Environmental Problems of Biofuel Production in Modern Energy

N I Makhonko *, Yu A Plotnikova, E A Tarasova, N L Varshamova, E V Yashina

Federal State Budget Educational Institution of Higher Education “Saratov State Law Academy”, Volskaya st., 1, 410056, Saratov, Russia

E-mail: *nmakhonko@yandex.ru

Abstract. One of the major challenges facing every developed state in recent decades has been ensuring that the national economy is energy-based and moving towards a sustainable energy future. The geopolitical interests of the leading world countries are formed and corrected by the well-known consequences of the shortage of hydrocarbons, efforts to ensure their own energy security and environmental issues. Therefore, the development and implementation of the state-of-the-art biofuel production technologies has become a matter of preoccupation for many states. The level of environmental and legal support for innovative energy options rely inextricably on the natural energy endowment, the development of a research base, the political and economic interests of states in achieving energy independence, as well as a public demand for environmental preservation over their national territory and neighboring states. This article attempts to study the legal framework for the eco-efficient biotechnology development in the energy-fuel sector of Europe, the United States and Latin America to harmonize national legislation and regulate relations within the framework of international cooperation. Under the economy-wide assessments the authors reviewed biofuel output figures in these countries, the biofuel production and use supply ratio in national energy systems, energy companies’ activities in the area of research and applying of various types of biofuel to production. The article proved possible to identify new interesting developments in this area and reach the understanding on the necessity for further active efforts in identifying a common approach to the biofuel targets in contemporary energy system within the context of wide-ranging environmental challenges.

Introduction

The instability of world energy markets prompts both the scientific and the industrial community to pay close attention to the development of not only the energy of hydrocarbons and the atom, but also the energy of biomass. The energy complex was and will be the most important segment of the economy of any state. The economic and political potential of a country in the modern world is often determined by the state and development prospects of the energy sector. On the other hand, the energy sector of the economy is one of the leading in terms of environmental pollution. The dynamism of the energy industry is directly related to the development of resource-intensive industries seeking to meet the needs of a growing population and the needs of the population to improve the quality of life. The paradox in the development of this segment of the economy lies in the fact that the quality of human life is affected not only by the growth of well-being, but also by the negative impact of the environment, encountered by all the countries.

The study of the legal framework for the biotechnology development in Europe, the United States and Latin America will provide an opportunity to harmonize national legislation and regulate relations within the framework of international cooperation. It is the integration of world scientific achievements into environmental and legal developments that sought to counter the increasing anthropogenic impact in the energy supply of modern industries. In this regard, in recent decades, the international community has been faced with the task of providing the energy complex of states with state-of-art technologies for the biofuel production [1]. Humanity is already on the brink of an energy-
demographic crisis and many experts attributes the solution to the energy production through the progressive biotechnologies’ development and implementation.

The term “biomass” includes a fairly wide range of energy sources: industrial, household, municipal waste [2, 3]. Waste from the timber processing complex and agriculture, etc., is to be distinguished into a separate category.

The preliminary research stage of the “positions” of biotechnology in the global energy markets should be an analysis of the legislation and practical experience of individual countries that have been dealing with the problems of low-carbon energy for more than a decade [4].

The norms of various states in the field of biotechnology application will make it possible to solve the problems of environmental protection both in individual countries and in the global community.

Results and discussion

The first phase of the research was an analysis of the legislation of a number of European countries and the Russian Federation in the bioenergy field, which resulted in the following.

The main documents in Austria, Great Britain, Germany, Finland, the Czech Republic and Sweden are represented by legal acts of various levels: pan-European, national and municipal. A separate category should be allocated to laws governing the processes of cooperation in the biofuel production and use between various EU member states or countries belonging to national and regional bioenergy associations.

The level of support (documents of various forms and status) for the biofuel production and use in the energy systems of the studied countries is presented in Table 1.

