Renewable Energy Country Profile
Version 0.6b

These profiles are a work in progress. They are presented to the international community for review and comment. The profiles are undergoing continual updating for technical content, formatting, grammar, and other issues. Each country profile will be modified on a continuous basis as new information is made available.

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4.0 Belarus

4.1 Overview of Electricity Supply

Belarus received its independence from the Former Soviet Union in 1991, however, little has changed in the past decade. In 1994 Alyaksandr Lukashenko was elected president and immediately reinstated administrative controls over prices, exchange rates and expanded the state's right to intervene in private enterprise. Only a few small industries have been privatized, but the vast majority of industry remains owned and operated by the state. As a result, the IMF stopped lending to Belarus in 1996.

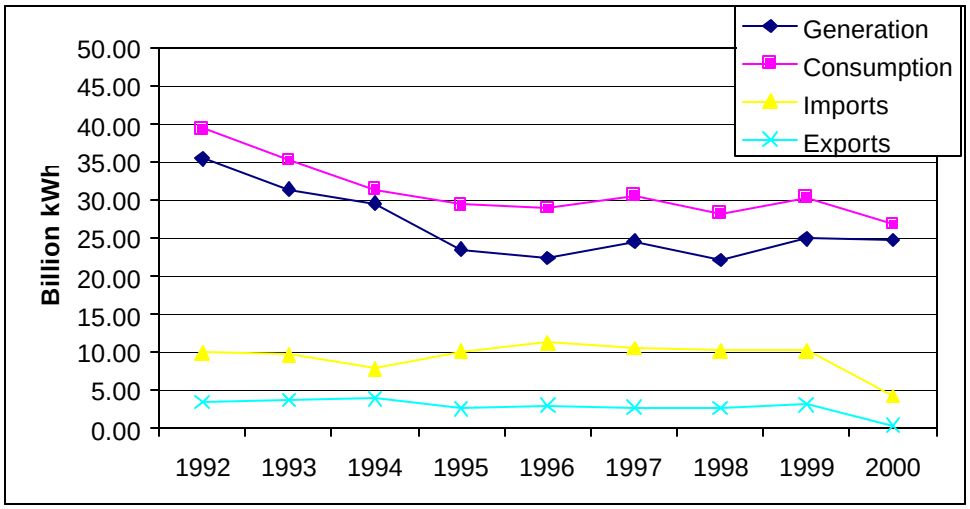
Belarus maintains a close relationship with Russia and, through Russian imports, had a 5.8% increase in real GDP in 2000. This real GDP growth comes in spite of hyper inflationary conditions of 251% in 1999 and 107% in 2000.

The Belarus power sector has a generation capacity of 7.4 GW, with 99.9% of generation from oil or natural gas fired power plants, and the remaining 0.1% from a hydroelectric facility.

Table 7-5
Installed Generation Capacity

Fuel	Number of Units	Capacity (MWe)	Percent of Capacity
Nuclear			
Thermal	N/A	7,401	99.9%
Hydro	N/A	7	0.1%
Other Renewables			
Total	N/A	7,408	100%

The infrastructure has been in a state of continual decay over the past decade as a result of a lack of investment in maintenance and renovation. Both generation and consumption have fallen over the past decade, however, as a result of the system deterioration consumption has risen above generation and left Belarus as a net importer of power from Russia and Lithuania. Owing to high inflation rates, and below market rate prices for power, Belarus has accumulated of $50 million in debt owed to Russia and Lithuania for imported electricity.



Privatization has proceeded little since the split from the Former Soviet Union. To date only about 10 percent of republican enterprises and about 40 percent of communal enterprises have been privatized. According to the five-year economic development plan adopted in May 2002, the state will continue to play a dominant role in the economy. At the present time the government believes that large-scale privatization, including public utilities, would be premature in the current economic environment.

1.1.1 Wind Resources

Current Status of Wind Energy [1, 2)]

Currently there are two wind turbines of total 850 kW installed capacity. The first 250 kW unit was installed two years ago, the second 600 kW unit July 2002. The second turbine was partly funded by the German Eldorado Program. The revenue from these turbines shall be used to fund resettlement projects for people suffering from the consequences of the Chernobyl catastrophe.

A country wide wind-atlas is available, where 3 main areas with annual average wind speeds of 4 - 5 m/s at 30 m height were identified.

