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MANAGING ENERGY SUPPLY SECURITY AND GAS DIVERSIFICATION IN HUNGARY

PUTTING THEORY INTO PRACTICE

WP

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Author:

Csaba Weiner

senior research fellow
Institute of World Economics
Centre for Economic and Regional Studies Hungarian Academy of Sciences
Email: weiner.csaba [at] krtk.mta.hu

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Managing energy supply security and gas diversification in Hungary

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Csaba Weiner[a]

Abstract

For a long time, gas has been the fuel that Hungary is particularly sensitive to in terms of security of energy supply; thus, gas diversification has become a key issue. However, along with the 2014 decision on the construction of new units at the Paks Nuclear Power Plant (Paks-2), the energy agenda has changed considerably. Paks-2 will have a decisive role in ensuring security of supply, and, in fact, it has already begun to perform a role in energy decisions. This paper aims to assess, on the one hand, the security of the stationary fuel supply in Hungary by applying the conventional three-dimensional approach, encompassing availability, affordability and sustainability, and, on the other, use our own gas diversification scheme to analyse the issue of gas diversification. We find that considerable progress has been made on gas diversification, and Paks-2 can also be included in our diversification scheme as a kind of sectoral diversification option. Prior to the Paks-2 decision, Hungary had followed an upward trajectory for its security of supply, despite certain negative developments. With Paks-2, Hungary's dependence will both decrease and increase – as new types of risks emerge. There is great uncertainty about Hungary's energy policies and security of supply, with the role of coal, gas and renewables in the energy/electricity mix still not settled. Their future is expected to be heavily dependent on political decisions rather than energy market factors, though energy market uncertainties are also high.

JEL: L71, L95, O13, P28, Q4

Keywords: Hungary, Russia, energy security, security of supply, gas diversification, coal, gas, nuclear energy, renewables

1. Introduction

Energy is the most important element of EU–Russia relations. In 2016, Russia provided the highest share of extra-EU imports of natural gas in gaseous state (46%), crude oil (32%) and coal (31%) (*Eurostat*, 2017a). Gas is the most sensitive issue, despite recent changes in European gas markets, and also despite the many years that

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[a] Ph.D., Senior Research Fellow, Institute of World Economics, Centre for Economic and Regional Studies, Hungarian Academy of Sciences, Tóth Kálmán u. 4, H-1097 Budapest, Hungary. Email: weiner.csaba [at] krtk.mta.hu.

have passed since the 2009 Russian–Ukrainian gas crisis, which was the most serious gas supply security incident ever experienced in Europe and one of the most serious energy supply security incidents in general (*Stern*, 2009). This warning signal has prompted the EU countries to truly focus on security of supply and diversification, with the latter seen as a key to enhancing the former. The EU has taken several steps to do so, showing a gradual change in its approach to the issue. Since 2009, security considerations have gained prominence in official EU documents, despite maintaining explicit references to market integration, the liberal principle and related regulatory measures (*Boersma and Goldthau*, 2017: 103). Meanwhile, key developments have also taken place in geopolitics, and not just regarding Ukraine. However, the events in Ukraine in 2014 became a turning point. The conflict has changed the EU's approach to energy policy and Russia. In recent years, the EU has come to see Russia as a growing threat. The plan of the Energy Union[1] marks a fundamental shift from a liberal approach towards a liberal mercantilist one (*Andersen et al.*, 2017). In contrast, the Hungarian government (2010–) considers Russian energy relations not as a threat but as an opportunity, and maintains increasingly closer ties with Russia. As part of this approach, in January 2014, Hungary concluded a huge nuclear deal with Russia, leading to Russia's State Atomic Energy Corporation Rosatom participating in the design and construction of the future fifth and sixth units of the Paks Nuclear Power Plant (Paks-2). Thus, in addition to gas, another sensitive issue was added to the Hungarian–Russian energy agenda.

Energy policy decisions have long-term implications and entail enormous costs. Complex decisions need to be made, while simultaneously – for an observer – it is not easy to evaluate these decisions and achievements. In order to make such an assessment, several energy policy-related concepts should first be defined properly, as they are more sophisticated and complex than commonly and conventionally perceived. Basically, they can be divided into three groups. The first group encompasses energy security, including security or insecurity of supply and demand. Different types of diversification represent the second group, while energy dependence, interdependence and independence belong to the third. For a net energy importer, the most important among these are security of supply and diversification. Therefore, in this paper, we first

[1] In February 2015, the European Commission released a package of three communications on the EU's Energy Union. One of them is the framework strategy for the Energy Union (*European Commission*, 2015).

present the concepts in general, and then concentrate on security of supply and gas diversification. On the one hand, we take a conventional approach to assessing the security of the supply of stationary fuels,[2] and, on the other, we develop and use a scheme for understanding gas diversification in Hungary. These are presented through two case studies, illustrating how the theory is put into practice. And, finally, conclusions are drawn at the end of the paper.

2. Theoretical framework

2.1. Energy security

Energy security has two sides. Although net energy importers tend to treat the terms energy security and security of supply as synonyms, security of supply constitutes only one aspect of energy security. The other side of this same coin is security of demand. While energy importers are concerned with security of supply, energy exporters aim to increase their security of demand. In many cases, however, exporters also import some energy, and, likewise, importers can also be exporters of energy. Hence, it is more precise to use the adjective "net". There is relatively little academic and policy literature on energy security that deals with security of demand, and, due to certain inaccuracies, the term "energy security" is often used in the meaning of "security of supply". It seems that we have to accept this inaccuracy.

Security of supply and security of demand have no uniform definitions.[3] There are different ways to approach security of supply *(Table 1)*. Here, the traditionalists' survival-based definitions are first to be mentioned. However, *Buzan et al.* (1998) warn that special care is needed when attempting to move the term security from a military context and to apply it to non-military issues, particularly to energy.[4] Another approach is applicable if security of supply is considered as a concept that has different

[2] Oil is not discussed here as it is principally a transportation fuel.
[3] In this paper, we focus on security of supply. Security of demand is only mentioned in relation to the potential Hungarian electricity exports resulting from Paks-2.
[4] Cited by *Yafimava* (2012: 12).