Table 1. Environmental and legal support for the biofuel production and use in the energy systems of European countries and Russia.

| Countries             | Pan-European | National level | Municipal level |
|-----------------------|--------------|----------------|-----------------|
| Austria               | +            | +              | +               |
| UK                    | +            | +              | +               |
| Germany               | +            | +              | +               |
| Finland               | +            | +              | +               |
| Czech Republic        | +            | +              | +               |
| Sweden                | +            | +              | +               |
| Russia                |              | +              |                 |

Thus, European active cooperation in the development of bioenergy might reasonably be observed. This process is quite natural and can be explained:
1. most European countries have a serious natural hydrocarbon shortage;
2. an urgent need for energy independence from oil and gas exporting countries, which in turn guarantees the political and economic stability of the European Union;
3. protection of the environment from the negative impact of traditional energy types during the transition to a "green economy" and the use of "clean technologies".

This trend is confirmed by a number of examples. The most important regulatory legal act at the pan-European level was the European Union Directive on the expansion of biofuels (2003/30), adopted in 2003. Directive 2003/30 / EC of the European Parliament and the Council of the European Union "On supporting the use of biofuels and other renewable energy sources in transport" defined a new stage in the development of transport bioenergy. In 2009, the European Union's Renewable Energy Directive (2009/28 / EU) came into effect, aimed at expanding the production of biomass, biofuels and biogas. Since 2012, Directive (2012/27 / EU) of the European Parliament and the Council of the European Union has established new criteria for energy efficiency. The studies of international experience show that the production of biofuel in European countries is dynamically developing in connection with the demand for its consumption in various sectors of the economy. The main
prerequisites for an increase in the demand for biofuel were the government programs on the transition to renewable energy sources adopted in developed countries [5]. It should be noted that the creation of international bioenergy associations at various levels played an important role in the development and implementation of advanced biofuel production technologies. So, in 2008, the World Bioenergy Association (hereinafter WBA) began its activities. This organization is global in nature and supports the introduction of advanced technologies in biofuel production processes in various countries. The WBA is represented by national and regional bioenergy associations, energy companies, interested institutions and individuals. The sphere of interests of the World Bioenergy Association includes the following topical issues: certification and standardization of bioenergy, as well as the impact of bioenergy on the environment and public health.

A special place in bioenergy associations is occupied by the European Biomass Association (hereinafter EBA), which represents the European bioenergy sector and forms a stable position of bioenergy in the global energy market. EBA was founded in 1990. It currently unites over 4000 members, including 30 national associations and more than 70 specialized companies. As a member of the European Council for Renewable Energy Sources, it takes an active part in the formation of legislative (in terms of bioenergy) at the level of the European Union countries. The authors review the activities of individual national associations that are part of the EBA: Austria - Austrian Biomass Association; UK - REA (Renewable Energy Association); Germany - BBE (Bundesverband BioEnergi); Finland - FINBIO (Bioenergy in Finland); Czech Republic - Czech Biomass Association (Czech Biomass Association); Sweden - Swedish Bioenergy Association (Svebio).

According to the authors, particular attention should be paid to the efforts of individual European countries representing the national level of ensuring the production and use of biofuel in their national energy systems [6]. Moreover, in order to optimize work on the development and implementation of progressive and environmentally sound technologies in biofuel production, individual countries have proposed a set of measures that contain not only the legislative regulation, but also indicative planning of production volumes, tax benefits and state budget support [7]. The above-mentioned measures are entirely consistent with national standards. We are presenting you some of them: Austria - ONORM M 7135 Austrian Association pellets; Great Britain - The British BioGen Code of Practice for biofuel; Germany - DIN 51731 Briquettes and pellets, Enplus, EN-B; Sweden - SS 187120 Pellets. In the Russian Federation, since January 1, 2009, GOST R 52808-2007 “Non-traditional technologies. Energy of biowaste. Terms and Definitions”. It should be noted that the standard was developed by the Laboratory of Renewable Energy Sources of the Moscow State University named after M.V. Lomonosov. This document contains the main definitions used in the biofuel production and use.