In 1994 Belarus introduced a standard feed-in tariff for renewable generated electricity in a law modeled on Germany's Electricity Feed Law. Renewables electricity will be bought for about USD 0.08/ kWh compared with a consumer price for electricity in of just USD 0.012/kWh. The governments of Germany and Belarus have said that they want to promote alternative energy sources.

Belarus has an industry association. No industry manufacturer was identified.

Belarus has a poor potential for wind energy development from a technical point of view, but there are strong legal and economical incentives

Wind Energy Resource Potential [3)]

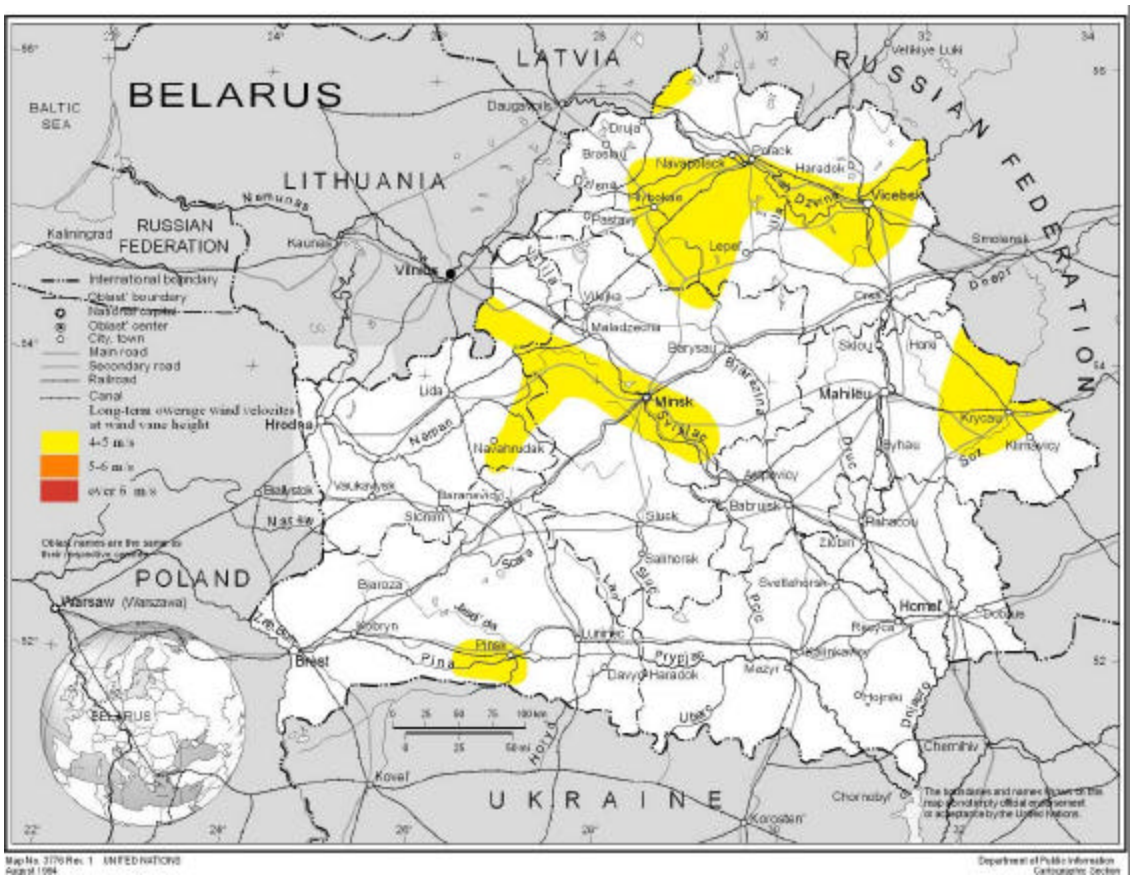
"Master Plan of Wind Power Development of the USSR till 2010", 1989 (MPWD) included a country-level wind map. The resource potential was estimated for 30m above ground. According to this wind map, there are no areas with a wind speed more than 5 m/s at 30m above ground.

Therefore the wind energy resource potential of Belarus would be low, however it would be recommendable to check this statement, with state of the art wind measurements, at least at 50 m above ground.

Based on available information today, we would rate the technical wind energy resource potential of Belarus as poor.

Identification of Areas/Projects with High Potential for Wind Energy

The most promising sites are Minsk and westwards of the country, Towns of Vitebsk and Polotsk in the Southern region of the country. The first two turbines are installed in Druzhnaya, about 150 km north of the capital city of Minsk.



