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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1.0 Russian Federation

Since the dissolution of the Soviet Union in the early 1990's, Russia has seen severe recession, and economic boom in the space of a decade. The industrial landscape has changed significantly with the advent of competition, and extensive foreign investment. This changed has reached the energy sector, with restructuring efforts underway to privatize the industry. Despite the progress, the electric sector faces many of the same challenges as other eastern European countries, including uneconomic tariff structures, non-payment, and aging electric systems.

Russia is the fourth largest generator of electricity, behind the US, China, and Japan. With large native reserves of oil, natural gas, and coal, power production has been predominantly from thermal units. However, Russia also has a large fleet of nuclear and hydroelectric plants.

Table 1-1. Russia Country Profile.

General information			
Population, millions		144.80	
Land area, thousand Ha		168,850	
Macroeconomic Information (2001)			
GDP, billion US$			
Real GDP growth rate, percent		5.00%	
Foreign direct investment (net), million US$		2,000.00	
EU accession status	Non-accession, EU Partnership and Cooperation Agreement signed Jun 1994		
Electricity sector			
EBRD electric power transition indicator		2	
Electricity tariff, US¢/kWh (year of data)		1.1 (1999)	
Collection rate, percent (year of data)		100% (1999)	
Load utilization factor, percent (2000)			
Electricity disposition, billion kWh (2000)			
Generation		835.57	
Consumption		767.1	
Exports		8.00	
Imports		18.00	
Generation capacity mix (2000)	No. of Plants	Capacity (MWe)	Percent of Total
Nuclear	N/A	21,242	10.42%
Thermal	N/A	138,700	68.04%
Hydro	N/A	43,900	21.54%
Other renewables	N/A	11	< 0.01%
Total	N/A	203,853	100%

There is some variation between the seven regions, or electric systems, in the share of each generation technology. For example, the Northwest has a 41% share of capacity in Nuclear generation, while Siberia and the Far East have no Nuclear plants.

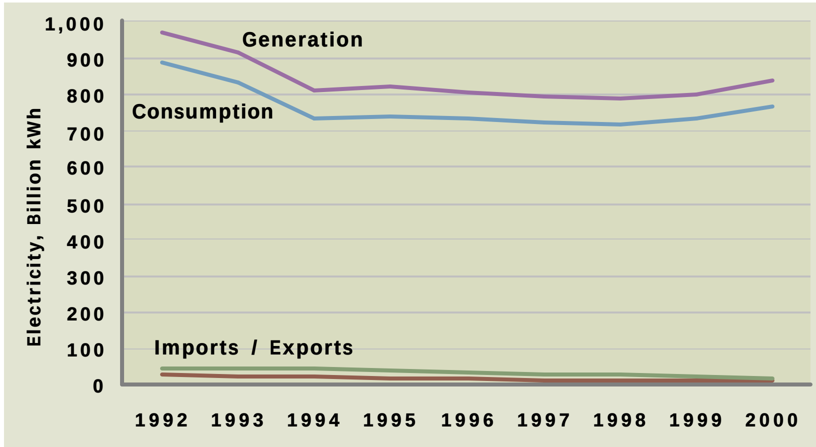


Figure 1 -1. Russia Electricity Balance (DOE).

Throughout the 1990's the consumption and generation of electricity fell dramatically. In fact, the total generation is not expected to reach 1990 levels until 2010. The decrease in production can bee attributed to a number of factors, including decreased demand through economic downturns, plants being retired, and customers being disconnected from the system for non-payment.

In 1992, there was a presidential decree to restructure the electricity sector into one joint-stock company (RAO UES). Additionally, Rosenergoatom was formed to run all of the nuclear plant, except Leningrad Nuclear Power Plant. A national wholesale market (FOREM) was also established to more efficiently trade power between regions. After 1994, non-payment became a large problem until RAO UES was permitted to disconnect customers, since then, the payment rate has risen to over 90%. While the collection rate have improved, the tariff structure has changed little over this period of time. The federal tariff is structured to reflect the cost to deliver power. However, the regional electric commissions have consistently lowered tariffs below this level, thus RAO UES continues to sell a significant amount of power a loss.

In 2001, a phased restructuring program was enacted to facilitate the liberalization of the electricity sector through 2009. Under this plan, generating companies owned by RAO UES will be divested into separate, independent entities. The regional "energos" will remain intact, but they will e required to form separate generation and distribution entities. A state transmission company will be formed to own and operate the high voltage transmission system. Finally, a wholesale market will be created in regions with the potential for multiple suppliers. It is envisioned that the requirements for smooth transition will be the non-discriminatory access of all firms to the high voltage and distribution grids, and the reality that electric rates must rise significantly to reflect the real cost of delivering power.

1.1.1 Wind Resources

Current Status of Wind Energy [1,4, 5]

Early in 2002 there were only 5 MW of operational wind power in Russia.

In Russia the "Unified Power System (UPS)" covered almost all inhabited areas and 98% of the total generating capacity of the former Soviet Union. In December1992 a joint-stock company was established in order to preserve at least the major part of UPS. It unites 70 energy systems and all large hydro (>300 MW) and thermal (>1'000 MW) power plants and comprises 40% of Russia's electricity production and virtually 100% of the distribution grid system. By the end of 1992 only 25 local systems had extra energy, while others suffered from energy shortages. In such conditions the possibility to re-distribute energy by UPS played an important stabilizing role in preventing a total crash of the economy. In case of connection of wind energy power plants to the grid the UPS would permit transfer of power from the wind areas to the industrialized and heavily populated regions with a large demand.

The regions most favorable for wind energy utilization (North of Russia, Frau East and part of Kazakhstan) are not connected to the IPS or even to any local grid. Although these territories are less densely populated, the need energy for lief and development.

The option of grid-connected wind power production may benefit from the existance of the unique extensive UPS. At the same time stand-alone wind power systems might be promising in the remote mountain and coastal regions which have large wind potential and are not connected to a grid. Western experince, research, and technologies could act as a catalyst to accelerate the introduction of wind energy [5].

For six weeks in July and August, 13 renewable energy experts from the former Soviet Union were trained in America in what appears to have been the first renewables program financed by the US Department of Commerce. The Special American Business Internship Training Program, or SABIT, operates specialized projects in the Ukraine and Russian far east. SABIT's program, founded in 1990 to support economic restructuring in the former Soviet Union, is said to have lead to $15 million worth of US exports yearly. Investment opportunities had also been expected to triple over the next five years. SABIT says that 70% of the trainees on its programs continue to do business with their US hosts.

A state of the art and up to date country wide wind-atlas is available. This atlas identifies huge areas with very favorable wind conditions.

No industry association was identified.

According to the decision of the Council of Ministers of the USSR in 1989 all the research and design works in the renewable energy technologies were united on the State Scientific and Technological program "Ecologically Clean Energy". The program included development of various wind turbine models 0.25 - 1'250 kW. Later the 30 kW and 1'250 kW models were abandoned due to lack of financing. The leading R&D organizations in the program were Vetroen and Yuzhnoe (both Science Production Associations), Hydroproject

(Scientific Research Institute), Raduga (Design Office) and Energobalance-SoVENA. The production association "Kirovskii zavod" in St. Petersburg designed another 250 kW turbine. Hydroproject had been developing a 1'000 kW unit designed for harsh wind regimes of the far North and the Far East since 1986.

As far as we know only Vetroen (now an Ukrainian company), is commercially active. It is not clear if the Ukrainian WindEnergo Ltd. is also an off-shoot of one of these. Both companies are also active in Russia. We also know that "JSC TMZ" (Tushino Engineering Works) was seeking buyers/partners/investors for the 1'000 kW Raduga-1 design for selling/manufacturing/exporting", as late as 2001. At that point in time JSC TMZ claimed that the prototype was installed in Elstia (Kalmykia) and 10 other units were in production. The most striking characteristics of this design was the extreme operational temperature range of - 50 °C to +40°C. According to various reports the prototype is operational, the fate of the other 10 units is not known.

All these indicate availability of local know-how and manufacturing capabilities. However, it is questionable if the technology and the resources of these companies would be adequate to tap the huge Russian wind energy potential. It will be necessary to transfer advanced western European technology, marry this with the local know-how and to start subsequent local manufacturing.

