The Prospects of Biogas Production and Use in the Russian Federation

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Introduction

In recent years, significant developments in the global economy have occurred that determine the necessity of revising the previous energy development scenarios. Growing prices for energy resources, deepening environmental problems, as well as energy security requirements and changing public attitude to energy in general dictate such necessity.

Requirements to reduce emissions and to create national environmentally sound energy sources, alongside with the energy independence policy have determined the development of institutional rules in industrialised countries that stimulate energy saving and use of renewable energy resources (hereafter - “RES”).

One can assert with a great deal of confidence that more and more the world continues on the path of development of bioenergy technologies. The process set in motion has passed the point when the development and use of biotechnologies could have been stopped; this implies to assume that biotechnological future is to come in the short term, a considerable part of which will be represented by bioenergy technologies or technologies that enable production of energy generated based on the utilization of biological raw materials.

Biogas production is considered as one of the most promising directions of bioenergy, i.e. the gas is produced using the process of fermentation or pyrolysis of biomass and organic waste materials.

Being produced from organic matter – a renewable resource – biogas is considered to be a type of renewable energy sources and often treated as a fuel capable to partially replace conventional (non-renewable) energy resources in the medium term.

Objectives

The main objective of the report is to disclose information about the potential and capabilities of biogas production in the Russian Federation (RF).

Methods

The report material is based on the undertaken study of the green gas market potential in the EU countries and capabilities of biogas production in the Russian Federation. The information has been based on:

- Data from independent experts;
- In-house analysis of the biogas production potential in Russia.

Result

The data based on the results of the analysis are indicative that the signing of the Kyoto Protocol by the industrially developed countries, as well as the adoption of some laws including the so-called EC Directive 20/20/20 that provide CO_2 emission reduction including due to a considerable increase of the RES share in the volume of total energy consumption of different countries gave rise to the biogas production.

The analysis has shown that application of the 20% RES share requirement for the today's natural gas consumption volume in the EU countries enables to estimate the green gas market potential volume in Europe at a level of 30 bcm. According to the European experts, however, the biomethane market potential volume will reach ca. 40 bcm by 2020.

It should be noted that this market development has been due to replacement of traditional natural gas by green gas.

At present, there are more than 5,000 biogas productions in Europe, with a total volume of production ca. 8 bcm per year. Germany, with its 4,300 biogas plants, is the largest biogas producer in the EU.

Concurrently, Germany represents the largest green gas sales market in Europe. Among other significant green gas markets in the EU are the Netherlands, France, and the UK.

Large commercial farms and wastewater treatment companies for which biogas production provides one of the ways to get rid of waste and to reduce environmental payments are typical biogas producers in Europe today.

In most cases, biogas production projects in the EU countries are intended for local use as an alternative to bought-in fuels.

At the same time, the number of projects associated with biomethane production (biogas purification) and supply thereof to outside customers via existing gas distribution networks has been growing in Europe since 2008. Similar project have been implemented already in nine EU countries: in Germany, Switzerland, Holland, Luxembourg, in the UK, Norway, Sweden, Austria and France.

The opportunity to supply green gas through gas pipelines gave rise to turning biogas and biomethane into commercial product and facilitating development of this market.

Large energy companies are the main biomethane buyers. Demand for biomethane is also noted on the part of transport and some industrial companies.

However, although there are quite a number of biogas companies in Europe, only around 100 of them are associated with biogas upgrading to biomethane being able to provide its delivery to gas distribution networks.

This number of companies is insufficient to satisfy the current needs of the EU countries in biomethane.

A considerable demand for gas from organic sources that cannot be satisfied by local production is obviously present. This problem can be solved through export from other countries, particularly from Russia.

