Forecast Model of Prices for Liquefied Natural Gas in the World Asian Energy Market

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Abstract: The relevance of the study lies in the fact that concerning the strategic objectives of Russia to take a share of the growing world market of liquefied natural gas, it is advisable to assess the impact of factors affecting the development of the global liquefied natural gas market. This article provides a comparative analysis of exports and imports in the global LNG market by region, identifies potential trends in the development of global LNG trade over the past 50 years, it makes a price forecast for liquefied natural gas (LNG) for the Asia-Pacific region (APR) based on a correlation and regression analysis of the dependence of LNG prices on changes in factors such as world oil prices, global demand for LNG, exchange rates and growth rates of the Asia-Pacific economies.

Keywords: Forecast, liquefied natural gas, the world market.

INTRODUCTION

Currently, Russia is one of the leaders among oil and natural gas exporters in the global energy market (Vasiljeva, Ponkratov, Kharlamova, Kuznetsov, Maramygin, and Volkova, 2019; Osipov, Ponkratov, Karepova, Bloshenko, and Vorontcov, 2019; Semin, Ponkratov, Sokolov, Lenkova, and Pozdnyaev, 2019). In addition to the oil and gas revenues annually incoming to the federal budget, the growth of GDP (Gross Domestic Product) and national income directly depend on the prospects of oil and gas companies. LNG production, which ensures independence from transit through the territory of third countries, the ability to engage remote gas reserves in commercial use, diversification of gas supply directions, and penetration into previously inaccessible markets, are extremely important for Russia's gas export (Razmanova and Machula, 2016).

In terms of LNG delivery to almost anywhere in the world, it is an alternative to other types of fuel, including natural gas pipelines, which is facing growing competition between gas suppliers and the increasing number of exporting countries (Van Chien, 2020; Osipov, Karepova, Chizhevskaya, Gnatyuk, Semin, and Mikhayluk, 2018).

The object of the study is retrospective and current trends in the global LNG market. The subject of the research is the history of the LNG market development and the LNG pricing in the Asia-Pacific region.

The purpose of the study is to forecast the world LNG prices in the Asia-Pacific region based on a historical analysis of the global LNG market and identifying pricing features in different regions. Under the study purpose, the following tasks were developed. Firstly, we compare world gas exports and imports to reveal the volume of world trade in liquefied natural gas for 50 years; secondly, we conduct a historical analysis of the global LNG market and highlight its main stages; and thirdly, we forecast LNG prices using regression analysis of the correlation of world prices with the main factors affecting the level of world prices for LNG in the Asia-Pacific region.

RESEARCH METHODS

The research methodology is based on the main provisions of the economic theory and system analysis, methods of correlation-regression analysis of the multiple variables' changes impact on the construction of a forecast model of prices for liquefied natural gas in the Asia-Pacific region. The study novelty is the development of a practice-realistic forecast model of changes in LNG prices in the Asia-Pacific market. An interesting fact was that based on the historical analysis of the world LNG market, the price formation features in different regions of the world were identified and taken into account. The forecast model we created differs and is more realistic and tested from the proposed model of other authors from Russia (Razmanova and Machula, 2016) and differs from them by the results and conclusions of this LNG market research).

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The research uses the following scientific methods: general scientific methods (systematic and historical method, analysis and synthesis method); specific scientific methods (research method, problem sequential method, trend analysis); theoretical methods with subsequent analysis and generalization of results (statistical, empirical and comparison methods).

In the course of the study, to build a predictive model of the dependence of the price of LNG for the Asia-Pacific region, the method of correlation and regression analysis was used to identify the correlation between factors. The significance of multiple correlation and determination coefficients were calculated and verified. The factors were selected that have the most significant effect on the resulting indication, based on measuring the degree of correlation between them. With a statistical input processing program, called StatSoft Statistica 10.0 (Statistica Package) correlation and regression analysis were conducted to identify the relationship between the studied parameters and to build a linear equation of the forecast model. In this regard, based on the research of specialists studying the global LNG market, a list of the main factors (input indicators) that affect the formation of LNG prices (Y_{LNG} APR) - LNG price for Asia-Pacific, USD / thousand m^3), such factors, is selected as x_1, the oil price in USD/bbl, x_2,. global demand for LNG in the Asia-Pacific region in million tons, x_3, exchange rate in RUB/USD and x_4 - APR economy percentage growth rates. First, a correlation analysis was carried out, where a correlation matrix was built, which showed the significance and direction of the relationship between the factors. Then strongly correlated features were excluded from the model since they would make the model inadequate. And further, a regression (projecting) model was built to compile a forecast for LNG prices.

