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World Biodiesel Market and Optimal Scenarios for Biodiesel Production and use in Russia

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Abstract*: The purpose is to analyze current situation and future developments in the global biodiesel market including Russia. Among the results obtained are the assessment of feedstock, technical standards and production cost of biodiesel and critical analysis of multidiscipline factors influencing global biodiesel market development. For Russia the potentials of biodiesel production and the rates of diesel fuel substitution are estimated. The main vectors of biodiesel market development and state supporting measures are suggested. The conclusion underlines main trends in the world biodiesel market and emphasizes reasonability to concentrate the use of biodiesel in the Russian agricultural sector.

Keywords*: liquid biofuel, biodiesel, Hydrotreated Vegetable Oil (HVO), diesel fuel, crude oil, motor fuel, electric vehicles, tax credits, energy intensity, biofuel legislation.

I. INTRODUCTION

Progress in the production and use of renewable energy in the world is increasing every year. The greatest success has been achieved in the field of renewable electricity and heat production. In mobile processes (including field and transport operations in agriculture), the achievements are more modest and the main source is still liquid biofuel produced from agricultural crops. Currently the major types of liquid biofuels are fuel ethanol and biodiesel.

Today and in the near future fat and oils represent the major source for biodiesel production throughout the world.

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Biodiesel market can be regarded as a special innovative segment of global fat and oils market along with developments including organic and transgenic fat and oils production and use. All these developments are sprouting and cover not only developed but a number of developing countries. Therefore, design of state policy for the development of national fat and oils market in every country should consider the potential for those innovative developments internally and estimate the outside influences.

Regardless of rapid evolution of gasoline and diesel fuel engines the interest in possible usage of vegetable oil for fuel appeared in some regions (European countries, Japan, Argentina, Brazil, China) as early as the first part of the twentieth century.

However the first samples of biofuel weren't good enough for large scale use mainly due to high viscosity. Therefore, later the scientific community focused on improvement of biofuel quality using new technologies of vegetable oil processing and testing it in various mixes including conventional diesel fuel.

The industrial scale production of liquid biofuel from vegetable oils started at the end of eighties in the last century when a factory with processing capacity of 30 thousand tons of rapeseed per annum launched biofuel production in Austria. Nevertheless, the large-scale commercial production of biofuel derived from vegetable oil started only in the first decade of XXI century.

II. LITERATURE REVIEW

Various aspects of biodiesel and liquid biofuel production and use have been studied over the years by a number of authors from around the world. Among them are Aatola H.; Bauer, U.V.; Bukljaš Skočibušić, M.; Fedorenko, V.F.; Fischer, G.E; Gebremariam, S.N.; Hill, J.; Huo, H.; Jones, W.D.; Kemp, W.; Kinast, J.A.; Knothe, G; McCormick, R.L.; Marchetti, J.M.; Melillo, J; Mosnier, A. P.; Ortiz-Cañavate, J.; Patzek, T.W.; Pimentel, D.; Roberts, D; Richards, I.R.; Robinson, J; Rosegrant, M.W; Sanford, S.D.; Schumacher, J.; Sheehan, J.; Shrestha, D.; Tyson, R.L.; Von Gerpen, J; Wang, M.; Zhang, W.; Ziesemer, J. and many others. But it should be noted that most studies relate to important, but particular problems associated with biodiesel. They include economics of biodiesel, technical characteristics of biodiesel as fuel, environmental and social aspects of biodiesel production and use. At the same time, much less research devoted to a comprehensive analysis of the current situation and future of the global biodiesel market, taking into account a set of factors of influence. There is also an extreme shortage of research aimed to determine the optimal development of biodiesel market vector and the potential of replacing conventional diesel fuel in Russia. Therefore, the chosen research topic seems to be very relevant.

III. PROPOSED METHODOLOGY

A. General description

Statistical base of the study include the materials of International Energy Agency (IEA), The Organisation for Economic Co-operation and Development (OECD), Food and Agriculture Organization of the United Nations (FAO), Renewable Energy Policy Network for 21st Century (REN21), Federal State Statistics Service (Russian Federation), Ministry of Agriculture of the Russian Federation. The study is based on the use of the method of energy analysis, economic and statistical, abstract and logical, analytical, computational and constructive research methods.

B. The algorithm of the study

The composition of the study contains two main parts. The first part concerns the global biodiesel market. Technical and economic characteristics, situation of world biodiesel production, consumption and trade for 2005-2018 and up to 2028 are investigated. The factors influencing the biodiesel market are determined and analyzed in detail too. The second part is devoted to poorly studied problem to determine the optimal vector of biodiesel market development in Russia. The reasonability of biodiesel use in agricultural sector is proved. After that, the results of calculations of conventional diesel fuel substitution by biodiesel in national and regional context are demonstrated. Finally, the steps that the state should take to support the biodiesel market are proposed.

IV. RESULT ANALYSIS

The results for the global biodiesel market. The critical raw materials for biodiesel production worldwide are soybeans (USA, Latin America, and EU), rapeseed (EU, Canada), palm fruits and seeds (South - East Asia). Other fat and oils feedstocks are limited in energy use or localized. They include sunflower seeds used for biodiesel production in the EU. Secondary fat and oils raw materials (waste vegetable oil, animal oil etc.) are also used for energy purposes. The feedstocks of that kind are relatively active in use particularly in the USA, EU and China.

The major source of biodiesel production in the world is rapeseed oil (53% of all biodiesel feedstocks). The share of soybean oil is 37% and 10% constitutes sunflower oil, wastes, and other sources.

The feedstock expenditures play a major role in cost production of biodiesel. They can amount to 85% of total cost [1]. The energy analysis of biodiesel production demonstrates similar proportion. For example when biodiesel is derived from rapeseed, field operations (planting, harvesting etc.) require 71% of total direct and indirect energy inputs [2].

Soybean oil is relatively cheap source for biodiesel production throughout the world. According to REN 21, the lowest production costs of biodiesel from soybean oil are observed in Argentina (56-72 US cents /liter of diesel or petrol equivalent). Production cost of biodiesel from soybean oil and other sources in other countries is noticeably more expensive. For soybean oil it varies from 100 to 120 cents /liter throughout the world, for palm oil (including production in Indonesia and Malaysia) – 100-130 cents /liter and for rapeseed oil (EU) – 100-130 cents /liter [3]. Until recently production of biodiesel was more expensive compared to conventional diesel fuel.

In the context of yield and land use intensity biodiesel production from palm biomass is the most favorable. According to some estimates the potential yield can be as high as 4748 liters /ha. In contrast biodiesel output from rapeseed is equal to 953 liters/ha and in the case of soybeans only 524 liters/ha [4].

Currently, transesterification of lipids contained in vegetable oils and animal fats by monobasic alcohols (methanol and more rarely ethanol and isopropyl alcohol) over various catalysts (NaOH, KOH, $NaOCH_3$ specifically) is a primary way of biodiesel production. Such biodiesel internationally is abbreviated as FAME which means fatty acid methyl ester.

When processing fat and oils feedstock, useful output depends on numerous factors (sort of raw material, technology etc.) and many studies in Russia and abroad deal with mass and energy balances of total production cycles. Generally, they are related to biodiesel derived from rapeseed and soybeans and more rarely to sunflower seed production and processing.