Table 1. A compilation of different definitions of security of supply

1. Traditionalists' survival-based definitions
– *Buzan et al.* (1998)
2. Dimensional classifications
– two-dimensional definitions: availability and price (cost) – *Manners* (1964), *IEA* (1985), *UNDP* (2000), *Yergin* (2006, 2011) – three- and multidimensional definitions – *Elkind* (2010): availability, reliability, affordability and environmental sustainability – *APERC* (2007): four 'A's: availability, accessibility, affordability and acceptability – *Sovacool and Mukherjee* (2011): availability, affordability, technology development, sustainability and regulation – *Alhajii* (2007): economic, environmental, social, foreign policy, technical and security dimensions – *Wicks* (2009): physical, price and geopolitical security – *Hippel et al.* (2011): environment, technology, demand-side management, social-cultural factors and international relations or military risks
3. Other definitions
– *Cherp and Jewell* (2011): three perspectives: sovereignty, robustness and resilience – *Stirling* (2007): system properties consisting of stability, durability, resilience and robustness

Source: Own compilation.

dimensions. The simplest and oldest definitions are two-dimensional, referring to availability and price. These two dimensions can also be called the physical and the economic dimensions (*Cherp et al.*, 2012: 330) or physical and price security (*Wicks*, 2009: 8). However, over time, many multidimensional definitions have emerged reflecting the different interests and energy-related challenges in various time periods. *Sovacool* (2011) identified 45 distinct definitions of the concept, though many of them are very similar to each other. This list remains incomplete and has definitely continued to expand since then. Nevertheless, many dimensions might overlap in one way or another. One such disputed matter, for example, is linked to whether geopolitical aspects or foreign policy considerations should be treated as a dimension of security of supply (*APERC*, 2007; *Wicks*, 2009; *Hippel et al.*, 2011; *EOP*, 2014). Aside from the aforementioned, other possible definitions have also been proposed. For example, according to *Cherp and Jewell* (2011), security of supply has three perspectives – sovereignty, robustness and resilience. Sovereignty focuses on protection from potential threats from external agents, such as unfriendly political powers and overly powerful market agents. Robustness centres on resource sufficiency, infrastructure reliability, and stable and affordable prices. And, finally, resilience refers to the ability to withstand diverse disruptions. Sovereignty has its roots in political science, while robustness – in natural science and engineering, and resilience – in economics and complex system analysis.

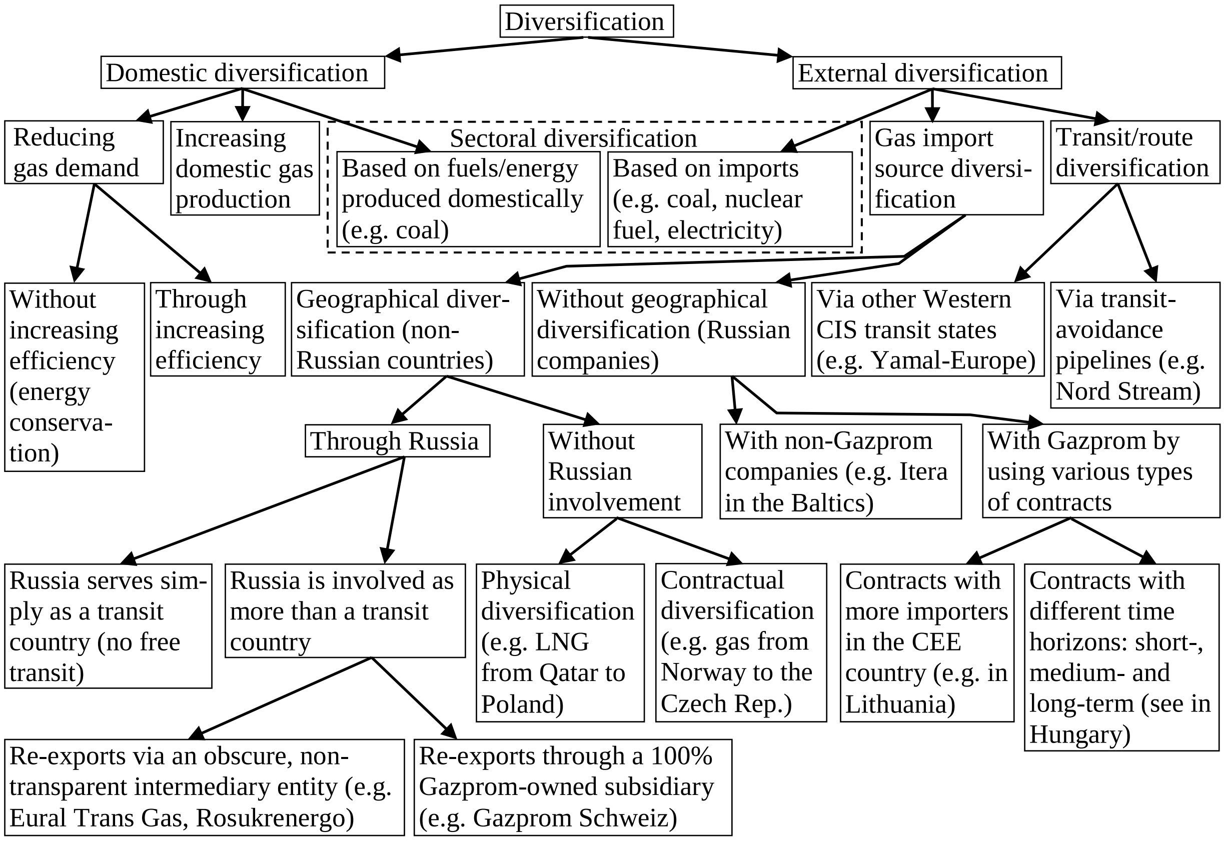
When discussing security of supply, one would first need to know if it is interpreted in a narrow sense or in a wider one. The EU and the last Hungarian energy strategy from 2011 interpret security of supply in a narrow sense. This means the EU, usually, does not consider the dimensions as part of the concept of security of supply, but as the main objectives of the EU's energy policy. The three main objectives of the EU's energy policy are security of supply, sustainability and competitiveness. We use the adverb "usually" because this has not always been the case. The *European Commission* (2000), in its 2000 Green Paper, defined the objectives resulting from the concept of security of supply by stating that "the European Union's long-term strategy for energy security of supply must be geared to ensuring, for the well-being of its citizens and the proper functioning of the economy, the uninterrupted physical availability of energy products on the market, at a price which is affordable for all consumers (private and industrial), while respecting environmental concerns and looking towards sustainable development". In reference to the objective of competitiveness, the EU refers to an internal energy market that ensures competitive and affordable prices. Thus, in practice, affordability is also a clearly articulated, but not distinguished objective, though it is – unlike, for example, in the Commission's 2006 Green Paper (see *European Commission*, 2006) – mentioned separately in the 2015 Energy Union framework strategy, when stating the aim of secure, sustainable, competitive, affordable energy for all EU consumers, both households and businesses (*European Commission*, 2015).

