Opportunities for Renewable Energy in Russia

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OPPORTUNITIES FOR RENEWABLE ENERGY IN RUSSIA

Introduction

In the 1930s, which country was the first in the world to start constructing utility-scale wind turbines? What country installed as many as 7,000 small hydro generating systems in the six years following World War 2? And, in 2000, which country's forests covered 22% of the earth's surface? Denmark, the United States, Brazil? No, the unexpected, but correct, answer to these three questions is Russia. Russia has enormous renewable energy resource potential, but current use of renewable energy is quite low. The reasons for this are quite understandable and have primarily to do with Russia's experience during the 20th Century.

First, in Russia, the general public, businesses and government lack reliable information about the availability and economic potential of RE resources. In the absence of this information, exploiting renewable energy in Russia is generally believed to be too expensive. This report identifies the potential of RE in Russia. It assesses the country's current energy market and specifies market applications where renewable energy could compete with conventional energy sources. The report identifies renewable energy technologies where small investments today can yield significant economic returns, not just in the longer term, but immediately.

The abundance of fossil fuel reserves, as well as over-capacity in electricity generation, are often cited as other major impediments to the development of renewable energy in Russia. Russia is the world's largest producer and exporter of fossil fuels, and the accepted wisdom is that it does not need to exploit its vast renewable energy resources. This report presents economic, social and environmental reasons why building a renewable energy market in Russia can play an important role in its energy future.

Third, renewable energy is often perceived as a "rich countries' toy", which to play with requires massive budget spending. This report highlights experiences in other countries that demonstrate that Russia can successfully and cheaply develop its RE resources. The report suggests a number of short-term measures that Russian policy makers could introduce in order to facilitate the market deployment of RE technologies. These cost-effective technologies already exist in Russia but lack a market in which to operate.

Finally, the development of renewable energy resources in Russia is hindered by its unattractive investment climate. A litany of vague laws and regulations, a weak financial sector, lack of transparency and violations of shareholders' rights are among the factors that deter investment in all sectors of the Russian economy. Artificially low domestic energy prices, in particular, are a crucial impediment to attracting investment in the energy sector. This report underlines the necessity of creating a more attractive and competitive investment environment in Russia. It is intended to enhance the on-going co-operation between Russia and the IEA.

IEA co-operation with the Russian Ministry of Energy dates back to the early 1990s, and a Memorandum of Understanding was signed in 1994. The broad objectives of this co-operation are to assist Russia with developing a market-oriented energy policy, to collaborate on projects of mutual interest, to increase the flow of data and information on the Russian energy sector and to share energy policy experiences of IEA countries. To date, the co-operation has focussed especially on gas supply security, energy efficiency, the investment framework and energy sector transparency. This report meets the objectives of

Russian-IEA co-operation outlined above by demonstrating the potential for developing a renewable energy market in Russia. It also expands on previous work contained in the IEA's *Russia Energy Survey 2002*.

In early March 2002, the IEA released the *Russia Energy Survey 2002*, updating the 1995 Survey. The preparation of the Survey paralleled the drafting of the Energy Strategy of the Russian Federation to 2020. Drafts of both documents were exchanged and comments were provided to both parties. The IEA Survey provided timely recommendations to the evolving discussion on the Russian energy policy and reinforced the Russian government's efforts to elaborate and effectively implement economic reforms. These reforms are critical for the energy sector to fuel the economy in this period of strong GDP growth. Increasingly, the energy security of Russia and its export markets are dependent on the creation of a stable and competitive investment environment, energy price reform, corporate transparency and dramatic improvement in energy efficiency.

Russian policy makers are currently debating a new energy strategy intending to make a national planning framework for the coming years. They are also actively pursuing membership in the World Trade Organisation and are contemplating ratifying the Kyoto Protocol. This report fills in a gap between information provided in the Russian Energy Survey and the currently available information on renewable energy. It defines the potential contribution of RE in a more open, market-based Russia. It shows areas where policy makers can adapt energy policy and legislation in order to fully capture the benefits of renewable energy. The report shows that Russia's RE potential is enormous and is spread over many resources: wind; geothermal; biomass; hydro; and solar energy. It demonstrates market applications that can yield immediate economic returns with very small initial investments. Finally, this report offers some suggestions for policies and measures as first steps toward building a market for renewable energy technologies. The challenges of scaling-up Russia's use of renewable energy are great, but this report provides a first outline of a strategy for developing a RE market. With the information provided in this report, policy makers will see that RE offers a real opportunity for contributing to solutions for some of Russia's energy challenges, and what might be the best first steps toward creating a market. At the same time, industry, both Russian and international, will better understand the potential for profitable projects, and can start mobilising to develop them.

Renewable Energy Market Opportunities

Renewable Energy Potential

Russia's vast renewable energy potential is regionally diverse. This distinguishes it from many smaller countries where one type predominates because of the homogeneity of geographic conditions. This section highlights the regional diversity of Russian renewable potential.

One estimate of renewable energy potential suggests that it might be as high as 30% of total primary energy supply (TPES). Bezrukikh et.al. estimate the potential of renewable energy in Russia.[1] *Gross* potential (or available resources) is the energetic equivalent of the total amount of different forms of RE available for extraction. *Technical* potential is the part of the gross potential, which can be effectively used with the help of known technologies, taking into consideration environmental constraints. Bezrukikh et.al. define the *economic*

[1] Bezrukikh, P.P., Arbuzov, J.D., Borisov, G.A., Vissarionov, V.I., Evdokimov, V.M., Malinin, N.K., Ogorodov, N.V., Puzakov, V.N., Sidorenko G.I. and Shpak, A.A., *Resources and efficiency of the use of renewable sources of energy in Russia*, SPb, Nauka, 2002.

potential as part of the technical potential, the use of which is economically justified, at the present level of prices for fossil fuels, heat and electricity, equipment and materials, transportation and wages**.** They estimate the economic potential of renewable energy in Russia at more than 270 million tonnes of coal equivalent (Mtce).[2] In 2000, Russia's total primary energy supply was 614 Mtoe (or 875 Mtce).[3] Thus, while its estimated economic potential was some 30% of total primary energy supply, only some 1% of TPES was actually derived from non-hydro RE in 2000.[4]

Table 1: Potential of Renewable Energy Sources in Russia
(million tonnes of coal equivalent)

Resource	Gross potential	Technical potential	Economic potential
Small Hydropower	360.4	124.6	65.2
Geothermal Energy	*	*	115.0**
Biomass Energy	10×10^3	53	35
Wind Energy	26×10^3	2000	10.0
Solar Energy	2.3×10^6	2300	12.5
Low Potential Heat	525	115	36
Total Renewable Energy Sources	**2.34×10^6**	**4593.0**	**273.5**

*geothermal energy resources at or above a depth of 3 km are about 180 mtce, those suitable for use are approximately 20 mtce.
** the economic potential of hot water and steam-water fluids of geocirculating technology.
Source: Intersolar Center, Moscow, www.intersolar.ru/events/congress/national_report.shtml

● **Biomass** Some 22% of the world's forests are in Russia[5]. Forests cover about 40% of the entire landmass, with the current annual allowable cut of 542 million m^3.[6] The largest forests are in the Siberian taiga, the Far East and the northern European territories. The forest industry is important for the Russian economy, and it is a large potential supplier and consumer of biomass (wood waste) products. At present, these products are only being minimally exploited. Agricultural wastes are another source of biomass fuel. The agricultural

[2] Ibid, p. 286, and "Role of Renewable Energy Sources in Russian Energy Strategy", in Business and Investment for RE in Russia, Proceedings of the Congress. Moscow 1999, part I, p.4.

