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Analysis of the Strategic State LNG plan for Russia

by

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Abstract

Recent developments in the global gas trade have a tendency for diversification. First of all it relates to the way the gas is transported between countries. Compressed natural gas (CNG) is transported through pipeline networks while liquefied natural gas (LNG) is transported by using special vessels. Usage of LNG opens new markets for gas exporters that couldn't be reached through pipelines.

Russia, being the top country in CNG trade, doesn't have sufficient position on the LNG export market. Russian Government developed State Strategic LNG Plan till 2035, first of all, to increase its presence on the global market and diversify its exports. Apart from gas market liberalization and focus on Asian market, other main strategic goal is to increase LNG exports to 30% of all gas exports by 2035.

By applying SWOT analytical framework, influencial factors for Russian LNG sector on micro level have been identified. Gravity model approach provides result on the main factors in the macro environment - for supply and demand on the global LNG market. The most important are GDP of the countries, gas reserves and gas consumption. Taking into account Russian gas reserves and increasing opportunities from demand side, Russia can reach the Strategic goals only if gas market has been further liberalized and technological gap between other competitors for LNG production has been closed in the future.

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List of Abbreviation

MT/a	Million tons per annum
BCM	Billion cubic meters
bln	Billion
MCM	Thousand cubic meters
BCM/a	Billion cubic meters per annum
LNG	Liquefied natural gas
CNG	Compressed natural gas
MT	Million tons
TCM	Trillion cubic meters
TCF	Trillion cubic feet
GDP	Gross Domestic Product
GNP	Gross National Product
FLNG	Floating liquefied natural gas

1. Introduction

The oil and gas industry is the most important sector in Russia’s economy. It stands as the main driver for Russia’s political and economic development. The energy sector now accounts for approximately 2/3 of Russia’s exports, around 30% of Russia’s Gross Domestic Product, and almost half of the federal budget (WB 2015). Russia is the second largest producer of natural gas and third largest petroleum producer in the world following the US and Saudi Arabia. Despite its significant reserves of coal, it only extracts a limited amount of coal. Russia's economy is highly dependent on its energy resources and oil and gas profits stand for more than 50% of the federal budget Russia is an important energy supplier on a global market. It holds the world largest natural gas reserves, the second largest coal reserves and the ninth largest oil reserves (U.S. Energy Information Administration 2015c).

During the period of 2009-2014, dependence of the Russian economy on the energy sector increased significantly. On the global energy market, more and more importers are switching their policies to foster energy self-sufficiency (BP 2015). Due to a slow down in economic development in Russia, Government together with state energy companies set priorities for quality improvements in the energy sector rather than increasing in volumes of energy extraction.

To strengthen positions of the energy sector internally and on global markets, Russian Government developed an Energy Strategic Plan up to 2035 (ESP 2035) to set up the objectives for the fuel and energy industry and companies operating on the market. Objectives are set separately for every energy sector of the industry. The plan contains chapters dedicated to coal, oil, gas and nuclear energy.

The Strategic Liquefied Natural Gas (LNG) Plan for Russia is one of the biggest parts of the ESP 2035. It is expected that Russian LNG sector will be modified dramatically during the next years. It allows Russia to diversify its export by opening new markets that previously were closed for conventional pipeline way of transportation. As a first step in 2013, Vladimir Putin, the President of Russia, signed the document that liberalized the whole gas export industry for Russia. According to the new law Russian energy companies where the government has a majority share can export LNG from Russia (NGE 2013). Apart from Gazprom, the biggest gas producer in Russia, other companies like Rosneft and Novatek start creating an infrastructure for LNG exports. For the LNG industry, ESP 2035 sets very specific objectives. The core objective is to reach diversification of gas exports by increasing share of LNG to conventional pipeline export from 6% to 30% by 2035. The ESP 2035 also sets milestones for three strategic stages. By 2035, the total LNG export should be increased to 100 mln/year. For meeting all the targets, big changes and investments are expected for the industry. There are several LNG projects have been running during the last years in Russia – including a LNG plant in Sakhalin, Vladivostok LNG, Pechora LNG, Yamal LNG and Arctic LNG. The key selling markets are envisaged to be China, Japan, Korea and India. Almost all of the projects realize with global energy company’s support. Companies like Shell, Exxon Mobil, Total and others have share in these projects. Some of them already operate at partial capacities; other projects are expected to be launched during the next 2-5 years. The critical area for Russia LNG sector in Russia is cost of LNG production comparing to main competitors like Qatar, Australia and USA (Statistics Department of Russia 2015) .

Demand for LNG is expected to grow in the mid-term perspective (BP 2015). Existing producers will reinforce their positions by bringing new technology and capacities on the market (BP 2014). New players can also appear both from demand and supply side. In this situation, developments and the degree of involvement of Russia on the global LNG market, could bring country into position among top LNG producers or leave Russia without opportunities on the LNG global market.

1.1. Research objectives

Execution of all the goals set by ESP 2035 depends on a number of factors, both external and internal. The Russian LNG Strategic Plan, being part of ESP 2035, sets very ambitious goals for the whole gas industry. The gas and oil industry is the most sensitive for Russia's economy because of its impact on other sectors (Kommersant 2007).

The demand side of Russian LNG seems to be unstable because of the strong competition globally. Conventional pipeline exports give more stability for the companies, because of long-term contracts, while LNG spot market could bring more profits in a short-term (Wood 2012) .

There are certain factors that influence LNG developments in Russia. These factors can be analyzed separately on the micro, by identifying internal Russian strength and weaknesses, and macro environment levels, comparing with developments in other countries. Identifying and evaluating the relevance of these factors could lead an adjustment of the political and economic risk assessment.

This research aims to identify and measure (where it is possible) factors and elements that are crucial for achieving export goals set in ESP 2035 for Russian LNG industry. In order to do this, the research focuses on the existing LNG market in Russia, its projects and plans, and an assessment of possible scenarios for its future development. The LNG market of other top producers and consumers are also analyzed within the context of this research in order to identify possible opportunities and threats for Russia on the demand side.

Following the research objectives, the main research question can be posed:

"What factors are crucial for Russia to diversify gas exports by increasing the share of LNG versus pipeline exports as targeted in Strategic LNG Plan 2035?"

The main idea behind this research question is to understand whether the Strategic LNG Plan can be executed and in what way or not, taking into account relevant factors both on micro and macro levels.

To support the main research question the following sub-research questions have been identified:

1. *What are the export goals set in Strategic LNG Plan for Russia?*
2. *What are the main strength and weaknesses of the Russian LNG sector vis-à-vis international competitors?*
3. *What are the main drivers for supply and demand on global LNG market?*

4. *How factors and their interplay in macro and micro environment can influence Russian future on the global LNG market?*

1.2. Research design and methodology

Both quantitative and qualitative methods will be applied in this research to identify crucial factors for achieving the export goals set in the Strategic LNG Plan for Russia. A SWOT analysis will be used as analytical framework for the study. The SWOT approach identifies all the relevant factors influencing Russian LNG developments and market future. SWOT analysis will be carried out for the Russian LNG industry. By identification of SWOT elements, later steps and recommendation can be identified. Also as a result of the analysis it will be clear whether export objectives set in Strategic LNG Plan 2035 are attainable or not. On the basis of identifying and prioritizing internal factors (on micro environment level) and opportunities and threats for Russia (on macro environment level) within the SWOT framework, a gravity model for trade between Russia and potential LNG importers will be built. The result of the gravity modelwill identify the structural drivers of LNG trade and by this guide the macro and micro assessment . Also these results will identify the partners for Russia that can be focused by Russian LNG exports. In the end of the analysis it will be clear whether and how Russian exports can be diversified by LNG exports.

The thesis structure consists of the following blocks. Chapter 2 describes the strategic document with its main targets and statements. It also observes main steps for strategy realization from Government side. The template and structure of the document is discussed starting from the time it was initially created and how it had been changed during the last years. The key changes during last years are identified. This chapter contains a part about which parties are responsible for what part of the implementation and how the targets are cascading vertically to the final executors. The degree of impact is discussed for all the levels responsible for execution of the strategy. Also, goals stipulated by the Strategic LNG Plan are described with a focus on export goals. From there the answer for first sub-research question is given. Chapter 3 provides results of the first two pillars of the SWOT analysis by identifying the main factors on the micro level. Internal strengths and weaknesses vis-à-vis other competitors of Russia on LNG market are discussed. Different academic studies and reports are used to explain and analyze main factors and reasons for their existence. Chapter 4 presents the main determinants of trade on the global gas market. When bilateral variables on bilateral flows between Russia and potential LNG importers are identified, gravity model is built to show what potential could Russia have on the global LNG market. Chapter 5 gives a presentation of the results of the gravity regressions. Chapter 6 describes the possible recommendations and assessment whether LNG export goals set by Strategic LNG Plan 2035 are attainable for Russia. Chapter 7 contains conclusion of the study and shows areas of future research.

2. Strategic Energy Plan for Russia

Chapter 2 describes the Strategic Energy Plan for Russia. The main targets for gas and LNG trade are identified.

Liquefied Natural Gas (LNG) is the natural gas chilled to a liquid form. Natural gas becomes liquid at a temperature of approximately -256°F (-160°C). For chilling the natural gas different elements and chemicals are used such as water, sulphur and hydrocarbons. The volume of the LNG is about 1/600 of the volume of natural gas (Institute for Enerrgy 2013).

The history of LNG started in the early 1900s. The first liquefying machine was constructed in Munich in 1873. The first LNG plant was built in 1912 and came to operation in 1917. In January 1959, the world's first LNG tanker, the Methane Pioneer, shipped from Lake Charles, Louisiana, USA, to Canvey Island, United Kingdom (Institute for Enerrgy 2013).

Liquefied Natural Gas can be used for different purposes. As an important commodity in world trade it can be shipped to remote markets such as Asia, Europe and North America. Also LNG can be used to fuel electric power facilities. Since LNG is a compressed natural gas to 600 times, LNG provides a storage function. Moreover LNG can be used as alternative motor fuel to diesel.

The main advantages for using LNG are that it makes easier for transportation and storage than natural gas. Transporting LNG by ships is quite safe because LNG ships designed with a double hull to provide additional protection in the event of emergency.

2.1. Background of the Energy Strategic LNG plan for Russia

The State Energy Plan for Russia is the fundamental document that contains all the main guidelines for the industry and mechanisms for its implementation. It is issued by the Russian Department of Energy. It was decided by Russian Government that Energy Plans should be updated every 5 years. The latest State Energy Plan up to 2035 was approved by Government of the Russian Federation in March 2015. Before that in November 2009, and Energy Strategic Plan for Russia up to 2030 was approved and it was the first time such kind of the document was provided by the Government.

The draft of the ESP 2035 was developed by the Institute of Energy Strategy, together with the Energy Research Institute of the Russian Academy of Sciences and Analytical Center under the Government of the Russian Federation and submitted to the Ministry of Energy of Russia. Validation and the final approval of the document consist of public debates, discussions between state-owned energy companies, state agencies and the submission to the Government of the Russian Federation.

There are several reasons why the Energy Strategic Plan has been decided to be updated in 2015 from the last version (Ministry of Energy Russian Federation 2015a). First, there is stagnation of the world economy in general. Secondly, there is a decrease of local Russian and external demand from consumers. Numerous geopolitical, geographical and natural disasters in the first decade of 2000 also made an impact on the basic guidelines of the Energy Strategic Plan. As a result, the optimistic scenario of the Energy Strategic Plan for Russia 2030 turned out to be unrealistic.

Forecasted values of production, internal consumption and exports of Russian energy resources according to Energy Strategic Plan 2030 were close to actual figures by the end of 2014.

The Energy Strategic Plan 2035 (ESP 2035) has a similar structure as its predecessor the Energy Strategic Plan 2030 (ESP 2030). But still there are some amendments between these documents. The part of the ESP 2035 about demand outlook contains a subsection about challenges for Russian Fuel and Energy industry. The “Government energy policy” section now includes a part about taxation policy and sustainability of the industry. In addition, “The main risks for reaching the strategy goals” has been added. Development forecast for Russian economy also has been changed compared to previous version. The annual average growth rate 2015-2035 for the baseline innovative scenario is 3,8%, and for the conservative risk-scenario 2.8% (Ministry of Energy Russian Federation 2014). Global demand for energy and its growth rate has been recalculated in the new plan. It is expected to be 1.2% annually instead of 1.5% set by ESP 2030. A shift of energy consumption from developed to developing countries where Russia has weaker positions is expected. Moreover when analyzing external demand, the authors of the ESP 2035 take into account strategic plans of the other producers and consumers. ESP 2035 assumes an annual export growth rate of 0.7% (Ministry of Energy Russian Federation 2014). The new Strategic Plan main idea is to transform Russian Fuel and Energy Industry from resource-based to resource-innovative approach. According to this, the guidelines have been set in the following strategic points – security of energy supply, energy efficiency, cost efficiency and sustainable development of the industry. Table 1 shows the main differences between ESP 2030 and ESP 2035.

Aspect	**ESP 2030**	**ESP 2035**
Structure	"Demand for Russian energy" part is extended with "Challenges for Russian energy sector" subchapter. "Government energy policy" is extended with "Taxation", "Sustainability" and "Social policy" subchapters. New chapter added "Risks for Strategy realization"	
Economic and demand indicators	GDP growth rate 5,2% annually 2010-2030 (basiline scenario)	GDP growth rate 3,8% annually 2015-2035 (basiline scenario)
	Energy export growth rate 0,5% annually 2010-2030	Energy export growth rate 0,7% annually 2015-2035
	Global energy consumption growth rate 1,5% annually 2010-2030	Global energy consumption growth rate 1,2% annually 2015-2035
Strategy goals	Fuel and Energy Industry to be development driver for other industries. To perform the role of the main customer for the economy.	Fuel an Energy Industry should create innovative environment for development of other industries.

Strategy guidelines	Security for energy supply	Security for energy supply extended with new indicators
	Energy efficiency=Energy conservation	Energy efficiency=Energy conservation+Cost effectiveness
	Budget energy efficient industry	Economic energy efficient industry
	Environmental security	Sustainable development of the industry

Table 1. ESP 2030 and ESP 2035 difference list (Source: compiled by author)

The main external challenge for Russian energy sector according to ESP 2035 is the intensification of competition on the global energy market. Next years will bring stronger competition for market share on conventional and non-conventional global energy sectors.

The following key objectives set by ESP 2035:

1. Modernization and development of energy sector (modernization of oil and gas refining industry, development of "smart pipeline" networks)
2. Development of internal energy infrastructure (more efforts for developing export projects)
3. Development of internal energy markets (demonopolization of the industry, new conditions for competition on internal energy market)
4. Improvements of the effectiveness for production, extraction and processing of the energy resources
5. Improvements of the availability of the products and resources (by price and quality) by implementing new technological standards and decreasing costs of production
6. Flexibility and diversification of exports by entering new markets and offering new products
7. Competitive recovery for Russian companies on external markets
8. Implementation of principles of sustainable development. Implementation of social and ecological responsibilities

All these objectives and directions should be carried out during the three stages:

- First stage (2015-2020). Stage of internal modernization that is focused on developing new infrastructure. New innovative model to be implemented by renovation of the existing production capacities
- Second stage (2021-2025). Creating of new innovative infrastructure for the industry. Cost and energy effectives, new production facilities in East Siberia and Russian Far East, developments of shale projects in Arctic - these are the key actions for the stage. Companies should put more priorities for processing than extraction of the resources
- Third stage (2026-2035). Stage of the new innovative energy sector. During this stage, cost and energy effectiveness indicators should reach the values of the global leaders in the industry. Nowadays capital and operational costs for production in the industry are 1,2-1,6 times higher than in Europe and USA (Ministry of Energy Russian Federation 2014)

The external energy policy has a separate part in ESP 2035. The main objective here is to maintain Russian positions by creating export geographical and product diversification and offering competitive products. The share of oil products and gas exports to Asia-Pacific region is expected to increase from 12 to 23% in oil and from 6 to 31% in gas by 2035 according to the Strategic Plan. European and CIS markets still will be the main markets for Russia. Product diversification will decrease crude oil exports by 1.3 times in volumes. Exports of heating oils will be decreased significantly while engine oil exports will be increased twice because of the product quality. LNG exports from Russia are expected to grow to 30 mln tons annually during the first stage and reach 100 mln tons annually by the end of the third stage. The ESP 2035 assumes increasing cooperation between foreign and Russian companies in the energy sector. Integration is vital for sharing technologies in realization of the innovative projects in the country.

