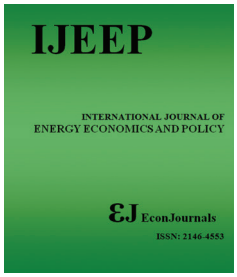

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Problems and Perspectives of BRICS Countries Transfer to "Green Economy" and Law-carbon Energy Industry

Mihail Nikolaevich Dudin[1]*, Evgenia Evgenevna Frolova[2], Julia Alexandrovna Artemieva[3], Vitaliy Vasil'evich Bezbah[4], Alexey Nikolaevich Kirsanov[5]

[1]Russian Presidential Academy of National Economy and Public Administration, 82, Vernadsky Prospect, Moscow 119571, Russian Federation, [2]Far Eastern Federal University, 8, Suhanova Street, Vladivostok 690950, Russian Federation, [3]People's Friendship University of Russia, 6, Miklouho-Maclay Street, Moscow 117198, Russian Federation, [4]People's Friendship University of Russia, 6, Miklouho-Maclay Street, Moscow 117198, Russian Federation, [5]People's Friendship University of Russia, 6, Miklouho-Maclay Street, Moscow 117198, Russian Federation. *Email: dudinmn@mail.ru

ABSTRACT

This article states basics of the "green economy" concept and the role of transferring from industrial to ecologically responsible development of renewable power sources. The main aim of this article is to determine principle regularities that stipulate and restrict abilities of the BRICS countries to use the renewable energy sector in order to replace high-carbon consumption in economic and social sector. Basic conclusions of this work are the following: (1) The aggregate of economic, social, ecological, and energetic problems faced by the modern civilization are directly interrelated. That is why in order to preserve the environment and natural resources for future generations, it is necessary to refuse from resources of unsustainable and high-carbon areas of development, (2) the concept of green economy lies in the fact that needs of the humankind must be rationalized, above all, in the power context, through ensuring a reasonable refusal from using economically destructive carbons by replacing them with renewable power sources, (3) a lot of European countries made the power breakthrough simultaneously developing traditional and renewable energetic. However, it is impossible to make the same conclusion in relation to the BRICS countries. In the BRICS coalition only one country – China - can be acknowledged as a leader in using the renewable energy sector. However, at the same time this country is an "anti-leader" in polluting the environment, (4) at the present time economy of the BRICS countries cannot be yet acknowledged as green. However, along with this, India, China, RSA, Russia, and Brazil have a considerable natural, climatic, and geographical potential for efficient use of benefits of the renewable energy sector. In the future it will allow them to transfer from the industrial and unsustainable vector of development to ecologically responsible development.

Keywords: Green Economy, Low-carbon Economy, Renewable Energy Sector, BRICS, European Union, Power Resources, Stable Development
JEL Classifications: Q57, Q28

1. INTRODUCTION

About 30 years ago the World Commission on Environment and Development (WCED) chaired by G.H. Brundtland published a report and results of its researches that stated that the future of the modern civilization was under threat, and, supposedly, the only way out of the current situation was the transfer from aggressive priority development to stable development (Pearce et al., 1997). Stable development must be interpreted as satisfying the present human needs without damaging the environment and without prejudice to the opportunities of future generations.

Actually 30 years ago the world started understanding that resources were exhaustible, economy had growth limits, and the environment did not manage to renew as quickly as the modern civilization was developed. The conclusions of the WCED entirely coincided with the provisions of the World Conservation Strategy (1980). The key idea of this strategy was in the fact that the development of the civilization, its maintenance, as well as conservation of environment were equally important for the normal life activity of the humankind that was simultaneously a curator of natural and other resources required for normal life activity of future generations (Chapple, 2008; United Nations Environment

Program [UNEP], 2011). According to regular inquiries of the European Union population, the problem related to conserving the environment is as important as poverty eradication, decrease in the level of unemployment in the world, and maintenance of economic balance (Historical and Statistic World Economy, 2015; UNEP, 2015), because the interrelation of natural, social, and economic environments can be observed every day, and not always this interrelation is positive (Dudin et al., 2015; Dudin and Frolova, 2015).