There are surprisingly few projects in the pipe line, if the potential is considered. We believe that this is due to the reluctance of financial institutions to provide credit to "new" technology in a "new" country.

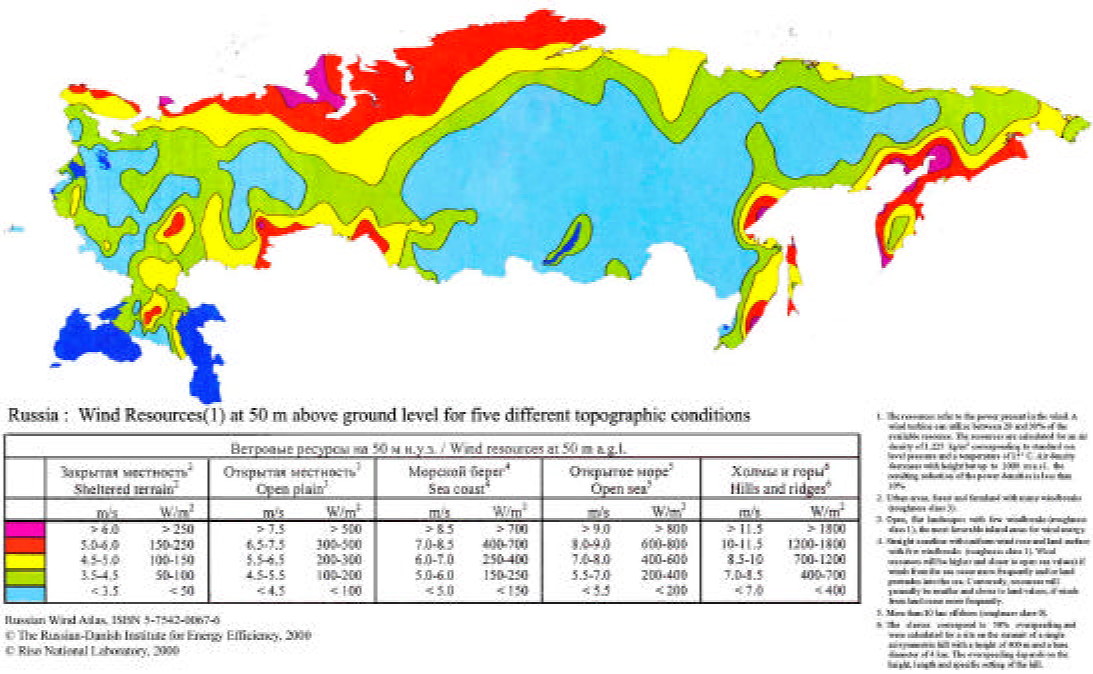
Wind Energy Resource Potential [1, 2, 4]

The state of the art Wind Atlas of Russia was published in 2002. Russia is one of the biggest countries in the world and it is situated in different climatic zones, which result in a tremendous wind energy potential. Highest wind energy potential is concentrated along Russia Federation seacoasts, in the vast territories of steppes and in the mountains.

Obviously Russia has an excellent wind energy potential. An attempt to utilize 25% of the available technical potential estimated in the "Master Plan of Wind Power Development of the USSR till 2010”, 1989 would lead to installation of some 175'000 MW of wind power.

Identification of Areas/Projects with High Potential for Wind Energy [2, 3, 5, 6]

The most promising areas are found around the Azov Sea, around the Crimean peninsula and the southeast of the country along the Black Sea coast. Some inland locations, for example Polatava, may prove to have equally strong potential upon closer examination.



Wind atlas of Russia

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

Project Name and Location	Size (MW)	Description
Eastern seashore of Sakhalin island		
South of Kamchatka		**Highest reported annual average wind speed in this study: at Lopatka, mys at the southern tip of Kamchatka Peninsula 42 m above sea level at 50m above ground** **Wind Speed 13.7 m/s** **Power Density 3'730 W/m²**
Magadan region		Near settlements Pevek and Bilibino in Chukotka peninsula, on the seashore of Magadan region.
Vladivostok		Southern seashore of Russian Far East in the zone of Vladivostok
Steppes along Volga river		in neighbourhood of Volga hydropower stations chain high-voltage lines
Northern Caucasus steppes and mountains		
The Kola Peninsula, north of the country [5]	6'000 MW estimated capacity	The most promising sites are Murmansk (6.0 m/s a.g.l. 50m), Teriberka (7.0m/s a.g.l. 50m), Monchegorsk (6.4 m/s s.g.l. 50m), Vaida-Guba(7.7 m/s a.g.l. 50m), Pjalica(6.2 m/s a.g.l. 50m)
The polar circle of Russia		
Southwest of Kotzebue on the tip of the Seward Peninsula		
Northern coast east of Murmansk		Power consumption in this area, however, has dropped this decade from 18 TWh to 13 TWh a year. Wind speed up to 5.2m/s a.g.l. 25m
Afghanez, in Volgograd		
The northern Caucasus		
Close to St. Petersburg	25 MW	Project planned for construction 1991- 1995

Barriers/Incentives for Wind Energy

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

- Well documented, very large wind energy potential
- The German Eldorado program for subsidizing renewable energy exports to developing countries.
- In Russia, the privatized national electric utility, RAO "EES Rossii" -- which owns a controlling interest in many of the 72 regional utilities -- has identified 17 of the country's 89 states, also known as 'oblasts' or 'krays', as having favorable wind resources for development.
- SABIT's and Joule -Thermie (financed by European Commission) programs.
- Great difficulties for power supply in the Northern region of Russia. Current diesel systems cost in the order of 0.14 cents for 1 kWh. Thus there are great problems with fuel delivery to north.
- NREL plans to help Russia apply for $300 million from the World Bank to equip all 900 sites in the region with wind-diesel systems.
- The break-up of the Soviet Union nearly a decade ago should have given renewables a push. Since then, Russia can no longer be relied upon to supply cheap oil and gas to the CEECs, and nuclear plant have had a dubious reputation in the West since the Chernobyl catastrophe in 1986.
- Unique extensive Unified Power System
- Large opportunities for autonomous wind-diesel systems
- Large manufacturing base for producing heavy components locally, as close to the project sites as possible

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

- Availability of cheap fuel in Russia is the first and most important barrier.
- The popular misconception that wind energy is not affordable (The calculations were based on prices for fuel that were far below world prices, the capital costs were calculated based on very high prices for the equipment established by producers. This is a phenomenon of the state ownership when the producer is not interested in decreasing of prices. This is changing while the privatization is going on.
- Awareness of environmental benefits of renewables is very low
- Unsuccessful experience with local manufactured wind turbines before the collapse of Soviet Union.
- In many cases, it’s possible to take loans in foreign banks or invites foreign investors. But generally political and economical instability frightens banks and potential investors.
- Unbalanced geographical distribution of wind energy resources and electricity consumption

Table 1-3. Russia Wind Energy Profile.

Current status of wind energy	
Installed capacity	10x 30 kW, Saratov region on the Volga 1x 37 kW, Afghanez, in Volgograd 15x270kW to 37kW 10x 30 kW, in Saratov 1 MW, Prototype turbine, 300 km south of Wolgograd 20x250kW, 6, near Workuta 40x 1.5kW to 10kW, remote villages, in the Murmansk and Archangelsk areas near the Arctic Circle ? MW, wind-diesel project, St Paul Island, one of the Pribilofs in the Bering Sea 1 MW, Raduga-1, near the Caspian Sea in Elstia, Kalmyk Pepublic 5.1 MW, Yantarenergo, Kaliningrad region >5 MW Total
Projects under construction	None
Supporting regulations?	Yes and No
Industry association?	No, but Central Institute of Wind Energy and the Russian-Danish Institute for Energy Efficiency prime sources of information
Wind energy resource potential	
Level of information available	Very Good
Highest wind class	Class 7+ (3'730 W/m^2)
Country-level wind atlas available?	Yes, state of the art
Estimated potential (MPWD)	**European part of Russia** 29.600 TWh/y, gross (theoretical) potential 2.308 TWh/y, technical potential **Siberia and Far East part of Russia** 50.400 TWh/y, gross (theoretical) potential 3.910 TWh/y, technical potential
Estimated potential (Interwind)	175'000 MW
Target established?	No
High wind speed locations	Many, see wind atlas
Identification of areas/projects with high potential for wind energy	
Recommended strategic assessments	Study 1 : an appraisal of legal and economical frame work Study 2 : identification of opportunities for autonomous wind-diesel systems for remote areas Study 3 : identification of large (>=100 MW) demonstration projects at especially favorable locations to demonstrate economy of wind energy projects
Identified areas/projects	10 MW Off shore, Japan's Electric Power Development Co (EPDC), Sakhalin 15 MW, Windenergo, Near Kaliningrad 2-5MW, Vetroen, at Krasnodar and Komi N/A, World Bank Project, Kamchatskaya near the Bering Sea
Incentives/barriers for wind energy	
Significant incentives	• The most significant incentive is the huge wind energy resource potential of Russia • Extensive Unified Power System • Western efforts to move Russian energy production "in the right direction"
Significant barriers	• Lack of low priced, long term capital • Financial uncertainty