Russia has the fuel and energy sector mainly developed on the basis of non-renewable hydrocarbon resources. Energy resources, such as gas (53% aggregate energy consumption) and oil (18.6%) have the leading role in the fuel and energy balance structure of this country. In addition, the share of solid fuel (coal, etc) is ca. 18% of the fuel and energy balance. Non-fuel energy sources ensure 10.4% of supply. The generation balance structure of the Unified Energy System of Russia in 2010 was as follows: thermal power stations – 61.8%, hydroelectric power plants – 15.7%, atomic power stations – 16.9%. According to the Energy Strategy of the Russian Federation (ES) for the period till 2030, the energy saving policy is the keystone for sustainable development of this country. It is not only the implementation of technologies enabling to improve efficiency of use of conventional energy resources but also the diversification of energy balance through the use of non-carbon energy, including based on renewable energy resources (RES).

Russia annually produces no more than 8.5 billion kWh of electrical energy from renewable energy resources (excluding hydroelectric power plants with an installed capacity exceeding 25 MW), which is less than 1% of the total energy. Total capacity of electric generating facilities and electric power stations that use renewable energy resources is not in excess of 2,200 MW. The main contribution to electrical energy production is made by biomass thermal power stations (39%) and small hydroelectric power plants (53%).

Russian biomass electric power plants use timbre, plant waste, and peat briquettes as fuels. It is boiler houses in the main that use biogas: in Russia, they generate 3% of heat energy from renewable sources, which is equivalent of 1.8 million Gcal of heat. After the adoption of Federal Law No. 261-FZ *On Energy Saving and Improvement of Energy Efficiency* in 2009, appropriate RF Government Ordinances, development and beginning of implementation of federal and regional energy saving programmes, it can be stated that Russia is following the global trend of the recent decades – energy efficiency .

In terms of reduction of environmental load from the fuel and energy complex activities, in addition to reduction of the share of use of organic fuels, the Energy Strategy envisage energy supply to consumers in remote locations using local fuels and RES. The adopted government programme is aimed that the share of electrical energy generated from renewable energy resources, excluding the largest hydro power plants, must be around 4.5% by 2020 in Russia. According to available estimates, the RES technical potential of Russia is ca. 4.6 billion TOE per year, which is approximately five times in excess of the total consumption of all fuel and energy resources in this country, and the economic potential is defined as 320 million TOE per year. This is an equivalent of ca. 25% of domestic consumption of energy resources in the country.

Creation of facilities for the organisation of industrial development of RES has just begun in Russia; however, the country has all necessary opportunities to joint the countries that actively develop bioenergy. High educational, scientific and technological potential, presence of the key factors for biotechnological industry development, cheap energy, fresh water, resources for intensive agricultural development and vast territory will facilitate that.

According to the estimates made by the National Research Centre “Kurchatov Institute” at the Russian Academy of Sciences, today this country has 3 billion tons of renewable non-food biomass: wastes from timber industry, agricultural production, peat fields, household wastes containing cellulose-based materials. Therefore, bioenergy will have the highest development rate (up to 80%) among the alternative energy sources in years to come.

This is due to the fact that large pig-breeding complexes and poultry farms have been established and appropriate engineering infrastructure has been developed in the country. Today, the Russian agro-industry faces the problem of disposal of great quantities of waste – most often they are removed from the farm territories and stored.

At the countrywide level, a challenge of intensive agricultural development with a high efficiency level and processing depth is issued. There is great potential here; the area of agricultural land in Russia is 402.6 million ha.

According to the Russian Energy Agency (REA), based on the current potential of agricultural wastes, the country will be able to generate from 60 to 70 billion cubic meters of biogas. This will be enough to satisfy the needs in biogas both inside the country and in the West European countries.

The table below gives the indices by sectors of the Russian agro-industry and their possible resource base for biogas generation.

Sector	Waste Volume, million ton	Biogas Production Potential, bcm
Livestock Breeding	350-370	73.7
Poultry Breeding	20-30	
Crop Growing	220	
Other	56	

If an opportunity of biogas production using biomass pyrolysis technology is considered, this potential may grow at least twice exceeding the indicator of 150 bcm; this can be explained by great timbre resources available in the RF territory.

