

RENEWABLES in RUSSIA

From Opportunity to Reality

INTERNATIONAL ENERGY AGENCY

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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- to operate a permanent information system on the international oil market;
- to improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- to assist in the integration of environmental and energy policies.

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FOREWORD

Russia is a key energy producer and exporter. IEA co-operation with the Russian Ministry of Energy dates back to the early 1990s; a Memorandum of Understanding was signed in 1994. To date, the co-operation has focused largely on gas supply security, energy efficiency, the investment framework and energy sector transparency. Recent developments in Russia's energy policy have demonstrated an increased interest in renewable energy sources. This publication is intended to support Russian-IEA co-operation by analyzing the prospects for developing a renewable energy market in Russia. By contributing to the evolving discussions on Russian policy in the sphere of renewable energy, this study supplements the "Russian Energy Survey" released by the IEA in March 2002.

Russia's current use of renewable energy is very low, although it has huge wind, hydro, geothermal, biomass and solar energy resources. The challenges of scaling-up Russia's use of renewable energy are significant. This publication offers a first outline of a strategy for developing such a renewables market. It details Russia's enormous and diverse renewable energy potential and characterizes opportunities for harnessing it. The book describes applications for renewable energy technologies that can yield immediate economic returns. It also offers some suggestions for policies and measures that could contribute toward building a market framework for renewable energy technologies that recognizes their special benefits and character. Finally, it describes economic, social and environmental gains that renewable energy can yield in specific Russian conditions.

The potential for renewables to contribute to Russia's public policy objectives will be shaped by the pace of reform across Russian society and its economy. Broad energy policy must incorporate all forms of primary energy and reforms will fundamentally alter the relative economics of each form. Care must be taken to ensure the cost effectiveness of renewable options in the evolving energy mix.

This publication is timely. Russia is restructuring its electricity sector and contemplating reforming its gas sector. It is debating ratification of the Kyoto Protocol and is also actively pursuing membership in the World Trade Organisation. *Renewables in Russia: From Opportunity to Reality* aims to contribute to the on-going debate on Russian energy and climate change policy.

Executive Director
Claude Mandil

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EXECUTIVE SUMMARY

RENEWABLE ENERGY RESOURCES AND POTENTIAL

Russia has substantial and diverse renewable energy resources — wind, geothermal, hydro, biomass and solar. Practically all regions have at least one or two forms of renewable energy that are commercially exploitable, while some regions are rich in all forms of renewable energy resources. The volume of renewable energy with economic potential corresponds to about 30% of the country's actual total primary energy supply (TPES), while the technical potential is estimated to be more than 5 times greater than TPES. Russian experts estimate that the amount of renewable energy that is economically recoverable is more than 270 million tonnes of coal equivalent (Mtce) per year¹, including 115 Mtce/y of geothermal energy, 65.2 Mtce/y of small hydropower, 35 Mtce/y of biomass, 12.5 Mtce/y of solar, 10 Mtce/y of wind and 36 Mtce/y of low potential heat.

It should be noted that these estimates of renewable energy potential have not been updated since 1993, and do not consider the more recent evolution of the economic situation in Russia. According to the new *Energy Strategy of Russia*, adopted in May 2003, the economic potential of renewables has grown significantly in recent years because the prices for fossil fuels have increased while the cost of renewable energy technologies has dropped.²

RENEWABLES IN THE RUSSIAN ENERGY MARKET

Russia currently uses very little of its huge renewable energy potential. In 2001, only 3.5% of its total primary energy supply (TPES) was based on renewable energy, of which two-thirds was hydro and one-third all other forms. According to official Russian statistics, renewable energy (without large hydro) accounted for 0.5% of total electricity generation in 2000 and 2001.³ There are no statistical accounts for heat production from renewable sources. Russian experts estimate that heat based on renewables⁴ amounts to about 4% of the total heat in Russia.

