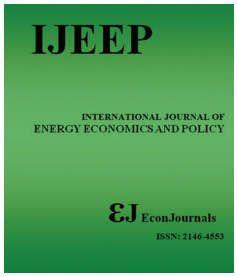
Simonova, Marina; Zakharov, V. E.; Mamiy, I.

Article

Prospects of renewable energy sources : the case study of the BRICS countries

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Simonova, Marina/Zakharov, V. E. et. al. (2019). Prospects of renewable energy sources : the case study of the BRICS countries. In: International Journal of Energy Economics and Policy 9 (5), S. 186 - 193. http://econjournals.com/index.php/ijeep/article/download/7874/4715. doi:10.32479/ijeep.7874.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2019, 9(5), 186-193.

Prospects of Renewable Energy Sources: The Case Study of the BRICS Countries

Marina Simonova[1]*, V. E. Zakharov[2], I. Mamiy[3]

[1]Moscow State Institute of International Relations (MGIMO University), Moscow, Russia, [2]Ministry of Foreign Affairs of Russia, Moscow, Russia, [3]Moscow State University, Moscow, Russia. *Email: rusinamar@mail.ru

Received: 17 March 2019 **Accepted:** 28 June 2019 **DOI:** https://doi.org/10.32479/ijeep.7874

ABSTRACT

The paper aims to analyze renewable energies consumption in the BRICS, given structural differences in production and consumption of energy forms, as well as development outlook study of renewable energies in Russia. New and innovative solutions are essential to provide sustainable energy supplies and security amid successful integration of emerging countries in the global economic system. The issue becomes extremely relevant in the context of, firstly, increasing regionalization, secondly, intense global competition, thirdly, pressing challenges of energy resource efficiency and high intensity of energy comparative production. Through comparative analysis the authors study the current state and development outlook of the energy sector in the BRICS, identify the most perspective directions of Fuel and Energy System development. The shift towards the renewable energy sources (RES) strategy in Russia would be driven by flexibility of the state support mechanisms, the investment rate in the sector, territorial and economic feasibility of RES consumption, better channelled innovative technologies and best practices of the BRICS to the Russian economy.

Keywords: Renewable Energy Sources, BRICS, Energy Security, Energy Resource Efficiency
JEL Classifications: C82, F64, O57, P48, Q20

1. INTRODUCTION

The existence and development of human civilization is inextricably linked with energy consumption and, as a consequence, its production. The rapid development of industry and the transport sector along with the growth of the world population in the second half of 20-th and early 21-st is accompanied by the use of a conventional model of meeting the growing global demand for primary energy sources by increasing production of oil, natural gas and coal. However, in modern realities such an approach to solving the problem of energy supply is already outdated and r equires new thinking.

First, the main disadvantage of the energy supply based on hydrocarbons is its irreversible exhaustion. The proved reserves of oil, gas or coal are always physical limit values. According to BP's energy yearbook (BP, 2018), the world proved oil reserves were 1696.6 bn barrels in 2017, while daily global oil consumption was 98.1 m barrels. Considering the current level of consumption and the proved reserves, the oil reserves are adequate for 47 years. In this way the actual proved reserves of oil will have run out by 2064. The proved reserves of natural gas totaled 193.5 trln cum in 2017, while the world annual natural gas consumption was 3.6 trln cum. Thus, the proved reserves of natural gas given the current level of consumption will have run out by 2070. Forecasts of coal reserves look more optimistic. However, the global coal consumption tends to decrease in OECD countries due to the high environmental risks associated with its consumption. At the same time, its consumption is rising on fast-growing markets (India, China, Indonesia), where coal is the main energy resource (BP, 2018).

Second, the uneven distribution of hydrocarbon reserves across the world aggravates the regional geopolitical situation (the Middle

East, the Caspian Sea, the Arctic, the South China Sea) and creates unfavorable preconditions for possible conflicts between countries over control of rich oil and gas fields and its transportation routes. Exporters and importers of hydrocarbons have to re-examine their energy strategies under the influence of such exogenous factors as multi-vector price trends in hydrocarbon markets and the rapidly changing configuration of international relations (Makarov and Voropay, 2018).

Thirdly, the growing anthropogenic pressure on the environment due to the production and consumption of hydrocarbons adversely affects the environment and human health and is one of the main causes of global climate change. For example, the global carbon dioxide emissions creating the greenhouse effect in the atmosphere delivered successive years of growth, showing an increase from 30 bn tonnes in 2007 to 33 bn tonnes in 2016, with the top five pollutants having included the world's main energy consumers: China, USA, India, Russia and Japan (Olivier et al., 2017).