In terms of regions, 3 RF Federal Districts have the largest resource base for production of biogas from agro-industry waste, they are: the Southern Federal District (24.4 bcm), the Volga Federal District (18.33 bcm), and the Central Federal District (12.1 bcm). These regions are most attractive for accommodation of biogas production facilities.

At present, there is a gap between biogas production and use in the RF and its production level in the European countries. The gap is due to factors such as:

- Low price of natural gas in the domestic market;
- High capital costs on construction of biogas power stations (from 3,500 to 10,000 US Dollars per 1 kW of installed electrical capacity);
- High price of the generated electricity compared to the electricity generated by traditional power plants;
- Low level of government support for project in the field of biogas and RES.

However, in recent times, the situation in the field of biogas production and generation has been changing for the better in Russia. It is primarily due to the following circumstances:

- Continuous growth of tariffs for energy and natural gas that must reach the price level comparable to the tariffs in the industrialised countries by 2014;
- High prices for connection of new facilities to existing electric mains;
- Opportunity to raise a tax credit in the amount up to 100% of equipment cost when implementing projects on improvement of efficiency of use of energy and reduction of adverse environmental impact. The regional administration also declare that there is an opportunity to provide privileges with respect to payment of regional portion of profit and property taxes as well as partial subsidizing of credit interests and costs for payment of leasing charges;
- Expected amendments to the RF legislation that will ensure payment of mark-ups for the wholesale rates to companies that produce energy from RES;
- Adoption of Edict of the President of the Russian Federation No. 889 dated 4 June 2008 *On Some Measures on Improvement of Energy and Environmental Efficiency of the Russian Economy* that envisages provision of budgetary allocations for implementation of pilot projects in the field of use of RES and environmentally friendly technologies, and RF Government Regulation No. 1-r dated 8 January 2009 *Main Directions of the State Policy in the Sphere of Improvement of Energy Efficiency of the Energy Power Industry on the Basis of Using Renewable Energy Sources for the Period till 2020* that sets forth target indicators for the use of RES in the field of electric-power industry as follows: 2015 – 2.5%, 2020 – 4.5%;
- Growing attention to the issues of biogas production on the part of energy consumers in the RF and intensification of activities of energy market participants, including large energy companies in the field of development of biogas production projects in the RF territory;
- Growing attention of large financial institutions and banks to this direction and appearing project crediting programmes associated with biogas production.

Analysis of the bioenergy development situation in the regions of Russia shows that it is mainly positive. Dozens of farms have started to locally use the alternative fuels and energy production technologies in their interests. Thus, for example, biogas production facilities of different capacities have been operating in Vladimir, Kaluga, Leningrad, Nizhny Novgorod, Lipetsk, Vologda, and Murmansk Regions, Republics of Dagestan, Tatarstan, Mari El, and Udmurtia, Krasnodar Territory. The gas from wastes of farm animal, poultry and plant production is used for the generation of electrical energy and heat for industrial premises there. In Russia, the overall estimated need in biogas plants for waste processing is ca. 20 thousand enterprises.

In Russia, biogas plants started to be developed as early as in the 80s; however, the large-scale implementation did not ever occur because of the break-up of the Soviet Union. Only in recent times, when other countries' progress in this direction became more than obvious, the local initiatives started to be implemented in Russia. In January 2009, mini thermal power plant at the Kurianovo aeration plant in Moscow was launched (based on the technology and investment provided by EVN, an Austrian Company). Similar TPP will presumably be built at the Lyubertsy Wastewater Treatment Facilities. A sludge digestion tank with capacity of 65 cubic meters has been operating in Lukhovitsky District in Moscow Region since 2002.

For Your Reference:

Mini thermal power plant at the Kurianovo aeration plant in Moscow. The project of biogas use at treatment facilities provided for construction of a mini thermal power plant utilizing biogas produced at the aeration plant as fuel. The generated electricity is supplied to the municipal grid while heat energy is partially used as auxiliaries and partially directed to satisfy the aeration plant's demand for heat.