	• Low domestic fuel and electricity prices • Lack of wind industry expertise • Unbalanced geographical distribution of resources and electricity consumption.
Overall Prospects	**Very Good** In spite of all the barriers, insecure economical situation and lack of adequate legal frame work and low energy prices, Russia still ranks as one of the top candidates for wind energy development because of a potential equivalent to almost 10 times the total wind energy capacity installed world wide today.

[1] Wind Power Monthly, various issues

[2] Russian Wind Atlas, The Russian -Danish Institute for Energy Efficiency and Rio National Laboratory, 2000

[3] "Master Plan of Wind Power Development of the U SSR till 2010", 1989

[4] WIND ENERGY IN RUSSIA Report by Grigori Dmitriev, VetrEnergo for Gaia Apatity and INFORSE-Europe First Part - June 2001

[5] Aspects of the wind energy potential in the Former Soviet Union, Nikolai N. Kukharkin Center for Energy and Environmental Studies, Priceton University, Princeton, NJ (1993?)

6 A Feasibility study of wind energy on the Kola Peninsula, European wind energy conference, October 1997, Dublin Castle, Ireland.

5.20 Russia Renewable Energy Profile

5.20.3 Solar Resources

Current Status of Solar Energy

Solar power engineering is currently developed in Russia quite poorly. Some organizations and companies in Moscow Ryazan and Krasnodar produce the photovoltaic converters (single-crystalline and amorphous silicon solar cells) and power modules as well as the package plants containing the photovoltaic modules, electric storage cell and inverter for converting dc into ac. These power plants have a small capacity and are intended for autonomous power supply of separate consumers. Because of very small demand for these products at the inner market the volume of production is low as well. Almost all manufactured photovoltaic cells and modules are exported in the foreign countries.

There is also a production of flat solar collectors and water-heating plants based on them. The volume of their production is quite small as well due to the absence of wide solvent demand. At present any scale projects on conversion of solar energy into electricity are not proposed at all.

Solar Energy Resource Potential

In spite of general northern geographic location, Russia possesses the considerable solar resources. Annually the solar radiation energy incident on its territory is equivalent to $18.7 \cdot 10^9$ GWh that exceeds significantly the power potential of any other available energy resources [1].

The technical potential of solar energy was estimated as $18.7 \cdot 10^6$ GWh, while the economic one – as $1 \cdot 10^5$ GWh per year in the national report "Role of renewable energy sources in energy strategy of Russia"[1]. The technical potential is equal to the solar energy incident into 0.1% of territory of the country, while the economic potential constitutes about 0.5% of technical one.

In the same time the value of total technical and economic solar energy potential depends greatly on the area of territory of the country under consideration or its region, and it doesn't characterize the real conditions and opportunities for using solar energy. In this connection the data on specific incident solar radiation per a unit of area (for example, per 1 m^2) for some time interval (month, season, year) carry much more information. Such information is presented in Figs.1 and 2, where the map of total annual solar radiation incident on horizontal surface (Fig.1) and the direct solar radiation on a surface normal to beams (Fig.2) are given in MJ/m^2.

The regions with mountain relief, which are cross-hatched (shaded) at the maps, have the great effect upon climatic characteristics. Therefore the isolines of incident radiation for the pointed regions are presented approximately and designated by dotted line. These maps are the graphic examples of incident solar radiation distribution at Russian territory. In particular they determine the regions with the largest incident solar radiation. The pointed maps were formed on the basis of statistic processing of the results of solar radiation measurements on more than 100 meteorological stations for the period of many years. In this case the total solar radiation incidence characterizes the application conditions for the stationary flat photovoltaic modules and heat solar collectors, while the direct solar radiation incident on the surface that is normal to the beams created the conditions of using the solar power plants with solar radiation concentrators oriented upon the Sun.

The annual course of solar radiation, i.e. its incidence during a year, has a quite considerable meaning for using the solar energy. Data on the total solar radiation incident on the horizontal surface and data on the direct solar radiation on a surface parallel to beams are presented below in Tables 1 and 2 correspondingly. They are given for five different points at the territory of Russia located in the different geographical and climatic zones of the country. Two points – Sochi and Astrakhan are located in the southern part of European territory, while three ones – in Asian part. From these three points Kyzil is located in the southern part of Siberia, Mangut – in the southern Transbaikalia and Vladivostok – at Far East. The data of Tables 1 and 2 were taken from [3] and they are the average values for measuring period of many years.

As it follows from the data presented in Table 1 and 2 , the annual course of solar radiation (total and direct) incidence has in three points (Sochi, Astrakhan, Kyzil) a sharply expressed summer maximum and a deep winter minimum. On the contrary, there is a summer minimum especially typical for the direct solar radiation in Vladivostok, i.e. in the zone of monsoon climate. The point Mangut occupies accordingly to the type of annual course of radiation some intermediate place. It is possible to find in works [4, 5] the results of calculated monthly electricity production by photovoltaic power plants and specific heat capacity of solar heat supply plants for the different climatic regions of Russia.

Table 1

Total solar radiation incident on horizontal surface, MJ/m^2

	I	II	II	IY	Y	YI	YII	YII	IX	X	XI	XII	Yearly
Astrakhan	137	202	371	528	690	737	719	651	477	301	144	94	5051
Sochi	152	211	347	458	599	737	743	647	485	345	190	131	5045
Kyzil	127	225	454	556	680	706	683	585	429	273	143	101	4962
Mangut	187	285	485	572	692	665	605	569	436	321	206	148	5171
Vladivostok	247	323	488	519	612	538	513	480	456	364	250	206	4996

Table 2

Direct solar radiation incident on surface normal to sunlight beams, MJ/m^2

	I	II	II	IY	Y	YI	YII	YII	IX	X	XI	XII	Yearly
Astrakhan	183	244	363	489	651	728	723	689	569	392	194	114	5339
Sochi	209	221	325	378	494	647	691	634	528	436	271	178	5012
Kyzil	183	267	506	549	658	673	648	617	557	383	194	128	5363
Mangut	441	525	645	572	657	596	556	583	560	550	425	351	6461
Vladivostok	437	461	535	433	478	341	326	361	487	495	423	383	5160

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

The areas, where the specific incidence of solar radiation is in maximum, have the largest potential of solar energy. Such areas include in European part of the country the lower Povolzhiye and Northern Caucasus that almost fully coincides with the territory of Southern Administrative District of Russian Federation, while in Asian part – Tuva Republic, Amur region, south of Khabarovsk Territory, Primorsky Krai. Southern Transbaikalia is the most sunshine area of Russia. Therefore the carrying out of any projects on using solar energy is most expedient in the mentioned areas of Russia.

As it has been noted, at present there are no any scale projects in the field of solar energy under consideration. The main reason for it is the absence of investments. In the same time it is expedient in our mind to return to the project of creating solar photovoltaic power plant with combined production of electricity and heat near city Kislovodsk (Northern Caucasus). This project has foreseen the creation of such power plant with electric power 1 MW_e and heat-generating capacity 8-10 MW_t. It was foreseen to direct the generated heat for covering the communal needs, while the electricity – in network. However this project was fulfilled up to the feasibility study stage (1993). Because of absence of investments the project was stopped.

Barriers/Incentives for Solar Energy

There are the general barriers for development of all types of renewable energy sources (RES) and the specific barriers concerning solar energy.