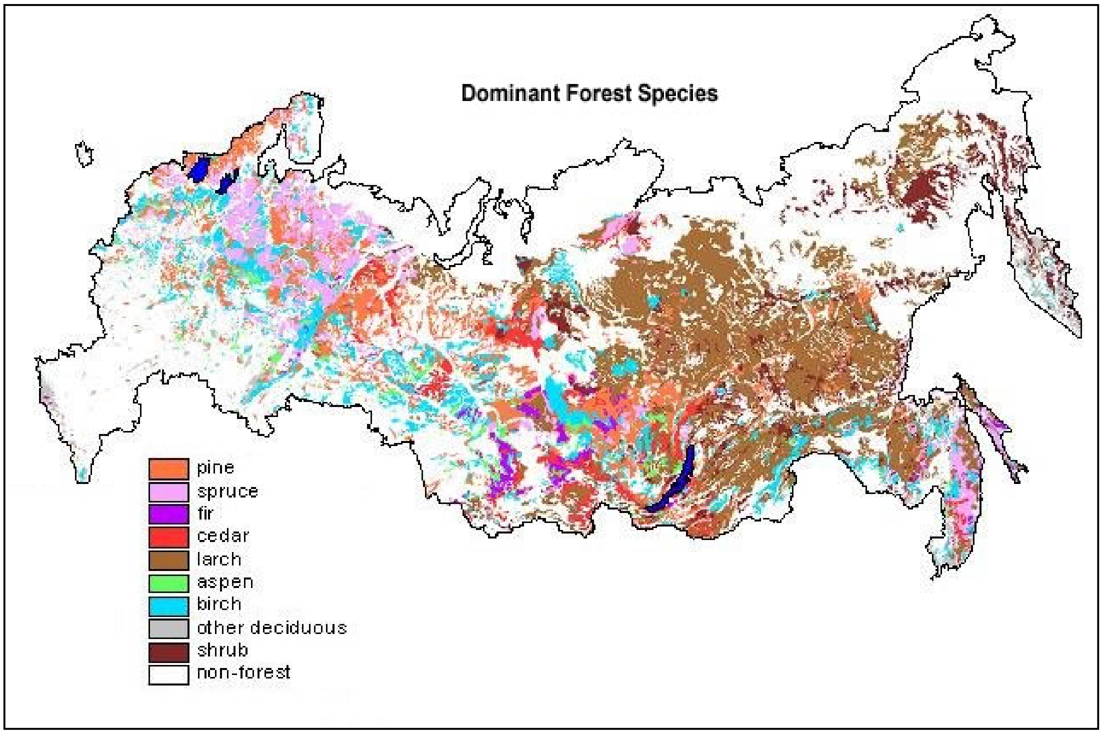
[3] IEA/OECD, *Energy Balances of Non-OECD Countries*, Paris, 2002.

[4] The technical potential of renewable energy (4593 Mtce) is estimated to be more than five times greater than TPES.

[5] *Russia: Forest Policy during the Transition*, World Bank country study, 1997, The World Bank, Washington, D.C., p. 30.

[6] Petrov, A., Financing Sustainable Forest Management in Russia and the Commonwealth of Independent State Countries: Alternative Mechanisms to Finance Participatory Forest and Protected Area Management, Oslo (Norway), January 2001, available at: http://www.cifor.cgiar.org/fsfm/Papers/25Petrov.pdf

sector is also important in Russia, accounting for 8% of GDP, and employing 11% of the labour force.[7] The technical potential of biomass is estimated at more than 50 Mtce.[8]



Source: Land Resources of Russia, http://www.iiasa.ac.at/Research/FOR/russia_cd/for_maps.htm#for

● **Hydro resources** Russia has more than two million rivers, which stretch for 3 million km, dumping more than 4,000 km^3 of water annually.[9] It has the second highest level of mean annual river runoff, after Brazil[10]. The European part of Russia, although the most populated and developed, accounts for less than 25% of the country's water resources. The bulk of the stream flow is concentrated in the northern and eastern parts of the country. Several large rivers supply most of the water resources, but Russia also has numerous small and medium-sized rivers.

The enormous economic potential of hydro resources, including small hydro, is largely unexploited. According to the World Commission on Dams, Russia's hydropower economic potential, which takes into account its impact on economic development economic efficiency, and ecological and other factors, is estimated to be 1,015,000 GWh/year. By comparison, in 1999, Russian electricity generation was 846,000 GWh. 1999.

The potential contribution of **small hydropower** ranges from 80 000 GWh/year [11] to 531 000 GWh/ year (65.2 Mtce)[12]. Even if the most conservative estimate of small hydro

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[7] Business and Marketing Analytical Centre of the International Centre for Scientific and Technical Information, http://www.bma.ru/abru/agro.html.

[8] EBRD, Strategic Assessment of the Potential for Renewable Energy, Russian Federation, Draft Profile.

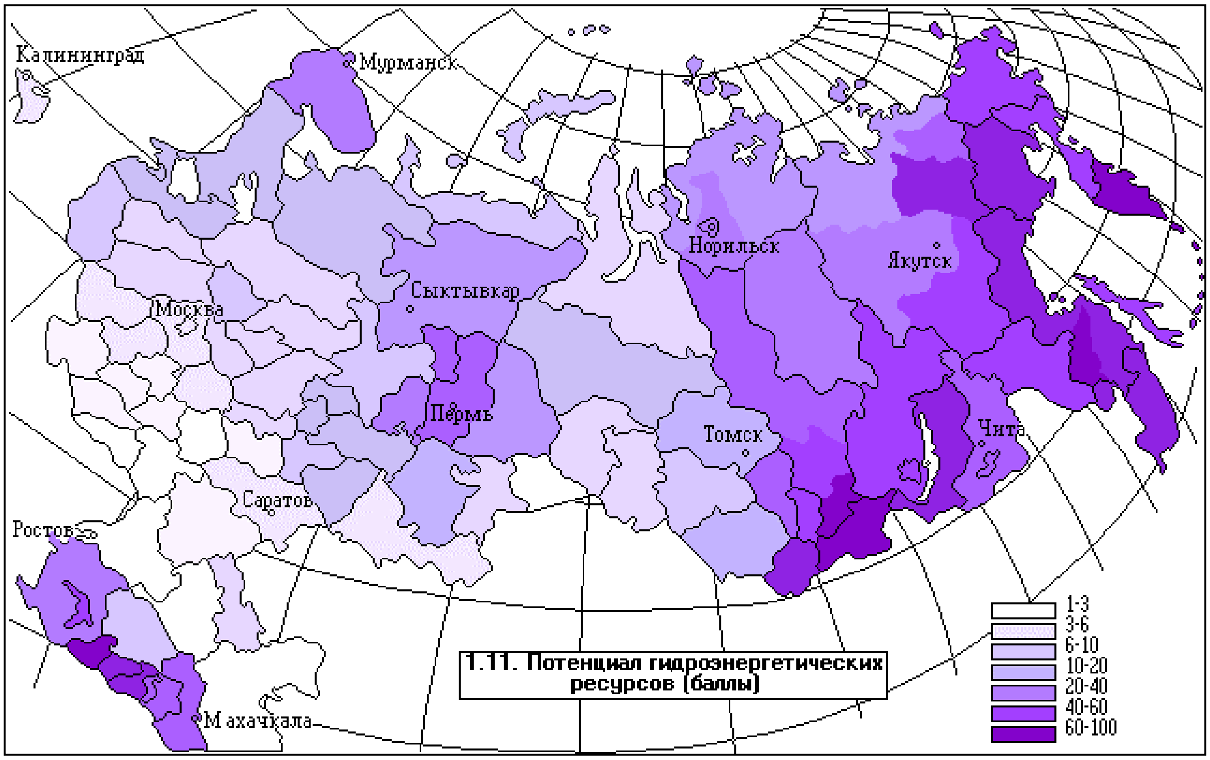
[9] http://www.russianembassy.org/RUSSIA/GEOGRAF.HTM

[10] Koronkevitch, Nikolai, *Water Resources of Russia*, *http://www.iiasa.ac.at/Research/FOR/russia_cd/hydro_des.htm*

[11] World Commission on Dams (WCD) Development of Dams in the Russian Federation and Other NIS Countries, WDC Briefing Paper, p 46.