For instance from 1 ton of rapeseeds, methanol (121 kg per 1 ton of refined rapeseed oil is required) and catalysts (15-23 kg) it is possible to obtain 379 kg of biodiesel, 603 kg rapeseed meal, 44 kg glycerin (subsequent purification of original glycerin fractions is necessary for commercial product) and 20 kg of phosphatides (pharmaceutical feedstock) [1, 2].

Collection and sales of byproducts significantly increase economic effectiveness of biodiesel production, which is essential for producers, especially for farms and agricultural enterprises.

Compared to conventional diesel fuel, high quality biodiesel operationally has some advantages and disadvantages. Energy content of biodiesel approximately by 5-10% lower than that of diesel fuel whereas its density and viscosity are higher. Among the shortcomings of biodiesel are problems in cold season (when it is necessary to preheat fuel fed from gas tank or use mixes of diesel fuel and biodiesel) and also relatively short storage life (according to some estimates, no more than 3 months).

Cetane number of biodiesel (45-51) is comparable to cetane number of conventional diesel fuel (42-53) and among advantages of that alternative fuel are good lubricating performance (increased engine lifetime) and higher ignition point (provides a superior safety) [1, 2, 5]. A further attribute of biodiesel is high mixing properties and marketability of biodiesel – diesel fuel blends over pure biodiesel.

Currently four main types of biodiesel are used commercially worldwide. They include B2 (2% biodiesel and 98% diesel fuel), B5 (5% biodiesel and 95% diesel fuel), B20 (20% biodiesel and 80% diesel fuel) and B100 (100% biodiesel). Utilizable fuel blends almost eliminate diesel engine's modification, however when using B100 modification is needed [6].

Developed countries established standards for biodiesel. The most common are European and American standards.

Common European standard was established for FAME by Comité Européen de Normalisation (CEN) and widely used abbreviation is EN 14214. The EU members generally practice EN 14214 (although it is recognized internationally) and every country has its own version of the common standard (the differences mainly associate with specific climate patterns of the EU region).

International biodiesel standard ASTM developed by American Society for Testing and Materials is established in the USA. Specifications of ASTM depend on blending types from B2 to B100.

According to REN 21 in 2005-2018 the annual biodiesel production (FAME) growth rate was 18,1% and in 2018 the production volume reached 34 bln liters. For the same period annual global production growth rate of fuel ethanol[1] was 9,9 %. However today world production of fuel ethanol is 3,3 times higher than that of biodiesel [7,8].

In contrast to global market of ethanol fuel, growing global biodiesel market infringes interests of global food market to a lesser degree firstly due to low production volume of biodiesel and secondly due to livestock feed production not being affected so much since manufacturing of meals and cakes remains unchanged.

But at the same time energy share in global vegetable oil consumption is increasing and in some cases it actively competes with traditional food oriented usage.

For example in 2005 manufacturing of biodiesel (FAME) worldwide took 2,6 % of all vegetable oil consumed but by 2017 the estimated share was 12,1%. In some places this level was much higher. For instance in the same year it accounted for 18,2% in the USA, 35,6 in Brazil and 44% in the EU [9].

Alongside with FAME production of new generation biofuel (also derived mainly from vegetable oil) - hydrotreated vegetable oil (HVO)[2] - is developing. Global HVO production is still relatively small and in 2018 amounted to 7 bln liters. Some EU members and the USA are currently the largest HVO producers. The world leader is the USA accounting for 31,4% of global HVO production [8].

The popularity of HVO is growing since 2007 when the first commercial plant with annual capacity of 0,22 bln liters was built in Finland [5]. It is resulted in high quality HVO leaving behind both FAME and conventional diesel fuel, for instance, by such parameters as lower heat content, viscosity, density, cetane number, and cloud point. Furthermore, HVO technology doesn't need methanol, which is rather toxic. The developments in regional structure of FAME production in the world for last decade can be seen in Table 1.

Table 1: Trends in Biodiesel Production by Major Regions and Worldwide

Regions[3]	Regional distribution of production, %			Annual growth rates of production, %	
	2005	2017	2028	2005-2017	2017-2028
Europe	89,5	38,8	30,8	11,7	-0,2
North America	8,4	20,1	21,2	28,8	2,5
Latin America	0	22	21,9	103,7	1,9
Asia	2,1	19	26,0	44,1	4,9
Rest of the World	0	0,1	0,1	71,4	0,9
World	100,0	100,0	100,0	19,8	1,9

Source: Authors' construction based upon OECD-FAO Agricultural Outlook 2019-2028 [9].

In 2005 Europe dominated the world biodiesel production whereas the EU members were leading producers and accounted for approximately 85% of total volume of global production. The next decade however demonstrated faster production growth of biodiesel in other regions. Among them was Latin America where biodiesel production increased more than twofold annually, and Asia (mostly South East, East and South parts) where production annually has been increased nearly by approximately 44%. As a result the EU region still dominates, but its share in the world's biodiesel production has reduced nearly to 39%. In recent years the corresponding shares of North America, Latin America and Asia stand more close to Europe and vary from 19 to 22%. By 2018 the volume of biodiesel production has exceeded 1 bln liters per year in nine countries. Top leaders are the USA, Brazil, Indonesia and Germany (Fig.1).

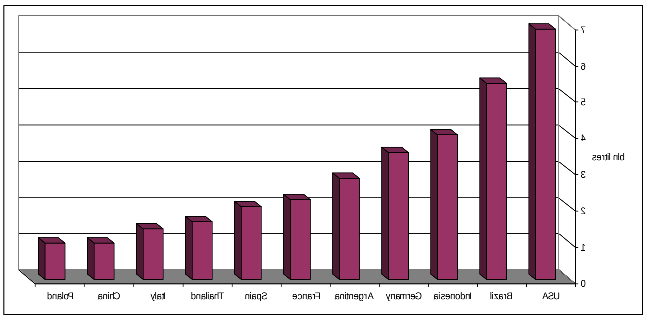

Fig.1: Leaders in Global Biodiesel Production (2018)[4]
Source: Authors' construction upon Renewables 2019. Global Status Report. REN21 [8]

It should be noted that over the past 12 years, the average annual growth rate of global biodiesel production has tended to slow down (Fig. 2) while in 1914-1915 production volume even had decreased by 8,2% (largely due to the emerging economies of Latin America and Asia, as well as the economy of North America).[5]

[1]In this article terms "fuel ethanol" and "bioethanol" are identical.
[2]Originally HVO technology (various vegetable oils, fat and oils wastes were used as feedstock) started up by Finnish oil company Neste Corporation. Chemically HVO technology uses catalytic hydrogenolisis (in which carbon – carbon ties or carbon – heteroatom ties are breaking by hydrogen) of vegetable oil for instance. Originally manufactured alternative fuel was abbreviated as NEXBTL. Today except for HVO sometimes term "Neste renewable diesel" is used).

[3]North America includes Canada and the USA. Latin America includes the Caribbean region. Asia includes the developing countries in the Pacific islands.
[4] Only production of FAME is included.
[5] According to OECD-FAO in 2014-2015 biodiesel production in the USA had decreased by 4%, Argentina – 29,8%. In Indonesia it had fallen by a factor of 2,8 [9].