In this paper, we apply the conventional three-dimensional approach, encompassing availability, affordability and sustainability, and consider security of supply in a wider sense. Decisions on security of supply and diversification are regarded as the consequences of choices among security of supply dimensions, in other words, the prioritisation of different dimensions.

2.2. Gas diversification

There are many types of diversification. We have developed a scheme of different Central and East European (CEE) diversification options for Russian gas imports *(Figure 1)*. Basically, diversification can be domestic or external. Possible domestic diversification options include reduced gas consumption, increased internal gas

Figure 1. A Central and East European diversification scheme for gas



Source: Own compilation, partly based on *Balmaceda* (2008, 2013) and *Stern* (2002). An earlier version was published in *Weiner* (2016).

production and sectoral diversification on the basis of fuels or energy produced domestically. External diversification comprises gas import source diversification, transit or route diversification and sectoral diversification based on imported fuels or energy. The aforementioned diversification options can be further broken down.

One type of domestic diversification is reduced gas demand. Principally, this can be attained through either energy efficiency (e.g. new technologies, home insulation) or without increasing efficiency (energy conservation: changing behaviour and cutting back gas usage). Increasing gas prices affects both types of gas-saving options.

Sectoral diversification, also called fuel mix, fuel type or energy-source diversification, supports efforts to move away from gas in the energy/electricity balance. As seen, sectoral diversification can be either domestic or external. This not only involves replacing gas with another primary energy (e.g. gas is substituted by coal, either domestic or imported, or imported nuclear fuel). If electricity, a secondary energy source, is imported, then gas-powered electricity generation and thus gas consumption could also be reduced. However, if seen in the context of diversification away from Russia, then the sectoral diversification achievement is overshadowed by the fact that, for example, the coal imports are from Russia and the domestic nuclear power plant uses Russian technology or nuclear fuel, and is set up with Russian participation.

One type of external diversification is gas import source diversification, which may be realized with or without geographical diversification. The former refers to other countries or regions and the latter to a more diverse contractual relationship with the actual exporting country, i.e. Russia.

Geographical diversification can work not only without but also with Russian involvement. Regarding geographical diversification without Russian involvement, purchasing gas from a non-Russian supplier can occur either through physical or contractual diversification. In the case of contractual diversification, as compared to physical diversification, under normal (i.e. non-emergency) conditions, typically gas of Russian origin is delivered, although physical delivery from a non-Russian seller is in principle also possible. If Russian gas is not physically available, for example during a Russo–Ukrainian gas crisis, the contracted volumes will be delivered from other gas sources.[5] This highlights that Russian gas plays an even greater role in CEE.

Physical diversification can also be ensured with Russian involvement. In this case, the transaction is arranged through Russia, either in such a way that Russia serves simply as a transit country or Russia is involved in the transaction as more than a transit country. The first case cannot work because no free transit is provided through Russia. Thus, CEE consumers are also unable to buy gas directly from Central Asia transited through Russia. Direct supplies to Ukraine were stopped at the end of 2005. In order to purchase Central Asian gas, transit diversification avoiding Russia is necessary. The second case for physical diversification with Russian involvement includes two methods. One special method was used until the end of 2008. Certain CEE countries bought gas from Central Asia through intermediary companies at a cheaper price than offered by Gazprom. This gas was transited through Russia, and Russians played different roles in

[5] Contractual diversification is used similarly to *Stern* (2002), but differently from *Balmaceda* (2008, 2013). According to *Balmaceda* (2008, 2013), contractual diversification refers to a variety of contractual relationships, either in terms of companies or types of contracts (short-term, long-term, etc.) without geographical diversification.

the various available obscure ways of conducting these transactions. For example, gas was delivered through the controversial Russo–Ukrainian Rosukrenergo to Slovakia, Poland, Hungary and Romania. The second method is still operational and refers to re-exports through a wholly-owned subsidiary of Gazprom. Gazprom Schweiz AG (formerly ZMB Schweiz AG) re-exports Central Asian gas to CEE (*Weiner,* 2016: 8).[6]

Some sort of gas import source diversification could also be achieved without geographical diversification, either with non-Gazprom Russian sellers or with Gazprom. The first option is now quite limited, and restricted to Itera's activities in the Baltics.[7] This is because, theoretically, buying piped gas from other Russian suppliers is not possible, as Gazprom holds almost exclusive rights to export pipeline gas from Russia. However, Gazprom's almost exclusive rights to export liquefied natural gas (LNG) were partially revoked at the end of 2013. The second option for import source diversification without geographical diversification is when Gazprom has various types of contracts, either with more than one importer in the particular CEE country or with one importer but for different time horizons (short-, medium- and long-term). A few examples of the former can be found, but at most only one example of the latter is known in CEE.[8]

Finally, there is transit or route diversification, which is generally supported by both CEE and Russia, but there are various views on how this should be implemented. Possible transit diversification options include other Western CIS transit states and transit-avoidance undersea pipelines. Russia prefers diversification of its transit routes to Europe via undersea pipelines bypassing Ukraine in order to reduce risks associated with Russo–Ukrainian disputes.