In this regard renewable energy sources (RES) in the global electricity production are considered as the most promising and reasonable solution to the growing problem of energy supply. Under conditions of uneven distribution of hydrocarbons, the growing global demand for electricity and current environmental risks associated with the production and consumption of hydrocarbons, such as oil, natural gas and coal, a gradual transition to renewable energy (solar, wind, small hydropower, bioenergy) opens up conceptually new opportunities for strengthening energy security and improving the energy efficiency of the economy, thereby laying the foundation for changes of quality parameters of the world economy amid globalization. The inexhaustible resource base of renewable sources along with their environmental friendliness is the main criteria for the dynamic development of the renewable energy industry (Simonova and Zakharov, 2016).

2. LITERATURE REVIEW

The statistical basis of the study is data from the Ministry of Energy of Russia, the Federal State Statistics Service of Russia, the International Renewable Energy Agency, IEA, the World Bank, as well as materials from the UN Conference on Trade and Development, the BP Yearbook. The particular emphasis was placed on the study of the Russian regulatory framework which allows assessing the state approach and identifying the features of the formation of a mechanism for regulating renewable energy.

The theoretical background of the analysis is based on the studies of the prominent Russian researcher Makarov A.A. (Makarov and Voropay, 2018) elaborating a systematic approach to the study of the fuel and energy complex, focusing also on the problems of the global energy sector, sustainable development and the prospects of RES, especially in countries with rapidly growing markets. Among other Russian researchers it is necessary to note the study of Bezrukih (2010), (Bezrukih, 2002) dealing with various issues such as: The study of energy efficiency and the formation of small energy, analysis of special aspects of the Russian FEC's development. The special attention of the authors was paid to studies of Favorskiy O.N. (Favorskiy et al., 2016), who reflects in his publications both the fundamental problems of Russian energy policy and the more particular problems related to providing the country's energy sector with competitive equipment. The studies of Veselov (Veselov et al., 2017; Veselov and Dorofeev, 2018) are devoted to the development of the electric power industry in the new conditions of the digital economy. These researchers present their vision of Russia's intellectual power system and analyze the priority steps on the way of the technological transformation of the industry. The authors also highlight the studies of Rustamov (Rustamov and Andreenko, 2011)., in which the researcher studies the issues of standardization and state technical regulation of the development of renewable energy in Russia.

Foreign researchers pay much attention to a study entitled "the political economy of clean energy transitions" by the researchers from the United Nations University World Institute for Development Economics Research. It concludes that sustainable energy transitions involve the shift of resources between competing industrial sectors and political constituencies (Arent et al., 2017). "Trends in global carbon dioxide and total greenhouse gas emissions" by Olivier, Schure and Peters (Olivier et al., 2017) emphasizes paramount importance of renewable energy in preventing greenhouse gas emissions and highlights the issue of environmental pollution by greenhouse gases.

The paper entitled "100% clean and renewable wind, water, and sunlight all-sector energy roadmaps for 139 countries of the world" by Jacobson, Delucchi and Bauer (Jacobson et al., 2017) is of interest as well. These researches develop a roadmap for 139 countries for transition to renewable energy by 2050. Using econometric analysis, the authors make a qualitative assessment of RES in solving such problems as climate change and environmental pollution.

3. RESEARCH RESULTS

3.1. The World Consumption Structure of Primary Energy Sources

The study of the world consumption structure of primary energy sources (oil, natural gas, coal, nuclear and hydropower, renewable energy) allows identifying the qualitative changes of the global energy sector in 1997-2017. According to the data presented in Figure 1, oil retains its position as the world's main energy resource in 1997-2017. but its share in the structure of world consumption of primary energy sources tends to decrease.

If the share of oil in the structure of the world consumption was 38,8% in 1997, it decreased to 33.0% in 2017.

Studying the world consumption dynamics of primary energy sources by type, the variable of an average annual growth allowed the authors to identify vector and speed of development of the world FEC's key sectors and determine the prospects of their development. In addition, these results enabled to distinguish two stages in the consumption of primary energy sources and their study added a lot. For instance, the absolute indicator of the world consumption of primary energy sources for the entire study period (in 2017 compared to 1997) tended to increase. If the