Russia's energy mix is dominated by natural gas, which accounts for 52% of TPES, and 42% of electricity generation inputs. Electricity and heat tariffs and domestic gas

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. (2002), *Resources and Efficiency of the Use of Renewable Sources of Energy in Russia*, SPb, Nauka.
2. Ministry of Fuel and Energy, *Energy Strategy of Russia until 2020*, Moscow, Approved 22 May 2003.
3. Interview with P.P. Bezrukikh, head of the Department of Technological Progress, Russian Ministry of Fuel and Energy, 11 March 2003.
4. Including biomass and wastes, low potential heat (heat pumps), solar thermal.

prices are state-controlled, and often kept artificially low. When the cost of using renewable energy is compared with the distorted price of the conventional energy market, it is not surprising that renewable energy is often not competitive.

Over the last decade, significant steps in an on-going privatization and demonopolization process have taken place in the Russian energy sector. A key element of these reforms is the introduction of cost-based pricing. In particular, major progress has been made in the electricity sector reform process with the adoption of a package of laws in April-May 2003. Work on secondary implementation legislation is currently underway and expected to be finalized by end-2003.

Reform in other energy markets is also underway, though its pace differs from sector to sector. Domestic prices of oil and oil products are already close to international levels. Domestic gas prices, which are still much lower than export prices, are gradually rising and are expected to reach international levels in the future. Then, as the existing energy infrastructure expands, comparisons among different fuel sources and technologies will favor those renewable energy technologies that are currently competitive in many market applications.

POTENTIAL MARKETS FOR RENEWABLE ENERGY TECHNOLOGIES

Currently in Russia there is significant “low-hanging fruit”—*i.e.* applications where renewable energy sources have a competitive advantage over conventional energy sources. There will be more such applications in the future when domestic gas prices increase. The combination of Russia’s rich renewable energy resources and modern, existing renewable energy (RE) technologies suggests that investment in renewable energy in Russia could generate large economic benefits. The Mechanisms of the Kyoto Protocol are particularly well-suited to foreign investment in this domain.

Grid-connected Electricity Supply

Globally, markets for grid-connected renewables, particularly wind, geothermal, small hydro and bio fuels, are growing rapidly due to investments in OECD and other countries. As a result of economies of scale, technology improvements and more efficient production techniques, costs have declined to a point where in many locations (in Russia and elsewhere) these systems are cost-competitive with conventional energy technologies.

Although Russia as a nation is an energy exporter, most Russian regions produce less energy than they need, so they have to import it from the few energy-rich regions such as Western Siberia. Some of Russia’s fossil-fuel-deficient regions face frequent disruptions in fuel supplies due to rugged weather and transportation conditions and to suppliers’ preferences for export markets. Given long distances between regions, transportation costs can dramatically increase the total cost of fuel. Indeed, some remote territories such as Kamchatka, Republic Tyva and Republic Altai spend more than half of their budgets on fuel.⁵

5. Bezrukikh, P. *Нетрадиционные возобновляемые источники энергии (Non-Traditional Renewable Energy Sources)*, Analytical Report, Russian Ministry of Fuel and Energy, http://www.mte.gov.ru/ntp/energo/analit_doc.htm

Many regions have locally-available renewable energy resources. Their exploitation is commercially attractive since current traditional energy supplies are expensive and unreliable. Geothermal plants are commercially viable in Kamchatka, the Kuril Islands and the North Caucasus. Large-scale wind projects can compete in coastal areas of the Russian Far East, in the steppes along the Volga River and in the North Caucasus. Small hydro development is attractive in the North Caucasus, the Urals and in Eastern Siberia. Large-scale use of biomass for energy purposes is cost-effective in many Russian regions, especially in the north-western part of Russia, where the pulp and paper industry is well-developed.

Off-grid Electricity Supply

Off-grid systems have proven to be very cost-effective in many OECD and developing countries because electricity suppliers can avoid the (often high) cost of extending transmission and distribution systems. 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, or nearly so, with traditional fossil fuel technologies in remote areas depending on local conditions and the level of subsidies to conventional energy.

