

Prospects of development of bioenergetics in Belarus

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Summary. The article contains materials on the bio-energetic potential of the Republic of Belarus and prospects of development of bioenergetics. In the area of bio-energetic, technologies which use renewed organic resources, the so-called biomass for energy manufacture, including the electric power, energy of liquid, firm and gaseous kinds of fuel, warmth, chemical substances and other materials were discussed.

Key words: bioenergy, power resources, biomass sources, agricultural production waste, recycling of waste in agriculture.

INTRODUCTION

The Republic of Belarus is located in the eastern part of Europe. It borders Lithuania and Latvia in the north, Ukraine in the south, the Russian Federation in the east and Poland in the west. The territory occupies 207,6 thousand sq. km.

The agricultural soil occupies 44,9%, of the ploughed land – 30% of total area. The weakly utilized soils in the national economy (sands, bushes, swamp so forth) compose 15% of total area [7].

The population of the Republic of Belarus as of 01.02.2012 is 9463 thousand people, 1885 thousand of them live in Minsk.

More than 75% of population live in the cities and there are only 25% rural inhabitants [6].

The dynamics of the population since 1990 is presented in Fig. 1.

The agriculture of Belarus' is specialized in the cultivation of cultures traditional for the temperate latitudes. In the plant growing the predominant grains are barley, rye, wheat, potatoes, feed crops.

In connection with the structural conversions and the orientation to the renewed energy sources in the Republic the volumes of the cultivation of leguminous and oily cultures are enlarged.

In the stock raising in essence large livestock is reared for the production of milk and meat, but also pigs and poultry.

The dynamics of cattle and poultry livestock since 2007 is presented in Tab. 1.

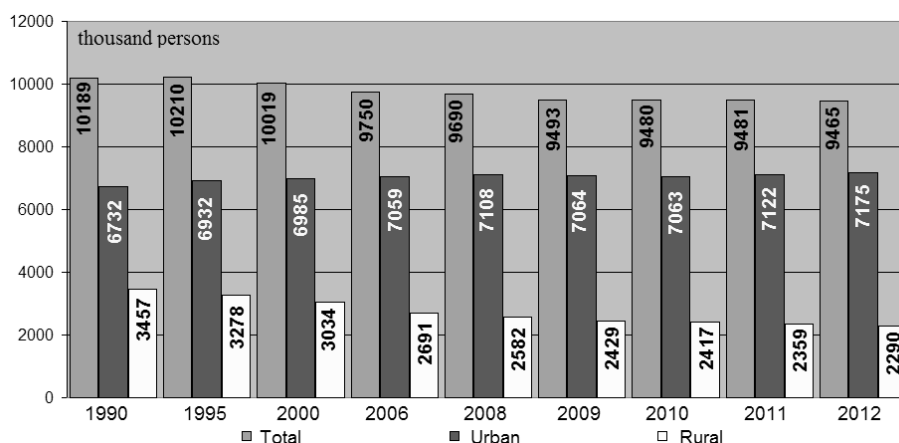


Fig. 1. The rural and urban population of Belarus

Table 1. Cattle and poultry livestock at the beginning of each year

Years	Large horned livestock	Cows of dairy herd	Pigs	Sheep and goats	Horses	Poultry
2007	3989	1506	3642	122	156	28,7
2008	4007	1459	3598	124	147	29,4
2009	4131	1452	3705	126	137	31,2
2010	4151	1445	3782	127	125	34,1
2011	4151	1478	3887	124	113	37,0
2012	4247	1477	3989	125	100	40,0

Note: The poultry is resulted in millions, the others in thousands

THE BASIC PART

According to the Republican program of rational use of power resources for 2011-2015, the total consumption of fuel and energy resources in the Republic in 2015 is predicted at 41 million tons of conditional fuel, in 2020 – 44 million tons of conditional fuel [1]. The forecast of total consumption of fuel and energy resources in Belarus is presented in Tab. 2.

Table 2. The forecast of total consumption of fuel and energy resources in Belarus, %

Fuel and power resources	2010	2015	2020
Natural gas	63,5	56,2	37,3
Coal	0,3	2,4	10,0
Nuclear fuel	0	0	11,4
Mineral oil	18,5	19,7	22,7
Others	17,7	21,7	18,6

The power supply system of Belarus has a difficult character, but it is perfectly integrated into the general uniform electric network in the other states (the scheme of a power supply system of Belarus and the other states is resulted in Fig. 2).