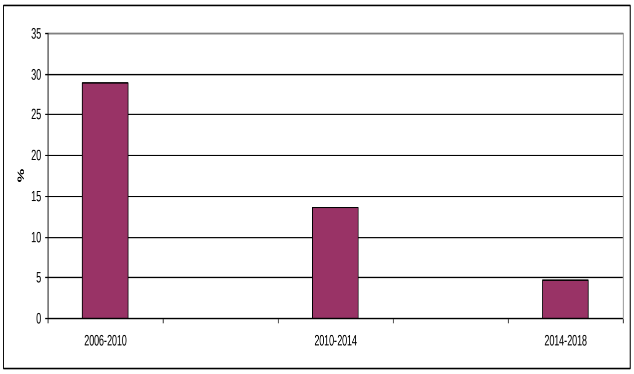

Fig. 2: Global Annual Growth Rates of Biodiesel Production

Footnotes: Period 2014-2018 (figures for 2018 are estimates).

Source: Authors' construction upon OECD –FAO Agricultural Outlook 2019 -2028 [9]

The reasons for the latter include the downfall of crude oil prices, relatively high cost of production of biodiesel and logistical problems in some countries (for example high freight tariffs for shipping of fat and oils raw materials in Indonesia) (Fig. 3).

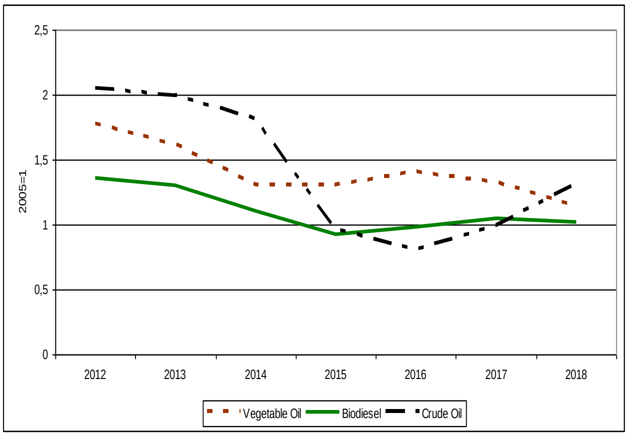

Fig. 3: The Dynamics of Vegetable Oil, Biodiesel and Crude Oil World Price Indices in 2012-2018[6]

Source: Authors' construction upon OECD – FAO Agricultural Outlook 2019 – 2028 [9] and BP Statistical Review of World Energy 2019 [10].

Uncertainties of state policy for biodiesel production in several countries represent additional factor too. For instance petroleum companies in Argentina (produce biodiesel from soybean oil) and Indonesia (produce biodiesel from palm oil) then had suspended the discretionary blending of biodiesel and conventional diesel fuel.

Low crude oil prices and high tariffs on biodiesel imported from Argentina to the EU have also affected biodiesel export from this country, which finally led to decrease in local biofuel production.

Finally in the USA the reduction in biodiesel production could be explained by uncertainties in the prolongation of tax credits for biodiesel producers (0,26 $/L) and delay in announcement of standards for the renewable fuels production.

The main consumer of biodiesel is the EU which according to OECD-FAO accounts for 15,2 bln liters or 41% of total global biodiesel consumption in 2017. Total Europe consumes 15,7 bln litres (Fig.4)

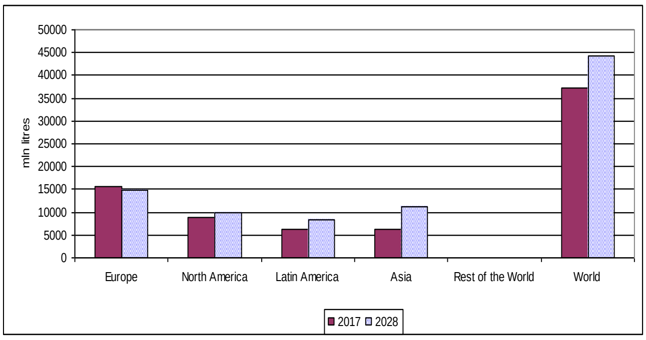

Fig. 4: Distribution of Biodiesel Consumption by the World Regions in 2017 and in 2028

Footnotes: Biodiesel Consumption in the Rest of the World (Africa,Oceania) in 2017 – 41 mln litres and forecasted consumption in 2028 – 45 mln litres.

Source: Authors' calculations and construction upon OECD – FAO Agricultural Outlook 2019 – 2028 [9]

Nowadays North America stands second as world biodiesel consumer while the USA is on the top, accounting for nearly 23% of global biodiesel requirements. However OECD-FAO estimates that Asian region will occupy second position by 2028.

Like fuel ethanol, biodiesel is used in various branches of economy and the largest consuming sector is transport, where it substitutes conventional diesel fuel. Unfortunately statistical coverage of this issue is rather poor. Some related statistics covering the world distribution of total liquid biofuel consumption is presented by IEA (Table 2).

Table 2: Internal Consumption of Liquid Biofuel in Some Regions and Countries by Economic sectors, % (2016)

Sector of economy[7]	**World**	**EU**	**USA**
Transport	95,8	91,2	96,6
Production of electricity and heat	1,9	7,1	0,2
Industry	0,9	0,6	1,6
Agriculture and Forestry	0,3	0,2	0,5
Other uses	1,1	0,9	1,1

Source: Authors' calculation construction upon International Energy Agency (IEA), 2019 [11].

With rising of global demand for biodiesel international trade of biodiesel also develops. Despite some fluctuations the world biodiesel export in 2005-2017 grew up from 0,2 to 3,7 bln liters. However, it remains less than the level of 2011-2014 when the volume of world trade varied from 4,1 to 5 bln litres. At the same period world biodiesel consumption in total internal markets grew up more steadily. That is true not only for largest consumers (including major importers of biodiesel) but also for biodiesel- exporting emerging economies (Argentina, Indonesia).

[6] Vegetable oil – Weighted average price of oilseed oils and palm oil, European port. Producer price Germany net of biodiesel tariff and energy tax. Crude oil – Brent Spot Price. Data on vegetable oil and biodiesel for 2018 are estimated.

[7] Production of electricity and heat includes electric power stations, combined heat and power plants and heating plants. Other uses include residential, commercial and other services, fishing, non-specified consumption and biofuel losses.

All that means the decline in international trade of biodiesel and shift of major producers toward satisfaction of national biofuel needs.

Argentina and EU are major biodiesel exporters altogether accounting for more than 2/3 of total annual world export volume in 2017 (Table 3).

Table 3: Top world exporters and importers of biodiesel in 2017, %[8]

Top exporters			Top importers		
#	Country/region	%	#	Country/region	%
1	Argentina	49,8	1	USA	51,0
2	European Union	18,1	2	European Union	28,6
3	Canada	11,3	3	Canada	6,9
4	USA	8,4	4	United Kingdom	6,6
5	Malaysia	4,0	5	Peru	6,4
Top 5 exporters		91,6	Top 5 importers		99,0

Source: Authors' calculations and construction upon OECD – FAO Agricultural Outlook 2019 – 2028 [9]

In recent years, significant changes have occurred among the leading biodiesel exporters and importers. For example Indonesia was second world biodiesel exporter in 2012-2014 while in 2017 she is out of the leading group of five. The USA now is obvious leader among importers of biodiesel, while China is no longer in the top 5 list.