[12] Intersolarcenter, Moscow, www.intersolar.ru/events/congress/national_report.shtml

resources was exploited, i.e. 80 000 GWh/year, some 9.5% of all Russian electricity could be potentially generated from this source.[13]



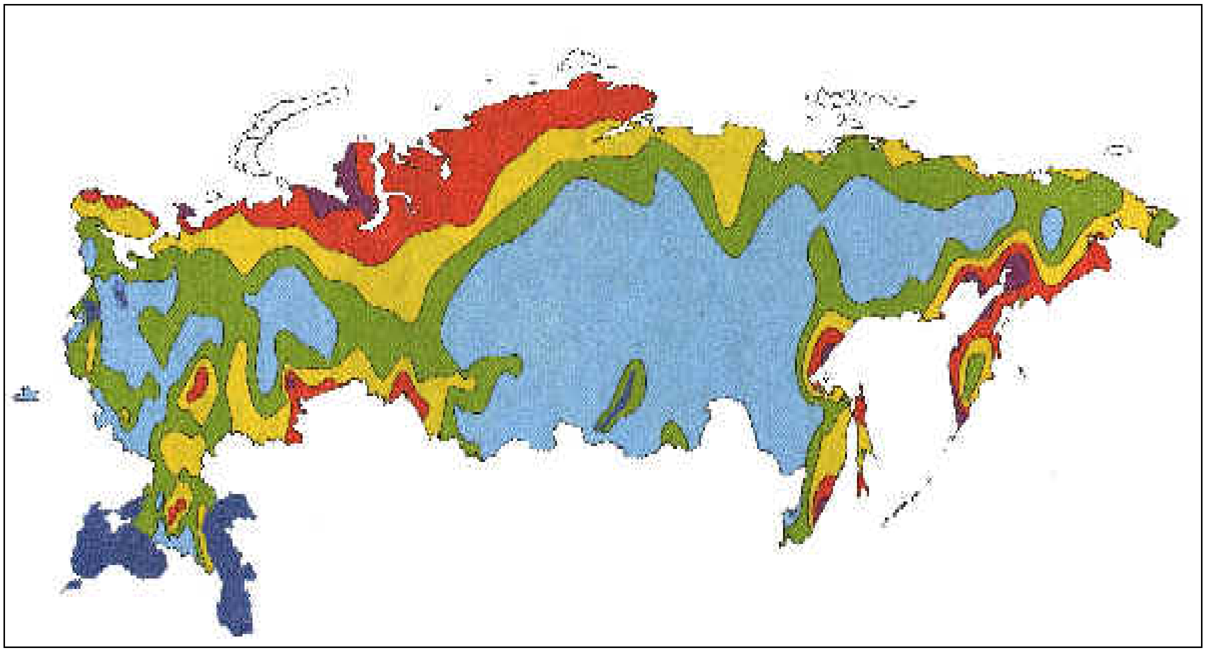
Source: **http://www.sci.aha.ru/RUS/wadb61.gif**

● **Wind resources**

are available over large parts of Russia, including the coastal areas of the Pacific and Arctic oceans and of the Caspian, Baltic, Azov and Black Seas, and the high plains and mountain regions. About 37% of wind resources are found in the populated European part of Russia, and 63% in Siberia and Far East. Most of the country's wind potential is located in the territories, where population density is less then 1 person per km^2. Here, wind energy can be exploited, as it has been successfully done in Mongolia, to service small isolated consumers. The challenge of bringing this energy to more populated areas is greater but still feasible in regions where extremely favourable wind conditions coincide with existing power infrastructure in the form of conventional electrical power stations and large scale industrial consumers. These regions include Sakhalin, Kamchatka, Chukotka, the seashore of Magadan region, Northern Caucasus steppes and mountains, and Kola Peninsula.[14]

[13] Total electricity generation was 846 TWh in 1999. Source: IEA/OECD, Russia Energy Survey, 2002, p. 195

[14] ECO-Accord Centre, Moscow, and Forum for Energy and Development, Denmark August 2001.



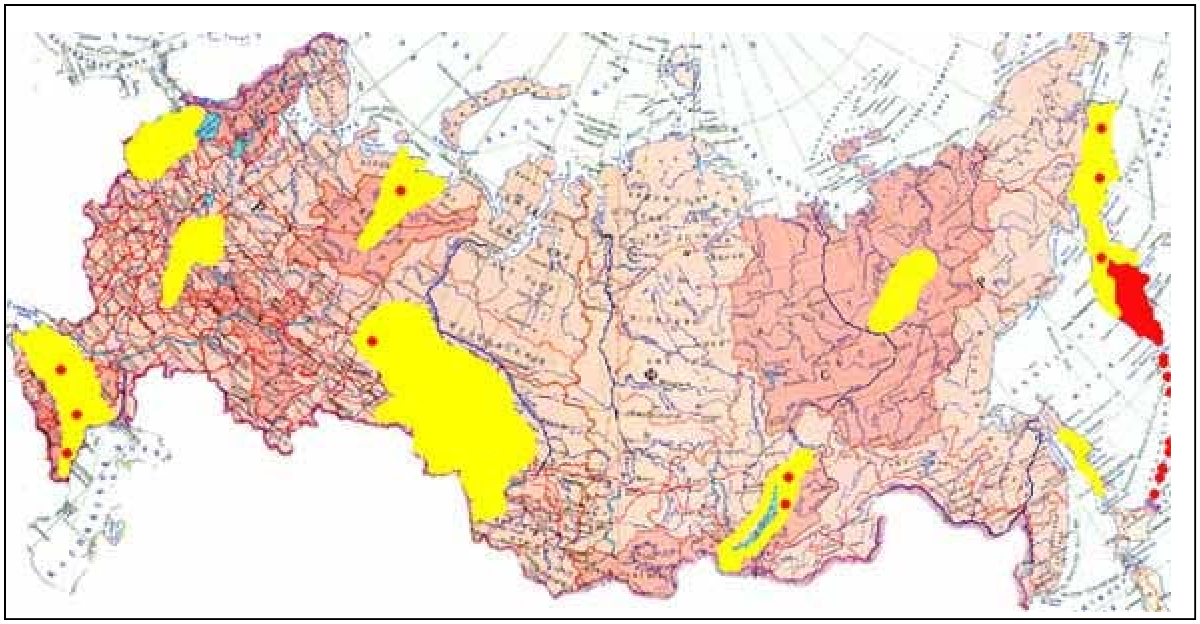
Source: Dmitriev, G. and Gunnar Boye Olesen, *Biomass and Wind Power Opportunities in Russia*, Eco-Accord Center, Moscow, August 2001, http://accord.cis.lead.org/cooperation/energy-engl/8.htm

● **Solar resources** The best solar energy potential is located in the southwest of the country (North Caucuses, the Black and Caspian Seas regions) and in the southern part of Siberia and Far East. The average solar radiation in the southern regions is about 1400 kWh/m^2 per year. In the remote northern areas, it is about 810 kWh/m^2 per year.[15] Regions with the best solar resources are located below or near 50 degrees N. Solar radiation levels, however, are seasonal. For example, at latitude 55 degrees N solar radiation is 1.69 kWh/m^2 per day in January, and 11.41 kWh/m^2 per day in July.