2.2. Strategic LNG Plan for Russia as part of ESP 2035

The Strategic LNG plan for Russia 2035 is a part of the ESP 2035. The Strategic LNG Plan does not stand separately and comes as a part of Gas Strategy 2035.

The first block of the Gas Strategy describes the latest activities and achievements in the sector. Achievements for LNG sector stand separately. The biggest achievement for LNG sector stands for "entering the Global LNG market by opening new LNG plant in Sakhalin with capacity up to 16.5 million tonnes per annum (Mt/a)" (Ministry of Energy Russian Federation 2014) . In addition, the decision about investment for the project of building new LNG plant in Vladivostok is described. Production capacity of "Vladivostok LNG" is expected to be 10 Mt/a with the possible extension up to 15 Mt/a. The first production line will be delivered by 2018. Discussion with potential customers are taking place now, mainly with Japanese customers. All Russian LNG projects with be discussed in this study in more details in the next chapters. Passage of the "Gas liberalization law" discussed earlier is also stated as achievement in the Strategy. The Law allows new energy companies to enter the Russian gas market and use Gazprom's infrastructure.

The Strategic Plan 2035 includes part about pressing problems of the industry. The main concern relates to intensification of competition on the global market. As a result entering the Asian-Pacific market goes less slowly than expected. Strategy states that it happens also due to high production costs of the export facilities in Russia. The costs of LNG production on Yamal, Barents Sea shelf, Sakhalin and Yakutia is higher than in Qatar, Australia and other LNG production countries. Moreover from some regions transportation costs are also higher, for example from Yamal half-island, water depth limits the size of LNG vessels. For that, the new technologies are needed both for ship construction and for terminal design. On the other hand, development in the renewable energy sector and alternative sources of power additionally threatens some export projects.

The Strategy provides several actions to avoid obstacles for reaching the targets. The most important ones are to create an environment for appearance of new LNG independent producers on the market and to create equal terms for all parties involved in production process. Developments of stock mechanisms will allow setting market prices for the sector. Apart from that, new LNG facilities should be built; new markets should be opened for Russian LNG with priority to Asian-Pacific region.

The key indicators for LNG sector are set as follows according to the Strategy. LNG export volume should be increased to 30 Mt/a by 2020 and reach 100 Mt/a by 2035 (Ministry of Energy Russian Federation 2014). Gas export is the key pillar for Russian Energy Strategy. In future main markets should be China, Japan, Korea and India. Share of European gas exports will decline. Total volume of gas exports can be increased from 223 billion cubic meters (BCM) in 2010 to 360 BCM in 2035 (Ministry of Energy Russian Federation 2014). Share of LNG can grow from 6% to 30%. Therefore, huge export diversification is expected in terms of products variety and ways of transportation. Table 2 summarizes the core objectives for LNG industry according to ESP 2035.

	2020	2030	2035
Share of independent LNG producers in total LNG production	**18%**	**26%**	**31%**
Share of Asia-Pacific countries exports in total exports	**31%**	**28%**	**33%**
Share of LNG exports in total gas exports	**12%**	**19%**	**30%**

Table 2. Key objectives for LNG industry according to ESP 2035 (Source: compiled by author)

3. Russian Gas and LNG sector

Chapter 3 describes the Russian Gas and LNG sector to identify strength and weaknesses on the micro level.

The Russian energy sector is the most important industry of Russia’s economy. In 2014 the consumption of primary energy resources was 699 MT (million tons) in oil equivalent, with the following breakdown: 53.2% - gas, 21.9% - oil, 13.4% - coal, 5.9% - hydro energy and 5.6% - nuclear energy(Ministry of Energy Russian Federation 2015c). Historically fuel power industry is the most meaningful for Russian Energy sector.

The fuel power industry includes sectors related to extraction, processing and delivering fuel raw materials. It includes coal, gas, oil, peat, shale and uranium mining industry. Because of electrification and heat supply development in various productions, fuel power role increases.

Starting from 1990 the oil and gas sector in Russia had been actively privatized, state assets were transferred to private sector. By the end of 1997 the Government owned the same number of companies as the private sector. These state companies were small and inefficient. When the oil prices started to grow, the Government decided to change the situation. During the 2004-2007 period Russian Government significantly increased its share in the industry – from 16.41% to 40.72% (Kommersant 2007).

The foundation of oil and gas industry in Russia is exploitation of gas fields in west Siberia (Urengoyskoe, Yamburgskoe gas field and Zapolyarnoe gas fields). The biggest gas production and gas transporting company in Russia is Gazprom.

The US Energy Information Administration (EIA) provides the following overview of the Russian gas industry. “The state-run Gazprom dominates Russia's upstream, producing about 74% of Russia's total natural gas output. Gazprom also controls most of Russia's gas reserves, with more than 65% of proven reserves being directly controlled by the company and additional reserves being controlled by Gazprom in joint ventures with other companies. While independent producers have gained importance, with producers such as Novatek and LUKoil contributing increasing volumes to Russia's production in recent years, upstream opportunities remain fairly limited for independent producers and other companies, including Russian oil majors. (U.S. Energy Information Administration 2015c) .

3.1. Openness of Russian LNG sector

Before 2013 only Gazprom, being the owner of the unified gas supply system, could export gas and LNG from Russia. By the end of 2013 as mentioned previously the legislative Amendments of a Federal Statutes provides for liberalization of the market and open opportunities for other companies to engage in LNG exports.

There are some discussions in the academic environment whether these Amendments changed the rules on the internal Russian market in the gas and LNG sector. The main question is whether the degree of government involvement has decreased after legislative changes and brings more freedom to the market.

The Amendments relate to the changes in two Federal Statutes. The first Federal Statute is “On the foundations on the State Regulation of Foreign Commerce” (Russian Government 2013b). The second Federal Statute “On exports of Natural Gas” (Russian Government 2013a). The first Statute is more general regulating mainly the preferences for the exporters of different commodities, the second statute is more specific related to the export gas market itself. As mentioned above, before the Amendments the exclusive right for export LNG out of Russia has “the owner of the unified gas supply system or its wholly owned subsidiary” (Russian Government 2013a). It means that open joint stock company, Gazprom, has exclusive rights for LNG exports. According to the new legislative changes the new groups of company can enter the LNG export markets. These companies should have licenses for using mineral resources of Russia, that are owned by the Russian Government according to the Constitution of the Russian Federation. Also, they should have a license for constructing LNG plants.

Roman Sidortsov (2014) argues that the Amendments can bring any changes to the Russian LNG market. He reminds in his article that a company that want to get a license for using mineral resources should have 50% of Russian Government participation that noticeably reduce the potential companies for the new LNG market of Russia. A license for using the subsoil reserves is the document issued by the State Agency Rosnedra that is directly controlled by the Ministry of Natural Resources. Government confirmation is always needed to get this license. The same Agency controls usage of Continental Shelf in Russia where gas extraction is possible. Therefore the scope of the participants both on using resources from subsoil reserves and Continental Shelf is limited directly by Government. Based on the analysis presented by Sidortsov, it is reasonable to conclude that liberalization on the LNG Russian market is far from reality taking into account Government involvement in the industry (Sidortsov 2014).

On the other hand, other academic studies show that the legislative Amendments are just the first step for Russian Government on the liberalization of LNG market. Mitrova (2013) underlines that these measures allow other companies to enter the market and make their plans to build first LNG plants in Russia, despite the fact that first LNG project was launched by Gazprom. After the implementation of the new law, more companies from Russian Energy sector entered the market of the LNG. Below are the description of the main LNG projects launched in Russia.

“Sakhalin – 2” LNG project

“Sakhalin – 2” is the first Russian LNG project. The location is Sakhalin Island. The project operator is Sakhalin Energy company. Shareholders are Gazprom (50%+1 share), Royal Dutch Shell (27,5%-1 share), Japanese Mitsui and Mitsubishi (12.5% and 10% respectively) (Gazprom 2015c). According to Gazprom’s official statement, “Gazprom will always participate in the project as majority stakeholder, and Royal Dutch Shell will be acting as operational executive and technical advisor” (Gazprom 2015c).

The first discussions about “Sakhalin – 2” project started in 1988. In 1991 the successful bidder was announced for development of technical and economic assessment of the project. Initially, bidders were Mebermott (USA) and Mitsui

(Japan). In 1992 two more companies joined this consortium – Royal Dutch Shell and Mitsubishi. In 1993 after approval of technical and economic assessment by the Russian Government, the negotiation upon project realization had been started. The final document between Russian Government and Sakhalin Energy was signed in June 1994. Two years later (?) the construction process begun.

The first stage of the project was focused on seasonal mining of oil deposits. The production complex Vityaz with the oil platform “Molikpak” started first oil production in summer 1999. Sea water around production complex Vityaz was covered with ice 6 months a year. So the production process was possible only half a year. Nowadays because of the installation of the new module, the complex operates all year around. Total investments in the project were estimated as 1.5 bln $ (Sakhalin Energy 2015).

The second stage included activities related to all year round production of the complex. Two new platforms had been installed during this period. One on Pitun-Astokhskoye field and other at Lunskoe field. After that the gas started to be transported by 800 km pipelines to Progorodnoe where the LNG plant is located. Capacity of LNG plant according to official Gazprom data is 9.6 Mt/a (Gazprom 2015c). 18 February 2009 near the Korsakov city the first LNG plant was launched. The plant operates with 2 production lines, 4,8 Mta each. 18 February 2009 the first export LNG tanker was shipped to Japan. The volume from Sakhalin – 2 LNG plant already contracted till 2030 for Japan and South Korea customers (Gazprom 2015c). In 2014 the Sakhalin LNG sales structure contained 80% Japan, 18% Korea, and other 2% divided between China, Taiwan and Thailand (Sakhalin Energy 2006).

The infrastructure of the Sakhalin – 2 project allows to export all production capacities without additional delays. The birth locates 805 m far from the plant deep in the sea. Water depth is 14 meters that allows tankers and LNG ships with capacity 18-145 MCM (thousand cubic meters) call the port. Port operational cycle time in the port is 24 hours. In 2014 160 LNG vessels and 65 tankers called the port (Gazprom 2015b). Two different types of LNG vessels are using for transportation – with independent spherical tanks and with membranes. Specially for the Japanese market 3 LNG vessels had been constructed in Japan – “Grand Aniva”, “Grand Elena” and “Grand Merea” (with capacity 145 MCM). The owners of the vessels are “Far East Shipping Company” and “Sovcomflot”. In next years these companies plan to extend their fleet by another 5-6 new vessels.

In 2014 Russian company Rosneft and Exxon Mobil started to develop new LNG project on Sakhalin Island. The construction process should start in 2015. The plant will use the Rosneft’s gas from reserves in Far-East and Sakhalin. Project investments are15 bln $. Capacity is estimated as 5 Mta (LNG Congress Russia 2015).

“Yamal-LNG” project

Yamal-LNG is the Russian gas producing company that was created for absorption of South-Timbeysk gas condensate field. The project includes the construction of the LNG plant. Total investments are estimated as 27 bln $ (Expert Online 2014). The company Yamal-LNG founded 7 April 2005 in Yar-Sal city.

In June 2013 during the Saint-Petersburg Economic Forum, Russian company NOVATEK and Chinese Corporation CNPC signed a document for starting cooperation on Yamal-LNG project. The document assumed long-term partnership for delivering 3 Mt/a LNG to China. In September 2013 the new Agreement was signed between NOVATEK and CNPC that 20% of the shares sold to CNPC. By 2015 the NOVATEK owns 60% of the shares, Total has 20% and CNPC 20% as well.

The capacity for new LNG plant is expected to be 16.5 MT/Y (million tons per year). The proven reserves of the field of South-Timbeysk field is 907 BCM. The first production line will be launched in 2017. During the project the transport infrastructure will be created around small town Sabetta, the new port and airport will be built by 2016. Also the transshipment hub will be built in Zeebrugge port for shipments to Asia-Pacific region when the navigation on Northern Route is not possible. Expected export routes are shown on the Picture 1.

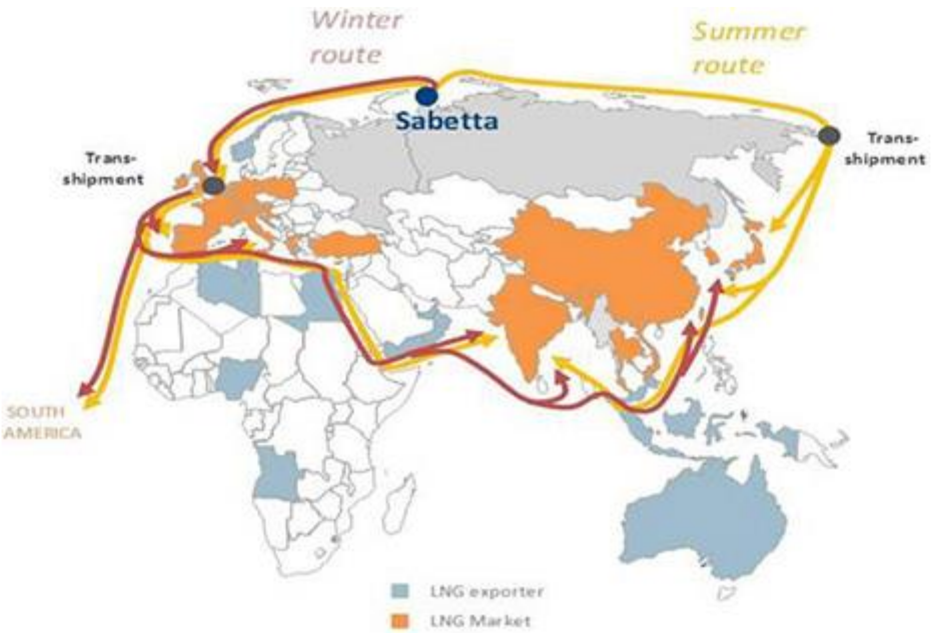

Figure 1. Yamal-LNG expected export market (Source: www.yamallng.ru)

According to official site of the project, "the LNG plant will be built in 3 phases which will be put in operation at the end of 2016, 2017 and 2018. The capacity of each train will be 5.5. Mt/a. The LNG Plant will be based on the integrated gas treatment and liquefaction process. The unique location of the Yamal Peninsula opens up opportunities for a more flexible and competitive logistical model, thus, allowing year-round LNG supply to the Asian, Pacific and Atlantic markets as well as to Europe and South America. A new transportation hub will be established for Yamal Nenets Autonomous District and the entire Urals Federal District. Sabetta Sea Port will become a vital transportation hub, instrumental for the development of the Russian Arctic" (Yamal LNG 2015) .