The authors point out that the most important role in the introduction of biofuel production technologies in European countries belongs to local governments. At the initiative of the European Union, a program called the Covenant of Mayors that unites local authorities was developed. This agreement defined the vector for the "green economy" development at the municipal level: biofuel production and use – environmental protection – improving of the population life quality. The "Covenant of Mayors" is signed by the heads of the administrations of cities and other settlements (regardless of the population size) in order to implement a sustainable energy supply policy on their territories. At the same time, municipal authorities are obliged to develop and agree on an appropriate plan, including indexes: local economic development, population quality of life, support for the development of renewable energy (biofuel), energy conservation at the municipal level. The significance of local governments in this area is manifested by the possibility of independent spatial territorial planning in terms of the bioenergy facilities placement. On the recommendation of the European Union, the Covenant of Mayors and the above plans should not conflict with national and European energy development plans. The end result of the European Union initiative should be increased investment in the local economy, withholding some taxes in municipal budgets and reducing social tensions by strong job creation policy. For example, in the UK, the Localism Act (Law on Local Governments) has been in force since 2011, according to it municipal authorities are vested with significant decision-making powers in the field of energy and environmental development, i.e. reduction of bureaucratic procedures in the construction of infrastructure for bioenergy facilities. In accordance with the legislation of the
Russian Federation, local governments are not vested with powers in the field of ensuring the biofuel production and use, that resulted in the municipalities’ economic and environmental vulnerability.

At the research second stage, we studied and analyzed the proportion of renewable energy sources (biofuel included) in the total amount of consumed energy in selected European countries.

A schematic increase in the proportion of renewable energy sources, including biofuel, is shown in Table 2.

Table 2. Achieved and planned indexes for the proportion of renewable energy sources (biofuel included) in final energy consumption in selected European countries (%).

| Country         | 2013 | 2020 |
|-----------------|------|------|
| Austria         | 32.6 | 34   |
| UK              | 5.1  | 15   |
| Germany         | 12.4 | 18   |
| Finland         | 36.8 | 38   |
| Czech Republic  | 12.4 | 13   |
| Sweden          | 52.1 | 49   |

Comparative analysis shows that Sweden, Finland and Austria are among the three European leaders in bioethanol consumption [8].

The authors note a technological breakthrough in the of biofuel production and use in Sweden and Austria:

1. in connection with the low endowment of natural energy resources;
2. developed research base;
3. the public demand to preserve the quality of the environment "at home" and on the territory neighboring states.

The Swedish government initiated the adoption of a special Energy Taxation Act (Act 1994: 1776), which provided for a reduction in the use of fossil fuels and an increase in the share of renewable energy sources (biofuel) through a number of tax and administrative mechanisms. Thus, producers and consumers of biofuel were exempted from energy taxes, environmental taxes and fees.

Germany and Austria are among the first EU countries to start producing biofuel on a commercial basis. These countries have no restrictions on biofuel production. So, for example, the Law on excise taxes on oil and petroleum products ("Mineralölsteuergesetz") regulates the national biofuel policy in Germany.

Special interest taken in Finland's biofuel production achievements (based on resource endowments). The Republic of Finland has been recognized as one of the most environmentally friendly countries with green economy demonstrating sustainable socio-economic and environmental development.

The data presented in Table 2 indicate a significant increase in the biofuel proportion in the energy sector of developed European countries.

At the third stage of the study, the authors analyzed the experience of companies in the oil and gas sector, whose areas of interest include not only conventional types of energy, but also the development of new types of biofuel in order to form a high-tech market for alternative energy. The efforts of companies (energy leaders) are justified both economically and environmentally. Indeed, the main economic vector ("green economy" - investments in “clean” energy technologies - ecology) naturally provides environmental protection measures and global control over carbon dioxide emissions.