Forecast model of the dependence of the price of LNG for the Asia-Pacific region:

$$Y_{LNG} = -61.45 + 3.06x_1 + 1.504x_2$$

where,

- indices for each analyzed parameter of the model shows how much the investigated parameter Y(LNG) changes when the affecting factors change
- the value of the intercept of the equation (-61.45) characterizes the negative impact on the price of LNG and other factors not taken into account in the model. This means that when analyzing a wider list of factors, the dynamics of LNG prices will decrease. The effectiveness of using the proposed model for forecasting LNG prices for the Asia-Pacific region has been proved by checking the reality of the model results in the retrospective period.

RESULTS AND DISCUSSION

Analysis of the dynamics of the world's gas trade volumes for 1950-2018, shows that the world market of LNG has undergone considerable changes (Table **1**).

Currently, global LNG supplies account for one-third of the global gas market. The volume of world LNG production increased from 140 million tons in 2005 to 250 million tons in 2015 (Gazprom, 2015). In 2018, LNG exports increased by 9.9% and reached 399.2 billion cubic meters, while pipeline gas exports grew by

Table 1: Dynamics of World Gas Trade in 1950-2018

Period	Liquefied natural gas, billion m^3	LNG share,%	Total, billion m^3	LNG share,%	Total, Billion m^3
1950	-	0	0.8	100.0	0.8
1960	-	0	5.3	100.0	5.3
1970	2.7	5.9	43.0	94.1	45.7
1980	31.3	15.6	169.6	84.4	200.9
1990	72.1	23.4	235.3	76.6	307.4
2000	137.7	21.8	492.8	78.2	630.5
2010	296.3	29.2	718.9	70.8	1015.1
2015	338.3	32.5	704.1	67.5	1042.4
2018	399.2	35.0	740.7	65.0	1139.9

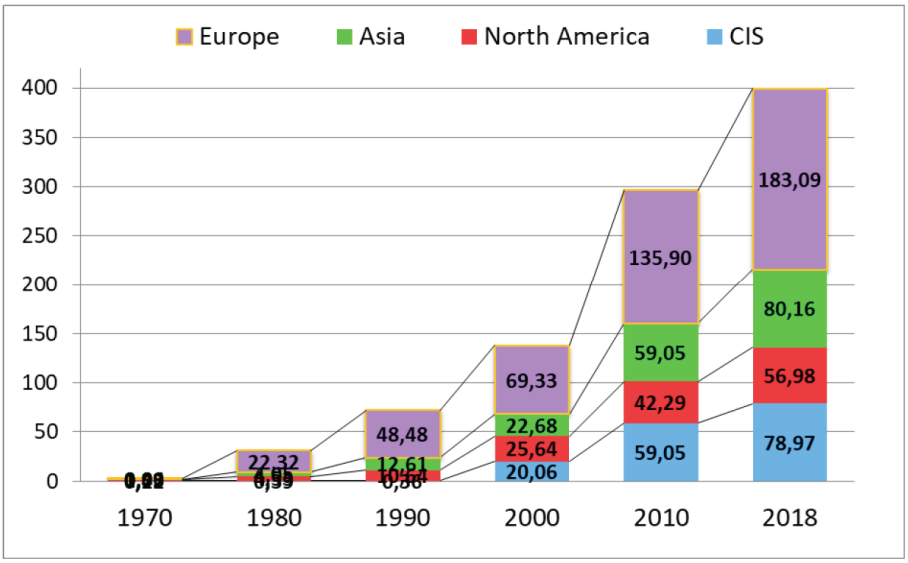

Figure 1: The structure of volumes of world LNG import by regions for 1970-2018, billion m^3.

3.5% to 740.7 billion cubic meters. According to the international GIIGNL LNG importers group, today more than 70% of global gas is supplied to consumers through the pipeline system and about 30% is sold as LNG (Pasture and Belova, 2013). According to estimates, in 2015, the volume of LNG trade in the world amounted to 250 million tons, with an increase of 1.7% (or 4.2 million tons) compared to 2014 (Dmitrieva, 2015).

The volume of world trade in natural gas amounted to more than 1 trillion cubic meters, while the share of natural gas transported through gas pipelines is 65%. and the share of LNG is 35% (Table **2**).

