DOI: 10.46299/ISG.2024.MONO.TECH.2.4.2

4.2 Main prospects of the LNG gas market

Natural gas, a hydrocarbon known to humanity for millennia, has been utilized in various ways throughout history. One of the earliest recorded uses was in Delphi, where natural gas seeped from a rock crevice and fueled a flame believed to inspire prophecies at a temple. The mysterious nature of these flames led many cultures to attribute them to divine sources. However, by around 500 BCE, the Chinese had already begun to harness the potential of natural gas. They developed a rudimentary system for transporting natural gas to heat water, which they used to extract salt from seawater. The commercial extraction of natural gas began in the mid-19th century, marking the start of its significant role in the energy markets. Since then, natural gas has become increasingly important in the energy mix of the world's largest economies.

Global economic growth has driven up the demand for energy products, leading to a continuous increase in the consumption of primary energy. In 1965, the global consumption of primary energy was 3,729 Mtoe. By 2014, this figure had risen to 12,928 Mtoe, nearly 3.5 times the consumption level of 50 years earlier. Chart 1 illustrates the changes in primary energy consumption from 1965 to 2014, highlighting the differences between each decade's final year and 2014. This rising energy demand is a direct consequence of economic expansion, as increased production scales have led to greater global energy needs. Variations in the annual global GDP growth rates are mirrored by corresponding fluctuations in primary energy consumption, a trend that was particularly evident during the global economic crisis at the end of the last decade.

In the past 35 years, the global economy has experienced only one period of regression, which occurred in 2009 when the gross domestic product (GDP) decreased by 0.1%. Despite this, the global economy has grown at an average annual rate of 3.48%, accompanied by a 1.92% annual increase in primary energy demand. The distribution of energy resources, especially hydrocarbons, around the world prevents most countries from meeting their energy needs with domestic resources alone. The five countries with the largest crude oil reserves hold nearly 62% of global deposits,

while ten countries account for 85%. Natural gas resources are similarly concentrated, with the top five countries holding over 63% of global reserves and the top ten holding over 79%. Coal deposits are even more concentrated, with the top ten countries possessing over 91% of global resources.

This uneven distribution of energy resources, coupled with the growing demand for energy, has necessitated international trade in resources, fuels, and other energy products. Hydrocarbons play a crucial role in the global energy mix, accounting for 86.3% of primary energy consumption in 2014, driving the continuous growth in international trade volumes. Today, most countries must import energy resources. In 2014, Russia was the only one of the ten largest economies that was a net exporter of all described hydrocarbons. The United States, the world's largest economy, imported 39% of its crude oil demand and 4% of its natural gas, despite being a net exporter of coal. The shale revolution in the U.S. has significantly increased natural gas production and reduced domestic demand for coal, making the U.S. the largest natural gas producer with a 21.4% share in 2014, up 6.1% from 2013.

China imports 62% of its oil, 6% of its coal, and 27% of its natural gas. Japan, the third-largest economy, is almost entirely dependent on imported hydrocarbons, especially after the Fukushima nuclear disaster in March 2011 increased its demand for natural gas. Several European countries also exhibit high levels of import dependence. Germany imports 100% of its oil, 89% of its natural gas, and 43% of its coal. France can only meet 1% of its domestic energy needs with its own resources. Italy imports 90% of its oil, 100% of its coal, and 88% of its natural gas. The situation is slightly better in the UK, where domestic production meets 57% of oil and 55% of natural gas demand, but 76% of coal is imported. In Brazil, 27% of oil, 79% of coal, and 49% of natural gas are imported. India, despite being the third-largest coal producer, imports 32% of its coal, 37% of its natural gas, and 77% of its oil [122].

The global demand for energy resources has led to the development of various transportation models for each resource in international trade. Due to their physical properties, these models vary. Oil has been transported by sea, rail, and pipelines since the 19th century. Coal, due to its nature and early commercial use, has long been

transported overland and by sea, with its industrial use boosted by the 18th-century industrial revolution. The large-scale transport of natural gas developed much later. Initially used locally due to its properties, the breakthrough came in the late 19th century with the construction of leak-proof pipelines up to approximately 160 km long. The 1920s and 1930s saw the development of a natural gas system in the United States. Natural gas gained popularity as a key fuel 30 to 40 years later, with global consumption rising by 83% between 1965 and 1975. This was driven by increased production in countries with significant natural gas reserves, such as the Soviet Union and the USA, the first oil crisis highlighting the need for alternative energy sources, and the development of pipelines from Soviet natural gas sources, a trend that continues with Russia. The 1970s marked the beginning of large-scale international trade in natural gas, significantly increasing consumption in countries without sufficient domestic production.