A schematic distribution of the activities of energy companies in terms of the implementation of biofuel projects is presented in Table 3.
Table 3. Activities of energy companies in the field of research and implementation in the production of various types of biofuel.

| Country       | Company                          | Activity                                                                                                                                 |
|---------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| The USA       | Chevron Corporation              | - entered the energy market with a new generation fuel - a mix of conventional fuels and ethanol;                                      |
|               | Exxon Mobil Corporation          | - jointly with American National Laboratory develops technologies for the production of second and third generation biofuels.          |
|               |                                  | - researches and develops technology for the production of third generation biofuel from algae (investments amount to more than 600 million dollars); |
|               |                                  | - developed and commissioned a high-tech plant for the production of biofuel with algae feedstock                                    |
| France        | Total S.A.                       | - develops and implements technologies for converting biomass into biofuel based on lignocellulosic biomass, which is the dry matter of plants for the production of bioethanol. |
| The UK        | British Petroleum                | - production of biofuels (bioethanol and biobutanol);                                                                                  |
| The Netherlands| Market Biosciences Corporation  | - participates in scientific research in the field of new biotechnology in the energy sector in cooperation with the Energy Biosciences Institute, Berkley National Laboratory and the University of Illinois. |
| Brazil        | Petrobras                        | - biofuel (ethanol) production accounts for 35% of global consumption;                                                                 |
|               |                                  | - exports ethanol (as a vehicle fuel);                                                                                                 |
|               |                                  | - invests in the production of biodiesel and the development of biofuel infrastructure, incl. ethanol piping.                         |

The data in Table 3 vividly illustrate the interest of states on different continents in biofuel production:

1) most of these countries invest heavily in research and development in the production of second and third generation biofuel;
2) the largest companies - major players in the international energy markets demonstrate a unified approach to the production of biofuel based on new types of feedstock (biomass).

By the beginning of the 21st century, the United States had developed a package of regulations that further defined the energy industry's achievements in the production of next-generation fuels: US President's Order No. 13134 established a national commitment to bioenergy, 1999; Renewable Fuels and Chemicals Law, 2000; Agriculture Law (Energy Section), 2002. On the basis of a package of normative acts, the main preferences for the purchase of biofuel and other biological products were developed, the topic of state grants in the areas of “bioethanol” and “biodiesel” [9], a Technical Advisory Committee has started its activities. As a result, the construction and operation of modern bio-plants has become not just an economic achievement but the United States national priority.

Significant progress in the biodiesel and bioethanol production of the French company Total S.A. was due to the fact that since 1992 the French government has established 100% tax exemption for biodiesel production and 80% tax exemption for ethanol. These state support measures for the introduction of the best biofuel technologies have enhanced the scientific and industrial community efforts in France in ensuring the country's energy security.

Brazil achieved significant results:
1) the largest amount of biofuel produced;
2) the use of biofuels not only for the domestic market, but also for sustainable export;
3) unlike colleagues in the "shop" is actively engaged in the development and implementation of biofuel infrastructure facilities [10].

According to experts, bioethanol produced in Brazil on the basis of sugar cane, is safe and effective, as it slightly pollutes the atmosphere and has a number of competitive advantages over other types of biofuels. Note that, despite the visible economic advantages of this type of production, Brazilian legislation pays great attention to environmental protection in the biofuel production. To protect the biocenosis in the Amazon forests, the cultivation of sugar cane in the surrounding areas is completely prohibited. Other environmental requirements are implemented through agroecological zoning, certification and environmental law. Back in 2008, Brazil completed this zoning and allocated four types of territories: where the production of ethanol from sugar cane already exists; lands suitable for this production according to natural conditions; areas where production should be especially supported by the state; areas with environmental and legal restrictions. It should be noted that Russian scientists long ago drawn attention to the development of biofuel energy in this region, especially emphasizing its environmental safety and economic feasibility.