Wind atlas of Belarus

Table 1-2 Belarus Areas/Projects with High Potential for Wind Energy..

Project Name and Location	Size (MW)	Description
Minsk and westwards of the country		
Towns of Vitebsk and Polotsk		
Southern region of the country		

Barriers/Incentives for Wind Energy

Specific incentives for the implementation of wind projects in Belarus include:

A fixed feed-in tariff of USD 0.08/kWh

Availability of a renewable energy law

Specific barriers to the implementation of wind projects in Belarus include:

- Low level of wind power potential is unable to make designs of the wind power plants to be competitive

Table 1-3. Belarus Wind Energy Profile.

Current status of wind energy	
Installed capacity	0.85 MW (REpower Systems, Germany, Elodrado Program)
Projects under construction	N/A
Supporting regulations?	Yes. In 1994 Belarus introduced a standard rate of pay for renewable generated electricity in a law modeled on Germany's Electricity Feed Law. Renewables electricity will be bought for about $0.08/kWh compared with a consumer price for electricity in Belarus of just $0.012/kWh. [2]
Industry association?	Yes, Economic Institute of The National Sciences Academy of Belarus.
Wind energy resource potential	
Level of information available	Fair
Highest wind class	Class 2 (~ 250 W/m^2)
Country-level wind atlas available?	Yes
Estimated potential (MPWD)	**30*10^{12}** kWh/yr or MW, gross (theoretical) potential **170*10^9** kWh/yr or MW, technical potential **500** MW, economic potential
Estimated potential (Interwind)	100 MW
Target established?	No
High wind speed locations	• Minsk and westwards of the country • Towns of Vitebsk and Polotsk • Southern region of the country
Identification of areas/projects with high potential for wind energy	
Recommended strategic assessments	Study 1 : state of the art wind measurements at candidate locations Study 2 : an appraisal of legal and economical frame work
Identified areas/projects	No Projects identified
Incentives/barriers for wind energy	
Significant incentives	• Fixed feed-in tariff of USD 0.08 / kWh • Renewable Energy Law
Significant barriers	• Low wind energy resource potential
Overall Prospects	**Fair** Although Belarus has a good legal and economical environment for wind energy development, the available information implies poor resource potential.

1) Mit lokalen Aktionen einen globalen Bezug herstellen, Dietrich von Bodelschwingh will Weissrussland eine neue Perspektive geben; Neue Energie 6/2002
2) Wind power revenues to resettle Chernobyl victims, Regine Suling, New Energy 3/2002
3) "Master Plan of Wind Power Development of the USSR till 2010", 1989

5.4 Belarus Renewable Energy Profile

5.4.3 Solar Resources

Current Status of Solar Energy

At present the use of solar power has no any noticeable spreading. There are only a few examples of application of solar water-heating plants on the basis of flat solar collectors [1].

Solar Energy Resource Potential

The climatic conditions of Republic of Belarus are on the whole unfavorable for using solar energy, the potential of which is not large/ It is characterized by the data presented in Tables 1 and 2 for the two places: Minsk (a capital) and Vasilevichi located at Southeast of the country. These data were borrowed from [2] and represent the averaged values for measuring period of many years.

Table 1

Monthly and annual total solar radiation incident on horizontal surface, MJ/m^2

Name of place	I	II	II	IY	Y	YI	YII	YII	IX	X	XI	XII	Yearly
Minsk	69	133	291	393	567	624	590	478	315	154	59	41	3714
Vasilevichi	86	145	295	402	570	623	613	505	344	176	71	52	3882

Table 2

Monthly and annual direct solar radiation incident on surface normal to sunlight beams, MJ/m^2

Name of place	I	II	II	IY	Y	YI	YII	YII	IX	X	XI	XII	Yearly
Minsk	83	127	293	325	467	531	483	415	307	160	56	44	3291
Vasilevichi	93	140	257	299	452	509	462	424	330	179	67	43	3253

Identification of Areas/Projects with High Technical Potential for Solar Energy

The data of Tables 1 and 2 show that there are no regions with high technical potential for solar energy at the territory of Belarus. Only the using of flat modules (flat thermal collectors, flat photovoltaic arrays) is possible and only in summer time.

Barriers/Incentives for Solar Energy

The main barriers for development of using solar energy are the climatic and economic ones. The climate in Republic is not favorable for application of any scale plants such as, for example, the solar power plants. The economic barrier consists of an absence of funds for investments even in small objects used the solar energy. Correspondingly there were no any noticeable incentives in this sphere in Belarus.