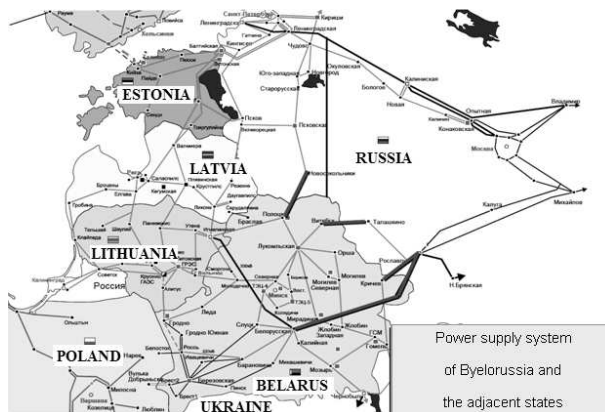


Fig. 2. Scheme of a power supply system of Belarus

Among the power companies of Belarus, Russia, Estonia, Latvia and Lithuania whose electric networks work in a uniform electric ring, the Agreement on parallel work of power supply systems has been in operation since February 7th, 2001.

The specified interstate electric communications of Belarus power supply system not only provides the reliability of electricity supply to consumers of the Republic, but also participate in the realization of steady parallel work of power supply systems of all the region Baltic – Belarus – Russia – Ukraine. Teamwork of a power supply system of Belarus with the CIS countries and Baltics allows to carry out deliveries of the electric power for the purpose of optimization of electric balances of the parties, and also to give reserves of capacity and to render the emergency help in extreme situations [4]. Within the limits of parallel work of power supply systems, Belarus imports the electric power from Russia and Ukraine, exports it to Lithuania, and also carries out electric power transit in energetically scarce regions of Russia and the Baltic State.

The structure of fuel balance of the Belarus power supply system is resulted in Fig. 3.

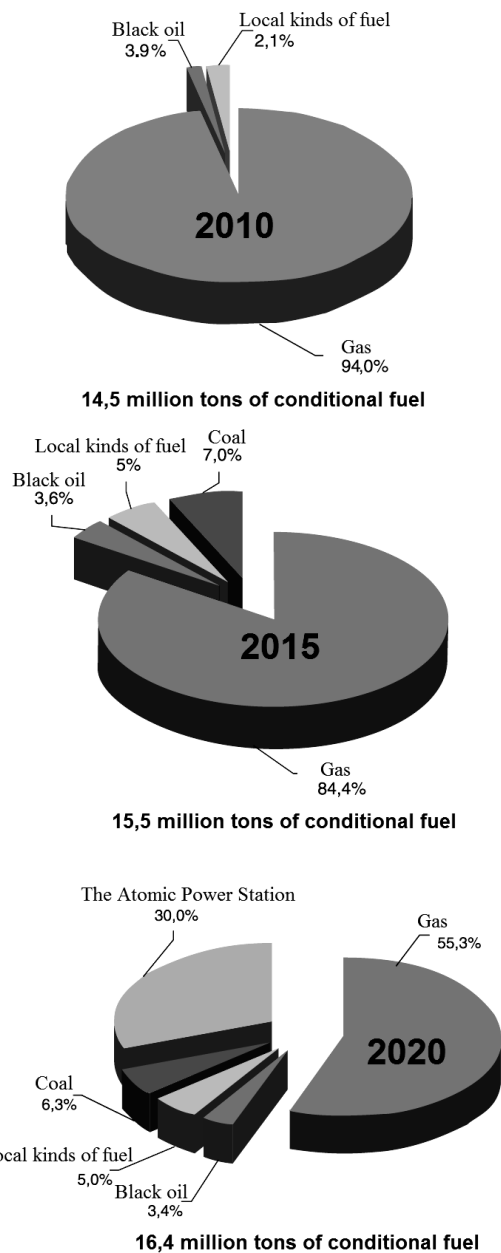


Fig. 3. Structure of fuel balance of the Belarus power supply system on 2010, 2015 and 2020

Bioenergetics – technologies which use renewed organic resources, a so-called biomass for energy manufacture, including the electric power, energy of liquid, firm and gaseous kinds of fuel, warmth, chemical substances and other materials. The bioenergetics after the sun is the most powerful renewed energy source [15].

Fuel from a biomass starts to become more popular because of the growing prices for fossil kinds of fuel. Besides, using biopower sources reduces pollution, helps to supervise emissions of carbon dioxide [14].

What is the biomass and how it can be used for warmth and electricity reception?

Biomass is constituted by any materials of biological origin, products of life processes and various organic waste. The biomass will exist on the Earth until there is life on it. According to the European Economic commission of the United Nations the annual gain of organic substance on the Earth is equivalent to manufacture of such quantity of energy, which is ten times more than annual consumption of energy by all mankind at the present stage [13].

