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RENEWABLE ENERGY IN BELARUS: STATUS AND PROSPECTS

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Abstract

Apart from Potassium Chloride and peat, Belarus lacks significant mineral and fuel resources including natural gas, oil and coal. At the same time it has significantly energy intensive economy. Development of renewable energy resources opens up for a double solution, improving of energy independency and reduction of greenhouse gases emission.

Currently, only about 6% of electricity produced in Belarus comes from renewable energy sources. It is planning to increase this quantity up to 9% by 2035. The following first pilot projects has been already put into practice: hydro 17 MW, wind 1.5 MW and biogas 0.5 MW.

In the framework of the Belarus-EU international technical assistance project "Green Economy in Belarus" it is planning to construct windpower plant near Novogrudok and about 20 smaller green projects.

Key words: *renewable, potential, pilot projects, regulations, technical assistance.*

INTRODUCTION

Republic of Belarus is geographically situated in the Centre of Eastern Europe. Extensive plains dominate the landscape: the highest elevation is only 345 meters above sea level, the lowest place is located from 80 to 90 meters above sea level. The climate is mild continental and moderately wet, about 40% of the area are forests, 2% - waters, 44% - agricultural lands and 16% - other mainly marshy lands. Average population density is 48 persons per km², relatively low by European standards.

Apart from Potassium Chloride and peat, Belarus lacks significant mineral and fuel resources including natural gas, oil and coal. Nevertheless it has significantly energy intensive economy. The use of renewable energy resources opens up for a double solution, improving of energy independency and reduction of greenhouse gases emission.

Renewable energy is developing unprecedented pace in recent years. In 2011 total capacity of grid-connected solar PV in the ten largest countries (Germany, Italy, Japan, USA, China, France, Belgium, Czech Rep. and Australia) has reached up to 62.3 GW and worldwide up to almost 70 GW. 75% of this capacity is installed in Europe.

During the 6 years from 2005 to 2011 global wind power capacity was increased by a factor of 4 and achieved 237.7 GW including newly installed capacity of 40.6 GW.

Along with recognized leaders such as Germany, US, Denmark, Sweden in the field of renewable energy in recent years China, India, Brazil are beginning to play an important role, notable efforts was made by Argentina, Costa Rica, Egypt, Indonesia, Columbia and other. In 2009 China produced 40% of the world's solar PV supply, 30% wind turbines and 77% of the world's solar hot water collectors.

The main reasons for increased interest in renewable energy sources (RES) are following: running out of conventional fuel resources, eliminating the threat of climate change and energy security.

As in other high-tech areas development of renewable energy requires joint efforts and cooperation of various countries, exchange of experiences, knowledge and technology, training of producers and end-users of renewable energy installations. The work of international organizations in this area is of great importance. Since the initiative of UNESCO the World Solar Program had been developed and approved by the UN in 1995 and the World Solar Summit hosted in Harare (Zimbabwe). At various times there was created: European Renewable

Energies Federation (EREF), European Renewable Energy Council (EREC), Global Wind Energy Council (GWEC), Greenpeace International, International Clean Energy Consortium (OCEC), International Hydropower Association, Renewable energy and Energy Efficiency Partnership (REEEP) and World Wind Energy Association (WWEA).

Finally, in 2009, the International Renewable Energy Agency (IRENA) was established. On April 2011 the Assembly of the IRENA held its first inaugural session. Session of the Assembly of the IRENA reaffirmed, that problem of the use of RES is relevant for bath rich and poor in fuel and energy resources countries. The second category includes the Republic of Belarus.

NATIONAL TARGETS

Currently, only about 6% of electricity produced in Belarus comes from renewable energy sources. The potential for renewable energy in Belarus is strongest in solar, hydro, wind power and bioenergy (Tabl.1).

Table 1.Potential of Renewable Energy in Belarus

Source	Theoretical	Technical	Economic or Environmental
Hydro, TWh	1.7	1.0	0.6
Wind, TWh	Not ass.	2.8	Not ass.
Solar, TWh	11.2	1.2	Not ass.
Fire Wood, Mtoe/y	2.9	2.9	2.2
Biogas, Mtoe/y	Not ass.	0.27	Not ass.
Municipal Waste, Mtoe/y	0.33	0.07	Not ass.
Waste Energy, Mtoe/y	6.5	5.2	1.0

The National Programme on Development of Local and Renewable Sources of Energy for 2011-2015 does not establish particular targets with regard to renewable energy but underlines the need to substitute traditional energy sources with renewable ones.According to the Concept of Energy Security of the Republic of Belarus (2007) it is planning to increase the share of domestic fuel and power resources up to 25 % in 2020 including the following grows of renewables:

- wood biomass as a fuel.....from 1 to 2.2 Mtoe/y;
- Wind PP..... .. from 0.85 to 400 MW;
- Hydro PP..... from 9 to 200 MW.