In 2014 Korean Daewoo Shipbuilding and Japanese Teekay won a tender on supplying new ARC7 ice-class LNG tankers for Yamal LNG project. The agreement also contained a right for financing and purchasing tankers from the third party. The total amount of ships are 16. ARC7 tankers are designed for the year-round transportation of natural gas produced by Yamal LNG. According to technical characteristics of the ship “they can operate in temperatures of up to -50 degrees centigrade and break through ice up to 2.1 meters thick” (Russia & CIS Business and Financial Newswire 2014). The German company Siemens will deliver the main components for the power stations that are going to supply Yamal LNG plant with electricity and heat. Technip company was awarded by Yamal LNG a contract to carry out all engineering, procurement and construction of the LNG facility of Yamal-LNG. Overall Yamal-LNG project attracts a lot of international business in different fields of the business.

“Vladivostok-LNG” project

In 2013 Gazprom begun new project “Vladivostok-LNG” in far-east part of Russia. The project aims for construction of LNG plant in Vladivostok. Expected production capacity of LNG – 15 Mt/a. First production line is expected in 2018 with production capacity of 5 Mt/a. The new plant will use the resources from Sakhalin Island territory, partially from other Gazprom projects Sakhalin-2 and Sakhalin-3. The focus customers will Japan and other countries of Asia-Pacific region. Now 100% of “Vladivostok-LNG” owns to Gazprom. Overall investments are estimated as 18-20 bln $ (LNG Congress Russia 2015).

Sakhalin-Khabarovsk-Vladivostok transmission system provides “Vladivostok-LNG” with necessary gas volumes. “The gas transmission system (GTS) route starts in Sakhalin, crosses the Nevelsky Strait, passes near Komsomolsk-on-Amur and Khabarovsk and ends in the vicinity of Vladivostok. Gazprom has constructed the GTS sections from Sakhalin to Komsomolsk-on-Amur and from Khabarovsk to Vladivostok with a total length of 1,354 kilometers (diameter – 1,200 millimeters, operating pressure – 100 Ata). The existing gas pipeline connecting Komsomolsk-on-Amur to Khabarovsk (diameter – 700 millimeters, length – 472 kilometers) is also a part of the GTS. The total GTS length exceeds 1,800 kilometers”, stated in official Gazprom announcement (Gazprom 2015e).

During 2015 several announcements are made by Gazprom officials that project can be postponed for 2 years because of the unstable situation on the Russian market. Gazprom starts to face problems with foreign financing for the project and technology that is needed for project implementation. During the 2016 Gazprom’s plans to deliver volumes allocated to Vladivostok LNG as pipeline supplies to China National Offshore Oil Corporation. Still it will not be cheaper to deliver gas through Sakhalin-Khabarovsk-Vladivostok pipeline than using LNG (ICIS 2014).

“Pechora-LNG” project

“Pechora-LNG” – is the project of private company Alltech. In 2011 LLC Pechora-LNG was created for project implementation. Resource portfolio of the project includes two fields in Nenets Autonomous Area – Kumzhinoskoe and Korovinskoe fields. Gas reserves of the fields are estimated as 145 BCM. The project presumes creating of gas transportation infrastructure, building of LNG plant and sea terminal for gas transportation. It is planed that exports will be carried out by ice-class LNG vessels.

In September 2012 Allteck announced the plans about launching the LNG plant by the end of 2018. The estimated plant capacity is 4 Mt/a. According to official publications the overall investments for the project are 6.6 bln $ (LNG Congress Russia 2015).

“Liquefied natural gas plant will be positioned on a site area of 220 hectares in Indiga community area in a non-freezing part of the Barents sea coast, 230 km off district administrative centre - Naryan-Mar town. The actual complex will provide dry gas processing in the volume of 4 billion cubic meters per year and 2.6 million tones LNG production even at the first phase. For LNG production, the Air Products will apply APCI liquefied technology. Capabilities of the gas processing plant expansion to 8 billion cubic meters are put in the project. Asian-Pacific region is specified as commodity market to a product. In compliance with the feasibility report prepared by Technip (Italian company) involving the leading Russian and international organizations, about $4 billion investments will be required for the construction of LNG plant together with infrastructure facilities. LNG shipment will be performed by special sea terminal built in a close proximity from the plant. Several Arctic LNG carriers of Arc4 ice strengthening with capacity for cargo 180 thousand cubic meters will be built for Project Services. Contract for construction of the tankers is made with JSC Far East centre of shipbuilding and ship repair, a member of OSK. Aside from consideration of a traditional onshore construction method of LNG plant, Pechora LNG explores the possibility to put to use Floating Liquefied Natural Gas Barge technologies (FLNG), providing production, processing, liquefaction, storage and shipment out of a shore land. It is assumed to use the basic facility without production and processing elements - FLSO in Pechora LNG Project. Thus, the concept of field development and transport scheme is not changed” says the official press release of the project (Pechora LNG 2015).

In 2014 Russian state company Rosneft started negotiation upon buying share in Alltech project. As a result during the 2015 Saint-Petersburg Economic Forum Memorandum of understanding was signed between two companies. The agreement expected by the end of 2015 (NAO24 2015).

“Baltic-LNG” project

“Baltic-LNG” project runs by Russian state company Gazprom. Project consists of construction of LNG plant in Ust-Luga. Expected capacity of the plant 10 Mt/a with possibility for extension till 15 Mt/a. Launching of the plant is expected in 2020 (LNG Congress Russia 2015).

The latest update from the official project site says tht “the project for an LNG plant construction in the Leningrad Region is oriented, in the first place, towards the European market (Spain, UK, Portugal, India and Latin America). The possibility for LNG swaps is considered among other things. Latin American countries, which are sticking to growing and diversifying LNG supplies, are also viewed as a target market. The plant’s output will be supplied to the Kaliningrad Region, and also will be used for bunkering (re-fuelling the vessels) and carrying out small LNG cargoes to the Baltics. In June 2013 Gazprom and the Leningrad Region signed a Memorandum of Understanding and Cooperation with regard to a liquefied natural gas (LNG) plant project. Under the Memorandum the Leningrad Region Government will ensure that necessary approvals are granted by authorized regulatory bodies and local authorities, relevant permits are issued and Gazprom's ownership rights to constructed facilities and purchased lands are registered. While delivering the project, Gazprom seeks to attract an investor or some investors with a view to acquire up to 49 per cent in the project (industrial enterprises, important potential buyers and institutional investors). The company plans to raise funds for the project” (Gazprom 2015a).

“Far-East-LNG” project

In 2012 Government of Sakhalin province came to an agreement with Russian state company Rosneft upon allocation of land for construction of LNG plant. Preliminary the plant location is near villages Ilyinskoe and Taranai. The contract for LNG plant construction was signed at the Saint-Petersburg Economic Forum together with ExxonMobil. The capacity of the first production line is expected to be 5 Mt/a, overall investments are estimated as 15 bio $. The launching of the plant is scheduled by the end of 2018. Starting from 2019 the deliveries are planned to Japan – 1.25 MT/a for Marubeni Corporation, 1 Mt/a for Sodeco and 2.75 Mt/a for Vitol SA. It means that possible output of the first production line is already under contract ((LNG Congress Russia 2015).

The resource portfolio of “Far-East-LNG” project includes the gas produces by Rosneft in the Sakhalin Island. The second production line can produce gas using reserves from “Sakhalin-1” project.

“Shtockman LNG” project

On July 13, 2007 Russian Gazprom and French Total signed the Framework agreement on cooperation for developing Shtokman gas and condensate field.
In order to implement the project, on February 21, 2008 Gazprom, Total and StatoilHydro signed the Shareholder Agreement to set up the special-purpose company Shtokman Development AG. Gazprom holds a 51 per cent stake in the company, while Total and Statoil – 25 and 24 per cent stakes, accordingly. Gazprom retains the license for the field and all rights for product marketing.

According to official press release of the company, the project implementation consists of the following steps. “The special-purpose company, Shtokman Development AG, operates Phase 1 of the Shtokman project and will own Shtokman Phase 1 infrastructure for 25 years starting from the date on which the field is brought onstream. Gazprom dobycha shelf (Gazprom's fully-owned subsidiary) implements Phases 2 and 3 by the order of Gazprom. The company is the customer of the port transportation and technological complex constructed in Teriberka. Field operations will be performed using deepwater production systems and special FPSO/FPU platforms equipped with quick-disconnect system and able to swiftly move off the icebergs. Produced gas will be conveyed via the offshore trunklines to the coast near the Teriberka settlement where an LNG plant (first production train capacity – 7.5 million tons a year), a port transportation and technological complex and other production facilities will be located" (Gazprom 2015d).

In February 2012 Gazprom announced tender for construction LNG plant at Shtokman field in provinces near Murmansk. Few months later the tender was cancelled due to financial reasons. Initially it was supposed that the LNG plant will produce export gas by the end of 2015 (Forbes 2013).

LNG markets globally are using different approaches for Government involvement in the industry. For example, in Qatar, one of the leading LNG producer, only few companies operate on the LNG market and they are totally controlled by the Government directly or through affiliates. Qatargas, the biggest LNG producer in Qatar, having 4 main LNG projects in the country. The owner of the 4 projects is Qatar Petroleum having more than 60% participation of the Qatar Government. But still foreign participation of other companies are high, Qatargas 1 has ExxonMobil (10%), Total (10%). Mitsui (7.5%) and Marubeni (7.5%) and Qatar Petroleum (65%) as shareholders. This policy allows Government to control LNG trade flows and at the same time attract foreign investments (Qatargas 2015). Another situation happens in Australia where LNG market presented by more than 150 producers both with Government and private participation. Such liberalization provides market with completion and more flexible conditions for customers globally (Australian Government Department on Industry and Innovation 2015).

3.2. Russian conventional pipeline gas network

Discussion about reasonability of developing LNG exports in countries using conventional pipeline way of transportation always takes place in the academic environment. Huge investments in pipeline construction are made to support specific deals in bilateral trade between countries. And the opportunity costs are much lower than in case of diversification. Susanna Dorigonni and Clara Graziano in their article "Can LNG increase competitiveness in the natural gas market?" develop an oligopoly model to analyze the potential role of LNG in the liberalization of gas market (Dorigoni et al. 2010). Pipeline transactions cover long-term contracts in global trade and focus more on stability and safety of the participants. Investments in LNG chain provide much lower level of specificity in the deals. Moreover during the last year costs for building LNG plants significantly decreased thanks to technological development (Dorigoni et al. 2010). Moreover LNG opens new spot market for the countries that previously were not involved in it. Also in some regions, like Europe, it is a regulation requirement that part of the LNG plant capacities should be available for spot transactions (Council of European Energy Regulators 2014). Other factors like increasing competition between local producers and diversifying portfolio on supply side are key factors for developing LNG sector specifically in the countries using pipelines. The main result provided from the paper is that developing LNG industry is both beneficial for exporters and importers because new competitors entering the market, activity on the spot market increases and as a result LNG costs decreasing that makes it competitive comparing to conventional pipelines (Dorigoni et al. 2010).

Using pipelines as the way of transporting gas is cheaper than creating special infrastructure and using LNG ships for transportation. Pipelines are competitive for distances below 2500 km and for inland destinations (Du & Paltsev 2014). At the same time pipeline gas exports can be limited by political issues especially when dealing with cross-border trade. The latest events related to instability in relation between Ukraine and Russia create a risk for European gas customers receiving gas from Russia through territory of Ukraine. "Whether the supply will be interrupted again, and to what extent the European Union will lessen its reliance on Russian pipeline gas, are still up in the air. These uncertainties are being closely followed by LNG players in the European market, but events in the region may have equally important implications for the Asian LNG market" says the Report from MIT Joint Program on the Science and Policy of Global Change (Du & Paltsev 2014).

The last but not the least important factor of using LNG comparing to pipeline is accessibility of remote markets that cannot be reached by land. Asia-Pacific and South American countries are good example of that.

During the 2012-2014 share of Russian LNG exports in total gas exports increased from 3% to 6% (WITS 2015). Russia is actively developing LNG industry to reach remote markets. Moreover this can bring additional profits for the companies acting at spot LNG market.

In 2013 Gazprom produces 71.3%, Vertically Integrated Oil Companies 11.4%, NOVATEK 7.9% and other private companies 4.1% of total gas production. Export share of gas was 34%. LNG exports were 14557 MCM with 10837 MCM to Asia-Pacific region (Ministry of Energy Russian Federation 2015b).

Destination country	**Pipeline**	**Russian participants**	**Status**
Poland	Yamal-Europe	Gazprom (48%)	33 BCM/a
Multinational project	South Stream	Gazprom (50%)	cancelled
Multinational project	North Stream	Gazprom (51%)	2 pipelines: 27,5 BCM/a each Total: 55 BCM/a
Turkey	Blue Stream	Gazprom (50%)	16 BCM/a
Germany	OPAL	Gazprom (40%)	35 BCM/a
Germany	NEL	Gazprom (25,5%)	20 BCM/a
UK	Interconnector	Gazprom (10%)	20,1 BCM/a
the Netherlands	BBL	Gazprom (9%)	16 BCM/a
Vietnam	Nam Com Son	Rosneft (32,7%)	7,1 BCM/a
China	Power of Siberia	Gazprom (70%)	under construction

Table 3. Russian gas pipeline network (Source: compiled by author)

Russian Government actively focuses on Asia Pacific countries in its LNG exports. The biggest consumer for Sakhalin 2 LNG project is Japan. Share of Japan increased almost twice in Russian exports to 9,46 MT/a in 2013. Moreover spot volumes were also shipped to Europe in 2013. Poland had agreement with Gazprom on shipping 0.5 MT of LNG in 2013 (WITS 2015).

For Russia, being the top country in gas pipeline exports, development of LNG sector will provide competitive advantage for the whole Energy Sector. Mainly because of the increasing competition and new potential markets. Existing of the pipeline gas network will only help to expand LNG sector

3.3. Northern Sea Route

Northern Sea Route is the shipping lane from the Kara Sea to the Pacific Ocean. Parts of the Northern Sea Route is free from ice only few months a year. And every year this route is actively involved in transportation between Europe and Asia-Pacific Region. For example, in 2012 vessels that used Northern Sea Route shipped 1.26 MT of raw materials, which is equal to 46 voyages of shipping. Gas condensate, LNG, and iron ore had been shipped using Northern Sea Route (Furuichi 2013).

Nowadays more and more academic authors are having discussion about using conventional Southern Shipping Route (through Suez Canal) and Northern Shipping Route. Joseph Francois and Hugo Rojas-Romagosa in their study “Melting Ice Caps and the Economic Impact of opening the Northern Sea Route” tried to examine economic impact of opening Northern Sea Route (Francois & Rojas-romagosa 2013). Since the distance through route in Arctic is lower and transit time is one-third lower than using Southern Shipping Route the huge shift in bilateral trade between European and Asia countries is expected. In their assumptions authors of the article assumes taking into account all uncertainties with melting ice in Arctic, that commercial fleet will start using Northern Shipping Route instead of Southern Shipping Route without any limitations as from 2030. When the new distances had been estimated, authors employed regression-based gravity model of trade to estimate possible trade reductions. After that computable general equilibrium model had been created to show the effect of the Northern Sea Route opening. As a result of analysis of reducing transit time and distance by one-third, trade cost reduction is 5% of the total value of goods sold. Moreover around 14% of all Chinese trade will be arranged using Northern Sea Route (Francois & Rojas-romagosa 2013). In this case geographic position of Russia gives possibility for using Northern Shipping Route in future. Trade costs can be decreased especially for trade between Northern China, Japan, and Korea. For LNG trade it means a lot because these Asian countries are main LNG customers for Russia. Shipping to Japan or China from existing LNG plant on the Sakhalin Island doesn’t use Northern Shipping Route for it. But if the customers in Europe will decide to buy LNG from Sakhalin, usage of Northern Shipping Route in future is reasonable. At the same time coming Russian LNG projects in Arctic will be benefited from Northern Route in future.