Source: http://ecoclub.nsu.ru/altenergy/images/karta2.gif

[15] Karabanov, S. "The Prospects for Photovoltaic Development in Russia," Renewable Energy 2001, World Renwable Energy Network, pp 88-89

● **Geothermal resources** The Kamchatka Peninsula and the Kuril Islands hold the richest geothermal resources. In Kamchatka, there are about 150 thermal spring groups and 11 high-temperature hydrothermal systems.[16] The Northern Caucasus, Dagestan, the Central region of Russia, the West Siberian plate, Lake Baikal, Krasnoiarsk territory (Krai), Chukotka, and Sakhalin also have substantial geothermal resources with temperatures of 50-200 degrees C at depths of 200 to 3000 metres. [17]



Source: http://www.geotherm.ru/HTML/resources/resources.html

Energy Market

Russia currently uses very little of its huge renewable energy potential. In 2000, only some 3% of its total primary energy supply (TPES) was based on renewable energy, of which 2% was hydro and less than 1% all other forms. Russia's energy mix is dominated by natural gas, especially for electricity generation. In 2000, over 40% of the electricity fuel mix was gas-fired. Another quarter was coal- or oil-fired.

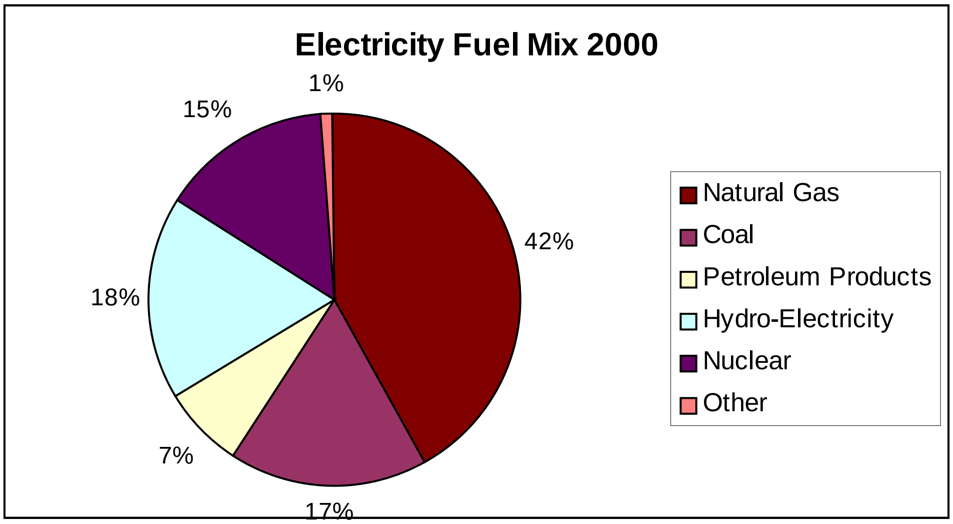
Table 2: Russian Total Primary Energy Supply, 2000

	Mtoe	*Share (%)*
Total*	**614**	
Natural Gas	319	52
Oil and Oil products	130	21
Coal	111	18
Nuclear	34	6
Renewable energy**	21	3

* Includes net electricity exports of 1.2 Mtoe.
** Hydro, geothermal, wind, solar, biomass and industrial and municipal waste.
Source: IEA/OECD, *Energy Balances of Non-OECD Countries*, Paris, 2002.

[16] Kononov V., Polyak B., Kozlov B. Geothermal Development in Russia: Country Update Report 1995-1999, Proceedings World Geothermal Congress 2000, Japan, 28 May-10 June 2000.

[17] www.geotherm.ru



Source: Adapted from IEA/OECD, *Russian Energy Survey*, Paris, 2002, p.62.

Reforms of the energy sector have been underway since early 1990s. However, Russian domestic energy market is still distorted. Energy prices still do not reflect relative or marginal costs. Domestic prices for gas, which represents the lion's share of TPES and of electricity generation mix, are still state-controlled and kept artificially low.

Electricity. Electricity supply is centralized and state-regulated in Russia. However, electricity sector reform is underway, aiming at de-monopolisation and at introducing cost-based pricing. Today electricity production and distribution are in hands of a state monopoly Unified Energy Systems (RAO UES). RAO UES possesses 72% of the total electricity generation capacity in Russia, and 2.7 million km of transmission lines, or 96 % of the total in Russia.[18] Regional *energos* generate the remaining part of electricity supply, and a large share of heat.

The government sets the maximum level of electricity tariffs to different groups of consumers. The regional energy commissions regulate electricity retail tariffs in regions. Typically, residential electricity tariffs are artificially low, often below generation cost and are compensated for by high tariffs to industrial consumers. Tariffs for agriculture vary: in some regions they are higher than tariffs for industry and residents, in other regions –the opposite.[19] Independent Power Producers (IPPs) exist in Russia, but today they are discriminated in the transmission network access.

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[18] Chubais, A., Presentation at the Seminar of EU Energy Ministers, 28 April 2002

[19] Hubert F., Cross Subsidies in Russian Electric Power tariffs Not as Bad as Their Reputation, April 2002

Electricity Sector Restructuring[20]

In June 2001, the Russian government approved the "Basic Guidelines of the Governmental Policy on Reforming the Power Sector of the Russian Federation". Under the restructuring process, the vertically integrated companies are to be dismantled, and the generation, transmission and distribution – unbundled. Generation and distribution are to move gradually towards free market through price liberalisation and competition. In contrast, in transmission and dispatching, which remain monopolistic under any circumstances, the role of the state is to be increased.

During the first stage, the regulatory framework for the new electricity sector structure is to be formed; the present structure of electricity sector is to be changed, and mechanisms to trade electricity at free wholesale market are to be tuned. At this stage regulation of independent suppliers is to be stopped, more agents are to penetrate the wholesale market. On this stage a certain percentage of electricity of every supplier can be traded on the free wholesale market, the rest is to be supplied at regulated prices. Retail prices will remain regulated at this stage, although tied to the wholesale prices.

At the second stage – 2-3 more years- all electricity at the wholesale market will be traded freely. Only prices for transmission and dispatching services will be left regulated. The process of independent retailers and brokers will be finalized, as well as a regulatory basis for the restructuring. Details of the third stage of the reform plan remain vague, but the key elements will be to complete market liberalization and privatization of generation assets. The reform program plans gradual elimination of cross subsidies, an increase in consumer prices sufficient to raise capital resources and to cover investment costs, and special social measures to help the poorest population cope with price increase.

Heat. Given Russian climatic conditions, heating is a very important form of energy use, especially in the residential sector. The share of heat in the total final consumption by fuel is 33%, while the share of electricity is only 12.4 % (as of 1999)[21]

The heat sector is closely linked to the electricity sector: about 30% of electricity production comes from co-generation. Regional *energos* produce most of heat and sell it to municipalities and industrial consumers. RAO UES produces about one-third of the total heat. Heat-only boilers account for some 52% of total heat generation; public co-generation plants account for about 37%; the rest is produced by industries that generate heat or heat and power for their own consumption.[22] Heat distribution systems are obsolete and badly maintained, which leads to significant heat losses. About 60% of the network need major repairing or replacement.[23] Heat prices to final consumers and municipalities generally do not reflect costs of supply. Electricity sales from co-generation are used to cross-subsidize the losses from heat supply.