STATE OF ART OF RENEWABLE ENERGY IN BELARUS

Wind. The average annual wind velocity in Belarus is less than 4 m/s and in majority of sites it changes from 3 to 4 m/s. Nevertheless 1840 “windy sites” in the country have been found with average wind speed of 5.5-6.5 m/s near the ground and 6.5-7.5 m/s at the height of 40 m.

Taking into account the moderate wind conditions in Belarus the new type of wind turbine has been developed on the basic of Magnus effect. It was equipped with rotating cylinders instead of conventional blades. The efficiency of this turbine has been demonstrated during testing of pilot unit with capacity of 100 kW. At present the second unit with capacity of 250 kW is under experimental operation not far from Minsk city (Fig.1).

The wind turbine design and manufacture enterprise “AEROLLA” was founded in Belarus about 15 years ago. Except rotary wind turbine the conventional one with capacity of 75 kW was developed and produced for farms and other local consumers as well as seven-module unit with capacity of 7.5 kW each (Fig.2) was disigned. It is expected that cost of module type of turbine in Belarus will be 500-550 EURO/kW.



Fig. 1. Picture of rotary wind turbine with capacity of 250 kW



Fig. 2. Module wind turbine with capacity of 52.5 kW



Fig.3. Wind turbine with capacity of 52.5 kW in Grabniki



Fig. 4. Grodno HPP wit capacity of 17 MW

The most powerful wind power unit in Belarus with capacity of 1.5 MW was commissioning in Grabniki (Grodno province) in 2011 (Fig. 3). Its height of tower is 90 m, blade length – 40 m, annual average electricity production is about of 84 GWh.

Hydro. Now in Belarus there are 50 small hydro power plants (HPP) with total capacity of 34 MW and annual generation about of 28 GWh of electricity. It is estimated that theoretical hydro power potential is

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about 850 MW, of which 520 MW are technically feasible and 250 MW are economically suitable. The design of construction of two middle-scale HPP cascades is developed: 4 plants with total capacity of 132 MW on West Dvina River and 2 plants (37 MW) on Neman River. The construction of first among them Grodno HPP with capacity of 17 MW (Fig. 4) was completed in 2012.

Solar. There are only 1815 sunshine hours in average per year at the latitude of Minsk, in the center of Belarus. The average energy density of solar radiation is 32 W/m² taking into account cloudy and night time. Therefore the typical solar energy implementation in the country is domestic one-loop hot water system. The average period of operation of such unit in Belarus is approximately 6 months (from the middle of April to the middle of October). It was investigated that the average heat flow during a season varied from 1 to 2 GJ/m^2 and water temperature reached 65 °C, but intensity of solar radiation is essentially changed from year to year (Fig. 5).