Figure **1** shows the growth in global LNG imports by region for 1970-2018 (Europe, Asia, North America, and the CIS) - from 2.7 billion cubic meters in 1970 up to 400 billion cubic meters in 2018.

At first, the LNG from the Middle East was supplied mainly to the markets of Northeast Asia, but later on, Europe and North America began to consume the product as well (Alferov, 2016).

The growth in global LNG exports in Europe, Asia, North America, and the CIS by region totaled from 1.4 billion cubic meters in 1970 to 293.62 billion cubic meters in 2018 (Figure **2**).

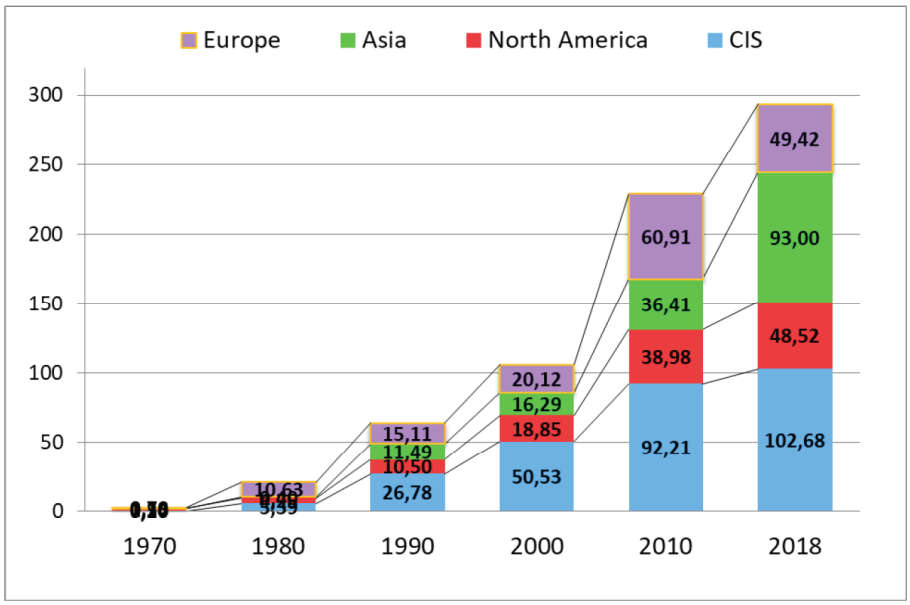

Figure 2: Structure world's LNG exports by regions in 1970-2018, billion m^3.

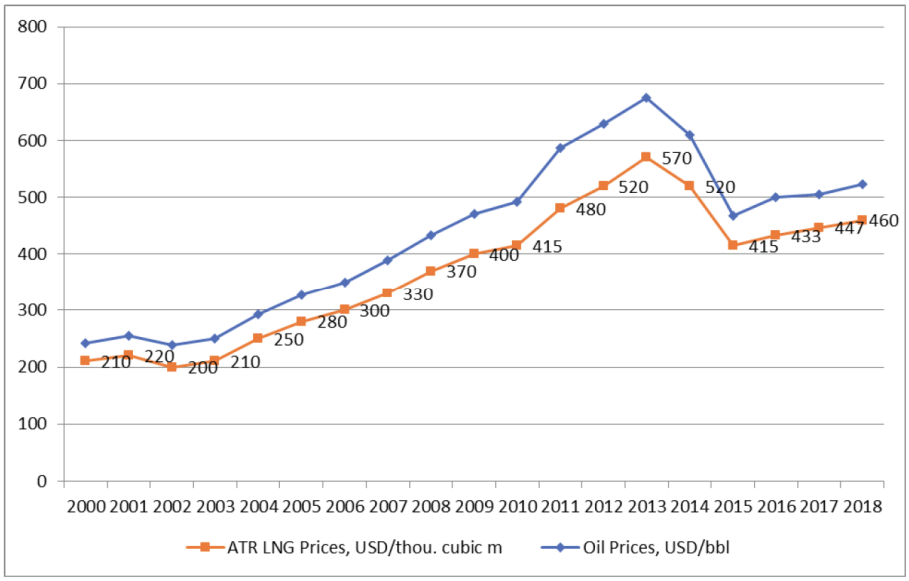

Figure 3: The structure of global LNG exports by region in 1970-2018, billion m^3.