In Russia, about 10 million people are not connected to electricity grid and are currently served by stand-alone generation systems using either diesel fuel or gasoline.⁶ Nearly half of these diesel and gasoline systems are reported to be no longer operating because of fuel delivery problems and/or high fuel costs⁷. Remote Northern and Far Eastern areas get their fuel by rail or road and sometimes by helicopter. These supplies are unreliable and expensive. Currently, the cost of transporting these fuels (when it can be sustained) is not borne by the users of these systems. Removing energy subsidies would provide the joint benefit of making renewable energy a viable alternative, as well as improving reliability by switching to locally available energy rather than depending upon distant suppliers and a strained transport system.

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.⁸ According to one estimate, 5 million individual farms and vegetable growers are not connected to an electricity grid.⁹ Many other dachas have unreliable and expensive power supply.

Heat and Hot Water Supply

Because of the subsidisation of input fuel costs and end user prices, the use of energy for heating is extremely inefficient in Russia. There has been little incentive to focus on either energy efficiency or fuel choice. Reform of energy prices will inevitably change this situation. Experience in North American and Europe shows that a number of currently available renewable energy technologies are cost-effective in heating and hot

6. 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.
7. Martinot, E., "Renewable Energy in Russia: Markets, Development and Technology Transfer", Renewable and Sustainable Energy Reviews, N3, 1999. www.martinot.info/re-publications.htm
8. Strebkov, D., "Trends In Russian Agriculture and Rural Energy", Intersolar Centre.
9. Karabanov S. "The Prospects for Photovoltaic Development in Russia", Renewable Energy Report, 2001, UNESCO.

water applications. These technologies can be also effectively used in Russia. 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. Conversion of coal- or oil-fired district heating boilers to burn biomass fuels (especially wood wastes) is another cost-effective application, especially in cases where Russian consumers face unsubsidized heavy fuel oil and coal prices. Small and medium-sized boilers have already been converted to biomass use in Estonia, Latvia, Lithuania and some regions of Russia.¹⁰ Simple payback time for these conversions has been around 3-5 years, and positive financial returns have been demonstrated.¹¹ The most favorable regions for this market are Leningrad, Karelia, Vologda, Novgorod, Maritime and Khabarovsk.

Solar collectors can improve the efficiency of heat supply either as stand-alone systems, or when combined with heat-only boilers. Today Russian district heating systems with heat-only boilers 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. Solar hot water collectors could replace the existing traditional source of hot water and allow the district-heating boilers to be shut down in the summer months. In other months, solar collectors could be used to heat boiler feed water, or as an additional heat source, thereby reducing the boiler's load and fuel consumption. If relative costs of the "hybrid" systems included the fuel savings and the reduction in operating and maintenance costs, these systems could be cost-competitive with conventional boilers in many areas.

Most rural settlements in Russia have no centralized heat supply, so some 12.6 million houses are heated by burning wood, peat or coal.¹² Families spend a significant part of their income and/or their time to provide fuel for winter. In-door burning of wood is often inefficient and harmful to human health and 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.

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 navigation aids, cathodic protection of pipelines and well heads, power for off-shore oil and gas platforms, power for telecommunications and many other applications. Along with providing lower costs at the respective sites, these industrial applications also provide a base of consumers so that RE technology suppliers can produce at higher volume and profitably expand into wider markets. The same dynamics will appear in Russia if industrial sector decision makers are aware of these cost-effective options.

10. 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.

11. Martinot, E., "Renewable Energy in Russia: Markets, Development and Technology Transfer", *Renewable and Sustainable Energy Reviews*, N3, 1999. www.martinot.info/re-publications.htm

12. Strebkov, D. "Energy Use of Biomass", Intersolar Centre (in Russian).

RENEWABLE ENERGY R&D AND MANUFACTURING

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. The cost of Russian technologies is on average 30 to 50% lower than that of western analogues,¹³ but the quality and reliability of most Russian RE equipment is typically lower. 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. The Russian renewables industry needs encouragement by the government in the form of national goals and legislation and partnership with the international industry to kick-start a viable domestic market. 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.