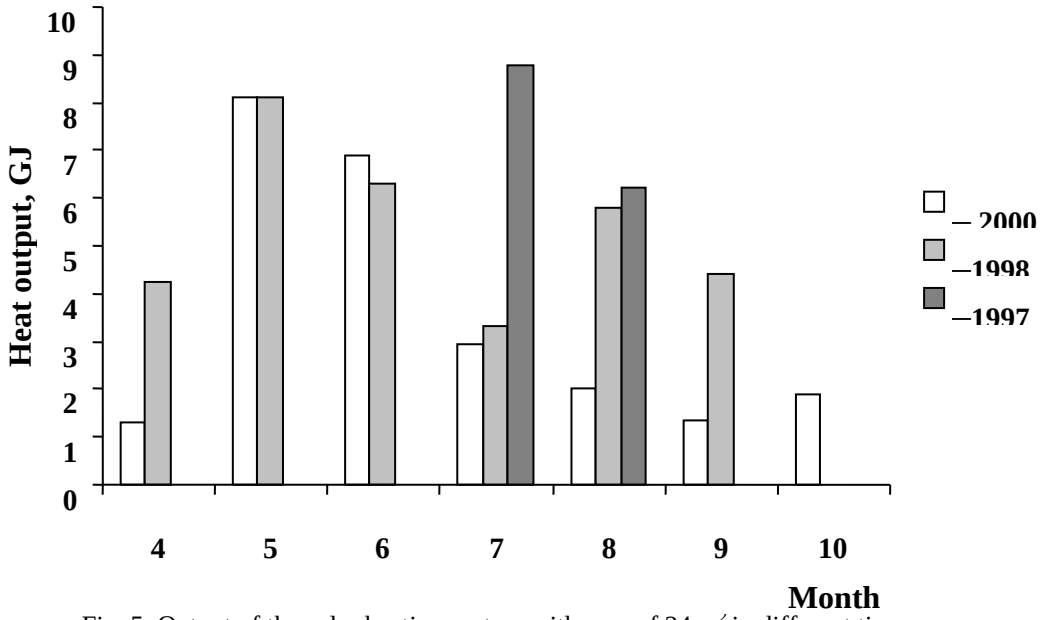

Fig. 5. Output of the solar heating system with area of 24 m^2 in different time

At present 6 solar power plants with capacity from 6 to 400 MW are under operation in Belarus. They are mainly used for electrical herd systems and local supply of cottages and small farms with electricity. The total capacity is 586 kW and annual production of electricity is 858 MWh.

Geothermal energy. Two regions with density of geothermal energy from 115 to 175 GJ/m^2 and water temperature of 50 °C at the depth 1.4-1.8 km and 90-100 °C at the depth 3.8-4.2 km are found. At present estimation of total geothermal potential in Belarus is being made. It is supposed that activity in this direction shall be carried out in the framework of research and development during 2015–2020.

Biomass .Wood fuel is the most significant renewable energy resource in Belarus and is promoted in the interest of reducing of Greenhouse Gas emission. The annual accretion of timber biomass is assessed to reach 32 mill m3, from which 10-12 mill m3 are harvested. At present only 4.3 mill m3 firewood is used by households and 0.9 mill m3 wood industry waste is burned in municipal boilers. New designs of boilers with capacity from 0.25 to 1.5 MW and efficiency up to 82% are developed for using of wood waste (Fig. 6).

Now following CHP plants are under operation with food chips as a fuel:

Retchitsa - 4.2 MW

Pruzshany - 3.7 MW

Vilejka – 2.4 MW

Osipovichi – 1.2 MW

Clutsk - 0.75 MW.



Fig. 6. Boiler with capacity of 1.2 MW

In Belarus there are almost 270 thousand hectares of soil which have been excluded from economic turnover due to high level of radioactive contamination after Chernobyl NPP accident .The technology of utilization of contaminated biomass has been developed by the Institute of Power Engineering Problems (Sosny-Minsk, Belarus) and Sandia National Laboratories (Livermore, USA). The most attractive option could be the fast rotation coppice technologies that can provide not only additional biofuel but certain removal of radioactive source term from contaminated soil.

The investigation of biomass production through short rotation crops was set up by Institute of Power Engineering Problems in co-operation with RISO National Laboratory (Denmark) and SCK-CEN (Belgium). It was received that 5.1 tons dry matter can be harvested annually on sand soil and 10.5 tons on peat soil.

Another substantial energy source is biogas from digestion of animal manure and other organic waste. In Belarus there are about 250 cattle-breeding complexes and 70 poultry farms. Approximately 1.7 bill. m^3 of biogas can be produced there annually.

In Belarus the first biogas power plant was constructed in 2008. At present 12 biogas plants are under operation. The most powerful among them was commissioned in 2013 at the farm Lebedevo with capacity of 500 kW (Fig. 7). The main equipment was delivered by LTV Landmaschinen und Transporttechnik Vertriebsgesellschaft mbH from Germany.



Fig. 7. Biogas power plant with capacity of 500 MW

***Waste heat recovery*.** Increasing of energy end-use efficiency is undoubtedly significant way of reduction of the energy-related environmental pollution. In tern, reuse of waste heat is one of the most effective options energy saving policy. In Belarus the total theoretical potential waste heat achieves 75 PJ/y (Table 2), technically feasible – 41 PJ/y, but utilization in year 2013 – 13 PJ.

Table 2. The theoretical waste heat potential in Belarus (PJ/y)

Chemical and petrochemical industry	46.5
Power district heat generation	11.4
Industry of building materials	7.4
Machinery and metallurgy	4.1
Others	5.6

More than 30 heat exchangers for production of steam and hot water by utilization of waste heat was developed in the Joint Institute of Power and Nuclear Research – Sosny. One of them is showed on the Fig.8.



Fig. 8. Picture of the heat waiste boiler with output of 10 t/h of steam

REGULATIONS RELATED TO RES DEVELOPMENT

To support development of RES, the Republic of Belarus has a basic system of regulations and incentives in place that are described in the following regulations:

- Law “On renewable sources of energy” No. 204-3 of December 27, 2010.
- Investment code of the Republic of Belarus No.37-3 of June 22, 2001.
- Directive of the President of the Republic of Belarus No.3 of June 14, 2007 “Saving and economy as the major factors of economic security of the country”.
- Decree of the President of the Republic of Belarus No. 6 of May 7, 2012 “On Stimulation of Business Activity in the Territory of Medium and Small towns, and Rural Areas”.
- Decree of the President of the Republic of Belarus No.10 of August 6, 2009 “On Creation of Additional Conditions for Investment Activities in the Republic of Belarus”.
- Edict of the President of the Republic of Belarus No.667 of December 27, 2007 “On withholding and granting land plots”.

