EU funding – 41% (with the vast majority coming from the Connecting Europe Facility – CEF) – and from Member States' national funding – 24%. A large role is also attributed to funds from the Three Seas Initiative Investment Fund – 9%. Looking at the current estimated value of the projects, this means that the resources for these investments should amount to more than EUR 16 billion. Meanwhile, the Fund has so far raised EUR 913 million, and its main investor is still its initiator, the Polish development bank Bank Gospodarstwa Krajowego, which shows the prospects of implementing these ambitious plans.

3. Analysis of Member States' consumption levels and dependence on natural gas imports

Among the countries associated with the Three Seas Initiative, the largest gas consumption covers: Poland with annual consumption of 21.6 bcm in 2020, Romania (11.3 bcm/year), Hungary (10.2 bcm/year), Austria and the Czech Republic (8.5 bcm/year each) [3]. The Three Seas countries have consumed between 70 and 80 bcm per year across the last five years of the Initiative. Analysing the reports by Gazprom, which reports sales, in 2020, of more than 50 bcm of natural gas to the countries associated around the Three Seas Initiative, including: in the case of Austria – 13.2 bcm, Poland – 9.7 bcm, Slovakia and Hungary – 8.6 bcm each, Czech Republic – 5 bcm, Bulgaria and Croatia – about 2 bcm each and Romania – about 1 bcm [4], it should be recognised that the dependence on the raw material from Russia is relatively high and poses a threat to the energy security of individual countries and the region. Correlating the above data with the production levels of the 3SI members, only Romania (with annual production of 8.7 bcm), Poland (3.9 bcm/year) and Hungary (1.5 bcm), to a greater (Romania – 77%) or lesser (Poland – 18%, Hungary – 15%) degree, demonstrate a certain "raw material self-sufficiency". In the case of the aforementioned gas self-sufficiency, it can be defined and assessed as the simplest indicator of a country's raw material security, in this case related to the natural gas sector. By definition, self-sufficiency is the result of the level of extraction of a given raw material to its consumption, which is equal to the sum of the quantities of gaseous fuels supplied to the domestic market [5]. When considering the low level of the above self-sufficiency, the recommendations of the International Energy Agency and the European Union, which in their recommendations emphasise that imports from the largest supplier should not exceed 30% of a country's total gas imports, it is reasonable to conclude that imports of natural gas from Russia should be significantly lower in the countries of the Initiative. Despite the historical and economic dimension of cooperation in importing natural gas between the countries of the former Eastern Bloc and the Soviet Union and Russia over the past 50 years, it should be recognised that the situation in which most of the members of the 3SI are to a significant degree (more than 70%), dependent on supplies from Russia, the Falin-Kwieciński Doctrine becomes relevant again.

4. The economic and political context of the directions of supply of this raw material of strategic importance to Poland and Hungary

This energy policy doctrine developed in the 1980s in the USSR assumed that it was more effective to influence countries by strengthening their energy dependence than by a tough military policy (the famous "gas pipelines instead of tanks"). According to this doctrine, the Soviets' direct influence was to be exerted through the use of energy on states that Moscow believed were part of its sphere of influence. Poland and Hungary are examples of countries which, as a consequence of the decisions made at the Tehran, Yalta and Potsdam conferences, found themselves precisely in Moscow's sphere of influence until the collapse of the USSR. More than 30 years after this event, it can be concluded that both countries, due to their small resources of their own and the development of gas-fired power plants are forced to import significant amounts of natural gas, but the directions of gas supply in both countries are quite different, as will be analysed in the following part of this paper.

Analysing the current situation of the energy sector in Poland, one may conclude that there is currently no alternative to the dynamic development of the gas market and gas infrastructure. In the case of Poland, natural gas demand is projected to increase and reach (by 2029), 30 bcm per year, further prospects indicate growth and maintenance of consumption at 35 bcm from 2035 [6]. Strategic investments made in the last decade, aimed at increasing the possibilities of receiving natural gas supplies by sea, called the “Northern Gateway” (LNG Terminal in Świnoujście and Baltic Pipe gas pipeline) and the contemplated construction of an FSRU terminal (Floating Storage Regasification Unit) in Gdańsk by 2028, demonstrate the Polish government's desire to become independent from gas transported from Russian deposits at Yamal within the so-called "Yamal Contract". Enhancing Poland's energy security by changing the direction of supplies to the north will enable Poland to become a clearing and trading centre for Central Europe and more broadly for the countries associated in the Three Seas Initiative through the creation of a gas hub. Such a hub would be a regional hub for natural gas trading using spot and financial instruments linked to physical delivery options. Its planned creation would enable the establishment of strategic cooperation with any country in the Central European region where gas plays an important role in meeting energy needs. With the construction of the second line of the Nord Stream Pipeline and consuming about 88 billion cubic metres of gas annually, Germany is a European giant. It should be noted here that there are countries in the region which consume similar volumes of gas as Poland; however, their ability to diversify import directions is very limited. Ukraine (29.3 bcm in 2020), Belarus (17.9 bcm in 2020) or the analysed Hungary (10.2 bcm in 2020) are the states which would benefit from natural gas imports from our country. The gas hub (a regional hub for gas transmission and trade for Central and Eastern Europe and the Baltic States), approved in February 2021 in the "Polish Energy Policy 2040", was recognised as strategic project 4B in the "Strategy for Responsible Development" in the area of intervention "Improving national energy security". The success of this undertaking will not only require the completion of the Baltic Pipe, expansion of the LNG terminal in Świnoujście, construction of an FSRU in the Gdańsk Bay area and connections with neighbouring countries, but also regulatory changes that will allow the service and commercial offer to be developed by creating attractive market and pricing conditions to encourage the use of Polish infrastructure. The current prospects raise the importance of Poland in the region and may positively influence stabilisation of renewable energy sources as key sources in the future energy mix.

The structure of Hungary's energy mix is quite different from that of Poland. In Hungary, natural gas and nuclear energy production dominate the energy mix (about 30% each), while a decreasing share is attributed to hard coal and oil. When analysing Hungary's energy policy, it should be noted that in order to achieve its ambitious climate targets aimed at climate neutrality in 2050, Hungary is intensively increasing the capacity of the Paks nuclear power plant (the construction of the fifth and sixth units, with a capacity of 1,200 MW each, being carried out by Rosatom, is expected to last until 2030). In addition to nuclear energy, renewable energy sources – mainly photovoltaics – will play a role in achieving a 90% decarbonisation of the energy industry compared to 1990. The actions of the Hungarian government, which has recently significantly strengthened its co-operation with the Russian Federation (in addition to the expansion of the NPP, the purchase of significant amounts of gas from Gazprom), have resulted in electricity and gas prices being lower than the EU average by approximately 50%, which effectively increases the country's competitiveness on the international arena and raises the standard of living of the Hungarian population. Cheap gas has a significant impact on the heating sector, as household consumption accounts for as much as 48% of natural gas, according to Eurostat. The decarbonisation of the country is an important project by the Hungarian government, because it corresponds with an important point on the European political agenda, i.e. the debate on climate targets. In this respect, Hungary is showing great initiative and willingness to be fully involved, which may be seen as a contribution to Budapest's attempt to "win" several other issues in the arena of European politics. On the other hand, however, Viktor Orbán's close relations with Moscow on energy issues contrast with the need to diversify the suppliers of raw materials of strategic importance. This relationship is confirmed by the fact that Hungary signed a 15-year gas supply agreement with Russia on 26 September 2021. Gazprom is to supply Hungary with 4.5 bcm of gas annually via two routes: 3.5 bcm from the south, via Serbia, and the remaining 1 bcm – via Austria.

5. The Potential Impact of Different Supply Directions in Poland and Hungary on the Energy Security of the Three Seas Countries

It has become customary for Russia to treat natural gas in Eastern Europe as an instrument of foreign policy. It is reasonable to conclude that countries in the region have alternative options. They may decide to make political concessions to Russia in exchange for cheap gas, or they may face price increases and, in extreme situations, interruptions of supply. There is, however, a third way. Ensuring alternative sources of supply by expanding connections with other countries in the region and building LNG terminals, which will enable gas imports from directions other than the east. With plans to reduce dependence on Russia, an instrument to exert pressure on the region is knocked out, hence plans to diversify the supplies of countries in the region cause opposition from the Kremlin.

One form of such action could be the creation of a new mechanism to strengthen cooperation of Initiative member states with Ukraine and Moldova, and in the future with other interested countries (Belarus, Georgia, Azerbaijan and Armenia). Another solution could be to adapt existing instruments for integrating countries into the European Union. In particular, it could be the creation of an analogy with the Eastern Partnership or the signing of association or cooperation agreements in specific areas. Analysing the situation in the region, it can be concluded that there is great potential for cooperation, especially between the Three Seas countries and Ukraine in terms of cross-border trade in gas, strengthening security of supply and support for the continuation of the reform of the Ukrainian gas market. Moreover, regional cooperation within the Three Seas Initiative should be used for the efficient use of gaseous fuel in the process of energy transformation and for the construction of technologies to obtain green gases (hydrogen). In this context, however, there are reasonable assumptions that the avoidance of the Ukrainian transmission network when supplying gas to Hungary in the contract with Gazprom in force since 01.10.2021, will slow down the integration process.

Another aspect influencing integration and the resulting strengthening of energy security is the question of future directions of energy supplies after the Nord Stream 2 gas pipeline becomes operational. Member states and Ukraine will be able to import gas not only from Poland (after 2022, i.e. expiry of the Yamal Contract and start of the Baltic Pipe) or Hungary (interconnectors under construction), but also through connections with our western neighbour which, by constructing first Nord Stream, and then the Nord Stream 2 pipelines, has ambitions to play the role of a gas wholesaler for a large part of European consumers, in particular those associated around the Three Seas Initiative (hence the increasingly active participation of Germany in this initiative). The choice of the direction of the transmission route, through which consumers and wholesalers of gas will be supplied, will most probably not be determined by the origin of the gas, but first of all by the price. The price will consist of the price of the raw material itself, as well as the transmission fees, i.e. the de facto "toll" which the gas companies pay to the gas transmission system operator for the transmission of the entry and exit points within a given gas transmission system. The key question about the attractiveness of obtaining gas from Poland is how much the transmission fees will rise after all the planned investments are constructed. It can be assumed that Poland will not be an attractive place of selling gas for the Czech Republic (hence the suspension of the construction of the interconnector between Poland and the Czech Republic – Stork II) or Austria, which have well-developed connections with Germany and may import gas directly from there. It is more realistic to export gas to Slovakia and Ukraine, especially after the closure of the Russian gas link running through Ukraine and supplying Central European countries with gas via the South Stream pipeline.

When analysing the situation of the gas market in Hungary, the most important conclusions include:

- The implementation of the BRUA project (the aforementioned gas corridor connecting Bulgaria-Romania-Hungary-Austria), as well as the related launch of gas production from the Black Sea shelf (planned at approximately 10-12 billion cubic meters annually), is of great significance not only to Romania, but also to Hungary and Moldova, as well as other countries in the region.

As an investment integrating the gas networks of Central Europe and increasing the energy security of the region, it fits in with the assumptions of the Three Seas Initiative.

- The Hungarian gas operator, FGSZ (Natural Gas Transmission Closed Company Limited by Shares) considers the Romanian-Hungarian interconnector BRUA as the most important international investment. Access to gas from the Black Sea shelf (Romania's EEZ), and connection to this pipeline would reduce Hungary's dependence on both Russian gas supplies and transit through Ukraine. The Hungarians hope that thanks to these moves they will be able to cover almost half of their annual domestic demand (the target capacity of the connection with Romania would allow it to import approx. 48% of the gas needed in Hungary according to data for 2020), or will allocate the surplus raw material for export. The completion of the first line of the BRUA gas pipeline in 2020 strengthened Budapest's negotiating position in talks on the terms of gas supplies from Russia after 01.10.2021.
- Budapest's gas strategy, which has been in place for more than ten years, is based on two pillars – maintaining cooperation with Russia, while striving to diversify its sources of gas supply (it should be emphasised that the interconnection with Romania is key to the implementation of this objective). Another direction of diversification is the import of LNG from the terminal on the Croatian island of Krk.
- The plans to phase out coal completely by 2025 [7] and the achievement of zero-emissions by 2040 will be facilitated by the expansion of nuclear power capacity and the simultaneous reduction of natural gas consumption by about 3.8 billion m^3 in 2020-2030 by the domestic economy, which will make it possible to re-export gas to the countries of the Initiative which will implement the transformation more slowly (also based on natural gas as a transition fuel).

In conclusion, the current situation, in which the governments of both countries concerned pursue the policy of diversification of the directions of natural gas supplies in a completely different way, it should be recognised that despite the infrastructural costs which Poland is incurring to develop the "Northern Gate", which will affect the prices of gas exported further south, it is the strategy of obtaining hydrocarbons from Norway, the U.S. and Qatar that gives an opportunity to reduce the influence of the Russian authorities. At this point, we should positively assess, in the context of regional security, the actions aimed at obtaining gas by Hungary from newly discovered deposits in Romania and the possibility of its redistribution through the transmission infrastructure being developed to neighbouring countries. Unfortunately, the multi-vector foreign policy of Hungarian Prime Minister Viktor Orban (apart from lobbying for cheaper Russian gas, cooperation with China on a huge project to build a railway line from Budapest to Belgrade and the Greek port of Piraeus, which is mostly owned by a Chinese state-controlled company), although in many respects beneficial to society, from the point of view of the member states does not affect the possibility of leaving the orbit of the Kremlin's influence. The North and South Stream and Turk Stream projects "grasp" Central Europe in Gazprom's "clutches"; additionally, the implementation of the projects hits the security, not only in terms of energy, of Ukraine the most. It deprives the country of income from the transit of Russian gas, but also reduces its security. By losing its status as a transit country, Ukraine loses much of its significance for the West. In the future, Belarus may also become endangered. In the optimal variant from the Kremlin's point of view, the implementation of gas supply projects to Europe bypassing Ukraine, Belarus and Poland would make it possible to cut off supplies to Ukraine and Belarus and provoke serious crises in Central and Eastern Europe, without risking supplies to Western partners [8]. The increase in the degree of control over the situation in the gas markets in Central Europe (including destabilisation through the bypassing of Ukraine), will significantly contribute to Moscow's intentions to exercise political control over the “Great Limitrophy” European area, i.e. the countries associated under the auspices of the Three Seas Initiative. Solidarity and united action in the region stands in contrast to the economic factor and the specific interests of politicians and individual states, but in order to avoid the threat of energy blackmail by the states of the region in the future, joint action should be developed and taken to limit Gazprom's freedom of action in the area between the Baltic, Black and Adriatic seas.

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Chapter 6

The Paks nuclear power plant and Hungary's attitude to the European Green Deal

Dominik Héjj

1. Introduction

Hungary was one of the fastest countries to express initial interest in joining the European Commission's climate initiative, known as the European Green Deal. We are talking here primarily about the countries of the so-called new European Union, i.e. those which were accepted into the Community as a result of accession in 2004, 2007 and 2014. The ambitious climate goals that have been being announced by the Hungarian authorities for a long time are subordinated primarily to political and business objectives.

It is possible to distinguish three main reasons for Hungary's attitude towards the European Green Deal. Firstly, acceptance of the agenda that everything must be done to stop the climate crisis, which is a real threat. This kind of approach makes it possible to stay in the mainstream politically and to take a big chunk out of the financial cake for the energy transformation of the poorer EU countries. Secondly, Hungary's attitude to emission limits is influenced by the fact that it uses non-carbon energy sources in its energy mix – mostly based on the Paks nuclear power plant. Thirdly, the Hungarian authorities see in the European Green Deal an opportunity to build the competitiveness of the economy. This was also an area of concern for the Hungarian government, since the approach to the European climate policy initiative was strongly influenced by the fact that the motor industry plays a significant role in Hungary. It will have to adapt to the new conditions, meet stringent emission standards, and shift production to electric cars.

In this article, I would like to analyse how the Paks nuclear power plant affects Hungary's attitude towards the European Green Deal. This investment, which is fundamental from the Hungarian government's perspective, has already been delayed for approximately four years, which in turn has led to concerns about Hungary's ability to ensure its energy security in the coming decades. The topic of nuclear energy plays an extremely important role in contemporary discourse. The Visegrád Group countries are making efforts to have nuclear power recognised as a non-emission source. At the same time, excerpts from the report of the UN

Intergovernmental Panel on Climate Change, presented in early August 2021, have not included nuclear power as a target source on which energy production should be based. Without atomic energy, it may be impossible for Hungary to achieve neutrality, or it may result in total and possibly irreversible energy dependence on the Russian Federation.

2. Analysis

2.1. European Green Deal

Before the main findings related to the Paks nuclear power plant – its importance in the Hungarian energy system – are presented in section 2.3, it is necessary to indicate (as briefly as possible) what the European Green Deal is, towards which Hungary's attitude will be examined.

At the European Council summit on 20-21 June 2019, the EU's top political body adopted strategic objectives for 2019-2024. Among them were those related to climate policy. Member States agreed that every effort should be made to achieve EU climate neutrality by 2050, following the commitment made in the Paris Agreement signed in November 2015.

Members of the European Council called on the European Commission in June 2019 to step up its efforts to combat climate change. The 20 June 2019 Conclusions devote three points to climate change, which read as follows [1]: "3 The European Council emphasises the importance of the United Nations Secretary General's Climate Action Summit in September for stepping up global climate action so as to achieve the objective of the Paris Agreement, including by pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. It welcomes the active involvement of Member States and the Commission in the preparations. 4. Following the sectoral discussions held over recent months, the European Council invites the Council and the Commission to advance work on the conditions, the incentives and the enabling framework to be put in place so as to ensure a transition to a climate-neutral EU in line with the Paris Agreement that will preserve European competitiveness, be just and socially balanced, take account of Member States' national circumstances and respect their right to decide on their own energy mix, while building on the measures already agreed to achieve the 2030 reduction target. The European Council will finalise its guidance before the end of the year with a view to the adoption and submission of the EU's long-term strategy to the UNFCCC [Eng. *United Nations Framework Convention on Climate Change*], in early 2020. In this context, the European Council invites the European Investment Bank to step up its activities in support of climate action. 5. The EU and its Member States remain committed to scaling up the mobilisation of international climate finance from a wide variety of private and public sources and to working towards a timely, well-managed and successful replenishment process for the Green Climate Fund".