The general braking factors include a legal barrier that is the absence in Russia of legislation in the field of using RES, which is similar to that used in many countries and foresees the legal, economic and organizational base for using RES, in particular, the different measures of economic stimulation. There is only one position in Russian legislation (Law “On energy conservation”, 1996) that gives a right for joining to the networks for the independent producers of electricity generated by using RES.

The next barrier of general type is an economic one. Because of more and more unsatisfactory state of Russian economy, the braking factors in RES development are the difficulties with attraction of investments and the low effective demand both from the side of different organization and companies and from the side of population.

The psychological barrier is general as well. For many years it was aroused in population that the former USSR and then Russia is rich by fossil fuel that guarantees from energy crisis. A tendency to the growth of unit powers became stronger in electric power industry; the ecological aspects of fuel-energy complex were not accented. The durable nature-protective psychology didn’t instill in population.

The specific barriers for using solar energy consist of the fact that the “solar electricity” is currently more expansive than the electricity obtained from another RES and also of the inconstancy and irregularity of solar energy incidence. For autonomous variant it forces to use the duplicate power plant operating with some traditional energy carrier.

Recently the RF Ministry of Energy showed initiative in development of Federal Program on using nontraditional and renewable energy sources, which according to decision of Russian Government became a subprogram Federal purpose program “Energy-efficient economy”. In particular, this program foresees the investments from Federal budget in crating the plants working on RES, though these funds are not large and can’t provide its fulfillment in the full volume.

However as to using solar energy it is foreseen only to create the photovoltaic power plants of autonomous application with power no more than 20 kW and the plant of solar hot water supply of different customers.

Table 20-3. Russia Solar Energy Profile.

Current status of solar energy	
Installed capacity	Solar water heating plants with total capacity 40-50 MW (thermal). Autonomous photovoltaic plants with total capacity up to 200 kW.
Projects under construction	Any large projects in the field of solar energy are absent
Supporting regulations?	No.
Industry association?	Yes. The enterprises on production of photovoltaic solar cells and modules (arrays): JSC “Solar wind” (city Krasnodar), scientific-production enterprise :Quant” (city Moscow), VIESKh (Moscow), Factory of metal and ceramic devices (Ryzan) etc Enterprises on production of thermal solar collectors and plants using them: Kovrovsky mechanical works (city Kovrov), SPA Mashinostroyeniya (city Reutov). SPE “Raduga C” (city Zhukovsky) etc.
Solar energy resource potential	
Level of information available	Fair
High range of solar insolation	0.5 – 3.5 kWh/m2/day [6] (worst month); up to 3.9 kWh/m2/day (year average, [3])
Country-level solar atlas available?	Yes
Target established?	No.
High solar insolation locations	Southern Povolzhiye, Northern Caucasia, Republic Tuva, Amur and Chita regions, South of Khabarovsk Territory, Primorski Krai.
Identification of areas/projects with high potential for solar energy	
Recommended strategic assessments	Technical-and-economic evaluation of possibilities, scales and directions of using solar energy in the regions pointed out in item 2.5
Identified areas/projects	Restoration of works on a project of Kislovodsk photovoltaic power plant with power 1 MW and combined production of electricity and heat. Development of legal basis in the area of nontraditional power engineering
Incentives/barriers for solar energy	
Significant incentives	Favorable solar climate in the regions pointed out in item 2.5. Existence of regions without the centralized power supply and the local energy resources. Existence as a part of Federal purposeful program “Development of nontraditional energy of Russia for the period up to 2005”. Existence of industrial production of main kinds of equipment for using solar energy and possibilities for widening this production with increasing solvent demand. Existence of sufficient scientific-technical potential. Economic requirements.
Significant barriers	Difficulties with attracting inside investors in solar energy. Low tariffs for electricity and heat. Absence of legal and normative base. Existence of sufficient own traditional energy resources in the country on the whole
Overall Prospects	Fair taking into account both the positive and negative factors

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5. B.V.Tarnizhevsky. Evaluation of solar heat supply in Russia. “Teploenergetika”, 1996, no.5.
6. Internet site: www.bpsolar.com/ContentDocuments/17/PV System Sizing Tools.zip

5.20.4 Geothermal Resources

Current Status of Geothermal Energy

At present the geothermal energy is used in Russian Federation both for heat supply and electricity production.

Direct utilization of thermal water with temperature 30 – 100 ?? for heating and hot water supply of buildings, for agricultural needs (heating of green houses and cattle raising farms), for fish breeding, in local industry, in balneology and for swimming pools takes place mainly at the Northern Caucasia (Krasnodar and Stavropol Territories, Republic Dagestan, Adygei Region, Karachai-Cherkessia) an at Far East (peninsula Kamchatka, Kuriles). Locally the thermal water is also used in the separate settlements of Western Siberia, near Lake Baikal, in Magadan and Chukot regions and at Sakhalin. At Kamchatka there are the experimental plants for using thermal water in combination with heat pumps.

The overall thermal capacity of geothermal heat supply system is 430 MWt [1], from them- 327 MWt in the regions of Far East and Northern Caucasia (Table 1).

Table 1

Utilization of geothermal energy for direct heat of 31 December 1999

Locality	Type[1)]	Maximum utilization					Capacity[2)] (MW_t)	Annual utilization		
		Flow rate (kg/s)	Temperature (°C)		Enthalpy (kJ/kg)			Ave.Flow (kg/s)	Energy[3)] (TJ/yr)	Capacity Factor[4)]
			Inlet	Outlet	Inlet	Outlet				
Kamchatka	HBG	532	85	30			122	372	2 701	0.7
Kuril Islands (Kunashir)	H						20			
Northern Caucasus region										
Platform Province										
Krasnodar territory	IAFHBG	370	80	30			77	222	1 465	0.6
Stavropol territory	AHG	60	100	30			18	36	335	0.6
Adygeya Republic	AH	49	80	30			10	25	162	0.5
Alpine Province										
Kabardino-Balkar Republic	G	70	70	30			2	6	33	0.5
Daghestan Republic	IHBG	339	80	30			71	203	1 340	0.5
Karachaevo-Cherkess Republic	O	25	65	30			4	13	58	0.5.
Northern Osetiya Republic	O	21	60	30			3	10	41	0.5
TOTAL		>1 466					327	>888	>6 135	

[1)] I = Industrial process heat, A = Agriculture drying (grain, fruit, vegetables), F = Fish and animal farming, H = Space heating and district heating (other than heat pumps), B = Bathing and swimming (including balneology), G = Greenhouse and soil heating, O = hot water supply
[2)] Capacity (MW_t) = Max. flow rate (kg/s)[inlet temp. (°C) - outlet temp. (°C)] × 0.004184
[3)] Energy use (TJ/yr) =Ave. flow rate (kg/s)[inlet temp. (°C) - outlet temp. (°C)] × 0.1319
[4)] Capacity factor = [Annual energy use (TJ/yr) × 0.03171] / Capacity (MW_t)

Electricity production is carried out at two operating geothermal power plants located at Peninsula Kamchatka.

Pauzhetskaya GeoPP with capacity 11 MWe has been operating since 1967. Two units with 2.5 MWe-steam turbines and one unit with 6 MWe-steam turbine are installed at this power plant. Steam-water mixture with enthalpy 760-800 kJ/kg and total flow rate 240 kg/s obtained from 7 wells is used at this GeoPP [3].

Verkhne-Mutnovskaya GeoPP with capacity 12 MWe was commissioned in 1999. It consists of three units with steam turbines 4 MW? each and with air condensers.

The 1st phase of Mutnovsaya GeoPP consisting of two units with 25 MW?-steam turbines is intended for commissioning in 2002. This project is carried out with attracting of EBRD loan equal to 99 million US$.

The total capacity of these power plants constitutes 73 MW?.

Characteristics of existing, being under construction and planned GeoPP at Far East are presented in Table 2 [1].

