

# Development of Sustainable LNG Markets

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**Abstract**—The article covers the key aspects of sustainable development of the global LNG market within the framework of energy security criteria for LNG importers and exporters. The authors emphasize the role of LNG in shaping the global gas market. Particular attention is paid to ensuring the security of LNG supplies and the mechanisms for generating free prices in the global gas market. The article analyzes the main trends in the development of the global LNG market in the context of dynamic growth and a high degree of uncertainty. Based on the analysis of statistical data, the authors attempt to identify world leaders in LNG production for the next decade.

**Keywords**—LNG markets; sustainable development; LNG energy security; gas prices; major LNG exporters

## I. INTRODUCTION

At the beginning of the XXI century the LNG industry has become a leader in terms of growth among the sectors of the global fuel and energy complex. The share of liquefied natural gas in the total world gas trade increased from 25% in 2000 to 46% in 2018 [1], which indicates a dynamic growth of the LNG industry. According to estimates by the International Gas Union, in 2017, the share of LNG in world energy consumption amounted to 9.8% with the prospect of a further increase [2].

The world natural gas market was previously limited by three largest regional markets – Asian, European and North American, which were limited by the availability of the gas pipeline infrastructure. With the development of LNG industry, the world natural gas market has become global. LNG provided natural gas supplies with flexible logistics and the ability to choose the form of the contract – from traditional long-term to short-term and spot. Furthermore, LNG is a more competitive compared to pipelines when transporting gas over long distances, as well as to regions with politically unstable conditions or with difficult environmental conditions, including increased seismic activity. LNG producers are able to deliver directly to major centers of gas consumption and, in the case of market change, are able to quickly change the vector of deliveries to regions with more promising markets. Thus, liquefied natural gas contributes to the development of flexibility in the global gas market.

Liquefied natural gas trading has a significant impact on the development of the global gas market. The expansion of geography and the increase in LNG supply volumes help to level the terms of oil and gas trade, providing globalization of the global hydrocarbon trade.

The beginning of the new century was marked by the commissioning of a large number of new LNG projects in

Qatar, Australia, Malaysia, Nigeria and Indonesia, as well as the development of industrial liquefaction technologies, and the active construction of regasification terminals in the countries importing liquefied natural gas. According to the International Gas Union, the volume of investments in the LNG industry worldwide will amount to more than \$ 300 billion during the period 2000-2030 [3]. Based on the experts estimates, the world gas market will become as global as the oil market by 2030, while the share of LNG in the export of natural gas will reach approximately 60% [3]

## II. METHODOLOGY

As part of the study, an approach was taken to ensure sustainable development of the global LNG market, based on the criteria of global energy security, covering both exporters and importers of liquefied natural gas. At the same time, uninterrupted supply mechanisms are considered as key aspects, considering the diversification of suppliers and routes, competitive pricing models for LNG, as well as an innovative component of the development of the LNG industry.

Based on statistics from the British Petroleum, the International Group of Liquefied Natural Gas Importers (GIINGL), the International Gas Union in terms of production, consumption of natural gas, production and volumes of LNG supplies for the period 2001–2018 prospects for the development of the global LNG market are considered, taking into account the identification of world leaders in the production of liquefied natural gas in the LNG industry.

## III. OVERVIEW OF THE CURRENT TENDENCIES ON LNG SUSTAINABLE DEVELOPMENT

Sustainable development of the global LNG market implies, above all, ensuring energy security of both importers and exporters of natural gas. According to IEA definition, energy security means “the uninterrupted availability of energy sources at an affordable price” [4]. In practice, the provision of energy security covers many interdependent aspects, including diversification of supplies, environmental safety, political factors, etc. Thus, the main criteria for the sustainable development of the global LNG market are the condition of uninterrupted supplies and their diversification, adequate prices regulated by market pricing mechanisms, energy efficiency of LNG production and transportation, and innovative technological development.

The condition for the uninterrupted supply of LNG is almost the main aspect of ensuring the sustainable development of the global gas market. Transportation of natural gas in the form of LNG allowed to combine regional

gas markets (North American, European and Asian), previously limited by the development of pipeline infrastructure, as well as to minimize the risks of pipeline deliveries. The main negative aspects of pipeline deliveries are the tight binding between the buyer and the seller in long-term contracts and the political risks associated with it. Thus, LNG supplies successfully complement pipeline deliveries, introducing aspects of maneuverability and free market pricing into the mechanisms of gas market development, as well as the possibility of diversification of suppliers, which generally contributes to energy security in the gas segment.