Six months later, the European Commission published a Communication on the European Green Deal, laying the foundations for a European climate policy strategy [2]. As spelled out in the Communication, the European Green Deal is responding with a new strategy for growth, aiming to transform the EU into a fair and prosperous society within a modern, resource-efficient and competitive economy, which by 2050 will have achieved net zero greenhouse gas emissions, decoupling economic growth from the use of natural resources. It was pointed out that the EU's energy transition will have to take place in a fair and inclusive manner. The authors of the Communication pointed out how important it would be to win the public's support and confidence, and to raise awareness of those people or entities that might suffer as a result of changes in energy policy (geographical regions, different industries and the people who work in them). The European Green Deal was to be a pact bringing together citizens, national authorities (at all levels), civil society and industry, which would in turn work closely with EU institutions and consultative bodies. It is also worth stressing the importance of measures to counteract energy poverty in households, i.e. the situation in which they cannot afford the most essential energy services they need to survive and achieve a minimum standard of living. In order to prevent this serious social problem, the European Commission has proposed appropriate funding programmes.

What is important from the perspective of this article, and what conditioned Hungary's involvement (or not) in the European Green Deal, was the provision in paragraph 2.1.2 of the Communication on the provision of clean, affordable and secure energy. In fact, it does not mention the use of nuclear energy. Renewables, gas, but not nuclear: "75 % of EU greenhouse gas emissions come from energy production and use in various sectors of the economy. Energy efficiency must become a priority. We need to create an energy sector based largely on renewables, while phasing out coal at a rapid pace and decarbonising the gas sector" [2].

At the summit of the next European Council on December 12, 2019, members of the European Council adopted the European Commission's Communication and made it a priority for the EU to achieve climate neutrality by 2050. These findings were reiterated in the Conclusions following the European Council meeting [3]. Eleven of the 20 points in the document are devoted to climate issues. From the point of view of this article, the most relevant is the sixth point, which is worded as follows: "The European Council acknowledges the need to ensure energy security and to respect the right of the Member States to decide on their energy mix and to choose the most appropriate technologies. Some Member States have indicated that they use nuclear energy as part of their national energy mix". From Hungary's point of view, this finding was extremely significant, as it had unambiguous consensual overtones and thus was not "confrontational" or "imposing". Years ago, after the 2015 Brussels Energy Summit, Viktor Orbán, commenting on the summit's findings, said, "no one can tell Hungary how much of this energy should come from gas, how much from nuclear energy, how much from coal – this is for Hungary to decide"[4]. This referred to EU criticism of the agreement between

Hungary and the Russian Federation on the expansion of the Paks nuclear power plant.

In her State of the Union Address [5] delivered on 16 September 2020, European Commission President Ursula von der Leyen spoke of the need to strengthen the building blocks of the European Green Deal. Referring to a public consultation and an impact assessment of the original draft of the European Green Deal, von der Leyen proposed on behalf of the European Commission to set more ambitious climate targets with a 2030 horizon. The aim was to increase the EU's emissions reduction target for that year from the original 40% to at least 55% net (relative to 1990). It was then, while still in the planning stages for the EU's new budget perspective, that she spoke of using a new financial instrument, the NextGenerationEU Fund, the first 37% of which would go directly towards achieving the objectives of the European Green Deal. EU climate legislation will be reviewed by next summer, the President indicated. This declaration resulted in the "Fit for 55" package adopted on 14 July 2021.

This package forms part of the European Green Deal strategy, with which it is necessarily fully complementary. The document sets out the specific measures that the EU as a whole will need to take to meet the challenge of reducing net CO_2 emissions by at least 55% by 2030. As described in the graphic accompanying the Fit for 55 presentation, the establishment of the European Green Deal marks a decade of concrete decisions. In turn, thirteen pieces of legislation covering both new legislative proposals and amendments to existing legislation are needed to implement them.

"New legislative proposals include: a new EU Forestry Strategy, the Carbon Boundary Adjustment Mechanism (CBAM), the Social Instrument for Climate Action, ReFuelEU Aviation (sustainable aviation fuels) and FuelEU Maritime (greening the European maritime space), while updates to existing EU legislation include: revision of the EU Emissions Trading Scheme (EU ETS), reform of the LULUCF Regulation (Land Use, Land Use Change and Forestry), revision of the Effort Sharing Regulation (ESR), revision of the Renewable Energy Directive (RED), revision of the Energy Efficiency Directive (EED), revision of the Alternative Fuels Infrastructure Directive (AFID), revision of the regulation setting CO2 emission standards for passenger cars and commercial vehicles, and revision of the Energy Taxation Directive" [6].

Achievement of the targets will be possible if, inter alia, EU energy consumption is reduced by 9% by 2030, the share of RES in the energy used in buildings increases by at least 49% by 2030, the costs of fees under the EU Emissions Trading System (EU ETS) begins to include areas not yet covered, i.e. the aviation and shipping sectors. At the same time, member states will be obliged to spend 100% (thus far 50%) of revenues from the sale of emission packages on the energy transition, EUR 72.2 billion will be allocated to fighting energy exclusion and from 2035 new cars registered in the EU will have to be zero-emission.

Member States agree on the objectives of the European Green Deal as well as on the ambitious target to reduce CO_2 emissions, but have different approaches to achieving these objectives. A large group are those Member States whose energy systems will require the most far-reaching transformations. The objections raised include, apart from the need to recognise nuclear power as a non-carbon energy source, the recognition of the role of gas as a transition fuel. This issue is also important for Hungary, for which nuclear and gas will become the dominant sources of energy, but in the public debate, as well as in the political debate, voices are being raised that the use of gas in the energy sector is a dead end just like coal. Other doubts relate to the excessive costs that could be incurred by individual EU countries and, above all, by consumers, onto whom companies would pass the costs of transformation not only in gas companies, but also in other industrial sectors that will have to adapt to the EU's new climate guidelines.

2.2. Hungary's energy policy

After the main assumptions of the European Green Deal, which were signalled in subsection 2.2, it is important to synthetically discuss the broad topic of Hungary's energy policy. The following issues will be addressed in this subsection: energy strategy and national energy goals, as well as Hungary's current energy policy.

The first directional legal act which determined the activities of the Fidesz-KDNP coalition in the field of energy was the Resolution of the National Assembly on the Energy Strategy (*OGY határozat a Nemzeti Energiastratégiáról*) [7]. Already in a kind of preamble to this legal act, the legislator indicates that this Strategy is in close correlation with the Strategic Environmental Impact Assessment (Hungarian *Stratégiai Környezeti Vizsgálat*), which is valid until 2030 with an outlook until 2050. It is worth noting at this point that the legislator decided to pass an act of a lower order – i.e. a resolution, and not an act of law, and thus it was a non-binding act. It is also interesting to note the structure of the resolution, in which individual chapters are interspersed with quotes from, among others, the 2010 Fidesz-KDNP election manifesto, as well as quotes from international climate documents.

The resolution underlines the special role of the Paks nuclear power plant, which accounted for 42% of energy production in 2009 (a decade later, the share of nuclear energy in the energy mix will approach 50%). One price per kWh was HUF 10.67, which was indicated as the cheapest functioning energy source at that time. It was both a source of uninterrupted energy supply and non-emitting. The increase in the share of Paks in the energy mix has enabled Hungary to significantly reduce its CO_2 emissions. According to data for 2021, Hungary emitted 17 million tons of carbon dioxide [8].

In 2009, Renewable Energy Sources accounted for 8% of energy. The production structure at the time was as follows: 68.5% biomass, 13.4% wind power (which was completely abandoned in the 2018 strategy), 9.7% hydropower, 2.2%

biogas, and 6.2% came from energy production from municipal waste. At that time, the most important limitations to the use of RES in the energy mix were cited as: disproportionate conditions for subsidising energy production entities, the bureaucratic and uncoordinated system of licensing energy production from RES, and an unprepared power grid.

The strategy focused on systematically reducing the share of hard coal and lignite in the energy mix. Unlike other countries, e.g. Poland, this type of policy was not burdened with serious financial consequences, because the share of coal in the energy mix has been systematically decreasing since 1990, both at the level of industry and at the level of energy use in households (where the largest share was recorded by natural gas, increasing from about 25% in 1990 to about 55% in 2007). It was therefore a natural consequence to seek to increase the share of gas in energy production, which currently stands at 30%. Another challenge was to systematically increase the share of RES in the energy mix. This has increased by over 60% in a decade. Already in 2018, Hungary had more than met the 2020 RES target set by the European Commission. According to 2021 data biomass (>50%) recorded the largest share of RES without change, photovoltaic farms accounted for 15% of energy and 16% from wind. Participation, albeit much lower, is also achieved by hydropower and geothermal power[9].

Another framework document for energy policy was the "National Climate Goals" enacted in the National Climate Change Strategy 2018-2030 with an Outlook to 2050 (Hungarian *Nemzeti Éghajlatváltozási Stratégiáról*) [10]. The document was passed on 31 October 2018, similar to the document discussed earlier, this one was also passed as a resolution and was not legally binding. It runs to several hundred pages, full of graphs, taking into account a broad spectrum of climate change from the perspective of both the international environment and Hungary itself.

The first part of the resolution discusses the current global climate situation. The second focuses on Hungary, and it is on this that I would like to concentrate. It cited, among other things, data from the National Meteorological Service (*Országos Meteorológiai Szolgálat*) on the decrease in the number of frosty days from 96 per year (in 1961-1990), through 77-78 in 2021-2050 and 41-64 in 2071-2100. Similar data are cited in the context of summer days, which will double between 2071 and 2100 relative to 1961-1990. The document also considers Greenhouse Gas (GHG) emissions.

As indicated, the distribution of greenhouse gas emissions among the various departments of state operations is uneven. In 2016, the largest share of emissions (72.6%) was from the energy sector, including transportation, agriculture and industrial fuel consumption, and emissions associated with building resources. Agriculture has a nearly seven times lower share (11.2%), industry is responsible for 10.5% of emissions and the waste sector for 5.7%. Comparing the data of 2016 with those obtained in 1990, Hungary recorded a decrease in emissions of 45% in the industrial sector, 35% in the energy sector, and 30% in agriculture. However, the energy sector remains by far the dominant emitter of greenhouse gases. It is in this area that the combustion of fossil fuels, necessary on the one hand for energy production, on the other for heat production, and on the third for fuel use in transport, still occurs (albeit a decreasing share). In the energy sector, the biggest emitters are the energy industry, responsible for electricity generation (30%), followed by energy use in agriculture, industry and households (29%), and transport emissions – 28%.

The Hungarian state over three decades (1990-2016) has made efforts to reduce greenhouse gas emissions. Thanks to the measures taken, the emissions from the energy production sector fell substantially after 1990 as a result of the decline in energy-intensive heavy industry and changes in the type of fuels used. Another point of decarbonisation of the energy sector was related to the economic crisis that Hungary was facing in 2008. Electricity production declined by 27% to 2014; however, electricity consumption did not decline proportionally. It is also interesting to note that energy production from natural gas fell sharply in 2013 by 41%, and by 24% in 2014. Overall, there was a total decrease of 72% from 2008 to 2014; however, natural gas-fired generation increased from 2015 to 2016, reaching 43% of the 2007-2008 generation level.

The decarbonisation of the energy sector is largely due to the increase in energy production at the Paks nuclear power plant, which is responsible for generating 50% of the country's gross electricity production. 39% comes from conventional and only 39% from fossil fuels, with lignite accounting for less than 10%. Low carbon intensity is also determined by the high share of electricity imports, which reached 29% in 2016. A significant problem is energy efficiency, which is not increasing despite the fact that new industrial facilities in terms of energy intensity are approaching the values of the old European Union countries (EU-15); however, the energy efficiency of the building stock has hardly changed, with one of the worst results in the EU, since 70% of about 4.3 million dwellings do not meet modern functional and thermal requirements, as in the case of public buildings. The declines in the share of household emissions that have occurred have been associated with the conversion of households from coal and wood to natural gas for heating, rather than with retrofits. Gas consumption in households, despite increases, is still 21% lower than the average recorded in the previous decade.

It is worth pointing out that "in the sectors which are not covered by the emission trading scheme (non-ETS), such as transport, agriculture or construction, even greater reductions of GHG emissions were achieved than assumed (the emissions in these sectors could have increased by 10% until 2020, however, in reality they fell by almost 9%)". [11]. This fact makes it possible to sell packages of GHG emissions to other countries and, consequently, to obtain certain financial benefits from this process.

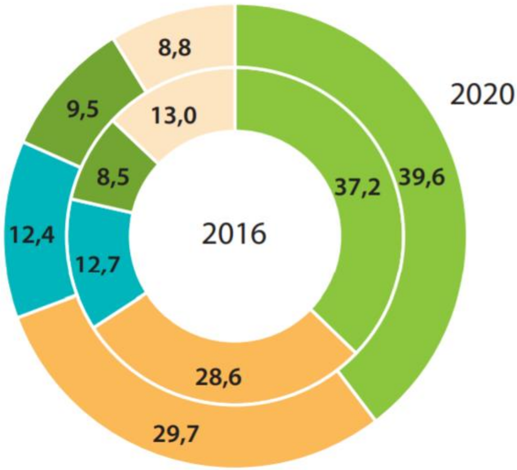
At this point, it is again necessary to go back to the Fit for 55 plan to recall that 100% of the funds raised from the sale of carbon rights will have to be used for the energy transition. Until now, half of these funds could be used according to other needs.

The 2018 parliamentary resolution is accompanied by Annex 1[12], which is a kind of "action plan" on very concrete solutions that the Hungarian authorities, but also the public, should take to achieve the national climate goals. This "action plan" consists of three elements: the National Decarbonisation Roadmap (*Hazai Dekarbonizációs Útiterv*), the National Adaptation Strategy (*Nemzeti Alkalmazkodási Stratégia*), and the "Partnership for Climate Action" attitude-shaping plan (*Partnerség az éghajlatért" Szemléletformálási Terv*). Each part of the plan, which totals over 250 pages, is several dozen pages long. The requirement to maintain discipline connected with keeping an appropriate volume for this article will not allow for extensive discussion of this extremely interesting document. There is also another important premise. Thus, although the National Decarbonisation Roadmap (*Hazai Dekarbonizációs Útititerv*) was aimed, on the one hand, at acting to improve the climate in Hungary, but also more broadly – it was part of the obligation to prepare a decarbonisation development strategy required by EU law, all the assumptions of the national climate strategy remain geared towards achieving the old EU climate target, i.e. to reduce greenhouse gas emissions by 40% by 2030 (a criterion of the European Council taken at the summit in October 2014). Since December 2019, when the EC presented the European Green Deal, also since December 2020, when the EU Member States accepted this climate strategy, no amendment to the 2018 resolution has been undertaken; however, despite this fact the national climate strategy foresees a 52-85% reduction in greenhouse gas emissions by 2050.

How did the Hungarian state plan to reduce CO_2 emissions, which were reduced by 32% between 1990 and 2017 by Hungary (however, since 2013 the emissivity is increasing again)? Despite the fact that approx. 1/3 of the energy produced in Hungary comes from blue fuel, by 2030 the share of gas in energy production will be reduced by half. The share of Renewable Energy Sources in the energy mix is to be significantly increased. By 2020, this share was expected to be 14.65%, but this value was not achieved.

The latest data on RES share in energy production were presented in the yearbook issued by the Central Statistical Office (*Központi Sztatisztikai Hivatal*). This publication notes that the energy intensity of the Hungarian national economy declined in 2020, which is attributed to the slowdown associated with the coronavirus pandemic. RES accounted for 12.6% of energy consumption, unchanged compared to 2019. [13]. It could be assumed that in 2021 this share will increase significantly as the country has begun to operate in the post-pandemic reality. However, there seems to be no such relationship, why? Because the share of RES at the level of 12.7%, i.e. higher by 0.01 percentage point, was already recorded in 2010. It was 12.5% in 2018 and at 12.6% in 2019-2020, as mentioned earlier.

Figure 1. Hungary's electricity generation sources in 2016 and 2020



Source: Magyarország 2020 éve., 254, https://www.ksh.hu/docs/hun/xftp/idoszaki/mo/mo_2020.pdf

The graphic above shows the sources of electricity production in Hungary in 2016 and 2020. The light green colour indicates nuclear power and therefore Paks. Dark green indicates coal, turquoise indicates natural gas, yellow indicates RES and waste processing, and cream/beige indicates oil and refined products.

The most important source within RES, from which the most energy is to come, is already solar. The Hungarian state has definitely bet on this type of energy. According to the Central Statistical Office (*Központi Sztatisztikai Hivatal*), the volume of energy produced from solar power in the first quarter of 2021 compared to the same period of 2020 increased 1.5 times, reaching 0.6 billion kWh. In contrast, total electricity consumption for the first quarter of 2021 was 12.5 billion kWh, up 0.9% year-on-year. By 2030, the production of energy from photovoltaic panels is expected to increase tenfold, which will be achieved mainly through the investment in Kaposvár, located in the south-western part of Hungary, in the county of Somogy. A 100 MWe photovoltaic farm will be built there.

As mentioned earlier, the Hungarian state has completely given up on supporting wind energy; Viktor Orbán has said that not a single licence will be granted for the construction of wind farms. For 2020-2030, an increase in the share of RES in the energy mix by 5 p.p. to 20% is envisaged; however, bearing in mind the data on the share of RES, which have already been quoted, it is necessary to increase it not by 5 p.p. but by 7.4 p.p., i.e. by almost 50% more than the initially assumed targets.

Although Hungary supports investments to increase energy efficiency in real estate and the use of renewable energy sources for home heating (mainly biomass and geothermal), growth is still too slow. Financial instruments to encourage energy efficiency include low-interest loans and tax credits.

The decarbonisation of the economy determines the direction of Hungary's energy policy. Electricity generation from carbon-free sources is to increase by 90% by 2030. The climate priorities also include increasing the energy efficiency of buildings (by at least 1/3) and a large-scale afforestation campaign, which will increase the forest cover in Hungary by more than 30%.

2.3. The Paks nuclear power plant in the Hungarian energy system

The Paks nuclear power plant, which accounts for about 50% of the energy needs, was built in the 1980s from 1974 by engineers from the USSR. The complex consists of four reactors of the VVER-440/V-213 type. Subsequent reactors came online in 1982, 1984, 1986 and 1987. To start with, each reactor generated 440 MWe, the total capacity was 1,889 MWe (1x470MWe+4x473 MWe). In the following decades, modernisation work was undertaken that increased the maximum power of each reactor to 500 MWe, i.e. 2000 MWe in total. In 2020, Paks produced a total of 16,056 GWe (39.6% of total production) [13].