The basic directions of use of biomass for power:

1st group

- Fire wood (coniferous, deciduous breeds and fast-growing trees),
- Manufacture pellets (wood or peat granules),
- Manufacture of combustible briquettes (wood, grassy, peat),
- Manufacture of special wood (for direct burning),
- Straw or grassy bales (in special fire chambers),

2nd group

- Gasification,
- Pyrolysis,

3rd group

- Ethanol manufacture,
- Manufacture of biodiesel fuel,

4th group

- Biohydrogen manufacture,

5th group

- Biogas manufacture.

In the conditions of Belarus, the development of bioenergetics is economically expedient and technically realizable. In Belarus there are in operation over 6300 complexes KPC; over 100 pig-breeding complexes and 60 poultry-farming complexes on which millions of tons of waste (Tab. 3) are annually formed [2].

Table 3. The forecast of an exit of manure and dung in 2012, tons

Animal (birds)	Large horned livestock	Pigs	Birds
Exit of manure (dung)	212 350	79 780	2 400

This waste (practically without their preliminary processing) is dumped on fields as fertilizers. However, besides advantage, they simultaneously cause a considerable ecological damage. Being washed away by snow and storm waters, manure from fields, and also non-neutralized waters of animal industries' enterprises, in particular pig-breeding

farms, get to reservoirs. Such sewage contain a considerable quantity of biogenic elements among which there is phosphorus and nitrogen promoting mass development of seaweed.

The potential of biogas from all the sources makes 160 thousand tons of conditional fuel in a year [16].

Biomass sources, characteristic for our republic, can be divided into five basic groups:

- Products of natural vegetation (wood, wood waste, wood dust and peat),
- Photogenes biomass (raps, straw, oil cake, silo, etc.),
- Waste of human life processes (solid household waste, waste of industrial production and deposits of treatment facilities),
- Agricultural production waste (manure, chicken dung, tops of vegetables, etc.),
- Agriculture waste (beetroot, potato waste, beer pellets, technical glycerin, meat waste, milk processing waste, etc.),
- Specially grown up fast-growing agricultures, plants and wood plantings.

In Belarus solid household waste goes to dumps and two waste recycling factories (Minsk and Mogilyov).

Annually there are taken out (thousand ton): paper – 648,6; food waste – 548,6, glass – 117,9; metal – 82,5; textiles – 70,8; wood – 54,2; skin and rubber – 47,2, plastic – 70,8 [3].

The potential energy included in solid household waste, formed on the territory of Belarus, is equivalent to 470 thousand tons of conditional fuel.

At its processing for the purpose of gas obtainment, the efficiency will reach no more than 20–25 %, which is equivalent to 100–120 thousand tons of conditional fuel. Besides, it is necessary to consider long-term stock waste, which is available in all large cities and creates problems with its warehousing. Only in regional cities, the processing of annual municipal waste into gas would allow to receive about 50 thousand tons of conditional fuel, and in Minsk – to 30 thousand tons of conditional fuel energy.

On the whole, in Belarus only 16 % of waste is processed [5].

Efficiency of the given direction should be estimated not only from biogas yield, but also on the basis of the ecological component which will be essential in the given problem.

For obtainment of useful products or substances the biomass demands processing which has complex character and allows to solve a number of extremely important problems:

- Sanitary-ecological (disinfecting of waste);
- Agrochemical (obtainment of effective organic fertilizers);
- Power (obtainment of qualitative fuel, and then thermal and electric energy);
- Social (improvement of working and living conditions, increase in productivity of agricultural crops, increase of efficiency of animals, reduction of poisonous chemicals' application etc.).

At present the following large biogas complexes in agrarian sector are being realized: Open Society «Gomel Integrated Poultry Farm» (340 kw); «The Western» (500 kw); «The Belarussky» (340 kw) and «Agrocombine of Snou» (2 MW, Fig. 4).



Fig. 4. Biocomplex «Agrocombine of Snou»

Understanding the importance of the question of waste recycling, in 2012 in the Belarus Republic it is planned to finish new large projects – seven biogas installations and the complexes working on the waste from agricultural production, with electric capacity 1–3 MBt.

They involve the following: Open Society “Gastellovsky” (electric capacity 3 Mw), Open Society “State Farm Combine” Sozh »(electric capacity 1 Mw), The closed joint-stock company “Lipovcy” (electric capacity 3 Mw), Agricultural production co-operative “Maiak Kommuny” (electric capacity 1 Mw), The republican unitary agricultural enterprise «Sovhoz “Slutck“ (electric capacity 1Mw), The republican unitary agricultural enterprise «Pig-breeding Complex “Borisovsky“ (electric capacity 1 Mw), Agricultural Production Co-operative “Vishnevetsky” (electric capacity 1 Mw) [6].