Based on the principle formulae of stable social and economic development of the modern civilization, a new concept – green economy concept – was formed (Fuks, 2016; Berger and Lester, 2015; UNEP, 2011; 2015). In other words, green economy includes low-carbon and ecologically safe productions that meet social and individual needs, and that herewith do not have a destructive impact on the global eco-system, and maintain its resources in order to transfer them for stable development by future generations of our civilization. Thus, the leading goal of green economy is to transfer from high-carbon to low-carbon economic and social sector.

2. METHODOLOGY

Based on the content-analysis of theoretic and empiric data, this article formulated basic conceptual provisions of green economy the global civilization is transferring to at the present time. It was concluded that economic, energetic, ecological, and social problems of stable development of the modern civilization were directly interrelated. That is why the transfer to green economy is possible, firstly, subject to the decrease in aggressive production and profusion in using traditional hydrocarbon resources, and, secondly, subject to rational use replacement of traditional energetic by renewable power resources. The example of statistic data on the BRICS countries showed the problems related to using the potential of renewable energy sector that do not allow Russia, India, China, RSA, and Brazil to transform its industry-focused vector of economic development in the area of green economy.

3. RESULTS

Over the recent century the world has changed its skin. This was only in 1900 when the population of the earth was about 1.6 billion people, but in 2000 the number of the population of the earth was above 6 billion people. In October 2011 the boundary in 7 billion people was passed. At the present time according to the results of 2015 the population of the earth is 7.4 billion people. Herewith, the average life duration almost doubled, and the poverty level decreased more than 3 times.

It became possible for the earth population to grow quickly, as well as for the level of welfare of countries and states to improve due to the scientific-technological progress that created the pre-requisites for the Industrial Revolution (in the XVIII – XIX centuries) and stipulated the transfer from the manufactory to industrialization. Civilization development is directly related to scientific and technical achievements that provide the advance economic growth as compared to the growth of the earth population. Thus, if for the period since 1900 till 2000 the number of the world population increased 3.75 times, the world gross domestic product for the same period increased more than 18 times (Figure 1).

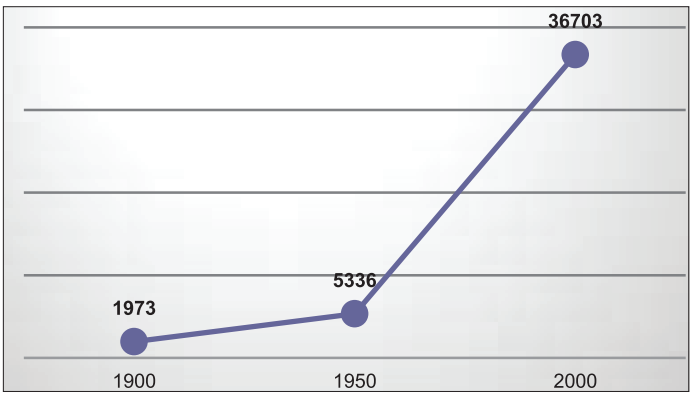
Along with this, it is necessary to note that the growth of the earth population, as well as economic progress came with the constant increase in the loading on the environment. Thus, for example, as a result of the people's economic activity over the recent 100 years the level of the world-wide ocean acidification has increased almost 1.2 times (in 2000 as compared to 1900), the losses of the rainforest has increased more than 6 times, and the level of the carbonic oxide emissions has increased 1.5 times. In the medium-term perspective the current changes of the climate as a result of the people's economic activity can cause catastrophic consequences. According to UNEP, if the current situation does not change (the world economy and socials sector are characterized by a considerable consumption of hydrocarbons in order to provide needs of functioning and developing), during the period from 2030 to 2050 the humankind may lose about 5 million people (i.e., about 250 thousand human lives every year) (UNEP, 2015). Changes in the climate and global natural system have an impact on almost all aspects of the human life, and deteriorate the level of welfare of nations, peoples, countries, and states.

According to UNEP during the period from 1990 to and including 2010, the level of welfare of some world regions, which is estimated in the context of three kinds of capital (natural, human capital assets, and manufactured), has considerably changed (Figure 2).

It is obvious that the economic growth comes with the increase in the loading on the natural system. Herewith, if in the Latin America, Western and Eastern Europe, Russia, and Asian-Pacific Region every percent of the natural capital loss comes with more than 2-3 times economic growth, in Africa losses of the natural capital are almost identical to the tempos of economic growth. It means that natural resources in Africa are used extensively, and besides they do not contribute to the accrual of the human capital assets.