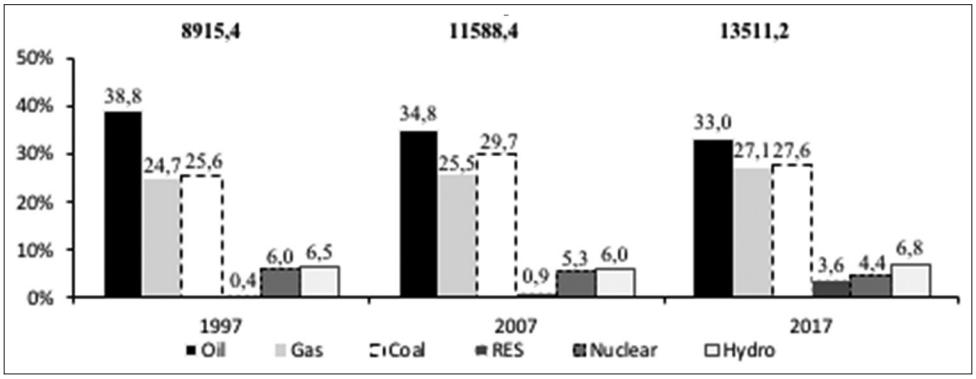
world energy consumption amounted to 8915.4 m tonnes of oil equivalent in 1997, in 2007 it already totaled 11588.4 m tonnes of oil equivalent, in 2017-13511.2 m tonnes of oil equivalent. (BP, 2018). There is a slowdown in the world consumption growth of primary energy sources. The average annual growth of the world consumption of primary energy sources was 2.2% in 1996-2006 but the same indicator declined to 1.5% in 2007-2017. According to the authors the revealed trend has a positive correlation with such exogenous factors as the world population and the world GDP (The World Bank).

The data presented in Table 1 illustrate the detailed picture of emerging trends. It is vital to note that the average annual growth of the nuclear energy consumption shows negative growth rate – 0.4%. It is remarkable that the consumption of hydropower produced by large hydropower plants (more than 30 MW) had an upstream trend. Amid gradual slowdown in the consumption of hydrocarbons RES showed the highest average annual growth of consumption among all types of primary energy sources.

Over 2007-2017, the average annual growth of the primary energy consumption as well as the similar indicator of the world GDP declined in comparison with the corresponding figures over 1996-2006 due to the negative effects of the global financial crisis causing the economic recession in many countries, which manifested itself in a reduction of industrial production, a decrease in international trade, an increase in unemployment, a weakening global demand for hydrocarbons (oil, natural gas and coal).

Renewable energy is becoming the most efficient way to counteract climate change as it enables to significantly reduce greenhouse gas emissions (Renewables, 2018). The countries interested in

Figure 1: Structure of world consumption of primary energy sources, 1997-2017



Source: BP Statistical Review of World Energy 2018. 67th edition BP Statistical Review of World Energy Centre for Energy Economics Research and Policy. Heriot-Watt University. 2017

Table 1: Dynamics of world consumption of energy resources, the world GDP and population

Variables	1996	2006	2007	2017	Average annual rate of growth 1996-2006 (%)	Average annual rate of growth 2007-2017 (%)
World population, bn	5.7	6.6	6.7	7.5	1.47	1.1
World GDP*, trln US dollar	31.5	51.3	57.8	80.6	4.99	3.38
Primary energy, m tonnes of o.e.	8816.4	11220.3	11588.4	13511.2	2.4	1.5
Oil, m tonnes	3480.7	3977.8	4039.1	4469.7	1.3	1.0
Natural gas, bn cum	2214.3	2834.8	2958.0	3670.4	2.5	2.2
Coal, m tonnes of o.e.	2280.0	3265.7	3451.8	3731.5	3.66	0.8
Hydro, m tonnes of o.e.	571.0	685.7	696.9	918.6	1.8	2.8
Nuclear, m tonnes of o.e.	544.6	634.4	621.5	596.4	1.5	-0.4
RES, m tonnes of o.e.	36.1	92.9	107.0	486.8	9.9	16.36

Source: The World Bank Group: GDP (current US $) and population, total. Available at: https://data.worldban k.org/indicator/SP.POP.TOTL; BP Statistical Review of World Energy - all data, 1965-2017 URL: https://www.bp.com/en/global/corporate/energy-/statistical-review-of-world-energy.html. *at current prices

Table 2: Share of the BRICS in the structure of key global indicators

Subject	Structure of world GDP*,%		Structure of world FDI inflow,%		Structure of world export,%	
	2006	2017	2006	2017	2006	2017
World	100.0	100.0	100.0	100.0	100.0	100.0
BRICS	14.2	21.2	10.42	18.3	11.7	16.1
Russia	2.2	2.0	2.6	1.7	2.2	1.8
Brazil	3.0	2.8	1.3	4.3	1.1	1.1
China	6.6	12.7	5.1	9.5	6.6	10.7
India	1.9	3.2	1.4	2.7	1.3	2.1
South Africa	0.5	0.5	0.2	0.1	0.5	0.4

Source: Calculated by the authors on the basis of the data of the domestic product: Total and per capita, current and constant (2010) prices, annual. Available at: http://unctadstat.unctad.org/w ds/Tabl eViewer/tableView.aspx. *at 2010 constant prices

developing renewable energy plan extensively integrate these innovations into state energy strategies. The rapid reduction in capital costs for the construction and operation of renewable energy objects due to cheap and improving technologies becomes a determining factor in the process of RES-development, making the industry more attractive for investment and competitive (Veselov and Dorofeev, 2018). For instance, in 2016 renewable energy overtook first traditional thermal energy in terms of investment with $260 bn, and the total value of installed RES-capacities amounted to a record 162 GW, or 60% in the structure of the introduction of energy generating capacities of all types (Investments, 2018).