Liquefied natural gas (LNG) is poised to hold long-term strategic importance for the European Union, particularly in ensuring economic development and energy security. To this end, EU member states are enhancing their energy infrastructure to secure access to global LNG markets, providing each country with direct or indirect (through intermediate countries) access to overseas LNG supplies. The utilization of this infrastructure will largely depend on global energy prices.

The increased availability of LNG will boost competition in the gas market, promoting market-based pricing. This competition could potentially lower prices, especially in the initial stages. Therefore, it is in the European Union’s interest to develop energy infrastructure that allows for the importation of LNG by sea from various directions and sources, ensuring its flexible economic use. Additionally, new installations will be built to expand the use of LNG as a fuel in road, rail, and maritime transport, as well as in local heat and electricity generation. Establishing appropriate supply chains for LNG is crucial for this purpose [123].

Environmental considerations are also significant. LNG is the cleanest fossil fuel in terms of emissions, thanks to its production process, which involves liquefying and refining natural gas to remove acidic gases, sulfur compounds, water, and mercury.

Consequently, burning LNG results in lower emissions of harmful substances (such as carbon dioxide, nitrogen oxides, sulfur dioxide, and ash). This, coupled with the growing versatility of its applications, makes LNG a vital fuel for the economy.

The goal of this chapter is to present the role of LNG in European Union policy. The direction of these activities will impact not only the EU energy market but also global markets. The importance of LNG terminals on the common EU energy market. LNG terminals play a pivotal role in the unified EU energy market by bolstering energy security and fostering competition, thereby ensuring market-driven pricing for the commodity across Europe. R. Dohms highlights that the functionality of the unified EU energy market hinges on unrestricted access to and the fluidity of energy resources and electricity. Research conducted by S. Dorigoni, C. Graziono, and F. Pontoni suggests that even with higher prices for LNG supply compared to pipeline natural gas, LNG exporters' access to the natural gas market will enhance market competitiveness under certain conditions: the entry of new competitors, the development of the spot market, and declining costs associated with LNG. The researchers also underscore the growing significance of spot transactions in the natural gas market, indicating their pivotal role in the liberalization of the EU energy market [124].

However, questions arise regarding whether the development of LNG terminals will foster integration or fragmentation of the natural gas market in Europe. An analysis of LNG terminal infrastructure development in the European Union reveals that countries with advanced liquefied gas import facilities, such as Spain, France, Italy, and Portugal, exhibit limited interconnectivity with neighboring countries, with France and Italy lacking a gas connection. Moreover, the throughput capacity of interconnectors between Spain and Portugal is low, and their gas systems' interconnector at Badajoz is contracted until 2035. This suggests that the Iberian and Apennine Peninsula countries may intend to regionalize their gas markets and are hesitant to expand interconnections due to concerns about market competition. Consequently, the development of LNG terminals could potentially delay the establishment of a unified EU energy market, prolonging its regionalization phase.

However, despite this, the global utilization of LNG terminal import capacity was only 35% in 2013, with Europe's ratio even lower, below 25%. Nonetheless, in the event of a political crisis disrupting supply from major sources to Europe, the import potential of LNG terminals would become invaluable. In such a scenario, the combination of entries into the gas system via LNG installations and natural gas interconnections would facilitate the distribution of required resource quantities to destination countries. This underscores that a geopolitical crisis would fundamentally alter the impact of LNG terminals on the integrated energy market and significantly increase the utilization of their import potential. Under stable political conditions, LNG terminals will be utilized to the extent deemed profitable by importers in EU countries, thereby constituting a strategic energy infrastructure aimed at ensuring the diversification of EU natural gas supply sources [125].

In February 2016, the European Commission unveiled the "EU strategy for liquefied natural gas and gas storage," a crucial component aimed at ensuring the security and diversification of natural gas supplies. Previous strategic documents had consistently highlighted the imperative to enhance energy security and broaden the spectrum of both the direction and sources of natural gas supply.