As can be seen from Table 1 in the next decade the world production of biodiesel is rising, however the growth rates of production become much slower and even slight decrease of production is forecasted for the EU.

Asia, Latin America and North America will compete with the EU to a greater extent as biodiesel producers, however the EU most likely will remain the largest global manufacturer. The world biodiesel production can reach 43,9 bln liters by 2028. Fig.4 demonstrates the fastest growth of biodiesel consumption in Asia and Latin America.

Total share of these regions in the world biodiesel consumption will increase from 34% in 2017 to 44% in 2028. By that time European Union most likely will remain greatest biodiesel consumer.

The latest OECD-FAO estimates show gradual decline in the volume of global biodiesel export beyond 2019. Forecasted biodiesel export throughout the world by 2028 is 3,7 bln litres which slower than in 2017.

Argentina is expected to retain the leading position as world biodiesel exporter however its share in global trade will reduce to 44% by 2028. European Union will hold second place (about 19%). EU is likely to be ahead of the USA in terms of imported biodiesel and its share will be 49% [9].

It should be noted that forecasts of global biodiesel market developments for next decade are rather speculative since they depend on various factors, which are highly changeable in time and space taking into account both the action force and direction of the action.

In our opinion at least seven factors can be associated with the development of global biodiesel market now and further on. Among them: substitution of conventional fuels; environmental factors; social factors; resource factors; technological factors; competitive factors; political factors.

[8] All figures are calculated as percentage regarding total world figure of export and import of biodiesel correspondingly.

Substitution of conventional fuels. By 2016 liquid biofuels (biodiesel, fuel ethanol) share in world total motor fuel consumption accounted for 4,6%, including Northern Europe (10,3%) and the USA (8,6%) [12].

In 2005 biodiesel's volume share in total world diesel type fuel consumption was nearly 0,3%. However in 2012-2014 volume share of biodiesel grew up to 3,5% while its energy share was 3,2% (Table 4).

The highest substitution of conventional diesel fuel by biodiesel is observed in South America (Argentina, Brazil) and the EU. Volume share of biodiesel in all of them is not lower than 5%. In Argentina it has already surpassed 7%. By 2024 the highest volume share of biodiesel in total diesel type fuel use is expected to be in Argentina where it amounts to 10,3% (energy share of 9,5%). Brazil will stand second with 7% (energy share of 6,5%).

Table 4: Share of Biodiesel in the World Consumption of Total Diesel Type Fuel today and in Future,%[9]

Country/ region	Volume share		Energy share	
	2012-2014	2024	2012-2014	2024
Australia	0,3	1,2	0,3	1,1
Argentina	7,3	10,3	6,7	9,5
Brazil	5,3	7,0	4,9	6,5
European Union	5,7	6,4	5,3	5,9
Canada	2,1	2,3	1,9	2,1
USA	2,5	2,6	2,3	2,4
WORLD	3,5	4,0	3,2	3,6

Source: OECD/FAO 2015. OECD - FAO Agricultural Outlook 2015 [13]

Environmental factors. The common perception is that liquid biofuel ecologically is more favorable than conventional motor fuel. In this regard emissions of carbon dioxide, various atmospheric pollutants (carbon monoxide, hydrocarbons, etc.) from combustion of biofuel and conventional motor fuels are usually compared to each other.

But the problem is more complicated and involves many factors associated with working conditions for biofuels, their uses, influence on other natural constituents (including water and land resources) and life cycle of final product. In the latter case it's necessary, if possible, to consider all supply chain and problems associated with biofuel combustion for production of electricity and heat.

With relation to greenhouse gas emissions it is considered that combustion of biodiesel is more favorable compared to burning of fossil fuel since carbon dioxide emissions for instance are offset by its absorption in the field conditions when growing oilseeds.

However it should be noted that production of oilseeds directly and indirectly contributes to greenhouse gas emissions and beyond that land use change is very important.

When oilseeds are grown on existing arable land the additional greenhouse gas emissions are negligible but they become a significant factor when exploiting forested areas or natural pastures.

[9] 2012-2014 – average figures per annum.

On the other hand complex utilization of oil-bearing feedstock lowers the greenhouse gas emissions and boost revenues due to sales of cake and meals indirectly decreasing the use of forage crops. In case of soybean meal, intensity of CO_2 emissions can be put down approximately by a factor of 1,8 assuming the absence of land use change when cultivating soybeans.

Taking into consideration both zero land use change and international trade movements 1 MJ of biodiesel, produced from soybeans in the USA, Brazil and Argentina contributes to 55-73 g of CO_2 emissions. With the same energy equivalent as rapeseed biodiesel (EU, Ukraine, Australia, Canada) it varies from 45 to 63 g and as palm oil biodiesel (Indonesia, Malaysia) – 38g.

Production of conventional motor fuels (gasoline, diesel fuel) and coal is less environment-friendly (85-86 and 112 g/MJ respectively). Only natural gas occasionally challenges biodiesel (62 g/MJ) [14, 15].

More serious matter is change in intensity of toxic atmospheric emissions when burning biodiesel instead of pure diesel fuel or fuel blends.

Biodiesel certainly less polluting agent and advantage goes up progressively when its share in blend with conventional diesel fuel is growing.

According to Environmental Protection Agency (EPA) the decrease of CO emissions when using B20 is 12% and when using B100 it amounts to 48%. The emissions of unburned hydrocarbons (HC) decrease by 20% (67%), particulate matter – by 12% (47%) and sulfates – by 20% (100%).

Biodiesel is more NO_x - emitting although it is due to not only biodiesel percentage in blend but also engine quality, catalysts (which make fuel more expensive), number and timeliness of testing. According to EPA, practically no differences are observed in NO_x emissions when using B20 however with B100 the emissions are larger by 10% [16].

The problem of NO_x emissions could be distinctly weakened by developing advanced biofuel, in particular - HVO. Researches in Finland show that burning pure HVO instead of conventional diesel fuel (EN 590) reduces NO_x emissions by 7-14% [5].

With regard to other natural constituents biodiesel is less intensive polluter (being compared to conventional diesel fuel) since most of studies show lack of toxicity and higher fuel-regression rate when getting to soil and water (both fresh and salty water). For the fuel blends regression rate increases as percentage of biodiesel is rising.

In biodiesel sector the most serious ecological problems associated with soil and water rise from oilseeds cultivation when intensive use of mineral fertilizers, pesticides and petroleum fuels results in accumulation and runoff of toxic pollutants.

In our view the problem could be partly solved with the development of transgenic and organic technologies and their use in the production of oilseeds for energy purpose. These technologies lead to drastic reduction in chemicals and petroleum fuels usage on a per hectare basis.

One more problem is high water consumption in biodiesel production and biodiesel based electricity generation. It occurs primarily during growing season when humidification is insufficient. Soybeans are among the most water consuming oil crops.