The degree of complexity of CEE choices is high. Even within one country, there may be several choices as regards a type of diversification. It is no coincidence that EU Member States were provided with the possibility of deciding on how to achieve the

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[6] Naturally, it is impossible to distinguish between the gas molecules originating from Central Asia and those from Russia.

[7] Russia's independent gas producer Itera Oil and Gas Company was acquired by Russia's state-controlled Rosneft from Itera Holdings Limited (Cyprus). On the role of Itera, see *Weiner* (2016: 61).

[8] However, this is not a perfect example. The major Hungarian contract, which was to expire in 2015 but was instead extended (see below), has been divided. Thus, two contracts are effective until 2019 and two until 2021 (*Gazprom*, 2016).

binding infrastructure standard "N-1" rule of the EU Regulation No. 994/2010[9] regarding security of supply. However, one needs to keep in mind that although diversification is seen as key to enhancing security of supply, it alone does not inevitably lead to achieving this goal.

2.3. Energy dependence, interdependence and independence

Energy dependence, interdependence and independence belong to the third and final group of concepts to be defined. Energy dependence is a natural feature. However, dependence of the consumer on the supplier is not a unilateral phenomenon, but rather a mutual one, i.e. interdependence. Interdependence can be either symmetric or asymmetric. Perceptions are important when evaluating interdependence. According to *Palonkorpi* (n.d.), energy dependency can be perceived either as a mutually beneficial interdependency (positive dependency) or an unequal and threatening dependency (negative dependency). A low energy dependency ratio with antagonistic relations with the exporter can be perceived as a serious threat to national security, while a higher ratio with cordial relations with the exporting country might not. Nevertheless, as seen, dependence has to be addressed, and it can be managed in various ways. Such an extreme case is self-sufficiency. According to the hard definition, energy or gas independence refers to independence from energy or gas imports (i.e. self-sufficiency) (*Weiner*, 2016). The soft definition suggests that the aim is to have import source diversity, in order to reduce reliance on unstable and unfriendly nations (*Branko*, 2012; *Stelzer*, 2009). By following our diversification scheme, self-sufficiency can also be interpreted as a result of diversification, for example as a consequence of increasing domestic production. As *Cohen et al.* (2011: 4860) outline, policymakers often equate the attainment of security of supply with the hard definition of energy independence. Nonetheless, as *Bazilian et al.* (2013) conclude, this aim can promote suboptimal policy choices.

[9] The aim is that in the event of an outage of the single largest gas supply infrastructure, the remaining infrastructure should be sufficient to satisfy total gas demand for an entire day of exceptionally high gas demand (occurring with a statistical probability of once in 20 years).

3. Case studies: putting the theory into practice

3.1. Case study 1: security of supply in Hungary

Since the change of regime, Hungary has had three energy strategies. The first was approved in 1993 and remained valid for one and a half decades. Approved in 2008, the second energy strategy, for the 2008–2020 period, was short-lived compared to the first one. The third, Hungary's National Energy Strategy 2030 (with an outlook to 2050), was approved in 2011, one year after the new government took office (*NES-2030*, 2011).[10]

The 2011 energy strategy has two primary goals, i.e. increasing direct state presence and economic development based on cheap nuclear energy (*Felsmann*, 2011). Among the six scenarios for Hungary's electricity mix by 2030 and 2050, the government chose the so-called Nuclear–Coal–Green concept, referring to new units at the existing nuclear power plant at Paks, a new coal power plant and the utilisation of renewables as a linear extension of the planned trajectory set in 2010 in Hungary's National Renewable Energy Utilisation Action Plan for 2010–2020. However, the energy strategy claims that this does not mean that the elements of the other scenarios are unrealistic. This, to some extent, contradicts the government's statement that Paks-2 is indispensable, as two of the above-mentioned six scenarios are opposed to further nuclear expansion.[11]

Nuclear energy. Currently, more than half of Hungary's electricity is generated by Paks. The role of gas in electricity production has drastically dropped, while the role of nuclear power has increased, with coal preceding gas. Of the gross electricity generated in 2015, gas accounted for 17 per cent, coal 20 per cent and nuclear 52 per cent *(Table 2)*. The Paks Nuclear Power Plant and the lignite-fired Mátra Power Plant provide the bulk of electricity generation, and operate at high utilization rates.[12] These developments are typically due to market factors, primarily the relatively high price of gas as compared to cheap coal and electricity, as well as low carbon prices.

[10] In 2015, the strategy's energy consumption projections were recalculated.
[11] The government taking office in 2010 seemed to focus on nuclear energy from the very beginning.
[12] In contrast, in the mid-2010s, the average capacity utilisation rate for the power plants in Hungary was around 40 per cent (*Mavir*, 2016).

Table 2. Gross electricity and heat production in Hungary, by fuels, 2006–2015 (%)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Electricity										
Nuclear	37.5	36.7	37.0	43.0	42.2	43.5	45.6	50.7	53.2	52.2
Coal and coal products	19.8	18.7	18.0	17.9	17.0	18.3	18.7	21.1	20.8	19.5
Natural gas	36.7	38.1	37.9	29.0	31.0	29.8	27.1	18.3	14.4	16.8
Oil products	1.5	1.3	0.9	1.8	1.3	0.4	0.5	0.3	0.3	0.3
Other combustible fuels*	0.4	0.4	0.3	0.3	0.4	0.4	0.3	0.4	0.6	0.7
Biomass (solid biofuels)	3.2	3.4	4.4	5.9	5.4	4.2	3.8	4.7	5.8	5.5
Biogases	0.1	0.1	0.2	0.3	0.3	0.6	0.6	0.9	1.0	1.0
Renewable municipal waste	0.3	0.4	0.3	0.3	0.4	0.3	0.3	0.4	0.5	0.7
Hydro	0.5	0.5	0.5	0.6	0.5	0.6	0.6	0.7	1.0	0.8
Wind	0.1	0.3	0.5	0.9	1.4	1.7	2.2	2.4	2.2	2.3
Solar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4
Total	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
Heat										
Nuclear	1.0	0.9	1.0	1.0	0.9	1.0	1.1	1.0	1.6	1.5
Coal and coal products	16.0	18.1	17.0	12.5	13.2	14.3	13.5	10.7	10.8	10.6
Natural gas	78.9	77.4	77.3	77.3	78.3	76.1	77.4	75.1	71.6	69.5
Oil products	1.4	0.2	0.9	4.6	0.4	0.5	0.5	0.5	0.7	0.6
Other combustible fuels*	0.8	0.9	1.0	1.0	1.0	1.0	1.0	2.9	4.7	4.7
Biomass (solid biofuels)	0.8	1.3	1.5	2.2	4.5	5.3	5.0	7.8	7.2	8.5
Biogases	0.0	0.0	0.0	0.0	0.2	0.5	0.1	0.2	0.2	0.3
Renewable municipal waste	0.8	0.9	1.0	1.0	1.0	0.8	0.6	0.6	0.8	0.9
Solar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.3	0.3	0.4	0.4	0.4	0.6	0.8	1.2	2.4	3.4
Total	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*