As far back as 2003, the EU recognized the potential of liquefied gas in its document "European Energy and Transport Trends to 2030," forecasting a significant role for LNG in integrating regional gas markets. Subsequent projections in 2007 emphasized the gradual development of the global LNG market over time. A 2014 forecast stressed the necessity of expanding infrastructure in European countries to accommodate the development of LNG fuel for road transport. In 2011, the European Commission reiterated the importance of extending connections between EU natural gas networks and third-party countries through the construction of new gas pipelines and LNG terminals, emphasizing the substantial impact of LNG on the global natural gas market. The Regulation of the European Parliament and of the Council (EU) no. 347/2013 highlighted the increasing significance of energy storage facilities and liquefied natural gas (LNG) reception, storage, regasification, or decompression facilities in European energy infrastructure. In the European Energy Security Strategy

of 2014 and the European Energy Union (EEU) project of 2015, LNG supplies were recognized as crucial for diversifying natural gas supply to Europe. Public consultations began in July 2015 regarding the EU strategy for utilizing LNG and natural gas storage facilities within the framework of the EEU, stressing the key role of LNG in diversification, continuity of supply, and enhanced competitiveness in the gas market. The European Union is committed to ensuring that all member states, including Bulgaria, Croatia, the Czech Republic, Estonia, Finland, Hungary, Latvia, Romania, Slovakia, and Slovenia, gain access to LNG importation, either directly or indirectly through neighboring countries. Enhanced regional cooperation and increased interconnectors will be vital to achieving this goal. The EU acknowledges existing barriers faced by potential new LNG suppliers at the terminal level, such as supply contracts, access to gas transmission systems, and storage facilities. Overcoming these barriers will optimize LNG terminal utilization. Furthermore, the EU recognizes LNG as an attractive alternative to existing fuels, particularly in sea transport. However, addressing barriers related to bunkering capacity, regulatory frameworks, and standardization across supply chains will be essential to expanding its use. Lastly, the document underscores the strategic importance of storage facilities in ensuring energy security, culminating in the announcement of the "EU strategy for liquefied natural gas and gas storage" in February 2016 by the European Commission [126].

The model for integrating the common EU energy market envisions the expansion of energy infrastructure to facilitate bidirectional and flexible exchange of energy resources. This integrated market will operate on the principles of market competition, established through appropriate regulatory frameworks resulting from market liberalization processes. The wholesale market, anchored by energy exchange markets and hubs, will play a pivotal role. An integrated energy market model must incorporate a robust natural gas security system that extends beyond neighboring countries. This entails recognizing the significant role of the LNG market alongside onshore and submarine pipelines and natural gas interconnectors, ensuring access to global natural gas resources. D.A. Wood highlights that LNG witnessed consistent growth from 1990 to 2010 at a global rate of 7.2% annually, with even higher growth

projected by 2020. Liquefied gas will be instrumental in the integrated market model, facilitating rapid access to additional gas supplies through LNG terminals. In the event of a long-term energy crisis depleting underground natural gas storage stocks, LNG will serve as a reliable element of the security system. It will emerge as a viable alternative to diesel oil and compressed gas, becoming a major fuel in road, maritime, and aviation sectors.

Its prominence in road transport will continue to rise alongside increasingly stringent environmental standards for combustion fuels, mirroring trends in air and maritime transport. This is evident in Directive 2012/33/EU, which mandates a reduction in sulfur content in marine fuels, paving the way for broader adoption of LNG fuel in maritime transport. In Northern European ports, fixed LNG bunkering stations are being established, with Stockholm among the first to offer liquefied gas bunkering using the vessel-to-vessel method. In the Baltic Sea region, Sweden currently offers bunkering services with LNG, with Poland poised to join through its Świnoujście LNG terminal. Providing these services is expected to yield significant revenue for service providers, including ports [127].

The integration model for the common EU energy market will likely introduce more legislative acts favoring low-emission fuels like LNG. Consequently, the development of the liquefied gas market in Europe hinges on expanding infrastructure to ensure efficient transport and distribution of this fuel across regions and countries.