For example according to Virginia Water Research Center from 15,5 to 31,2 th. liters of water are required to produce 1000 kWh of electricity from conventional petroleum fuel. Whereas biodiesel water requirements are significantly higher and estimated at 180,9 - 969,0 th. liters (Jones, 2008) [17].

Taking this into consideration, any biodiesel scheme should take into account agroclimatic features of oil crops acreages and the opportunities for the appliance of alternative technologies in biofuel production.

Apart from HVO other advanced technologies should be considered. Among them is "biomass to liquids" technology (BTL) which is based on well-known Fischer-Tropsch process and is characterized by relatively small water requirements. Total water requirements for electricity production using on the basis of Fischer-Tropsch process are relatively small and vary from 530 to 750 liters/1000 kWh (Jones, 2008) [17].

Social factors. In the beginning of commercial production of liquid biofuel social factors occasionally played an important role. Classic example is Brazilian Proalcool program which allowed to increase jobs in biofuel (ethanol fuel) sector from several thousands to almost a million in 1975-1986.

According to Worldwatch Institute in 2005 the fast growing ethanol sector in the USA created almost 154 thousand jobs, boosting household income by 5,7 bln dollars [18].

Biodiesel sector both directly and indirectly generates new jobs too. It is very important for rural areas because level and stability of income of rural population grow whereas migration to urban areas decreases.

On the data of REN21 in 2017-2018 renewable energies (biomass, geothermal, solar, wind, small hydroelectric) altogether provided for 10,9 (in 2014-7,7) mln jobs worldwide from which liquid biofuel sector accounted for 19%. As job producer it stands second after solar PV.

The US biodiesel industry in 2018 generated 72,3 (in 2014 - 49,5) th. jobs or more than 8% of total employment in the domestic renewables sector. The number of direct jobs in Brazilian biodiesel sector amounts to 257 th. (about 23% of total domestic renewables sector) [3,8].

Social advantages of global biodiesel market as well as other renewables markets will still remain in the near future but in the long term they will be weaker as far as development of computer technologies and robotics continues [12].

Resource factors. According to OECD-FAO by 2028 vegetable oil remains the major source for biodiesel production. However share of vegetable oil in total consumption of vegetable oil and percentage of primary vegetable oil in total feedstocks of biodiesel production will virtually remain unchanged in 2017-2028. At the same time, the role of alternative sources (including biofuel of second and third generation) of biodiesel production is likely to increase significantly in some regions.

Various wastes (used vegetable oil, animal fats, other wastes), plants of minor agricultural significance (jatropha, for instance), special algae plantations, etc. are also regarded as alternative sources for biodiesel production.

Wastes (used vegetable oil, animal fats) are already widely utilized for biodiesel production in some countries. Other types of wastes for biodiesel production demand further research for the purpose of profitability and nature protective considerations.

Biodiesel production from algae despite their very high energy potential per unit of area also demands further research. According to US Department of Energy (DOE), energy output per hectare of algae as much 30 times as soybeans cultivated for biodiesel production [6].

For a long time great expectations have been associated with jatropha (especially for biodiesel production in African countries and in India). As a feedstock jatropha more energy effective than soybeans, rapeseed or sunflower seed. However its production is strongly depends on soil and climate conditions, which limit its energy use in arid areas.

Technological factors. Biodiesel is a relatively renewable energy source and that is its obvious disadvantage. Biodiesel's feedstock is reproduced at least every year but it is necessary to use fossil fuel (for example manufacturing of mineral fertilizers and pesticides for field operations, etc.) directly and indirectly.

Additional amount of non-renewable energy has also got to be used for production of methanol and maintenance of vegetable oil refining, transesterification, etc. Some calculations show that energy output/input ratio for biodiesel production from rapeseed (including production of useful by-products like rape cake and glycerin) is 2,4. That is higher than output /input ratio of ethanol produced from corn (1,3) but notably lower being compared to petroleum motor fuels where energy output/input ratio exceeds 4,0 [2, 19]. These disadvantages significantly decrease the competiveness of biodiesel.

The problem could be solved to a large extent by using part of produced biodiesel for satisfying the energy needs of total process of biodiesel production.

Modern biotechnologies are also promising. They include organic and transgenic agricultural technologies. Both of them technically allow to sharply decrease the usage of fossil energy and ramp up the efficiency of energy and usage of other resources due to better resistance to natural stresses, for instance, associated with insufficient humidification.

Nevertheless the best chances could have genetically modified oilseed crops since their non-food utilization (for biodiesel production) will not spark such brisk discussions and serious arguments. The possibility of transgenic rapeseed usage for biodiesel production has already studied in Russia (Tarasova, 2014) [20]. Taking into account progress in science and technology, transgenic technologies are able to increase biofuel output both per unit area and mass unit. The investigations in the field of possible negative influence of genetically modified organisms on natural environment and agroecosystems should be continued in the meantime.

Organic agriculture in most cases more energy effective being compared with conventional one [21-24]. Consequently, the production of "green" biodiesel will require less fossil energy.

However organic agriculture is unlikely to be the large scale producer of biodiesel because its philosophy will always focus principally on healthy nutrition. Production of liquid biofuel in organic agriculture, if it happens, will be limited to meet its own energy requirements.

The progress is also associated with development of alternative technologies such as HVO and BTL. They are compared favorably to FAME technology in order to increase quality and ability to use more diversified feedstock including various types of vegetable oil as well as biomass and waste. Limiting factor is high production cost (in particular due to high investment costs of biodiesel producing plants) of these technologies that is why they are unfitted for utilization in small and medium farms. They are well-handled either on large farms or off farms in rural areas where special high output private or cooperative capacities could be built up.

Competitive factors involve competition with conventional petroleum fuels (the major opponent is diesel fuel), intra-sectoral competition and competition with alternative energy sources.

In spite of relatively high production costs, the substitution of conventional diesel fuel by biodiesel will continue to grow. Technological factors (biodiesel manufacturing improvements), state support of biodiesel market, price factors (according to OECD – FAO in 2017-2028 annual growth rates of crude oil prices will prevail over biodiesel prices [9]) are the main reasons for this.

This will also be facilitated by changes in the structure of the world energy balance. According to BP forecasts (BP Energy Outlook, 2019) the transition to a lower – carbon energy system continues with renewable energy and natural gas gaining in importance relative to oil and coal. In evolving transition (ET) scenario, renewables and natural gas account for almost 85% of the growth in primary energy consumption until 2040, with their importance increasing relative to all other sources of energy [25]. This is confirmed by the US Energy Information Administration (EIA) which forecasting increase of all fuels consumption other then coal by 2040. As for oil its consumption will continue to rise, however annual growth rates will be significantly slower being compared with the renewables and natural gas [26].

As noted above essential part of liquid biofuel is used in transport sector globally. Meanwhile increased competition with other economic sectors including agriculture, domestic households and heat power industry is quite possible.

For transport sector other alternative energies are becoming strong opponents of biodiesel and ethanol fuel. It is true for electric vehicles (EVs) foremost. Prominent progress is observed in this sector.

