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DEVELOPMENT OF NATURAL GAS EXCHANGE INFRASTRUCTURE: EUROPEAN EXPERIENCE AND UKRAINE

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Abstract. The *aim* of this paper is to summarise the conditions and problems of the development of the gas market exchange in European countries, and to identify the necessary elements for its successful functioning in Ukraine. *Methodology*. The study is based on the historical and logical methods of analysing the development of the infrastructure of energy exchanges in Germany, Austria, Italy, Romania and Poland. The paper uses empirical (observation, comparison) and theoretical (analysis, synthesis, systematisation, generalisation) research methods. In general, the years of analysis cover the period from 2007 to 2023 due to the launch of natural gas trading on the analysed exchanges. In order to analyse the dynamics and show the evolution of natural gas trading on the European energy exchanges, information on volumes and structure of the natural gas segment was collected from their annual reports, official press releases and newsletters for the years 2007–2021 (EEX and EEX Group), 2019–2022 (CEGH, also using Energy Community data), 2021–2022 (GME), 2020 (ANRE, TGE). To analyse the dynamics of the UEEX development, a sample of data for 7 years has been presented, collected from annual reports, press releases and additional sources of analytical data due to the lack of official data for some periods. In order to examine changes in the structure of UEEX natural gas trading volumes, monthly trading volumes for 2020–2023 were collected and grouped by short-term and medium- and long-term products. *Results*. This paper examines the importance of exchange trading in the natural gas market. Based on the experience of European countries, such as EEX in Germany, CEGH GE in Austria and GME in Italy, BRM in Romania, and TGE in Poland, it can be said that each country has its own characteristics and path to a liberal market. The German and Austrian cases showed that cooperation and integration inevitably lead to the growth of exchanges, as happened with the start of the PEGAS cooperation, when the Italian government-regulated exchange did not show such a rapid growth trend. Other elements that ensured the development of exchange trading in natural gas were identified: diversification of the market and commodity portfolios, improved clearing, a reliable control and accountability system, a combination of market mechanisms and state supervision, and the development of technology. It was concluded that Ukraine has the prerequisites and potential for the functioning of the natural gas market on a liberal basis. At the same time, there is a need to further develop the institutional environment for exchange trading, and the above elements could be areas for improvement. The *practical implications* are that an energy exchange is a key institution of a liberal gas market, and a strong exchange infrastructure ensures efficient trade and regional integration. *Value/originality*. The analysis of the experience of European countries allows to draw conclusions about the successful development of infrastructure and provide recommendations for the development of the Ukrainian energy exchange, as well as identify areas for the development of regulatory policy to ensure the successful launch of exchange trading in gas on national markets.

Key words: natural gas, energy exchanges, energy market regulation, liberalisation, Europe, market economy development.

JEL Classification: Q35, Q40, F19, F13, O52

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1. Introduction

The evolution of the global energy landscape has brought the natural gas market into sharper focus, highlighting the critical role of robust infrastructure in ensuring efficient trading, price transparency and regional integration. This paper delves into the complex world of gas exchange infrastructure, focusing on the experiences of European countries and their invaluable contributions to the development of this key sector. It introduces the topic and its importance in the context of the natural gas market.

The natural gas market is a cornerstone of modern economies, powering industries, households and transportation networks. Natural gas exchange infrastructure serves as the backbone of trading activities, connecting buyers, sellers and other market participants in a web of transactions that shape the course of the energy market. The establishment and development of exchange infrastructure has become an important step in promoting energy security, economic stability and harmonious regional cooperation.

The main objective was to summarise the conditions and problems in the development of gas market exchanges in European countries in order to identify the necessary elements for their successful functioning in Ukraine. The study focuses on the cases of the European Energy Exchange (EEX) in Germany, the Central European Gas Hub (CEGH) in Austria, the Gestore dei Mercati Energetici (GME) in Italy, the Bursa Română de Mărfuri (BRM) in Romania and the Polish Power Exchange or Towarowa Giełda Energii (TGE) in Poland. At the same time, it analyses the Ukrainian Energy Exchange (UEEX) and examines its development in the context of the wider European experience.

The structure of this paper is as follows: Section 2 presents a literature review that provides an overview of existing knowledge and research on the development of natural gas exchange market infrastructure. Section 3 presents the methods and main data sources. The results sections of the study begin with an analysis of general trends in natural gas exchange trading in Europe (Section 4). Section 5 deals with specific cases of successful infrastructure development in the exchange segment of the natural gas market. This section includes notable examples from Germany's EEX, Austria's CEGH Gas Exchange, Italy's GME, Romania's BRM and Poland's TGE. Section 6 focuses on the Ukrainian Gas Exchange (UEEX) and recommendations for its development based on the cases analysed.

2. Literature Review

The analysis of numerous scientific publications on the energy sector and the natural gas market proves the importance of liberalisation for the creation of a regional gas hub in Ukraine. This is confirmed by the experience of European countries. The development and functioning of the traded gas market in the UK is examined by Heather P. (2010). The liberalisation of the UK gas market was part of the privatisation programme of nationalised industries. As a result, the liberalised gas market in the UK is unique and very different from continental European markets. Heather notes the positive impact of liberalisation on the expansion of the natural gas market in the UK. The Gas Act (1995) and the standardisation of OTC trading helped to bring in new players and trading approaches that had not previously been seen in the traditional British gas market. For example, American companies brought to the market American trading methods, namely aggressive market making and price disclosure, both of which are very important components in enabling the beginnings of a truly traded market. The result has been greater transparency and confidence among market participants.

Heather P. (2021) looked at how the German hubs are performing and what their prospects are. The author was sceptical about the prospects for the merger of German gas hubs to increase market liquidity, particularly due to the long process of German market consolidation. It concludes that although Germany has the highest physical gas demand in Europe, an extensive gas pipeline and storage infrastructure and good connections to all surrounding countries, the two German hubs have not continued to improve progressively in all respects in recent years. Instead, the study pointed to significant progress of the gas market in Ukraine and assessed positively Ukraine's prospects to become a regional hub for Southeast Europe. In addition, in a recent study (Heather, 2023), the author focused on the geopolitical situation and changes in trade and prices. European gas markets have been very volatile over the past three years, due to the global COVID-19 pandemic and then the Russian invasion of Ukraine. In addition, there are ongoing debates about the green transition and reducing the consumption of carbon-based energy sources, including natural gas.