LNG terminals play a crucial role in diversifying the sources of natural gas supply, granting importers access to global markets. This is particularly vital for EU nations that have previously faced disruptions in natural gas supply due to conflicts involving Russia and Ukraine or Russia and Belarus. Liquefied gas terminals enhance Europe’s energy security by bolstering the stability of gas supply. The International Energy Agency (IEA) underscores that LNG terminals act as a safeguard against risks associated with disruptions in natural gas supply. The IEA has developed the Model of Short-term Energy Security (MOSES), which highlights that LNG terminals serve as vital entry points to the gas system, enabling the diversification of natural gas suppliers. Consequently, countries with more avenues for importing gas are more resilient to

disruptions in this domain. Among EU member states, Spain stands out for its significant reliance on liquefied gas supplies. Thanks to a well-established energy infrastructure allowing both pipeline imports and LNG terminal access, Spain boasts the most diversified gas system in Europe, importing from 11 different countries in 2014. In the event of a geopolitical conflict leading to political instability in either the country exporting natural gas via pipelines or the transit country, the impact of LNG terminals on the EU's gas supply security would be even more pronounced. Assessing the current global landscape, potential armed conflicts or political destabilization are most probable in Northern African countries and the Russian Federation. Russia frequently utilizes natural gas supplies as a political tool to exert pressure on consumers and advance political objectives. Regarding southern sources of natural gas supply to Europe, increasing competition is observed among countries with significant recent discoveries of the resource, such as Cyprus, Egypt, Israel, Lebanon, Syria, and Turkey. Additionally, both Algeria and Qatar aim to maintain their positions as stable LNG suppliers to the EU. Furthermore, countries investing in LNG export infrastructure, including the US, Canada, and Australia, are keenly interested in accessing the European market. The expansion of the international liquefied gas market has intensified competition among LNG exporters vying for end customers. With the discovery of more confirmed natural gas reserves, competition among nations has escalated significantly in recent times. The emergence of numerous entities offering liquefied gas supplies on global markets has spurred the construction of new gas liquefaction terminals. Presently, the primary LNG exporters globally include Qatar, Malaysia, Australia, Nigeria, Indonesia, Trinidad and Tobago, Algeria, Oman, and Yemen, with additional countries planning to develop facilities to export liquefied gas. Consequently, competition among LNG exporters is on the rise, potentially leading to heightened political tension and increased armed conflicts worldwide. In Europe, a battle for end customers is also underway between pipeline natural gas exporters and exporters of liquefied gas transported via sea through LNG terminals. This competition is advantageous for consumers as it disrupts monopolistic practices prevalent among some gas companies in the European natural gas market. Additionally, it has resulted

in the establishment of two price tiers in the EU market: one for natural gas supplied via pipelines under long-term contracts, indexed to crude oil and its derivatives prices, and another for natural gas under short-term contracts, increasingly tied to wholesale market prices [128].

Since 2008, the price of natural gas under short-term contracts has been lower compared to that supplied under long-term contracts by Russia, Norway, and Algeria, which traditionally index prices to crude oil. This has prompted the renegotiation of prices for long-term gas contracts, particularly with Gazprom, the Russian exporter, known for including unfair clauses in its long-term contracts. Consequently, LNG terminals have significantly enhanced competition in the natural gas market, leading to lower prices for the resource in the European market under short-term contracts. This, in turn, exerts greater pressure on negotiations with suppliers offering natural gas under long-term contracts. Thus, from the perspective of natural gas-importing countries, having an energy infrastructure that fosters competition among various exporters is crucial. Countries lacking the technical capability to import natural gas from multiple sources and directions, relying instead on a single source, have limited bargaining power in negotiations with exporters. Such dependence allows exporters to dictate contract terms, including exerting political pressure or threatening supply disruptions [129]. Therefore, expanding energy infrastructure and implementing appropriate regulations are imperative for EU countries to ensure competitive development in the natural gas market. As the number of terminals in Europe grows, competition will intensify, leading to transformations in the EU natural gas market. Most European countries have long-term natural gas supply contracts, enabling renegotiation every 2 or 3 years to adapt to changing market conditions. Consequently, the expansion of LNG infrastructure will enhance the bargaining power of European countries in negotiations with existing natural gas suppliers [130].