One of the obvious drivers of the rapid RES-development is a large-scale investment. The share of the RES investment made up 68.2% in the structure of global investment in all energy generating capacities in 2017.

3.2. Renewable Energy in the BRICS

To study the RES-development as an innovation phenomenon of the world energy, the authors focused on investigating renewable energy in the BRICS, using the example of Russia to find out features and problems of this industry in the country with deficit of financial resources.

BRICS unites countries with different political, economic, social, cultural, civilizational, historical, religious and ethnic characteristics, presenting the model of a polycentric world order. The backbone of its influence on the international arena is a growing economy, a significant population and large reserves of natural resources. Over the past decade, the position of the BRICS club in the world economy has strengthened significantly. According to the data of Table 2, for instance, the share of the BRICS in the structure of the world GDP (in prices of 2010) was 14.2% in 2006, but it increased to 21.2% in 2017. The shares of the BRICS in the structure of the world export and the inflow of foreign direct investment also markedly increased, confirming the growing export potential and investment attractiveness (Foreign, 2018).

The tendency of a country's economic development is largely determined by the state and potential of its FES, especially for the BRICS. The comparative analysis shows that each BRICS country conducts its own unique energy policy taking into account similar and specific endogenous and exogenous factors, including stores of energy resources, population, speed and vector of economic development, level of dependence on imported resources, environmental situation and climatic conditions (Arent et al., 2017). According to the data presented in Table 3, the consumption of primary energy sources in the BRICS increased almost 1,5 times from 3944.8 m tonnes of oil equivalent in 2006 to 4999.2 m tonnes of oil equivalent (o.e.) in 2017, while the joint share of the BRICS in the structure of the world consumption of primary energy sources increased from 30.1% in 2006 to 37.0% in 2017.

Analyzing the electricity generation sector the authors noted that the total volume of electricity produced by the BRICS club almost doubled from 5275.1 TWh in 2006 to 9929.5 TWh in 2017. At the same time, the total share of the BRICS in the structure of the world electricity production also noticeably increased from 27.5% in 2006 to 38.8% in 2017. Electricity production went up in Russia, China and India, but the shares of South Africa and Brazil showed negative dynamics. Thus, the significance of the BRICS in the world consumption structure of primary resources and power generation is growing significantly, while there is an unevenness and "push-and-pull" factors in these processes, suggesting about specifications of economic development models.

Analysis of changes in the consumption structure of primary energy resources by country helps in detail assess the current structural changes and to determine the dominant trends. According to the data presented in Table 4, the main energy resource of Russia is natural gas (the share of gas in the structure of the energy consumption was 52.2% in 2017), China, India, South Africa - coal (60.4%, 56.2% and 68.1% correspondingly), Brazil - oil (46.0%). There is an increase of oil share in the consumption structure of primary energy by the BRICS, except China's indicator tended to decrease (2006-20.6%, 2017-19.4%), while the share of coal dropped significantly in all countries except India, where this indicator almost retained its previous value (2006-56.1%, 2017-56.2%).

The change of the share of nuclear energy and hydropower resulted from large-scale installation of new nuclear and hydropower plants and their operational capacities. The notable feature became an appearance of RES in the consumption structure of all the BRICS. Brazil with the increased share of renewable energy from almost zero in 2006 to 7.5% in 2017 became a leader in 2017 in that regard. In China, the share of renewable energy was 3.4% in 2017, in India – 2.,9%, in South Africa – 1.6%, in Russia – 0.04% (BP, 2018). Considerable qualitative changes were detected in the consumption structure amid the growing consumption of primary energy sources. There are two most notable trends: a reduction in

Table 3: Consumption of primary energy sources and production electricity in the BRICS countries

Countries	Consumption of primary energy resources				%*	Electricity production				%*
	2006		2017			2006		2017		
	M tonnes o.e.	%	M tonnes o.e.	%		TWh	%	TWh	%	
BRICS	3394.8	100.0	4999.2	100.0	3.6	5275.1	100.0	9929.5	100.0	5.9
Russia	676.1	19.9	698.3	13.9	0.3	992.1	18.8	1091.2	11.0	0.9
India	414.0	12.2	753.7	15.1	5.6	744.1	14.1	1497.2	15.1	6.5
S. Africa	113.2	3.4	120.6	2.5	0.6	253.8	5.8	255.1	2.6	0.05
Brazil	216.8	6.4	294.4	5.8	2.8	419.4	8.0	590.9	5.9	3.2
China	1974.7	58.1	3132.2	62.7	4.3	2865.7	54.3	6495.1	65.5	7.7