Capece G. (2014) analyses the evolution of the natural gas market, both at European and Italian level, through the legislation that has modified the sector since 1998, with the aim of promoting a more efficient service and better protection of consumers' interests. It is concluded that without the appropriate infrastructure, Italy risks becoming a provincial branch of the European gas network rather than a major transport hub. The importance of facilitating the access of the national network to all infrastructures linking the different markets is stressed. However, Italian hubs remain poor (Heather, 2023).

Regarding the Ukrainian gas sector, Pirani S. (2021) looked at Ukraine's energy policy and prospects for the gas sector. The study describes the transformation of the government's energy policy from a post-Soviet administrative approach to a market-oriented approach influenced by the European Union. It notes that the biggest changes in the last 20 years have been in the gas sector, due to factors such as the decline in gas consumption caused by economic recessions, the change in the direction of supply through "reverse flow", and the separation of transport and supply. It was rightly noted that in the next decade the gas sector will be shaped by Ukraine's own political choices. Dergachova V., Kravchenko M., Kuznietsova K. and Kotsko T. (2020) also reported on Ukraine's energy policy under difficult political conditions. However, as can be seen now, the war of conquest launched by Russia on the territory of Ukraine has had a much more significant impact on the Ukrainian energy sector, with the destruction of energy infrastructure, large energy-intensive industrial enterprises and a general decline in economic activity. However, the conclusions about the need to develop an energy strategy in line with Ukraine's closer economic ties with Europe, the principles of market reform and the reduction of carbon-based energy consumption remain valid.

However, Bublyk Y., Kurbet O. and Yukhymets R. (2022) showed that Ukraine is developing the conditions for the widespread use of gas futures due to the Ukrainian energy market reform and the current EU policy of creating gas hubs. This was confirmed by the rapidly growing volume of gas trading on the UEEX. It shows that the number of participants, suppliers and diversification of instruments has grown rapidly in recent years. Increasing the number of transactions and participants creates a competitive environment and improves price transparency. The introduction of gas futures on the Ukrainian capital market will improve energy market processes and price transparency. The organisation of the Ukrainian energy market as a hub has become a strong factor in the integration of Ukraine into the EU energy and capital market.

Ukraine has the necessary components to become a regional gas hub. It has developed infrastructure, gas storage and trading. There are also prospects for gas exports. However, the issue of liberalising the Ukrainian gas market and increasing its liquidity remains unresolved (Oliinyk, 2023). The main problems of the Ukrainian gas market include low liquidity, high market concentration, the almost monopolistic position of the state-owned company Naftogaz in the production and supply segments, limited transparency of operations, and insufficient development of trading platforms. In order to solve these problems, experts believe it is necessary to lift the ban on gas exports, solve the problem of concentration, harmonise activities in accordance with European standards of transparency and promote the development of exchange trading in standardised products.

At the same time, there are empirical studies that partially refute the positive effects of gas liberalisation. Hamie H., Hoayek A. and Auer H. (2021) examine the impact of gas liberalisation on market concentration and gas prices in Austria and the Netherlands. The results show that consumer gas prices are closer to monopoly prices despite the presence of several suppliers. The parametric and non-parametric game theory methods showed that suppliers in the market maximise their "utility function" not only by seeking profit, but also by pursuing non-profit objectives such as cooperative collusion. At the same time, it is shown that the risk of price manipulation is reduced by ensuring that the different gas hubs in Europe are highly integrated.

3. Methodology

Historical and logical methods have been used. The selection of Germany, Austria, Italy, Romania and Poland as focal countries for analysis was driven by their importance and diversity within the European natural gas market. These countries represent different regional dynamics and gas exchange developments, making them relevant case studies for understanding the evolution of exchange infrastructure. *Natural gas exchange infrastructure* refers to the physical and digital components that facilitate the trading, pricing and distribution of natural gas on the market. It comprises a combination of physical facilities, electronic platforms, standardised contracts and regulatory frameworks that together enable efficient and transparent trading of natural gas products (see Figure 1). This infrastructure plays a crucial role in connecting suppliers, consumers, traders and other stakeholders in the natural gas market and contributes to price transparency, risk management and market integration in the natural gas market.

The analysis years are based on the start of natural gas trading on the energy exchanges and cover the period from 2007 to 2023. The starting point is 2007 for the German exchange, 2009 for the Austrian exchange and 2011 for the Italian exchange. The analysis of the Ukrainian exchange covers the period from 2017 to 2023.

The analysis uses a graphical method to visually represent the evolution of natural gas exchange trading. Graphs and charts are used to illustrate the volume of natural gas traded in Europe in general (Figures 2, 3, 4) and the development of the EEX (Figure 5), CEGH Gas Exchange (Figure 6), GME (Figures 7, 8) and UEEX (Figures 9, 10) in particular.