Table 2

Geothermal power plants in the Far East of Russia

Locality	Power Plant Name	Year Com-mision ed	No. of units	Status[1]	Type of unit[2]	Unit Rating MW_e	Total Installed Capacity MW_e	Annual Energy Produced 1999 GWh/yr	Total Under Constr. or Planned MW_e
Kamchatka									
Pauzhetka hydrothermal system	Pauzhetka	1966	2		1F	2.5	5		
		1980	1		1F	6	11	35	
		2000	3		1F	6			18
Severo-Mutnovka hydrothermal system	Verkhne-Mutnovka	1998	1		1F	4	4		
		1999	2		1F	4	12	50	
		2001	2		1F+B	3+6			21
	Mutnovka	2001	2		1F	25			50
		2005	2		1F	25			100
Kuril Islands									
Paramushir Isl.	Ebeko	1998	1	N	1F	2	2		
Iturup Isl.	Okeanskaya	1999	4	N	1F	2	8		
		2000	1		1F	4			4
		2001	2		1F	4			12
		2003	1		1F	20			32
Kunashir Isl.	Goryachii Plyazh	1992	1	N	1F	0.7	0.7		
TOTAL							34	85	171

[1] N = Not operating (temporary), R = Retired.
[2] 1F = Single Flash B - binary

Geothermal Energy Resource Potential

The overall reserves of geothermal heat carriers in Russia depending on temperature potential and the area of application [3, 4]:

2. Geothermal steam and water0steam mixtures used for electricity by means of steam turbines, MWe
   - Used resources 73
   - Proven resources 159
   - Theoretical resources 950 - 2000
3. Thermal water and brines with temperature above $90^{?}$? used for electricity generation at binary GeoTPP, MWe
   - Used resources 0
   - Proven resources 106
   - Theoretical resources > 1000

3. Thermal water with temperature from $30^{?}$? to $90^{?}$? for direct usage, MWt
   - Used resources 430
   - Proven resources 820
   - Theoretical resources ~21000

The prospective geothermal areas of Russia and location of geothermal fields with proven resources are shown in the map (Figure 1). The characteristics of these thermal water fields are presented in Tables 3 and 4 [5].

Table 3

Thermal water fields with proven resources

NN	Field	Thermal water temperature, ??	Proven resources, thousand m^3/h	TDS, g/l
1	Kabinskoye (Krasnodar Territory)	100	6	15
2	Mostovkoye (Krasnodar Territory)	75	12	1-2
3	Cherkesskoye (Stavropol Territory)	60	5	1-5
4	Khankalskoye (Chechen Republic)	90-100	10	1-3
5	Kizlyarskoye (Republic Dagestan)	90-100	10	8-10
6	Vakhachkaninskoye (Republic Dagestan)	60-80	11	1-10
7	Tobolskoye (Western Siberia	70	20	17
8	Omskoye (Western Siberia)	65	1	25
9	Ush-Beldirskoyr (Republic Altai)	80	1	0.4
10	Pitatekevskoye (Republic Buryatiya)	65	1.5	1
11	Goryachinskoye (Republic Buryatiya)	65	1.5	0.5
12	Kuldurskoye (Khabarovsk Territory)	70	1.7	0.5
13	Talskoye (Magadan region)	90	1.2	0.5
14	Esso (Kamchatka region)	75-80	19	1
15	Paratunskoye (Kamchatka region)	70-90	46	1-2
16	Reidovskoye (Iturup, Kuril Islands)	70	1	1-3
17	Poyarkovskoye (Sakhalin)	70	10	3-5

Table 4

Proven fields of steam-water mixture and high-temperature brines

NN	Field	Temperature, ??	Proven resources, MWe	TDS, g/l
1	Mutnovskoye (Kamchatka region)	250	200	0.5
2	Pauzhetskoye (Kamchatka region)	180	11	3.5
3	Nizhnekoshelevskoye (Kamchatka region)	250	90	1-2

4	Okeanskoye (Iturup, Kuril Islands)	180	25	1-2
5	Goriachi Plyazh (Kunashir, Kuril Islands)	180	3	5-10
6	Neftekumskoye (Stavropol Territory, Dagestan)	150-170	100	80-100

Fig. 1. Geothermal resources in Russia for power and heat generation

- High enthalpy geothermal resources for power generation (steam & combined cycles);
- Medium enthalpy geothermal resources for binary power plants;
- Low enthalpy resources for district heating and agriculture;

Identification of Areas/Projects with High Potential for Geothermal Energy

There are the most favorable conditions for developing geothermal energy at Kamchatka and Kuril Islands, where all available in Russia fields of steam-water mixture are located. The international Mutnovsky Geothermal Project has been recently carrying out at Kamchatka. Its phases are shown in Figure 2.

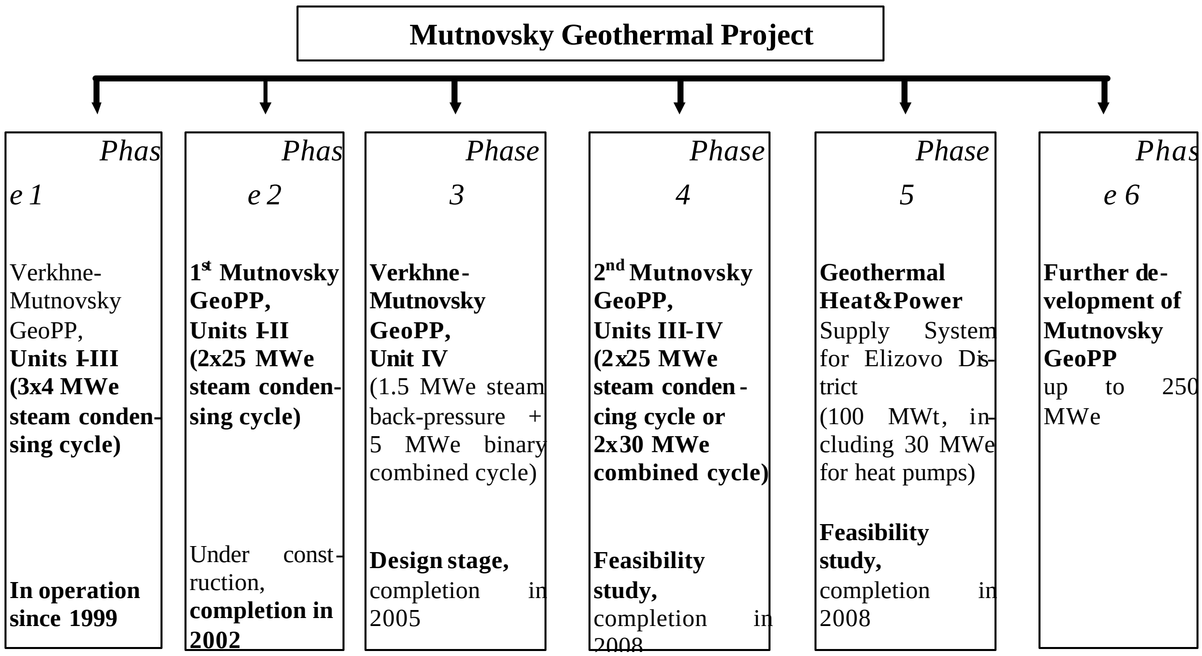

Fig. 2. Development strategy of Mutnovsky Geothermal Project

Rehabilitaion of the project on construction of Okeanskaya GeoTPP is possible at Iturup. The construction was stopped because of investment absence.

Rehabilitaion of the project on construction of pilot Kayasulinskaya GeoTPP with power 3 MWe and binary cycle has been planned at Northern Caucasia (Stavropol Territory). In 1985-92 the well with depth. 4.2 km were drilled, the tests of geothermal circulating system of doublet type and heat exchanging equipment were carried out, and the project of power plant construction was developed. Fulfillment of the project was stopped in 1992 ?. because of investment absence. Mastering of using the heat of geothermal brines that is planned at this power plant ???????? will allow in future to build up a few GeoPP with total capacity about 1003 MWe on the basis of existing wells at the neighboring exhausted oil fields.

In addition, the updating of geothermal heat supply is required at Northern Caucasia. The equipment here is morally and physically obsolete.

Barriers/Incentives for Geothermal Energy

Specific incentives for the implementation of geothermal projects in Russia include:

– High prices for imported mazute (fuel oil) used at thermal power plants of Kamchatka and Kuril Islands and correspondingly high tariffs for electricity.
– Shortage of basic power in Eastern part of Northern Caucasia, where the large thermal power plants are absent.