Source: BP Statistical Review of World Energy - all data, 1965-2017. Available at: https://www.bp.com/en/global/corporate/energy-/statistical-review-of-world-energy.html. *average annual growth rate in the period 2006-2017

Table 4: Primary Energy Consumption and electricity production in the BRICS countries

Countries	Energy resources												Primary energy, m tonnes o.e.	
	Oil, %		Gas, %		Coal, %		Nuclear,%		Hydro,%		RES,%			
	2006	2017	2006	2017	2006	2017	2006	2017	2006	2017	2006	2017	2006	2017
Russia	18.2	21.9	55.1	52.2	16.0	12.2	5.0	6.5	5.6	5.9	n/a	0.04	676.1	698.3
India	28.5	29.4	8.5	6.2	56.1	56.2	0.9	1.2	6.0	4.1	n/a	2.9	414.0	753.7
S. Africa	19.3	23.8	0	3.2	78.0	68.1	1.9	2.9	0.6	0.2	n/a	1.6	113.2	120.6
Brazil	44.6	46.0	9.2	11.2	6.3	5.6	1.5	1.2	38.3	28.3	n/a	7.5	216.8	294.4
China	20.6	19.4	2.9	6.5	70.1	60.4	0.7	1.8	5.5	8.3	n/a	3.4	1974.7	3132.2

Source: BP Statistical Review of World Energy - all data, 1965-2017 Available at: https://www.bp.com/en/global/corporate/energy-/statistical-review-of-world-energy.html

the coal share and an increase in the share of renewable energy. The authors also conclude that Russia significantly lags behind the rest of the BRICS countries in the development of renewable energy.

3.3. The Prospects of RES in Russia

The analysis of the Russian energy system including the prerequisites of RES-development and the special aspects of the state support mechanism allowed the authors to determine the prospects and directions of this innovative industry given that Russia has a sufficient resource potential for large-scale development of solar, wind, geothermal, small hydro and bioenergy. According to expert estimates, the annual technical potential of RES makes up at least 3.1 bn oil equivalent that is almost 4 times as high as consumption of all energy resources in Russia (in 2017, consumption of primary energy in Russia reached 698.3 m oil equivalent), while the current economic potential of renewable energy is estimated at 189 m oil equivalent) (Bezrukih, 2010).

The RES-opportunities with the commercialization economically feasible are different but exist in almost all Russian regions. For instance, the largest wind zones are located mainly on the coast and islands of the Arctic Ocean from the Kola Peninsula to Kamchatka, in the areas of the Lower and Middle Volga and Don, the shores of the Caspian, Okhotsk, Barents, Baltic, Black and Azov Seas. Radiation level that is suitable for the development of solar energy have been recorded in the regions of the North Caucasus, Southern Siberia and the Far East (Bezrukih, 2010).

In accordance with the data presented in Table 5, the power plants of the Russian Unified Energy System produced 1053 bn kWh in 2017, that 4.6% as much as in 2008. The average annual production of electricity increased by 0.5% during this period. Thermal power plants traditionally held a leading position in the structure of power generation, but its share was gradually dipping. The share of thermal power plants was 68.3% in 2008, higher than 59.0% in 2017 (Federal, 2018). It is remarkable that the shares of nuclear and hydropower plants, on the contrary, tended to increase during the same period: the share of nuclear power plants increased from 16.1% to 19.2% with electricity production surged by 24.5%. The share of hydroelectric power plants rose from 15.5% to 17.7%, with electricity production grown by 19.1%. The data of Table 5 also demonstrate that all installed energy capacities increased by 10.6% over the study period, with the highest indicator of 21.7% for nuclear power plants (Order, 13.2009).

The ratio of progressive production growth to capacity's installation growth was 0.946, indicating a low efficiency of the industry while

Table 5: Electricity production and installed power capacity by type of power plants in Russia

Type of energy	2008	2009	2011	2013	2015	2017
Installed energy capacity, GW						
Total, including:	216	212	218	226	235	239
Thermal plants	145	144	149	155	160	162
Hydroplants	47	44	45	47	48	48
Nuclear plants	23	23	24	26	27	28
RES plants	n/a	n/a	n/a	n/a	n/a	0,6
Production of electricity, bln kWh						
Total, including:	1007	957	1019	1013	1026	1053
Thermal plants	688	579	634	623	614	622
Hydropower plants	157	166	155	175	160	187
Nuclear plants	163	163	173	177	195	203
RES plants	n/a	n/a	n/a	n/a	n/a	0,7

Source: Ministry of Energy of Russia: Main characteristics of the Russian electric power industry. Available at: https://minenergo.gov.ru/node/532

capacity growth rate outpaced the production of electricity in general. Only at nuclear power plants production of electricity was growing by 21.9% faster than commissioning. Therefore, nuclear energy can be considered effective. Thermal plants were the least productive as production of electricity decreased by 9.6% with the installed power capacity grew by 11.7% during the same period. Its largest share in the production structure as a whole makes affects the energy efficiency indicators. The emergence of RES is a new trend of the Russian energy sector, but its share is still less than 1% in the electricity production structure.