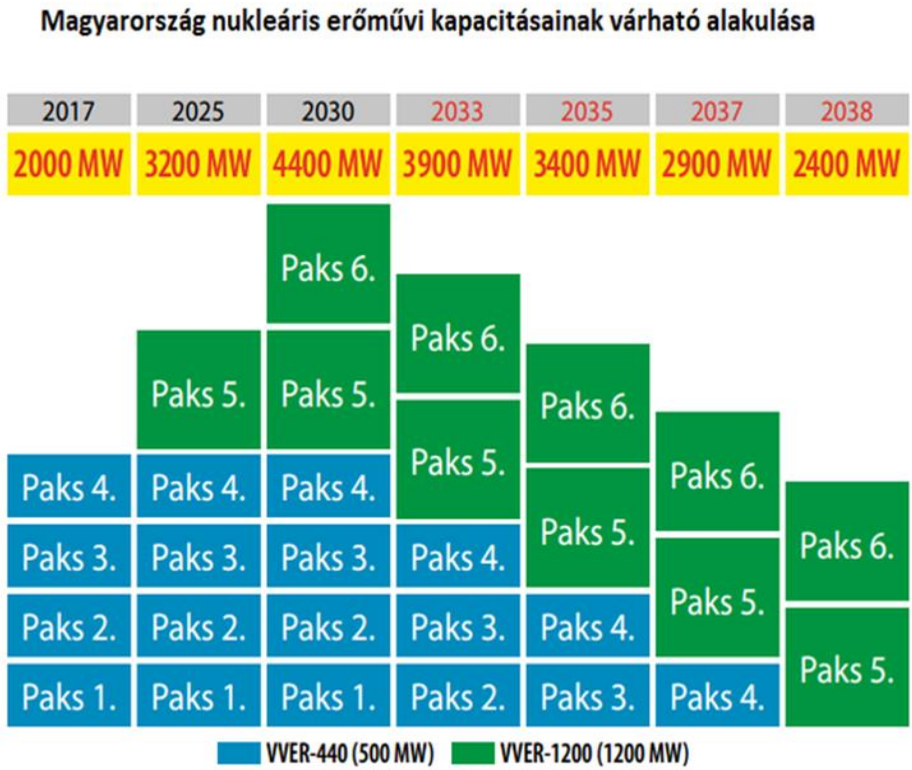
It is important to point out that in 2009, the Energy Law was amended by parliamentary consensus (with the support of 330 out of 346 MPs present in the plenary). This was a legal act of importance for the nuclear power plant that is difficult to overestimate, as this legal act extended the maximum lifetime of the individual reactors. These will be sequentially and eventually switched off between 2032 and 2037.

At that time it was also decided that new nuclear units had to be built. Their final contractor was Rosatom. An agreement to this effect was signed in Moscow in January 2014 at the highest interstate level. On the Hungarian side, it was signed by Prime Minister Viktor Orbán, and on the side of the Russian Federation by President Vladimir Putin. According to the arrangements, the value of the investment, which came to be known as “Paks 2”, was to be EUR 10.37 billion. The source of financing of this investment was to be a loan granted by the Russian Federation for a period of 30 years with a variable interest rate in the range of 3.95%-4.95%.

The original start date for the work was 2018. Under the contract, Rosatom has committed to build two reactors at the Paks 2 project, with a lifetime of sixty years for each reactor. The two new units will have a capacity of 1,200 MWe each, thus the total power plant capacity will increase from 2,000 MWe to 2,400 MWe. According to the original intentions presented in 2017, the new Paks 2 reactors were supposed to be ready in 2025 or 2026, but this has long been outright unrealistic. Now, with delays of up to four years (at least three) already occurring, there are concerns about a bad scenario where Paks 2 will be completed just before 2032. Any delay is of fundamental importance, since the consequence of failing to meet the schedule will be the need to switch off the nuclear reactors and the reduction of the maximum power of the power plant by 500 MWe each time. The decline in nuclear power's share of gross electricity generation will have consequences that are difficult to quantify, not least in the context of Hungary's, but also the EU's, climate targets.

The following graphic very clearly shows the assumed power achievable from the Paks nuclear reactors according to the original plans. If construction were to proceed as planned, it would be possible to obtain surplus energy that could either be used for the domestic market or sold on.

Figure 2. Expected maximum capacity of nuclear reactors at Paks plant over the years (2017-2038)



Source: Teljesülhet a kormány álma: Magyarország széttépheti láncait Paks és a napenergia segítségével. https://www.portfolio.hu/uzlet/20180218/teljesulhet-a-kormany-alma-magyarorszag-szettepheti-lancait-paks-es-a-napenergia-segitsegevel-276891

Analysing the above, it is also worth pointing out here the difficulties (apart from those related to the schedule of the works), affecting the profitability of the power plant. They were influenced by three consecutive European Commission proceedings that began in 2015, that is, several months after the Hungarian-Russian agreement was signed. Final approval from the European Commission was given in March 2017; however, the recommendations stated at that time have and will fundamentally affect this investment, as well as the figure presented above, which has made it absolutely impossible to reap the financial benefits of surplus energy.

The European Commission has required the separation of the plant operator from the energy seller, and at least 30% of the energy produced by the Paks 2 facilities will have to be sold on market conditions through a publicly available and open energy exchange or other sales platform. The release of prices for the energy produced by the new Paks facilities will no longer be so profitable from the point of view of its operator, as they will not be subject to state regulation. The Hungarian investor assumed that in the coming years energy prices would be steadily rising, but these calculations will be confronted with market circumstances. Another major difficulty is the financing of the investments. On the one hand, the cost of the loan proved to be too high, which was already communicated by the Minister of Economy Mihály Varga at the beginning of 2018, and on the other hand, under the EC's decision, the repayment period of the financial obligation was shortened from 30 to 21 years (maximum until 15 March 2036), which significantly affected the unit cost of instalments.

Another problem with the plant relates to environmental issues, specifically with the level of the Danube River, which cools the reactors. The temperature of the river often exceeds 30 degrees Celsius, the consequences of which will concern not only ecological issues (e.g. fish mortality), but also technical ones. Water that is too warm cannot adequately cool the reactors, and the new reactors will have twice the power. This will mean that new, more efficient cooling systems will have to be built, which may increase investment costs [14].

2.4. Hungary's position on the European Green Deal in the context of the Paks nuclear power plant

The Hungarian authorities have expressed initial scepticism about the European Commission's plans for strong CO_2 emission reduction targets. This was largely conditioned by the fact that the consequences of the EU climate targets could hit the automotive sector in Hungary, where German automotive companies have the largest market share, hardest. In order to better illustrate the importance of the automotive sector in the Hungarian financial and economic space, it is necessary to know that this is where the largest investments are made. It is also this branch of the economy that has an extremely significant impact in Hungarian exports (according to 2019 data, the share of this branch of the economy in Hungarian exports is 18% or USD 21.7 billion). The automotive industry's contribution to Hungary's GDP is estimated at 5-6%. However, if the industry's suppliers and service providers are also included, they account for another 8-9%. Automotive factories account on average for 25% of Hungarian exports. More than half a million passenger cars were manufactured in Hungary in 2019. It is worth pointing out here that according to the Fit for 55 package, by 2035 newly registered cars in the EU can only be non-emission vehicles. This is a new challenge for the automotive sector, as well as for the automotive giants, who will have to shift their machine parks to produce new car models.

In view of the above, Hungary's approach to the European Green Deal depended to a large extent not on the stance of the Visegrád Group countries, for example, but on that of Germany. Having received assurances that the automotive sector would not suffer from the proposed changes, as well as the opportunity to fit in (as noted in the introduction) with the European mainstream, the Fidesz-KDNP coalition began to treat climate policy as a business and a development opportunity. On 15 January 2021, the position of state secretary for the development of a circular economy, energy and climate policy was created in the Ministry of Innovation and Technology. He is Attila Steiner.

In addition to the automotive market component, the Hungarians communicated that while they support measures to achieve climate neutrality, support (or not) for the European Green Deal depended on four issues. The overriding objective was that the cost of the transformation should not be passed on to poorer countries; secondly, that the transformation should not result in energy and food price increases that would hit citizens; thirdly, that the EU should properly secure additional funding under the Cohesion Fund for the energy transformation and the fight against energy poverty; and fourthly, (as mentioned in the introduction to this paper), that the EU should recognise nuclear energy as a non-carbon energy source and support its further development.

Every time Hungarian government politicians make statements on energy policy, both Prime Minister Viktor Orbán and Foreign Minister Péter Szijjártó emphasise the need to maintain and ensure low energy prices for the citizens. There is a specific, systematic programme for reducing energy prices in Hungary, which operates under the name *rezsicsökkentés*. The costs of running households are reduced, including to a very large extent those related to electricity prices. It is one of the government's most important socio-economic programmes, announced in 2012 and implemented continuously since 2013. In 2013-2014 alone, prices were reduced in three stages: gas (by 25.19%), electricity (by 24.55%) and heating (by 22.63%). At that time, the energy distributors were renationalised, so that pricing policy is entirely regulated by the Hungarian state, which sets the maximum tariffs by regulation. Year-on-year, this is an average decrease of 10%.

In December 2020, the Hungarian government supported the European Green Deal, and there was a consensus among the political groups on this decision. The pro-environment parties supported the reduction of greenhouse gas emissions; however, they were opposed to the Paks 2 project. Basing the energy mix on nuclear power plants is still based on the assumptions of the Hungarian authorities regarding the construction of new nuclear facilities, including the price per 1 kWh. However, there is a lack of adequate and reliable studies and source documents that could provide some foundation for the analyses. The contract for the realisation of Paks 2 has admittedly been declassified, but with the most important parts removed. However, this document is the pillar of nuclear energy in Hungary. Most of the material that concerns Paks 2 is available in the Hungarian investigative media.

Let us return for a moment to the social aspect of the energy transition, which is extremely important. Reacting to the Fit for 55 programme's initial assumptions, the minister in Prime Minister Orbán's office, Gergely Gulyás, said that the European Commission's proposal remains "unacceptable in its current form". According to Minister Gulyás, and thus the Hungarian government, the costs of the fight against climate change will be borne by households and not by those who are the biggest polluters. Gulyás stressed that the current formula of the Fit for 55 package compromises the government's successes related to the *rezsicsökkentés* programme. The minister also added that Hungary would demand greater solidarity for the transformation of the poorer regions of the EU, but also demand that China or the US make plans to reduce greenhouse gas emissions, as the EU is responsible for only 7% of global emissions.

The position of the Hungarian authorities is that the Fit for 55 package can only be approved unanimously. The mode of decision-making under which the climate programme should be introduced is symptomatic and should be largely linked to the choice of energy production sources in Hungary.

On the one hand, this concerns nuclear energy, which is a pillar of the Hungarian energy system and which is not treated as a goal and priority by the EU or the UN, and on the other hand, the failure to include the role of gas as an interim fuel in the funds proposed by the EC, which is fully in line with the position of the Polish government. The communiqué issued by the Polish Ministry of Climate and Environment [15] states that "for Poland [gas - D.H.] is a key transition fuel which is an indispensable part of a fair energy transition. The specific role of gas should be recognised in particular in the Taxonomy. Poland does not see the possibility of implementing the target without recognising the role of gas at this transitional stage", and this coincides with the position of the Hungarian side, although the specifics of the Hungarian energy system, which relies on coal to a relatively small extent, must be taken into account. It is worth mentioning here the conclusions of the European Council summit of December 2019. It states that "the European Council recognises the need to ensure energy security and to respect the right of Member States to decide on their energy mix and to choose the most appropriate technologies. Some Member States have indicated that they use nuclear energy as part of their national energy mix."[3] However, this statement does not give rise to any concrete action.

The essence is that if nuclear is not recognised as a non-carbon fuel, it will not be possible to meet the climate targets without Paks. The same is true for gas. In early 2021, it was reported that the aforementioned Minister Attila Steiner announced at the Powering Past Coal Alliance (PPCA) summit that Hungary would phase out coal use in power generation five years sooner than anticipated – i.e. in 2025 rather than 2030, as in turn announced by Hungarian President János Áder at the 2019 Climate Summit. Minister Steiner also declared that Hungary would achieve climate neutrality of 90% by as early as 2030. The climate goals that have been set are ambitious, but it is worth looking at the chances of achieving them.

Data on the importance of nuclear power is presented above. As indicated earlier, 9.5% of energy in 2020 was generated from coal, which translates into a total of 3,817 million kWh. Lignite is used at the Mátra power plant, which has a capacity of 950 MW, i.e. approximately half the capacity of the Paks power plant. Mátra accounts for just under 20% of Hungary's energy production, but also for about 14% of Hungary's carbon dioxide emissions and accounts for half of Hungary's carbon dioxide emissions in total. The Mátra power plant has also started to use biomass as a result of subsequent upgrades (1,647 million kWh in 2020). By 2025 only gas will be used for energy production. To do so, the power plant operator (MVM) will have to build a new 500 MWe gas-fired reactor [16]. Around the power plant, the largest photovoltaic power plants in Central Europe will be built with a total capacity of 200 MWe (twice the capacity of the Kaposvár development). The third local energy source will be a 31.5 megawatt small waste and biomass power plant that will be built on existing infrastructure.

The date of Mátra's switch to gas coincides with the declaration of the complete abandonment of coal-fired power generation. It is necessary to emphasise the fact of the necessity of creating a new gas power unit, which was mentioned by Minister Steiner himself in an interview for the Világgazdaság portal, adding that in order to talk about neutrality, it is necessary to build two gas units first [16]. However, this issue has not penetrated the European discourse. Steiner added that it is crucial for the region to maintain the jobs provided by the Mátra power plant, which is the largest employer in the region (as is the Paks nuclear power plant). The Hungarian state has applied for funding for the realisation of the project from the European Union's LIFE programme. A grant was awarded in the amount of HUF 5.2 billion, i.e. over EUR 15 million.

The new gas reactor at Mátra will require increased supplies of this raw material. Recently (August 25, 2021), Hungary's Foreign Minister announced that 1.4 billion m^3 of natural gas will flow to Hungary annually over the next four years from the floating LNG port on KRK Island. It will be 1 billion m^3over the succeeding three years. In turn, on 30 August 2021, Minister Péter Szijjártó announced the conclusion of an agreement to initial a new long-term gas contract with Gazprom, to take effect on 1 October 2021. In total, Hungary's gas demand exceeds 10 billion m^3. In 2020, Hungary imported a total of 8.6 billion m^3 of gas from Russia. Five billion m^3 were contracted under a long-term gas supply agreement that ends on 30 September 2021, which was supposed to be signed (as Minister Szijjártó communicated) back in 1995. The new agreement is to be in force for 15 years, with an annual gas volume of 4.5 billion m^3 ordered for the first 10 years, and decreasing over the next five years (there is no word on what level). Of the volume ordered, 3.5 billion m^3 will be supplied via a newly built interconnector on the Hungarian-Serbian border, through which gas flows from the South Gas Pipeline. The remaining 1 bcm^3 will reach Hungary from the Austrian side, i.e. most likely via the Nord

Stream 2 pipeline. The financial terms of the agreement with Gazprom are expected to be more favourable than those under the current gas contract, and thus to enable further continuation of the policy of reducing energy prices. However, securing further gas supplies remains an open question. It is worth pointing out here that Minister Szijjártó, commenting on the successful negotiations with the head of Gazprom, said that an increase in the importance of Gazprom's supplies has been observed in Europe, which makes it possible to ensure the region's energy security.

If the completion date for Paks 2 is not met, the maximum capacity of the plant will be reduced by 500 MWe at a time, and the share of nuclear power in gross electricity generation will fall, with very serious consequences. It will not be possible to make up for this shortfall with production from gas-fired power plants, since, according to the plans already cited, the share of electricity generation from gas will be declining. Speaking about the coal-fired units in Mátra, Minister Attila Steiner said that hypothetically there is a possibility of extending the life of the lignite-fired units, but that due to the increasingly stringent EU environmental standards the adaptation of these units is not financially viable.

3. Conclusions

In view of the findings so far, it should be pointed out that Hungary's ambitious climate targets are based to a large extent on the assumption of increasing the share of the Paks nuclear power plant in the energy mix. No other energy source will be able to enable the self-sustaining demand for energy, which continues to grow. *De facto* the only alternative will remain energy imports, which in turn may lead to sudden and sharp increases in energy prices, which will probably affect all areas of the economy. For private consumers, this will be all the more noticeable since the *rezsicsökkentés* scheme consists of freezing energy prices on the internal market, and thus the amount has long been without much relation to trends in world energy prices. The Hungarian consumer is currently paying more than it would if prices were fully dependent on the market situation.

Therefore, the problem of nuclear energy in Hungary is determined by internal factors on the one hand (the pace of realisation of Paks 2), and the European climate debate on the other. The Hungarian state will not give up the key role of nuclear energy in the energy mix. This position remains in line with the objectives of the other Visegrád Group countries. The same is true for the recognition of natural gas as a transition fuel. Both these elements, nuclear and gas power, will result in an increase in Russia's energy involvement in the region, which in turn is not in the interest of Poland. On the other hand, increasing the share of RES in the energy mix will require a serious debate on the details of the EU's attitude towards China, whose dominant role in the RES sector is beyond doubt, and whose tariff policy cannot be the only solution. We should, however, bear in mind the very different approach of the countries not only of the Visegrád Group, but also of the European Union, to relations with Beijing.

One of the methods of influencing the direction of changes proposed by the European Commission in its new climate strategy is to demand, together with the Visegrád Group countries, an increase in expenditure on an energy fund that will support the energy transformation of the poorer EU countries and will also make this transformation fairer. At every stage of the negotiations, the Hungarian authorities assure their willingness to participate actively in the talks on the European Green Deal.

However, apart from the potential costs, which will have to be borne both by the state and the citizens, an important component also concerns the business use of the energy transformation, e.g. in the aforementioned automotive sector. The use of new technologies will have an impact on the competitiveness of the economy. Among the interesting proposals that the Hungarian government is looking at are, on the one hand, all possible methods for the storage of energy from Renewable Energy Sources and its subsequent use, and in addition the use of clean coal technology, which, however, is not yet suitable for industrial use. The situation in Hungary is relatively good, as although political circles are very strongly polarised, there is a consensus on climate policy, which is worth emphasising all the more. The situation may be changed by what happens around the power plant in Paks, above all, if it turns out that the cost of realising the project exceeds the assumptions and the price of producing one kilowatt hour is no longer so competitive.

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Chapter 7

Considering renewable potentials and supporting policy for energy transition

Viktor Varjú

1. Introduction

In tackling climate change, governments and other agents have launched initiatives to reduce greenhouse gas emissions. This involves the decarbonisation of energy – among others – due to its serious environmental burden across the whole lifecycle [1], and the increased use of renewable energy [2]. However, it requires a comprehensive and multilevel approach.

The EU2030 goal includes the increase of renewable energy share to at least of 32% of the EU's energy consumption. Renewables, especially photovoltaic energy investments and use have become very popular over the last few years. New technologies and solutions can contribute to increasing development in renewable energy.