– Considerable proven resources of geothermal energy including with already drilled wells.

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

– Absence of legal support at the level of Federal laws.
– High investment risks.
– Low tariffs for electricity in European part of the country.

Table 20-4. Russia Geothermal Energy Profile.

Current status of geothermal energy	
Installed capacity (electric)	11 MWe, Pauzhetskaya GeoPP, Kamchatka Peninsula 12 MWe, Verhne-Mutnovskaya GeoPP, Kamchatka Peninsula 23 MWe Total
Installed capacity (thermal)	430 MWt Total (Northern Caucasus, Far East, Siberia)
Projects under construction (electric)	50 MWe, Mutnovskaya GeoPP-1, Kamchatka Peninsula 50 MWe Total
Supporting regulations?	No. Federal Law on Renewable Energy Sources has not been adopted yet.
Industry association?	Yes. JSC Geotherm (Kamchatka Region)
Geothermal energy resource potential	
Level of information available	Good
Country geothermal atlas available?	Yes. Atlas of Thermal Water Resources of the USSR contains detailed information on proven (for specified geothermal fields) and theoretical (regional) resources.
Estimated potential (electric)	>3000 MW, gross (theoretical) potential 400 MW, technical potential (with proven resources) 300 MW, economic potential (by 2005)
Target established?	Yes. Geothermal energy development is envisaged by the National Program on Renewable Energy Sources Development
High enthalpy geothermal locations	Kamchatka Peninsula (steam-water fields) Kuril Islands (steam-water fields) Northern Caucasus (hot geothermal brines).
Identification of areas/projects with high potential for geothermal energy	
Recommended strategic assessments	1. Feasibility study on Geothermal Binary Power Plants Construction in Stavropol Region and Dagestan Republic (updating of former feasibility study completed in 1989) 2. Feasibility study on Geothermal Power Plants Construction in Kamchatka Peninsula and Kuril Islands (updating of former studies to modern international standards)
Identified areas/projects (electric)	50-60 MWe, Mutnovskaya GeoPP-2, Kamchatka Peninsula 6 MWe, Unit IV of Verhne-Mutnovskaya GeoPP, Kamchatka Peninsula 12 MWe, Okeanskaya GeoPP, Iturup Island 3 MWe, Kayasulinskaya Pilot Binary GeoPP, Stavropol Region.
Incentives/barriers for geothermal	
Significant incentives	1. High heavy oil (mazut) prices and electricity tariffs in Kamchatka and Kuril Islands 2. Insufficient base electric capacity in the east of Northern Caucasus 3. Large proven geothermal recourses (based on existing wells)
Significant barriers	1. Absence of legal support at the level of Federal laws. 2. High investment risks. 3. Low tariffs for electricity in European part of the country

Overall Prospects	Good . Good prospects for further development of GeoPP exist for Kamchatka and Kuril Islands (primarily Mutnovsky Geothermal Project). Binary geothermal power plants in Stavropol Region and Dagestan Republic will also become competitive by 2005 when local electricity prices grow up to 4 cent/kWh. Geothermal heat supply systems will also develop following to inevitable increasing of natural gas prices.

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5.20.5 Biomass Resources

Current Status of Biomass Energy

In 1994 individual biogas units (IBGU-1) for peasant application are operating in 10 regions of Russia (Altai Territory, Kemerovo, Tula, Moscow, Leningrad, Yaroslavl, Smolensk, Bryansk, Nizhnegorodsk regions and Republic Chuvashia).

IBGU-1 is intended for the ecologically clean wasteless processing of organic waste formed during peasant activity with obtaining gaseous fuel – biogas and ecologically clean organic fertilizers without the patogeneous microflora, the eggs of helmints, the seeds of weeds, nitrites and nitrates, specific manure odors.

All organic wasted of vegetable and livestock origin can be used as a raw material for the continuous operation of the plant for obtaining biogas and fertilizers:

1. Manure of cattle from 2 heads (50-60 kg) to six heads (200 kg per day), manure of small cattle and pigs from 20 to 60 heads, droppings of poultry from 200 to 600 heads;
2. Vegetable waste – vegetable tops, grass plants, stems of corn, sunflowers etc.;
3. Solid domestic waste – paper, cardboard, textiles, food waste.

The complete set of individual biogas plant IBGU-1 includes:

- bioreactor-methane tank with volume 2.2 m^3;
- wet gasholder with volume 3 m^3.

Manufacturing of IBGU-1 is carried out by four factories - JSC "Tula factory Stroitekhnika", JSC "Orlov RMZ", JSC "Urginsk engineering works", JSC Zavolzhsk ARZ".

One biogas plant BIOEN-1 is used for farming purposes in Moscow region.

The BIOEN-1 unit is intended for wasteless, ecologically clean processing organic waste of agricultural production (manure, droppings, faecal mass, solid domestic, wood and vegetable wastes) in gaseous fuel - biogas, which is converted into electricity and heat and ecologically clean organic fertilizers.

One BIOEN-1 unit includes:

- two bioreactors-methane tanks with volume 5 m^3;
- wet gasholder with volume 12 m^3;
- biogas heat generator with capacity 23 kW;
- electric generator with capacity 4 kW;
- infrared radiant burners on biogas with capacity 5 kW.

Technical data of unit:

- area of housing, which is heated by BIOEN-1 covers from 150 to 200 m^2;
- daily amount of processing waste with moisture content 85% is up to 1 ton;
- biogas yield (60% methane) makes up to 40 m^3/day;
- amount of electricity generated is up to 80 kW·h/day;
- amount of produced heat is up to 230 kW·h/day;
- the amount of produced organic fertilizer is 1 t/day

- auxiliary’s energy demands of unit for maintenance of thermophile process constitute 30%.

A series of thermochemical gas generators, in which the gaseous fuel is obtained from biomass, was developed. Now some of them are in experimental and commercial operation.

More than 7000 steam and hot-water boilers including 745 integrated pulp-and-paper mills are operating at the factories of forest complex of Russia. These units consume 18.6 million toe per year. 55% of combustible fuel fall on wood fire and wood waste, another 45% of fuel consumed in the wood logging and woodworking industry are formed by fuel oil, diesel fuels, natural gas, bituminous coal. Only 5% of wood fire and wood waste are used in the integrated pulp-and-paper mills, while the fuel oil (34.6%), natural gas (22%), coal (22.5%) represent the main fuel.

Overall Biomass Energy Resource Potential

Table shows the overall biomass resource data for Russian Federation

Russia 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)	383,046,975 (1)	227 (25)
Top 10 primary crops		
Mixed Grasses, Legumes	160,515,008	95
Maize for Forage & Silage	68,000,000	40
Wheat	37,422,050	22
Potatoes	33,281,283	20
Forage Products (misc)	15,000,000	9
Barley	14,734,207	9
Sugar Beets	14,602,347	9
Oats	6,135,647	4
Rye	5,394,010	3
Cabbages	3,980,183	2
Animal units, number	(number)	(number / 1000 Ha)
Cattle	27,990,000	17
Poultry	345,084,000	204
Pigs	17,774,150	11
Equivalent animal units	38,550,500	23
Forest products, cubic meters	(avg 1999-2000, cu meters)	(cubic meters /1000 Ha)
Wood fuel and charcoal	50,705,000	30
Wood residues	15,290,000	9

REGIONS	Technical potential, million toe/year			
	Livestock	Wood waste treatment	Sewage sediments	Total
Northwest	1.1	0.8	2.8	4.7
Center	0.9	0.7	6.3	7.9
Povolzhie	0.5	0.4	3.6	4.5

South	0.5	0.4	3.8	4.6
Ural	0.9	0.6	3.9	5.4
Siberia	1.7	1.3	3.1	6.1
Far East	0.6	0.6	0.7	2.0
Russian Federation	6.2	4.6	24.2	35.0

As follows from Table, practically all regions of Russia possess a significant biomass resource potential. The overall biomass technical potential in the country is estimated as 35 million toe including the sewage sediments - 24.2 million toe, livestock waste - 6.6 million toe, wood treatment waste - 46 million toe.

Siberia, Northwest and Center have the largest wood processing waste potential. Center is a leader in the available sewage sediment biomass resources potential.