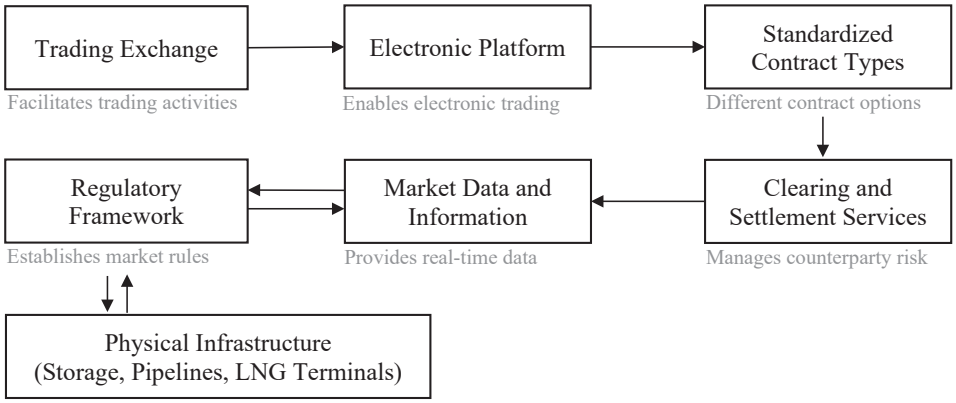

Figure 1. Elements of the infrastructure of natural gas exchanges

Source: own development

Data on the structure of natural gas trading in Europe were sourced from the Trayport report (Trayport, 2019), ACER-CEER 2016–2018 annual reports (Multiple: 2017..2019) and Almeida & Starn (2022), whose data are based on ICIS. Data for specific stock exchange analyses were obtained from the open data of the selected stock exchanges, mainly from the annual reports available on the official websites. In particular, EEX data collected from EEX 2007–2016 (Multiple: 2008..2017) and EEX Group 2017–2021 (Multiple: 2018..2022) annual reports along with newsletters available on the official website (EEX Group, Multiple: 2022..2023), CEGH Gas Exchange data collected from Energy Community (2021) and CEGH 2019–2022 (Multiple: 2020..2023) press releases, GME data collected from GME 2021–2022 (Multiple: 2022..2023) annual reports, data for Poland and Romania collected from ANRE (2020) and TGE (2020) annual reports, UEEX data collected from UEEX 2019–2020 (Multiple: 2020..2021) annual reports, UEEX 2021–2023 press releases (Multiple: 2021..2023) and SKAT-TRADE analysis (Multiple: 2020..2023). The growth rates of CEGH and GME natural gas trade were calculated by the authors (Figures 6, 8).

Data limitations are related to UEEX. In particular, there is no data for natural gas traded volumes in February 2022, so this month is not included in Figure 9. Also, the publicly available UEEX data did not include the structure of monthly traded volumes

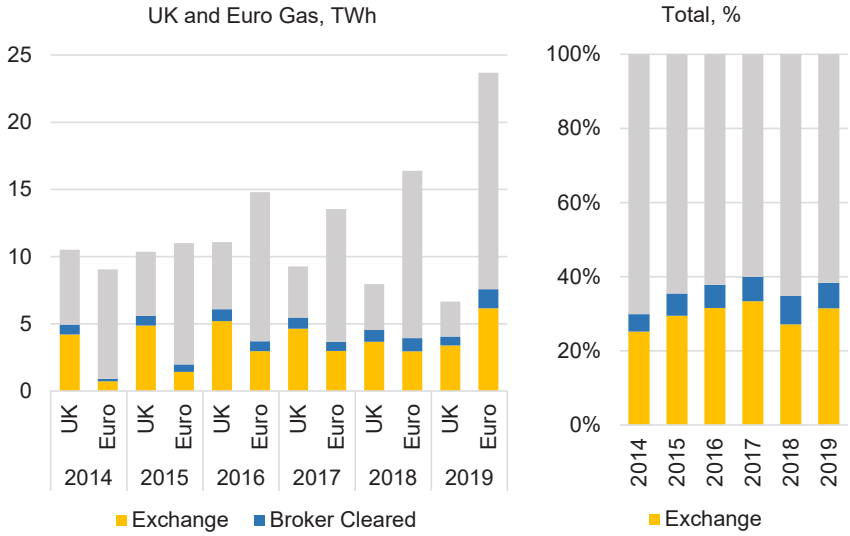

Figure 2. Trade volumes of EU and UK gas

Source: own development based on (Trayport, 2019)

Note: YTD Trends. Information as at: 30 June 2019. Definitions: Broker Bilateral – total volume executed at a broker and settled bilaterally, without the involvement of a clearinghouse. total volume concluded with a broker and settled bilaterally, without the involvement of a clearing house. Broker cleared – the total volume concluded with a broker or off-exchange and transferred for clearing to a clearing centre. Exchange – the total volume executed at the clearing centre

in August 2020 – April 2021, September–October 2021 and October 2022. To fill this gap, the SKAT-TRADE data for these months was used.

4. Development of Natural Gas Exchange Trading in Europe

Exchange trading is one of the signs of the development of the natural gas market that is strongly related to the liberalisation process (see Kurbet, 2022). This can be seen in the growth of the share of natural gas traded on exchanges in the European market. According to Trayport data (see Figure 2), the share of exchange trading on the UK market was significant, accounting for 40% of traded volumes in 2014 and rising to 51% in 2019. The situation is quite different for Euro gas, where the share of exchange traded volumes was only 8%, but increased by 18% over the same period. In general, the share of exchange trading increased from 25% to 31%.

The trend towards an increasing share of exchange trading with a simultaneous dominance of OTC trading also applies to the individual European gas hubs. According to ACER (Multiple: 2017..2019), the share of exchange trading on the Dutch TTF, the UK NBP and the Danish NCG increased significantly in the period 2012–2018 (see Figure 3). On many hubs it mostly fluctuated within a few percent, not without exceptions where natural gas exchange trading predominated, such as Poland, or was the only type of trading, such as Romania and Hungary.

According to broader data from Almeida & Starn (2022), the proportion of shares traded on the stock exchange changed radically between 2014 and 2021, from 7% at the beginning of 2014 to 80% at the end of 2021 (see Figure 4).