Basic technical characteristics of the mini thermal power plant:
- *Electrical capacity of the mini thermal power plant: 10 MW;*
- *Heat capacity of the mini thermal power plant: 6.9 GCal/hr;*
- *Efficiency (total): 84.6 %.*

Basic technical and economic parameters:
- *Investment value: 29.6 million Euro;*
- *Cost of electricity at the mini thermal power plant: 2.13 Roubles/kW·hr; cost of heat energy: 755 Roubles /Gcal; cost of electricity without the investment component: 1.80 Roubles/kW·hr;*
- *Payback period: 15 years.*

At present, one more biogas plant has been operating in Russia with capacity over 320 kW, in Kaluga Region not far from Moscow.

For Your Reference:

The project in Doshino Village, Medynsky District of the Kaluga Region includes a factory based on the LIPP technology for production of biogas for a herd of 960 milking cattle units and a mini thermal power plant designed for electrical capacity of 320 kW and heat capacity of 450 kW. The generated energy is used for the farm needs.

Cost of equipment, cost of installation and construction works and commissioning and start-up works amounts to 65 million Roubles (1.6 million Euros).

At present, an additional unit is under construction, which is designed to receive and process biological waste from neighbouring agricultural facilities as well as to generate electricity to supply to regional grids. The design capacity of the new power plant is 2MW.

A biogas production project in the Tyumen Region may serve as another example of biogas production. A biogas plant operates there at the agricultural farm to produce 100 m3 of biogas per day. The company has well-developed distribution channels for fertilizers produced at the biogas plant. The plant capacity is expected to be increased up to 1,300 m3 per day in 2011.

In addition, five more biogas production projects are under construction in RF and 10 more projects (for a capacity of 1.2 to 10 MW) are at the design stage in the Southern Federal District, Archangelsk, Nizhny Novgorod and Tula Regions, and in the Altai Territory.

One of the most prospective directions for biomethane is the use of it as a motor fuel. This biomethane market segment has been growing dramatically today. The use of green

gas as a fuel for municipal transport became a customary practice for some countries of the West and Central Europe. Number of vehicles modified to use gas as fuel is growing year by year, there are more and more private enterprises and motorists that wish to contribute to the improvement of global environmental situation. In addition to automobile transport, some marine vessels are expected to be modified to use natural gas and biomethane in particular.

Russia does not stand on the sidelines of the global trends. Today, a biomethane production plant is at the stage of design at the wastewater treatment facilities in the city of Saint Petersburg, the second large city in the RF territory. The new production capacity is expected to be ca. 19.8 million m3 of biomethane per year. It will be one of the world's largest projects of gas production from organic sources.

According to the project, the produced biomethane will be transported to the liquefaction units and then it will be exported to foreign countries in the form of LNG. The project is planned to be implemented by the consortium of companies with the participation of JSC Gazprom and Gasym OY, a Finish Company.

Later, the similar enterprises can be established at wastewater treatment facilities in other large cities of the Russian Federation.

National manufacturers of equipment for biogas production gradually appear in Russia. Yet, there are no more than 10 of them, and among them are ZAO Centre EcoRoss, OOO Greentech, OOO Siberian Institute of Applied Research, ZAO Energ-Biogaz Concern KONATEM, BiogasEnergoStroy Corporation etc.; and their number is growing year after year.

By the order of the Russian Federation Government and Ministry of Agriculture of the Russian Federation, the Federal Centre for Bioenergy Development has been established on the basis of the All-Russia Scientific Research Institute of Mechanization of Agriculture (GNU VIM) of the Russian Academy of Agricultural Sciences.

Agreement has been reached about mutually beneficial cooperation between the Federal Centre for Bioenergy Development and the German Biomass Research Centre. The Federal Center for Bioenergy Development has been fruitfully cooperating with its Czech, Italian, Polish, and Hungarian partners with respect to implementation of bioenergy projects.