The dynamics of world prices for LNG in 2000-2018 are shown in Figure **3**. The average LNG prices were set at 210 USD in 2000 and 460 USD in 2018. A sharp increase in gas prices up to 570 USD was observed in 2013, which was associated with an increase in global demand for LNG. The sharp decline in oil prices at the end of 2014 also contributed to lower gas prices, which became very disturbing for all key hydrocarbon exporting countries and undoubtedly affected LNG projects implemented by *Gazprom* PJSC (Rogers, 2015).

The cost of LNG is affected not only by the costs of natural gas production, liquefaction, transportation, regasification, but also a number of the following presented factors, such as weather and climatic

Table 2: The Main Factors for Determining the LNG Price Model for the Asia-Pacific Region

Years	$Y_{LNG\ APR}$, LNG price for Asia-Pacific, USD thousand m^3	X_1 Oil price, USD / bbl	X_2 Demand for LNG in ATR, m tons	X_3 Exchange rate, rub/dollar	X_4 APR economy growth rates,%
2000	210	32.11	102	28.14	3.1
2001	220	34.21	110	29.17	3.6
2002	200	38.27	118	31.35	4.2
2003	210	40.28	120	30.69	4.5
2004	250	43.27	125	28.81	5.1
2005	280	46.26	130	28.30	4.0
2006	300	50.28	135	27.17	5.7
2007	330	58.27	147	25.58	5.9
2008	370	63.18	150	24.86	7.2
2009	400	70.15	150	31.83	7.0
2010	415	77.45	155	30.36	10.4
2011	480	107.46	162,5	29.39	9.2
2012	520	109.45	170	31.08	7.8
2013	570	105.87	188.8	31.85	7.7
2014	520	90.13	195	38.61	5.8
2015	415	52.15	192	61.07	5.4
2016	433	66.83	196	66.08	5.6
2017	447	58.30	202	58.29	5.8
2018	460	62.92	246	62.69	5.5

Table 3: Correlation Matrix of Paired Correlation Coefficients between the Factors Affecting the Price of LNG for the Asia-Pacific Region

	Y	x_1	x_2	x_3	x_4
Y	1.00	0.89	0.82	0.38	0.68
x_1	0.894	1.00	0.53	0.01	0.80
x_2	0.82	0.53	1.00	0.77	0.36
x_3	0.38	0.01	0.77	1.00	-0.09
x_4	0.68	0.80	0.36	-0.093	1.00

conditions; technical and technological progress; world economic conditions (including changes in oil prices); geopolitical conditions (stability and instability of the geopolitical situation in the world), and macroeconomic conditions.

This study aims at forecasting changes in the price of LNG due to changes in main conditional factors. To build a predictive model of the dependence of the price of LNG for the Asia-Pacific region, we used the method of correlation and regression analysis with software for processing statistical input data StatSoft Statistica 10.0. to identify the relationship between the studied parameters and build a linear equation of the predictive model. For this, based on the research of specialists studying the global LNG market, a list of the main factors (input indicators) that mostly affect the formation of LNG prices ($Y_{LNG\ APR}$ - LNG price for Asia-Pacific, USD/thousand m^3), such factors are selected, as x_1 - oil price, USD / bbl, x_2– global demand for LNG in the Asia-Pacific region, m tons, x_3– exchange rate, rub/dollar. and x_4 - APR economy growth rates,%. The main factors for calculating the LNG price model for the Asia-Pacific region are presented in Table **2**.

The correlation-regression analysis of the factors influencing the price of LNG for the Asia-Pacific region was carried out with the *Statistica* application.

As the first stage of the study, a correlation analysis was carried out resulting in the correlation matrix that shows the tightness and direction of the relationships between variables.

The correlation coefficients, which are in bold, reveal the phenomenon of multicollinearity (the presence of a linear relationship between the explanatory variables (factors) of the regression model). Multicollinearity occurs if the correlation coefficient is greater than 0.7. From a practical approach, the authors believe that if factors such as X3 and X2 were simultaneously included in the model, this connection would give an inadequate model for forecasting, also if, with the simultaneous inclusion of X_1 and X_4, the model would also be inadequate. Therefore, two factors X_3 and X_4 indicators should be excluded from the forecast model of LNG prices. The indicator X_4 is closely interrelated with Y, but it is not included in the model, since with the simultaneous influence of X_1, X_2, and X_4, the constructed equation would be insignificant.

The value of the free term means a negative impact on the price of LNG, with other factors not included in the model. Thus, the use of more factors in the analysis will reduce the price of LNG for the Asia-Pacific region. Based on the foregoing, to assess the influence of factors on the price of LNG, factors such as x_1,x_2 remain in the analysis.