FACILITATING RENEWABLE ENERGY MARKETS

Just like other sectors of the economy, the renewable energy sector faces major barriers to investment, including lack of transparency; competition from subsidized conventional energy sources; and a weak financial industry. The lack of a specific national RE strategy, of adequate legislation and regulatory framework further constrains the development of renewable energy markets. Improving the overall investment climate, by continuing the economic, financial, legal, regulatory and fiscal reforms, is therefore vital. It is also important to maintain and extend the reforms to the energy sector and to eliminate subsidies for conventional energy sources.¹⁴

In addition to broad economic reforms, Russian policy makers could also introduce specific measures to enhance the development of renewable energy. This will not necessarily require substantial financial support because there are practical low-cost and often competitive measures that would stimulate investment in renewable energy technologies and could lead to considerable economic returns. In the short term, Russian policy makers could concentrate on measures that would enhance the use of RE systems that already have competitive advantages in specific applications. As Russian businesses become experienced with installation and maintenance on a large scale, new markets for these technologies will open up, creating even more competitive opportunities.

Each renewable energy technology will require specific measures to facilitate its market deployment, but a number of general actions are suggested here that could enable the development of a market for RE technologies.

The typical pattern that countries have followed to develop a renewable energy market is to implement a strategy in three main steps: adopt a renewable energy strategy

13. 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

14. For a more detailed discussion of the reform process in Russia see IEA/OECD 2002, *Russia Energy Survey*.

(identify goals); adopt relevant laws (set up the market structure); and specify implementation mechanisms (establish market rules). It is possible, however, to introduce some actions of each next step before the full implementation of the preceding one.

Russia has made the first important steps toward the recognition of the importance of renewable energy sources. The Federal program “Energy Efficient Economy in 2002-2005 and up to 2010” adopted in November 2001, contains a section “Effective Energy Supply of Regions, including Northern Territories, on the basis of Non-traditional Renewable Energy Sources and Local Fuels”. The national energy strategy¹⁵, adopted by the Russian government in May 2003, states the strategic goals of the development of renewable energy and local fuels (wood and peat) are to:

- reduce use of non-renewable energy sources
- reduce negative environmental impact of the energy sector
- stabilize energy supply in decentralized and isolated regions
- reduce the expense of fuel transported over long distances

National goals can be quantified in the form of Renewable Energy Targets (RETs) that set a minimum percentage of energy or electricity supply in a given country (or region) from renewables. For example, the European Union’s Renewable Energy Directive¹⁶ sets the target to achieve 22,1% of electricity produced from renewable energy and 12% of renewables in gross national energy consumption by 2010. The Russian energy strategy does not articulate official targets for renewable energy development, but it states that it is possible to put into operation 1000 MW of power generation capacity and 1200 MW of heat capacity based on renewables by 2010, if the necessary government support is ensured. It is not precise, however, about how the government will support renewables. Building on experience in other countries, Russia could also establish national renewable energy targets and outline a strategy (or an action plan) to achieve these targets. Conversely, Russia could eschew a national target and focus on setting real energy prices and then establishing a set of incentives and other market mechanisms to encourage renewables’ contribution to the goals of the 2003 national energy strategy.

The new Russian energy strategy underlines the necessity of adopting a federal law on renewables. Indeed, a national renewable energy law would translate a national strategy into a structure of roles and authorities. The next step in the RE strategy implementation would be bringing into practice the national strategy on the territorial, regional and local levels. This will require adequate regulatory and institutional rules authorized under the national renewable energy policy. Regulations and provisions can either enforce the mechanisms outlined in the national law, or introduce specific regional/local initiatives in accordance with the national strategy.

15. *Energy Strategy of Russia up to 2020* (in Russian), <http://www.mte.gov.ru/docs/32/103.html>

16. Directive 2001/77/EC on the promotion of electricity from renewable energy sources in the internal electricity market, adopted by the Council of Ministers and the European Parliament in September 2001.