* Other combustible fuels = industrial waste + non-renewable municipal waste + other sources.
Source: Own calculations based on *Eurostat* (2017e, 2017f) and *MEKH* (2017a, 2017b).

Under these circumstances, the share of net imports in total electricity consumption has increased and has been above 30 per cent since 2014 *(Table 3)* (*MEKH–Mavir*, 2015, 2016; *Mavir*, 2016; *MEKH*, 2017a; *Eurostat*, 2017e). Regarding security of supply, increased electricity imports are advantageous from the perspective of both affordability and environmental sustainability,[13] but the government sees them as a risk in terms of availability, especially if the share of net electricity imports continues to grow in the future. Seemingly, the government considers electricity to be a special commodity, which should not be threatened by problems with electricity imports. Thus, electricity supply should not be dependent on imports that may be cut in a crisis situation. Therefore, the government believes Hungary should be able to satisfy its electricity demand through domestic production. This means Hungary is developing its ability to achieve electricity self-sufficiency. This is an energy policy decision, in which

[13] Naturally, this is only true if we do not take into account imported electricity generated by polluting power plants.

Table 3. Electricity balance of Hungary, 2006–2015 (GWh)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Imports	15 393	14 680	12 774	10 972	9 897	14 664	16 970	16 635	19 079	19 935
Exports	8 186	10 694	8 871	5 459	4 702	8 021	9 003	4 758	5 689	6 249
Net imports	7 207	3 986	3 903	5 513	5 195	6 643	7 967	11 877	13 390	13 686
Total gross production	35 859	39 960	40 025	35 908	37 371	36 019	34 635	30 294	29 392	30 342
Total net production*	33 345	37 220	37 383	33 344	34 613	33 533	32 351	28 031	27 131	28 132
Available for final consumption	33 240	33 744	34 327	33 150	34 207	34 574	35 238	34 877	35 728	36 975
Final consumption	33 238	33 744	34 327	33 150	34 207	34 540	35 004	34 873	34 737	36 193
Total consumption**	43 066	43 946	43 928	41 421	42 566	42 662	42 602	42 171	42 782	44 028
Net imports/total cons. (%)	16.7	9.1	8.9	13.3	12.2	15.6	18.7	28.2	31.3	31.1

* Total net production = total gross production – own consumption of power plants.
** Total consumption = net imports + total gross production.
Source: Eurostat (2017e) and own calculations.

priority is given to the availability dimension. The government insists that the only plausible solution for this is the Paks-2 project. The two new units are expected to be commissioned in the second half of the 2020s, with a slightly higher combined capacity (two units of 1200 MW each) than that of the four old units (four units of 500MW each).[14] The four old units shall be phased out in the 2030s. The new nuclear units will be owned by the Hungarian state and are planned to cost around EUR 12.5 billion, accounting for more than 12 per cent of the Hungarian GDP. The Russian budget will provide a EUR 10-billion credit line for the project, and Russia's state-owned Vnesheconombank (VEB) will act as an agent for the Russian government. Previous forecasts indicated that with Paks-2, Hungary would become a net exporter of electricity (*REKK*, 2011), thus security of demand, i.e. a market for excess electricity, would also have to be ensured. However, recent forecasts show that Hungary will likely remain a net importer on a yearly basis *(Table 4)* (*ENTSO-E*, 2015). Nonetheless, security of demand is still a challenge for shorter time periods. Regarding the availability dimension, the government contends Paks-2 will also increase security of supply, as nuclear fuel will be available in sufficient quantities at the site. But there is no possibility of diversification of nuclear fuel for this type of reactors. Regarding affordability, the government promises cheap electricity from Paks-2. For the project to pay off, a substantial price increase is needed in Europe. The government anticipates that because of the investment gap in the electricity generation sector under cheap electricity,

[14] The 2011 energy strategy suggested two 1000 MW units each.

Table 4. Electricity production and demand scenarios for Hungary, by fuels, in 2020 and 2030

	Biofuels	Gas	Hard coal	Hydro, other storage	Lignite	Nuclear	Oil	Other non-RES	Other RES	Solar	Wind	Total	*Demand*
2020 "Expected Progress"													
ICAP	223	3 794	0	56	849	1 892	407	850	500	60	750	9 381	
AGEN	1 423	932	0	248	6 081	13 322	0	3 835	2 256	79	1 616	29 792	*43 480*
2030 Vision 1: "Slow Progress"													
ICAP	210	4 185	0	56	470	4 108	407	720	550	60	750	11 516	
AGEN	1 337	1 944	0	248	3 458	28 701	0	3 249	2 482	79	1 616	43 114	*48 000*
2030 Vision 2: "Money Rules"													
ICAP	210	2 980	0	56	470	4 108	407	720	550	60	750	10 311	
AGEN	1 201	420	0	248	3 323	28 765	0	3 249	2 482	79	1 616	41 383	*45 738*
2030 Vision 3: "Green Transition"													
ICAP	210	4 977	0	100	0	3 000	407	720	1 040	200	1 000	11 654	
AGEN	1 305	8 467	0	445	0	20 886	0	3 249	4 692	265	2 154	41 463	*44 785*
2030 Vision 4: "Green Revolution"													
ICAP	210	4 977	0	100	0	3 000	407	720	1 040	339	7 114	17 907	
AGEN	1 417	10 207	0	445	0	21 023	0	3 249	4 692	449	15 326	56 808	*48 336*

RES – renewables. ICAP – installed capacities (MW). AGEN – annual generation (GWh).
Note: Grey cells indicate the scenario in which annual demand is lower than generation.
Source: ENTSO-E (2015).