The deployment of renewable energy systems has increased significantly since 2005, mainly due to the growth of photovoltaic and wind power generation, especially in the European Union, where Germany has been the market leader since 2004 [3]. For the first time in 2017, the EU generated more electricity from renewable sources (specifically wind, solar and biomass) than from coal. In Germany (which is a leader alongside Denmark), in 2017, 30% of electricity was generated using wind, solar and biomass power plants [4]. A similar figure can be found in 2020 when renewable energy reached its highest recorded share in the global electricity mix in 2020 (with an estimation of 29%). The pandemic also contributed to this favourable data. Every month of full lockdown during the pandemic reduced electricity demand by 20% on average, or more than 1.5% on an annual basis [5].

As an EU member, Poland is committed to securing a 15% share of RES in final energy consumption by 2020 [6] while Hungary aimed at 13% (with an extension to 14.65%) of share. The new commitments are still not among the highest in Europe (21% of RES in gross final energy consumption in 2030 both in Hungary and Poland). Both countries aim to continue with nuclear power as part of their energy policy, and besides, Poland still is aiming at a 60% share of coal in electricity generation in 2030 [7-8]. These trends cannot be ambitious and show a very slow transition.

In order to move towards energy transition, to increase the use of renewable energy, it is essential to take into consideration the available potential. Development on (local) resources can be based on external resources or based on internal resources, but most often it lies in the combination of the two [9]. In the renewable energy resource availability 'catalogue', theoretical, geographical, technical, economic, and market potential are the factors most often taken into consideration [10]. These are also internal and external factors; however, an important element is missing, that is, the social factor. For improving renewable energy use, it is essential to take into consideration the available knowledge about renewables and the intention of agents (whether they be a market player, a governmental organisation, NGO or a simple household).

This chapter seeks to examine the different types of potential that might influence the increase in renewable energy development. Emphasising the factors within the different types of resource potential, the chapter also gives an insight into the Polish and Hungarian situation. As this is an overview, data and literature sources are provided in the text to go further and more deeply into the assumption of local potential taking into consideration the complexity of renewable energy use tackled in this chapter.

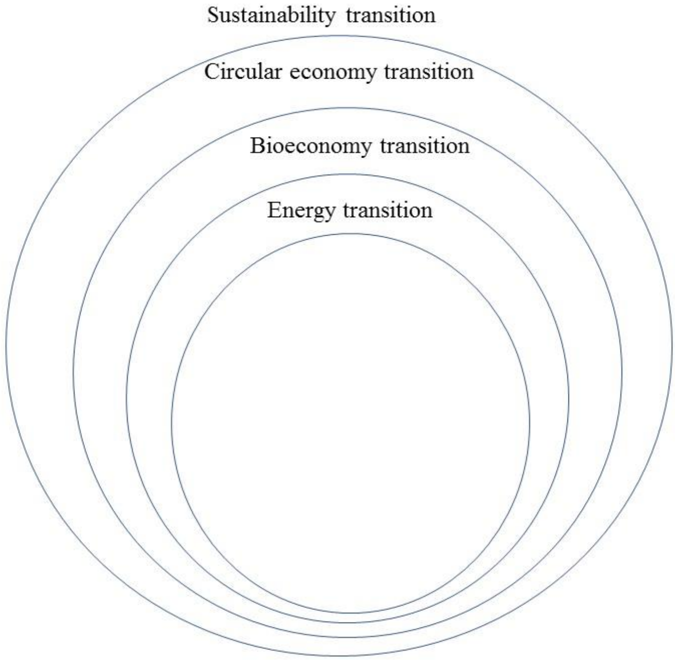
Hence, the methods in use for preparing this chapters based partly on the different international and national projects (see in the acknowledgement) of the author (where the author was the principal investigator of the Hungarian team). This synthesising analysis is supplemented by further literature and secondary analysis.

2. Energy transition

The notions of sustainability transition and technological transition have emerged in recent decades [11-12]. However, technological transitions not only involve changes in technology, but also changes in user practices, regulation, industrial networks, infrastructure, and symbolic meaning or culture [13]. Sustainability transition requires broader engagement, empowerment, and breakthrough strategies [14]. Transitions are situated in a 'socio-technical landscape' that has a set of heterogeneous factors, includes place-based cultural and normative values and situated environmental challenges [13]. Concerning the model of Geels [11], energy transition is embedded into sustainability transition (Figure 1).

A multi-level perspective framework is a dominant concept in transition literature. Geels [13] used this approach to describe the interrelationship between the tiers of niche, regime, and socio-technological landscape. Transition can be launched not only by governing processes within the niche but also by developments at the other two levels [13, 15]. It also might mean that the changes in an individual situation or knowledge (that are usually caused by the change in external circumstances both at an upper or the same level) can open up the way towards transition. Concerning Truffer and Coenen [16], this means the adaptation (or translation c.f. [17] or [18]) of national and international factors to the local context [16], which might include the knowledge, normative values, and resources that are locally available as well.

Figure 1. Framework of sustainability transition [11]



Source: Own elaboration

Energy transitions are underway on different levels, some reasonably fast, others excruciatingly slow, displaying different technologies and institutional structures, and reflecting differing public and private concerns and political approaches [19]. Energy transition is a blurry and ambiguous concept [20], hence different approaches can be captured using the examples of different countries, for instance, taking Germany's early and vigorous adoption of the concept of the Energiewende [21], or the stubborn adherence to coal by policymakers in Poland [22], while Hungary's decarbonisation (or energy "transition") based on nuclear energy (and new investment on it) and (small scale) photovoltaic (PV) investments. Hence, energy transition does not necessarily mean decarbonising an energy system but simply moving from a primary energy source to another one [20].

Within energy transition, substituting renewable energy supplies for non-sustainable energy sources is considered to be one of the major mitigation options for climate change. Therefore, the "potentials" of renewable energy supplies (and resources and circumstances) need to be assessed as accurately as possible. Estimating these potentials is difficult, and requires a better understanding of locally available natural resources, technology, economics, politics, and human behaviour [23], hence energy transition with renewable resources requires a comprehensive approach to assess the (locally) available potentials.

3. Modelling the potentials

In order to increase the share of renewable energy production and consumption, a first issue to take into account is the availability of renewable energy resources. In the literature, different types of potentials can be found. One of the most frequently cited types and their definitions are the following [10]:

- *Theoretical potential*: The highest level of potential. This potential only considers natural and climatic parameters.
- *Geographical potential*: Geographical restrictions, elevation, land cover or land use can reduce the theoretical potential. Hence the geographical potential is the theoretical potential limited by the resources at geographical locations that are suitable.
- *Technical potential*: The geographical potential is further reduced due to technical limitations.
- *Economic potential*: The economic potential is the technical potential at cost levels considered competitive.
- *Market potential:* The market potential is the total amount of renewable energy that can be implemented in the market taking into account the demand for energy, the competing technologies, the costs and subsidies of renewable energy sources, and the barriers [10]. A significant element or influencing aspect of the market potential is the incentive usually produced by states and representing the energy policy of a country (or meta governing level).

Beside the "hard" element, there are soft factors that can influence the available resources for use. Comprehensive management of local resources and the local development solutions (including renewable development) based on its resources presuppose the presence of an actor with a mandate to advance the community interest. In many countries, this agent is usually the local/regional government [9]. But before the local/regional government can take any action as an agent, it needs knowledge about the locally available resources (geographical potential), the best available technology (technological potential), the market that should be apply locally, and the attitude of local actors (i.e. are they willing and capable to install any renewable resources?). All this can be named *Local management potential.*

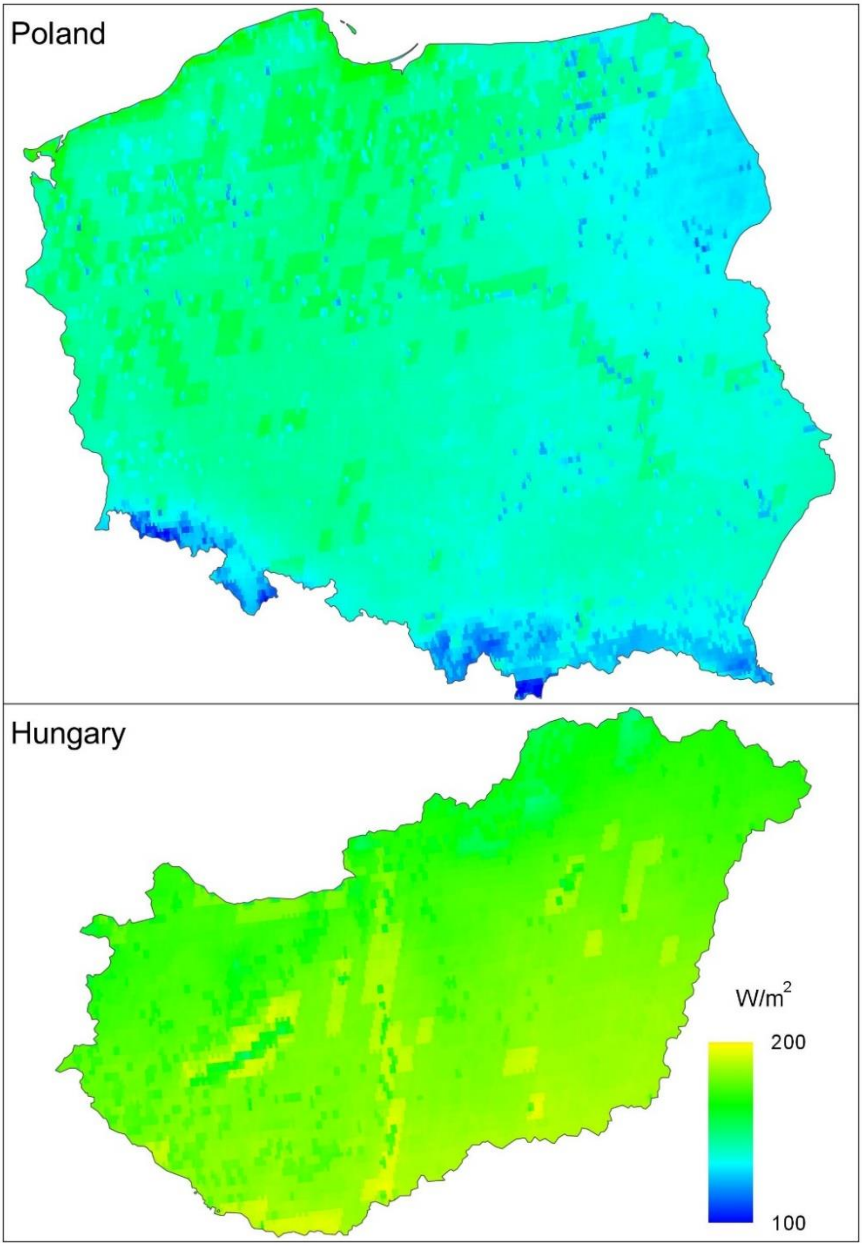
To learn about these potentials, to know which potential can be used and how they can be achieved, in other words, the transfer of knowledge, is also challenging. Collaboration, open communication, and trust between the actors involved are important and the actor also has to face the barriers [17].

3.1. Aspects of theoretical, geographical and technical potentials serving local development

3.1.1. Resource potentials

In general, estimating the radiant energy of the sun is the most common potential estimate, as the use and investment of this type of renewable energy source has become the most widespread in recent decades. The irradiation energy of a site can be determined in two ways. On the one hand, it can be measured with a pyranometer. Another type of determination is the use of analytical data available in different measurement databases. These make data from larger units of space available instead of a single point, allowing calculations for larger areas. Examples of such databases are the European Centre for Medium Range Weather Forecasting or the NASA Surface Meteorology and Solar Energy databases. The most widely used database for comparing solar resources is the PVGIS (Photovoltaic Geographical Information System) database of the EU Joint Research Centre [24]. Figure 2 shows the theoretical potential of solar energy in Poland and Hungary. The figure clearly shows the theoretical differences that are further influenced and modified by geographic (elevation, exposure, land use etc.) features.

Figure 2. Yearly average global irradiance on an optimally inclined surface (W/m2), period 2007-16



Source: PVGIS, https://ec.europa.eu/jrc/en/PVGIS/downloads/CMSAF

Although PVGIS is suitable for assessing the theoretical potential of solar energy use, one of the main obstacles to its usage is that it only calculates with a single technology [10]. In addition to this, technology is continuously evolving.

Therefore, there are several attempts to make individual measurements experiencing an appropriate technological set of solar energy use (and certainly to other renewable energy uses). An example is made by the Regphosys (http://regphosys.eu) project, where three different PV panel technologies are measured and assessed regarding their electricity production, techno-economic and ecological characteristics [25].

For electromagnetic radiation, in addition to the duration, intensity is also important. Both values can be influenced by (evidentially) physical and human geographical factors. Especially around major cities, air pollution is a decisive factor.

Besides solar energy use, there is a growing global demand for wind energy production. A basic feature of geographical potential is that the wind speed increases with height. On the sloping side of the mountains, however, a wind shadow effect can be observed [26]. A large number of studies related to wind characteristics and wind power potential have been made in many countries in recent decades [27]. National meteorological services can usually provide information about the statistical characteristics of the wind, and a variety of probability density functions (PDFs) can be used to describe wind speed frequency distributions. Among others, many wind energy potential assessment studies have been carried out with the help of the so-called Weibull distribution [28], and Bayesian methods are used to assess the uncertainties of the parameters [29]. Newer studies investigate the changes in future wind resources initiated by climate change that will influence wind resource assessments [30].

The use of biomass in energy production is usually classified by the states of matter of the biomass generated as a source of energy. Basically, solid, liquid and gas biomass can be distinguished. The most widely used (incinerable) biomasses typically have relatively low content of humidity and consequently high calorific value. The use of these kind of biomasses requires special attention to be paid to the chemical composition and the careful deposition of non-combustible ashes. Biomass can also be categorised by the origin of its creation. Hence, biomass can originate from agriculture, forestry and solid waste [31]. Both theoretical and geographical potential can be assessed by taking into account the regional statistical data on agriculture, forestry and waste management.

Agricultural biomass can be divided into biomass from farming – liquid and solid manure and biomass that originates from perennial crops. Depending on the technology, the biomass can be used for production of heat, electricity, mechanical energy (liquid fuels) as well as derivatives which can be used for the production of usable energy. Biogas is mostly produced by anaerobic digestion. The liquid biofuels bioethanol and biodiesel are produced by hydrolysis and esterification of vegetable oils with alcohol. The theoretical annual energy potential of bioethanol production from corn and sugar beet and biodiesel production from rapeseed and soy are among the highest [31].

The most used wood biomass types for energy purposes are wood, wood chips, bark, sawdust, wood shaving, briquettes and pellets. Forestry biomass can be used for the production of heat, electricity and liquid and gaseous fuels with different types of thermochemical and biochemical processes [31].

Solid waste biomass is considered a biodegradable part of municipal waste, besides, a significant amount can originate in the food and wood industries [31].

Waste can also be converted into fuel used for electricity production if not recycled, repaired or reused. In case remaining materials are deposited mixed, after a mechanical sorting process it still can converted into RDF (refuse derived fuel) or SRF (solid recovered fuel) and used [31].

Geothermal energy is the internal energy stored by the high temperature masses of the earth's crust, mantle and core. This internal energy flows from the hot zones in the depths towards the surface, and this phenomenon is called geothermal heat flow. The closer the high temperature medium carrying the internal energy to the surface in a given area, the more advisable the production of geothermal energy. The geothermal heat flow and the value of the geothermal gradient show specific territorial distribution [31].

3.1.2. Building upon potentials for modelling

In order to understand the operation and effects of innovation systems (including the transition of renewable energy), the mainstream research direction today is the study of economic life and the institutions of innovation phenomena. Within institutional studies, a distinction is made between formal institutions, where, for example, legal and economic rules are analysed, and informal institutions, by which are meant the rules of a particular social arrangement [32]. Bodor (2013) calls this duality hard institutions, or "non-social factors," or soft-informal institutions, or "social factors" [33].

All the factors that constitute the set of opportunities and provide value to developers and users are considered to be resources adaptive, bottom-up local development has at least three conditions: 1) Mobilisation of locally available community and resources; 2) Possibility of room for manoeuvre in governance and decision making (at local/regional level); 3) Adaptive use of local development tools [14]. For the latter, the learning / lesson drawing / transfer of best practices can provide solutions to local problems for decision makers [18]; however, the adaption to the local context is the key aspect.

Local level has an important role within development processes through the interactions of local stakeholders and the mobilisation of internal and external resources [14]. This means the use of local natural, human, social and economic resources as well as resources from external sources, including financial or knowledge resources. The author argues that in renewable development locally available natural resources should be used due to the (environmental, social and economic) sustainability viewpoint that helps maintain local communities.

The local resource-based LED concept endeavours to use all local resources as efficiently as possible. One of the essential features of this local resource-based development approach is not the precondition of development, but its purpose: the intervention's focus on the interests of local actors and local resource owners of a territorial unit, and the interests of all other actors subordinate to it [14, 34].

Only a portion of local resources are owned by a community. However, resource mapping must also cover those elements that are privately owned, but the local government can have an impact on the way these resources are used and the opportunities for their development. The efficient use of resources is most often achieved in the common interest of the resource owners and the local community, in cooperation with the two groups of actors [35].

The resource mapping model provides a framework for decision makers. The map provides current resource constraints and also considers alternative utilisation options to assess development opportunities based solely on existing local resources [35].

Previous studies show that local governments do not treat environmental issues as predominant. In most cases, one of the major reasons is the lack of knowledge [36]. Therefore, a resource mapping should take into account the ecological and environmental conditions of the surroundings. The inventory of the use of renewable energy sources and the integration of their application possibilities into decision-making processes are no exception [35].

In order to make decisions at local level concerning the renewable energy sector – regardless of whether it is local regulation, investment permit, or self-sustaining investment – local decision-makers must have accurate knowledge of the potentials in renewable natural resources at the local / regional level [35]. Such a model, which is the basis of renewable resource mapping, has been created in the RURES (https://rures.eu). It provides information for local decision makers about solar, geothermic, biomass and waste potentials situated locally. This provision of collection and synthesis of information on available renewable resources is especially important for smaller and / or rural municipalities. In most cases, expert knowledge and competence and capacity for coordination are absent.