- Resolution of the Council of Ministers No.1058 of August 6, 2011 "On Measures to implement the Decree of the President of the Republic of Belarus No. 4 of June 6, 2011".
- Resolution of the Ministry of Economy No. 100 of June 30, 2011 "On tariffs on electricity produced from renewable energy sources".
- Resolution of the State Committee for Standardization of the Republic of Belarus No. 10 of February 27, 2009 "On Approval of Instruction on the procedure for issuance of conclusions about the attribution of imported goods to the equipment used in the production or reception, transformation, accumulation and (or) transfer of power produced from unconventional and renewable sources of energy".

The Renewable energy Law establishes the main legal framework for the support of renewable energy sources and namely:

- guaranteed connection to the state-owned energy grid;
- guaranteed purchase by the state energy supplying organizations of all proposed energy produced from renewables, as well as its payment at preferential tariffs (for electricity only);
- protection against unfair competition, including from legal entities dominating in Belarusian energy production market;
- possibility of expansion (reconstruction, modernization) of RE plants if design documents are provided as prescribed by law;
- independent identification of energy facilities location;
- high feed-in-tariffs compared to EU standards;
- no VAT and import duties on renewable energy equipment imported into the territory of the Republic of Belarus;
- no land tax on land plots occupied by RES installations, as well as on land plots allocated for the period of construction (reconstruction) of RES plants;
- a highly developed grid inherited from the Soviet Union period.

For electricity from biogas, wood, hydro, wind, geothermal:

- for the first 10 years from the date of putting the plant into operation – 1.3;
- the following 10 years of the power plant operation – 0.85.

For electricity from solar:

- for the first 10 years from the date of putting the plant into operation – 3;
- the following 10 years of the power plant operation – 0.85.

In USD the feed-in-tariff currently amounts to (exchange rate as of November 15, 2013):

Electricity from biogas, wood, hydro, wind, geothermal	for the first 10 years from the date of commissioning of electricity generation	*USD 0.18 per 1 kWh*
	the following 10 years	*USD 0.12 per 1 kWh*
Electricity from solar	for the first 10 years from the date of commissioning of electricity generation	*USD 0.41 per 1 kWh*
	the following 10 years	*USD 0.12 per 1 kWh*

The Government intends to regulate the penetration of RES. The quota for the construction of alternative sources of energy will be introduced in Belarus since 2015. The quota for 2015 will be planned about 110 MW, of which 60 MW will be allocated to construction of solar power plants of "Belorusneft" in the Gomel region. The total investors' plans for building solar power plants in 2014 were significantly larger, up to 750 MW. Also state company "Belenergo"intends to build and use own sources of power generation using wind and solar power. In addition to restriction on connected capacity of RES, the Government intends to revise the feed-in tariffs as early as 2015.

EU SUPPORT PROGRAMS

The EU has provided technical assistance to Belarus titled: "*Support to the Implementation of the Comprehensive Energy Strategy for the Republic of Belarus*" under which there was a special part dealing with feed-in tariffs: "C.1.4 Development (calculation) of Feed-in-tariffs for RES" with the following activities:

- Development and consultation on methodology;
- Development of recommendations and consultation on categories of RES for which different Feed-in-tariffs will be calculated;
- Collection of data related to costs (Belarus and international data);
- Development of assumptions;
- Calculation of Feed-in-tariffs.

Another three activities under the above technical assistance relevant to the current assignment are:

A.2.5: Development of an optimal electricity capacity structure for the period till 2030 and investment needs possible.

C.1.2. Setting up the database of legislation in the field of renewable energy and development of incentive models to encourage the use of renewable energy and set up of a web portal specialized on renewable energy technologies utilization.

C.1.3. Development of a guidance manual for RES developers.

A windpower plant will be built near Novogrudok as part of the Belarus-EU international technical assistance project *"Green Economy in Belarus"*. Nearly €5 million from the funds allocated under the project will be put into the implementation of a pilot project to construct a windpower plant near Novogrudok in order to determine the efficiency of using wind energy in the country and demonstrate its potential.

Under the agreement, Belarus is planning to implement about 20 smaller green projects. Activities will be undertaken to improve the institutional and legislative framework. Attention will be given to the exchange of knowledge and experience in the field of the green economy, small green initiatives and mini-projects.

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