Table 4 -3. Belarus Solar Energy Profile.

Current status of solar energy

Installed capacity	Are absent except of insignificant amount of small solar water heating plants of seasonal action.
Projects under construction	Are absent.
Supporting regulations?	Are absent.
Industry association?	Is absent.
Solar energy resource potential	
Level of information available	Poor
High range of solar insolation	1.0 – 1.5 kWh/m2/day [3] (worst month); up to 2.9 kWh/m2/day (year average [2]
Country-level solar atlas available?	Is absent/
Target established?	No.
High solar insolation locations	The solar climate is uniform. Any points with much higher radiation are absent.
Identification of areas/projects with high potential for solar energy	
Recommended strategic assessments	Technical-and economic analysis of possibilities for commercial application of seasonal solar plants for different customers
Identified areas/projects	Due to unfavorable climatic conditions any new considerable projects on using solar energy are not expedient.
Incentives/barriers for solar energy	
Significant incentives	Shortage of own traditional energy resources. Unfavorable climatic conditions. Low tariffs for electricity and heat. Absence of inner sources f investments
Sig1nificant barriers	Absence of inside investment sources for solar energy. Low tariffs for electricity and heat. Absence of legislation in the field of nontraditional energy.
Overall Prospects	Poor mainly because of unfavorable climatic conditions which exclude the realization of any large projects in the area of solar energy

References

1. V.G.Fedoseev, A.A.Mokhailov. Renewable energy sources in Belarus. “Renewable Energy”, 1998, no.2.
2. Applied scientific reference book on climate of the USSR. Hydrometheoizdat, L., Issue 7, 1987.
3. Internet s ite: www.bpsolar.com/ContentDocuments/17/PV System Sizing Tools.zip

5.4.4 Geothermal Resources

Current Status of Geothermal Energy

Belarus territory is characterized mainly by low and middle values of geothermal gradient. In spite of a large number of not productive prospecting oil wells, the thermal water is not produced and not used. There is no State program on using geothermal energy [1,2].

Geothermal Energy Resource Potential

The thermal water reservoirs were discovered and partially studied during exploration drilling for oil and gas. Generalization of these data in Atlas of thermal water resources [3] allowed to allocate the following geothermal resources:

- Geothermal brines with temperature up to 100^0C, TDS 200-400 g/l were found in the area of Pripyat Trough at Southwest of Belarus at depth of 4.5 km;
- Temperature of thermal water 35 ^{0}C was fixed at West of Belarus (Brest Depression) at the depth of 2.5 km.

Identification of Areas/Projects with High Potential for Geothermal Energy

Fields with high temperature thermal water are absent in Belarus.

Barriers/Incentives for Geothermal Energy

A main incentive for using thermal water in Belarus is the shortage of own fuel resources.

Specific barriers to the implementation of geothermal projects in Belarus include:

- Unfavorable geothermal conditions .
- Low tariffs for electricity and heat

Table 4-4. Belarus Geothermal Energy Profile

Current status of geothermal energy	
Installed capacity (electric)	0
Installed capacity (thermal)	0
Projects under construction (electric)	0
Supporting regulations?	No
Industry association?	No
Geothermal energy resource potential	
Level of information available	Fair
Country geothermal atlas available?	No.
Estimated potential (electric)	0
Target established?	No
High enthalpy geothermal locations	Absent
Identification of areas/projects with high potential for geothermal energy	
Recommended strategic assessments	No
Identified areas/projects (electric)	No
Incentives/barriers for geothermal energy	
Significant incentives	Shortage of own fuel resources.
Significant barriers	Unfavorable geothermal conditions.
	Low tariffs for electricity and heat

Overall Prospects	Poor. Unfavorable geothermal conditions with low tariffs for heat make uncompetitive the utilization of thermal water.

References

3. A Strategic Plan for the Development of European Geothermal Sector. *Blue Book on Geothermal Resources,* European Communities, 1999.
4. V.Zui, V.Levashkevitch. Preliminary Estimates of Geothermal Potential of Belarus. . *Proceedings World Geothermal Congress 2000,* Tokyo, 2000.
5. G.Kulikov, B.Mavritsky *et al.* Atlas of Thermal Water Resources of the USSR. Moscow, 1984.

5.4.5 Biomass Resources

Current Status of Biomass Energy

Wood fuel. The most significant renewable energy source in Belarus is wood. At present 461 boiler plants are operating in Republic using the combined combustion of wood and other types of fuel.