The developing world regions (particularly, such as Africa) must invest not less than USD 70-100 billion annually for renewing

Figure 1: Dynamics of the World Gross Domestic Product, USD billion



Source: Historical and Statistic World Economy (2015)

their ecological systems, biological diversity, and climate in order to overcome harmful consequences of the impact of irrational and unsustainable use of natural resources. Along with this, it is possible to note that the investment potential of the developing world regions is rather low. The involved foreign investments are directed to the areas that are strategically important for these regions (production and processing of subsoil resources). Besides, national legislation of many developing countries does not provide ecological or social responsibility of economic entities (companies and enterprises) (Global Environment Outlook-5, 2015). It is obvious that such aggressive approach to exploiting the natural capital is fraught with catastrophes for the whole modern civilization.

The transfer of economic and social sector to the use of renewable power resources can be considered to be the most optimal solution in the existing situation. Almost all world regions have considerable potential related to using the renewable power sector: Solar, wind, hydroenergy, and bioenergy. Thus, for example, according to the data of the International Renewable Energy Agency (IRENA) Agency, Canada and the USA established production capacities that generate the energy from renewable power sources that are about 90,000 and 200,000 MW respectively (IRENA, 2015).

Russia with its considerable potential and climatic diversity established capacities that generate energy from renewable power resources only in the amount of 50,000 WT per year. Brazil and China put into operation the installations that generate energy from renewable power resources in the amount of 120,000 and 500,000 MT per year respectively. In this context Africa is an outsider. In the whole African continent they put into operation the installations that generate energy from renewable power resources with total capacity of not more than 24,000 MT per year (IRENA, 2015).

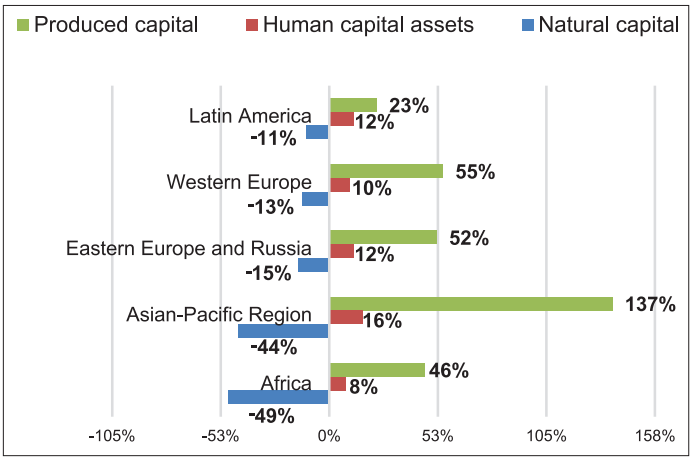
The problem of arrears of some countries in using the renewable power sector in order to decrease anthropogenic and technology-related loading on the ecology lies not so much in the lack of the investment potential, as in the total unreadiness to transfer to green economy. As a rule, the countries that are the richest in minerals and recreational resources focus on exploiting the resource rent. Such countries are characterized by high resources dependence, while the innovational activity of such countries (including in terms of exploiting renewable power resources) remains rather low. The European Union countries and the USA are the most stable leaders according to the Global Innovation Index (GII) (Figure 3).

Among the countries that enter the BRICS coalition, only China (position 29 in the rating) enters the group of the first 30 countries leading in the GII. Other BRICS states occupy low positions in the rating: Russia occupies position 48, the South Africa - 60, Brazil - 70, and India - 81.

A number of key factors have an impact on the level of the innovational activity of the BRICS countries. The most important ones include the following:

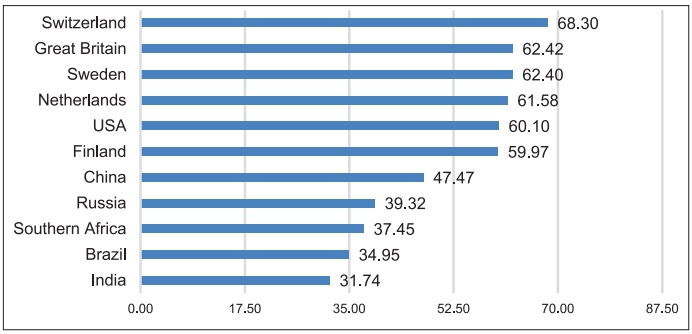
1. Maintenance of protectionism, state paternalism, and extended state participation in national economies, and first of all, in key sectors and areas of the fuel and energy complex,