National policies as well as regulations can be of a different nature depending on their purpose: to create a legal and institutional framework for renewable energy project implementation, to help the RE industry, or to stimulate or assist consumers of RE systems. Some regional and local activities can be aimed at direct support of concrete renewable energy projects. This report suggests, based on international experience, a number of policies and measures that could contribute toward building a market for renewable energy technologies: e.g. renewable energy portfolio standards, broad information dissemination, fiscal incentives (reduced VAT, accelerated depreciation, investment tax credits, etc.), direct project support and others.

RENEWABLE ENERGY IN RUSSIA: THE ECONOMIC, SOCIAL AND ENVIRONMENTAL CONTEXT

Economic Development

Russia's President Putin has set a goal to double the gross domestic product in a decade. If Russia is to meet this ambitious goal, the Russian energy sector will face the challenge of meeting rapidly growing domestic energy demand. Renewable energy can contribute to this challenge, particularly in regions with a deficit of traditional energy sources. Renewables can also play a role in providing power to distributed consumers. In many isolated settlements renewables are the most economic, and sometimes even the only option of providing electricity and heat services to consumers.

In Russia, energy exports are the major source of hard-currency income and budget revenues. Russia would like to further increase its oil and gas output and sales to enhance economic growth. At the same time, however, one of the government's objectives is to reduce the economy's dependence on energy exports by diversifying its base of industries. Increasing the share of renewable energy would stimulate the development of Russian renewable energy industry, thus contributing to meeting the goal of diversifying Russian industry. In the medium to long term, "green exports" could become a reality, thus contributing to the goal of diversifying Russia's exports. Russia is located nearby 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 also in Europe and Asia in the future.

Social and Environmental Benefits

Renewable energy has significant environmental and social benefits over conventional energy sources. In Russia, increasing the use of renewable energy could reduce unemployment, improve living conditions and reverse the depopulation of rural areas and of Northern and Eastern territories. Replacing conventional energy sources with renewable energy technologies could also reduce the rate of environmental degradation and improve the health and well-being of the population.

INTRODUCTION

On a percentage basis, renewable energy (RE) is the fastest growing energy source in the world today. The belief that renewable energy can contribute to solutions to energy security and environmental concerns has led many OECD governments to provide incentives and other policy supports, thus causing RE costs to drop and markets to grow. As a result, renewable energy in the best conditions can be quite cost-competitive with conventional energy, particularly when environmental benefits are added.

In Russia, however, a country with enormous renewable energy resource potential, current use of renewable energy is quite low. The reasons for the lack of renewable energy use in Russia result from a complex set of factors.

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

Second, 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. Yet, the development of a renewables market does not conflict with fossil resources, but complements them. This report presents economic, social and environmental reasons why building a renewable energy market can contribute to Russia's energy portfolio now and in the future.

Third, renewable energy is often perceived as a "rich countries' toy" and to play with it, massive budget spending is required. However, the substantial investments made in OECD countries to drive down costs need not be repeated by Russia to achieve the same cost or market level. This report highlights experiences in other countries that demonstrate that Russia can successfully and inexpensively 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.

Fourth, the development of renewable energy resources is hindered by Russia's difficult 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