When the cost of using renewable energy resources is compared with the cost of conventional energy sources in the actual distorted energy market, it is not surprising that renewable energy is viewed unfavourably. The pace and timing of the restructuring process is uncertain but it is very likely that prices of relative energy sources for Russian users will better reflect costs in the near future. As the existing energy infrastructure is upgraded, economic

[20] Sources: "Basic Guidelines of the Governmental Policy on Reforming the Power Sector of the Russian Federation", Moscow, 2001; IEA/OECD Russia Energy Survey, 2002 pp. 212-213; and http://www.eia.doe.gov/emeu/cabs/russrest.html

[21] IEA/OECD Russia Energy Survey 2002 p. 49

[22] IEA/OECD Russia Energy Survey 2002 p. 219

[23] IEA/OECD Russia Energy Survey 2002 p. 219

comparisons among different technologies will favour those renewable energy technologies that are already competitive in market economies.

> **Energy Pricing and Accession to the WTO**
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> Artificially low domestic energy prices have been one of the most debated questions in the negotiations of Russia's entry in the WTO. The gap between domestic and export prices is seen as an implicit subsidy for Russian manufacturers, which gives them an advantage over their foreign competitors. Russia will need to continue to liberalise its domestic energy market if it is to enter the WTO

Potential Applications for Renewable Energy Technologies

The most cost-effective applications of renewable energy technologies in Russia are noted in the following section. The report offers examples of successful renewable energy projects in Russia and in other transition countries. Many other applications are already cost-effective based on experience in the US and Europe. With Russia's renewable energy resource base, and given the technologies that already exist in the global marketplace, small investments, combined with sound policy changes, could generate large economic returns.

● Off-grid Electricity Supply

Off-grid systems have proven to be very cost-effective in many OECD and developing countries. In Russian areas not connected to centralized electricity supply renewable energy systems can replace or supplement existing traditional systems cost-effectively as done in other countries such as Canada, the USA, Norway, and Sweden**.**

In Russia, some 20 million people live in regions that are not connected to the centralized grid administered by the Unified Energy Systems (UES). While half of them are connected to smaller, autonomous power grids, about 10 million are served by stand-alone generation systems using either diesel fuel or gasoline.[24] Nearly half of these diesel and gasoline systems are reported to be no longer operating because of fuel delivery problems or / and high fuel costs[25]. Most stand-alone systems are used in the far northern regions of Russia, in the Far East and in Siberia. Every year 6-8 million tonnes of liquid fuel (diesel, black oil) and 20-25 million tonnes of coal are sent to these territories[26]. Remote northern and Far Eastern areas, not connected to oil and gas pipelines, get their fuel by rail or road and sometimes by helicopter. Such supplies are very unreliable and expensive. The cost of transporting these

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[24] Bezrukikh, P. "Non-Traditional Renewable Energy Sources", Analytical Report; Martinot, E., "Renewable Energy in Russia: Markets, Development and Technology Transfer", Renewable and Sustainable Energy Reviews, 1999, p. 53.

[25] Martinot, E., "Renewable Energy in Russia: Markets, Development and Technology Transfer", Renewable and Sustainable Energy Reviews, 1999, p. 53.

[26] Bezrukikh, P. "Non-Traditional Renewable Energy Sources", Analytical Report

fuels is not borne by the users of these systems. Removing these energy subsidies could make renewable energy a viable alternative.

> *Success Story*
>
> The village of Shalotch in the Vologda region, 450 km north of Moscow, is not connected to a centrialised grid. Because of the area's boggy terrain, construction of a transmission line would cost about $380,000. It would cost some $12,000 per year just to maintain it. Until 1993, the inhabitants of the village used kerosene lamps for lighting and kerosene or gas-fuelled appliances for cooking. Migration out of the village was such that in the early 1990s, only three families lived there. But in 1993-4, the Russian Institute for Electrification of Agriculture and the Centre "Electrdomotechnika" installed three 160 W wind turbines and 14 PV modules with peak capacity of 65 and 130 W. The project was originally to be financed from the state budget, but the inhabitants of Shalotch paid 50% of the installation cost. The installed capacity in not sufficient to cover all of their electricity needs, yet it allows the use of energy-efficient electric lights, TV sets and water pumps. People have returned to the village and now some 45 families live there.
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> Source: Intersolar Centre, *Renewable Energy Bulletin*, December 2000.

Another potential market for renewable energy off-grid systems is Russian *dachas* (summer country houses). Sixteen million families and ten million individuals have a small plot of land, and 22 million families have their own country house with private land, where they grow vegetables and fruit for personal use or for sale.[27] Reportedly 5 million individual farms and vegetable growers are not connected to an electricity grid.[28] Many low-income families spend practically all their weekends from April through October in dachas.

> *Success Story*
>
> Local farmers in Istinka, in the Leningrad region, are not connected to an electricity grid, and, they frequently rely on car batteries for a source of energy. In January 1996, a farming family in Istinka purchased a small wind-power plant to produce electricity for their farm. The material costs were $800. The plant was purchased from a local company that produces wind-power plants as a part of a conversion programme for companies previously producing military equipment. The generator is small, with a power output of about 300W. It weighs approximately 40 kilos, including the control unit, and two people in less than three hours installed it. The owners of the wind-power plant no longer need to spend time recharging car batteries every week.
>
> Source: INFORSE http://www.zpok.hu/inforse/24.html.

Because of the sheer size of Russia, wind or hybrid wind-diesel systems, biomass-fired steam boilers with turbine-generators, and small hydro power stations are cost-competitive with traditional fossil fuel technologies in remote areas, or nearly so, depending on local conditions and the level of subsidies to conventional energy.

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[27] Strebkov, D., "Trends In Russian Agriculture and Rural Energy", Intersolar Centre.

[28] Karabanov S. "the Prospects for Photovoltaic Development in Russia", Renewable Energy Report, 2001, UNESCO pp 88-89.

● Grid-connected Electricity Supply

Markets for grid-connected renewables, particularly wind, geothermal, small hydro and biofuels, are growing rapidly due to investments in OECD countries. As a result, costs have come down to the point that in very good locations these systems are cost-competitive with conventional technologies.

Most Russian regions produce less energy than they need, so they have to import it from energy-rich regions such as Western Siberia (See Table 3, p.12). Some of Russia's fossil-fuel-deficient regions face frequent disruptions in fuel supplies since they depend on fuel "imports" from other parts of the country. High fuel costs mean that regional utilities are often unable to pay for the fuel. They can be cut off from the fuel supplies because of non-payment, as it was at Kamchatka local power station in summer 2002. Transportation costs increase the total cost of fuel, which has topped $350 per tonne of coal equivalent in Kamchatka, Republic Tyva and Republic Altai. More than half of these territories' budgets is spent on fuel.[29]

Table 3: Russia's Regional Fossil Fuel Balance, 2000
(million tonnes of coal equivalent)

Region	**Gas**	**Oil**	**Coal**
	Deficit(-) / surplus(+)		
North	-14.2	7.5	2.0
Northwest	-19.7	-10.8	-1.4
Central	-88.2	-34.0	-9.2
Volga-Vyatsky	-20.0	-10.1	-2.6
Central-Black soil	-21.9	-5.3	-6.4
Lower-Volga	-54.1	29.6	-1.1
North Caucasus	-31.6	-8.6	1.9
Urals	-58.5	15.3	-28.9
Western Siberia	534.3	293.2	45.4
Eastern Siberia	0	-15.0	5.3
Far East	0	-9.1	-0.8

Source: IEA/OECD, *Russia Energy Survey*, Paris, 2002, p. 57.

Many regions have locally available renewable energy resources. The fact that their current energy supplies are expensive and unreliable means that renewable energy technologies could be commercially attractive**.** Large-scale wind and geothermal plants are attractive options in Kamchatka, the Kuril Islands, and the North Caucasus. Small hydro development is commercially attractive in the North Caucuses, the Urals and in Eastern Siberia. By increasing the share of renewable energy in their energy systems, Russian regions with locally available renewable resources can increase security of energy supply.