In 2005 total fleet of EVs throughout the world numbered in the hundreds, while in 2015 it reached 1,25 mln and was amounted to about 3,1 mln in 2017. China, Europe and the United States are the largest users of EVs [27, 28, 29].

According to IEA forecasts global number of EVs will hit 125 mln by 2030. However, the IEA also sees a pathway to 220 million EVs by 2030, provided the world takes a more aggressive approach to fighting climate change and cutting emissions than currently planned. While battery costs are falling, the IEA acknowledges that government policy remains critical to making EVs attractive to drivers, spurring investment and helping carmakers achieve economies of scale [27].

From an environmental point of view, the most promising direction is the creation of vehicles powered by solar energy. Solar electricity refueling stations (designed as conventional gas-filling stations) equipped with photovoltaic cells are quite possible to be widely used for electricity production and sale. Relevant developments are carried out by American corporations and firms i.e. Tesla Motors Inc., SolarCity and General Electric Company.

With growth in electricity consumption related to transport sector the importance of biofuel as leading alternative fuel for vehicles will decrease.

Therefore in the long term both biodiesel and ethanol fuel will be produced and used only where they are most profitable. Given that the implication of agriculture is expanding.

Political factors. Evidence suggests that progress in liquid biofuel and other non-conventional renewables worldwide has been achieved by supporting state policy. Such support is needed due to relatively high production and capital costs when starting up large-scale projects (especially associated with advanced biodiesel production) still remain.

Developed countries are well experienced in the field of biofuel state support.

The financial tools include subsidies for farmers producing energy crops, subsidies for construction of biodiesel plants; various tax incentives (tax credits and abatements for producers of pure biodiesel and blends).

Development of quality standards for biodiesel and its blends and establishment of voluntary or mandatory absolute or relative levels of biodiesel production and substitution of conventional diesel fuel are also important.

Various instruments of foreign trade policy (including export incentives, anti-dumping rules) are also used for protection of internal biodiesel markets.

The newest state policies focused on boosting the development of domestic biodiesel markets in some countries are listed in the table in the attached Appendix 1.

Apart from direct support of biodiesel market development indirect measures are also used.

Among them are so called Pigovian Taxes[10], which put on negative external effects associated with any economic activity for the purpose of weakening them by set of direct and indirect measures.

The imposing of Pigovian Taxes on conventional fossil fuels increases competitive ability of biodiesel and other alternative energy sources, which are exempt from these taxes.

Pigovian Taxes include Energy Tax, Ecological Tax (Ecotax) or Green Tax, Carbon Tax. They are imposed singularly or plurally in various countries and regions.

V. DISCUSSION

The Russian case in context of current and future situation in the global biodiesel market. Among largest world economies Russia is the only country where neither biodiesel nor fuel ethanol are produced and consumed commercially yet.

In contrast it is produced in sever former soviet republics including Belarus, Ukraine, Lithuania, Latvia and Estonia.

Today only Russian National Biofuel Association (RNBA) and some research institutions are really interested in biodiesel and other biofuel production in Russia nationwide.

More attention to biodiesel is paid at the regional level including Volgograd, Orel, Omsk, Pskov, Rostov regions, Altai and Krasnodar territories and the Republic of Tatarstan. In 2008 Rostov region has adopted a law (N62-zs) "On regional policy objective program of production and usage of vegetable oil - based biofuel in agro-industrial complex of Rostov region for 2008-2015" however no real achievements can be seen yet.

Taking into account the factors mentioned above, world experience in production and usage of biodiesel, existing Russian elaborations in this area and regional commitments, it becomes apparent that national biodiesel market ought to be developed. However it should be done in a right way.

In principle, there are two possible development options of biodiesel production and usage in Russia:

1) Centralized production of biodiesel (basically on large plants) and following usage for substitution (in various proportions) of conventional diesel fuel presumably in urban areas and to lesser extent in rural areas.

2) Biodiesel production concentrates mainly in agricultural organizations (including agricultural cooperatives) and biofuel is used (as tractor fuel and as feedstock for electricity and heat production) presumably in rural areas where it could satisfy energy needs of agricultural producers.

Both development options make an opportunity for export of biodiesel surpluses.

The first option is capital intensive and requires adequate infrastructure (including blending facilities, feedstock and biodiesel storehouses and infrastructure providing filling stations with fuel blends), which makes farmers dependable on private companies that own biodiesel plants and vehicles. Before choosing this development vector additional comprehensive and interdisciplinary scientific research is needed. It is also necessary to develop and launch experimental – industrial and demonstration projects. They could be financed on the basis of private-state ownership.

Second option is more preferable and the arguments are following.

First, economic, technological and geographical benefits of such scenario has been investigated better from theoretical [30, 31] and experimental (All - Russian Institute of Mechanization, Moscow State Agrarian University named after V.P.Goryachkin, ZAO "OPKT SibNIPTIZh") points of view.

Second, local biodiesel production and use are profitable for agricultural producers since it is less capital intensive,

[10] Named after English economist Arthur Pigou, 1877-1959.

less dependent on federal support and has the opportunity to sell surpluses of biodiesel fuel, bioelectricity and by-products.

Third, economic position of many agricultural producers stimulates the use of biodiesel and other local renewable energies. Mostly it is associated with high energy intensity of the Russian agricultural production. Energy intensity of Russian agriculture (direct inputs are included) is from 1,8 to 4,1 times more than that of the USA, Canada, European Union and Australia [32].

High agricultural energy prices aggravated by unbalanced price parities are also very important. For example in 2012-2018 the average diesel fuel price (diesel fuel accounts for 34% in total (direct and indirect) national agricultural energy consumption) for Russian agricultural organizations had risen almost twofold whereas an average producer price for soybeans had increased only by factor of 1,7 and for rapeseed by a factor of 1,5 (Fig.5).

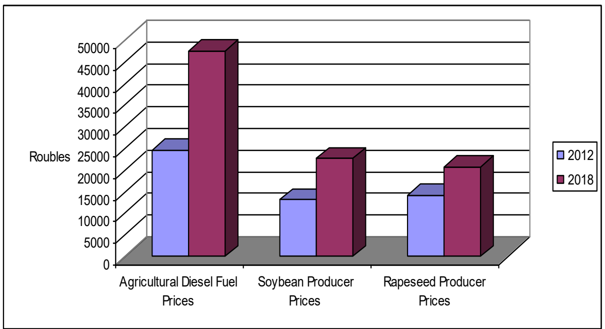

Fig. 5: Diesel Fuel Prices vs. Soybean and Rapeseed Producer Prices in Russian Agriculture

Source: Author's construction upon Federal State Statistics Service (Rosstat) [33].

Fourth, biodiesel production could give an additional incentive for the Russian organic agriculture, which certified areas have been increased more than fivefold in 2011-2017 [34]. The use of biodiesel in organic agriculture complies with the general philosophy of organic production striving for maximum possible utilization of local renewable sources.

By our opinion when carrying out second scenario the priority should be given to biodiesel production from rapeseed and soybeans. It will tend to increased production of these oilcrops and weakens the dominating position of sunflower.

In theory all vegetable oil produced in Russia is enough for biodiesel production accounting (by weight) for nearly 20% of national diesel fuel domestic supply[11]. It is quite enough for total substitution of diesel fuel used in Russian agriculture. However all oilcrops area can't be utilized for biodiesel production just due to food security considerations.