Identification of Areas/Projects with High Technical Potential for Biomass E nergy

It is possible to allocate some regions among 89 subjects of Russian Federation, where there is a high biomass potential ready for energy purposes using.

In the Northwest of the country among these objects Republic Karelia, Arhangelsk, Leningrad, Novgorod regions should be noted.

In the Center they are Moscow and Voronezh regions.

In the East - Krasnodar and Stavropol Territories, Rostov region.

In Siberia - Irkutsk and Tomsk regions.

For example, the energy wood fire and wood waste potential in Republic Karelia is estimated as 0.5 million toe, among which more than 85% is practically planned for using within the next 10-15 years. Large-scale investment project was prepared for this purpose. The project is intended for reconstruction of heat supply system in one city and eight settlements of the Republic. In the framework of this project it is foreseen to transfer the boilers from fuel oil and coal to the combustion of wood fuel.

Using of wood waste for energy purposes is currently widened and takes place during the reconstruction and modernization of large integrated pulp-and-paper mills (IPPM) including Arhangelsk and Solombalsk mills located in Arhangelsk region as well as IPPM Pitkjaranta in the Karelia.

There is a series of investment project for using biomass wood waste in Leningrad region.

Moscow and Nizhni Novgorod regions possess the large technical potential for using biomass sewage. So, the project is prepared in Nizhni Novgorod for biogas utilization in the city aeration station. The project foresees the usage of biogas for production of electricity covering the auxiliaries of power plant.

The projects of using biomass fuel after updating and substitution of diesel boilers are now under consideration in Tomsk region.

Particular Barriers/Incentives for Biomass Energy

Main reasons for low level of using the nontraditional energy potential are:

- Low tariffs in traditional electric power industry that makes the nontraditional energy poorly competitive even in regions, where it could be rather profitable;
- Absence of Federal and regional legislation's for using nontraditional energy in national economy and daily life as well as of laws, which regulate the relations between centralized power production and local nontraditional energy;
- Low buying ability of population, and bad propaganda of real and effective using of nontraditional energy;
- Absence of wide market assortment of reliable, moderate, autonomous and working in power system plants using the nontraditional renewable energy sources. Absence of spreading of mounting and servicing stations.

Table 20-5. Russia Biomass Energy Profile.

Current status of biomass energy	
Installed capacity	Biogas plants IBGU-1 with productivity 10 m^3/day of biogas are operating in 10 Russian regions (Altai Krai, Kemerovo, Tula, Moscow, Leningradskay, Yaroslavl, Smolensk, Bryansk, Nizhni Novgorod regions, Chuvash Republic). Biogas plant BIOEN-1 with thermal power 23 kW is operation in Moscow region.
Projects under construction	Realization of subproject on constructing the 5 MW-combustion-wood boiler in settlement Kalevala was begun within the frameworks of investment project on reconstruction of heat supply systems in one city and 8 populated points of Republic Karelia The widening of using timber waste for energy purposes takes now place with reconstruction and updating of the largest in country wood-pulp and paper mills including the Arkhangelsk and Solikamsk ones, which are located in Arkhangelsk region as well as the integrated pulp-and-paper mill Pikiaranta in Karelia.
Supporting regulations?	No
Industry association?	Yes Center "EcoRos" "Intersolarcenter" Russian association of small and nontraditional energy (MAGI) All-Russian Institute of Agriculture (VIESKh)
Biomass energy resource potential	
Level of information available	Good
Relative biomass potential (total / density)	Total: 100%; Density: 5%
Country-level biomass investigations available?	Yes
Estimated potential	Overall technical biomass potential in the country is estimated as 35 million toe including: – Sediments of sewage – 24,2 million toe – Waste of cattle raising – 6,6 million toe – Woodworking waster – 4,6 million toe.
Target established?	Yes
High density biomass areas	Republic Karelia Arkhangelsk region Leningrad region Novgorod region Moscow region Voronezh region Krasnodar Territry

	Stavropol Territory Rostov region Irkutsk region Tomsk region
Identification of areas/projects with high potential for biomass energy	
Recommended strategic assessments	Study 1 Preparation of Feasibility studies for investment projects Study 2 Realization of investment projects
Identified areas/projects	Transfer to biomass fuel of municipal heat supply systems at Northwest of the country. Reconstruction and updating of the largest wood pulp and paper mills at Northwest of the country. Utilization of biogas at the sewage treatment station. Nizhni Novgorod. Usage of agricultural waste and livestock breeding wastes at Russian South.
Incentives/barriers for biomass energy	
Significant incentives	Constant growth of organic fuel prices. The remote location of some regions from traditional energy sources and the existence of own biomass resources.
Significant barriers	1. Low tariffs in traditional electric power industry that makes the nontraditional energy poorly competitive even in regions, where it could be rather profitable; 2. Absence of Federal and regional legislation's for using nontraditional energy in national economy and daily life as well as of laws, which regulate the relations between centralized power production and local nontraditional energy 3. Low buying ability of population, and bad propaganda of real and effective using of nontraditional energy 4. Absence of wide market assortment of reliable, moderate, autonomous and working in power system plants using the nontraditional renewable energy sources. Absence of spreading of mounting and servicing stations
Overall Prospects	Good

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Renewable Energy Profile (draft)

RUSSIAN FEDERATION

HYDRO POWER POTENTIAL FOR DEVELOPMENT 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

The share of hydropower in total installed generating capacity accounts for 21%. Average annual hydropower generation in Russia amounts to 175 billion kWh.

The installed capacity of 153 operating HPPs totals 47.0 million kWh. There are 89 small HPPs with combined capacity of 0.55 million kW.

Existing Hydro Power Plants in Russia

Hydro power plants	Guantity	Installed capacity, MW	Share of HPPs in hydro power, %
Large and medium-size HPPs:	64	46450	98.8
Small HPPs	89	550	1.2

Existing Medium-size and Small HPPs

Hydro power plants	Installed capacity, MW	Region	Note
Medium-size HPPs:			
Beloporozhye	130	North-West	Abandoned
Yumaguzin	45	Central part	Under construction
Aushiger	60	Northern Caucasia	Date of commissioning – 2002
Gotzatlin	100	Northern Caucasia	Low utilization of capital investments
Krasnogorsk	100	Northern Caucasia	Ditto
Small HPPs			
HPP No.2 on Tolmachova	24.8	Chukotka	Construction is halted

2. Hydro Power Resources of Russia

9% of world hydro resources are concentrated on the territory of Russia. By availability of hydro resources Russia is the second in the world after China, leaving behind the USA, Brazil, Canada.

By absolute indices of potential hydro resources Russia is the first among the CIS countries.

Hydro Power Resources of Russia

Characteristics	Indices		Share of HPPs, % from the total
	Total	Including small HPPs of capacity up to 30 MW	
1.Gross theoretical hydropower potential,			
- Billion kWh/year	2395	1105.6	46.2
- concentration of power resources on the territory, thou.kWh/km^2	170		
European Part and Urals:	**393**	**183.9**	**46.8**
-Northern and North-Western regions	99	48.6	49.1
-Northern Caucasia	108	50.1	46.4
Eastern regions:	**2002**	**921.7**	**46.0**
-Western Siberia	144	74.5	51.7
-Eastern Siberia	849	395.2	46.5
-Far East	1009	452	44.8
2.Technically feasible hydropower capability,	1670	357.1	21.4
Billion kWh/year	**229**	**58.1**	**25.4**
European Part and Urals:	55	15.1	27.5
-Northern and North-Western regions	53	15.5	29.3
-Northern Caucasia	**1441**	**299**	**20.7**
Eastern regions:	93	24.6	26.5
-Western Siberia	664	128.4	19.3
-Eastern Siberia	684	146	21.4
-Far East			
3.Economically feasible hydropower capability,	852	Not determined	Not determined
Billion kWh/year			
European Part and Urals:	**162**		
-Northern and North-Western regions	43		
-Northern Caucasia	25		
Eastern regions:	**690**		
-Western Siberia	46		
-Eastern Siberia	350		
-Far East	294		
4.Power generated by existing HPPs,			
- Billion kWh/year	175.0	2.55	1.4
European Part and Urals:	69.9	2.28	3.2
- per cent of economic potential:	43.2	-	
-Northern and North-Western regions	13.2	1.06	8.0
- per cent of economic potential:	30.7	-	
-Northern Caucasia:	5.1	1.22	25.5
- per cent of economic potential:	20.4	-	
Eastern regions:	105.1	0.27	0.3
- per cent of economic potential:	15.2	-	
-Western Siberia	1.6	0.25	15.6
- per cent of economic potential:	3.5	-	
-Eastern Siberia	96.3	total for Eastern	0.02
- per cent of economic potential:	27.5	Siberia and Far	
-Far East	7.2	East - 0.02	
- per cent of economic potential, %	2.5		

The extent of developed economically feasible resources on the territory of Russia is non-uniform. In the European part 43.2% of economically feasible resources have been developed (which is close to economically developed countries), while in Siberia and the Far East this figure is not large and accounts for 15.2%.
At estimation of total hydropower potential of RF small hydropower with combined capacity of 30MW was singled out. Small hydropower potential is spread on the whole territory of Russia and accounts for 46 per cent from total resources and for more than 20% of technically feasible potential. Current use of small hydro potential is insignificant, i.e. less than 1% of technically feasible capability.