European electricity prices will rise by enough, and will be higher than Paks-2 electricity prices. In contrast, others warn that electricity from Paks-2 will not be cheap and such long-term price growth in the European market is unlikely to be observed. Price increases of such magnitude would provide incentives for innovations in other energy-generation technologies and energy efficiency, and thus ultimately leading to lower prices (*Felsmann*, 2015). Finally, regarding the sustainability dimension, nuclear energy contributes a very small amount of emissions to the atmosphere. Nonetheless, handling nuclear waste remains a challenge.

The 2014 decision on Paks-2 was unexpected and early. This might turn out to be disadvantageous due to a lack of knowledge on how markets for renewables will develop, and as nuclear energy innovation could also significantly lower investment and operating costs (*Felsmann*, 2015). The 2011 Hungarian energy strategy considers the construction of new nuclear capacities at a new site after the shutdown of the four old units. At the beginning of October 2017, the minister in charge of Paks-2 made the first references to the possibility of building these new units. According to this information, the construction of two new Paks-2 units will start in 2020 (*Kormany.hu*, 2017).

Renewables. Seemingly, the Hungarian government does not believe that renewables will have a powerful role to play. Obviously, the government views renewables more as a problem than an opportunity. This seems to stem from the need for subsidies to develop this energy option and due to it being a challenge for the transmission system operator. However, the flexibility in power grids is often underestimated and the question of subsidies should be seen in light of sizeable state aid for the Paks-2 project. Based on the newest statistics, at first glance, the share of renewables looks favourable *(Table 5)*. The target share of renewables in gross final energy consumption has been achieved, but only because of a very recent change in the statistical methodology pertaining to wood biomass, the largest renewable source in Hungary (*REKK*, 2017).[15] With this change, the main incentive for increasing the role of renewables has gone, while with the exception of solid biomass, mostly wood biomass, renewables continue to perform a minor role in Hungary. Meanwhile, the political environment for renewables has remained a big challenge in the country. A couple of disadvantageous changes have recently occurred, including the introduction of a fee on solar photovoltaic panels and a *de facto* ban on new wind projects, with no new permits having been issued since 2006. The government claims wind is not optimal for Hungary and thus wind energy has no place in the Hungarian energy system (*Német*, 2016). Although limited, hydropower opportunities exist in Hungary, but larger-scale projects have been politically unacceptable since the Gabčíkovo–Nagymaros Dam issue on the Danube.

With Paks-2, the Hungarian government has also made a decision in favour of centralised energy production and thus against decentralised, local energy. Nevertheless, according to the calculations of *Felsmann* (2016), nuclear energy and renewables can co-exist in Hungary. As widely known, renewables have the lowest variable costs, followed by nuclear energy, and then comes coal, while gas-fired units have the highest variable costs (*Székffy*, 2014: 723). This means that if one commits to

[15] When the national energy regulator moved from using supply-side statistics to being based on statistics of household energy consumption, the figures drastically increased. The 2014 share of renewables in gross final energy consumption increased from 9.5 per cent to 14.6 per cent (*Eurostat*, 2016a). It reached 14.5 per cent in 2015, and since 2011, it has been above the 2020 target value of 13 per cent, specified by the 2009 Renewable Energy Directive of the European Parliament and Council (*European Parliament and Council*, 2009), though Hungary's National Renewable Energy Utilisation Action Plan for 2010–2020 sets a target of 14.65 per cent by 2020 (*NFM*, 2010). The other target, namely the 10 per cent share of renewables in the transport sector by 2020 still needs to be reached. The share of solid biomass in renewable energy consumption was slightly above 82 per cent in 2014 and 2015 (*MEKH*, 2017c).

Table 5. Share of energy from renewable sources in Hungary, 2006–2015 (%)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Share of energy from renewables in gross final energy consumption	5.1	5.9	6.5	8.0	12.8	14.0	15.5	16.2	14.6	14.5
Share of electricity from renewables in gross electricity consumption	3.5	4.2	5.3	7.0	7.1	6.4	6.1	6.6	7.3	7.3
Share of renewables in heating and cooling	7.5	8.9	8.3	10.5	18.1	20.1	23.3	23.7	21.2	21.3
Share of renewables in transport	1.1	1.5	5.1	5.7	6.0	6.0	5.9	6.2	6.9	6.2

Source: Eurostat (2016b, 2017c).

power generation units with low variable costs, then once these capacities have been built up, intentions exist for the units to be operated in any case. This approach in turn has a serious impact on other energy sources already in use or for which there are plans that they will be used in electricity generation – while significant changes may occur in the energy markets.

Coal. Coal is the energy source for which the dimensions of availability and environmental acceptability or sustainability strongly collide with each other. Coal held a prominent position in the national energy policy discourse in the 1990s because of coal-fired power plants and coal mines. However, currently, there are only three power stations in Hungary that burn or can also burn coal.[16] Among them, based on its two lignite mines, the lignite-fired Mátra Power Plant is of great importance, also holding a significant employment position in the region (*Mert.hu*, n.d.).[17] The power plant has been controlled by German owners since its privatization, while the government through Hungary's state-owned energy group MVM acts as a minority shareholder. However, the power plant's current licenses will expire by 2025. The 2011 energy strategy gives two reasons why coal-based energy production should be maintained in Hungary: (1) in case of an energy crisis (e.g. gas price explosion, nuclear disruption), coal is the only internal reserve which could be rapidly mobilized;[18] and (2) to prevent losing the professional culture of such energy production, which might be necessary in

[16] Hungary's 2015 coal and coal product balance sheet can be seen in *Table 6*.
[17] The two other power plants are Ajka Power Plant in the city of Ajka and the power plant belonging to Hamburger Hungaria, a leading corrugated base paper manufacturer in the city of Dunaújváros.
[18] According to Hungary's 2013 Reserve Management and Utilisation Action Plan, the amount of primary energy currently available from domestic coal can practically be doubled (*NFM*, 2013: 6).