The forecast model of LNG prices for the Asia-Pacific region will include x_1 and x_2, which in principle is

Table 4: The Results of the Regression for the LNG Price Model for the Asia-Pacific Region

N = 19	R = 0,98301153 R2=0,96631166 multiple-adjusted comparisons R2 = 0,96210062 F(2,16) = 229,47 p < 0,0000: standard error of estimation: 23,018					
	b*	Standard error b*	b	Standard error b	Criterion	Acceptable limits of error
Intercept	-	-	-61,45	23,27	-2,64	0,02
x_1	0,64	0,05	3,06	0,26	11,72	0,00
X_2	0,48	0,05	1,50	0,17	8,89	0,00

b* - standardized regression coefficients, b - non-standardized coefficients.

confirmed by our model. The calculated values of the regression coefficients for the LNG price model for the Asia-Pacific region are presented in Table **4**.

According to the calculations of the regression results, we can conclude that the proposed forecast model of LNG price for the Asia-Pacific region is adequate, it fulfills all the conditions that must correspond to significant equations. For example, $F_{fact} > F_{table}$, DW <2, as well as the determination coefficient ($R^2 = 0.97$) is very high, which speaks of the quality of the constructed model, only 3% of the factors not taken into account were included in the forecast model of LNG prices. Since values such as the coefficient of determination corresponding to almost 100%, the most important Darwin-Waterson coefficient is less than 2.0, and the analysis of the residuals of the probabilistic model, showing the smallest values, proves that the predictive model is realistic and effective for its use.

Forecast model of the dependence of the price of LNG for the Asia-Pacific region:

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where,

- the value of the intercept of the equation (-61.45) characterizes the negative impact on the price of LNG and other factors not taken into account in the model. This means that when analyzing a wider list of factors, the dynamics of LNG prices will decrease. The effectiveness of using the proposed model for forecasting LNG prices for the Asia-Pacific region has been proved by checking the reality of the model results in the retrospective period.

- indices for each analyzed parameter of the model shows how much the investigated parameter (Y_{LNG}) changes when the factors influencing it changes, i.e.:

- with an increase of 1 USD in the price of oil (x_1), the price of LNG for the Asia-Pacific Region will increase by USD 3.06 / thousand cubic meters;

- with an increase of 1 ton of global demand for LNG (x_2) the price of LNG for the Asia-Pacific region will increase by USD 1.504 / thousand cubic meters;

Thus, the conducted modeling of LNG prices for the Asia-Pacific Region showed an increasing trend in the forecast perspective after 2019 (Figure **4**).

The predicted increase in LNG prices for the Asia-Pacific region is associated with the expected increase in oil prices and a decrease in competition between natural and shale gas. For 2025, the forecast for the LNG price level for the Asia-Pacific region is USD 635/ for thou. cubic meters. It is greater than in 2019 by 38%. The development of such a scenario may well be justified by the previous steadily increasing demand for LNG from the countries of the Asia-Pacific region.

Thus, we, the authors, believe they have made a correct forecast of the LNG prices for 2020-2025 (before the COVID-19 pandemic) and we are confident that the model we developed is sufficiently reasonable and realistic.

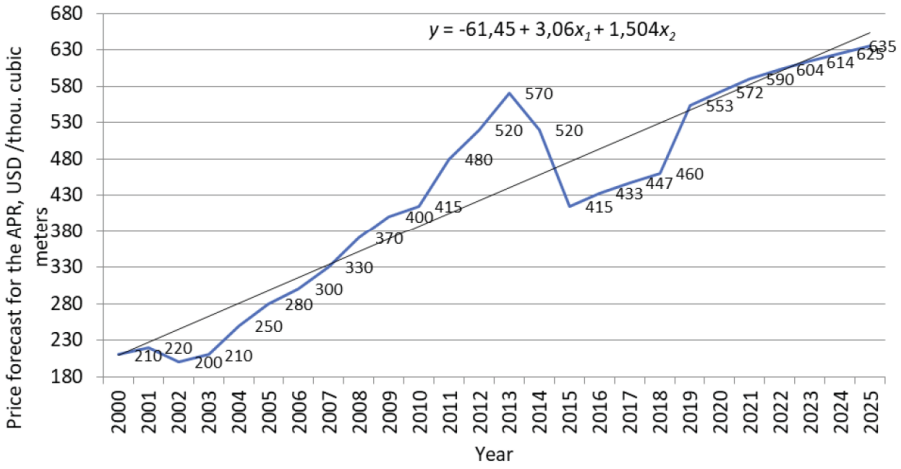

Figure 4: Dynamics and forecast of global LNG prices for the Asia-Pacific Region.