Figure 2: Changes of the welfare of separate world regions (in % per head)



Source: UNEP (2011, 2015)

Figure 3: Global Innovation Index of countries – 2015 (points)



Source: Global Innovation Index (2015)

2. Growth of inflation and relatively high consumer prices for energy products as compared to the tempos of the people's welfare growth; it is stipulated by economic and political instability, maintaining of considerable shadow sector and hidden unemployment,
3. Dependence on the import of technologies in spite of sufficient development of scientific and educational sector in some BRICS countries, and
4. Strengthening confrontation on the background of the struggle for political leadership in the world an access to the minerals reserves.

Together with the factors that limit the innovational activity in the BRICS countries, it is necessary to pay attention to the resourceful component of the development of these countries. As mentioned above, the countries that have high natural and recreational potentials are characterized by insufficient strive for exploiting renewable power resources, and the national economy of such countries can be considered as the one that depends on resources or rent economy (Moran and Russell, 2009; World Energy Perspective: Cost of Energy Technologies, 2013). This thesis is considerably related to the BRICS countries. Thus, for example, as on 2015 the BRICS countries were fully provided with hydrocarbon power resources (Figure 4).

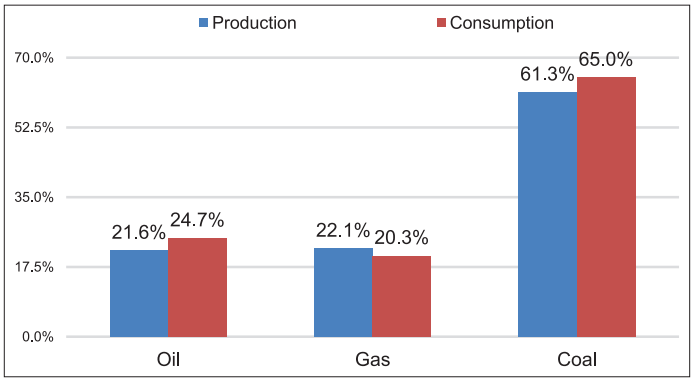
However, at the same time data about the reserves of oil, gas, and coal that have been explored in the BRICS countries by the

present time do not let us be sure that the power needs of these countries can be met at the expense of the existing reserves of the hydrocarbon raw materials (Figure 5). It is actually possible to say that only in terms of the natural gas, the power consumption of the BRICS countries is provided with the relevant type of power resources.

The energy intensity of economies of the BRICS countries is characterized by various indicators. Thus, for example, in Brazil and India the energy intensity of economies is relatively low (about 0.11-0.14 tons of the oil equivalent per UAS 1 thousand), in RSA and China the energy intensity of economies is on the medium level (about 0.22-0.24 tons of oil equivalent per USD 1 thousand). The Russian economy has the highest energy intensity (above 0.35 tons of oil equivalent per USD 1 thousand).

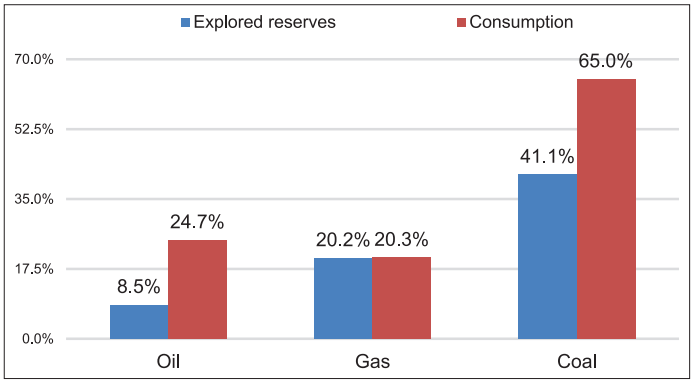
Thus, it is obvious that the BRICS countries must change the vector of their economic development from industrial to ecologically responsible, as well as they must activate implementing and exploiting renewable power resources. It is necessary to note that each of the above countries have potential opportunities to transfer to the low-carbon economy. In particular, China is already actively using these opportunities. Other BRICS countries use the accumulated potential of renewable power sector less actively and less efficiently.