Taking into account solar energy use, alongside the technology, land use is an important factor. It has been suggested to use brownfield and rooftop installation in order to avoid bad examples (such as in Hungary) of using active agricultural land for the installation of major photovoltaic systems. Due to its long-term research and measurement, the PVGIS database is appropriate for selecting technologies. For Hungary, the PVGIS suggests crystalline silicon technology (polycrystalline is the best in this country) with an annual optimal inclination angle of 35°, while in Poland it is 37°. Concerning other research, optimal tilt angles for fixed tilt solar PV panels is 30° for Hungary and 31° for Poland [37].

The meteorological module of PVGIS (https://re.jrc.ec.europa.eu/pvg_tools/en/#TMY) can help the user to visualise the windspeed and wind direction at a given point based on a 10 year-long measurement. Hence basic data for a typical meteorological year can be gained in (.csv, .json or .epw) data format. For the assumption of other resource potentials, there is a need for statistical data and technological knowledge. In the aforementioned RURES project, lower heating values for solid agricultural remains, annual energy potential of biogas production from different types of manure (cattle, pigs, poultry), and annual energy potential of liquid biofuel production (from corn, sugar beet, rape-seed and soy) were calculated based on national statistical databases and techno-logical documents. For wood biomass – using Corine land cover data – an assess-ment of the size of local forested areas (of settlements) were calculated taking into account the sustainability of the forest in extraction (4t/year/ha). A similar calcu-lation – based on waste management, and statistical and measurement data of waste composition – were applied to assess theoretical waste-based energetic potential [31].

The potential of geothermal energy is usually assessed by using the available data from geological boring made by oil companies. The catalogue of registered thermal wells can be the basis for these calculations [31]. In Hungary, the Pannon basin has a significant potential for geothermal usage [31], while in Poland, the Polish Lowlands is of similar importance [38].

As can be seen above, to take the potentials into account, there is a need for expert knowledge or knowing where resource data can be obtained. In order to bridge this gap, Mezei and colleagues – based on their elaborated methodology [31, 35] – have created an MS Excel-based model uploaded with data for all 3,255 settlements in Hungary [39]. In the drop-down menu template, all the settlements' decision makers can find the available renewable resources, the potentials and the exploitable energy (source) for their settlements. The aforementioned resource map includes not only data for renewables, but data for other resources (like human resources, and the state of the environmental, biodiversity, economic potentials of the settlement, meteorological data etc.). Here, Table 1 shows an image of the available renewable energy potentials. The model calculation is based on complex scientific methods; however, the representation was tailored to local decision mak-ers with an average understanding of technological and scientific language, i.e. scientific knowledge was translated.

Table 1. Content of the renewable energy potential decision-making tool for settlements created in the KÖFOP-2.3.3-VEKOP-16-2016-00001 project

From the drop-down menu, please choose the name of your settlement: ….			
Data used for calculation of the potentials for settlement			*Potentials, suggestions*
Solar energy	Optimal annual irradiation	1452.72 kWh/m^2	"The settlement does not have the best conditions for the use of solar energy in the country (Hungary), but it is worth performing calculations."
Wind energy	Wind speed in a height of 75 m	5 m/s	Calculated on the basis of the average na-tional reference value.

	The rate of protected areas and inner settlement	0.06%	*No wind farm can be established in a nature conservation area and in the inner area of a settlement!* Wind farm investment is not limited by the ratio of protected natural area to inner area in your settlement.	
Geothermal potential	Temperature of at least 50°C at a depth of 1,000 m.	Yes	A thermal water investment may be considered.	
	Temperature at least 90°C at a depth of 2,000 m	No		
Biomass	Area of forests	0.00 ha	Potential	Annual energy production capacity
	Protected natural areas	0 ha	0.00 tons	0 MWh
	Is there a livestock farm?	Yes	Exploitable energy	
	Number of cows	11	5,507 kWh	
	Number of pigs	56	2,830 kWh	
	Number of poultry	0	0 kWh	
	Landfill for landfill gas-fired power plant:	No	0 kWh	
	Sewage plant that can be used for a wastewater gas power plant:	No	0 kWh	
	Is there a biomass power plant operating in the catchment area of the settlement?	No	*The establishment of new biomass power plant capacity is recommended.*	

Source: [39]

The model – based on a substantial number of cases – has been integrating data of energetics investments (costs, capacities, prices, economic indices etc.) using the methodology – basically the set in the aforementioned Regphosys project [40-41]. Calculations concerned to payback time, unit cost (levelised cost of electricity – LCOE) and net present value taking into consideration settlement potentials, desired located capacity, and the available and sufficient technological settings taking into account a wide range of technologies, for instance from gasification via pyrolysis to anaerobic digestions, in the case of biomass. Feedstock cost assessment by country and investment costs were also calculated [42]. However, these calculations require a considerable amount of market and economic data [31] and have to consider the country specificities and the subsidy system of a given country. Hence, subsidy policy matters.

3.3. Influencing economic and market potentials

As Németh and colleagues argued, Eastern and Western Europe face different challenges in the growth of renewable energy and that has an effect on energy transition. Besides, in attempting to unify EU energy policy, Eastern Europe simply has a much deeper hole to climb out of to change their energy mix and traditional systems. Apart from the large hydropower capacity, mostly constructed several decades ago, renewable energy development is still at an early stage in Eastern Europe [43-44].

New technologies and eco-innovative solutions can contribute to increasing the share of renewable energy use; however, especially at an early stage, many renewable technologies require subsidy in order to spread out. Besides, a subsidy system can influence the geographical location of a renewable power plant [45], which is especially important in poorer regions where energy is needed. Furthermore, physical geography is not the dominant factor in installation anymore in the case of solar energy use [44].

3.3.1. Subsidy policies

The aim of support policy is to correct non-priced pollution (external costs) from the burning of fossil fuels [46]. Jenner and his colleagues [47] argue that two main approaches can be distinguished in subsidies: it (1) regulates either the price of electricity from renewable sources or (2) the quantity produced [44].

Feed-in-tariff – taking over the price of electricity produced from renewable energy sources in a fixed way – is the most frequently used incentive method, sometimes combined with a premium price and a green certificate [48]. It has also been shown to be the most effective tool for promoting the fastest development of renewable energies [49]. The feed-in-tariff is higher than the normal market price, thus encouraging the spread of the investments [49-50]. However, the impact depends on the country-specific policy frames [51-54]. The guaranteed takeover price is regulated in many respects. In most countries, preferential conditions are no longer granted above certain installed capacities or are tied to a certain period.

However, in many countries the high-level feed-in-tariff spilled over into retail prices and resulted in the appearance of (sometimes speculative) investor groups in the renewable sector [55]. This phenomenon also pushes municipal or community initiatives into the background. (In Australia, as a counterexample, municipalities are "responsible" for half of all reductions in greenhouse gas emissions [44, 56]. Another issue raised in the research is that for grid-connected systems, the application of take-over price does not consider the spatial location of the power plant, which also increases feed-in and transportation costs over long distances [44, 53].

The premium system, often accompanied by a tendering procedure, is an additional amount for the price calculated on the basis of the size of the renewable energy production, based on the (market) take-over price, which is used to 'reward' electricity produced from renewable energy sources. Typically, the combined market transfer price and premium price are usually less than the value of the guaranteed transfer price [44, 47].

In the quota system, a given country's service / distributor providers grant a guaranteed receipt for electricity produced from renewable resources. The amount of the quota depends on the type of resource in use and the capacity of the power plant. The value of the receipt may vary from year to year. A fixed takeover price may also be specified for a fixed period [44].

The green certificate system is based on an obligation imposed on an element of the supply chain (such as consumption, distribution), according to which a certain proportion of total electricity consumption must come from production based on renewable resources. A green certificate is required to show compliance with the obligation. These green certificates can then also develop a secondary trading market, which can make the system more expensive to operate [44, 48].

A "green certificate quota system" is a hybrid solution. The quota system is known as the quota obligation, which is called the "Renewable Portfolio Standard" (RPS) in the USA. The price of energy is set by the participants in the programme, and quotas can also be traded [53, 55]. In this subsidy system, the renewable energy producer receives different numbers of green certificates, depending on the technology applied. The electricity distribution company must purchase an electricity quota with the help of green certificates, between a specified minimum and maximum price. An additional obligation for the distribution company is to purchase a green certificate from renewable producers, the costs of which can then be passed on in the selling price of the electricity [57]. In the tendering process, (premium) quotas are spread during auctions / tendering procedures, based on which the beneficiaries are entitled to various benefits (e.g., subsidised takeover price) [55]. This procedure allows differentiations, hence territorial inequalities can be considered when allocating benefits [44].

Beside the subsidy of operation various forms of investment support are also emerging around the world. These include direct investment support, VAT or other tax subsidies (e.g., business tax or income tax rebates or investment tax credit in the USA) and are also intended to encourage investment [44, 53].

3.3.2. Subsidies and their impacts in Poland and Hungary

During the take-off part of the trajectory of renewable energy investments, many countries applied incentive schemes (e.g., premium schemes, tendering). The different supporting tools and their application periods, and the changes of supporting values resulted in territorial differences in Europe.

In Central and Eastern European (CEE) countries in 2000, firstly Poland (then Slovakia in 2003) declared tax-supporting and investment supporting tools in order to increase electricity production from renewable resources. In 2002 Czech Republic, Hungary and Latvia, in 2003 Bulgaria, in 2004 Slovenia, in 2005 Slovakia, in 2007 Croatia and in 2009 Lithuania introduced fix or premium feed-in systems. In 2008, Poland and Romania introduced quota systems (Jenner et al. 2013). However, as can be seen later on, the date of introduction of a subsidy system could not influence the spread of renewables [44].

Having regarded firstly the photovoltaic (PV) deployment and other renewable investments in Poland, one can say it was slow. The reason was the lack of an effective subsidy system and the negative approach of the Polish government (and the huge share of fossil energy in the mix). At the end of 2008, in-built PV capacity was little above 1 MWp, and almost all of these were off-grid investments. PV power plants had no priority in the connection to the grid and the connection process was also complex. Furthermore, the feed-in system did not distinguish between types and sizes, therefore small investments had a drawback [58]. Poland introduced a feed-in tariff system from 2017, instead of the former green certificate. The explanation (concerning the government) is that the feed-in tariff system is cheaper for the state and the treatment of it is also easier. The feed-in tariff is combined with auction in order to create a competitive situation [57]. The result of the change to the subsidy system caused a significant increased, achieving more than 1,300 MWp in-built capacity in Poland by the end of 2019 [44].

Unlike Hungary (see details bellow), Poland has a significant – actually the largest – increase in wind turbine energy production between 2000 and 2018. However, the percentage of energy production from wind is only ranked fourteenth. The dramatic increase is largely down to Poland’s previously very poor record [59]. This intensive increase was halted in 2017 (resulting in more than 50 GW in built capacity) and the effect of the (unfavourable) legal solutions for wind energy, in particular the Wind Farms Investment Act of May 20, 2016. The effect of the act was about a 10-fold increase in property tax, as it results from the conducted efficiency analysis for an example wind farm [6].

In the 2010's the promotion of renewables has contributed to an intensive increase in installed capacity, in wind energy, biomass and biogas in Poland. Besides, PV installations have become noticeable and a slight increase in hydroelectric power can be detected as well [6]. However, a challenging issue in Poland –

from the point of view of renewable transition – is that concerning the draft of the Energy Policy until 2040 taking into account domestic coal resources as an important element of Poland’s energy security and the core of its energy balance [7].

As can be seen in Figure 2, the physical geographical situation is good in Hungary. From 2000, there has been a legal basis for renewable investments. However, Hungary’s capacity remained very low until the mid of 2010's. Even though Hungary introduced steep recycling fees on solar modules in 2015 [44]. Until 2010, approximately 300 MW wind turbine capacity was settled; however, since then, no new permissions for major wind energy investment have been given. The official reason cannot be published, the regulation on wind energy investment remained strict; it prescribes a 12 km buffer zone for non-household size wind farms from built-up or planned built areas. In practice, this means that there is no land for installing wind farms in Hungary [60]. Besides the traditional major water dam, solar energy is the preferred renewable energy in Hungary and the recent renewable energy policy builds upon this. However, the evolution of PV policy and investment has been uneven.

In Hungary, the actors of PV investments were and recently are mainly telecommunications companies and households (in order to reduce the price of electricity). Hungary had the feed-in tariff (FIT) system until the end of 2016. The country had and has the lowest tariff in the region at around 32 HUF/kWh (without significant changes). This price meant 0.109 EUR/kWh in 2012, and recently the price of 34.14 HUF/kWh means 0.095 EUR/kWh. Although there is a Structural Fund-based support for renewable investors, the amount was very small. In Hungary, there was and still is another barrier to big investments. Electricity producers from 500 kWp must give an electricity production schedule for the operator in advance and if there is a discrepancy, the producers must pay a penalty. However, a manifold significant 'systemic' change occurred in the second half of the 2010's. In the National Energy and Climate Plan of Hungary, the government had been committed to PV development, with special attention on small-scale (up to 50 kWp, household level) investments. Besides, based on the new energy strategy, domestic installed solar capacity is expected to exceed 6,000 MW by 2030 and to be close to 12,000 MW by 2040. Additionally, the boom is rooted in the fact that LCOE costs are now below the subsidised price level, and there is a favourable financing environment (low loan interest rate) for small scale investors [61]. Also, there was a change in the subsidy system in Hungary, from 2017. For PV investors (above 50 kWp), a new subsidy system is available, called/abbreviated in Hungarian METÁR, that is premium-type support. The former feed-in-tariff system (called KÁT in Hungarian) is available to small-scale investors, in its recent form, supposedly, until 2023. This special structure of subsidy meant that in the 2010's, the increase of cumulative PV capacity was due to the significant increase of small-scale (household, rooftop) investments in Hungary [44].

Having regarded the two countries, it can be said that although Poland and Hungary had different paths regarding renewable energy subsidy, the increases in the two countries are not among the leaders. The reason for the slow movement may be that both countries have a core / massive non-renewable energy source in the mix. This is coal for Poland and nuclear for Hungary. In the latter case, the challenge may be that nuclear energy is promoted as a clean energy from the point of view of CO_2 emissions, hence the new nuclear development plant plan does not facilitate a move towards a more renewable-oriented policy. This is the situation even though – as previously mentioned – the Hungarian energy policy is planning a significant increase in PV capacity.

3.4. The soft potentials

According to Polányi's substantive, sociological approach, economic behaviour is embedded in society [62]. Beyond the sociology of economics, the (social) embeddedness of regional innovation systems also appears in the theoretical literature of economics [63]. Hence, the efficiency of development policy depends not only on macroeconomic subsidies, but also on governance capacities, its social embeddedness, complexity, and its open or closed, hierarchical or horizontal nature [14]. This means both that social capacity affects integration and application of innovations and new (resource) investments, and the use of new technologies can influence local everyday people in their development directions.

The created resource potential model can help decision makers; however, successful application requires complex and conscious planning in the development process, including the human capacity. Rural territories in this sense have disadvantages concerning some studies [64] that usually include unfavourable demographic processes and a low activity rate. The low level of schooling is against the proliferation of major innovations and the spread of state-of-the-art technologies, and the base of vocational training and adult training is also in need of these regions' development. These challenges decrease the capital absorption capacity. Additionally it creates a gap for large businesses [64-65].

The basic condition for the use of renewable energies (as innovation) is the capacity of a given society. In addition to the above, social inclusion is also influenced by individuals and the formal, elected and informal leaders of local society [66].

3.4.1. Actors and institutions

As it can be seen above, national- or meta-governmental organisations – via subsidy policies – can influence actors in sustainability/renewable transition. Also, in the case of local knowledge regarding resources (c.f. chapter 3.1.2.), local stakeholders can also influence local everyday people in the choice of new (renewable) technology in order to transform the local society towards a more sustainable one. However, there are other factors that influence the role of local / regional stakeholders' role in it.

Some empirical research shows that in Central and Eastern Europe, the elements of sustainability do not appear with equal weight in the task-orientation of local governments [67]. The sustainability of the natural environment and environmental protection activities are typically pushed into the background. Even if they do appear, they are not motivated by environmental awareness but by economic interests. In several countries, only those investments that have been supported by ISPA / Cohesion Fund (CA) (investments in wastewater and waste management) or renewable energy investments and legal obligations have been implemented so far [66].

It can be treated as axiomatic that the development of a settlement basically depends on the network of interests and personal competence of decision-makers, settlement leaders and local actors. “Behind personal influence systems in larger settlements there is always a complex organisational base” [68]. “The smaller the village, the more closely its prosperity depends on the local government, the mayor's abilities and personal ambitions” [69]. The lower the level we move to, the more marked the role of the individual, the unity. Therefore, from an environmental policy point of view, the active role of the local level is unavoidable [66].

Based on empirical international research (interviews with majors and case study researches), [66] it is argued that mayors were key players in municipal renewable energy investments, and with their representative body they were able to accept the new direction. However, it can also be said that the decisions were driven by economic rationality, the environmental consideration did not appear or only barely appeared in the decisions. Later, the environmental aspect was used as a marketing tool. In addition to economic rationality, the educational function of the propagation of environmental protection as a spin-off effect can be utilised [66].

If information structures in energy are confusing and opaque, it also affects the decision-making process. Unfounded, ill-considered decisions based on momentary interests can lead to a distorted energy structure and publicity. In its research analyses, the Energy Club states that the social public has suffered in many cases, transparency is limited, due to the fact that the reporting culture in energy is still underdeveloped in Hungary and the anomalies of the national legal environment do not help efficiency. The analysis also reveals that law enforcement practice also severely impairs the chances of environmental democracy [70].

Varjú's international research showed the above-mentioned outcomes. Renewable investments are largely contingent, linked to a call for proposals (the support system is not as systematic as in Germany). According to them, the level of transparency related to renewable energy is low; however, the institutional system is quite politicised. Objectivity as well as the appearance of expertise is limited, leaving something to be desired Table 2 [66].

Table 2. Typical distribution of answers to the question "How would you evaluate the attitude towards renewable energy in Hungary in terms of" based on interviews

	High	*Medium*	*Low*
Politicisation	X		
Objectivity (expert knowledge)		X	
Level of transparency			X

Source: [66]

The reason why the peculiarity of local stakeholder level matters is the partly mentioned fact that local governments have a relatively significant effect on inhabitants [68-69].

3.4.2. The role of Households

As can be seen above, both national and regional / local governmental level can influence the choice of everyday people. Hence, on one hand when considering the impacts of solar energy use, it becomes inevitable to also pay attention to the assessment of its social impacts, which means assessing how the communication affects a given social group and in what ways such communication affects renewable/solar energy-related decisions made [71].

Pálvölgyi and colleagues – based on their analysis – summarised the influences that a renewable energy development project can have [72]. This sustainability refers to the potential positive and negative effects of it (Table 3).