3. Plans for Development of Hydropower Potential

Power development strategy of Russia for the period of up to the year of 2020 envisages expanded use of hydropower resources with consideration of vast available non-developed economically feasible potential (more than 650 billion KWh, out of which more than 600 billion kWh are concentrated in the East), which indicates on real possibilities of further hydro development.
The Program of hydropower development of Russia up to the year of 2020, worked out in 2001, lays down the following first priority trends:

- Completion of 16 large HPPs, the construction of which was started last century in 80-s in Siberia, Far East, North-West and the South of Russian European part with combined capacity of 9 million kWh and annual average output of 35 billion kWh. Capital investments into these constructions comprise 30-60% of their construction budget, which is attractive for investors;
- Current retrofitting and rehabilitation of existing HPPs. At present 12 projects have been operating for more than 50 years.
- Construction of new large HPPs in the Far East (with combined capacity of 5.1 million kW), Siberia (with combined capacity of 18.8 million kW).

First Priority Potential Hydro Power Projects

Projects	Installed capacity, MW	Location
New construction:		
Morskaya HPP on the Kem River	33	North-West, Karelia.
Rynda HPP	100	North-West, Karelia
Sovetskaya HPP on the Cherek River	60	Northern Caucasia, Republic of Kabardino-Balkaria
Cascade of 3 HPPs on the Zeya River	126/126/97	Amur obl., Far East
Verkhnyaya Kolyma on the Kolyma River	120	Magadan oblast
Reconstruction of existing HPPs:		
Volkhov HPP on the Volkhov River	66	North-West, Leningrad District
Niva-2 on the Niva Riva	60	North-West, Murmansk obl.
Nizhnyaya Tuloma on the Tuloma River	50	North-West, Murmansk obl.

Programs of small hydropower development in Russia have the following first-priority trends:

- Construction of small HPPs in isolated power regions or in the power system outlying districts based on diesel power stations and using imported fuel (North and North-West of Russian European part, Northern Caucasia, Krasnoyarsk territory, Irkutsk oblast, Chukotka, the Republic of Saha, Primorsky and Khabarovsk territories, Kamchatka and Sakhalin);
- reconstruction and renovation of previously constructed small HPPs;
- adding small HPPs to water management projects with already existing water retaining structures with the aim of utilizing waste releases.

Proposed Program of Small Hydro Development (by documents prepared in 1995)

Name of regions	Type of construction	Quantity	Installed capacity	Average over-year power output, million kWh	Note
1	2	3	4	5	6
European part					
North and North-West	Reconstruction and rehabilitation	19	10	60	
	New construction	2	13,5	70	
	Total	**21**	**23,5**	**130**	
Center	Reconstruction and rehabilitation	10	9	41	
	Adding HPPs to water management projects	17	34	186	
	Total	**27**	**43**	**227**	

1	2	3	4	5	6
Northern Caucasia	Reconstruction and rehabilitation	11	12	52	
	Adding HPPs to water management projects	27	164	683	
	New construction	76	260	1370	
	Total	**114**	**436**	**2105**	
Urals	Reconstruction and rehabilitation	14	96,3	274,7	
	Adding HPPs to water management projects	35	33,9	150,9	
	Total	**49**	**130**	**425,6**	
Eastern regions					
Eastern Siberia	Reconstruction and rehabilitation	2	6	21	Energy deficiency. Lack of investments Regions of isolated power supply.
	Adding HPPs to water management projects	1	12	72	
	New construction	30	97	487	
	Total	**33**	**116**	**580**	
Western Siberia	Adding HPPs to water management projects	3	6	20	
	New construction	13	52	342	
	Total	**16**	**58**	**362**	
Kamchatka oblast	New construction	27	Data are not available	Data are not available	At present there worked out and approved the regional “Program of utilization of local power resources in the oblast”, realization of which will permit to lessen significantly the need in expensive imported organic fuel
	Total	**27**			
Far East	New construction	73	Data are not available	Data are not available	Currently in Primorsky territory there has been worked out and approved a special regional program “Construction of energy saving installations and development on non-traditional sources of energy in rural areas of the territory”. The administration of Magadan oblast is rendering assistance in organization of financing
	Total	**73**			

First Priority Potential Small Hydro Power Projects

Projects	Installed capacity, MW	Location
1	2	3
North and North-West		
Reconstruction:		
Pravdinsk HPP-4	2.1	Kaliningrad oblast
Kharlu small HPP	3.8	Republic of Karelia
New construction:		
Cascade of 3 HPPs on the Voenga River	8.6	Archangelsk oblast
Small HPP on the Vesliana River	4.9	Republic of Komi
Central part		
Adding to water manage-ment projects:		
Small HPP on the Soure River	6.0	Penza city
Sofiinsk on the Moskva River at water transport project	2.3	Moscow oblast
Small HPP at water treatment plants in Toliatti	6.9	Samara oblast
Chaikovskaya on the drops of service water supply facilities	4.2	Perm oblast
Reconstruction:		
Zjuratkul HPPs-1 and 2	5.8	Chelyabinsk oblast
Rassypukhin HPP on the Tzna River	2.0	Ryazan oblast
Northern Caucasia		
Reconstruction:		
Maikop	10	Krasnodar terrotory
Krasnaya Polyana	28.9	Krasnodar territory
Baksan	25.2	Republic of Kabardino-Balkaria
New construction:		
Small HPP on the Beshenke River	1.5	Krasnodar territory
Aibga Small HPP	0.6	Krasnodar territory
Small HPP on the Alibek River	2.5	Republic of Kabardino-Balkaria
Small HPP on the Bilyagidon River	4.5	Republic of North Osetia
Adding to water manage-ment projects:		
Ust-Jegutinsk	4.7	Stavropol territory
Egorlyk HPP-2	14.0	Stavropol territory
Gorkaya Balka	13.6	Stavropol territory
HPP-1 on Baksan-Malka canal	9.0	Republic of Kabardino-Balkaria
Veselovskaya	3.5	Rostov oblast

1	2	3
Western Siberia		
New construction Jazatorskaya small HPP on the Akalakhe River Balykchanskaya small HPP on the Chulyshman River	1.8 2.0	Republic of Altai Republic of Altai
Far East		
New construction Cascade of HPPs on the Raduga River	4.0-8.0	Kamchatka oblast, Ust-Kamchatski district
HPP No.4 on the Tolmacheva River	10-15	Kamchatka oblast
7 small HPPs on non-regulated streams	23.0 (unit capacity within 1.8-6.0)	Primorsky territory, settlements in Terneisk, Olginsk and Krasnoarmeisk districts

Local authorities are supporting development of first priority projects and seeking for investors.

4 Favorable Factors for Development of Hydro Potential

- growth of energy consumption inside the country and increase of electric energy export;
- deficit in natural gas and black oil and expected fuel price escalation;
- growth of thermal power rates;
- By resolution of Russian Government No.60 dtd. 07.12.01 there was approved a special program “Ecology and Natural Resources of Russia” (2002-2010). The adopted solution indicates on the important role of the tasks posed for regional organizations in effective utilization of local resources.

5. Unfavorable Factors for Development of Hydro Potential

- lack of investments

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Zones of location of planned small HPSs

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