Experts have estimated that Russia's share of the biotechnology market in the segment of biofuels and biodegradable materials is practically zero. A number of factors that have a constraining effect on the development of the Russian bioethanol market should be highlighted:

1) insufficiently developed Russian legislation;
2) the presence of highly profitable enterprises for the extraction of natural hydrocarbons;
3) insufficient economic competitiveness of biofuels in comparison with the other electricity production technologies.
4) the problematic nature of the biofuel usage in the Russian climate. Despite the fact that alcohol and its mixtures with gasoline are "indifferent" to negative temperatures, they are characterized by such properties as hygroscopicity. This leads to stratification of the fuel mixture, the formation of condensate, which provokes corrosion processes in the power system as well as freezing of filters and fuel lines.

Nevertheless, the Federal Law "On Amendments to the Federal Law "On State Regulation of the Production and Turnover of Ethyl Alcohol, Alcoholic and Alcohol-Containing Products and on Restricting the Consumption (Drinking) of Alcoholic Products " outlined the main directions for the development of Russian biotechnologies that will allow obtaining energy from renewable sources of raw materials. The law regulates relations in the field of production and turnover of bioethanol used as a component of high-ecological class motor gasoline. Among the introduced norms, a definition of the concept of "bioethanol" has appeared, which means denatured ethyl alcohol produced from food and (or) non-food raw materials of plant origin, the denaturation of which is carried out in compliance with the requirements established by the law on state regulation of ethyl alcohol (containing no more than 1% water). However, it should be noted that in recent years, the Russian Federation has achieved certain results in the development of bioenergy products as raw materials for the production of electrical and thermal energy. We are talking about the use of biomass obtained from forest waste (pellets).

Results and discussion

The study of the regulatory legal framework in the field of environmental and legal support for the biofuel production and use in the energy systems of selected countries predetermines the possibility of discussion on its production justification and the environmental consequences of hydrocarbon fuel phase-out and its partial replacement with bioethanol and biodiesel. The authors respect the opinions of colleagues and are ready to discuss controversial issues.

We assume that the "optimistic" view of the importance of biomass energy for environmental quality and sustainable use of natural resources will become controversial [11]. The question of the greater social significance of economic or environmental preferences in the field of energy security of various states remains open. The main criteria in this discussion are country ratios for natural hydrocarbons, the national economic development level, the activity of the population in the public demand for the preservation of the natural environment and the state of health of the population ensured by the development of a "green" economy. In this case, we will allow to note that there is no irreconcilable contradiction between "economists" and "ecologists" when discussing the prospects of using biomass energy.
In our opinion, it is logical that states strive for independence from price fluctuations in the world energy markets; the situation in certain oil and gas producing regions and the political situation in the international arena, that we have observed in recent years.

Economic support measures enshrined in national legislation are becoming environmentally sound. For example, exemption from taxes for enterprises producing biofuels from industrial, household and municipal waste, waste from timber processing and agricultural production has significantly improved the environmental situation in urbanized areas for a number of indicators: atmospheric air, water resources, soil. We add that the opening of new job opportunities at the newly commissioned energy facilities has allowed many countries to reduce the level of social tension.

There is however the room for discussion about the degree of legislation development on biofuel production from the natural energy resources supply ratio of a particular state. Nevertheless, the United States being quite prosperous in terms of natural resources, has successfully formed a regulatory legal framework in the field of biofuel production, with due consideration for the environmental protection requirements.

The authors have declared solidarity with the opinion of scientists who emphasize the importance of legislative consolidation of economic (market) mechanisms and scientific and technical achievements to solve the problem of harmonizing the economic needs of modern society and preserving the environment for present and future generations.

Conclusion

The analysis carried out on the available data reveals some trends and gives an initial overview with the following findings and conclusions.

Environmental support for the development and implementation of biofuel (as one of the renewable energy sources types) based on modern technologies began with quite pragmatic economic and political aspirations of individual states to gain energy independence from countries that supply hydrocarbons to world markets. The research institutions of various countries and different status have joined this process with a common conclusion that the biofuel production can reduce the human-induced pressures on the environment and bear positively on the population health.

First, the study of the legislation governing the biofuel production and use had noted positive outcomes. The economic feasibility of the latest technologies introduction in the energy sector (growth of employment and socio-economic stabilization in the state) influenced the environment-related mentality level in modern society and ardently galvanized a regulatory framework for the energy development from renewable sources (biomass energy) with a view to forming a stable energy market ...