Masahiko Furuichi from Kyoto University in his study “Cost analysis of the Northern Sea Route and the Conventional Route Shipping” made an analysis of the costs for different types of vessels based on its tonnage (Furuichi 2013). Masahiko assumed that operational time when vessels could use Northern Sea Route was limited to 3 months a year that was close to reality. The results show that for small and medium-sized container vessels (with capacity from 4000 TEU to 8000 TEU) it is economically beneficial and cost effective. But for Ultra Large Container Vessels using Suez Canal Route is still preferable (Furuichi 2013). Moreover the transit is estimated to be reduced by more than 35% to 20 days. Reduction of CO2 emissions is also significant and it can be reduced from 13% to 35% (Furuichi 2013).

Zeeshan Raza has quite the same results in his academic study “A comparative study of the northern sea route (NSR) in commercial and environmental perspective with focus on LNG shipping” (Raza 2013). The author made his calculations and assumptions based on the data from LNG shipping voyage from Norway to Japan ports. All the calculations bring the following results – the distance for LNG vessels shipping from Norway to Japan can be decreased by 42%, CO2 emissions will be decreased by 52%, and total savings can be evaluated as 69$ per ton of the fuel spent on the route (Raza 2013).

Nowadays there is still uncertainty when Northern Shipping Route can be used full year and without any limitation. But it is clear that this day will come in the future and all participants involved in bilateral trade between Europe and Asia will get benefits from that. Russian LNG projects especially in the Arctic region already include usage of Northern Shipping Route in their long-term strategies (Ministry of Energy Russian Federation 2014). Northern Shipping Route definitely creates comparative advantage not only for LNG industry but for the whole Russian shipping industry.

3.4. Gas reserves

Based on the statistics provided by U.S. Energy Information Administration Russia has the biggest gas proved reserves in the world, equal to 47.79 Trillion Cubic Meters (TCM) or 1688 Trillion Cubic Feet (TCF) (U.S. Energy Information Administration 2015b).

Country	2011	2012	2013	2014	2015
Russia	1680	1680	1688	1688	1688,228
Iran	1045,67	1168	1187	1193	1201,382
Qatar	895,8	890	890	885,287	871,585
United States	304,625	334,067	308,036	338,264	NA
Saudi Arabia	275,7	283,5	287,844	290,811	294,311
Turkmenistan	265	265	265	265	265
United Arab Emirates	227,9	215,035	215,025	215,035	215,098
Venezuela	178,86	195,1	195,1	196,411	197,087
Nigeria	186,88	180,458	182	180,737	180,49
Algeria	159	159	159,05	159,1	159,054

Table 4. Proved reserves of natural gas (trillion cubic feet) (Source: EIA)

The study “Global oil and gas reserves study” by Ernst & Yong gives an overview on top countries and latest activities related to gas structural changes in the country. More than a half of top ten countries with proved reserves of natural gas using both conventional pipeline gas exports for transportations and LNG (E&Y 2013).

Algeria has 4.5 TCM of natural gas reserves. In 2013 Algeria supplied 33 BCM of natural gas and 26 BCM of LNG to the world market. Italy accounted for 46%, Spain 26% and France 8% (WITS 2015). All the Algerian gas reserves are located in the town of Skikda and western town of Arzew. Algeria was the first country that supplied LNG commercially to UK by shipping it on tanker-vessel Methane Princess (Natural Gas Intelligence 2014). Country has diversification in it exports. In 2013 share of LNG in total gas exports was 33%, in 2014 already 43% (WITS 2015). Algeria has three gas pipelines, taking the gas capacities across the Mediterranean Sea, one for consumers in Italy and two in Spain. The biggest LNG consumers for LNG are located in China and Japan. Despite the time of political and military instability, the whole economy of the country is driven by gas industry and such a diversification between pipeline gas to Europe and LNG to Asia-Pacific region allow country to optimize it profits and hedge risks related to specific markets.

Qatar is number 3 on the list of top countries with proved gas reserves. They are estimated as 25 TCM or 890 TCF (U.S. Energy Information Administration 2015b). At the same time Qatar is the top country in exporting LNG. In 2013 and 2014 more than 220 BCM of LNG were exported (WITS 2015). Because of the low internal energy demand, Qatar exports almost all of the produced gas. At the same time Qatar doesn’t use pipelines for export transportations. There are a lot of factors that restrain Qatar from opening gas pipeline with another country. For example, the pipeline project between Qatar and Turkey from Doha to Istanbul has been discussed for a long time. The pipeline is supposed to cross Saudi Arabia, Jordan and Syria. The bottlenecks of the projects are shifting sands, salt marshes, extreme heat, storms and difficulties in government relations between countries (Pipelines International 2015).

These two examples of Algeria and Qatar, being among top countries with proved gas reserves, show that usage of LNG always beneficial. For Algeria provides additional security and diversification in gas exports, for Qatar it is the only possible way to avoid risks connected with pipeline exports through territory of other countries and geographical layout of the country. As discussed previously not all countries can accept LNG because special infrastructure is needed like terminals and reliquefaction facilities but still for customers that can accept LNG it is preferably to work with countries with bigger proven reserves because it opens opportunity for long-term cooperation.

For Russia being the top country on the list of proven gas reserves with 47.5 TCM or 1680 TCF, LNG development is a good opportunity for export diversification. According to King and Spalding presentation on a Conference of International Petroleum Negotiator, strong resource (together with financeability of the project, cost competitiveness of the project etc.) of base is one of the key factor for successful LNG export project (King and Spalding 2013). It can be explained that different fields have different characteristics and customers need to minimize their risk that contract will be cancelled before the end date. Moreover buyers are always looking for reliable supply, attracted to large gas reserves. Shale gas that started to be popular in some regions or coal seam gas have lower Gross Heating Value so quality is less attractive for the consumers market (King and Spalding 2013).

Existence of huge proven gas reserves in Russia is a competitive advantage for the country. This is strong side for Russian LNG industry, because it creates additional selling point and overall competitiveness for Russian LNG projects.

3.5. LNG technological development and financial influencing

Since the LNG production plants require the highest operating costs and liquefaction process is a key area that constantly require development to save costs and increase LNG efficiency, technology can be considered as a key factor for LNG industry. There are several different types of liquefaction technologies exist nowadays.

Liquefaction process for the LNG production requires powerful compressors and a lot of energy. The energy can be generated mainly from 2 different sources: from natural gas or from the power grid. Therefore there are two main methods for operating LNG plants, using whether direct drive or electric drive (Antweiler 2013). Direct drive employs gas turbine that uses small amount of natural gas, so there is no reliance on the external source. The process requires industrial heavy-duty gas turbines or aero-derivative gas turbines. Electric drive is the new technology. It was created and actively used in Norway (Antweiler 2013). Using electric drive is beneficial for LNG producer because it is cost efficient and brings less environmental effect if the source of electricity is clean. Compressors being the key and most capital intensive tools in LNG production are produced mainly in Norway, France and USA.

Among all recent LNG developments, floating LNG (FLNG) seems the most interesting because it can have substantial impact on the industry. The main advantage of using off-shore FLNG is absence of necessity for creating land infrastructure because FLNG vessels can process LNG on board. Many difficulties that onshore LNG producers experienced have disappeared especially ones related to regulatory procedures of land use. Moreover the construction period is only two thirds comparing to the typical onshore plant. Finally the using of FLNG provides more flexibility for producers since they can easily move production facilities from one production field to another and less CO2 emissions generated from using FLNG (Du & Paltsev 2014). Nowadays total FLNG capacities are estimated as 120 MT with 30 floating liquefaction projects (Yep 2014). Prelude floating structure designed by Korean shipyards for Shell will be the biggest vessel ever built. Prelude will be about 488 meters long, 74 meters wide. The Prelude facility can produce itself 3.6 MT/a of LNG, it is approximately annual demand of Hong Kong (Yep 2014). The three main FLNG projects are located in Columbia, Malaysia, and Australia. All projects are financed by global energy producers and from the biggest consumers (KPMG 2015). Russia started discussion about FLNG in 2015. Golar LNG being one of the world’s largest independent owners and operators of LNG carriers signed a Memorandum of Understanding with Russian state company Rosneft to pursue LNG opportunities. Companies are planning to start their cooperation in Latin America in the next years with potential expansion to Europe (PESA news 2015).

In the end of 2014 during the latest LNG exhibition in Moscow, the recent activities in sector had been discussed. According to the majority of participants of the Conference new developments in Russia of LNG technology are far from the world standards in terms of costs, production efficiency and environmental impact (CREON 2014). The main suppliers and designers of Russian existing LNG plant and coming projects in Yamal LNG and Stockman LNG are Technip and Air Liquid Global Solutions France. So in situations with political instability and sanctions it becomes complex to meet the deadlines in construction process and financing of the projects.

A lot of commercial issues can influence the financial costs and feasibility of the LNG project. The equity ratio (the proportion of the total assets that are financed by the company itself) can vary significantly from one project to another. LNG projects with low risk profiles can have equity ratio and average capital cost as 10% and 8% respectively (Du & Paltsev 2014). The more risky the project is the bigger is the equity ratio and opportunities to find investors are limited. There are some factors that can create better investment performance for the company, like existence of long-term sales and purchase agreement (PSA) and its pricing formula, shipping contracts and availability of volumes for the spot market. Sophia Ruester in her study “Financing LNG projects and the role of long-term sales-and-purchase agreements” showed and proved empirically using the multi-regression model that “the debt ratio of an LNG project decreases with the increasing risks associated with future cash flows” (Ruester 2015). The author made such results by using data of 26 existing LNG projects. Creating of new LNG facility employs different things like designing the regasification terminal, constructing the ships, etc. that can make the ownership and project structures changed significantly during time. That is why project financing is considered to be the best option for financing LNG projects (Ledesma & Young 2015). Starting from 2000 up to 2014 nearly $97 billion in project financed debt has been raised for the LNG projects (Ledesma & Young 2015). Project finance is critical for LNG industry globally. Project sponsors are using project financing to transfer their risks to lenders to generate competitive debt and equity ratios that allows low credit rating countries verify their investments grades.

Russian LNG projects are actively using project financing and long-term sales agreements. Recent political instability and economic sanctions against Russia create difficulties with financing for Russian companies. In the beginning of 2015 Gazprom started discussions with Qatar Investment Authority and Qatar Investment Fund for financing two LNG projects – “Far-East LNG” and “Vladivostok LNG”. Previously Gazprom planned to invite funds from Europe that became impossible because of the sanctions (Pogosyan 2015). Because of this more and more LNG projects in Russia are start looking for financing in Asia-Pacific region. Yamal LNG project initially was planned to be financed including various countries but finally the agreement was signed with China National Oil and Gas Corporation. All that makes in a determinate sense Russia dependent on one partner.

3.6. Chapter summary

Using the information discussed in the Chapter 3 and applying SWOT approach the following “Strengths” and “Weaknesses” can be identified as shown in Table 4.

Strengths	Weaknesses
1. Gas reserves	3. LNG technological development and financial influencing
2. Russian conventional gas pipeline	4. Openess of Russian LNG sector
5. Northern Sea Route	

Table 5. Strengths and weaknesses of Russian LNG sector (Source: compiled by author)

In the “Business Environment Ratings” prepared by Economist in 2014, Qatar, Malaysia and Australia, being the top producers of LNG, stand among the first countries for business environment. Australia has 5^{th} position for 2014-2018 time period, Malaysia has the 19^{th} position, and Qatar on the 21^{st} place. Russia stands in 60^{th} position in rating (Economist 2014). Business environment is measured by attractiveness of the economy for possible investors and general openness of the economy. The overall rating is calculated by using indicators for political environment, market opportunities, policy on competition in the countries, taxes, financing and labor regulation. LNG sector is highly sensitive to such indicators connected to investment environment in the country. Therefore the success of the countries being the top LNG exporters can be explained by investment climate in the country to a great extent.

All the strengths and weaknesses in the Table 4 are ranked according to their importance as the internal factors for LNG sector development. Gas reserves provides security for developments in specific fields no matter whether it is conventional pipeline or LNG project. Also sufficient gas reserves can give additional guarantee to customers that deliveries can stop unexpectedly. Moreover in case with Russia, mineral deposits for LNG production can be exploited geographically depending on location of potential customers like in case with Sakhailn-2 LNG project located in the Far-East of Russia near Japan and China. Russian conventional gas pipeline system creates regional market rather than global one that can be created by LNG. At the same time LNG contracts can be used as an additional tool together with long-term conventional gas contracts to provide diversification for the supplier and the customers. LNG technological development and financial influencing is the weak point for Russian sector especially nowadays when economic sanctions block import deliveries of technological equipment for Russian LNG plants. This makes the whole industry quite sensitive to such kind of changes in the political environment. Entire liberalization of the LNG industry in Russia and appearance of the new players on the market could bring competition and speed up project performance. Realizing all the risks connected with such liberalization and possibility to lose control over strategic industry Russian Government selects position of moderate changes. Possibility of using Northern Shipping Route even few months a year gives opportunity for Russian companies to save on the transportation costs significantly and develop Arctic fields with more enthusiasm.

4. World LNG market and Russian future directions on it. Set-up for regression-based gravity model of LNG trade for Russia

Chapter 4 describes the global LNG market and the position of Russia on it. It analyzes main threats and opportunities for Russian LNG market.

Steady growth of LNG production throughout the 20th century had been stopped first time in 2012 globally. In 2012 the LNG production was decreased by 2% and in 2013 by 1%. At the same time demand was persistently high. Decreasing in demand from USA and Europe was compensated from Asian markets where it grows very fast. By the end of 2013 share of Asian countries in LNG consumption was 71% comparing to 64% in 2011 (International Gas Union 2014). With a lack of its own nuclear plants, Japan LNG consumption increased by 11,4%, China to 12,2%, India to 7,7%. At the same time imports to some countries were significantly decreased: to Belgium (-55,3%), USA (-49.6%), UK (-43.6%), France (-31.9%), Spain (-16.1%) (International Gas Union 2014).

The equilibrium of demand and supply on the market was crashed by the suppliers. New production facilities was even lower than expected in 2014. Only one new LNG plant was built in 2014 in addition to 24 existing facilities in the world. It was Australian LNG Pluto project with capacity 4.3 MT/a. But the introduction of the new capacity was not sufficient for the market to compensate planned closure of some plants, political instability in some production countries and growth of internal demand. That is why global LNG trade was decreased to 236.8 MT/a in 2013. Figure 2 shows the dynamics in LNG trade volumes.