Table 3. Potential effects of renewable uses on a local / regional society

Designation of social indicator	*Expected effect*
Human health	Minimal effects (see detailed in life-cycle analysis)
Quality of life	Due to the sense of independence for the supply system, no or minimal effect
Education, qualification, knowledge	Positive effect, involvement of students into research tasks for the purpose disseminating results
Public awareness, approach, presenting good examples	Positive: Give information and good examples / best practice

Mitigation of social disparities	Negative impact: Access to household level renewable systems (it mainly means PV) is possible mainly for wealthy people and savings resulting from the use of such systems also contribute to their cost-benefits, thus creating possibility for a further increase in social disparities
Enhancement of co-operation between social actors, strengthening cohesion	Positive impact: Good example can be seen in cross-border cooperation [73, 74]
Prevention of migration (job creation)	Exerting no impact: job-creation effect of PV or wind turbine systems usually does not appear in a given region (see detailed in the chapter about regional impacts)
Energy poverty alleviation	Positive impact: renewable energy not exploited as yet becomes incorporated in the energy system

Source: Based on [71, 72] own contribution

On the other hand, it is unavoidable to have a look at on the local society, local cultural and moral circumstances that are the "social bed" of the local actions performed by households, as "the existence, lack, number, composition, applicability and value of social relationships exert a fundamental influence on the everyday life of an individual or that of a community" [75]. These factors have important implications for the spread of environmentally conscious patterns also including (i.e. pro-environmental attitude and behaviour) the advance of renewable/solar energy investments [71].

Investigations on pro-environmental attitude and behaviour are increasingly in focus as the attitude is "a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour" [76], and it is of vital importance in the forecasting of actual behaviour [77], including pro-environmental or "pro-renewable attitude". A significant part of the environmental challenges can be traced back to human behaviour, so most investigations are targeted at the discovery of motivations. Several studies have explored the strong correlation between a pro-environmental attitude and environmental action (or non-action) [78–80] focused, among other things, on the motivations of actions concerning environmental challenges, "counter-measures". Beside attitude, the factors influencing behaviour include elements. Most of the work on environmental attitudes [81–83] concerns Ajzen's behaviour theory [84] as a basic work, which refers to subjective norm (which refers to the pressure by the environment potentially influencing one's behaviour to implement or not implement some action), or to “experienced behaviour control” (referring to the past experiences and visible obstacles like money, schooling, knowledge, and available time) as an additional factor in attitudes influencing behaviour [85]. Furthermore, the value system, identity, moral convictions, the already experienced advantages and disadvantages, context and habits are also discussed as influencer elements [81, 82].

Less attention is in literature is paid to the examination of differences regarding the environmental attitude by territorial types. Freudenburg and McGinn [86] found that previous research had quite a mixed opinion with respect to differences according to territorial character (urban vs. rural, industrial vs. agriculture-dominated areas) and environmental attitude. Some research did not find any difference between environmental conviction and the character of the respondents’ territory, and there were some that found a positive correlation between the urbanisation level and the environmental conviction [85].

Responding to the mentioned territorial question, Bodor et al.s' empirical research made an attempt to compare rural areas in Croatia and Hungary in the topic of renewable energy and energy efficiency. In their outcomes, they pointed out a contradiction when comparing attitudes to the actions conducted or behaviours. On the one hand, the outcome of the survey revealed a higher environmental attitude among the Hungarian respondents, while Croatian respondents acted more environmentally consciously [85].

In this research, the examination of the regression model revealed that incomes or the subjective financial situation had no significant impact on energy-efficient-oriented actions and in this respect, no difference can be seen between the older and younger generation [85]. However, another study that also relates pro-environmental attitude and behaviour found less concern for the negative effects of climate change are more likely to be characteristic of older age groups, and of those with lower levels of education [87]. It also draws to our attention to an important issue raised by scholars, namely that we cannot tackle pro-environmental attitude and behaviour in one domain [88].

With regard to energy transition, there is the Eurobarometer 492 aimed at assessing awareness of climate and energy issues among EU citizens to better understand attitudes towards EU energy policy. To the question which detects what EU energy policy means to the respondents, at a national level, "shifting from fossil fuel to renewable energy sources to combat climate change" was the most-given answer in 17 out of the EU's 28 member states. In that sense, there is a huge gap in Poland and Hungary. While in Poland, with 31%, this was the most popular answer, in Hungary, with a 37%, respondents would see more competitive energy prices for consumers as an energy policy solution. The keen to encourage more investment in renewable energy is a little bit higher in Poland (91%), slightly above the EU average, while it is 89% (slightly below the EU average) in Hungary. (Although it is accompanied by a higher level of disagreement from the Hungarian side (10%) than that in Poland (6%).) Almost the same rate of respondents (Hungary

90%, Poland 89%) agreed with the statement that it should be the EU's responsibility to address energy poverty and ensure a fair energy transition so that no citizen or region is left behind. Alongside this attitude, both Hungarian (45%) and Polish (43%) respondents mentioned majorly that the EU should tackle "Ensuring that energy costs are as low as possible" as a priority instead of the option of "Investing in and developing clean energy technology"[89]. This suggests that in both countries, prices are more important than the energy transition.

In terms of energy-efficiency, what was interesting was that more Hungarian respondents recognised (81%) the "classic" EU energy label (that is usually used labelling the energy consumption of devices such as televisions or refractories) than respondents from Poland (76%). Also, 89% of the Hungarian respondents (first place in the EU) responded that it has an influence on the purchase of a device (this was 80%, but still above the EU average in Poland) [89].

4. Conclusion

According to endogenous growth theory, the successful development (i.e. local development) of a region depends on the optimum utilisation and appropriate use of local resources, including renewable energy and human resources [90-91]. The presented resource potential model can help decision makers; however, successful application requires complex and conscious planning in the development process, including the human capacity.

Local governments with financial difficulties are only able to carry out significant investments in a supportive regulatory and financing environment (even if a (renewable investment) has a slow payback), although it is evident that these developments can lead to considerable savings for the investor, for the local government itself. In order to change this trend, the first step of successful adaptation is attitude shaping and conscious economic development activity which, in some places, is the reinforcement of the economic organisational function of local governments, activation of local businesses and inhabitants, their preparation and involvement in developments [64].

The positive effects of investment incentives affect not only the advance of renewable systems but also the spread of democracy, i.e. the so-called energy democracy [92], consequently to which “fundamental decisions are taken not by energy supply companies but by end-consumers who gain this predominance because they themselves satisfy their energy needs by the application of low-capacity energy-generating equipment purchased by them” [92].

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Chapter 8

Teachable Moments: Economic and Energy Security Implications of Coal in Poland and Hungary

Jakub A. Bartoszewski, Anna Mikulska

1. Introduction

The history of modern Central Eastern Europe (CEE) is a story of dynamic transformation. The turbulent decade of the 1990s brought a panoply of changes that profoundly influenced the region in a relatively short period of time. The fall of the Iron Curtain enabled the renaissance of civil liberties: autocracies were replaced with democracies and new institutions paved the way for new trajectories of economic growth and international cooperation. This, in turn, facilitated the CEE's reintegration into the world economy, unleashing the forces of globalisation that added societal and cultural layers to the spectrum of economic and political novelties. The accession to the European Union (EU) in 2004 accelerated these changes. Nowadays, once impoverished, most CEE nations are prosperous, stable and boast bright perspectives for future development [1].

Yet, this transformation is far from being over as global energy transition forces interfere with the setup of many of the CEE economies. The energy transition contained within the framework of the European Green Deal, adopted by the von der Leyden Commission in 2019, sets eventual decarbonisation of the European Union as its paramount objective [2]. This effort towards the ambitious goal of a greener Europe might pose a challenge to the trajectory of development of the CEE hitherto; though the magnitude and character of the challenge differs from one country to another, as per Poland's and Hungary's experience.

In this chapter, we take a close look at the place of coal in the economies of two CEE nations, Poland and Hungary, and how, despite the obvious differences that exist between them, these countries can cooperate and prosper as they navigate a less carbon-intensive future. We start with a review of the literature that considers the role of coal in both countries. Then we describe the economic development trajectories of both countries, the role coal plays in each of their respective energy mixes and the implications this has for Poland's and Hungary's energy security.

We close the chapter with a discussion that considers the impact of the upcoming energy transition on the possible cooperation between the two nations.

While both countries are often seen as examples of a successful economic transformation in the region, their energy foundations are significantly different in terms of possible approaches to decarbonisation, its pace, and available and acceptable solutions. The differences between Poland and Hungary in terms of coal production and consumption are striking and lead to different policy outcomes. They also highlight the problems each country either will or is likely to face moving down the energy transition route. Yet, as we show, Poland and Hungary have a lot to learn from each other's experience to balance the elusive goals of energy transition with the objectives of energy security dictated by both markets and the harsh reality of geopolitics. A closer cooperation between the two states in the area of energy can be forged along the lines of complementarity in national interests, mutual sharing of know-how, and a common voice within the EU as well as globally, including via organisations such as the Three Seas Initiative and the Visegrád Group.

2. Literature Review

The complexity of Poland's relationship with coal is first revealed when exploring the special place of coal in Polish culture and national identity. The slogan 'Poland stands on coal' dates back to the communist period of Polish statehood, experienced after 1945, and encapsulates the alleged importance of the fuel for the prosperity and stability of the country. The rhetoric of coal as "black gold" and the reverence with which the occupation of miner has been perceived by Polish society are part of the legacy of those times. As Bridge and Kuchler claim, this national imagination is strengthened by modern Polish policy makers [3]. Yet, these cultural realities stem primarily from firm economic foundations.

Coal has historically been essential for the functioning of the Polish economy as the main component of its energy mix. The importance of coal in Poland's development was meticulously outlined by Zientara in a 2007 study, shortly after the country's accession to the EU in 2004. The author argues that Poland's economic growth in the 20th century was largely dependent on the abundance of coal reserves located in the Upper Silesia region, the second largest in Europe. According to Zientara, coal was perceived by the communist authorities as the driving force of the post-WWII industrialisation in Poland. Indeed, at its pinnacle coal accounted for 98 percent of electricity generated within the Polish economy, suggesting that the veneration of the fuel was intertwined with a near-full dependence on it. Importantly, the by-products of this special role of coal in Poland were not only cultural constructs, but also a gamut of economic and political privileges lavished on the miners [4].

These eventually turned out to be a major obstacle to the restructuring of the largely unprofitable state-owned Polish coal mines during the transformation of the centrally planned economy in the 1990s, as argued by Szpor and Ziółkowska. The authors of this more recent, 2018, study confirm Poland's continued, yet gradually decreasing, reliance on coal, even after the 2004 accession to the EU. They assess the attempts to either close or reorganise the least profitable coal mines, concluding that the entire process remains largely unfinished [5]. This implies the challenge that the completion of transforming the Polish coal mines will pose in the process of achieving the goals of decarbonisation. The issues related to the mining sector are also discussed by Rybak and Rybak, who point out the notorious mismanagement of the mines, indicated by their continuously decreasing productivity [6]. On the other hand, Kasztelewicz et al. argue that Poland's enormous lignite resources offer promising perspectives for further growth of the Polish coal industry, which may remain unexploited due to the EU's climate policy [7]. This argument finds confirmation in recent events related to the lignite mine at Turów, ordered to be shut down by the European Court of Justice, thus emphasising the economic challenge lignite poses to any decarbonisation plans Poland may want to introduce. A continued use of the mine by Poland that resulted in the Court imposing a 500,000 Euro per each day the mine operates defying the order additionally underscores the complexity of the issue and the need for updated dialogue and new, creative solutions [8].

Poland's economic reliance on coal is coupled with political factors that contribute to the sustained use of this fuel. Zientara, as well as Baran, argue that the Polish mining industry remains heavily unionised, which obstructs governmental attempts to close unprofitable mines and restructure the inefficient ones [9-10]. Mikulska points to the structure of the electoral system in Poland which – given its the basis in population size – affords the densely populated mining regions a very high number of seats in the parliament, thus translating into the region's and the miners' political influence [11]. On top of that, the public debate about the phase-out of coal in Poland currently follows ideological lines. As shown by Pluciński et al. in their 2021 study the currently dominant right-wing parties advocate against the energy transition goals and for the coal status quo. The polarisation of Polish politics experienced in recent years has likely contributed towards this attitude that has been only strengthened by anticipated increases in energy prices influenced by the EU environmental regulations [12-13]. All in all, coal remains very much at the centre of Polish politics.

As of 2021, Poland's energy mix remains largely undiversified, thus hampering the perspectives for the Polish economy's decarbonisation, argues Kiuila [14]. As a result, the use of coal in Poland is likely marked by an institutional lock-in effect, as is suggested by Kramej et al [15]. Another dimension of Poland's relationship with coal is that of energy security, an argument often brought up by Polish policy makers in the context of their country's geopolitical situation and a sustained sense of threat from Russia [16]. Manowska et al. claim that it is the coal deposits that make Poland 50 percent less dependent on energy imports than the EU average [17]. The energy security concerns have for long constituted a foundation of Poland's energy policy and might eventually become the main point of resistance against the new wave of changes in the realm of energy brought by the EU's decarbonisation plans. This is confirmed by the fact that the official energy transition strategy of the Polish government, contained within Poland's "National Energy and Climate Plan", anticipates a reduction of coal-generated electricity only to the level of 60 percent by 2030 [18]. While the Polish government also recently managed to convince the mining unions to close all coal mines by 2049, thus effectively ending the production of coal in the country, it is unclear whether these changes will be accompanied by the complete phasing-out of coal from Poland's energy mix, i.e. a recalibration of current coal-based energy infrastructure to other fuels [19].

Hungary's experience with coal is significantly different from that of Poland. As noted by Bart et al., Hungary is poor in fossil fuels and its only significant source is low quality lignite, whose mining is constantly declining [20]. To put it in perspective, the Hungarian coal reserves constitute only 11 percent of the Polish ones [21]. Coal accounts for just 18 percent of electricity generation in Hungary, which has a relatively diversified energy mix, shows Szoke [22]. Consequently, the aggregate economic, political and societal influence of coal in Hungary, as well as the impact of coal's phase-out, is much smaller than it is in Poland.

The low proportion of coal in the Hungarian energy mix makes the country's energy transition according to the EU's plans possible, if not relatively easy when compared to Poland. Indeed, this allowed the Ministry of Innovation and Technology of Hungary, in its "National Energy and Climate Plan" submitted to the EU Commission in 2019, committing the country to a total phase-out of coal from the country's power generation by 2030, with the deadline adjusted this year to an even more ambitious 2025; a goal unachievable in Poland in either of the time frames [23-24].

A closer look at the Hungarian energy infrastructure shows why the phase out is possible: just two power plants are responsible for most of the power generation in the country, lignite fuelled Matra and nuclear Paks. Kiss points out that the latter accounts for the majority of power generation, approximately 50-55 percent of the total domestic production, whereas Matra contributes a significantly smaller share of energy to the Hungarian economy, around 20 percent, and hence it is easier to replace [25]. The overall plan of the Hungarian government is to decrease the share of Matra while increasing the share of Paks in the country's energy production. This also includes investment aimed at increasing the share of renewables sources of energy and gas-based power plants [26].

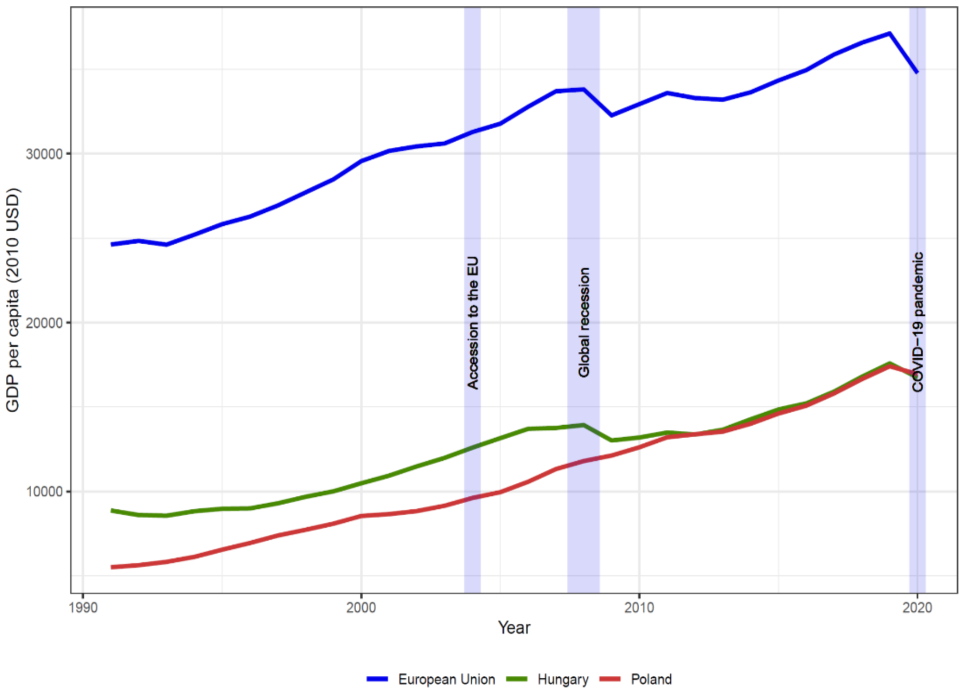
Weiner notes that the actions undertaken to implement this plan reveal an attitude of Hungary towards Russia in the realm of energy that is dramatically different from that displayed not only by Poland, but also by the rest of the EU. While Russia is often perceived as a threat to the energy security of the EU, in particular by countries in Central and Eastern Europe, Hungary is an outlier and is open to energy cooperation [27]. Notably, the current expansion of the Paks nuclear power plant is being carried out in close partnership with Russia, with the latter providing 80 percent of financing for the project [28]. This is in addition to the fact that all of the uranium needed for the plant's operations already comes from Russia. Moreover, Russia supplies 95 percent of natural gas and 80 percent of oil consumed in Hungary [29-30]. In fact, the one energy export where Russia is not a dominant supplier includes coal, though import volumes are low and only supplementary to domestic production.

Although Hungary is currently pursuing a quick coal phase-out, its government remains sceptical of the European Green Deal. In that context, Schulz suggests that the Visegrád Group – comprising Poland, Hungary, Czechia and Slovakia – has evolved into an alliance against the decarbonisation plans; though the unity of the group is clearly undermined by the recent events related to the Turów power plant [31]. In the case of Hungary, this scepticism can in part be explained by its turbulent relationship with Brussels, although Vadovics suggests that the main causes can be found in the current structure of the energy market in Hungary. Per Vadovic's analysis, a reform conducted in the early 2010s resulted in a strong state control over the majority of the energy market in Hungary. The state-owned and centralised character of the market are an obstacle to innovation and disruptive changes, such as the sweeping propositions of the European Green Deal [32]. This results in a degree of scepticism, the source of which is structural rather than stemming from the specifics of Hungary's energy mix. This is also where Szabo and Fabok notice similarities between Poland and Hungary in the structure of their respective energy markets. They note that while the EU promoted a pan-European energy market based on the rules of free competition, the two countries preferred to follow a more paternalistic model based on state ownership of key energy companies which would allow them to control energy prices and protect the individual customer from market volatility [33].