Unlike pipeline gas, which supply is limited by the development of pipeline infrastructure, LNG is characterized by “freedom of maneuver”, which, of course, benefits both sellers and buyers (both importers and exporters) of natural gas. The flexibility of routes, the ability to freely change suppliers and buyers without penalties greatly simplify the natural gas trading.

Over the past decade, the share of LNG in world gas trade has increased from 30.8% (2008) to 45.6% (2018) (Fig. 1). However, the dynamics of supply and demand in the global LNG market is characterized by a high degree of uncertainty. Until 2011, global LNG consumption grew on average by almost 8% per year, however, in 2012–2016. Its average annual growth rate fell to 0.4%.

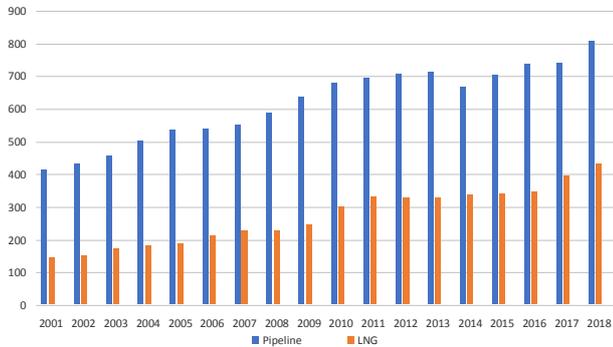


Fig. 1. World natural gas pipeline and LNG exports, billion cubic meters (compiled by the authors, based on [1]).

However, during the period 2011–2015 there was a slowdown in the development of LNG business, which is partly due to the unfavorable price situation on the world oil market and a drop in natural gas prices. Unfavorable pricing environment 2015–2017 (Fig. 2) had a significant impact on the implementation of new LNG projects around the world. At the same time, in 2017–2018, the average annual growth rate of LNG trade movements increased to 10%, which was facilitated by a significant increase in China's LNG imports due to the transfer of heat supply in cities from coal to gas [5].

The development of the liquefied natural gas market is characterized by the rapid growth of LNG facilities. The aggregate nominal liquefaction capacity reached 406 million tonnes per annum at the end of 2018, while the total regasification capacity reached 868 million tonnes per annum. The total capacity of the LNG plants, which are currently under construction, is 93 million tons per year. In the current decade of 2009–2018 the average load of existing LNG production capacities decreased on average to 85% compared to 91% in the previous decade (2000–2008) [6].

In this regard, we can conclude that there are no infrastructural restrictions on the production of liquefied natural gas and its regasification, which allows us to increase LNG supplies in the foreseeable future.

With the development of the LNG market, the natural gas pricing mechanism has undergone significant changes. Currently, there is no single mechanism for pricing natural gas in the global gas market. Along with the monopoly prices of long-term contracts (as well as with reference to oil prices), the model of competitive prices for natural gas in the free market is now widely used [7]. With the growth of LNG production and the shale revolution as a whole, there is a slight decrease in natural gas prices (Fig. 2).

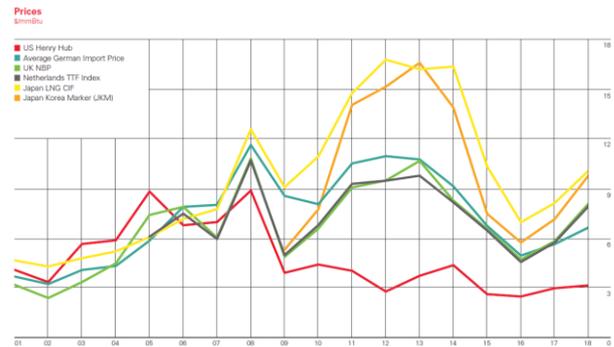


Fig. 2. Gas prices, 2001-2018 (\$/mmBtu) [1].

In addition, LNG pricing mechanisms have significantly affected pipeline gas trade. Along with long-term “take or pay” contracts, spot deliveries of pipeline gas are being widely used. Thus, it was the LNG industry that contributed to the liberalization of the natural gas market.

A dynamic increase in global LNG production is transforming the LNG industry into a global and efficient business. For several decades, the LNG market has transformed into a huge developing industry, becoming a reliable source of gas supplies to the world market. Currently, the development of the LNG industry is accompanied by the introduction of innovative developments in the field of cryotechnology, the latest technical solutions in the organization of shipping and storage of liquefied natural gas.

Due to the high volatility of global natural gas prices, special attention is paid to the constant cheapening of new production capacities. In fact, at the present stage, the LNG industry is an innovative technological platform that combines fundamental research and practical experience in implementing advanced technologies.