Figure 4: Ratio of production and consumption of carbon power resources in BRICS countries as on 2015 (in % of the world indicators)



Source: Statistic Annual of the World Energetics (2015), Transparent Cost Database (2015)

Figure 5: Ratio of explored reserves and consumption of carbon power resources in BRICS countries as on 2015 (in % of the world indicators)



Source: Statistic Annual of the World Energetics (2015), Transparent Cost Database (2015)

4. DISCUSSION

The renewable power sector is not a unique new solution in providing power needs of the modern civilization (Berger and Lester, 2015; European Commission, 2013). During the whole development of the humankind solar, water, wind, and biomass energy, as well as muscle power of people and animals were primary and in many cases irreplaceable resources of power. However, these resources were not sufficient. Besides, the used primitive technical devices did not allow to obtain the power capacity with the efficiency factor efficient to generate warmth and electricity that are so much required to maintain reasonable life activity.

Consequently, during the period of the scientific and technical progress that happened to be a catalyzer of the Industrial Revolution (the XVII – XIX cent.) when transferring from the manufactory to the machine labor, they created technical devices that allowed to transform the primary power into energetic resources with the efficiency factor that was high at that time. The occurrence of oil and gas production technologies stipulated the breakthrough in providing the power needs of both economic agents and social sector. The first three fourth of the XXth century were practically characterized by unconditional leadership of oil and gas production technologies in providing the world power needs (Rena et al., 2015; Clerici et al., 2015):

- About 50% of all world power needs were provided by the production of oil and products of its processing
- About 16-18% of all world power needs were provided by gas production and its products processing, and
- About 25% of these needs were provided by the mineral coal production.

Oil, gas, and coal started being considered as traditional resources of power. It is essentially difficult to imagine the life of the modern civilization without them in the last quarter of the XXth century. However, two crises (1973 – "the oil embargo," and 1979-1980 – the Islamic Revolution in Iran) that had followed the power stability showed that traditional power resources could not be considered, firstly, as exclusive, and secondly, as unconditionally reliable and long-term basis of the world economy development. During the last decade of the XXth century on the background of the war in the Arabia Gulf, one more power crisis was documented. Almost simultaneously with it the world community acknowledged the problem related to changes in the climate due to the emissions of CO_2, including as a result of the unsustainable exploitation of natural mineral resources and careless use of the produced traditional (hydrocarbon) power resources.

These are the instability of the monopolized markets of the hydrocarbon raw materials and products of their processing stipulated by the dominating impact of political rather than market factors, and the negative consequences of the anthropogenic activity that led to a considerable exhaustion of natural reserves

of hydrocarbons, stipulated the occurrence of the concept of the renewable power sector, but with new technical and technological characteristics. And first of all the countries whose dependence on supplies of hydrocarbon raw materials and products of their processing was rather high (the European Union countries) were interested in the development of new renewable power sector.

At the present time other countries, including those that are traditionally provided with reserves of traditional (mineral) power resources, started displaying their interest in the benefits of using the renewable power sector. Along with this in the previous part of this article we showed that unlike China other BRICS countries were less active in using renewable power resources in spite of the fact that Russia, India, and RSA as well as Brazil have the natural and climatic potential that allows to generate power resources from the environment (Table 1).

Scientists and researchers share the view that the production of power from biomass and solar irradiation are the most efficient in terms of finances, economy, and investments. And in this part two BRICS countries – Brazil and China – are the most leading in terms of acquiring separate technologies related to exploiting renewable power resources.

Brazil together with the USA and European Union countries produce about 85% of the world volume of bioenergy (Scarlat et al., 2015; Connolly et al., 2016). Herewith, the basic product of production is bioethanol. Not more than 10% of the world production includes the bio-diesel fuel. Other BRICS countries lag behind Brazil in terms of the level of bioenergy development, and this lagging is rather considerable, above all in RSA and Russia. However, along with this, it is necessary to note that India and China are the most promising players on the world market of biofuel in the medium-term perspective. What is the strive of India, China, and Brazil for developing the bioenergy stipulated by? Here it is necessary to take into account several key factors:

- Firstly, in Brazil, India, and China the volumes of the explored reserves, as well as volumes of production of traditional hydrocarbons are limited due to the poverty of these countries in mineral types of fuels and power,
- Secondly, for the recent decade in Brazil, India, and China the priority growth of car fleers has been observed; on the one hand, it characterizes qualitative changes of the social and economic development, and on the other hand, it means the increase in emissions of carbonic oxide in the atmosphere, and
- Thirdly, in China there are considerable areas of inefficient lands that cannot be used in the agriculture. In Brazil and India the agrarian sector where large volumes of plants wastes and farm animals' waste products is rather developed.