The usage of small part of existing cropland under rape and soya and some larger area on unusable arable lands is most likely. According to Ministry of Agriculture of the Russian Federation the unusable agricultural land in 2017 occupied 32,7 mln ha including 19,4 mln ha of unusable arable land, which equaled to 16,7% of total arable land in the country [35].

To estimate justified potential of biodiesel production for Russian agriculture we suggest two scenarios. Fist scenario (soft) doesn't affect the interests of food sector and other possible land use. Soft scenario envisages allocation 10% of the existing planting area under rape (both winter and spring) and soya and 20% of total unusable arable land (proportion between oilcrops is the same as on existing croplands).

Second scenario (optimistic) is more active and intensive. Share of energy oilcrops is 20% of the existing planting area under rape (both winter and spring) and soya and 40% of total unusable arable land (proportion between oilcrops is the same as on existing croplands). The estimations of feedstock for biodiesel production are listed in Table 5.

Table 5: Possible Rapeseed and Soybean Resource Base for Biodiesel Production in Russia[12]

Federal District	Resource base for biodiesel production			
	Soft scenario		Optimistic Scenario	
	Feedstock planted area, 1000 ha	Feedstock production, 1000 t	Feedstock planted area, 1000 ha	Feedstock production, 1000 t
Central	877,9	1341	1755,7	2681
Northwestern	298,5	758	597,3	1515
Privolzhsky	1115,0	1147	2229,9	2294
Siberian	998,4	1041	1996,8	2082
Ural	357,9	399	715,8	798
Far Eastern	222,1	273	444,2	546
Southern	352,7	627	705,3	1255
North Caucasian	21,3	45	42,6	90
Russian Federation	4243,8	5631	8487,6	11261

Footnotes: The data on planted areas are for 2017.

Source: Authors' calculations upon Agropromyshlennyy kompleks Rossii v 2017 godu / Ministerstvo sel'skogo khozyaystva Rossiyskoy Federatsii. - M.: FGBNU «Rosinformagrotekh», 2018. - 568 s. [36].

Table 6 demonstrates biodiesel production potential in Russian agriculture assuming that all feedstock for biodiesel production (see Table 5) is going to be used for that purpose.

It is possible to produce 1,6 bln liters of biodiesel (FAME) nationwide (soft scenario) or 3,1 bln litres (optimistic scenario). If the optimistic scenario would is achieved, Russia would be among the five largest biodiesel producers in the world.

For agricultural sector substitution of conventional diesel fuel by biodiesel could be rather significant change. Potentially assuming that all biodiesel is consumed in agriculture substitution ratio could approximately reach 31% (volume share) and 29% (energy share) by soft scenario. Optimistic scenario demonstrates 62% (volume share) and 57% (energy share).

The greatest biodiesel production potential concentrates in Siberian, Central and Privolzhskiy Federal Districts where volume share is almost equal (20-21%).

But ratio of substitution is highest in Northwestern region so it could be possible to export biodiesel to neighboring

[11] Author's estimations for 2016 [9, 11]. Data on Gas/diesel oil fractions were used for calculations.

[12] Rape (winter and spring) and soya yields are taken as average for 2014-2017.

regions and even abroad.

Even if we take soft scenario Far Eastern Federal District could satisfy 38% of regional agricultural diesel fuel demand by biodiesel (volume share). That is very important due to region's self-sufficiency in conventional diesel fuel is low.

Biodiesel export from Russia is possible and contributes to diversity of the external trade. Beyond that future world prices of biodiesel according to OECD-FAO forecasts for 2019-2028 are expected to be relatively favorable [9].

However, the problem of export value should be considered by taking into account biodiesel requirements in internal market including agriculture. Future geographical distribution of countries by biodiesel demand and corresponding Russian opportunities is an additional limitation. The most favorable sales areas for Russian biodiesel are the EU and Far eastern countries (China, the Republic of Korea, and Japan). Nevertheless it should be taken into consideration that in the EU drastic decrease of biodiesel import is forecasted after 2019 [31]. With regard to China, Japan and the Republic of Korea no evidence of having an interest in biodiesel import is observed yet.

The international practice shows that sustainable development of biodiesel market without various kinds of state support is impossible. It is true for Russia to the full extent.

The formation of adequate legislation is indispensable first of all. In this regard, certain steps have been taken so far only in relation to fuel ethanol

Table 6: Biodiesel Production Potential for Russian Agriculture[13]

Federal District	Biodiesel production			Ratio of substitution , %	
	Mln L	**Share of total volume in Russia, %**	**1000 Toe**	**Volume share**	**Energy share**
Soft Scenario					
Central	324,4	20,6	255,3	32,9	30,6
Northwestern	258,8	16,4	203,7	193,6	180,0
Privolzhsky	317,1	20,2	249,5	26,2	24,3
Siberian	325,3	20,7	256,0	33,4	31,1
Ural	135,7	8,6	106,8	40,6	37,7
Far Eastern	56,0	3,6	44,1	38,0	35,3
Southern	143,7	9,1	113,1	14,3	13,3
North Caucasian	12,5	0,8	9,8	4,0	3,7
Russian Federation	**1573,5**	**100,0**	**1238,3**	**30,8**	**28,6**
Optimistic Scenario					
Central	648,8	20,6	510,6	65,8	61,2
Northwestern	517,6	16,4	407,3	387,1	359,8
Privolzhsky	634,1	20,2	499,0	52,3	48,6
Siberian	650,5	20,7	512,0	66,8	62,1
Ural	271,3	8,6	213,5	81,1	75,3
Far Eastern	112,0	3,6	88,2	76,0	70,7
Southern	287,5	9,1	226,2	28,6	26,5
North Caucasian	25,0	0,8	19,7	8,0	7,5
Russian Federation	**3146,8**	**100,0**	**2476,5**	**61,7**	**57,3**

Source: Authors' calculations upon Agropromyshlennyy kompleks Rossii v 2017 godu / Ministerstvo sel'skogo khozyaystva Rossiyskoy Federatsii. - M.: FGBNU «Rosinformagrotekh», 2018. - 568 s. [36].

On December 5, 2018, the President of the Russian Federation Vladimir Putin signed the amendments adopted by the State Duma to the Federal law "On state regulation of production and turnover of ethyl alcohol, alcoholic and alcohol-containing products and on restriction of consumption (drinking) of alcoholic products" [37]. The amendments also regulate the production of bioethanol. In particular, the law regulates relations in the sphere of production and turnover of bioethanol used as a component of high-environmental gasoline The concept of "bioethanol" is also introduced and the procedure for licensing the production, storage and supply of bioethanol is determined [38].

At the same time, the production and turnover of biodiesel at the Federal level is not yet regulated. In this regard, it would be reasonable to develop and adopt a separate law on biodiesel or a law regulating the production, trade and usage of all types of liquid biofuels.