*b** – standardized regression coefficients, *b*–non-standardized coefficients.

The LNG price forecasts differ from those by other Russian authors (Razmanova and Machula, 2016), and this is also correct. Each researcher can check his/her forecasts on the facts of how much percentage of them coincide with the forecast price thanks to the following retrospective analyses of the world LNG market.

CONCLUSIONS

In the Russian Federation, in the distant and near future, for the largest Russian gas producers like *Gazprom* PJSC and *Yamal LNG* OJSC, taking into account the accelerated development of the Northern Sea Route, the strategic objectives of the national plan are to become the largest exporters of LNG to Asia-Pacific countries, primarily to China, Japan, India and South Korea by increasing the production of natural gas through major infrastructure projects in Yamal, Sakhalin and Yakutia.

Although in our forecast scenario, according to the proposed model, LNG prices will be rising until 2025, the risks of price reduction come from unpredictable macro-level factors, such as the geopolitical situation in the world, a decline in energy production, the emergence of alternative energy sources, accidents in gas producing and processing industries, etc. They may affect in drastic changes in LNG prices.

And also, in our opinion, the results of this study will enable to better predict the effect of export prices of liquefied natural gas on revenues from the oil and gas while forecasting the national budgets of LNG exporting countries, including the Russian Federation.

REFERENCES

Alferov, S. Y. (2016). Prospects for the LNG market of East and Southeast Asia. *Oil, Gas and Business,* 2, 43-47.

Dmitrieva, T. (2015). LNG Production and Export: World Trends and Russian Prospects. *Sea Ports,* 4. http://www.morvesti.ru/tems/detail.php?ID=37876

Gazprom. (2015). Multipolar energy. http://www.gazprom.ru/fZposts/26/228235/gazprom-annual-report-2015-ru.pdf

Osipov, G. V., Ponkratov, V. V., Karepova, S. G., Bloshenko, T., & Vorontcov, A. (2019). Transit tariff optimization model for Russia and Central Asia energy cooperation. *Entrepreneurship and Sustainability Issues,* 7(1), 398-412. https://doi.org/10.9770/jesi.2019.7.1(28)

Osipov, G., Karepova, S., Chizhevskaya, E., Gnatyuk, M., Semin, A., & Mikhayluk, O. (2018). Directions to improve the effectiveness of Russia's energy export policy. *International Journal of Energy Economics and Policy,* 8(6), 227-239. https://doi.org/10.32479/ijeep.7055

Pasture, G., & Belova, M. (2013). *Development of the Global LNG Market: Challenges and Opportunities for Russia.* Skolkovo: Energy Center of the Moscow School of Management Skolkovo. http://www.pro-gas.ru/images/data/gallery/0_206_SEneC_Global_LNG.pdf

Razmanova, S. V., & Machula, I. A. (2016). The market of the Asia-Pacific region as a leading driver for the development of liquefied natural gas production in the Russian Federation. *Oil and Gas Geology. Theory and Practice,* 11(4). https://doi.org/10.17353/2070-5379/42_2016

Rogers, N. (2015). *The Impact of Lower Gas and Oil Prices on Global Gas and LNG Markets.* Oxford: Oxford Institute for Energy Studies. https://doi.org/10.26889/9781784670337

Semin, A. N., Ponkratov, V. V., Sokolov, A. A., Lenkova, O. V., & Pozdnyaev, A. S. (2019). Investigating the Competitiveness of the Russian Oilfield Services Market. *Industrial Engineering & Management Systems,* 18(3), 563-576. https://doi.org/10.7232/iems.2019.18.3.563

Van Chien, N. (2020). Energy Consumption, Income, Trading Openness, and Environmental Pollution: Testing Environmental Kuznets Curve Hypothesis. *Journal of Southwest Jiaotong University,* 55(1). https://doi.org/10.35741/issn.0258-2724.55.1.49

Vasiljeva, M. V., Ponkratov, V. V., Kharlamova, E. Y., Kuznetsov, N. V., Maramygin, M. S., & Volkova, M. V. (2019). Problems and Prospects of Development of the Oil Exchange Market in the Russian Federation. *International Journal of Energy Economics and Policy,* 9(3), 77-86. https://doi.org/10.32479/ijeep.7378

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