A large range of water-heating combustion wood and felling residues boilers with capacity from 60 to 5000 kW is produced in Republic. There is a much less number of developments for steam boilers and gas generators. It should be noted from them: the steam boiler GSKB with 330 kg/h productivity of steam and gas generator of company "IMPET", the gas-generating water heating boilers with capacity 45, 70 and 90 kW produced by Production Association "Teploenergomach" (city Mogilev), the gas generating plant with capacity 50-100 kW of association "Belavtodizel". However all these plants have small power and it is unlikely to achieve by means of them the considerable increase of biomass share in the fuel-energy balance of Belarus

Biogas obtained from animal husbandry wastes is another renewable energy source in Belarus. In 1992 the first biogas plant "Kobos" was commissioned in Republic. It was designed and manufactured similar to West European plants. Its productivity made up 500 m^3 of biogas a day with cattle manure 50 m^3/day. About a half of obtained biogas was used for auxiliaries, and nevertheless the plant was able to substitute here the organic fuel with volume 47 toe

Biomass Energy Resource Potential

Table shows the overall biomass resource data for Republic of Belarus

Belarus Biomass Resource Data (FAO 2002a, FAO 2002b).

Biomass resource type	Total production	Production density
Primary crop production, tonne	(avg. 1999-2001, tonne)	(tonne /1000 Ha)
Total primary crops (rank among COO)	53,361,633 (5)	2,572 (8)
Top 10 primary crops		
Mixed Grasses, Legumes	22,566,667	1,088
Maize for Forage & Silage	11,733,333	566
Potatoes	8,302,933	400
Vegetables and Roots, Fodder	2,662,333	128
Barley	1,501,567	72
Sugar Beets	1,380,033	67
Rye	1,222,633	59
Wheat	803,467	39
Cabbages	527,100	25
Oats	486,500	23
Animal units, number	(number)	(number / 1000 Ha)
Cattle	4,505,850	217
Poultry	30,000,000	1,446
Pigs	3,632,200	175
Equivalent animal units	6,258,730	302
Forest products, cubic meters	(avg 1999-2000, cu meters)	(cubic meters /1000 Ha)
Wood fuel and charcoal	1,036,700	50
Wood residues	1,462,450	70

Wood fuel The overall volume of forestry constitutes 1 billion m^3 (of clear wood). The annual growth of wood biomass is estimated as 25 million m^3. Last three decades the general storing of wood constituted 1`--12 million m^3 a year. From them 4-5 million m^3 falls on merchantable wood and 4-5 million m^3 for firewood. About 40% of stored round wood falls on felling residues, and 1-1.5 million m^3 of them was burned in boilers.

The permitted felling volume made up 15 million m^3 a year. Both the necessity of restoration of forest and the circumstances that the forest usage is possible on 80% of area occupied by forest stand (due to the pollution of forest as a result of Chernobyl catastrophe and carrying out the measures on environmental protection at some sections occupied by forests) was taken into account in this case. Due to it there is a possibility to use another 4-5 million m^3 of wood per year. In addition about 1 million m^3 of not used felling residues are at the enterprises of woodworking industry. The energy value of this 4 million m^3 of additional wood reserve is approximately equal to 7 million Gcal or 0.7 million toe.

Investigations of a possibility of cultivating of quickly growing wood on the lands, which are badly suitable for productive agriculture, carried out in Republic should that the economically expedient potential of biofuels obtained on the working out peat deposits is on the level of 1.2 million toe.

Biogas There are in Republic 275 livestock breeding plants and 66 poultry breeding factories, where it is annually possible to produce 1.7 billion m^3 of biogas that is equivalent to 0.9 million toe.

Identification of Areas/Projects with High Technical Potential for Biomass Energy

The increased utilization of wood pulp as a fuel can be carry out in three directions:

- Modernization of coal-fired boilers;
- Construction of new combustion wood boilers and CHP plants;
- Introduction of topping gas generator in power plants using natural gas and liquid fuel with corresponding change of burners.

The resources of wood fuel can be increased by cultivation of quickly growing forests on the worked out peat deposits.

Barriers/Incentives for Biomass Energy

Significant incentives:

1. Limited reserves of organic fuel.
2. Considerable timber resources.

Significant barriers:

1. Low solvent demands of population and organizations.
2. Absence of mechanisms for financing and return of invested funds.