In this paper, it was assumed that the recent data for 2022 and 2023 may not reflect long-term trends, as they are the result of force majeure circumstances

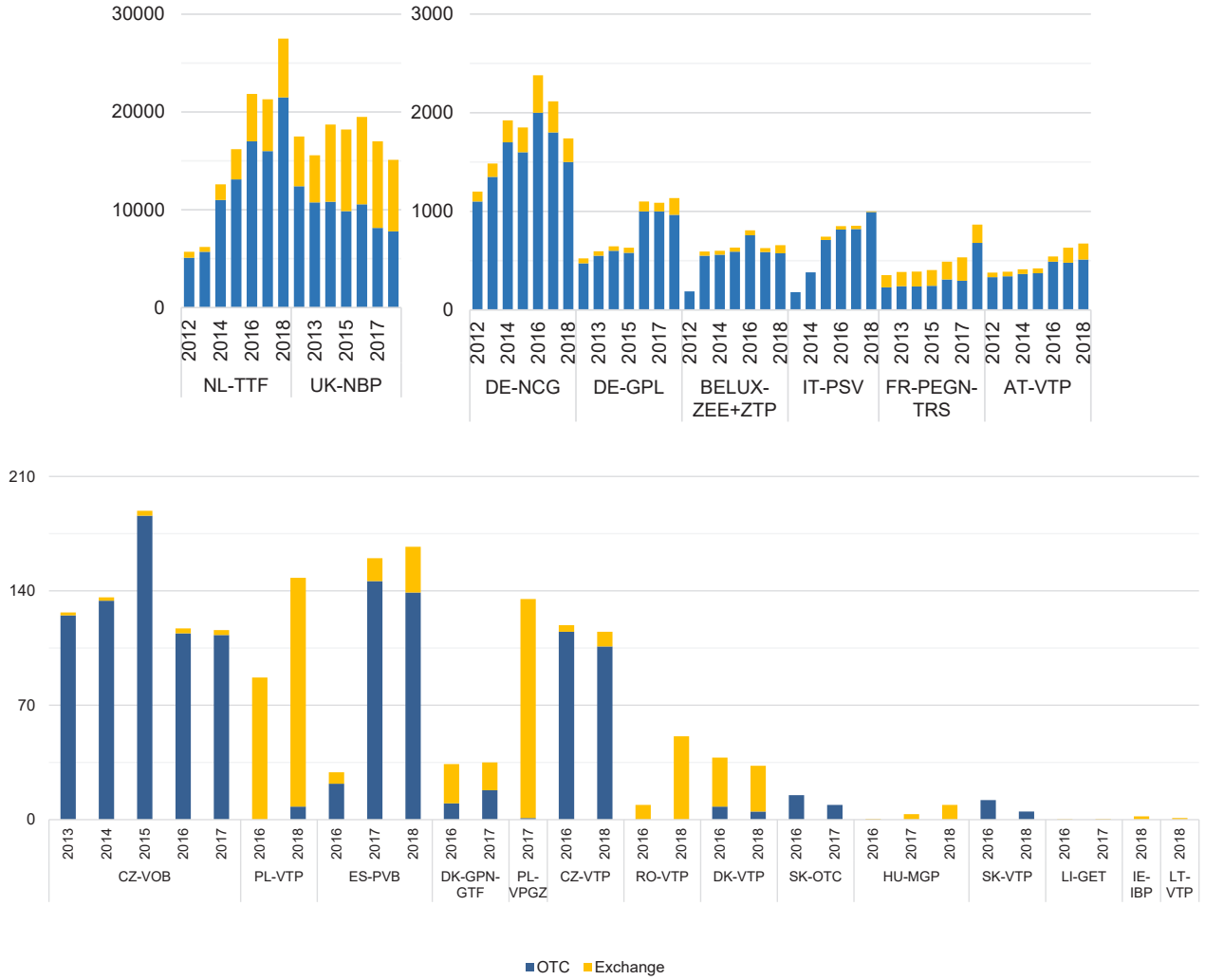

Figure 3. Shares of OTC and exchange trading volumes by hubs, TWh/year

Source: own development based on (ACER, Multiple: 2017..2019)

Note: Since 2019 there is no data on OTC and Exchange traded volumes in ACER-CEER reports

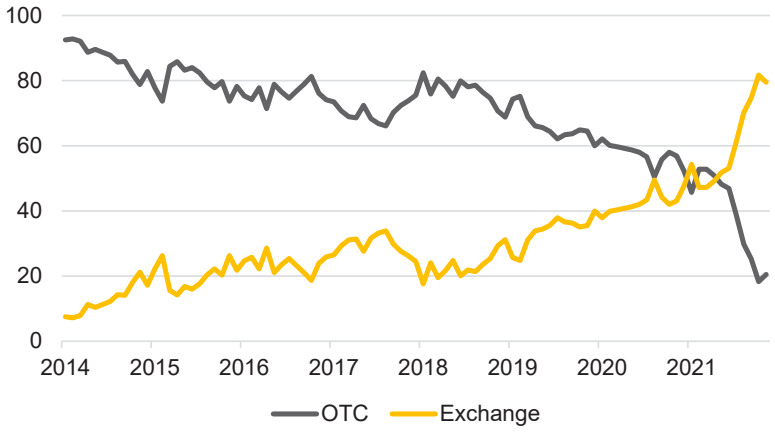

Figure 4. Share of European gas trade volumes in 2014–2021, %

Source: own development based on (Almeida & Starn, 2022), original data from ICIS

related to Russia's full-scale invasion of Ukraine, which radically affected the entire energy sector and caused a global gas crisis. In 2022, the volume of natural gas traded on the European gas hubs decreased significantly due to the record increase in gas prices. Short-term products were favoured over long-term products due to the uncertainty of the environment. Participants preferred trading on exchange platforms to protect themselves against the risk of non-payment, rather than OTC, as evidenced by a significant reduction in the share of OTC traded products from 50% in 2021 to 30% in December 2022 (ACER, 2023). At the beginning of 2023, according to the IEA (2023b), the pressure on the gas market could be reduced despite the market situation, also due to successful political decisions. However, despite decisive changes in the recent past, the natural gas market has tended to increase the role of exchange trading, demonstrating the reliability of the exchange institution in the long term and also during the crisis period.

5. Examples of Natural Gas Exchange Infrastructure

In the European natural gas market, there are several exchanges that trade natural gas contracts on gas hubs. They are the following: ICE / ICE-Endex (UK), EEX (Germany), Powernext (France), CEGH GAS Exchange (Austria), GME (Italy).