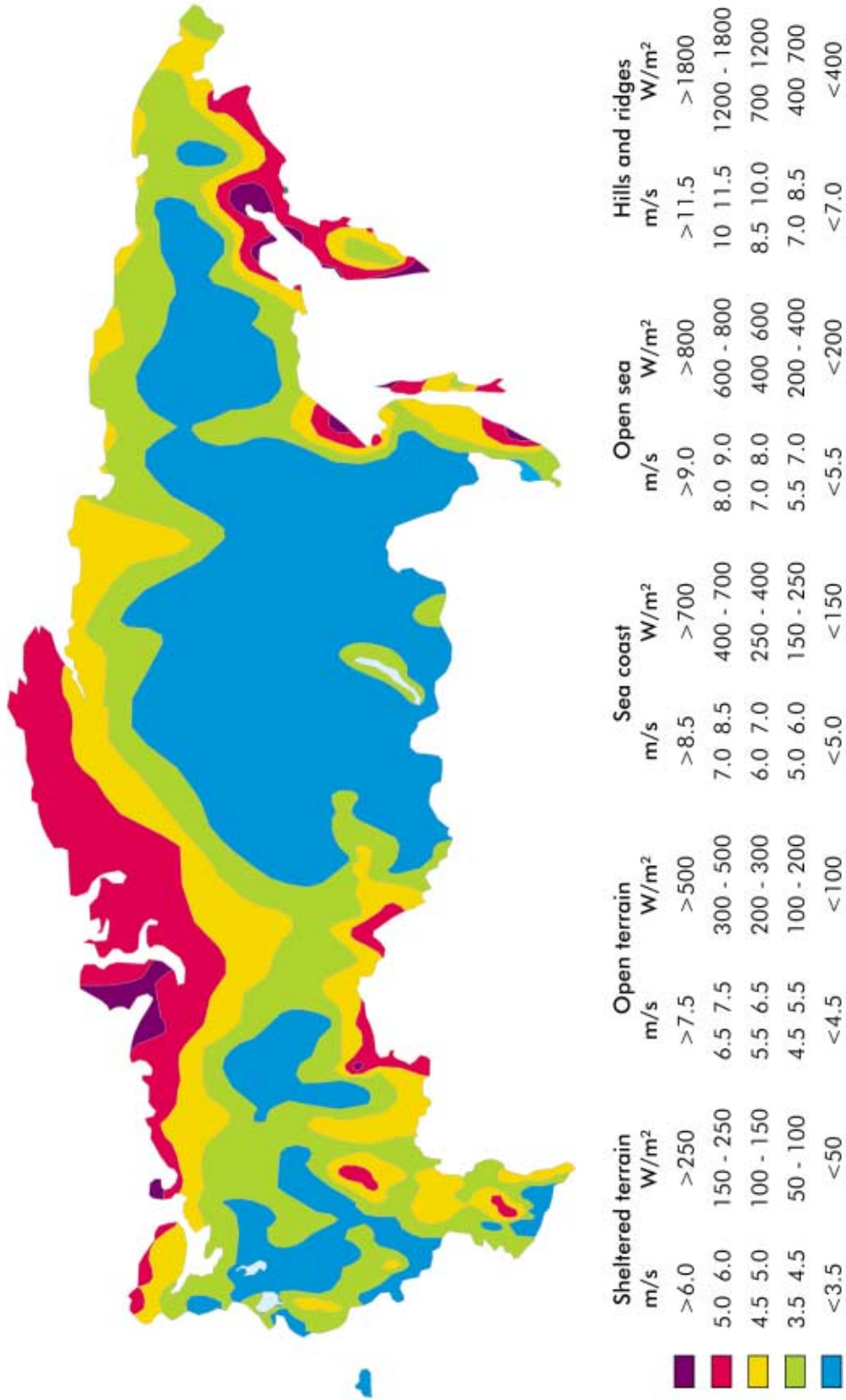
prices, in particular, are a crucial impediment to attracting investment in the energy sector. This report underlines the benefits of creating a more attractive and competitive investment environment in Russia.

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 focused especially on gas supply security, energy efficiency, the investment framework and energy sector transparency. This report is intended to support Russian-IEA co-operation by describing the potential for developing a renewable energy market in Russia.

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. This report supplements information provided in the *Russian Energy Survey 2002* and the currently available information on renewable energy.