The results of the RES-development in Russia are largely determined by the level of state support and the effectiveness of a regulatory framework aimed at stimulating entrepreneurial initiative and competition. The country embarked on the formation of an innovative economy and the improvement of its energy efficiency. The development of renewable energy should contribute a great deal to reducing the anthropogenic pressure on the environment, lower electricity production costs, strengthening energy security and energy supply through its diversification and decentralization.

According to the data presented in Table 6, the total capacity of renewable energy projects put into operation within 2015-2024 should be almost 5.4 GW, including the share of wind farms of 60.7%, the share of solar plants – 31.9%, the share of hydropower plants – 7.2% (Order, 01.2009). Thus, it is also worth noting that there are three types of RES (wind, solar and small hydro projects) with an obvious dominance wind power in the focus of state interest.

The strategic plan of the RES-development includes not only the creating of a competitive market of renewable electricity, but also the foundation of a domestic industry of RES –equipment. The data presented in the Table 7, demonstrated a gradual increase in the level of localization of the equipment designed for the construction of RES-plants in 2015-2024 (small hydropower plants, less than 25MW) – from 20% to 65%, wind power plant – from 25% to 65%, solar power plant - from 50% to 70%. Any RES-project under the state program should be partially implemented with the help of equipment of the Russian origin. Government Order N 861-p describes the contribution of each component of the RES plant. For instance, the contribution of blades of wind aggregates will be 18% in the technical structure of a wind power plant, the contribution of crystalline silicon photocells will be 25% in the technical structure of the solar plant (Order, 28.2013). In relation to renewable energy the indicator of «localization level» refers to the coefficient, which is the aggregate share of all spare parts, components and assemblies of domestic production in the technical structure of the renewable energy facility. According to the developers of renewable energy facilities, the problem is the mandatory requirement to the level of localization being an obstacle for new players to the renewable power market access. Adherence to localization level leads to higher capital costs, at the same time, imported equipment is often cheaper. Failure by developers to meet the localization level requirements serves as the reason for applying penalties against the prescribed capacity payment (for wind power plant – 0.45; for solar power plant – 0.35).

Vital feature of the Russian mechanism of RES-support in comparison with that of other countries is the starting indicator determining the level of support for RES power plant. In Russia, when estimating the size of support for a qualified RES-power plant, the indicator of the volume of available output electric power (MW) is applied, while abroad, they mainly apply the indicator of the volume of electricity produced (MWh). So far, the RES-support mechanism applies only to three types of RES power plants: solar, wind and small hydropower plants, with capacity of above 5 MW (the minimum level for entering the Russian wholesale electricity market).

Since 2013 OJSC "administrator of the trading system of the wholesale electricity market," a commercial operator of the Russian wholesale electricity market, has been conducting the selection of RES-projects within the limits of a maximum amount of installed capacity. For instance, 26 wind farm projects with a total capacity of 853.3 MW, 3 hydroelectric projects with a total capacity of 39.7 MW, 10 solar power projects with a total capacity of 148.5 MW were selected in 2018 (Competitive, 2018). The qualification procedure of an RES facility begins upon completing its construction, connecting to the grid and commissioning. The Russian RES-support system ensures the right of investors to choose the site for construction of the renewable energy object. However, support will be provided to RES facilities located in the price zones of the Russian wholesale market, i.e., in the areas with electricity trading at free market prices. Thus, the income of the producer of RES-electric power consists of two components: Payment for power and revenue from the sale of electricity produced on the wholesale market.

The main advantages of the existing mechanism are the following: Firstly, competitive selection, which allows selecting RES-projects with the lowest capital expenditures; secondly, it is the introduction of a mechanism for monitoring the efficiency of the RES-object with the help of the installed capacity utilization factor; thirdly, the support of domestic manufacturers of RES equipment thanks to the localization degree indicator. Finally, this is a return on investment at the expense of guaranteed payments, which is possible if a contractor meets the terms of the contract. Thus, the state guarantees a return of about 12% on invested capital.

The disadvantages of that mechanism include both the complexity and the duration of the qualification procedure of the RES-objects. Accounting for localization level makes potential producers of renewable electricity partially dependent on Russian equipment, even if cheaper and more efficient foreign one is available. The variable nature of the production of RES-electricity (wind speed or solar radiation) does not guarantee absolute readiness for electricity production.