Besides, by means of foreign investors, during the same period it is planned to construct six biocomplexes on treatment facilities and 5 biocomplexes on distilleries.

They involve the following: The Municipal Unitary Enterprise «Minskvodocanal» (investments about 20 million \$ and 15 million \$), The Municipal Unitary Enterprise «Bobruiskvodocanal» (investments about 5 million \$ and 4 million \$), The Municipal Unitary Enterprise «Baranovichvodocanal» (investments about 5 million \$), The Municipal Unitary Enterprise «Slonimvodocanal» (investments about 3 million \$), 5 complexes «Belstatefoodprom» (investments about 15 million \$) [12].

It is necessary to notice, that the main ecological advantage of the “know-how” of biogas consists of reduction of emissions of methane, carbonic gas and nitrogen oxide in atmosphere. During fermentation process exactly such quantity of carbonic gas which has been absorbed before by plants in the course of photosynthesis is allocated, and methane renders 21 times stronger influence on the hotbed effect than carbonic gas, as it is caught and not dissipated in the environment [9].

State policy realization in the sphere of use of renewed energy sources is carried out according to the following documents:

1. The Law of Belarus «About rational use of power resources» from July, 15th, 1998 №190-3.
2. The Law of Belarus «About renewed energy sources» from December, 27th, 2010 №204-3.
3. The instruction of the President of Belarus «Economy and thrift – primary factors of economic safety of the State» from June, 14th, 2007 №3.

4. The republican program of rational use of power resources for 2011–2015 (it is confirmed by the decision of the Ministerial Council of Belarus from December 24th, 2010 №1882).
5. The national program «Development of local, renewed and nonconventional power sources for 2011–2015».
6. The program of social and economic development of Belarus for 2011–2015.

Among the State’s priorities in fuel and energy sphere there is the searching for and commercial operation of alternative energy sources on the basis of modern world technologies. Development of agriculture of Belarus will be carried out according to the Government program of strengthening of agrarian economy and development of rural territories for 2011–2015.

The major problems of development of agriculture are the formation of competitive, ecologically safe manufacture of the agricultural production, fully satisfying the internal requirements of the State, growing export potential as well as an increase in profitability of sales [11].

The prior directions providing an increase of agricultural production concern:

- Creation of highly effective integration structures of corporate type on technological grocery chains from manufacture of initial raw materials till finished goods sale.
- Intensification of an agricultural production on the basis of an effective utilization of industrial and climatic conditions, manpower, infrastructures of sale in the country and abroad with orientation to requirements of the process industry and demand in the foodstuffs world market.
- Modernization of the enterprises processing agricultural raw materials, introduction of new equipment and technologies allowing for deep processing of raw materials, greater assortment, and also the provision of output with high added cost.

The ecological policy of Belarus is directed on the maintenance of ecological safety, effective utilization of natural resources at preservation of integrity of natural complexes, including the unique ones. The basic directions of its realization can result in:

- Considerable improvement of the environmental components quality on the basis of an increase in the technological level of production.
- Reduction of volumes of formation of waste, emissions of polluting substances into the atmospheric air and dumps of polluted sewage in superficial reservoirs, prevention of pollution of underground waters, soils and degradation of agricultural grounds.
- Realization of a complex of actions for the prevention and minimization of the harm caused to the environment by accidents of techno-genic and natural character, at the expense of carrying out of preventive organizational-technical measures in the sphere of manufacture, working out and introduction into practice of modern methods, technologies and equipment for hydro meteorological supervision and preparation of hydro meteorological forecasts.
- Increase in the level of waste involvement in the civil turn, neutralization of the accumulated dangerous production waste.

- Preservation of biological variety, natural landscapes, natural ecological systems by the development of especially protected natural territories network.
- Development of the National system of monitoring of environment on the basis of introduction of progressive technologies of supervision, data gathering, reception and representation of ecological information.
- Formation of ecological culture of the population through the educational system;
- Prevention of the ecological threats connected with the increase in emissions of hotbed gases in atmosphere, anthropogenic change of climate and technology-induced accidents.