[29] Bezrukikh, P. "Non-Traditional Renewable Energy Sources", Analytical Report

Geothermal Energy in Kamchatka

Exploration of geothermal fields in Kamchatka started in the1950s. Since then, about 400 boreholes have been drilled. The first geothermal power station, Pauzhetskaya - with installed capacity of 5 MW, was built in 1967, and it is still in operation with current capacity of 11 MW. A 12 MW Verkhne- (Upper) Mutnovskaya geothermal station is also operating. The largest geothermal installation in Russia today is the 50 MW Mutnovsky geothermal power station, the construction of which was financed by the European Bank for Reconstruction and Development, the Unified Energy Systems of Russia, Kamchatskenergo and the regional administration. The first 25 MW unit was put into operation in 2001, and the second in October 2002. Today, the total electricity generation capacity based on geothermal energy in Kamchatka is 73 MW, accounting for a quarter of the region's power supply. The use of geothermal has reduced the region's dependence on expensive imported fuel. In late 2002, AO "Kamchatsenergo" paid 5,750 roubles ($182) per ton of black oil, which is the highest price among the plants within RAO "UES Rossii".[30] By using geothermal energy, Kamchatskenergo's imports of fuel oil have fallen by 90,000 tons, down from 480 000 tons previously demanded for power generation.[31] In addition to the economic benefits, geothermal-based electricity generation has improved the ecological situation in the region. Emissions of GHG and local pollutants are estimated to have fallen: CO_2 by 1.6 million tons per year, nitric dioxide by 8 thousand tons per year, sulfurous anhybride by 11 thousand tons per year and ash by 650 thousand tons per year.[32]. There are plans to further increase geothermal capacity in Kamchatka. The potential capacity of the Mutnovsky field alone, located about 120 km from the city of Petropavlovsk-Kamchatsky, is estimated at 300 MW.[33]

In the Russian Far East, geothermal and wind power can be competitive with conventional sources today without any additional incentives. In 2001, the average cost of electricity generation in Kamchatka was about 3 roubles/kWh. The tariff for residents was below cost, some 2 roubles/kWh, and was cross-subsidised by the industrial tariff of 4.20 roubles/kWh. [34] In February 2003, the residential electricity tariff was increased to 2.30 roubles/kWh (0.069 euros/kWh).[35] Experience in European countries demonstrates that the cost of electricity production from on-shore wind is about 0.04-0.07 euro/kWh. The cost is expected to fall to less than 0.035 euros /kWh by 2008. The wind regime is considerably stronger in the Kuril Islands and in Kamchatka, and it is likely that production costs in these regions would be even lower than in Europe.

The cost of electricity from geothermal (liquid-steam water resources) varies between 0.05 and 0.09 euros/ kWhe, while heat production from geothermal costs 0.005-0.035 euros/kWh (th).[36] Assuming that Russian-made equipment can be produced more cheaply than in the West, the cost of electricity (and heat) generation from geothermal could also be even lower than Western levels.

[30] http://www.rao-ees.ru/en/news/pr_depart/show.cgi?101002mut.htm

[31] Platts RE report no 45 nov. 2002, p. 14

[32] Povarov, O.A., Tomarov, G.V. "Power Supply of Kamchatka Based on Geothermal Energetics", IntersolarCentre

[33] http://www.rao-ees.ru/en/news/pr_depart/show.cgi?101002mut.htm

[34] Mashkovtsev, M.B., governor of Kamchatka region, Presentation, Moscow, Kremlin, 29 May 2001, http://www.kremlin.ru/text/appears/2001/05/19318.shtml

[35] Financial Times , 9 January 2003

[36] EU CORDIS "Scientific and Technological References. Energy Technology Indicators", ESTIR Working document, December 2002

- **Heat and Hot Water Supply**

Energy use for heating is extremely inefficient in Russia. In the past, there has been little incentive to focus on energy efficiency or on choice of fuel. Liberalisation of energy prices will inevitably change that.

North American and European experience has shown that a number of renewable energy options are cost-effective for a variety of heat and hot water needs. These range from using waste wood in modern boilers to individual solar collectors for hot water. These technologies can be also effectively used in Russia.

Energy efficiency of heat supply is especially low in Russian district heating systems with heat-only boilers, which account for some 52% of total heat generation. These centralized boiler plants operate to produce heat and hot water in winter, and only hot water in summer. During the summer months, producing this hot water is especially inefficient: boilers are operated at low loads and distribution losses are high. In these applications solar hot water collectors on roofs of buildings and single-family houses could replace the existing traditional source of hot water and allow the district-heating boilers to be shut down in the summer months.[37] Solar collectors could be used as the only source of hot water throughout much of Russia from May until August, and for longer periods in southern regions. In other months, solar collectors could be used as an additional water heater, thus reducing the boiler's load. Running the boiler plants more efficiently could improve their reliability and increase their service life. If relative prices were such to incorporate the fuel savings and the reduction in operating and maintenance costs of not operating boilers in the summer months, solar collectors could be cost-effective in many situations.

Success Story

The owners of a hotel in Primorsko, Bulgaria on the Black Sea Coast have successfully employed solar collectors for water heating to meet an increase in demand for hot-water consumption on the part of their guests at a time of increasing electricity prices.[38] The owners wholly financed the purchase and installation of the solar collectors. The payback time for the project is estimated to be two years. The solar water system, comprised of 9 solar panels of 1.5 m^2 each, provides the hotel with a stable capacity of 600 litres of water at 40^{o}C. The only electric appliance powered at the solar collector system is a small pump, which uses no more power than a light bulb.

Another renewable energy application for heating lies in conversion of coal- or oil-fired district heating boilers to burn biomass fuels (especially wood wastes). Since Russia faces Western-level heavy fuel oil prices, use of wood wastes for heat production could be cost-competitive. Small and medium-sized boilers (with capacity less than 10 MW) have already been converted to biomass use in Estonia, Latvia, Lithuania and some regions of Russia.[39] Simple

[37] Martinot, E., "Renewable Energy in Russia: Markets, Development and Technology Transfer", Renewable and Sustainable Energy Reviews, 1999, p. 56 ; Suslov A. "Vosmozhnost ot kotoroi my vriadli imeem pravo otkazatsia", ABOK, 2/2001; c.54-60 .

[38] http://www.zpok.hu/inforse/16.html

[39] See http://www.grida.no/climate/ipcc/tectran/346.htm for a detailed review of the Swedish Government's programme for biomass boiler conversions in the Baltic States.

payback time for these conversions has been around 3 –5 years, and positive financial returns have also been demonstrated. [40] The most favourable regions for this market are Leningrad, Karelia, Vologda, Novgorod, Maritime and Khabarovsk. Potential investors in district heating boiler conversion are municipal or privatised district heating companies, or the responsible local or regional administrations.

Although district-heating systems provide heat and hot water to most of the urban population and to industry, most rural settlements have no centralized heat supply. Only 2 million rural houses are connected to the gas supply grid, while the remaining 12.6 million houses are heated by burning wood, peat or coal.[41] Families spend a significant part of their income or/and of their time to provide themselves with fuel for winter. In-door burning of wood is inefficient and is harmful for human health and for the environment. These rural areas represent a vast potential market for modern technologies for small-scale (individual) heat and hot water production from biomass (agricultural and municipal wastes and wood), and also for individual solar collectors.

Large-scale use of biomass waste for heat or for combined heat-and-power generation are other cost-effective options, especially in the northwestern part of Russia, where the pulp and paper industry is well-developed. Biofuels account for only some 20 to 30% of the energy supply of the pulp and paper industry in Russia, compared to 52% in the European pulp and paper sector.[42] Given that energy price reform is already taking place in Russia and the fact that current electricity supply in the northwestern part of Russia is very unreliable, using more biomass waste for their own energy use makes good economic sense. It can also increase energy efficiency.