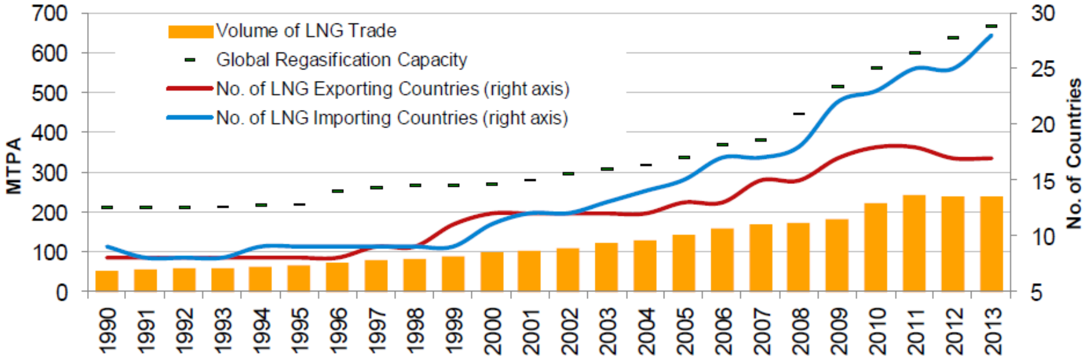

Figure 2. LNG Trade volumes, 1990-2013 (Source: IHS, IEA, IGU)

While spot market had been developed fast, during 2009-2011 it was increased by 110%, LNG spot trade also stopped due to decreasing in demand in 2013-2014. Short-term contracts (contracts that are valid for less than 4 years) in 2012 made 59 MT or 25% of the total LNG trade. More than a third of spot market was shared between Qatar (35.5%), Nigeria (15.2%) and Trinidad and Tobago (8.7%) (International Gas Union 2014).

The dramatic situation in the sector took place in Europe where the LNG deliveries were decreased by 3 times, from 65 MT to 47.5 MT in 2014 ((International Gas

Union 2014). Previously Europe market focused more on LNG than conventional natural gas creating infrastructure for this. A lot of long-term contracts had been revised, more pressure on pipeline players, new LNG terminals did not allow Europe to increase LNG imports. Among 55 LNG contracts for 2014 Europe signed only 5. Other contracts were signed by Asia-Pacific and Latin America countries.

In such a way, in 2012 the situation on the LNG market completely changed. In 2009-2010, on the peak of shale boom in USA, significant volumes of LNG came to Europe that created an illusion for European customers of LNG being an infinite and low priced commodity. All that abundance of the LNG commodity for European countries stopped after Fukusima accident and stoppage of the nuclear industry in Japan. The trade volumes changed direction to Asia-Pacific region, to China, Korean and Japan mainly.

In 2014 the tendency of changing trade flow to Asia-Pacific market consolidated further. In the first months of 2013 share of Europe in total LNG imports was 15%, share of Asia – 77%. Exports to Asia-Pacific region increased by 6% comparing to 2013, stable for Japan, increased to Korea by 10%, to China by 50% (International Gas Union 2014).

4.1. Global LNG production capacities.

In 2014 the situation with global LNG production capacities didn’t changed dramatically. The leader on LNG market, Qatar, increased its production capacity using existing facilities to 76.4 MT. Nigeria, despite the problems with pipeline network, also could increase its production to 19 MT. Australia and Trinidad and Tobago increased their production to 20.9 and 13.5 MT respectively. Indonesia and Malaysia decreased their export production due to planned breaks on the plants; Egypt decreased volumes due to increasing in local consumption. Political instability hit the production in Libya and Yemen by 23% (International Gas Union 2014).

The new LNG facility was launched in 2012 Australia – Pluto LNG plant with capacity 4.3 MT/a. In 2014 overall LNG plants can produce globally 282 MT/a with demand 240 MT/a meaning 86% of capacity utilization.

The biggest LNG breakthrough is expected in Australia where the new LNG production plants are planned to start during 2016-2017. 7 new plants with total capacity of 61.8 MT/a are under construction. Taking the fact that Australian LNG projects are much more expensive than in other countries, all LNG trade flow from Australia will be focused on Asia-Pacific region. Besides that, Australian projects are usually postponed.

Despite the turndown case of existing regasification facilities, the new terminals are still designed. New six terminals are now built in China, India, Brazil and Chile where the consumption of LNG increases. Japan having 30 terminals, with utilization of 50%, is designing more 5 terminals. In 2014 terminal utilization rate in Europe is 31%. Still new European projects are expected on the market in France, Italy, Poland and Lithuania ((International Gas Union 2014).

The discussion about USA being the leading export country for LNG gains momentum nowadays. As a result the price system also can be changed in the market.

Under the conditions of overflow of internal US gas market, American companies develop a far-reaching programs and campaigns for LNG exports. Annual Energy Outlook assumes increasing in gas export from USA by 2025 to 44.24 BCM with following increasing to 71.4 BCM by 2035 (International Gas Union 2014). By now only one terminal Sabine Pass has all necessary licenses to export to FTA (Free Trade Agreement) countries and non-FTA countries. Overall production capacity of the plant will be 23 MT/a by 2016.

4.2. Threats for Russian LNG sector

Nowadays there are a lot of external threats for Russian LNG sector coming from other LNG producers. Because of the “shale boom” in the next years US can become exporter of the gas for Europe and Asia-Pacific region. Qatar continuously is looking for new markets. Australia adding new LNG capacities each year. All that creates risks for Russian traditional markets in Europe and Asia.

Qatar LNG sector

Qatar is one of the top countries for gas reserves coming after Russia and Iran (Table 3).

The biggest part of gas reserves (25.1 TCM) is located in the North Field, which is in fact a part of Iran South Pars. Actually these two fields create huge gas condensate field. Gas reserves were also found in other fields like Duhan, Id Ash Shargi, Meidan Mahzam, Byul Hanin and Ar-Ryan (BP 2014).

Before 1990s new gas fields in Qatar were not surveyed intensively that adversely affected on the natural gas production statistics. In the middle of 1990s the volumes started growing significantly. As from 2000 the gas production increased every year in the Qatar.

In 2005-2010 gas production was increased by 2,5 times (from 45,8 to 116.7 BCM), in 2011 145.3 BCM of gas was produced (BP 2014). Following such a trend of gas production in Qatar, not only home gas consumption was increased - export started to grow more than 10% each year (International Gas Union 2014).

Qatar supplies gas using conventional pipelines as well. In 2012 Qatar joined the “Dolphin” project for delivering gas through pipelines to UAE. The first gas priming to UAE was arranged in 2007 with regular export supply started in 2008. In 2011-2012 “Dolphin” provided 19.2 BCM/a. It is expected that by 2016 the volume will be increased by 1.5 times when Kuwait and Bahrein will join the project.

Overall Qatar LNG capacities are estimated at 93.7 BCM. In 2012 Qatar shipped LNG to Asia-Pacific region (66.5 BCM), Europe (31.3 BCM), North, Central and Latin America (4.9 BCM). The total market consists of more than 20 countries expanding each year. During the 2011-2012 Qatar sold more than 20% of LNG using short-term contracts to the markets where the price was higher. At that time presence on the spot market is also a part of the strategy for Qatar LNG industry (BP 2014). But in 2013 Qatar started to decrease its share on the spot market and managed to sign more long-term contracts (Reuters 2014).

According to Qatar Petroleum, in 2013 long-term contracts covered 93,1% of LNG production planned for 2014-2020 (Qatar Economic Insight (QNB) 2015). Asian countries traditionally have been clients for Qatar LNG industry. Emirate, having its own fleet of LNG vessels, can quickly arrange LNG transportation to Asia-Pacific region where prices are more preferable for LNG suppliers because of continuously increasing demand. In Europe main Qatar clients are UK, Italy, France, Belgium and Spain. From 2008 to 2012 LNG volumes to Europe increased by 5 times, from 7.9 BCM in 2008 to 43.4 BCM in 2011 (BP 2014). As from 2012 the volumes started to decrease mainly because of slow-down in Europe economy and because of massive cheaper coal supply to European market from US. Despite the decreasing of European gas consumption, Qatar had 8.7% share in gas supply to Europe (U.S. Energy Information Administration 2015b).

According to the 20 year's contract signed between Poland and Qatar in 2009, starting as from 2015 Qatargas will supply annually 1.4 BCM of gas to Poland with possibility of extension in 2017-2018. The actual contractual volume is equal to 13% of total Poland gas imports. For example, Poland in 2013 consumed 16.6 BCM of gas, produced 4.2 BCM with imports of 10.9 BCM (import from Russia was 9 BCM) (WITS 2015) . Qatar also plans to negotiate LNG supply with Baltic countries, Belorussia and Ukraine to start first deliveries by 2016 (Qatar Economic Insight (QNB) 2015).

Last years the investments in Qatar LNG industry increased prominently. Emirate actively attracts foreign companies with its breakthrough technologies, preferably from US. Activities performed by joint projects of Qatar and foreign investors cover not only fields exploitation and LNG plants construction but also LNG production. For example, Oryx plant, that was launched in 2003, can liquefy natural gas by using oxidation catalysts without decreasing the temperature as in traditional way of production (Halstead 2008). The project owns by Qatar Petroleum (51%) and South African Sasol (49%).

The most important competitive advantage of Qatar LNG industry is using advanced manufacturing technologies that allow to decrease cost of production, optimize production process, transportation and gas regasification. Using LNG vessels type Q-Flex and Q-Max provide gas supply and transportation with additional security by transforming boil off gas into liquid form.

Increasing gas supply to European market by Qatar causes difficulties for Russian state company Gazprom on this market. Main threats are coming from the spot market. According to the report of Qatar National Bank in 2015 Qatar is planning to decrease spot contracts to Europe by 40% mainly because of long-term agreements with Latin American and Asian market where LNG prices are higher than in Europe. Therefore the demand in Europe will be increased that open more opportunities for Gazprom (Tuttle 2015). Industry professionals believe that in the nearest years Qatar can deliver to Europe not more than 50 BCM/a that is equal to 5% of all European demand (Tuttle 2015).

Qatar Oil and Gas Report prepared by Business Monitor in 2014 assumes that increasing competition from Australia, East Africa and North America will become the biggest threat for Qatar LNG industry in the next decade. The effective response from Qatar should include transformation of gas processing industry, including more investments for creating new capacities, and increasing customer's portfolio. Business Monitor forecasts gas production of 180 BCM by 2022 in Qatar meaning that growth rate will be decreased (BMI 2014). Barzan Gas project that is supposed to be launched by the end of 2015, is the last big gas field development project in the country

Qatar is putting a lot of efforts for geological exploration for the new gas fields. As a result, Block 4, that was found in Qatar shelf sea region, proves that there is still a potential for new reserves in the shelf area (BMI 2015). With that the home gas consumption is expected to grow significantly to 60 BCM by 2022 (BP 2015). Report by Business Monitor provides information that Qatar proved gas reserves will be decreased by at least 2% by 2021 to 25 TCM (BMI 2014).

Moreover as a part of its pricing strategy in Asia-Pacific region, Qatar ties the prices for LNG with oil prices that benefit producers with higher prices and more profits in the last years. Since the LNG volumes are increasing to Japan and China from Australia and Russia, Qatar will have to reconsider its pricing strategy.

Formally US is the selling market for Qatar LNG sector. There are some LNG plants in Qatar built specifically for producing LNG for North American market. Actual Qatar exports to US in 2013 was 1 BCM (WITS 2015). Because of the shale gas revolution in US, demand decreased and as result contractual LNG was forwarded to European and Asian market. Qatar gas re-export by US companies is supported by long-term contracts.

In 2013 Gazprom opened its first office in Doha. Gazprom plans included cooperation with Qatar government, oil and gas companies of Qatar and other Gulf countries, activities coordination between other Gazprom subsidiaries in the region. In 2010-2011 Russia offered various investments projects to Qatar in gas and oil, gold mining and construction industries. Total investments were expected to be 10-12 bln $. Due to several reasons none of the mentioned projects had been realized. Kasaev Eldar, being an investment professional for the Middle East region, emphasizes three main issues in dialog between Qatar and Russia. First reason is the different political point of view on so called "Syrian" question and governmental changes happened in Arabic countries in 2011. Secondly, top managers mainly from US working for gas industry in Qatar for a long time have been implementing anti-Russian strategy to get rid of new players on the market. And the last issue relates to differences in business ethics between two countries (Kasaev 2014).

More closer and effective cooperation could be possible within the scope of Global Gas Forum on the analogy of OPEC in oil industry. Such Forum could provide security for gas producers allowing to perform gas strategies with sustainable approach. Moreover participants could share their experience and exchange their technologies. Forum could also regulate pricing strategies for the gas markets and its main mechanisms. Qatar is one of the country standing against creating the gas cartel. It happens mainly because Qatar is an active participant on the LNG spot market where prices are higher in some regions.

As a summary, Qatar, being a top player on the LNG market globally, creates certain obstacles for Russia to develop on the market. It happens mainly because Russia and Qatar are fighting for the same market in Asia-Pacific region. While almost all Russian volume from Sakhalin-2 is contracted for the next years, Qatar is actively using spot market to diversify sales market and get maximum profits and benefits. Moreover advanced technological environment allows Qatar to decrease production costs and increase production capacities. From 2007 to 2010, there were a significant number of so called “Q-Flex” (210-217,000m3) and “QMax” (260-270,000m3) ships delivered into the LNG fleet. These vessels were designed to specifically service new projects in Qatar and are likely to remain attached to these projects. No additional ships of this size have been ordered since. Ships ordered in 2012 were sized between 150-170,000m3 (Clarkson 2013). These ships makes Qatar LNG industry more flexible for market needs and requirements. Moreover new technologies for liquefying gas create additional competitive advantage for the industry. Russia and Qatar can benefit each other by cooperating more closely, Qatar can access new markets with the support of Russia, and Russia can get necessary technology for the industry. In the next years such a cooperation not likely to take place mainly because of the increasing competition in the market, especially in the Asia-Pacific region.

Australia LNG sector

According to BP report Australia by 2020 will overtake Qatar in LNG production and become the biggest producer in the World (BP 2015). Nowadays three production facilities are located in Australia with total capacity of 24 MT/Y. Seven production facilities are under construction with potential production capacity of 85 MT/Y. Qatar potential capacity is 77 MT/Y (BP 2015).

Australian LNG plants can be divided into two main groups. First group includes plants on West Coast where the gas supplies from offshore sea fields. All existing capacities are located on the West Coast. Among plants under construction, four will be located on the West Coast. They are Gorgon, Whearstone, Ichthys and the first floating plant – Prelude. The total production capacity of these facilities is estimated as 40 MT/Y, meaning that West Coast generates 2/3 of total capacity. The rest part of the volume will be generated from the plants located on the East Coast - Gladstone, Queensland Curtis, Australia Pacific. The resource base for these plants will be coal bed methane that is exploited now in Australia.

One of the main obstacle to create efficient LNG project using the coal bed methane resource base is continuity of gas supply. To provide plant with necessary volume of gas, more 100 wells needed for coal-methane field comparing to traditional gas reserves. Based on the calculations, 3000 wells are needed in 20 years to provide resources for LNG plant with capacity 1.5-4 MT/Y (Unsworth & Wheeler 2010). 27000 new wells should be created to provide necessary amount of gas for the new 4 plants (Unsworth & Wheeler 2010).

Coal methane is extracted by using low pressure and requires additional compression for transporting it to LNG facility. Lack of light hydrocarbon gases C2 in coal methane gas decreases its calorific capacity that is not suitable for some LNG customers. Impurity profile of natural gas from coal-beds can vary significantly that requires additional investments for installation additional gas cleaning and drying equipment. Commercially interesting gas contains not less than 90% of methane. In Australia gas contains 98% of methane and doesn’t contain carbon dioxide that makes it cheaper to liquefy. The typical LNG production procedure from coal methane consist of removing solid particles, acid components, drying, sulphur removing, cooling and liquefaction. Natural gas extraction from coal-beds leads to decreasing of fire damp outburst in atmosphere and increase security at coal miners (Unsworth & Wheeler 2010).