The **European Energy Exchange (EEX)** in Germany is one of the leading exchanges for energy products, including natural gas. It was created in 2002 through the merger of the European Energy Exchange in Frankfurt and the LPX Leipzig Power Exchange in Leipzig. EEX is based in Leipzig and has developed significantly in terms of size, organisational structure, number of participants, trading volumes and product differentiation. Today, the EEX Group consists of the European Energy Exchange (EEX), EPEX SPOT, EEX Asia, GET Baltic, Power Exchange Central Europe (PXE) and Nodal Exchange, the registry provider Grexel Systems and the software companies KB Tech and Lacima. In 12 years, the number of employees has increased nine times, reaching 929 employees in 19 locations in 2022. From 40 trading participants in 2000, EEX has grown to more than 800 in 40 countries today (EEX, Multiple: 2008..2017; EEX Group, Multiple: 2022..2023).

Natural gas market products were launched in 2007. Initially, only futures were traded, but a few months later the offer was extended to the day-ahead spot market. Key milestones in the development of the EEX natural gas segment are the launch of 24/7 natural gas spot trading in 2011 and the launch of the PEGAS cooperation in 2013. PEGAS resulted in the combination of German EEX and French Powernext gas products on one trading platform. It led to a rapid increase in traded volumes in the following years. In 2015, the PEGAS gas markets exceeded 1000 TWh for the first time and continued to grow steadily (see Figure 5).

Today, EEX is a leading player in the European gas market, covering 87% of spot trading and offering spot products on the following gas hubs: CEGH VTP, ETF, NBP, THE, PEG, PVB, TTF, ZEE, ZTP. The market share of derivatives is much smaller and amounts to 6% in 2022. However, it has increased by 4% compared to the previous year. EEX offers its futures products on CEGH CZ VTP, PSV and the above-mentioned hubs.

The EEX operates on the principle of the so-called Leipzig model – "a market that is financed by private means, but is subject to state supervision and is itself exposed to competition". According to the EEX management, this is of great importance when it comes to dealing with crisis phenomena, optimising

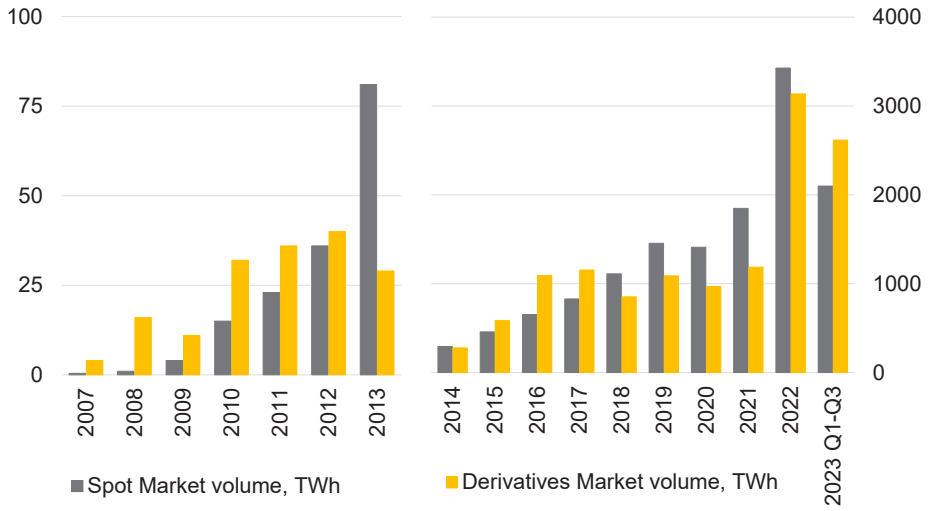

Figure 5. EEX natural gas trading volumes

Source: own development based on (EEX, Multiple: 2008..2017; EEX Group, Multiple: 2018..2017, 2022..2023)

Note: The data includes PEGAS trading volumes and Gaspoint Nordic volumes since October 2014 for the spot market, and PEGAS trading volumes for the derivatives market

the relationship between the state and the market and not pitting them against each other.

Ultimately, EEX owes its success on the energy market to the accountability and transparent regulation of its activities. From the very beginning, EEX Exchange has been a public-law entity (Exchange Council, Management Board, Market Surveillance) and EEX AG has been a private-law entity (Supervisory Board, Management Board, Business Units). At the same time, it is subject to intensive state supervision: Exchange Supervisory Authority (Saxon State Ministry of Economic Affairs and Labour), Market Surveillance (HÜSt), Exchange Council, as well as (according to the 2008 annual report) BNetzA, E-Control (A), CRE (F), CEER (EU), ERGEG (EU), BaFin, CFTC (USA), AFM (NL), EBK (CH), FSA (GB), EU Commission (DG Competition, DG Energy).

Another prerequisite for the effective functioning of a modern exchange is a clearing institution that acts as an intermediary between market participants. EEX has spun off the clearing segment into European Commodity Clearing (ECC), which also provides clearing services for the partner exchanges EEX Asia, EPEX SPOT, Hungarian Derivative Energy Exchange (HUDEX), Hungarian Power Exchange (HUPX), Norexeco, Power EXCHANGE CENTRAL EUROPE (PXE), SEEPEX and SEMOpx (ECC, n.d.). In particular, the EEX's resilience to the 2008 crisis and global instability is attributed to clearing, which "has proven to be a safe haven for the market".

Following the launch of the over-the-counter trading platform CEGH in 2005, the **Central European Gas Hub (CEGH) was launched in Austria** in December 2009. At the same time, a spot market segment was added (together with the Vienna Stock Exchange) and a year later, a futures market segment. In December 2013, a platform for trading gas futures contracts was launched together with Power Exchange Central Europe (PXE). Since 2016, CEGH has been a virtual trading point (VTP) operator in Austria. In December 2016, CEGH launched exchange-traded products on PEGAS.

The CEGH case study has confirmed that product differentiation (see Table 1) and entry into new markets are elements of an exchange's success and development.

With the introduction of futures trading in 2013, the volume traded increased significantly from 3 to 13.2 TWh. Cooperation within PEGAS, as with EEX, provided an additional boost. In 2015, the volume traded increased to more than 4 TWh per month. Already in 2017, the traded volume increased almost threefold during the year, reaching 90 TWh, and continues to grow, albeit not as fast (see Figure 6).