Table 4-5. Belarus Biomass Energy Profile.

Current status of biomass energy	
Installed capacity	At present 461 boiler plants combusting in combination the wood and other fuel types are functioning in Republic. The wood fuel substitutes at

	these plants 250 thousand toe of organic fuel. The biogas plant "Kobos" was put into operation in Brest region and substitutes about 50 toe of organic fuel
Projects under construction	No data.
Supporting regulations?	Yes
Industry association?	No
Biomass energy resource pote ntial	
Level of information available	Fair
Relative biomass potential (total / density)	Total: 13%; Density: 55%
Country-level biomass investigations available?	Yes
Estimated potential	Wood fuel – 1,5 million toe biogas – 0,9 million toe
Target established?	Yes
High density biomass areas	There are no data on the concrete territories
Identification of areas/projects with high potential for biomass energy	
Recommended strategic assessments	Study 1 Creation of national program on biomass fuel utilization. Study 2 Creation of demonstration p ilot plants for using biomass for energy purposes.
Identified areas/projects	No data

Incentives/barriers for biomass energy	
Significant incentives	3. Limited reserves of organic fuel. 4. Considerable timber resources. 5. Considerable agricultural wastes
Significant barriers	3. Low solvent demands of population and organizations. 4. Absence of mechanisms for financing and return of invested funds.
Overall Prospects	Good

References

1. V.G.Fedoseev, A.A.Mikhzalevich. Renewable energy sources in Belarus. Quarterly information bulletin “Renewable Energy”, 1998, no.2.
2. V.G.Fedoseev, A.A.Mikhzalevich. Mastering of renewable energy sources in Belarus. Quarterly information bulletin “Renewable Energy”, April 2001.

Renewable Energy Profile (draft)

REPUBLIC OF BELARUS
HYDRO POWER POTENTIAL FOR DEVELPOMENT OF SMALL AND MEDIUM SIZE HYDRO

According to the adopted classification, small HPPs are of capacity up to 30 MW, medium-size HPPs are of capacity up to 100 MW.

1. Current State of Hydro Power

There are no large and medium-size HPPs on the territory of Belarus.
Small hydro installed capacity in Belarus totals 9 MW.

Existing Hydro Power Plants in Belarus

Hydro power plants	Installed capacity, MW
Small HPPs	9.0

2. Hydro Power Resources of Belarus

Hydro resources in the Republic are rather scarce. By hydropower potential Belarus is one of the last among the CIS countries.

Characteristics	Indices		Share of HPPs, % from the total
	Total	Including small HPPs of capacity up to 30 MW	
Gross theoretical hydropower potential, - Billion kWh/year - concentration of power resources on the territory, thou.kWh/km^2	7.6 36.6	3	39
Technically feasible hydropower capability, Billion kWh/year	3.1	0.9	29
Economically feasible hydropower capability, Billion kWh/year	0.9	Not determined	
Power generated by existing HPPs, - Billion kWh/year - per cent of economic potential, %	Data are not available	Data are not available	100

At estimation of total hydropower potential of Belarus small hydro was singled out. The largest small hydro potential is concentrated in the Northern and Central parts of the Republic.

3. Plans for Development of Hydropower Potential

Programs of small hydropower development envisage development of small hydro by adding small HPPs to existing water management projects and reconstruction of the existing small HPPs.

Proposed Program of Small Hydro Development

Type of construction	Quantity	Installed capacity, MW	Average overyear power output, Million kWh	Note	Region
Reconstruction and rehabilitation of the previously constructed HPPs	15	9.0	27.0	Mostly former rural HPPs of capacity within 0.2-2.175 MW	Spread on the whole territory of Belarus. Located near settlements.
Adding to water management projects	4	3	8	Small HPPs of capacity within 0.245-1.9 MW	Northern and Western regions of Belarus
New construction	19	16,5	43	Small HPPs of capacity within 0,28-2,1 MW	Eastern and Northern regions of Belarus
Total	38	28.5	78		

4. Unfavorable Factors for Development of Hydro Potential

- Lack of investments

5. Favorable Factors for Development of Hydro Potential

- Insufficient local fuel resources;
- Power system deficiency

Bibliography

1. Power Resources of the USSR. Hydropower Resources. A.N.Voznesensky et al.,1997
2. Small Hydropower, L.P.Michailov et al, 1989
3. Master Plan of Wind Power Development in the USSR, 1989
4. Periodicals: Hydraulic Construction, Power Stations, etc