The signing of the Memorandum on Joint Production of Green Gas (Biogas) by and between JSC Gazprom, Gasunie, ZAO Eurotekhnika and BiogasEnergoStroy Corporation became a momentous event in the history of bioenergy development in Russia. Pursuant to the Memorandum, the Parties will discuss an opportunity of establishing a joint venture in the territory of Russia for the development of "green" gas production.

Important is the further provision of legislative framework for the development of bioenergy and use of renewable energy resources in the Russian Federation.

At present, the work on development of the regulatory and legal framework is in progress in the Russian Federation; it will set forth regulatory procedures for the issues of production and use of the energy produced from renewable sources, including from biological raw materials. However, in the recent years, some projects have been already proposed to the Sate Duma for consideration with respect to support of development of renewable energy resources and biofuels to facilitate development of this direction.

Today, the legal framework in the field of RES is based on the following documents:

1. RF Government Regulation No. 1-r dated 8 January 2009 *Main Directions of the State Policy in the Sphere of Improvement of Energy Efficiency of the Energy Power Industry on the Basis of Using Renewable Energy Sources for the Period till 2020*.
2. Edict of the President of the Russian Federation No. 889 dated 4 June 2008 *On Some Measures on Improvement of Energy and Environmental Efficiency of the Russian Economy*.
3. Federal Law of the Russian Federation No. 264-FZ dated 29 December 2006 *On Development of Agriculture*.

In addition, the RF Government Regulation provides for the implementation of the policy of stimulation of use of renewable energy resources in the field of electric-power

industry, for example, through implementing measures for raising non-budgetary investments, defining and adding a mark-up to the wholesale market price for electrical energy produced from RES, imposing an obligation on the customers to purchase RES-related electrical energy, improving the legal regulation for use of electric generating facilities, stimulating electrical energy consumers to increase purchasing quantities of "green" electrical energy, and purchasing of products produced using RES.

In accordance with the government contract between the Russian Academy of Agricultural Sciences and All-Russia Scientific Research Institute of Mechanization of Agriculture, the work on the Draft Federal Law *On the Principles of Bioenergy Development in the Russian Federation* is in progress. The draft law is aimed at defining legal, economic, environmental, social and organisational principle of production (recovery) and consumption of solid, liquid, and gaseous biofuels. Adoption of this law will enable to create a uniform legal framework for the bioenergy sectors of agricultural, timber production and energy power industry.

The expected development of the regulatory and legal framework aimed at regulation of the issues of use of RES, green energy production and provision of support for its producers will facilitate further expansion of the scope of activities associated, inter alia, with the use of biogas in the RF.

Thus, the biogas market in Russia has a great potential for development: it has sufficient raw materials for biogas production and potential energy and heat consumers. In addition, the regulatory and legal framework that is being created in Russia fosters the development of renewable energy resources and environmentally sound productions.

This is indicative that Russia has integrated into the global process of bioenergy development and we can expect that the market of bioenergy technologies in our country will grow dramatically in the short run.

In order to implement such projects, an active search for investors and contracting organisations experienced in implementation of this kind of projects is underway.

Conclusions

1. Development of bioenergy in Russia is a relevant government objective with respect to reduction of energy dependence of agricultural production, reduction of greenhouse gas emissions and diversification of fuel balance of the country in the direction of development of environmentally cleaner energy.
2. The well-developed gas infrastructure currently existing in Russia, as well as its huge biogas production potential are indicative of highly attractive prospects of Russia in terms of establishment and development of biogas production companies there that will be aimed at provision of domestic needs and supplies of green gas to the customers in the European Union countries.
3. The government, commercial, non-profit organisations and joint ventures established in Russia together with the foreign companies to intensify the works in the field of bioenergy enable to expect a mass development of biotechnologies any time soon.