3. Post-1989: From Misery towards Prosperity; though at a different rate

The geopolitical changes of the 1990s resulted in a period of sustained prosperity in both Poland and Hungary. Although the exact paths of reforms undertaken by the governments of both countries upon their liberation from the Soviet Bloc differed from each other, the outcomes of each have been similar.

Figure 1. Dynamics of economic development in Poland and Hungary post 1991 - 2020

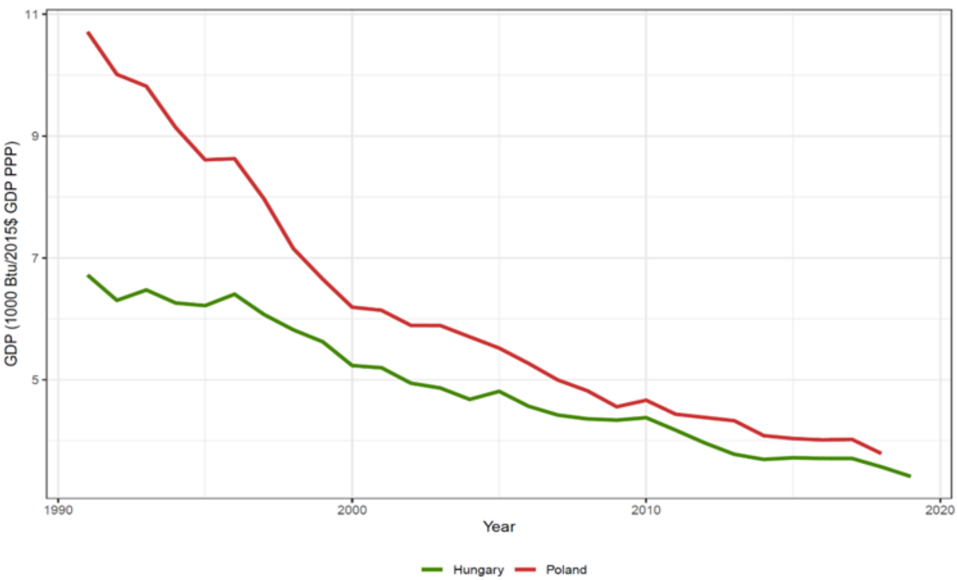


Source: [21]

As shown in Figure 1, Poland entered the last decade of the 20th century significantly poorer than Hungary. In fact, its GDP per capita constituted almost a half of that of Hungary. In the subsequent years leading to the accession to the EU in 2004 both countries experienced incessant economic growth, with Hungary maintaining its lead when it comes to economic performance. This situation began to change on the eve of the Great Recession of 2007-2009. At that point Hungary was experiencing a temporary period of economic stagnation, which eventually turned into a recession. On the other hand, the effects of the global financial crisis were relatively mild in Poland, partially due to its relatively large domestic market and low level of exposure to fluctuations in international trade [34]. The country experienced only a decrease in the rate at which its GDP grew, instead of economic contraction. In effect, in the years following the Great Recession the wealth gap between Poland and Hungary effectively closed. Since the early 2010s the levels of income in each country remain almost identical, as shown by the close overlap in Figure 1. Although the average GDP per capita in both nations is still far from the EU average, indicating lower levels of economic development relative to their

Western European counterparts, the countries are facing bright perspectives for further economic growth. Both countries boast a qualified workforce and have become hosts to many multinational corporations active in the CEE region [35]. Poland's relatively large internal market and an export-oriented economy are a significant strength, while Hungary's central geographic position accounts for its competitive advantage, especially in the realm of energy and energy infrastructure.

Figure 2. Energy intensity of GDP in Poland and Hungary: 1991 – 2018



Source: [21]

The economic development of both Poland and Hungary was accompanied by continuously decreased energy intensity of their respective economies, as illustrated by Figure 2. The pattern conforms to the economic theory which predicts that higher levels of development translate into a more efficient use of energy, a sort of Kuznets curve for energy efficiency [36]. Indeed, with energy being the most basic input into an economy, it is reasonable to assume that development should go in line with more efficient uses of energy that eventually creates economic output. This is clearly the case for Hungarian and Polish economies, with the changes being much more significant for the latter, which between 1990 and 2018 registered a nearly 80 percent decrease in energy intensity. Notwithstanding this impressive reduction, Hungary remains the less energy-intensive economy out of the duo thanks to its nuclear power capacity, although the difference between the two countries has been becoming gradually smaller over the past decade.

4. The Role of Coal in the Energy Mix

At the first glance, historical patterns of sectoral consumption of coal in both Poland and Hungary have been marked by relative similarity, with the majority of the fuel being used for industrial and residential purposes (Figure 3). The main difference here is Poland's sustained use of coal in agricultural activities, as well as in commercial and public sectors, contrasting with Hungary's complete phase-out of coal from these parts of the economy shortly after the accession to the EU in 2004. In addition, Poland experienced an expansion of coal use by the residential sector, which was accompanied by a simultaneous contraction of consumption by the industry. Further differences between Warsaw and Budapest become visible once we zoom out to see the wider role of coal in the two countries' respective energy mixes.

Figure 3. Sectoral consumption of coal in Hungary and Poland: 1980 – 2018

Source: [21]

Given the use of coal for the purposes of electricity production, heating, and industry, the fuel's main alternatives are either nuclear, natural gas, and/or renewables. From Figure 4 we can see that for the period 1980-2018, diversification of energy consumption in terms of fuel type has been much higher in Hungary with coal satisfying a relatively small part of the demand, i.e. an approximate share of 10 percent. Instead, natural gas, petroleum, and nuclear dominated with a small amount of renewable generation also included in the mix. Of the three, only nuclear power constituted a domestically produced source of energy with natural gas and petroleum production not sufficient and significant imports needed to fill the gap. That being said, since Hungary needs to import uranium to be able to produce nuclear power domestically, this source of energy cannot be considered entirely domestic and hence, can be also a source of dependency.

Figure 4. Dynamics of energy consumption and production mix in Hungary and Poland: 1980 – 2018

Source: [21]

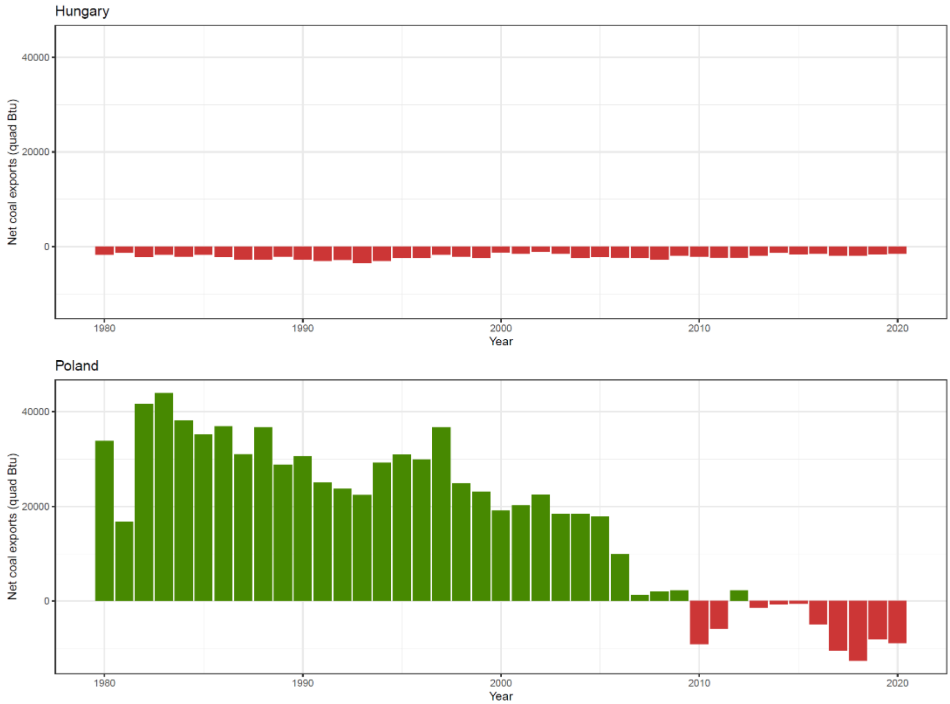
In contrast, Poland's energy mix remained significantly reliant on coal (50 percent of total primary energy consumption in both 2017 and 2018) as petroleum, natural gas, and a very small share of renewable energy complete the picture. This reliance on coal is not coincidental. It is directly tied to the historically high level of domestic production of the fuel. That being said, the absolute value of coal production in Poland has decreased for the past three decades; a change that is partly attributable to the decrease in energy intensity of the Polish economy.

Still, even today coal still accounts for 82 percent of Poland's primary energy production. The remaining energy production in Poland includes small amounts of natural gas, petroleum and renewable power. Similar to Hungary, Poland's domestic production of natural gas and petroleum has never been sufficient enough to satisfy domestic demand and both fuels need to be largely imported. Production of renewable power in both countries increased in recent years – to a large degree thanks to their accession to the EU with generous subsidies from Brussels for green infrastructure that created a dynamically growing, though still quite small, renewable branch of the energy industry [37]. Importantly, Hungary is currently using EU funds to transition away from lignite as it restructures the coal (lignite)-fired Matra power plant into an industry cluster where renewable power (solar) plays an increasingly important role [38].

All in all, the structure of Hungary's energy mix is clearly more diversified, with no one fuel dominating in a way that coal dominates Polish energy production and consumption. Thanks to nuclear power and a more recent EU push toward decarbonisation, the role of coal in Hungary has steadily diminished over the past three decades. This prevented the domestic coal industry from gaining the significant amount of political influence that it is enjoying in Poland, thus facilitating an easier coal phase-out [39].

Conversely, Poland not only has historically been highly dependent on coal for domestic energy needs. Until 2010, the country was also a net coal exporter (See Figure 5 below). The industry was especially coveted during the communist regime as exports of coal constituted a significant source of foreign currency for Poland's centrally planned economy [40]. The exports of Polish coal have decreased over time after 1989 due to the mismanagement and inefficiency of the mines, but the reverence around mining and coal has not disappeared so quickly, neither has the political power of unionised miners who have, often successfully, pushed back against any attempts directed at minimising coal extraction, disappeared [41].

Figure 5. Net Exports of Coal in Hungary and Poland: 1980 - 2020



Source: [21]

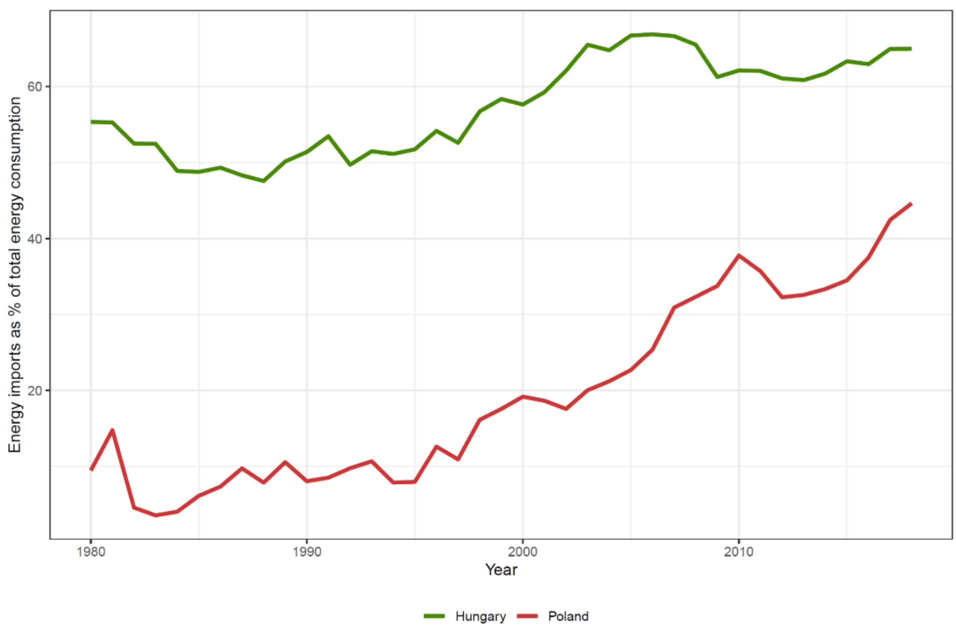
That being said, the decreased economic rationality for the extraction and use of coal implies a possible weakening of the power of Polish coal mining unions in the future. The same cannot be said, however, about another element of coal's popularity in Poland: energy security, which domestically extracted coal provides in a way that other fuels cannot. Herein lies another important difference between Poland and Hungary revealed by their use of coal.

5. Energy Security and Coal

The "4 As" approach is one of the most rudimentary ways in which the literature defines energy security [42]. It points to availability, accessibility, affordability and acceptability as the main elements of a secure supply of energy. Domestic sources of energy are usually best suited to provide a secure supply as they require no dependence on any other country for delivery of a fuel. Coal, thanks to its wide geographical distribution, plays the role of secure energy supply in many countries. It is usually easy and not too expensive to extract, transport and store (accessibility and affordability) and historically has been widely accepted as a fuel of choice, something that has been currently changing due to the movement toward decarbonisation and societal demands for clean air. This stands in contrast to natural gas or crude oil, which are sparse and concentrated in only a few places worldwide, often expensive and difficult to extract, transport and store. Natural gas in particular has been problematic from the energy security perspective in the CEE due to its logistical complexity. Unlike coal or crude oil, the physical state of natural gas makes its transportation difficult, as it requires sophisticated and usually expensive infrastructure, such as pipelines or LNG terminals [43]. The latter implies access to the sea to be a *sine qua non* for countries that want to participate in the global natural gas market, a condition that is enjoyed by Poland, but it is absent from many central European nations, including Hungary. The region's heavy historical dependence on Russia for piped natural gas supply and lack of alternatives facilitated the latter's geopolitical leverage [44].

Data analysis reveals a crucial difference between Hungary and Poland when it comes to security of energy supply. Figure 6 shows the total energy imports of both countries for the period of 1980 – 2018.

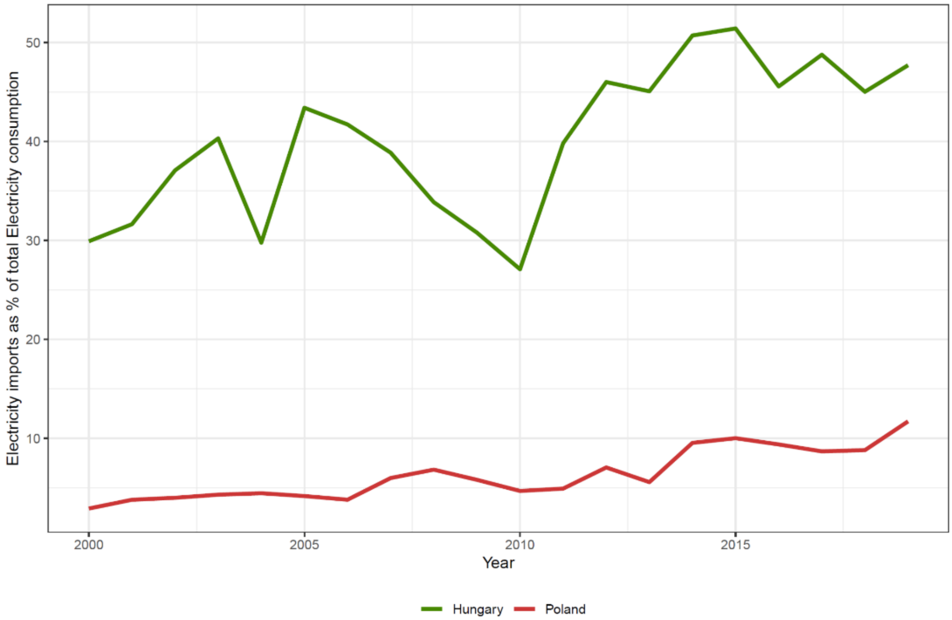
Figure 6. Energy imports of Hungary and Poland: 1980 - 2018



Source: [21]

The initial position of both states is very different at first. While Hungary was largely dependent on energy from external sources as far back as 1980, with imports constituting 55 percent of its total energy consumption, Poland kept its energy production largely in-house, largely thanks to coal. Polish energy imports started to increase only at the end of the 1990s. The data clearly suggests that while both countries' dependence on energy imports rises, the trend is much stronger for Poland. Still, the latter does not ever reach the level of dependency observed in Hungary.

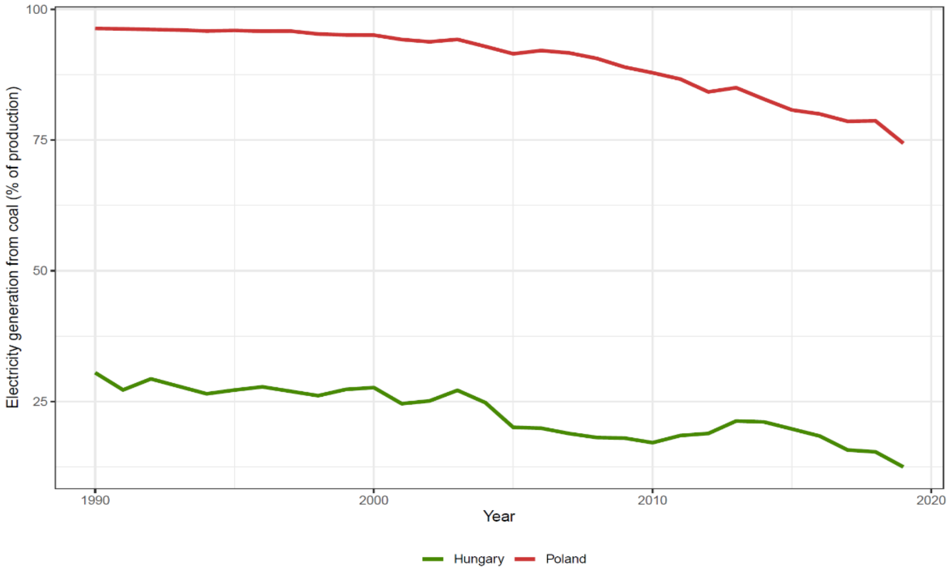
Figure 7. Electricity imports of Hungary and Poland: 2000 - 2018 [21]



Source: [21]

The role of coal is even more pronounced when one compares the levels of import dependence in the case of electricity for both countries. Figure 7 shows that although Poland's energy imports have increased as a whole in the period of 2000 to 2018, its electricity imports remained at a marginal level of less than 10 percent of the total electricity consumption, only recently and only slightly crossing the 10 percent threshold. As Figure 8 illustrates, this is thanks to the use of (mostly) domestically produced coal with the vast majority of Poland's electricity still produced domestically by the coal-fired power plants located in Poland. In this sense, coal has insulated Poland from a high degree of dependence on external sources in electricity production. In contrast, Hungary with sparse fossil fuel endowment has been highly dependent on external sources not only when total energy mix is considered but also when it comes to electricity.