If biodiesel production will be oriented to agricultural sector it is advisable for Ministry of Agriculture of Russian Federation to be more implicated in the formation of legal framework for biodiesel and other biomass energies

[13] All figures are as of 2017. Consumption of conventional diesel fuel in agricultural organization is taken from statistics of Ministry of Agriculture of Russia [2][36]. Toe – ton of oil equivalent (1 toe = 42 GJ). Ratio of substitution: (potential for biodiesel production/ quantity of diesel fuel consumed by agricultural organizations) *100% (in volumetric and energy equivalents respectively).

generated by agriculture. Besides it is important to work on development of departmental program for biodiesel or larger program for biofuel. The program should be closely coordinated with Russian energy policy too.

At international level cooperation in the field of biofuels is important within CIS and especially Eurasian Economic Union (EAEU). Mutual activities in the field of standardization of liquid biofuel are primarily in scope of such cooperation within EAEU. As an example, in 2016 was introduced Intergovernmental Standard – GOST 33131-2014 "Biodiesel Fuel Blends (B6-B20). Technical Requirements" for such CIS member states as Belarus, Kyrgyzstan, Moldova, Russia, Tajikistan, and Uzbekistan.

Co-financing of demonstration of biodiesel and other biofuel projects in CIS and EAEU would also be of great use.

VI. CONCLUSION

For the last 15 years global biodiesel production is increasing each year by almost 20%. The main drivers are environmental and social factors and the periodically favorable world crude oil price situation. There are two distinct trends. One of them is associated with a slowdown in biodiesel production growth (price, political factors), and the other shows a gradual equalization in biodiesel production distribution. The EU remains the leading producer, but is gradually catching up with North America, Latin America and Asia. In the future, these trends will only increase until 2028. However, the supporting factors are likely to be, first, the weakening of the role of petroleum fuel in the global energy balance, and secondly, technological innovations related to the further increase in the role of HVO and second and third generation liquid biofuels as well. Environmental and social drivers in the next decade will also support the biodiesel market, but their impact will be seriously weakened in the near future. In the case of environmental factors, this will be due to increasing competition from electric power vehicles (including solar powered cars), and in the case of social factors, the increased role of ICT and robotics, which will significantly weaken the process of increasing the generation of additional jobs.

All that means the decline in international trade of biodiesel and shift of major producers toward satisfaction of national biofuel needs.

In the next 10 years, the consumption of biodiesel will be increasingly determined by domestic production in different countries rather than by imports, since no significant increase in activity in the world biodiesel trade is expected. Regional trends will be associated with the fastest growth of Asian biodiesel consumers. Europe will remain the main consumer of biodiesel, but consumption will decline slightly.

Russia unlike the world's leading economies does not produce biodiesel on an industrial scale but the interest in liquid biofuels is growing. Now it is especially important to choose the most rational vector of biodiesel consumption development. Currently, the most promising is to use biodiesel in agricultural sector in order to meet the energy needs of the producers, as diesel fuel is relatively expensive, and the energy intensity of agricultural production is very high.

For that purpose it is reasonable to use partially the existing acreage under soya and rape, but to a greater extent to involve of unused arable land for growing these crops. Soft scenario (10% existing acreage and 20% unused arable land) demonstrates the rate of conventional diesel fuel substitution of 31% (volume share) while Optimistic scenario (20% existing acreage and 40% unused arable land) shows national average substitution rate of 62% (volume share).

The experience of developed countries shows that it is also important for Russia to have effective legislation regulating the market of liquid biofuels. Now this is an urgent problem because the production and consumption of biodiesel in Russia is not regulated.

APPENDIX

Newest State Policy Measures for Developing Biodiesel Markets by Various Countries (Mid October 2018 to March 2019)

Country/Region	Date	Measures
Argentina	November 2018	Implemented two successive increases in the price that oil-refining companies are required to pay for biodiesel.
	November 2018	Requested formal consultations with Peru at the World Trade Organization (WTO) over anti-dumping duties collected by Peru on imports of biodiesel from Argentina since February 2016.
Brazil	October 2018	Proposed a gradual increase in the mandatory content of transport diesel sold in the country. In June 2019, the blending rate would rise from 10 percent to 11 percent, followed by annual increments of 1 percent, until it reaches 15 percent.
European Union	November 2018 to December 2018	Approved key chapters of the bloc's bioenergy policy reform, including plans to phase out the use of cropbased biofuels by 2030.
	December 2018	Considered reinstating anti-subsidy duties on imports of biodiesel from Argentina, citing an imminent threat of material injury caused to the EU's biodiesel industry.

	January 2019	Determined that US soybeans certified via the US' voluntary Sustainability Assurance Protocol comply with the sustainability criteria contained in the EU's Renewably Energy Directive, thereby allowing biodiesel produced from US soya to count towards the EU's renewable energy targets.
	February 2019	Introduced definitive anti-subsidy duties ranging from 25 percent to 33 percent on imports of biodiesel from Argentina, while agreeing to exempt selected Argentine producers who undertook to sell biodiesel at a set minimum price.
	March 2019	Released draft criteria for identifying biofuel feedstock that carry high indirect land-use change (ILUC) risks, and determined that oil palm cultivation causes significant deforestation – a measure implying that as of 2030, palm oil-based biodiesel would no longer count towards meeting the EU's green fuel consumption targets. The measures remained subject to final approval by the European Parliament and Council.
Finland	February 2019	Approved a law that envisages a steep rise in domestic biofuel consumption targets by 2030.
France	December 2018	Considered ending tax incentives provided when palm oil-based biodiesel is added to regular transport diesel.
Indonesia	December 2018	Announced additional measures to boost domestic biodiesel consumption, with a view to enhancing the uptake of crude palm oil, amid fluctuations in the commodity's global market price.
Malaysia	November 2018	Decided to implement its long-standing plan to raise the country's mandatory blending rate for biodiesel, with the objective of boosting domestic demand for the commodity and supporting palm oil prices. Mandatory blending of transport diesel with 10 percent rather than 7 percent of palm oil-based biodiesel became effective on 1 February 2019.
	February 2019	Considered increasing the country's mandatory biodiesel blending rates further in 2020, with the objective of raising domestic palm oil uptake, thereby helping to stabilize prices and reduce stocks of the commodity.
Norway	December 2018	Called, through Parliament, for the formulation of a comprehensive set of measures to exclude from the market biofuels whose production entails a high risk of deforestation.
	February 2019	Requested that proposals to ban the importation of non-sustainable biofuel feedstock be taken up in trade talks between the European Free Trade Association and Malaysia.
Thailand	March 2019	Confirmed plans to raise mandatory blending of regular diesel with palm oil-based biodiesel from 7 percent to 10 percent in the first half of 2019, with a view to helping absorb excess domestic palm oil production.
United States of America	November 2018	Initiated a 'changed circumstances review' to re-examine the anti-dumping and countervailing duties it placed on imports of Argentine biodiesel in late 2017 and early 2018.
	November 2018	Finalized the country's biofuel blending obligations for 2019, raising the volume for the 'advanced biofuel' category, while leaving the requirements for 'conventional biofuel' and 'biomass-based biodiesel' unchanged.
	November 2018	Examined proposals, through the US Congress, for a long-term extension of the USD 1 per gallon tax credit traditionally accorded to biodiesel blenders, which expired in December 2017.

Source: Extracted from FAO Food Outlook, 2019, May [39]

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