Russia and RSA make separate attempts to develop bioenergy. Russia has all necessary conditions to create capacities and generate power from biomass. However, the main problem lies in the fact that, unlike Brazil, India, and China, Russia does not support projects on involving bio fuels in the economic turnover on the state level. There is the similar problem in RSA. Herewith, while in Brazil, India, and China separate types of transportation can use both petrol, and bioethanol, and biofuel as fuel, in Russia and RSA this area of using bioenergy has almost not been implemented.

Table 1: Empiric estimation of potential related to renewable energy sector in Russia, India, Brazil, and RSA

Type of resource	Production and use potential
Bioenergy	RSA and India are agrarian and industrial countries. Russia and Brazil are industrial countries with the well-developed agriculture. In these countries waste plants and wood, and farm animals' products of life can be used as bioenergetic resources. The resource is universal to use: biomass can serve as a resource to obtain all energy carriers (biogas, thermal and power energy). The potential related to using the resource is the highest in rural areas that are remote from networks of the centralized generation and power supply
Hydroenergy	River networks of Brazil, India, and Russia are very extensive. These three countries, as well as RSA have borders with oceans. Hydro resources of the countries can be used not only to establish large hydro power stations but also for creating pump accumulating and tidal hydroelectric stations of small and allocated generation. The potential related to using the resource is rather high because its transformation into energy is made with a high efficiency factor. The power obtained from hydro resources can be transferred for long distances
Wind energy	Climatic position of RSA, India, Brazil, and Russia allows to transform kinetic energy of air mass into power, mechanic or thermal energy with a high efficiency factor. The potential related to using the resource is rather high in areas with stable and powerful air flows (mainly southern and south-western areas). Wind generators can be used in areas with stable and powerful air flows as an alternative of traditional centralized generation in order to decrease the expenses for power supply to these areas
Solar energy	Weather and climatic conditions of Brazil, India, and RSA allow to almost without limitations use everywhere solar irradiation to obtain thermal, electric or mechanic energy. In Russia the potential related to using solar energetic is rather high in southern and south-western areas of the country. Accumulating solar panels and solar batteries as well as wind generators can be used as an alternative of traditional centralized generation in order to decrease expenses for power supply to separate regions and areas of the countries under consideration
Geothermal energy	Geothermal energy (earth interior power processed into thermal and electric power) is localized in regions around volcanoes and areas with a high content of dry subsurface rocks. That is why the potential of geothermal resources can be used for power provision in Brazil, India, and Russia. The potential related to using geothermal energy is somehow lower in Southern Africa. However, in Eastern Europe such projects are already successfully implemented

The main reason is in the fact that Russia does not have enough reserves of natural gas to refuse from petrol fuels and decrease the emission of carbonic oxide. In RSA the number of cars exploited by the population is not considerable. The tempos of car fleet growth in RSA as compared to India are rather low. That is why the problem related to the emission of carbonic oxide and availability of car fuels is not so urgent as in other BRICS countries. General limitations for the development of bioenergy in the BRICS countries can be structured as follows:

1. Non-availability of system state support for mechanisms related to integrating biofuels in the economic turnover and, above all, in RSA, Russia, and India,
2. Lack of stimuli and motives with the population and economic entities to utilize biomass for its further processing in power resources,
3. Low demand for biofuels on the part of economic and social sector due to insufficient awareness of population and economic entities about advantages and benefits of using ecologically safe power resources,
4. Lack of the differentiated fiscal policy in terms of taxation and excise duties when producing traditional hydrocarbon power resources and power resources obtained from renewable resources,
5. Low profitability of business projects on developing bioenergy due to the absence of both system state and scientific support, and
6. Decrease in market prices for hydrocarbons that makes bioenergy uncompetitive according to the price.