There are some plans for new LNG projects with production capacity exceeding 50 MT/Y. Some of them are not likely to be realized mainly because of increasing costs of production. Shale gas projects in USA are 40% cheaper than the same in Australia. The main reason stated by foreign investors like Chevron and Exxon Mobil is wages and cost of labor. It happens because iron ore and coal miners are performing multimillion projects at the same time creating huge competition on the labor market. Unions are taking advantage of the situation (Sonali 2014).

Australian LNG market is located in the Asia-Pacific region. Geographical distance to the customers and quality of the product create main threats for Russian LNG industry. At the same time Australian LNG production cost is the highest at the market that makes LNG export market heavily dependent on the price fluctuations.

Asia-Pacific region. Indonesian and Malaysian LNG sectors

Indonesia is the one of the biggest LNG producer in the world. Proved gas reserves of the country is estimated at 3 TCM (BP 2014). Indonesia was a leader in LNG exports by 2005 leaving its top position to Qatar in 2006. Now according to the UN trade statistics it holds 4^{th} position among other LNG exporters (WITS 2015).

LNG plants construction in Indonesia was dictated mainly by demand from South Korea and Japan. There are 3 plants operating in the country LNG sector (Global LNG 2015).

Bontang LNG Plant that is often called “Badak” LNG plant has been producing LNG for 36 years. The plant construction started in 1974 and first LNG vessel was shipped to Japan in August 1977. Now the facility consists of 8 production lines that allows to increase capacity from 3.3 MT/a in 1977 to 22.5 MT/a in 2013. The main consumer of “Bontang” LNG is Japan together with South Korea, China and Taiwan (Bontang 2015). Badak LNG company that manages the plant is owned by Indonesian company Pertamina (55%), Indonesian Vico has 20%, Japanese consorcium JILCO has 15% and 10% of Total.

The second Indonesian LNG plant Arun was built in 1974. Arun is sourced from the gas field located 30 km to the north. Among local state companies It is owned by ExxonMobil and JILCO with 30% and 15% share respectively. In 2010 local newspaper Jakarta post announced that only 4 production lines of 6 were operated in the Arun plant (Jakarta Post 2010). After that the Arun officials admits that all LNG export contracts with Japan and South Korea were valid only till 2015 because of the gas resource depletion in the area.

In 2002 Indonesian Government confirmed construction of the third LNG facility. Tangguh LNG plant having 2 production lines has gas capacity of 7.6 MT/a. The resource base for the plant is the biggest in Indonesia. Gas in coming from 6 gas fields discovered in 1990. BP has 37.16% in the project and plans to build third production line. The main consumers are located in Japan. The project is important for Indonesia because it supplies LNG for the local market and also provides gas to Arun plant.

Despite the depletion of gas reserves and decreasing in local energy consumtion in 2011 Indonesia announced construction of the new LNG plant – Donggi Senoro LNG plant. The plant has small gas production capacity of 2 MT/a. Under the 13 year contract LNG is supplied to Japanese Chubu Electric and Kyushu Electric.

Malaysia holds a second place in the LNG production in the present time (WITS 2015). Proved gas reserves of Malaysia is 1.3 TCM that 20 times lower than in Qatar (U.S. Energy Information Administration 2015b). The biggest LNG complex in the world is located in Tanjung Kidurong port area – Petronas LNG complex. According to official Petronas LNG complex web site "an integrated world-class LNG production complex spread over 276 hectares of land, it receives its gas supply from upstream facilities offshore Sarawak. With a total of eight production trains and a combined capacity of 24 million tonnes per annum (mtpa), the complex is one of the world's largest LNG production facilities at a single location" (Petronas LNG Complex 2015). First LNG vessel was shipped in Japan in 1983. Malaysia was the first country entering Chinese LNG market by signing long-term contract with Shanghai LNG Company Ltd in 2007. In 2015 Petronas plans to build two floating LNG plants with gas production capacities of 1.2 MT/a and 1.5 MT/a respectively (Petronas LNG Complex 2015). These floating LNG plants are supposed to increase already a huge complex of Petronas LNG.

African LNG sector

Total natural gas reserves of African countries were 14.5 TCM by the end of 2012 (U.S. Energy Information Administration 2015b). The LNG production facilities are concentrated in Algiers, Nigeria, Egypt, Libya and Angola.

Algiers gas reserves are estimated at 4.5 TCM (U.S. Energy Information Administration 2015b). As mentioned before the first LNG delivery was arranged from Algiers to UK in 1964. After that the 3 other LNG plants were built. The sales market is European countries mainly.

The oldest LNG plant in Algiers was closed in 2010 by Sonatrach (managing company) because of the ecological issues in the area – Arzu town that located close to the plant was heavily polluted during LNG production.

The biggest LNG production facility in the region – LNG-1K located near Skikda has been operating since 1970. LNG-1K initially had 6 production lines (trains). In april 2004 the explosion in the plant destroyed 3 of the 6 production lines (Sonatrach 2015). Now only three lines operate in the plant.

Proved gas reserves of Nigeria is 5.2 TCM (U.S. Energy Information Administration 2015b). Nigeria is the one of the youngest player on the world LNG market. In 1990 TSKJ consortium that included French Technip, Italian Eni and Japanese JGC concluded an agreement to build LNG plant in Nigeria. In 1999 the first LNG train was produced. In 2014 the production capacity of six lines is 22 MT/a.

During the last ten year the proved gas reserves in Egypt has been increased by 20% and equals to 2 TCM (BP 2015). Discovery of new gas fields in the delta of Neil river made Egypt important participant on the global gas market. Egypt entered the global LNG market in 2000s with running Arab Gas Line and launching first LNG production in 2006. In 2014 Egypt supplied 6.7 MT of LNG (WITS 2015). Segas and Egyptian LNG plant deliver their products to European and US markets. 80% of

Segas owns by Spanish-Italian Union Fenosa Gas company. Due to increase in local gas consumption in the next years Egypt most likely stop development of export LNG facilities.

Latin American LNG sector

Overall gas reserves of Latin America is 7.6 TCM (U.S. Energy Information Administration 2015b). Before 2010 the Latin America had only one LNG supplier – Trinidad and Tobago.

Atlantic LNG Company of Trinidad and Tobago was created in July 1995 to carry out a project to design LNG plant. In 1998 the first production train was launched with capacity of 3 MT/a. Plans for constructing new lines are now postponed. Conoco Phillips is using its technology for Atlantic LNG. This technology was used first time in 1969 for Kenai LNG Plant in Alaska.

Using the resources from one of the biggest gas field Camisea, Peru LNG plant was launched in 2010. Project started in 2007 by American Hunt Oil Company (50%), South Korean SK Group (20%), Spanish Repsol (20%) and Japanese Marubeni Corporation (10%) (Hunt LNG 2015). Now the capacity of Peru LNG is 4.4 MT/a that allows country to shore up its position of gas netto-exporter.

Belgium Exmar company is finalizing construction of floating LNG project near the Columbian coast in the Caribbean sea – Puerto Bahia FLRSU. Brasilia also has plans for expansion on LNG market by constructing floating LNG plant (Santos Basin FLNG 2015). Delta Caribe LNG plant in Venezuela was freeze recently due to lack of financing.

US LNG developments

In US a number of LNG export projects are expected to start over the next few years totaling in more than 300 MT/a (BP 2014). The world expects these projects to provide opportunities to some additional and unique benefits with regards to timings, pricing and flexibility.

There were of course some perceived benefits from participation in these projects, for example an immediate access to contracts link to gas indices like Henry Hub, however the recent fall of oil prices has diminished the difference between gas and oil indexed LNG prices, hence the sustainability of this price spread is not guaranteed anymore.

Setting aside these perceived benefits there are still more predictable benefits of US LNG projects especially where infrastructure is already in place like quicker time-to-market deliveries, ability of resource and labor, need of lower capital investments and flexibility in destination and volume of offtake. The latter is known to be valuable to consumers in Asia who are in most cases quite uncertain of a long-term forecasting of demand.

Along with the benefits, one of the risks remains being the usage of gas for other projects than LNG on the Gulf coast. It may result in higher competition for the gas supplies and as a result diminish the benefits stated above.

In terms of commercial and contractual relationships US has adopted the so called "buy-sell" structure where the terminal owner is not present in any part of the value chain of the LNG. This means, unfortunately, that terminal owner has to deal with all the contract mismatches of the third parties.

Before US is able to erode a significant share on the export LNG market, there are couple of steps that need to be taken and long term strategy to be built to guarantee the sustainability of US LNG projects development. There is a need to look for a strong portfolio of basins and gas supplies to ensure the reliability of gas supply. In terms of contractual risks the service-level agreements need to be arranged describing but not limited to responsibilities, definitions and scheduling coordination.

European LNG sector

Gas reserves of European region is 58 TCM or 31% of world reserves (U.S. Energy Information Administration 2015b). With that LNG production doesn't have broad-scale development in the region. Small LNG production facilities are located in North Europe, in Norway. Due to arctic climate the costs for LNG production are significantly high and unconventional technologies are required.

Taking into account all climate obstacles and applying modern technologies, Norway launched Snohvit LNG in 2007. For this project reserves from 3 gas fields was combined – Snohvit, Albatross, and Askeladd. These gas fields are located in the shelf, 140 km from North point of Norway - city Hammerfest. Apart from leading company in the project Statoil (33.53%), other global energy companies took part in the project – Norwegian Petoro 30%, French Total (18.4%) and Gas de France (12%), American Hess (3.26%) and German RWE-DEA (2.81%) (BP 2014). In 2007 the construction of 4.3 MT facility with 5.3 bln $ was finalized (Statoil 2015). During 2008-2014 period plant had been experienced issues related to gas and sea water leaks. Because of that Statoil decided to postpone plans on investing in delivery new LNG trains for the project.

Also the small production facility was arranged near Risavika port in Norway- Nordic Skangass LNG plant with capacity 0.3 MT/a (Skangas 2015).

Norway, having 1% of world gas reserves (U.S. Energy Information Administration 2015b), is an important LNG supplier not to only to Europe but to US and Asia-Pacific customers.

Table 5 summarizes the main threats for Russian LNG industry coming from global markets.

Country-supplier	Gas reserves (2012), TCM	Threats for Russian supply	Forecast
Qatar	25,1	- gas reserves - focus on LNG (no pipelines) - differentiation on LNG market (sales market consists of 21 country) - huge government support - LNG technology - advanced shipping capacities	Qatar will remain in his role for being the main player on the global LNG market on all markets especially in Europe and Asia
Oman	0,9	- in 2012-2013 Oman was in top 10 countries for LNG trade - long-term-contracts with Korean and Japan customers	No expansion expected on the market due to limited gas reserves
Australia	3,8	- advanced LNG technology (first FLNG (floating LNG), using unique equipment for cooling) - more advanced product (due to high methane consistency) - extensive plans for building new plants (by 2017 production capacity can be inreased more than twice) - proximity to Asian markets	Australia in next years can become the biggest LNG producer. Developments in the sector and investments can be limited by high production cost.
Indonesia	3	- experiene in LNG exports (leader in LNG exports till 2005) - proximity to Asian markets - focus oon specific market (Japan)	Due to depletion of gas reserves and increasing of local gas consumption Indonesia most likely will be loosing leading positions in the sector)
Malaysia	1,3	- Governmental focus on LNG sector - the second biggest LNG supplier - Experience at Asian market (malaysia was the first country entering Chinese LNG market)	Malaysian LNG sector doesn't have plans for extension but the long-term contracts with Chinese customers provide stability for the sector
Algiers	4,,5	- first LNG plant - experience on the market	Due to high level of LNG plants depreciation Algiers need to attract a lot of investments to upgrade its facilities
Nigeria	5,2	- attractive for investors - big ambitions	Nigeria can be a leader in LNG production next years especially if country become more transparent for foreign investors
Egypt	2	- discovery of new gas deposits in the Miderranean shelf - proximity to European market	Political instability and lack of investments can disturb LNG sector fplans for further developments
Latin America	7,6	- openess for using new solutions and equipment (Trinidad and Tobago, Peru) - high potential - attractive for investors - FLNG	Huge potential for LNG sector but in a long-term perspective
Europe	20	-proximity to the local market - new LNG technology	The only European LNG developments in Norway are limited by high costs of production and usage of new technologies

Table 6. Threats for Russian LNG sector from global suppliers (Source: compiled by author)

5. Gravity model for global bilateral LNG trade

Chapter 5 is dedicated to gravity model of trade. By implementing gravity model approach main determinants can be identified on global and Russian LNG sector.

Gravity equation is a popular tool for statistical estimation and analysis of bilateral trade flows between countries. The foundation of the economic gravity model comes from "Law of Universal Gravitation" formulated by Isaac Newton in 1687. The Newton Law explains the attractive force between two objects by physical masses and distance between these objects (The Guardian Science 2013).

In 1962 Jan Tinbergen proved that roughly the same approach could be applied to international trade flows. At the same time new indicators often called "social interaction" like migration, tourism, levels of unemployment and foreign direct investments could be applied for the model (Bergstrand 1985). Prominent models of international trade at that time included the Ricardian model explaining the trade between countries by difference in technology and Heckscher-Ohlin theory explaining trade by differences in factor endowments. These theories couldn't provide a foundation for the gravity model since the sizes of the countries have no significant impact on trade between them. Because of that gravity model was often criticized for being purely econometric tool without a theoretical basis. But after 1980s various academic authors found a theoretical explanations for the gravity model. In particular in 1985 Bergstrand showed that basis for gravity model can be found in theory of monopolistic competition developed by Paul Krugman (Bergstrand 1985). Later in 2002 Eaton and Kortum in their study "Technology, geography and trade" provided gravity equitation from based on the theory of Ricardo (Kortum & Eaton 2002).

Generally gravity law can be provided by the following notation:

$$F_{i\,j} = G\,\frac{M_i^{\propto} * M_j^{\beta}}{D_{ij}^{\theta}}, \qquad \text{Equation 1}$$

where notation is defined as follows

$F_{i\,j}$ is the trade (migration) flow from i to j. In some cases it can represent the total volume of interactions between i and j as sum of flows in both directions

M_i and M_j are the relevant economic sizes of the two locations (if F measures the monetary flow it is usually Gross Domestic Product (GDP) or in some cases Gross National Product. If F measures the migration flows, M is often stands for population of both partners)

D_{ij}^{θ} is the geographical distance between locations (usually measured from center to center

G stands for the "gravitational constant"

The gravity equation can be treated as a presentation of the supply and demand forces for the trade. Country i can represent the origin with M_i as a total amount the country willing to supply where M_j can represent destination demand. Distance can be treated as a trade costs.

The multiplicative nature of the gravity equation means that natural logarithms can be taken to obtain log-linear equitation that can solved by applying least squares regression. The equitation assumes the following shape:

$$lnF_{i\,j} = \propto lnM_i + \beta\ lnM_j - \theta lnD_{ij} + ln\varphi_{ij} + \epsilon_{ij}, \qquad \text{Equation 2}$$

where φ_{ij} stands for trade costs and ϵ_{ij} is the error term.

The economic masses M_i and M_j are often measured by GDP of the bilateral trade partners. The usage of the natural logarithms allows to easy interpretation of the estimated parameters. For the example, the estimated parameter of the GDP in the formula is the elasticity of trade to GDP meaning that percentage variation in trade following a 1% increase in GDP.

The geographical distance between two countries is often measured using the "great circle formula". This formula estimates the earth as a sphere and calculates distance as a minimum along the surface. The calculate the distance between two country centers the longitude and the latitude are required (Bullock 2007). The formula has the following shape:

$$D_{ij} = 3962.6\,\text{arccos}\ \frac{\left(\{\sin(Y)_i * \sin(Y)_j)\right\} +}{+\{cos(Y_i) * \cos\left(Y_j\right) * \cos(X_i - X_j)\}}, \qquad \text{Equation 3}$$

where X is longitude in degrees multiplied by 57.3 to convert it to radians and Y is latitude multiplied by -57.3 (assuming it is measured in degrees West).