Problems in the sphere of efficiency increase, use of local and renewed power resources in Belarus so that:

1. To lower power consumption of gross national product to the level of 2005: not less than 50 % in 2015; not less than 60 % in 2020.
2. To provide economy of power resources (in comparable conditions): not less than 7,1–8,9 million tons of conditional fuel in 2011–2015; not less than 5,2 million tons of conditional fuel in 2016–2020.
3. To provide a share of use of own power resources in the balance of power resources for manufacture of thermal and electric energy: not less than 25,0 % in 2012; not less than 28,0 % in 2015; not less than 32,0 % in 2020.

The financing of actions for the rational use of energy and own power resources in 2010–2015 is presented in Fig. 5. The total amount of financing will make 8 662,5 million \$.

The program of building of the power sources working on biogas in 2010–2012 (the purposes and program problems):

- Ecological load decrease in the environment.
- Reception of biogas and its use for the development of electric and thermal energy with the view of replacement of imported fuel and energy resources.
- Obtainment of high-quality organic fertilizers.
- Reduction of the contamination of areas under crops from the use on them of unprocessed organic chemistry.

As a result of realization of this Program in the Republic, 39 biogas installations with the total electric capacity of 40,4 MW will be placed in operation, which will allow for the annual development of about 340 million kWh electric energy and for the replacement of imported natural gas in volume greater than 145 thousand tons of conditional fuel.

Realization of the national program «Development of local, renewed and nonconventional power resources in 2011–2015» assumes:

- Building of 102 biogas complexes in the rural organizations as well as housing and communal services, micro-

- biological industry and on ranges of the municipal and household waste the total electric capacity of 77,8 MW.
- Building wind stations of the total electric capacity 365–385 MW.
- Introduction of 184 solar power plants for the needs of hot water supply.
- Introduction of 166 thermal pumps for the use of low potential secondary power resources and geothermal energy [10].

In the conditions of the world's financial crisis and limitation of resource potential, the increase of efficiency of using fuel and energy resources gets the special importance for the Republic. The economy becomes not simply obligatory principle of managing, but the major requirement of maintenance of national safety of the State.

As the basic directions of research and search works for bioenergetics development in Belarus it is possible to consider:

- Reception of new data on resources of biofuel and its characteristics.
- Studying of processes and creation of bases of technologies of preparation, processing and biofuel conversion in power production.
- Studying of accompanying environmental problems, including pollution of surrounding space by production of waste and harmful gas emissions.
- Working out and substantiation of technologies of using materials from waste processing for manufacture of fuel, warmth and electric power.
- Estimation of economically expedient potential of bio-resources for manufacture of fuel, warmth and electric power, including their use in small agricultural towns.

CONCLUSIONS

There is the basic direction in recycling of waste in agriculture, including processing enterprises of an agrarian complex (milk factory, meat-packaging plants, spirit manufactures etc.), old dumps and sewer drains in Belarus.

As to municipal services, both in the industrial and private scale it is still necessary to work intensely. In immediate prospects, the organization of separate collection of food and industrial waste is considered very much as a challenge. As, living in modern high-rise houses (8–16 floors) and having a refuse chute, the population will hardly voluntary carry out waste separation. Besides, the presence of special services (firms) which would be engaged in delivery of the collected waste to destination is very important, and they are not present as yet. All these problems can be solved sooner or later, there would be desires and the will to carry them out. Certainly, the State's support is required.

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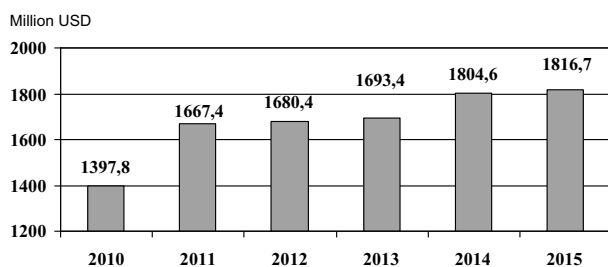


Fig. 5. Financing of actions for rational use of energy

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PERSPEKTYWY ROZWOJU BIOENERGETYKI W REPUBLICIE BIAŁORUŚ

Streszczenie. Publikacja zawiera materiały dotyczące bioenergetycznego potencjału Republiki Białoruś. Przeprowadzono analizę perspektyw rozwoju bioenergetyki. W jej obszarze rozpatrzono technologie wykorzystania odnawialnych organicznych źródeł, w tym biomasy do produkcji energii elektrycznej; energię z ciekłych, twardych i gazowych paliw; energię cieplną związków chemicznych i innych materiałów. W powyższym aspekcie bioenergetyka po słońcu jawi się podstawowym odnawialnym źródłem energii.

Słowa kluczowe: bioenergia, źródła energetyczne, źródła biomasy, odpady rolnicze, przetwórstwo odpadów w produkcji rolniczej.