However, along with this, such factors as availability and accessibility of the primary raw materials, mobility of processing and generating installations, lack of the need to construct large allocating infrastructure and others stipulate the perspective, ecological compatibility, and energy efficiency of projects on involving bioenergy in the economic turnover of the BRICS countries.

As for the solar energy, it is necessary to note that China is an unconditional leader here (Kalogirou, 2013; Seitz et al., 2015).

Starting since 2011 China has adopted the state program of developing basic areas of its power industry for the period till 2030. During the period from 2011 to and including 2015 China increased the capacity of installations that generate power form the solar irradiation from 9.2 GW to 14.5 GW, i.e., more than 1.5 times (to compare, for the same period in the USA the growth of generating capacities in the solar power sector was 30%).

In Brazil and Russia solar energy almost is not used. In India the total established capacity of solar batteries, panels, and accumulators is about 5 HW, and not more than 1.3 HW in RSA, in spite of the fact that these countries have considerable potential to exploit power obtained from solar irradiation. As a rule, the main reason of refusal from projects related to using solar energy is relatively high cost of generating power resources. However, along with this solar power sector has more advantages in the low latitudes and this is the south that requires additional capacities.

The higher cost of electrical power in the solar power sector could be compensated by direct and indirect benefits related to decreasing expenses for long-distance networks, and transfer of electrical power. Unfortunately, a lot of these benefits are not taken into account within traditional accounting of money flows. The distributed power generation decreases the amount of energy lost when transferring electrical power, because electrical power is generated close to the places of its consumption. Typical systems of distributed power generation have low exploitation expenses, low level of the environmental pollution, and high efficiency. Modern built-in systems can provide the best quality during automated exploitation and using renewable power resources. It decreases the size of the power plant that can earn profit.

Here it is necessary to understand that on the one hand, the current limitations do not allow to make solar energetic sufficiently mobile. However, on the other hand, using autonomous solutions (power provision due to transforming solar flow of separate buildings, constructions, and small settlements) allows to solve a serious problem related to supplying Chinese provinces that are remote from centralized generation networks with the required power resources. Besides, the use of autonomous solutions of solar energetic allows to consistently decrease the level of harmful emissions of carbon dioxide in the atmosphere (that is a basic condition when transferring to green and low-carbon economy), as well as to decrease the level of power dependence of economy and social sector on external supplies.

5. CONCLUSIONS

The transfer to green and low-carbon economy comes both with energetic breakthroughs (for example, in the European Union countries) and energetic arrears. In particular, some BRICS countries make separate attempts to transfer to using renewable power resources in order to decrease anthropogenic and technology-related loading on the environment. Along with this, it is necessary to note that only Chine among BRICS countries can be considered as a leader on using the potential of renewable energy sector (solar, wind, hydroenergy). However, at the same time this is China that is an "anti-leader" in terms of the emission of carbonic oxide in the atmosphere. That is why the Chinese economy cannot be acknowledged as green and aiming at conserving the natural environment and natural resources to provide normal life activity of future generations. National economies of Russia, RSA, India, and Brazil cannot be acknowledged as low-carbon, either, also because these countries have not implemented system mechanisms of involving the whole range of renewable power resources in the economic turnover in spite of the fact that these countries have a considerable natural, climatic, and geographic potential that can be used to replace ecologically aggressive traditional power resources.

In the short- and medium-term perspective, the BRICS countries will have to pay close attention to and activate the implementation of renewable energetic in the economic activity, because the "oil époque" is about to finish, and the explored reserves of other hydrocarbon resources (natural gas and coal) can be quickly exhausted due to low efficiency of their production and high energy-output ratio of economic and social sector.

The conservation of the environment, its resourceful and biological diversity is a key formula of green economy. Consequently, the low-carbon way of development is, supposedly, the only way that will contribute to physical maintenance and further stable development of the modern human civilization.

Within this article we have considered the general basics of green economy and the role of renewable power resources in it. This article has not considered methodological aspects of estimating the dynamics of processes related to replacing traditional power resources by renewable energy sector (globally, in separate regions and countries of the world). In future researches on this theme we are going to offer the estimation methodology and make a comparative analysis of the efficiency and performance of processes related to replacing traditional energy by renewable power resources through the example of the European Union and BRICS countries.

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