Like EEX, CEGH clearing is provided by ECC. Speaking of technology, it's worth noting that CEGH

Table 1
CEGH gas exchange products

	Spot market		Futures market
Contracts	Hourly products	Day-Ahead	Next 6 Months
		Weekend	Next 7 Quarters
	Within-Day	Saturday	Next 6 Seasons
		Sunday	Next 6 Calendar years
		Bank holiday	
		Individual Days	

Source: own development based on (CEGH, n.d.)

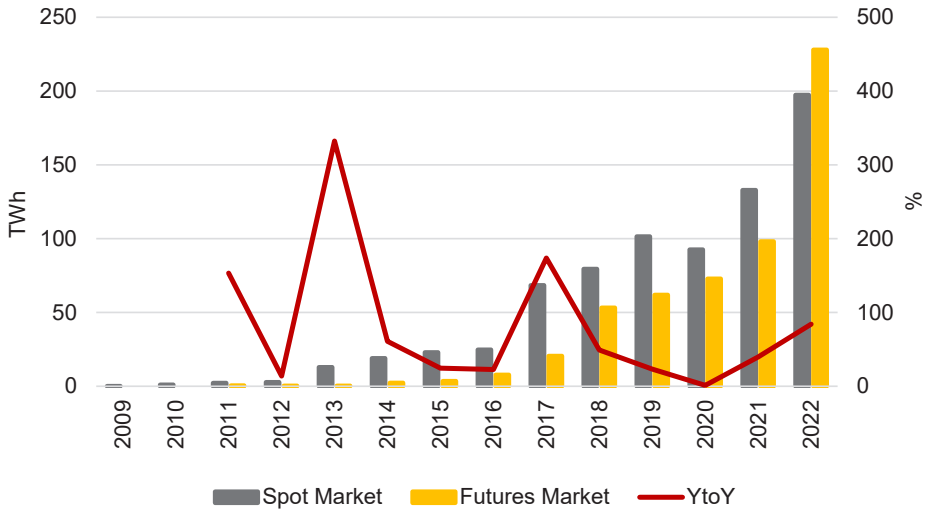

Figure 6. Natural gas trading volumes on the CEGH gas exchange, TWh

Source: own development based on (CEGH, Multiple: 2020..2023; Energy Community, 2021)

launched the EU's first Gas Hub app in December 2020. This application offers the following main features: all available market data of the EEX CEGH Gas Exchange, price alerts for exchange products, push notifications for CEGHIX, check of daily nominated CEGH VTP volumes, REMIT: UMM publication (push notification) (Energy Community, 2021).

One of the key features of the Austrian gas market is that it is relatively new. Unlike NBP or TTF, it does not deal with such large gas reserves or production, but is a transit point for many gas supply routes. While NBP and TTF, the largest hubs in Europe, developed under conditions more in line with the principles of the free market, CEGH and EEX faced the challenges of modern times, in particular the processes of liberalisation, and accordingly operated under conditions of special regulation of actions.

A rather different case is **Gestore dei Mercati Energetici (GME) in Italy**. The launch of the Italian gas exchange was preceded by the creation of the VTP in 2006. At the same time, the spot market for natural gas was launched in Italy for the first time. Due to the relatively long process of setting up and registering institutions, GME was actually launched in 2010. GME's peculiarity is that it is *fully owned by the Ministry of Economy and Finance* and is an energy operator in the Italian market.

There are three platforms on the GME: a spot market M-GAS (consisting of the day-ahead market – MGP-GAS, the intraday market – MI-GAS, the locational products market – MPL, the regulated market for trading in stored gas – MGS); a market for monthly and yearly products – P-GAS (including imports, royalties and investment segments); a balancing platform PB-GAS (Honoré, 2013).

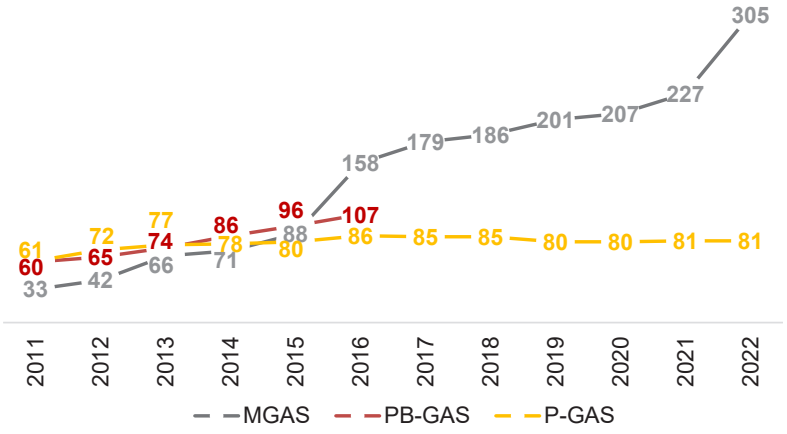

Figure 7. Participants in the GME natural gas trading market

Source: own development based on (GME, Multiple: 2022..2023)

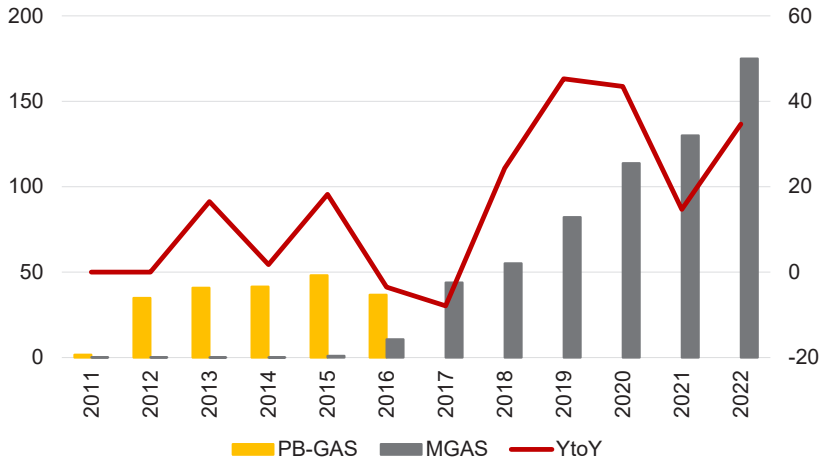

Figure 8. GME natural gas trading volumes, TWh

Source: own development based on (GME, Multiple: 2022..2023)

According to GME's annual reports, the exchange's gas segment is growing. Thus, the number of participants increased almost every year (see Figure 7), as did the growth in traded volumes, with the largest jumps in 2019 and 2020 (+45%). The exceptions were 2016 and 2017, when trading volumes fell by 4% and 8% respectively (see Figure 8). At the same time, since 2017, trading has only taken place on the short-term market. In 2022, the phenomenon of the dominance of the day-ahead market was observed. Its share reached 72%.