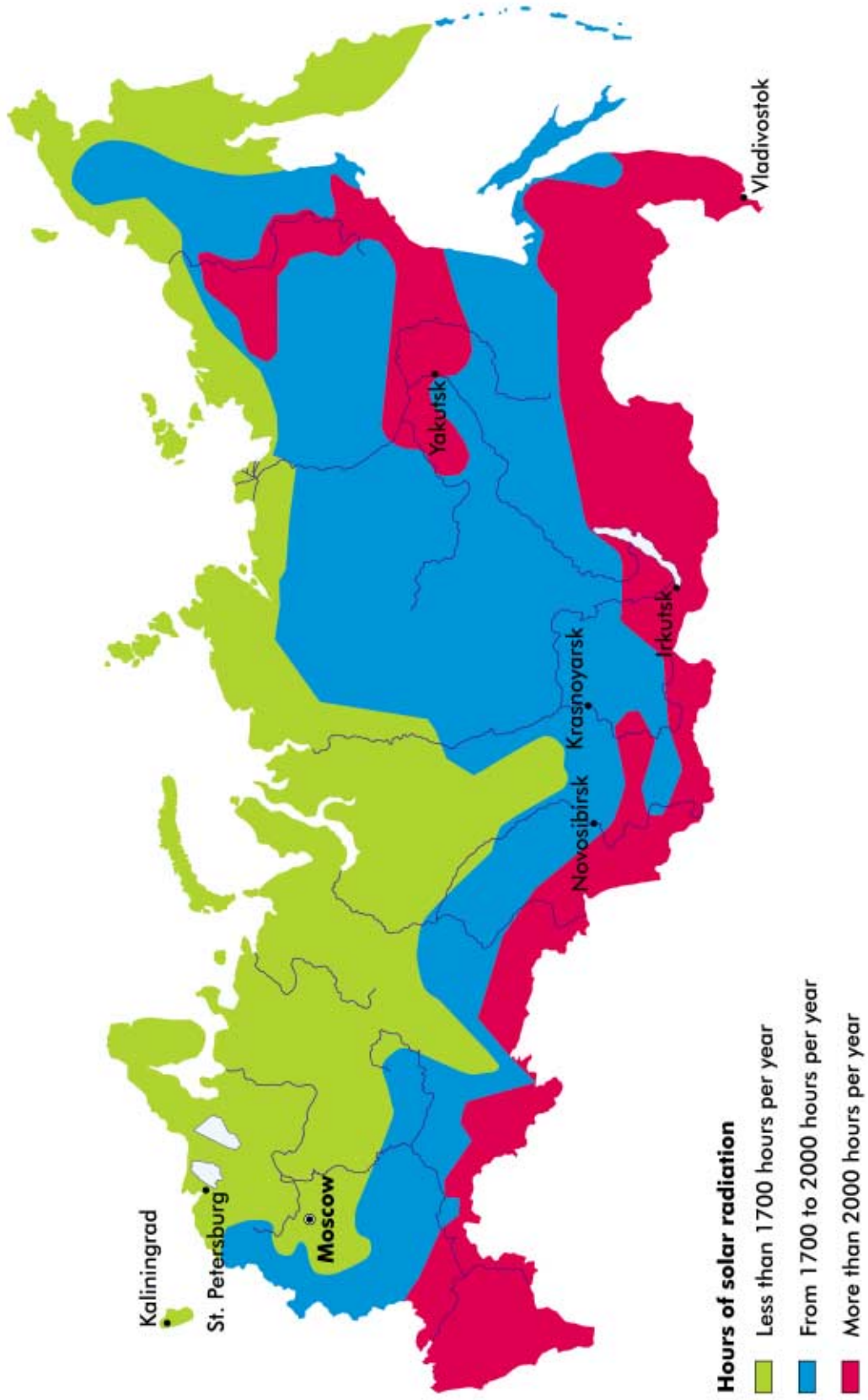
The challenges of scaling-up Russia's use of renewable energy are great, but this report offers a first outline of a strategy for developing a RE market. With the information provided in this report, policy makers will see that RE offers a real opportunity for contributing to solutions for some of Russia's energy and economic 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.