Using "great circle formula" for calculating geographic distance between countries couldn't matter much for the trade for the several reasons. For example, shipping routes between countries include various barriers such as indirect routes and ice blocks.

For that reason a number of variables are often used to estimate trade costs φ_{ij}. Apart from distance, other additional variables can be used for analysis. These variables could include dummies for islands, landlocked countries, common borders, existence of common infrastructure, common language, colonial history and cultural variables. Countries with common language and history are more likely to understand each other and have the similar business ethics that in the end can influence trade flows between countries. At the same time academic authors argue whether geographic borders between countries are still relevant for the trade. Kenichi Ohmae in his book "The bordless world" states that country borders are becoming irrelevant and explains that "fundamental paradigm shift has occurred that is changing the way business is being done" (Ohmae 1999).

Several studies on gravity are using R_j as a "remoteness" of the trade. Helliwell in his book "How much do national borders matter" state that "each bilateral flow should depend not just on the economic masses of the two trading partners and the distance separating them, but also on the economic masses and distances of alternative trading partners" (Helliwell 2000). To explain this, the following formula for remoteness can be used:

$$R_{ij} = \sum \frac{D_{ij}}{GDP_{ij}}, \qquad \text{Equation 4}$$

where D_{ij} stands for distance between countries.

Evaluating of country regional trade agreements under the scope of gravity model is also an important influential pattern for trade between countries. Free trade agreements like European market and North American Free Trade Agreement (NAFTA) can raise trade by around 50% according to academic research performed by Frankel and Rose. Moreover the authors see the connection between the currencies shared by different countries and their volume of trade. As a result traded volume can be increased by three times (Frankel & Rose 2000).

Gravity model for gas market

In 2015 Barnes and Bosworth published their study “LNG is linking regional natural gas markets: Evidence from the gravity model” in journal Energy Economics (Barnes & Bosworth 2015). In their research the authors used gravity model to test whether trade in LNG provides de-regionalization at the total natural gas market. For testing these, authors used LNG and compressed natural gas (CNG) markets separately.

The study employs data from U.N. comtrade database separately for CNG (HS 271121) and LNG (HS 271111). The reported period includes 1988 to 2011. To form a dataset for gravity analysis the U.N. comtrade database was merged with data from World Bank’s Development Indicators. It includes GDP both for exporters and importers, unemployment ratios, share of natural gas production in GDP, share of protected territory in the country. The distances between countries were calculated based on “great circle formula” described above.

The panel regression with random effects was used in the research. Random effect was used because fixed effect estimator doesn’t estimate the coefficient for the variables. Regression was performed both for exporters and importers.

Variables	(1)	(2)	(3)
	Total	CNG	LNG
Log(distance)	−1.258***	−2.880***	0.155
	(0.469)	(0.540)	(0.494)
Export			
Log(GDP)	−0.0488	−0.259	0.218
	(0.331)	(0.408)	(0.333)
Landlocked	−3.796	−6.518***	−6.014*
	(2.712)	(2.387)	(3.340)
Unemployment %	−0.0342	−0.0578	−0.199**
	(0.0727)	(0.101)	(0.0810)
Nat. Gas GDP %	0.119*	0.229***	−0.124
	(0.0627)	(0.0623)	(0.115)
Protected land %	−0.0982	−0.206**	0.0406
	(0.0678)	(0.0915)	(0.0691)
Import			
Log(GDP)	0.0193	0.122	−0.0350
	(0.365)	(0.456)	(0.360)
Landlocked	4.194**	2.415	−2.760
	(2.078)	(1.962)	(2.545)
Unemployment %	0.0983	0.148*	−0.00423
	(0.0728)	(0.0787)	(0.107)
Nat. Gas GDP %	−0.149	−0.219	−0.120
	(0.112)	(0.135)	(0.131)
Protected land %	0.0187	−0.0234	−0.000791
	(0.0497)	(0.0511)	(0.0565)
Time trend	0.00570	−0.0577	0.189**
	(0.0578)	(0.0658)	(0.0771)
Constant	22.44***	40.12***	5.924
	(6.368)	(8.076)	(6.585)
Observations	507	290	264
Number of pairs	146	75	104
R^2	0.217	0.412	0.133

Standard errors are in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Table 7. Panel regression with random effects for gas trade (Source: Barnes, R., & Bosworth, R. (2015). LNG is linking regional natural gas markets: Evidence from the gravity model. Energy Economics, 47, 11–17.)

The results of the regression are shown in Table 6. The p values for distance for LNG trade shows that there is no statistical significant correlation between trade and the distance. On the other hand p value for CNG trade is lower than 0.01 meaning that it is a strong correlation between distance and CNG bilateral trade between countries. Overall the result states that LNG is traded on an international market while CNG is purely regional commodity.

Other results from panel regression and pooled ordinary least square method shows that LNG trade has been increasing at average rate of 20% per year. GDPs both of importer and exporter have no significant influence on the trade. Taking into account coefficients for the variables it is seen landlocked export countries trade less and import landlocked countries trade more. Share of protected land influence the CNG trade significantly for export countries.

The main findings from Barnes and Bosworth are that recent increasing in LNG exports is the main influencial factor to the increasing integration at global natural gas markets. LNG trade between countries becomes less sensitive to the distance between countries (Barnes & Bosworth 2015).

Gravity model for LNG bilateral trade

Using the gravity model theory, the more detailed regression model for LNG trade can be designed to estimate the main drivers on the global LNG market. The model used by Barnes and Bosworth and findings of their study can be extended to evaluate level of influence for each selected factor.

To design the gravity the following variables can be included in the research. These are distance between traded partners, variable for GDP, binary variable for landlocked countries, variable for unemployment rate, variable for natural gas rent, variable for share of protected areas in the country, variable for gas consumption, variable for proved reserves of natural gas in the country, variable for research and development expenditure in the country, variable for natural gas traded flows between countries, binominal variable for gas pipeline existence between countries.

GDP data is provided by World Bank. “GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used” as stated on the official web resource of World Bank (World Bank 2015a).

Distances between traded partners obtained from CEPII database. CEPII is the French research center that provides various datasets for researchers in international economics. Mayer and Soledad collected various variables in their “The GeoDist database” for the 225 different countries (Mayer & Soledad 2011). Using this dataset information on landlocked countries was obtained as well.

Data for unemployment rates (% of total labor force) obtained from World Bank as well. This indicator measures share of the labor force without work but willing and available for employment (World Bank 2015e). The indicator can be used as a proxy for the level of economic development in the country.

Natural gas rents (% of GDP) data is also provided by World Bank and defined as “the difference between the value of natural gas production at world prices and total costs of production” (World Bank 2015b). The variable is important because it can significantly influence the gas trade between countries. Also it measures the size of the gas industry in the country.

Share of protected areas in the country or terrestrial protected areas (% of total land area) provided by World Bank are defines as “totally or partially protected areas of at least 1,000 hectares that are designated by national authorities as scientific reserves with limited public access, national parks, natural monuments, nature reserves or wildlife sanctuaries, protected landscapes, and areas managed mainly for sustainable use. Marine areas, unclassified areas, littoral (intertidal) areas, and sites protected under local or provincial law are excluded”(World Bank 2015d). The indicator is vital for the countries having significant gas reserves but limited by Government of not using special territories. Countries with high share of the value could import more and export fewer natural resources.

Gas consumption data is provided by U.S. Energy Information Administration (U.S. Energy Information Administration 2015a). The variable is important and can have significant impact for the trade especially for exporter as discussed previously as a limitation factor for LNG exports.

Data on proved reserves of natural gas is also provided by U.S. Energy Information Administration (U.S. Energy Information Administration 2015b). It can be considered that countries with abundant reserves can export more. The variable could influence the gas trade between countries.

Variable for research and development expenditure in the country can be used as a proxy for science and technological development indicator in the country. Data for indicator is provided by World Bank. “Expenditures for research and development are current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge, including knowledge of humanity, culture, and society, and the use of knowledge for new applications. R&D covers basic research, applied research, and experimental development” (World Bank 2015c).

Data on LNG and natural gas reserves is provided by U. N. comtrade database (U.N. Comtrade 2015). Global trade flows can be sorted by using 6 digit HS code for LNG “271111” and for compressed natural gas “271121”.

Taking into account all mentioned variables the gravity equitation has the following form:

$$\ln\left(exports_{ij}\right) = \alpha \ln(egdp) + \beta\ln(igdp) + \gamma \ln\left(dist_{ij}\right) + \delta * eld + \delta_1 * ild + \delta_2 * eun + \delta_3 * iun + \delta_4 * engr + \delta_5 * ingr + \delta_6 * epl + \delta_7 * ipl + \delta_8 * egc + \delta_9 * igc + \delta_{10} * egr + \delta_{11} * igr + \delta_{12} * erd + \delta_{13} * ird + \delta_{14} * eng + \delta_{15} * ing + \delta_{16} * ep + \delta_{17} * ip + \varepsilon,$$ Equation 5

where:

$exports_{ij}$ – LNG traded volumes between pair of countries i and j (kg);

$egdp$, $igdp$ – GDP value for exporter and importer respectively (US$);

$dist_{ij}$ – distance between pair of countries i and j (km);

eld, ild – binary variable for landlocked countries both for exporter and importer (1=landlocked, 0=not landlocked);

eun, iun – unemployment rates both for exporter and importer (%);

$engr$, $ingr$ – natural gas rent both for exporter and importer (%);

epl, ipl – share of protected territory both for importer and exporter (%);

egc, igc – gas consumption both for exporter and importer (BCF);

egr, igr – natural gas reserves both for exporter and importer (TCM);

erd, ird – research and development expenditure both for exporter and importer (%);

eng, ing – traded volume of compressed natural gas (BCM);

ep, ip – binary variable for pipeline existence both for exporter and importer (1=pipeline; 0=no pipeline);

ε – error term.

The bilateral data for 2002-2014 period is used by the model. Starting as from 2002 the LNG trade has been increased significantly. The panel data includes all countries engaged in gas trade flow both LNG and CNG.

The regression results for the model are shown below in Table 8.

VARIABLES	(1) LNG exports
lndistance	-0.554**
	(0.257)
lnexportergdp	-0.153
	(0.231)
lnimportergdp	0.504***
	(0.176)
exporterlandlocked	-1.578
	(1.166)
importerlandlocked	-2.236**
	(0.890)
exporterunemployment	-0.0451
	(0.0508)
importerunemployment	0.0460
	(0.0531)
exporterngrent	0.108***
	(0.0293)
importerngrent	-0.0842
	(0.0669)
exporterprotectedland	-0.00792
	(0.0210)
importerprotectedland	-0.0444*
	(0.0257)
exportergasconsumption	-0.000861***
	(0.000228)
importergasconsumption	6.16e-05
	(0.000127)
exporterreserves	0.00868***
	(0.00136)
importerreserves	-0.00350
	(0.00356)
exporterrd	-0.146
	(0.404)
importerrd	-0.354**
	(0.180)
exporterng	0***
	(0)
importerng	-0
	(0)
o.exporterpipeline	-
o.importerpipeline	-

Constant	8.502
	(7.364)
Observations	962
R-squared	0.32

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8. Regression results for global LNG export trade with random effects (Source: compiled by author using Stata)

The first parameter need to be looked at is R-squared. The overall R-squared parameter as seen in the Table 7 is 0.3155 meaning that 31.55% of variation in LNG exports can be explained by observed variables. The parameter of R-squared has statistically low value. Barnes and Bosworth in their research had R-squared 0.133 for LNG trade and they used only 5 parameters (Barnes & Bosworth 2015) (Table 6). It means that parameters chosen for this model explain variation more significantly.

To prove the hypothesis of Barnes and Bosworth that trade of compressed natural gas (transported by pipeline) has regional nature, the regression can be run for the following model:

$$\ln(eng_{ij}) = \alpha \ln(egdp) + \beta \ln(igdp) + \gamma \ln(dist_{ij}) + \delta * eld + \delta_1 * ild + \delta_2 * eun + \delta_3 * iun + \delta_4 * engr + \delta_5 * ingr + \delta_6 * epl + \delta_7 * ipl + \delta_8 * egc + \delta_9 * igc + \delta_{10} * egr + \delta_{11} * igr + \delta_{12} * erd + \delta_{13} * ird + \delta_{14} * exports + \delta_{15} * ing + \delta_{16} * ep + \delta_{17} * ip + \varepsilon, \quad \text{Equation 6}$$

In this formula the trade of compressed natural gas is observed variable and LNG export is one of the independent in the model. The results are shown in the Table 9.

VARIABLES	(1) NG exports
lndistance	-0.831***
	(0.255)
lnexportergdp	1.658***
	(0.247)
lnimportergdp	-0.264
	(0.177)
exporterunemployment	-0.0823**
	(0.0414)
importerunemployment	0.0707*
	(0.0413)

exporterngrent	0.00866
	(0.0348)
importerngrent	-0.208*
	(0.124)
exporterprotectedland	-0.100***
	(0.0314)
importerprotectedland	0.00252
	(0.0241)
exportergasconsumption	0.000104
	(0.000195)
importergasconsumption	0.000221
	(0.000139)
exporterreserves	0.00991***
	(0.00141)
importerreserves	-0.00193
	(0.00566)
exporterrd	0.772*
	(0.420)
importerrd	0.000241
	(0.195)
exporterng	9.50e-11***
	(0)
importerng	0
	(0)
o.exporterpipeline	-
o.importerpipeline	-
exports	7.10e-11**
	(0)
Constant	-15.23**
	(7.536)
Observations	965
R-squared	0.52

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9. Regression results for global compressed natural gas trade with random effects (Source: compiled by author using Stata)

The R-squared value as seen from the Table 7 is 0.5154. Barnes and Bosworth had R-squared lower value of 0.412. The regression results from Table 8 confirm the hypothesis of Barnes and Bosworth that LNG is indeed global commodity, whereas the compressed natural gas trade is more regional (Barnes & Bosworth 2015).

To coefficients from Table 8 for compressed natural gas trade can be treated as follows. 1% increase in the distance between countries will decrease trade by

0,83%. GDP increase of exporter will increase trade by 1,65%. This effect is statistically significant at the 1% level indicated by p-value in the Table for above mentioned variables.

Since one of the research question for this study is to identify core drivers for supply and demand on the LNG market the model should be updated according to statistical significance of the variables included in the model.

Taking into account p-values from the Table 7 we can leave in the model only some variables being of interest for defining drivers for the trade. These are binary variable whether importer is landlocked or not, exporter natural gas rent (% of GDP), exporter gas consumption, exporter natural gas reserves, importer research and development expenditures (% of GDP) and exporter compressed natural gas trade volumes. Binary variable for exporter and importer using pipeline for gas transportation can be omitted from the model because they have perfect collinearity with the compressed natural gas trade volumes.

The updated model will take the following shape then:

$$\ln\left(exports_{ij}\right) = \alpha \ln(egdp) + \beta \ln(igdp) + \gamma \ln\left(dist_{ij}\right) + \delta_1 * ild + \delta_4 * engr + \delta_8 * egc + \delta_{10} * egr + \delta_{13} * ird + \delta_{14} * eng + \varepsilon, \quad \text{Equation 7}$$

The regression results are shown in the Table 10.