Direct use of geothermal energy for space heating, hot water production, warming of greenhouses, crop drying, etc. is commercially viable in Kamchatka, the North Caucasus and other regions with large geothermal resources.

● Competitive Industrial Markets

In certain industrial applications in OECD countries, renewable energy technologies (PV, small wind turbines, etc.) have proven to be more cost-effective than conventional energy sources in many instances. The number of such application is growing and includes:

- marine/river navigational aids,
- cathodic protection of pipelines and well heads
- power for off-shore oil and gas platforms
- telecommunications
- radar
- aircraft obstruction lighting
- air traffic control
- weather stations/ seismic monitoring

In some countries, these industrial applications have provided an economic base to allow sufficient volume and profitably to pursue wider markets. The same could be true of Russia, if those engineers making these decisions were better aware of the options.

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[40] Martinot, E., "Renewable Energy in Russia: Markets, Development and Technology Transfer", Renewable and Sustainable Energy Reviews, 1999, p. 54.

[41] Strebkov, D. "Energy Use of Biomass", Intersolar Centre (in Russian).

[42] BASREC, Development of the Use of Bioenergy in the Baltic Sea Region, October 2002, p. 15

Renewable Energy in Russia: the Economic, Social and Environmental Context

Security of Domestic Energy Supply

The Russian energy sector faces the challenge of meeting rapidly growing domestic energy demand. Russia's total primary energy demand is projected to grow by 1.4% per year to 2030.[43] Electricity consumption is expected to increase by 79% by 2020 and central heat consumption is expected to go up by 25%.[44] The existing overcapacity in generation is expected to disappear by 2009.[45] The investment needs to meet growth in electricity demand over the next two or three decades are challenging, particularly given the old age and poor maintenance of existing generation. About 40% of installed capacity has been in service for more than 25 years.[46] Independent experts estimate that the electricity sector will need between $20 billion and $50 billion over the next 10 years to avoid nation-wide electricity shortages between 2003 and 2008.[47]

Residents in Kamchatka have already faced severe electricity blackouts. Many individual and industrial consumers in other regions as well frequently face limitations and cut–offs from electricity and heat supplies. Damage to the economy caused by power disruptions is estimated in the billions of US dollars.[48]

The investment needs for power generation are challenging in the current Russian market. As de-regulation proceeds, however, suppliers will be more likely to compare costs among competing generating technologies. Renewable energy, as a source for distributed generation, avoids a large "lumpy" central investment and will play a larger role. Energy pricing reforms will be key to encouraging the levels of investment needed. Smaller and more quickly deployed distributed generation based on renewable energy can offer high reliability on a more evenly paced budget outlay.

Russian electricity transmission and distribution systems are ageing and weak. Much of the equipment at electric power substations is badly worn out. Overall depreciation is estimated at 61 percent. About 30 percent of transformers and 43 percent of high-voltage switches (in the range 110 to 500 kilowatts) have exceeded their working life of 25 years.[49] Today electricity supply disruptions due to breakdowns are especially frequent at local low-voltage electrical lines.

With an efficient transmission pricing structure, distributed generation from renewable energy can reduce the need for upgrading part of the electricity distribution systems, or for expanding distribution or transmission capacity. DG based on renewable sources can be a

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[43] IEA/OECD, *World Energy Outlook 2002*, Paris, 2002, p. 272.

[44] IEA/OECD, *Russia Energy Survey*, Paris, 2002, p. 51.

[45] Troika Dialog Research, *UES: Undervalued Despite Overcapacity*, November 2002

[46] IEA/OECD, *Russia Energy Survey*, Paris, 2002, p. 198-9.

[47] "In Need of Shock Therapy", The Economist, 22 August 2002

[48] Bezrukikh, P. "Non-traditional Energy Sources", Analytical Report, Russian Ministry of Fuel and Energy, http://www.mte.gov.ru/ntp/energo/analit_doc.htm

[49] "Russia to Demonopolise Its Power Sector – but How and When?" World Bank, Transition Newsletter January – February 2002

more economic option in areas rich in renewable energy resources, and where the costs of building or modernising electricity transmission lines are too high.

Energy Exports

Energy exports are the major source of Russian hard-currency earnings. Many energy analysts doubt Russia's capacity to maintain the recent strong growth rate of oil production to meet rising export and domestic demand.[50] These concerns are partly due to the current unfavourable investment climate and partly due to geological conditions. Most easily accessible oil fields with high discharge flows have already been exhausted or heavily damaged. Many new prospective fields have difficult geological profiles and are situated in severe climatic conditions. Limitations to a significant increase in gas output also exist. Exploration of new oil and gas fields will be necessary to maintain and increase the output. This will require heavy investments.

Increasing the share of renewable energy could not only help Russia meet part of domestic energy supply in a more sustainable way but also could free more oil and gas for export.

Economic Diversification

Heavy dependence on energy exports makes Russian economy vulnerable to world energy prices and demand fluctuations. The 1998 Russian economic crisis was partially a result of low oil prices. One of the Russian government's objectives is to diversify the economy by developing industries in order to break up the country's dependence on energy exports.

Renewable energy commercial deployment could diversify the economy through the development of Russian renewable energy industry. Manufacturing of renewable energy systems could become one of the sectors where Russian scientific and technical knowledge and engineering and technical skills could be applied.

Social and Economic Stability

As a result of its economic transition, Russia faces serious social problems: a high poverty rate and poor living conditions; unemployment; a potential demographic crisis; unfavourable migration patterns, etc. Many rural areas have unstable electricity supply, and power outages occur very often. A number of remote settlements have no access to electricity at all. Rural areas have the highest unemployment rate. Both rural-to-urban and north-to-south migration patterns are evident in Russia today.

Renewable energy technologies can improve life quality of people in rural areas by providing reliable electricity, heat and water supply. Most renewable energy technologies are also considered to be more labour intensive than conventional energy.[51] International experience demonstrates that renewable energy technologies can provide direct employment

[50] IEA/OECD, *World Energy Outlook Insights 2001: Assessing Today's Supplies to Fuel Tomorrow's Growth*, Paris, 2001.

[51] "Employment Benefits of Renewable Energies", IEA/CERT/REWP(02)16, Note by the Secretariat, 2002

opportunities on different stages of their development: from research and demonstration to manufacturing, installation, operation and maintenance. Renewable energy technologies also create indirect employment opportunities in other sectors of economy, notably in agriculture and forestry, which supply biomass.

Environment

The well-known Soviet slogan "We cannot expect charity from nature: we must tear it from her" represented the Soviet state's attitude towards the environment. The centrally planned economy, which focused on extensive industrial production at all costs, was characterised by the inefficient and unsustainable use of natural resources, including mineral resources, land and water, regardless of environmental and ecological concerns. Transitional Russia has not given priority to environmental issues. As a result, the country faces severe environmental problems. The short-term reduction in pollution due to the economic decline following the break-up of the Soviet regime may easily be reversed when production levels recover. The reversal could be severe, if efficiency and environmental performance are not improved.[52]

The international financial community is likely to look favourably on environmentally friendly investments such as for renewable energy technologies. This is fortified by increasing awareness and concern within the general Russian population.

Facilitating the Market Deployment of Renewable Energy

The cost of Russian technologies is on average 30 to 50% lower than that of western analogues[53], but the quality and reliability of most Russian RE equipment is typically lower. The companies involved do not have access to a market for their technologies and therefore lack the production volume sufficient to improve. Most Russian technologies could best be described at the stage of R&D or demonstration, while similar western technologies are already more or less commercialised.