Speaking of peculiarities, it should also be noted that prices on the Italian gas market have been quite high over the years compared to other European countries, with household taxation reaching almost 40% in 2021 (IEA, 2023a).

The Romanian gas market has several similarities with the Ukrainian market. These include a late start to liberalisation, a high concentration of production and operators, and a strong regulatory influence of the state. At the same time, government measures have had both stimulating and inhibiting effects (Ciot, 2021). In 2014, the government deregulated prices but obliged producers and small suppliers to trade a defined gas limit through the licensed platforms of **Operatorul Pietei de Energie Electrica si Gaze Naturale "OPCOM"** (Electricity and Gas Market Operator) and **Bursa Română de Mărfuri – BRM** (Romanian Commodity Exchange). A significant driver for the development of exchange trading was the introduction of new clearing services to the market.

Favourable geographical location, active policies of the government and market participants have influenced the strong growth rates of natural gas trading volumes. BRM has significant advantages in the market. If in 2013 there were only 16 auctions, 26 customers and 0.7 TWh of gas sold on the BRM, in 2017 there were 675 auctions on the exchange with more than 360 customers and 67.7 TWh sold (ANRE, 2020). The BRM and OPCOM platforms represent around 56% of national consumption and act as the central counterparty for all trades concluded on the spot, forward and balancing markets.

In 2018, the Romanian government adopted Resolution No. 114/2018 in order to limit the growth of gas prices. This had a negative impact on the market activity – the volume of trading on the BRM in 2018–2020 stabilised and decreased to 30-50 TWh (Visenescu & Bartelet, 2017). Later, this intervention was cancelled, but in the conditions of the war in Ukraine, the Romanian government was forced to resort again to strict regulation of volumes and sales prices on the domestic market.

Obstacles to the planned development of the exchange segment of the Romanian gas market include high concentration with an unstable producer structure. This is compounded by a changing regulatory environment in terms of price requirements and sales volumes. Nevertheless, Romania is actively developing its gas market and increasing production volumes thanks to new fields in the Black Sea. Romania's role as a transit country for gas from Greece and Azerbaijan to Hungary and Moldova is growing.

Poland started creating its own gas market in 2012 with the launch of the commodity derivatives and day-ahead market for natural gas as part of the European Union's energy strategy. The incentive for the launch of the exchange segment in Poland was the requirement to sell 55% of the annual volume of gas traded by energy companies. This requirement was enshrined in the Polish Energy Act of 2013.

And the only platform at that time was the **Polish Power Exchange (TGE)**. As a result, already in 2013–2014, the annual trading volume on the exchange grew from 2 to 112 TWh, and in 2020 it reached 151 TWh and included 69% of the domestic gas consumption (TGE, 2020).

The Polish gas market is not fully liberalised. Polish legislation provides for very significant obligations for gas suppliers in line with energy security priorities (Niewiński et al., 2017). The main growth prospects of the Polish gas exchange market are based on its locational advantages. This leads to another major prospect – the integration of the Visegrad Group countries, as well as the Scandinavian countries, into the gas hub in Poland. The creation of a gas hub has already appeared as one of the goals in the Polish energy strategy until 2040 (Ballak, 2022). The downside is that the gas storage infrastructure may be an obstacle.

6. Development of Ukrainian UEEX

The Ukrainian Energy Exchange (UEEX) was established in 2017 with the aim of organising and conducting exchange trading of energy resources. UEEX is an open electronic trading platform, where fair market prices are formed based on the supply and demand of bidders and calculations are made on this basis. UEEX is the only centralised platform where the largest liquidity and trading of all types of energy resources is concentrated. UEEX organises auctions in which an unlimited number of buyers and sellers can participate simultaneously and transactions are concluded on a competitive basis, respecting the principle of bidder anonymity through matching.

Until recently, the GTS operator was obliged to comply with the terms and conditions of the contract for the purchase of balancing energy, which is carried out on the ProZorro platform (electronic public procurement system) and could be different for each procurement procedure. However, the requirement for public procurement has recently been abolished by the law of Ukraine, which allows OGTSU to buy/sell gas on the gas exchange.

At the same time, the Ukrainian financial sector at this stage of development is not yet capable of serving as a basis for clearing. The reform of the financial sector requires the creation of an appropriate institutional framework for the establishment of a broad-based commodity exchange. At present, the so-called escrow accounts operate on the basis of the UEEX. However, a memorandum of understanding has been signed between UEEX, the EBRD, the NBU and major participants in the natural gas market on the involvement of a central counterparty to ensure full clearing.