Figure 8. Electricity generation from coal as a percentage of total generation in Hungary and Poland: 1990 - 2018



Source: [21]

Hence, despite the relatively diverse portfolio of fuels that Hungary uses to power its economy and support its population, the country seems to be highly dependent on imports, which could have negative implications for its energy security. This concern is additionally augmented by a high level of dependency on one supplier, namely Russia.

The extent of Budapest's dependence on Moscow for energy supply is vast. As noted earlier, Russia provides 100 percent of the uranium used in Hungarian power plants, as well as 95 percent of natural gas and 90 percent of oil [45]. In addition to this, 80 percent of financing for the expansion of the Paks nuclear plant comes from Russia. This policy decision will deepen the dependency further as it will enable effective coal phase-out, in effect replacing mostly domestically sourced coal for domestically produced – but dependent on Russia for financing, technology, and fuel – nuclear power. Such an extensive degree of dependence is always troubling, but even more so when there are no immediate alternatives (as in the case of Hungary) and when the source of dependence is a country known for high level of state intervention into energy flows, as well as its readiness to use energy as a tool of geopolitical influence [46].

In effect, although Hungary's energy mix seems to offer a well-diversified selection of fuels, the origin of these energy inputs implies a long-term dependence on external factors and suppliers. This contrasts with the Polish strategy, where coal has remained a cornerstone of energy security while the country has pushed for diversification of natural gas supply away from Russia. That being said, as decarbonisation trends and policies such as carbon tax are taking hold, Poland is bound to struggle. The EU directives on levels of renewable energy and phase-out of fossil fuels, particularly coal, have already sown disagreement between Poland and EU institutions and high cost of carbon within the EU Emissions Trading Scheme (ETS) has added significant cost to the operation of the Polish coal-fired power generation [47]. The country needs to decarbonise and fast. But the structural elements that have protected coal so far – such as infrastructure, economic development and social and political forces, as well as energy security – are making this a difficult endeavour.[13]

6. Discussion and Conclusions

Poland and Hungary are examples of Central European nations that have gone through a wide range of transformations experienced by the region. The democratisation of the 1990s was followed by the liberalisation of their economies and three decades of almost incessant economic growth. Continuous increases in wealth were accompanied by improvement in the energy efficiencies of the Polish and Hungarian economies. As the levels of wealth rose, the amount of energy needed for economic output continued to fall. Here, however, the similarities between Hungary and Poland's energy transition paths seem to end. While Hungary followed the typical predictions in economic theory, according to which the less efficient and more polluting fuels were replaced by more efficient and cleaner ones; Poland kept exploiting its vast reserves of coal and continued to use its coal-based energy infrastructure.[14] Cemented by the might and political influence of the Polish coal mining industry, Poland's dependence on coal has proven difficult to break. Not only would coal phase-out mean the loss of well paid jobs and potential economic atrophy of the coal regions, it would also potentially mean a significant loss in terms of energy security as coal's alternatives would need to be imported,

[13] For further discussion on this issues see: https://www.bakerinstitute.org/research/obscure-mining-dispute-highlights-clash-local-interests-global-climate-goals ,https://rienergia.staffettaonline.com/articolo/33129/Poland,+Europe+and+The+Coal+Conurum+/Mikulska and https://www.bakerinstitute.org/research/explaining-polands-coal-paradox

[14] There is a generally negative correlation between economic development and the use of coal, as shown by Apergis and Paine – developed countries tend to generally move away from the "black gold" due to the negative externalities caused by its environmental effects.# This trend is often described as the Environmental Kuznets Curve, i.e. the proposition that indicators of environmental degradation first rise, and then fall with increasing income per capita. Despite rising levels of wealth, Poland's economy remained fueled by coal, thus making it an outlier in the developed world and a rare case of a prosperous Western country with an energy mix almost incompatible with the goals of the energy transition. See: Apergis, Nicholas and Payne, James E. 2010. "Coal consumption and economic growth: Evidence from a panel of OECD countries." Energy Policy 38 (2010): 1353-1359. & Hao, Yu et al. 2016. "Does the Environmental Kuznets Curve for coal consumption in China exist? New evidence from spatial econometric analysis." Energy 114 (2016): 1214-1223.

either directly like natural gas or indirectly when nuclear power is considered via transfer of technology, financing and nuclear fuel.

However, since, unlike Hungary, Poland has been focused strongly on diversifying its energy suppliers with special attention given to diversify away from Russia, some of the geopolitical implications of high level dependence on energy imports could be abated. Other challenges will hold. As, for example, gas markets become more liquid, prices could become less stable and shortages of natural gas supply may occur under challenging market conditions, as exemplified by the shortages and exorbitant prices of natural gas that Europe has been facing in the fall of 2021 [48].

The challenge of the energy transition in the form of decarbonisation, brought about by the European Green Deal, is much less serious for Hungary than it is for Poland. The former boasts a highly diversified energy mix which allows for the relatively easy removal of coal from its energy mix, especially if it adds more nuclear power generation. For Poland, dependence on coal – so important for its energy security – creates a serious obstacle, particularly in the absence of nuclear power generation or even a firm agreement to install it. In the absence of nuclear power, Poland would have to rely significantly either on natural gas or on renewable energy, or a combination of both. And though the country has significantly expanded its natural gas access to non-Russian supply, issues of price and global availability of natural gas, especially at times of pent up demand, are at the very least worrisome. Also concerning is the fact that natural gas has been increasingly shunned by the EU given the fuel's CO2 and methane footprint. At the same time, both countries are only at the beginning of their experience with renewable power and, in general, the renewable energy potential there is not as high as in other countries in Europe. Though Poland has the potential for offshore wind, Hungary does not have access to the sea. Also, neither country has a very high level of sun exposure year round, although Hungarian experience around the revitalisation of the coal region around the Matra power plant, which includes a solar power build-up, all of which could be instructive for Poland as it looks into restructuring its own coal regions. In turn, Hungary should consider lessons from the Polish energy mix diversification. The scale of dependence, which extends to the financial control of Moscow over Budapest's key energy infrastructure investments, should be treated with caution and new avenues for energy delivery should be explored and pursued.

All in all, even though Poland and Hungary face significantly different circumstances when it comes to coal production and consumption, the countries have a lot to learn from each other. In fact, their differences are a great basis for such learning: some of the biggest challenges that stand ahead of Poland will be the restructuring of coal regions; something that Hungary has been trying to do for some time. Meanwhile, Poland's successful diversification of natural gas suppliers can be something that Hungarian policy makers would want to analyse. Neither of the experiences is perfect and neither will apply directly, but this is not what learning is about. Instead, learning from mistakes and adjusting for different circumstances could be a valuable lesson, particularly if both countries participate in it. Here both, intergovernmental, expert-level, and societal consultations within a Hungarian-Polish dialogue could be especially enriching. In addition, both countries should look into expanding this dialogue to other countries with which they already collaborate. Most obvious is the Visegrád Group that besides Poland and Hungary also includes Czechia and Slovakia, both of which face similar challenges related to energy transition and coal as well as energy security and the threat of Russian dominance in the region. Only when working together – despite their differences – can these countries provide an alternative to the current energy transition strategy championed by the EU, which is often difficult to follow, if not incompatible with these countries' societal, political, and economic needs. As such, the V4 countries could be at the forefront of redefining energy transition in a way that incorporates environmental concerns as well as the need for economic development and abatement of energy poverty that are destined to hamper decarbonisation efforts in many countries in the developing world. Finding creative solutions to those challenges could be crucial for the wider climate change agenda.

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CONCLUSION

This book deals with the difficult subject of finding common vectors in the energy policies of Poland and Hungary, which could become the basis for extending the cooperation between the two countries. The obviousness of looking for links in the policies of Poland and Hungary results from their geographical and cultural proximity, as well as from their membership in key international organisations such as NATO and the European Union. The topic is difficult because of the level of complexity of energy issues, which are strongly correlated with the geo-economic conditions of the two countries. These, in turn, have significant differences based on the foreign policy priorities they pursue in the region. However, the motivation for strengthening cooperation in this area lies in the potential for synergies and common economic interests. The energy sector is nowadays one of the critical elements enabling economic development and, at the same time, burdened with demanding pro-environmental expectations, it poses new challenges for the countries. Revitalising economies has become one of the priorities in today's world dealing with the severe effects of the pandemic. However, according to the European Union, this reconstruction must be carried out in accordance with the imperatives of environmental and climate policy.

The book devotes a chapter to the energy and climate policy of the European Union, which inextricably corresponds with the policies of Poland and Hungary as Member States. It identifies certain paradoxes in the EU's energy transition policy, the consequences of which must be dealt with by Member States. One of the more controversial issues is how to reconcile the processes of economic integration and liberalisation of energy markets while preserving the sovereignty of Member States and reconciling their different interests. The questions to which we are still seeking answers relate to the degree of EU interventionism in energy prices and in levelling the playing field between Member States which are at different levels of economic development and therefore of progress in the energy transition.

While we recognise that the EU's energy and climate policies are gaining momentum, this is accompanied by the realisation that without a strong political consensus on their foundations, the European energy transition will not succeed. Agreeing on a common position for all EU members is made impossible by their different, often conflicting national interests. They are reflected in issues such as the Nord Stream projects, the double standards concerning South Stream and

Nabucco, and the economic sanctions against the Russian Federation after the invasion of Crimea. At the same time, the EU is facing an internal crisis that is also affecting other international organisations, which are clearly not keeping up with the pace of change and need reform. This also applies to the North Atlantic Alliance, which needs to rethink its joint mission. We have seen in recent years that NATO has made moves to clean its energy security agenda up and make it coherent. As a result, it has been refocused on three main areas: increasing strategic awareness of the energy area for security, supporting the protection of critical energy infrastructure, and increasing energy efficiency in the military.

Today, energy is no longer just a strategic input to warfare as the domain of logistical planners, but has become a system-wide strategic lever in the military. Energy matters to combat capability and ultimately to the civilian energy sector. For Poland and Hungary, NATO plays a big role in providing collective security, and energy is an integral part of this. One of the issues of interest from this perspective is the NATO Pipeline System (NPS), which could potentially be extended to the Alliance's eastern flank, which would be in the profound interest of both Poland and Hungary. For a number of decades, the NPS has served the allies in times of crisis and peace, offering real solutions for both missions and operations, as well as the civilian market. As highlighted earlier in the book, the expansion of the NPS network would likely contribute to NATO's energy security as a whole in terms of military readiness and mobility, economic benefits for host countries, including Poland and Hungary, and long-term environmental benefits. In other words, the NPS serves three main functions: it provides military security as an important logistical asset, it is an important peacetime commercial enterprise, and it contributes to reducing the Alliance's environmental footprint because pipelines are less energy intensive and produce fewer greenhouse gas emissions than other means of oil transportation.

Continuing the topic of the influence of international organisations on Poland's and Hungary's energy security, the relatively new Three Seas Initiative is also worth mentioning. While in the case of NATO the analysis is based on oil supplies, the potential of the Three Seas Initiative is considered in the context of natural gas. This Initiative creates specific conditions for natural gas imports to Poland and Hungary, especially as regards the opportunity to diversify supply directions. This is all the more critical because the dominant supplier in Eastern Europe is the Russian Federation, which treats natural gas as an instrument of foreign policy in the former Soviet bloc countries. The expansion of connections with other countries in the region and the construction of LNG terminals will make it possible to import gas from directions other than the east, thus reducing Russia's ability to exert pressure on the region. To this end, an appropriate cooperation mechanism should be created between the countries of the Three Seas Initiative while strengthening integration with the European Union.

The natural gas sector is undoubtedly one of the crucial areas representing significant potential for Polish-Hungarian cooperation, although of moderate importance for the Hungarian side. Hungary has significantly reduced its natural gas consumption in the last decade and is developing new natural gas supply routes, but also, unlike Poland, has decided to retain Russia as its key natural gas supplier. The Polish strategy anticipates an increase in natural gas consumption in the future, inter alia, due to the need to reduce coal consumption in the energy sector. Moreover, Poland is strongly focused on eliminating gas supplies from Russia, diversifying the market, ensuring competitively priced gas supplies via LNG terminals and purchasing gas from Norway.

The price of natural gas for end-customers in the form of households as well as for industry is important for both Poland and Hungary, as it affects the competitiveness of the economy, as well as jobs. Hungary, by taking political decisions in the field of natural gas in line with the interests of the Russian Federation, obtains natural gas from the latter at prices such that it can offer it to domestic end-users at the lowest price in the entire European Union. Given that Hungary also uses this raw material for the production of electricity, it can be seen that the competitiveness of certain industrial sectors, such as petrochemicals and chemicals, depends to a certain extent on political relations with Russia. On the other hand, Poland seeks to reduce the price for end users through an appropriate policy of diversification of natural gas supply sources. However, a direct comparison of prices over the last few years shows a clear advantage for Hungary in this respect. The contract signed in September 2021 for the supply of natural gas from the Russian Federation to Hungary will strengthen their position as a supplier for the next 15 years. Poland, on the other hand, has decided to sign agreements with Qatar and the USA, among others. The project to expand Poland's interconnections with its neighbours is in line with the "North-South" gas corridor, while Hungary aims to make the country a regional gas hub re-exporting Russian gas. On the other hand, the future integration of regional markets offers an opportunity to strengthen Polish-Hungarian cooperation in the area of natural gas. The second area of significant value for Polish-Hungarian cooperation is the nuclear power industry. Nuclear power already supplies about 50% of Hungary's electricity needs. Hungary plans to build two new units at the Paks nuclear power plant by 2030. However, the expansion does not serve to transform Hungary's energy mix, but to sustain electricity production at a similar level to today. Although Poland does not have a nuclear power plant, it treats this sector as the foundation of its energy security. Construction of the first nuclear plant is expected to begin in 2026. The nuclear power plant is supposed to prevent the power deficits in the national power system forecast today, which will result, inter alia, from the withdrawal of exhausted coal-fired power plants. At the same time, it will allow Poland to reduce greenhouse gas emissions and air pollution. If the Polish and Hungarian nuclear power plans come to fruition, a new market for very high-value services will be created that will exceed the economic capacities of both countries. It will create scope for cooperation between subcontractors of nuclear power plants and, subsequently, potential for growth and mutual economic benefit.

Finally, the third area important for Polish-Hungarian cooperation is the coal sector. Due to the policies of the European Union, Poland and Hungary must take up the challenge of rebuilding coal-based energy. This involves the reclamation of post-mining areas and the simultaneous transformation of existing coal-fired power plants. From this perspective, it is much more challenging for Poland, whose energy mix is strongly based on the use of coal, while Hungary is characterised by a greater degree of diversification of different energy fuels. However, Hungary is condemned to importing most of its necessary energy raw materials, while Poland in its energy policy is much more focused than Hungary on diversification of energy suppliers and independence from Russia. Although Poland and Hungary have significantly different circumstances in terms of coal production and consumption, this area illustrates well the similarities between the energy transition paths of the two countries.

Meanwhile, the energy transformation in Poland and Hungary is an issue that arouses many emotions and contradictory social reactions. It therefore requires a comprehensive and multi-level approach. As members of the EU, Poland and Hungary have committed themselves to certain values in terms of RES share in final energy consumption by 2030. As mentioned earlier, both countries are pursuing nuclear power in their energy policies to help modernise the energy sector to a "cleaner" and more environmentally friendly one. However, the energy transition process is limited by the available potential, which is based on local resources and accessibility to external resources, as well as geographical, technical, and economic factors and market potential. According to endogenous growth theory, the successful development of a region depends on the optimal and appropriate use of local resources, including renewable energy and human resources. It is important in this respect to shape attitudes and conscious activities for economic development in order to build acceptance for the changes accompanying the energy transition. The positive effects of investment incentives are influencing the progress of renewable systems, but also the spread of so-called energy democracy, in which the importance of end users is increasing.

Poland and Hungary are examples of Central European nations that have gone through a wide range of political and economic transformations experienced in the region. The steady increase in wealth that has been observed since the 1990s has accompanied improvements in the energy efficiency of the Polish and Hungarian economies, but so did the steady growth of demand for energy. The energy policies of Poland and Hungary to date are marked by many differences, and the plans for the future development of this sector in both countries are also different. Nevertheless, there are common points of contact that represent promising prospects for Polish-Hungarian cooperation towards a more efficient and environmentally friendly energy sector and more competitive economies in post-pandemic recovery.

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The monograph deals with the issue of Polish-Hungarian cooperation in terms of energy security. The book comprehensively addresses the energy transition of both countries. It shows the nature of the energy transformation of Poland and Hungary, highlighting the shift from fossil fuels to renewable energy. Through comparisons, the similarities and differences of the two countries in this process are identified (…).
In the context of climate policy challenges, the book is an attempt to systematise and organise knowledge. (…) The analysis contained in the book is of a general nature, which creates the perspective of familiarisation covering various issues. The book is cognitively interesting because it identifies existing trends in the energy transformations of both countries (...) It allows readers to become familiar with the panorama of energy changes in Poland and Hungary in the first decades of the 21st century. (...) It is worth emphasising that the different forms of action for energy security of Poland and Hungary have been indicated.

From the review by
Jarosław Gryz Professor (full)
War Studies University

The issue of Hungary's participation in the energy system of Central and Eastern Europe is extremely important, yet it is often treated in a perfunctory manner. The situation is similar with regard to Poland. A much more common approach is to treat energy policies in autonomous models, often ignoring interdependence and cooperation. (...) This book significantly fills this gap, at the same time confirming the topicality and importance of the issues examined. (…) The monograph addresses the intractable issues of similarity of interests in energy, but also the important differences in conditions. These considerations are embedded in a robust contextual analysis (...).
This book is therefore the work of authors representing various research approaches, using different methodologies and investigating different but related fragments of the energy sector. The whole publication combines into an innovative achievement at a high substantive level, abounding in original conclusions and recommendations.

From the review by
Jacek Reginia-Zacharski PhD, DSc,
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