[52] Environment in the Transition to a Market Economy: Progress in Central and Eastern Europe and the New Independent States, OECD 1999

[53] Bezrukikh, P. "Non-Traditional Renewable Energy Sources", Analytical Report, Russian Ministry of Fuel and Energy, http://www.mte.gov.ru/ntp/energo/analit_doc.htm

Russia's Early Developments in Renewable Energy Technology

Russia has developed numerous renewable installations, beginning in the early 20[th] century. In the early 1930s, the Soviet Union was the first in the world to start constructing utility-scale wind turbines (Bataclava Wind Turbine). In the six years following the end of the Second World War, Russia increased its small hydro capacity to 1500 MW by installing 7000 SHPSs. Research into solar photovoltaic cells was one of the best-developed technologies in Russia due to the Soviet space programme. The satellite fuelled by solar cells sent Sputnik 3 into orbit in 1958. The Pauzhetkaya geothermal power station in Southern Kamchatka was built in 1967, with installed capacity of 5 MWe.

As central planning came into fore in the energy industry in the 1950s and 1960s, fossil fuel resources began to be further exploited and concern over energy security dissipated; broad interest in renewable energy fell by the wayside. For much of the second half of the twentieth century, the knowledge was preserved in technology institutes and associated companies. Today, Russia's RE technologies (except for large capacity wind turbines) are comparable to foreign technologies in function and in scientific and technical characteristics. But, without ready markets, a commercial industry has been slow to develop.

Russian enterprises have technological infrastructure, scientific and technical knowledge, as well as engineering and technical skills sufficient for mass production of renewable energy systems. Today there are 100 to 150 Russian companies, which can manufacture small and large-scale RE systems.[54] Many of them are former enterprises of the military complex, which have been converted to production of more modern and promising technologies. However, only few of these companies actually manufacture RE systems because of the absence of demand. Russian enterprises in this area still lack the associated managerial, financial, legal, and market-transaction skills to successfully sell their products.[55]

The market penetration of renewable energy systems in Russia is limited by a number of barriers: economic, financial, legislative and regulatory. Market penetration is also subject to limited awareness. Government attention and support is necessary to overcome these barriers. Improving the overall investment climate, by continuing the economic, financial, legal, regulatory and fiscal reforms, is particularly vital. It is also important to maintain and extend the reforms to the energy sector and to eliminate subsidies for conventional energy sources.

Government support to renewable energy technologies will not require billions of roubles of assistance. There are some practical low-cost measures that can stimulate investment in renewable energy technologies and lead to considerable economic returns. In the short term, Russian policy makers should concentrate on measures that would enhance the deployment of RE technologies that already have competitive advantages in specific applications. These applications, such as biomass boilers, wind turbines in remote areas, solar hot-water heaters and geothermal sites are discussed above. Government support to these systems would lead to a decline in their costs as Russian businesses become experienced with installation and maintenance on a large scale. Lower costs will open new markets for these technologies and will allow them to compete with conventional energy technologies. There is a renewables industrial base to work from in Russia, with a long history. It needs partnership with the international industry to kick start into a viable industrial sector.

[54] See details in the catalogue, "Equipment for Non-traditional and Small-Scale Energy', Moscow, 2000, or on www.intersolar.ru.

[55] Martinot Eric(Energy efficiency and renewable energy in Russia: transaction barriers, market intermediation, and capacity building," Energy Policy 26(11):905-915 (1998).

Each renewable energy technology will require specific measures to facilitate its market deployment, but a number of general actions are suggested here that enable the development a market for RE technologies. These actions would increase awareness and attract investment. Contrary to subsidies and direct funding of renewable energy, the following measures are low-cost investments that will reap short-term benefits.

Political / Legal / Regulatory Supports

Political support of renewable energy and an appropriate legal framework are necessary to increase the attractiveness of investment in renewable energy projects. The first important step in this direction was the adoption of the "Development of New Renewable Energy in Russian Northern Regions in 2002-2005" as part of the Federal programme, "Energy Efficient Economy". Further steps could include:

- Develop an integrated supply / demand approach to energy policy, which would encourage more energy-efficient and environmentally-friendly technologies

- Recognise RE development as one of the focal points of the national energy strategy in the coming decades;

- Develop a renewable energy action plan within the general energy policy

- Adopt a law on renewable energy to give a legal status to developers of renewable energy projects;

- Clarify the status of independent power producers (IPP). Industrial companies producing electricity for their own use must have a non-discriminated access to the grid.

- Introduce effective regulation that would guarantee equal or even prioritised access to the transmission grid to independent RE power producers.

Information and Awareness

Stakeholders' awareness of the existing renewable energy resource base, technologies and their benefits should be increased through effective information dissemination. The following measures could be introduced:

- Creation of a federal and regional centres responsible for collecting, up-dating and disseminating information on renewable energy resources.

- Obliging electricity supply utilities to study renewable energy resources within their area of service to determine the most effective technologies and sites;

- Publication of atlases of renewable energy resources (federal and regional) and their dissemination for potentially interested parties: e.g. energy companies, electricity utilities, investors and local authorities;

- Increasing the awareness of professionals and general public about renewable energy benefits and existing technologies through mass media, organisation of conferences, publication of outlets, etc, particularly in those segments that can be "early adopter" consumers;

- Wide coverage of existing RE projects ("success stories").

International experience has demonstrated that increasing public awareness of RE can lead to a significant increase in the use of RE in the residential sector, especially for biomass and solar thermal.[56]

Support of Domestic RE Industry

Governmental support is necessary to facilitate the commercial deployment of Russian renewable energy technologies. The following measures would help domestic RE industry on the first stage of market development:

- Encourage further R&D to improve the quality of Russian RE systems and to reduce costs;

- Encourage technology partnerships with international companies and joint production of RE systems;

- Introduce tax credits/ tax exemptions for RE manufacturers for a limited time.

Demand-side measures for RE systems would also stimulate the development of RE industry:

- Reduced or zero VAT to make RE installations more affordable for end-users;

- Investment tax incentives and /or accelerated depreciation to encourage investments in RE by industrial users;

- Favourable loans for individual consumers of RE;

- Net Metering, allowing small electric systems to feed power directly to the distribution line.

The following measures would further facilitate the implementation of RE projects

- Reduce planning barriers and facilitate RE project registration procedures;

- Lower or eliminate customs duties for imported RE installations;

- Selectively reduce RE project taxes.

In the medium and long terms, other measures could be introduced to support the development of other RE technologies.

● Adopt environmental regulations, which would benefit environmentally clean energy sources while banning polluting options: emissions standards; emission taxes, etc.

[56] KWI and Energy Centre Bratislava "Renewable Energy Action Plan", Slovak Republic, July 2002.

- Introduce a Renewable Portfolio Standard (RPS) or Renewable Target, combined with a system allowing renewable energy credits to be traded on the international market
- Establish a protocol for renewables to qualify for JI status under Kyoto.

Conclusion

Russia is not usually perceived to be at the top of the list of countries with significant renewable energy potential. This report demonstrates that, in fact, Russia is at or near the top. The report details the country's enormous and diverse renewable energy potential and demonstrates market applications for renewable energy technologies that can yield immediate economic returns with very small initial investments. The report also offers some suggestions for policies and measures that could contribute toward building a market for renewable energy technologies.

If Russia were to develop a viable domestic market for renewable energy technologies, based on its already considerable technical and scientific experience, it could eventually compete in the international arena. Russia is located next to many energy-hungry neighbours who are also searching for ways to improve their environment and their energy security. If Russia could establish a commercial market for renewable energy, Russian renewables-based electricity could fire homes and industry not only in Russia, but in Europe and China in the following decades.