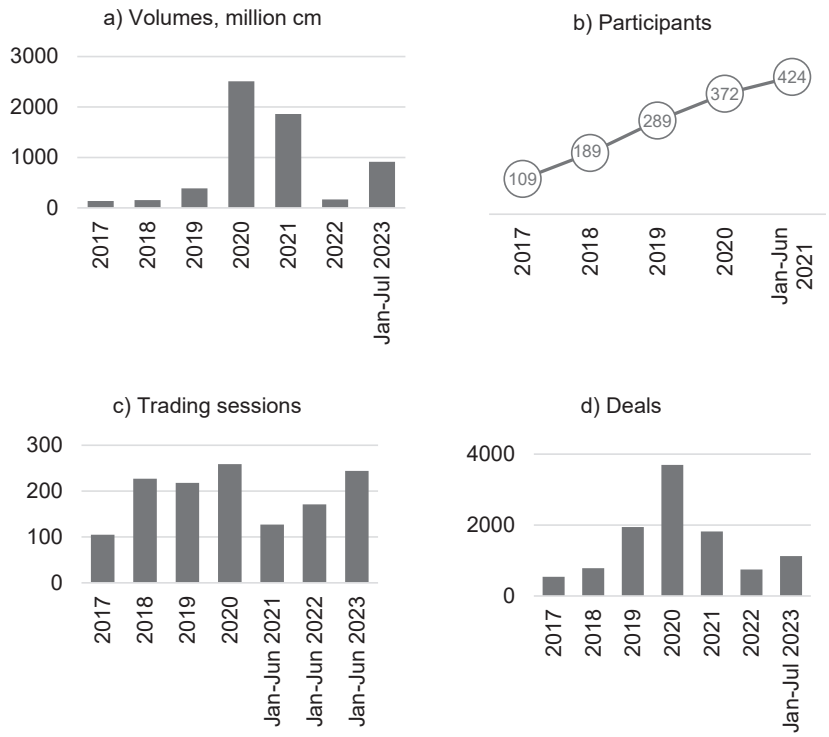

Figure 9. Natural gas trading on the UEEX

Source: own development based on (SKAT-TRADE, Multiple: 2020..2023; UEEX, Multiple: 2020..2021, 2021..2023)

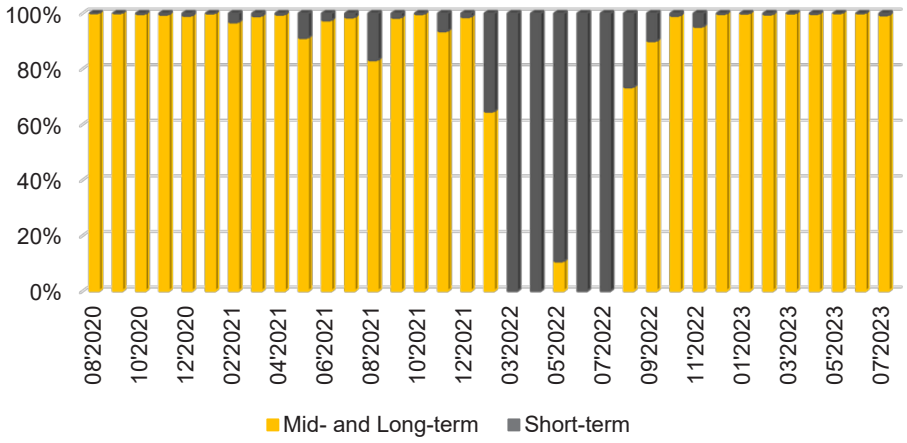

Figure 10. UEEX: Structure of natural gas trading volumes

Source: own development based on (SKAT-TRADE, Multiple: 2020..2023; UEEX, 2021..2023)

Since the launch of the natural gas market on the UEEX, this segment has developed significantly and shown an upward trend. As of June 2021, the number of participants has more than quadrupled and the trading volume has increased from 388 million cm in 2019 to 2509 million cm in 2020 (see Figure 9).

The situation changed rapidly, with 167.5 million cm traded in 2022. During the first months of the full-scale Russian invasion, there was no medium- or long-term trade, except for May when a small amount was traded (see Figure 10). The structure of the volumes traded stabilised somewhat in 2023, which cannot be said for the total volumes traded.

Based on the cases analysed in the previous section, it is possible to identify the components of the successful development of a natural gas trading exchange, which can be useful for Ukraine and can be transformed into recommendations for the development of UEEX. First, *diversification*, which is manifested in the variety of products and the involvement of a wider range of participants. Second, *risk management* related to the provision of clearing and settlement services, which ensures the integrity of trading and helps manage counterparty risk. It has also been proven to be one of the key elements of crisis resilience. Third, *market integration and cooperation*, which allows participants to trade across borders. The UEEX is already on the path to European market integration and is moving towards its deepening, which can contribute to the development of a regional gas market and gas hub. Fourth, a robust *regulatory and accountability system* that builds trust among market participants. Modern Ukraine lacks reliable institutions at a time when they are crucial for creating a strong and competitive environment. In this context, the development of exchange trading requires a clear legal and regulatory framework that gives market participants confidence in its integrity and ensures that market surveillance mechanisms are in place to prevent market abuse. Fifth, *digitalisation* related to technology and electronic trading, which increases market accessibility and efficiency by allowing participants to trade in real time. This also requires a modern cybersecurity system.

7. Conclusions

This article has shown an increase in the share of exchange trading in the European natural gas market, proving the key role of the exchange as an institution. The study of the specific development of the exchange infrastructure in Europe has shown that each country has its own unique characteristics in the formation and development of its natural gas market. Summarising the prerequisites and problems in the development of EEX, CEGH GH, GME, BRM, TGE, it was possible to distinguish the elements of successful functioning of energy exchanges trading natural gas, which are: diversification of the market and product portfolios, integration into the European market, reliable system of control and accountability, combination of market mechanisms and state supervision, clearing and settlement, technologies ensuring the most efficient operation of all processes.

Based on the cases of Romania and Poland, which have similar institutional and economic conditions to Ukraine, the regulatory policy development was determined to ensure a successful start of gas exchange trading on national markets. In the first stages, the policy measures should be combined by price liberalisation measures and requirements for mandatory sale of a certain share of gas on the exchange market. In the following stages, policy development should require the coordination of price fluctuation compensators and measures to develop infrastructure and instruments (futures, forwards, clearing services, etc.). It is also important to emphasise that cooperation and integration into

a wider market leads to growth of exchanges, as shown by the German and Austrian cases.

There are significant threats to the functioning of the market under conditions of full-scale war. At the same time, Ukraine has the prerequisites and potential for the functioning of the natural gas market on a liberal basis, as evidenced by the data presented in the article. It requires a continuous process of ensuring institutional conditions for the functioning of the gas exchange as a stable and reliable institution.

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