Table 6. Hungary's coal and coal product balance in 2015

	Primary coal products				Secondary coal products				Manufactured gases	
	Coking coal	Other bituminous coal	Sub-bituminous coal	Lignite	Patent Fuel	Coke-oven coke	Coal tar	Brown coal briquettes	Coke-oven gas	Blast furnace gas
	thousand tonnes								TJ	
Production	0	0	0	9 261	0	960	46	0	9 182	7 607
Imports	1 310	63	161	63	0	34	14	4	0	0
Exports	0	0	0	355	0	298	46	0	0	0
Stock changes	17	-7	-1	193	0	3	1	0	0	0
Total dom. cons.	1 327	56	160	9 162	0	699	15	4	9 182	7 607

Source: MEKH (2017d).

an emergency, and because of the possibility of greater use of coal in the future if sustainability and emission criteria (carbon capture and storage, as well as clean coal technologies) are met (*NES-2030*, 2011). Analysing the medium- and long-term supply capacity development up to 2031, the Hungarian electricity transmission system operator Mavir, an MVM subsidiary, argued in 2016 that coal power plants would almost completely disappear in Hungary. Coal may only play a role post-2031, due to the availability of technologies mentioned in the 2011 energy strategy (*Mavir*, 2016).

3.2. Case study 2: Hungary's gas diversification

Since the Russian–Ukrainian gas crisis of January 2009, Hungary's dependence on both gas in general and Russian gas in specific has decreased, while Hungary's gas security has increased *(Table 7)*. This has involved the wide availability of large-scale cheaper gas imports from Western Europe, constructions of new gas interconnections with neighbouring countries and sharply decreasing domestic gas consumption.[19] However, decreasing gas demand has partly been offset by growing electricity imports, and as indicated, the role of nuclear power has increased. In residential heating, many people have turned to firewood and coal, with consequences for the dimension of environmental acceptability. In contrast, domestic gas production has declined, large gas

[19] Underground gas storages also play an important role in security of supply, but they are not regarded as diversification. Hungary is a great power in the field of gas storage. After the 2006 Russo–Ukrainian gas crisis, Hungary also set up a strategic storage facility. Meanwhile, all the facilities have become state-owned. Nonetheless, there was a time when storages did not hold satisfactory quantities of gas, which was risky and thus reduced security of supply.

Table 7. Hungary's gas balance, 2006–2015 (TJ)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Primary production	99 734	83 926	83 981	95 764	93 570	88 562	74 027	64 656	60 177	57 319
Imports	394 454	358 995	390 442	331 059	331 283	276 281	282 398	283 348	311 343	237 669
Exports	185	716	787	2 955	7 801	19 495	28 915	50 703	25 860	19 184
Stock changes	-14 330	5 985	-31 475	-40 697	-6 097	46 282	23 216	25 253	-53 354	37 817
Gross inland consumption	479 672	448 190	442 161	383 171	410 955	391 630	350 726	322 554	292 306	313 622

Source: Eurostat (2017d).

pipeline projects, either aimed at transit avoidance or source diversification, have failed, and two of Hungary's neighbours, Croatia and Romania, have not fulfilled their obligations regarding the joint gas interconnections. Liquefied natural gas (LNG) regasification plans in neighbouring countries (in Croatia and Romania) have also remained on paper.

Following the completed gas interconnectors with Romania and Croatia, another one linking Slovakia and Hungary was also launched, but in line with preliminary expectations, there is no demand for it, and thus it is not in use. However, due to increased interest, the capacity of the western (Austrian) entry point was expanded. For the first time in 2011 and then in 2012 (but not in subsequent years), Hungary imported more gas through the western entry point than through the eastern (Ukrainian) one, though Gazprom supplies gas from both directions.

On the Southern Gas Corridor, the Nabucco West pipeline project, a scaled-down version of Nabucco "classic", based on Azeri gas and aimed at geographical diversification without Russian involvement by transporting gas from the Turkish–Bulgarian border through Bulgaria, Romania and Hungary into Austria, was shelved in June 2013. In turn, South Stream, essentially a transit diversification project running under the Black Sea to Bulgaria and then onwards, was terminated in December 2014.[20] Initially, the Tesla pipeline, to be laid down from the Turkish–Greek border through Greece, Macedonia, Serbia and Hungary to Austria, was proposed as the continuation of the TurkStream pipeline project, stretching from Russia to Turkey across the Black Sea. However, recently, a Bulgarian–Serbian–Hungarian pipeline has been put on the agenda. But any such plan would face similar EU regulatory challenges experienced by South

[20] Although Hungary actively supported South Stream, it was also among those Central and East European countries that in March 2016 signed a letter objecting to Nord Stream-2, a trans-Baltic Sea pipeline project between Russia and Germany, aimed at diverting gas from the Ukrainian gas corridor.

Stream if it ever entered the project phase. As a result of so many disappointing projects, enthusiasm for large-scale pipeline plans remains rather low in Hungary. Any announcements pertaining to this effect should be regarded with caution.

Currently, Hungary has two long-term gas import contracts, both of them with Gazprom Export, Gazprom's export arm. The major one is with MVM's Hungarian Gas Trade (formerly Mol Natural Gas Supply and then E.ON Natural Gas Trade), Hungary's leading gas trader through Panrusgáz, the Russian–Hungarian gas intermediary joint venture.[21] This contract was signed by Hungarian oil and gas company Mol.[22] Concluded in 2007 for the period 2008–2028, the small contract has been entered into with Centrex Hungary, an affiliate of the Gazprombank-owned and Vienna-based Centrex Europe Energy & Gas AG.[23] Although the major long-term gas supply contract was to expire in 2015, unused gas will be available until 2021.[24] The Hungarian government intends to sign a new long-term gas supply contract with Gazprom for post-2021.