One of the vital conditions for the development of renewable energy is the bearish electricity market sentiment being reflected in decline in demand. In compiling the general plan of the distribution of electric power facilities until 2020 a forecast was adopted with allowances made for the growth of electricity consumption in Russia from 1196,6 bn kWh in 2010 to 1710 bn kWh (the base version) and up to 2000 bn kWh (the maximum version) in 2020.

Table 6: State targets of installation of RES-facilities, 2016-2024

Plants	2016	2017	2018	2019	2020	2021	2022	2023
Wind plants, MW	50	200	400	500	500	500	500	500
Solar plants, MW	199	250	270	270	270	162,6	162.6	…
Hydro plants, MW	-	124	…	49.8	109.2	35.6	35.6	35.6
Total, MW	249	574	670	819.8	879.2	698.2	698.2	535.6

Source: Order of the Government of the Russian Federation No. 1-p, 08/01/2009 "on approval of the main directions of the state policy in the field of increasing the energy efficiency of the electric power industry based on the use of RES for the period up to 2024" Available at: http://docs.cntd.ru/document/902137809

Table 7: Requirements to the level of localization, 2015-2024

Type of energy	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Hydro	20	45	45	65	65	65	65	65	65	65
Wind	25	25	40	55	65	65	65	65	65	65
Solar	50	70	70	70	70	70	70	70	70	70

Source: Order of the Government of the Russian Federation of May 28, 2013 N 861. Available at: http://www.garant.com/products/ipo/prime/doc/70288052/#ixzz50f4qQkB9

Thus, the forecast average annual growth of energy consumption within 2010-2020 should make up in the base version 3.6%, or in the maximum version – 5.2%. In fact, the consumption in 2017 totaled 1089.1 bn kWh but the average annual growth was merely 0.9% in 2010-2017 (Order, 22.2008).

Stable demand for electricity stimulates the active participation of large domestic investors in the formation of the Russian renewable energy. For instance, the State Atomic Energy Corporation "Rosato m" has already won domestic tenders for the construction of wind power farms with a total capacity of 610 MW, having invested more than $ 1 bn. The state corporation has set tasks not only to build wind farms but to create an innovative industrial platform for the production of wind equipment that could be in demand on both local Russian and global markets (Until, 2017). Another company, a joint venture between Renova and Rosnano "Hevel" began the construction of solar power plants using in-house photovoltaic cells in 2015. According to the results of the latest auctions, the company gained commitments for the construction of solar power plants with a total capacity of 434 MW in 2015-2020 (The Hevel, 2017).

4. CONCLUSION

On the basis of the conducted analysis new trends of the world FES have been revealed including a reduction in global oil consumption and an increase in global consumption of renewable energy. However, the global energy demand keeps increasing due to the growth of the world production that leads to a shift in the structure of consumption of primary energy sources.

Increased interest in renewable energy has been displayed mainly by developed countries until recently due to poor reservoirs of energy resources as well as their open access to high technologies and financial capital. There is no doubt that the BRICS countries also staunchly support the transition to a low-carbon economy in the long run and consistently implement a policy of the expanded use of RES.

Russia as the largest producer and exporter of energy resources has not become currently a major participant in the international process of replacement of conventional energy by renewable one. However, it should be noted that the forming of RES-state support mechanism has already been set up. The degree of participation in the development of Russian renewable energy will depend, first, on the flexibility of the state support mechanism; secondly, on the level of investment in that industry; thirdly, on the economic and territorial feasibility of RES; fourth, on the efficiency of introducing the advanced technologies and digitalization into domestic practice. In the authors' opinion, the mechanism of RES-state support should be constantly adjusted for changing economic realities and best practices of other countries that will enable to reduce the economic costs of RES consumption.

5. FUTURE RESEARCH AREAS

The current problems and prospects of RES in the BRICS discussed in the article reveal new directions for further research such as the impact of the digital transformation of the economy on the formation of RES-industry in Russia, the CIS and BRICS countries.

Research interest is caused by further analysis of economic and social factors influencing the development and efficiency of RES. Undoubtedly, it is vital to pay more attention to building up the development model of the Russian renewable energy market as well as its quality assessment. While wind power holds the leading position, it is possible also to conduct a specially organized survey devoted to that trend. It will help to estimate the economic effect from the introduction of wind farms. Such indicators as average wind speed, area occupied by wind plants, operational and maintenance costs would improve the assessment of the effectiveness of this sub-industry in Russia and other BRICS countries. Renewable energy has to be feasible.

REFERENCES

Arent D., Arndt C., Miller M., Tarp F., Zinaman, O. (2017), The Political Economy of Clean Energy Transitions. United Nations University World Institute for Development Economics Research (UNU-WIDER). p240-276.

Bezrukikh, P.P. (2002), Resources and Efficiency of use of Renewable Energy Sources in Russia. Russian: Science. p67-71.

Bezrukikh, P.P. (2010), Energy efficiency and development of small energy industry. Academy of Energy, 4 (36), 20-28.