Secondly, we have revealed “grey areas” in the very understanding of the term “biofuel”, for example:
1) biofuels (liquid fuel) are alcohols (methanol, ethanol, butanol), ethers, biodiesel and biomass oil used in the transport industry;
2) biofuel (solid fuel) is fuel granules (pellets) made from woodworking industry waste.

The revealed different approach to the definition of the components that make up the basis of biofuel production indicates the imperfection of the regulatory framework in the field of production and use of biofuel. It should be noted that in modern conditions of constant technological dynamics of biofuel production and the resulting “legislative surge”, the rule-making legal technique is of particular importance, ensuring the legal system stability and the regulatory legal acts of proper quality to create a hierarchically balanced and consistent legal regulatory system in the field of the new generation energy production.

Thirdly, regulatory, statistical, estimated and projected data summarized from the legislative and executive acts of selected countries, international organizations, energy industry representatives have been revised to enable the long-term vision to be reflected in the next bioenergy development plan that requires novel modalities to energy security legislating, resource conservation, actions in the field of the green public policy at the international, national and even municipal levels. We would like to emphasize that in the bioenergy regulatory framework technical standards are abundant. The specific subject of regulation explains this trend, since energy production is knowledge-based and complex technological system. However, the lack of a very broad scope of technical and technological expertise,
both in terms of normative and regulatory proficiency, can cause difficulties in rulemaking, law enforcement and international cooperation.

Thus, in this context and in view of the general and different features in the technological international and national structures creation for the biofuel production, legal support for this segment of the energy sector and the environmental concerns integration, the following issues need to be addressed:

1. We should come to understanding that the scale of biofuel production and use in European countries, the USA and Latin America demonstrate the urgency of the renewable energy development. In this context, the constraints on the biofuel production and use in the Russian Federation are the lack of economic competitive edge on both the natural hydrocarbons use and other energy technologies. Therefore, certain national set-ups for promoting sustainable development of cleaner energy technologies should become the key to bioenergy development. Otherwise, the Russian Federation will lag far behind the countries developed in the production and use of modern energy sources, which will be detrimental to the Russia’s standing in the global energy markets. Economic mechanisms need to be legislated through the formation of state support programs for the development and implementation of the best technologies in the production of biofuel: targeted investments, scientific grants and tax incentives.

2. The challenge facing Russian scientists at this point is to work with the difficult task of integrating the national law norms into international energy legislation. Different interpretations in terms such as biofuels and biomass should be eliminated. Particular attention must be paid to the correlation issues in concern of technical, technological and production standards with international technical norms, rules and standards. The corresponding standards and technical regulations developed on this basis, taking into account the requirements of the existing international legislation in this area, will serve as a guarantor and incentive for environmental safety in the development of one of the most promising sectors of the economy and will strengthen the authority of the Russian energy sector in the international community.

3. It is necessary to develop and adopt a package of normative legal acts where technical and technological requirements for a long-term model of the new generation environmentally safer forms of biofuel production pattern should be legislated in conformity with international norms and standards. Such measures would enable the Russian Federation to increase its participation in international activities to ensure that more serious consideration is to be given to newer energy sources which could compliment conventional sources in the quest to promote energy for all (endorsed by the United Nations). It is imperative to expand Russian involvement in the work of issue-based international organizations and structures, as well as in specialized subgroups on energy cooperation as part of bilateral and multilateral intergovernmental commission that will improve the national mechanism for monitoring the world energy markets shifts and the impact on them.

The solution of these issues will make it possible to announce the formation of a unified approach to the development, implementation and production of various types of a new generation biofuel. Improving the legal framework for the development of biotechnology in the Russian Federation will harmonize national and international legislation. Thus, the integration of world scientific achievements into the environmental and legal norms of various states in the field of biotechnology application in the energy sector will guarantee the solution of environmental protection problems, both in selected countries and in the global community.

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