Non-Russian gas supplies were commenced in the 1990s. These supplies included – on the one hand – those from Germany's Ruhrgas (later E.ON Ruhrgas, then E.ON Global Commodities, now Uniper Global Commodities) and the French Gaz de France (later GDF Suez, now Engie), and those from Ukraine and then from Central Asia, on the other.[25] The contract with GDF expired in 2012, while the contract with E.ON Ruhrgas was successfully terminated well before the 2015 expiration date. Thus, these contracts were not handed over in 2013 when MVM bought E.ON Natural Gas Trade. It is true that as contractual diversification and not physical, gas was not physically delivered to Hungary from Germany and France via Austria. Moreover, gas with western contracts was more expensive than that with Russian ones. However, the benefits of the western contracts were observable during the January 2009 gas crisis, when this scheme worked well and Hungarian (and other foreign) consumers benefitted from this possibility. As mentioned above, Central Asian imports via gas intermediaries were stopped at the end of 2008.

[21] With this contract, Gazprom Export sells gas not only from the eastern direction but also from the western direction via Slovakia and Austria.
[22] Mol's wholesale, marketing and trading business Mol Natural Gas Supply was taken over by Germany's E.ON Ruhrgas in the mid-2000s. E.ON Natural Gas Trade, the new name of Mol Natural Gas Supply, was subsequently acquired by MVM in 2013. E.ON Natural Gas Trade was renamed Hungarian Gas Trade.
[23] Gazprom has not had control over Gazprombank for many years.
[24] As noted above, the Panrusgáz contract was divided. As a consequence, Gazprom and Panrusgáz currently have four contracts (*Gazprom*, 2016).
[25] There was no need for these quantities, especially at such high prices.

However, Gazprom Schweiz AG, exporting Central Asian gas to Central and Eastern Europe, is present in Hungary through its Hungarian subsidiary WIEE Hungary.

While steps have been taken towards increasing the physical availability of gas, there has been a shift in domestic energy policy towards the affordability dimension, reflected in a major utility rate cut campaign. Affordability considerations contributed to the politically-driven regulatory squeeze on the profitability of the utility sectors and on the partial renationalization at the corporate level. This shift was to some extent imminent in most of the region's countries *(Table 8)* (*Deák and Weiner*, 2016). For large segments of society, the duly payment of gas and electricity bills has been an everyday challenge. Utility prices belong to the top issues on people's minds. The government cut regulated gas prices when they still were not justified by the Russian long-term contract gas prices.[26] The latter have only recently become competitive with gas prices based on gas-on-gas competition (market-based gas prices), partly due to Russian discounts and partly because of the decline in oil prices. However, the recent drop in contract gas prices has not been reflected in domestic regulated gas prices. Without Gazprom's concessions on gas volumes and prices, the government's utility rate cut would have been hardly sustainable even in the medium run (*Deák and Weiner*, 2016). However, these concessions are overshadowed by having been negotiated as part of a package deal related to Paks-2, if this is in fact what happened. On the other hand, utility rate cuts have weakened security of supply because of the lack of investments (*LaBelle and Georgiev*, 2016), and also because decreasing energy prices for households have had a positive impact on energy use in Hungary (*Sebestyén Szép*, 2017).

Table 8. The share of gas, electricity and other liquid and solid fuels in household spending in the Visegrad countries and the EU, 2006–2015 (%)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
EU28	3.9	3.7	4.2	4.2	4.4	4.4	4.6	4.7	4.2	4.1
EU15	3.7	3.5	4.0	4.0	4.1	4.1	4.4	4.4	3.9	3.9
Czech Republic	7.4	7.3	7.4	8.1	8.3	8.1	8.4	8.6	7.5	7.4
Hungary	5.3	5.7	6.5	7.2	7.5	7.5	7.4	6.7	5.3	5.1
Poland	7.9	7.2	7.6	8.0	8.6	9.0	8.8	8.8	8.8	8.5
Slovakia	11.7	11.0	10.4	10.7	10.5	10.8	11.2	11.1	10.9	10.6

Note: Dark grey cells indicate years affected by the government-introduced utility rate cuts in Hungary.
Source: Eurostat (2017b).

[26] We do not know how important a role oil product prices are now playing in gas pricing, though it has surely decreased drastically.

4. Summary and conclusions

The EU countries, including the EU-member CEE countries, have very different conditions, various priorities, and their energy policies therefore differ. We find that there is no universally optimal choice or mix for enhancing security of supply and gas diversification. There are only different sets of choices and a large variation in the influencing factors that impact the prioritisation of different security of supply dimensions, with uncertain and different rewards both in the short and long term.

Paks-2 represents an unexpected turn as regards Hungary's energy dependence. With Paks-2, Hungary's dependence will both decrease and increase – as new types of risks appear. The Paks-2 decision happened at a time when Hungary was following a decreasing trajectory for its energy dependence, notwithstanding certain negative developments. The decision was surprising despite preceding references in the 2011 energy strategy. One would expect a very different process when making decisions for many decades ahead. Nonetheless, this was still a legitimate decision that also won EU approval. Paks-2 can be understood as a form of sectoral diversification, and it has its own place in our gas diversification scheme.

However, despite the decision on Paks-2, there is great uncertainty about Hungary's energy policy and security of supply. It remains unclear what the future role of coal, gas and renewables in the energy/electricity mix is to be. Their future might be mainly dependent on purely political decisions rather than energy market factors. Among these questions, the future of the Russian (major) long-term gas supply contract is of particular importance. Gazprom has practically extended it until 2021, which is not only economically significant for Hungary, but has also provided the Hungarian government with more time prior to signing a new contract, which could take into account both the progress made in gas diversification and the latest developments in the gas markets. Regarding coal (lignite), so far no decision has been made to introduce a new unit. As for renewables, solar energy will certainly squeeze profitability rates in the electricity generation sector. Recently, permits have been requested for the installation of large volumes of solar plants.[27] The question is how much of these capacities will be realised. Present electricity prices do not support any type of power plants (*Szalai*, 2017). However, there is always a lot of uncertainty in the energy markets, and thus every decision carries with it certain risks.

[27] However, stricter award criteria from 2017 onwards played a major role in a large number of requests submitted for authorization (*Mohos*, 2017).

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