BP Statistical Review of World Energy. (2018), BP Statistical Review of World Energy Centre for Energy Economics Research and Policy. 67th ed. Edinburgh: Heriot-Watt University. p12-36.

Competitive selection of renewable energy projects. (2018), Administrator of the Trading System of the Wholesale Electricity Market. Available from: https://www.atsenergo.ru/vie/proresults.

Favorskii, V.M., Batenin, V.M., Maslennikov, V.V., Kudryavyi, S.P. (2016), What is to be done to implement Russia's energy strategy? Herald of the Russian Academy of Sciences, 86(5), 351-356.

Federal State Statistics Service: Electrobalance of Russia. (2018), Available from: http://www.gks.ru/wps/wcm/connect/rosstatmain/rosstat/ru/statistics/enterprise/industrial/#.

Foreign Direct Investment: Inward and Outward Flows and Stock, Annual. (2018), United Nations Conference on Trade and Development. Available from: http://www.unctadstat.unctad.org/wds/TableViewer/tableView.aspx.

Investments in Renewables: IRENA Analyses Where that Money is, and isn't, Coming From. (2018), International Renewable Energy Agency. Available from: http://www.irena.org/newsroom/articles/2018/Jan/Investments-in-Renewables-areBringing-RecordCapacityOnline.

Jacobson, Z., Delucchi, M., Bauer, Z. (2017), 100% Clean and renewable wind, water, and sunlight all-sector energy roadmaps for 139 countries of the world. Joule, 1(1), 108-121.

Makarov, A.A., Voropay, N.I. (2018), System Studies in the Energy Sector: Methodology and Results. European: M.: INEI, Publishing House MEI. p309.

Ministry of Energy of Russia: Main Characteristics of the Russian Electric power industry. Available from: https://www.minenergo.gov.ru/node/532.

Olivier, J.G.J., Schure, K.M., Peters, J.A.H.W. (2017), Trends in Global CO_2 and Total Greenhouse gas Emissions. Netherlands Environmental Assessment Agency. Report. p20-27. Available from: https://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2017-trends-in-globalco2-and-total-greenhouse-gas-emissons-2017-

report2\674.pdf.
Order of the Government of the Russian Federation (2008), Portal Garant. ru. p215. Available from: http://www.garant.ru/products/ipo/prime/doc/92908/#ixzz5PTm dz8ES.
Order of the Government of the Russian Federation. (2009), On approval of the Main Directions of the State Policy in the Field of Increasing the Energy Efficiency of the Electric Power Industry Based on the Use of Renewable Energy Sources for the Period up to 2024. p1. Available from: http://www.docs.cntd.ru/document/902137809.
Order of the Government of the Russian Federation. (2009), On the Energy Strategy of Russia for the Period up to 2030. Official website of the Ministry of Energy of the Russian Federation. p1715. Available from: https://minenergo.gov.ru/node/1026.
Order of the Government of the Russian Federation. (2013), Available from: http://www.garant.ru/products/ipo/prime/doc/70288052/#ixzz50f4qQkB9.
Renewables (2018), Global Status Report. p139-141. Available from: http://www.ren21.net/wp-content/uploads/2018/06/17-8652GSR2018FullReportwebfinal.pdf.
Rustamov, N.A., Andreenko, T.I. (2011), State technical regulation of the development of renewable energy sources in Russia. Alternative Energy and Ecology. 11, 49-54.
Simonova, M.D., Zakharov, V.E. (2016) Statistical analysis of global renewable energy trends. Vestnik MGIMO-University, 3(48), 214-221.
The Hevel Group of Companies Modernized the Plant and Doubled the Production of Solar Modules. (2017), Rosnano Portal. Available from: http://www.rusnano.com/about/press-center/news/20170703-hevel-modenizirovalzavodvdvoe-uvelichil-obiomproizvodstvasolnechnykhmoduley.
The World Bank: World Development Indicators. (1997-2017), Available from: http://www.databank.worldb ank.org/data/indicator/NY.GDP.MKTP.CD/1ff4a498/Popular-Indicators.
Until. (2020), Rosatom Plans to Build a Wind Farm in Russia with a Capacity of 610 MW. 2017. portal Neftegaz.RU. Available from: http://www.ng.ru/energy/2017-02-01/100_rosatom0 1021 7.html.
Veselov, F.V., Dorofeev, V.A. (2018), Intellectual power system of Russia as a new stage in the development of the power industry in the digital economy. Energy Policy Journal, 5, 24-32.
Veselov, F.V., Erokhina, I.V., Makarova, A.S., Khorsheva, A.A. (2017), Comprehensive assessment of the effective scope of modernization of thermal power plants to substantiate the rational structure of the generating capacities for the future until 2035. Thermal Engineering, 64(3), 161-169.