#### IV. THE POSSIBILITIES FOR THE FUTURE WORLD LNG MARKET

As already noted, the LNG market is currently characterized by dynamic growth and a high degree of uncertainty. The established structure of the global LNG market is undergoing fundamental changes. The growth in the total number of producers and consumers of liquefied natural gas is accompanied by a change in the roles of players in the global LNG market: former importers (the USA) are increasing exports, while the former LNG exporting countries are starting to import (Egypt, Indonesia), and traditional

importers are more often involved in international LNG trade with re-export of gas surplus (Japan, South Korea, European countries, Brazil).

Six key gas exporters can be identified on the global LNG market in 2018, which together provide more than 70% of the global liquefied natural gas trade. These include Qatar, Australia, Malaysia, the USA, Russia and Nigeria (Fig. 3).

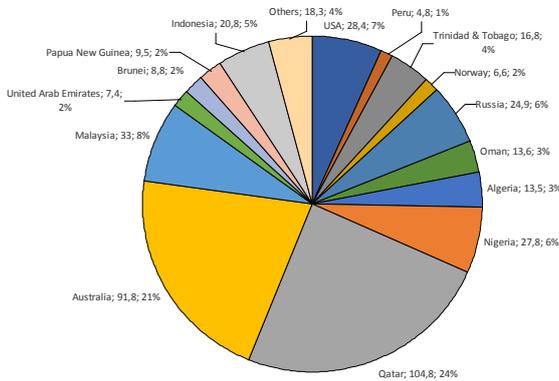


Fig. 3. The major LNG exporters in the world in 2018, billion cubic meters (compiled by the authors, based on [1]).

At the same time, Malaysia and Nigeria do not plan to dramatically expand LNG production in the medium term, and Australia’s influence on the world market is limited to the Asia-Pacific region [6]. On the contrary, such countries as Qatar, the USA and Russia, having sufficiently powerful production and developed LNG infrastructure, are planning large-scale production increase programs along with a wide coverage of the geography of supplies.

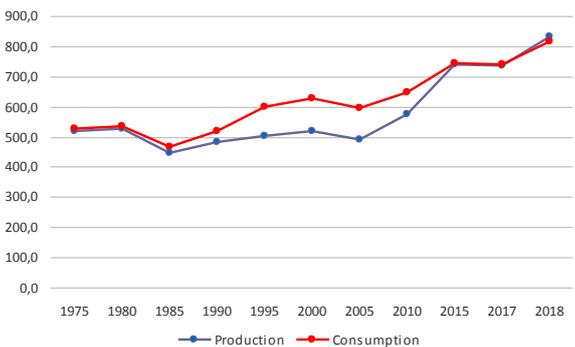


Fig. 4. US “loop of the shale revolution”, billion cubic meters (compiled by the authors, based on [1]).

Over the past few decades, Qatar has been a leader in the global LNG market, providing about a quarter of the world’s supply of liquefied natural gas. Over the past decade, the United States has significantly increased natural gas production thanks to large-scale development of shale deposits (Fig. 4). At the same time, the production of liquefied natural gas has become the main focus of the USA, and the growth of the country’s own gas production allowed it to take a stable position in the global LNG market.

Russia, being the world leader in pipeline deliveries of natural gas, is currently increasing its LNG production volumes. Along with the existing LNG projects “Sakhalin-2” and “Yamal LNG”, which provide 16.4 million tons of

liquefied gas [1] in 2018, large-scale LNG projects “Arctic LNG-2”, “Baltic LNG” and “Far-Eastern LNG ” are under construction which is projected to allow Russia in the following decade to increase LNG supplies abroad to 68 billion cubic meters.

Thus, we can conclude that the leading positions of Qatar, Russia and the United States in the global liquefied natural gas market in the coming decade.

With regard to LNG consumption, its main importers are expected to be China, India, Japan, South Korea and the EU [6].

V. CONCLUSION

1) Sustainable development of the LNG market is primarily associated with the provision of the main criteria / conditions for energy security. Natural gas as a low-carbon fossil energy carrier fits perfectly into the concept of an energy transfer to green energy, aimed at combating climate change (prediction climate changes) and reducing CO2 emissions. Compared to pipeline gas, LNG provides greater security of supply, since it does not require a strict binding between the buyer and the supplier.

2) The development of the LNG market significantly influenced the pricing mechanisms for natural gas in the framework of competitive pricing in a free market, and also contributed to the liberalization of the natural gas market.

3) The active development of LNG technologies has contributed to the creation of an innovative technology platform that combines fundamental research and practical experience in implementing advanced developments.

4) In the context of dynamic growth and a high degree of uncertainty, there is a need to develop a structural approach to the analysis of current trends in the development of the LNG market.

5) Given the outstripping growth rates of liquefied natural gas production over pipeline deliveries, we can conclude that the global trade is gradually switching to the LNG format.

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