VARIABLES	(1) LNG exports
lndistance	-0.228
	(0.193)
lnexportergdp	0.0382
	(0.103)
lnimportergdp	0.499***
	(0.0860)
importerlandlocked	-0.997*
	(0.597)
exporterngrent	0.105***
	(0.0248)
exportergasconsumption	-0.000908***
	(0.000155)
exporterreserves	0.0113***
	(0.00134)
importerrd	-0.0945
	(0.137)
exporterng	0
	(0)
Constant	-0.991

	(3.111)
Observations	1,851
R-squared	0.27

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10. Regression results for global LNG trade with selected variables with random effects (Source: compiled by author using Stata)

The results from the Table 10 show that R-squared has been decreased comparing to initial regression for gravity model in Table 7 to 0.2733 meaning that 27% of variation of observed variable can be explained by variations in independent variables. At the same time it is seen that increasing of exporter and importer GDP positively affect the trade while distance has a negative impact on the trade. The natural form of logarithms can lead to the following conclusions. 1% increase in the distance will lead to 0.22% decrease in the trade. 1% increase of exporter and importer GDP will lead to 0.03% and 0,49% increase in the trade respectively.

Based on the results from the final model and taking into account statistical significance of the variables and p-values, it is seen that some variables has more statistical influence on the observed LNG trade variable. These are importer GDP, exporter natural gas rent (% of GDP), exporter gas consumption and gas reserves of the exporter.

The analysis made described the main factors from supplier perspective, from the exporter side. To identify influencial factors for the LNG trade the same gravity model should be run for import LNG flows. The results are shown in the Table 11. The following gravity model is used:

$$\ln(imports_{ij}) = \alpha \ln(egdp) + \beta \ln(igdp) + \gamma \ln(dist_{ij}) + \delta * eld + \delta_1 * ild + \delta_2 * eun + \delta_3 * iun + \delta_4 * engr + \delta_5 * ingr + \delta_6 * epl + \delta_7 * ipl + \delta_8 * egc + \delta_9 * igc + \delta_{10} * egr + \delta_{11} * igr + \delta_{12} * erd + \delta_{13} * ird + \delta_{14} * eng + \delta_{15} * ing + \varepsilon$$, Equation 8

where $imports_{ij}$ –LNG bilateral import trade between I and j countries

	(1)
VARIABLES	LNG imports
lndistance	0.127
	(0.251)
lnexportergdp	1.440***
	(0.141)
lnimportergdp	-0.917***
	(0.208)
exporterlandlocked	0.506
	(0.898)
importerlandlocked	-1.733
	(1.289)

exporterunemployment	0.0579
	(0.0469)
importerunemployment	-0.00501
	(0.0389)
exporterngrent	-0.156*
	(0.0870)
importerngrent	0.0940***
	(0.0267)
exporterprotectedland	0.0348
	(0.0246)
importerprotectedland	-0.0535***
	(0.0208)
exportergasconsumption	-3.59e-08
	(2.54e-07)
importergasconsumption	-4.29e-06***
	(6.98e-07)
exporterreserves	3.34e-06
	(1.25e-05)
importerreserves	-9.75e-06
	(1.79e-05)
exporterrd	-0.282*
	(0.158)
importerrd	-0.233
	(0.231)
exporterng	0
	(0)
importerng	0*
	(0)
Constant	-2.234
	(7.199)
Observations	994
R-squared	0.3725

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11. Regression results for global LNG import trade with random effects (Source: compiled by author using Stata)

The R-squared for the LNG import trade model is 0.375 meaning that 37.5% changes in import trade is explained in changes of independent variables.

Taking into account p-values from the Table 10 we can leave in the model only some variables being of interest for defining drivers for the import trade specifically. These are import natural gas rent (% of GDP), importer protected land (% of all territory), importer gas consumption. The modified gravity model can be built:

$$\ln(imports_{ij}) = \alpha \ln(egdp) + \beta \ln(igdp) + \gamma \ln(dist_{ij}) + \delta_5 * ingr + \delta_7 * ipl + \delta_9 * igc + \varepsilon,$$ Equation 9

The regression results are shown in the Table 12.

VARIABLES	(1) LNG imports
lndistance	0.448***
	(0.143)
lnexportergdp	1.201***
	(0.0619)
lnimportergdp	-0.696***
	(0.0754)
importerngrent	0.0627***
	(0.0141)
importerprotectedland	-0.0193
	(0.0136)
importergasconsumtion	-9.86e-07*
	(5.73e-07)
Constant	-4.881*
	(2.574)
Observations	3,208
R-squared	0.4321

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12. Regression results for global LNG import trade for selected variables with random effects (Source: compiled by author using Stata)

In the case with imports the R-squared parameter improves significantly and according to Table 12, 42% of LNG import trade flows can be explained by variation in distance, GDP of the countries, importer natural gas rent, importer protected territory and importer gas consumption.

5.1. Discussion of results

As described in the previous chapter the main drivers for supply side of LNG trade are importer GDP, exporter natural gas rent (% of GDP), exporter gas consumption and gas reserves of the exporter. The key drivers from demand side are distance, GDP of the countries, importer natural gas rent, importer protected territory and importer gas consumption.

The exporter natural gas rent is the difference between natural gas production and total costs of production. It is calculated as a share in GDP (% of GDP). Among LNG exporters only Qatar have value of this indicator more than 10%, in 2013 it was 11% (WB 2015). Apart from other meanings it shows the dependency of country on the sector and diversification of production. Qatar is one of the country which much more narrowly that others focuses on the developments specifically in LNG sector. Other big LNG producers like Malaysia and Indonesia have 4% and 2% respectively (World Bank 2015b). In case with LNG trade, this indicator can be of interest for countries that don't have pipeline networks with other countries and are involved only in LNG trade. Moreover this indicator is declining last years for these countries. According to regression results in Table 9 it is seen that increase of natural gas rent by 1% will increase the LNG exports by 0.1%.

Exporter gas consumption is important indicator influencing directly the LNG exports in the countries. It was stated in this research before that a lot of countries had to cut their LNG export plans because of increasing in local gas consumption, like it happened in Malaysia and Oman. Russia is one of the leader in gas consumption in the world but the consumption value was stable during the period of 2002-2014, it was between 13500-1500 BCF (U.S. Energy Information Administration 2015b). The same can't be said for other LNG suppliers. During the same period Indonesia and Trinidad and Tobago almost doubled their consumption by 2014. Qatar consumption was increased from 392 BCF to 1162 BCF (U.S. Energy Information Administration 2015c). Based on the regression results each increase of consumption by 1 BCF on the exporter side will decrease the LNG exports by 0.0009%.

Almost all suppliers on the LNG market have prominent natural gas reserves. For some countries this volume had been increasing in time due to discoveries of new gas fields in the country. The discoveries of new gas fields can influence in LNG exports according to regression results, by increasing reserves by 1 TCF the LNG exports can be increased by 0.01%.

From the demand side the factors are similar to the suppliers market but with opposite effect. According to results in Table 11 increasing of the gas consumption in the country can lead to imperceptible decrease in LNG imports. This statistical conclusion is quite illogical and can be explained by overall statistical significance of the model. The 1% increase of importers GDP lead to 0.69% decrease in the import flow.

In both regression results distance is not a significant factor for the trade and it can be explained by decreasing in transportation tariffs. Increasing of importers and exporters GDP can positively influence the LNG trade from suppliers side.

Overall regression results show that gas consumption is the vital characteristics for LNG trade development. And it comes from the simple arguments, from the exporter side – the more country consume, the less it can export, from importer side – the more country consume, the more it is demanding. For exporter gas reserves are important and development of new territories whether it is new land or shelf is important for LNG developments. More developed countries tend to trade more as it can be expected from the nature of gravity equation.

6. Final results and recommendations

As mentioned in the previous parts of this study in 2014 global LNG exports was 327.9 BCM and Russia's impact was 14.8 BCM that is equal to 4,5% of all LNG global export (WITS 2015). Before that period the Russian LNG share was in average 3.6%. Taking into account main drivers analysis for the LNG export market, Russia has all suppositions to develop in the Global LNG sector.

From the supply side the growth of the global LNG market will be stipulated by the following factors:

- implementing of numerous LNG projects in Australia
- appearance of new suppliers on the market like Canada, Columbia, USA, Iran and Venezuela
- developments in LNG production technology resulting cost decreasing of production including gas extraction from hard-to-reach regions
- promotion and developing new sea gas fields
- technology developments of gas extraction from coal beds and complex rocks

From the demand side the growth will be dictated from the following factors:

- overall growth of gas consumption in the world
- demand growth from fats-growing economies of Asia-Pacific region principally in China and India
- degradation of performance of nuclear energy, specifically in some European countries, with refocusing on gas
- campaign developments for decreasing polluting emissions
- technology development for transporting, storing and production of LNG

According to the State LNG plan – 2035 Russia focuses on the Asia-Pacific market in LNG export. Nowadays world demand for LNG reached its peak and growth rate has become higher than for compressed natural gas. Compressed natural gas trade has been increased by 4% during 2011-2014, while LNG trade increased by 10% (BP 2014). Beside Japan and South Korea which increase their LNG consumption during last years, demand will be increased from other fast-developing LNG consumers like India, China, Bangladesh, Pakistan, Thailand, Singapore and Philippines.

Japan is the longest-standing LNG consumer in the world. There is no gas extraction in the country and gas pipeline infrastructure doesn't exist. Because of these Japan remains the biggest LNG consumer in the world – 36% of global LNG imports in 2014 (WITS 2015). Moreover Japan has the biggest number of LNG receiving terminals. The main LNG suppliers are Australia, Qatar and Malaysia. 50% of Sakhalin-2 volume has already been contracted by Japanese companies. Due to accidents related to earthquake and incident with the Fukushima nuclear plant, in September 2013 the last nuclear pile had been stopped in Japan by Kansai Electric Power Company. All that events leads to reconsideration of energy policy by Japanese government. At the same time increasing of LNG volumes is closely connected to GDP growth of Japan. According to OECD forecast the Japanese GDP will be growing slowly in long-term prospective, not more than 1% annually meaning the LNG imports will remain stable (OECD 2015). To increase its share on the Japanese market Russia needs to create new competitive advantage for this market first of all by reducing cost of LNG production to outrun main competitors from Qatar, Australia and Malaysia. Moreover Japan is an active participant of LNG spot market where Russia is still not participating in.

South Korea's LNG imports had been increased by 45% to 49.7 BCM during 2010-2014 (WITS 2015). The LNG demand is explained by growth in the industry production mainly. In the end of 2004 the first Korean gas platform was launched in Japanese sea, 58 km from East Coast near Ulsan city. The reserves are estimated as 5-6 MT/a that counts only about 2% of total gas consumption in the country. That is why Korea is the second LNG importer in the world (BP 2014). In 2010 South Korean Ministry of Knowledge Economy announced its strategic plan for decreasing energy dependence of the country. The government forces local energy companies to buy foreign gas infrastructure and develop its own offshore gas reserves.

Chinese gas market considered to be most promising for LNG exports. Government promotes using natural gas more aggressively due to a pollution issues related to coal use. During the last five years gas consumption in China had been increased twice to 73.2 BCM in 2014 (U.S. Energy Information Administration 2015b). The Chinese Government runs a national program to implement LNG in energy sector of the country to stand a promise of CO2 emissions reduction by 40-50% by 2020. Russia is the fifth supplier for Chinese LNG market.

Taking into account developments on the demand side the most attractive LNG markets for Russia are countries from Asia-Pacific region. Specifically Japan, Korea and China. According to OECD report South Korean GDP will be growing on average 3% annually and Chinese 4% annually that can lead to increasing of LNG import consumption. India and China also show the biggest growth rate for gas consumption. The existing LNG exports to Japan, Korea, China and India from Sakhalin-2 could build long-term relations with these countries for other Russian LNG projects.

Russia has fundamental factor as exporter to succeed on the global LNG market. The biggest gas reserves factor is the most significant one. Liberalization on the Russian gas market could bring new players and global energy companies on the market with necessary technology and skills for producing more competitive commodity. Recent sanctions against Russia and limitations in international financing can put in a risk new Russian LNG projects. This can be crucial for LNG sector development while other competitors enlarge their production capacities. More importantly is that Russian Government expectations from Northern Sea Route are most likely will not prove to be true. LNG is the global commodity and distance factor doesn't influence trade at all. The gravity model for LNG trade also proves that.

According to various reports and forecasts, Russian GDP I long term will not be growing inconsiderably, in the nearest years it is more likely that it will be decreasing. This will definitely influence the LNG trade with Russia. GDP growth could become the stoppage factor for trade development.

As a result taking into account increasing consumption of LNG and growth rates of GDP of main consumers, there are no constraints for Russia on the macro level. The crucial factors lay in the micro level where further liberalization is needed and technology breakthrough is required. Only by interplay of all these factors Russia can reach the goals set in the long-term State Energy Strategy. According to various reports and forecasts, during the next years Russian GDP will not be growing inconsiderably, in the nearest years it is more likely that it will be decreasing. This will definitely influence the LNG trade with Russia.

Under the framework of SWOT analysis the main opportunities for Russian LNG sector are markets where the gas consumption is growing fast and own gas reserves are not sufficient. At the same time threats are coming from other LNG producers where technology and LNG capacities have been improved and increased rapidly during the last years.

Further studies of this subject can be focused on identifying more specific correlations between specific countries in the LNG trade. More relevant factors can be identified for the specific LNG markets.

7. Conclusion

Russian LNG Strategic Plan – 2035 has been created to identify main goals and development ways for Russian LNG industry. The Plan doesn't identifies specific means how the objectives will be achieved. The three main objectives are – 30% of independent LNG producers on the market, 30% of gas export consumers to be located in Asia-Pacific region and 30% - share of LNG exports in total gas exports. These targets should be achieved by 2035.

The internal factors on the micro level such as existence of conventional pipeline network, possible operational extension of northern sea route, gas reserves and lack of LNG technology, form the way where Russia develops its LNG future. With such level of liberalization, where few state companies still rule the market, start of new LNG projects can be postponed. For the same reason it becomes more difficult to attract investors to the market and as a result apply modern technology in LNG production. More than that the situation is complicated by the economic sanctions against Russia.

The gravity model of bilateral trade being the popular tool among academic researchers provides interesting results for the study. First of all, the model shows that distance is no longer significant in the LNG trade, and LNG is the global commodity, because transportation costs become lower and remote countries can trade LNG without additional obstacles. Moreover the GDP values both for exporter and importer are also significant for the trade (basically it comes from the nature of the economic gravity theory).

From the suppliers' side the most significant factors are gas reserves and gas consumption in the country. Some huge LNG exporters like Indonesia and Oman had to decrease their exports because of increasing local gas consumption. So this can be the stoppage factor for the further development. Sufficient gas reserves in Russia most likely will not create such situation for the country where revenues from gas exports have become so sizeable for the budget.

From the demand side the development level of the country (for example, GDP indicator) is one of the determinant for LNG imports. The local gas consumption also drives the trade between countries.

By looking at the existing partners in first LNG project of Russia – Sakhalin-2, the conclusions can be made that these countries, specifically Japan, Korea and China, will continue demanding significant amount of LNG in the future. Moreover the emerging markets like India, Thailand and Bangladesh show significant growth in LNG trade.

As a result Russia has no serious obstacles on the demand side. The developments should start internally and first of all further gas industry liberalization is required. Almost all LNG big exporters have already liberalized their markets. Long-term goals achievement, set in the Strategic LNG Strategy, are highly improbable. Appearance of new players on the Russian LNG market and development of new technologies for gas extraction, production and transportation, together with existing gas reserves, could bring Russia to the top of the global LNG market.

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