One strategic objective of the European Union is to enhance its energy infrastructure to maximize the utilization of liquefied natural gas (LNG), which currently stands as the most promising source of gas supply to Europe. The existing and planned LNG facilities ensure supply continuity in emergency scenarios. However, the

distribution of gas imported via sea is constrained by the pipeline capacity between countries with significant LNG import potential and other EU nations. Therefore, expanding the natural gas transmission infrastructure could enhance supply reliability in regions where pipeline-based supply might face disruptions [131]. Central and Eastern European countries exhibit the weakest LNG infrastructure, posing a higher risk of supply disruptions during geopolitical crises. Conversely, under political stability, this may lead to reduced competitiveness in the gas market, particularly in the absence of adequate bidirectional flow capacities at interconnections. Consequently, the European Union aims to streamline the development of energy infrastructure to facilitate flexible energy resource transfer, alternative fuels, and electricity. Another EU objective is to establish a network of LNG refilling stations in seaports by 2025 and inland ports by 2030. These stations are anticipated to include LNG terminals, tanks, mobile containers, bunker ships, and barges [132]. Member states are expected to expand their LNG transmission networks and establish a distribution system between storage facilities and LNG refilling stations. It is estimated that LNG refilling stations should be spaced at least 400 km apart, with the EU aiming to establish a significant number of publicly available LNG refilling stations within the TEN-T network by December 31, 2025. To reduce oil usage in transportation and foster alternative fuels, the European Commission adopted the Roadmap to a Single European Transport Area in March 2011, aiming for a competitive and resource-efficient transportation system. Achieving these goals necessitates substantial investment in expanding liquefied gas infrastructure, including low-scale distribution, which will significantly influence the pace of LNG market development in Europe. Establishing an appropriate supply chain for LNG is paramount for the development of a distribution system in Europe. Ensuring efficient supply chain design, as highlighted by experts like R. Jokinen, F. Pettersson, and H. Saxen, is crucial for cost-saving in investment and operating expenses. A typical low-scale supply chain should encompass a large LNG import terminal, small LNG terminals, and a fleet of ships and trucks for liquefied gas transportation [132].

European Union member states have the capacity to import 490 billion cubic meters (bcm) of natural gas annually through pipelines and 197 bcm using LNG

terminals. At present, Spain, France, Portugal, and Great Britain possess the most advanced technical capabilities for importing liquefied gas. However, the proportion of LNG in total gas consumption varies across countries, with Spain and Portugal utilizing about 50%, while the Netherlands utilizes less than 3%. Central and Eastern European countries, except for Lithuania with its newly established LNG terminal, currently lack access to LNG imports. Establishing a liquefied gas trading hub depends on having sufficient energy infrastructure. Spain, Great Britain, Sweden, the Netherlands, France, and Norway (though not an EU member) possess the most developed LNG infrastructure in Europe. These countries not only have LNG import terminals but also have systems facilitating small-scale distribution for maritime and road transport. However, the establishment of LNG trading hubs necessitates an expansion of LNG infrastructure and sufficient capacity of pipelines or gas distribution networks. Presently, gas hubs in Europe, whether physical or virtual, primarily serve as points for gas off-take and trading on the wholesale market [133].

Analyzing the European landscape, potential LNG trading hubs could emerge in countries like Great Britain, Spain, Sweden, France, the Netherlands, Belgium, and Italy. For instance, Rotterdam, with its advanced National Balancing Point (NBP) and robust infrastructure, has become a pivotal gas hub in the northwest EU region. Although most LNG infrastructure is concentrated in specific countries, efforts are underway to expand LNG installations in Portugal, Finland, and Germany. In Central and Eastern Europe, Poland is poised to become a regional LNG trading hub, leveraging collaboration within the Visegrad Group and Eastern Partnership [134].

Projects related to LNG infrastructure development may receive EU funding if they qualify as Projects of Common Interest (PCIs). These projects aim to contribute to EU energy policy objectives, enhancing energy market integration, and reducing carbon emissions. The European Commission's Connecting Europe Facility (CEF) supports such projects, replacing the former Trans-European Transport Network (TEN-T). Many LNG-related projects have received EU funding, indicating the EU's commitment to advancing LNG infrastructure and energy market integration.