Figure 1 Wind Resources



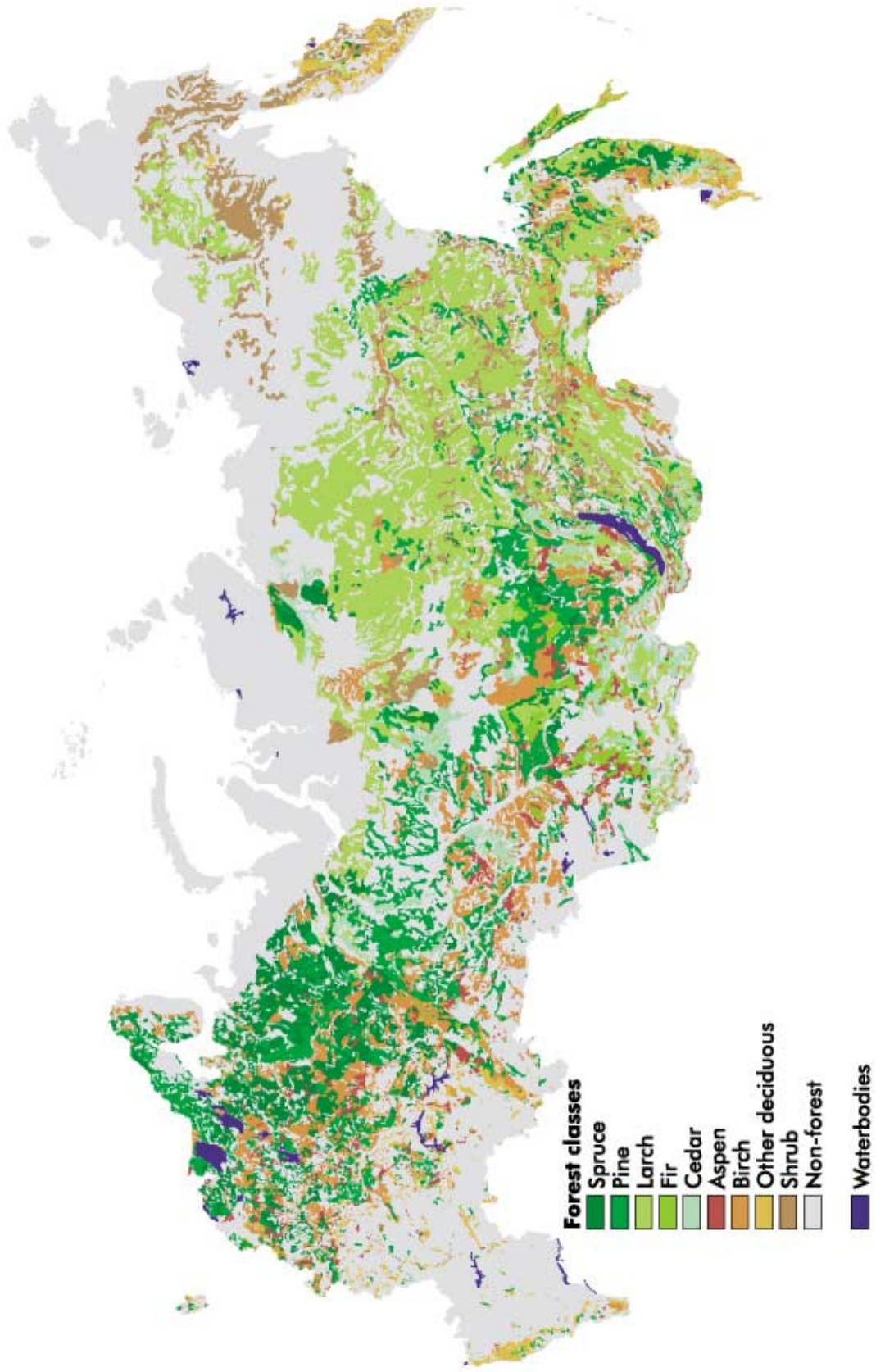
Source: Starkov A., L. Landberg, P.P. Bezroukikh, M.M. Borisenko (2000), Russian Wind Atlas. Riso National Laboratory (Denmark) and The Russian-Danish Institute for Energy Efficiency, 2000.

Figure 2 Solar Resources



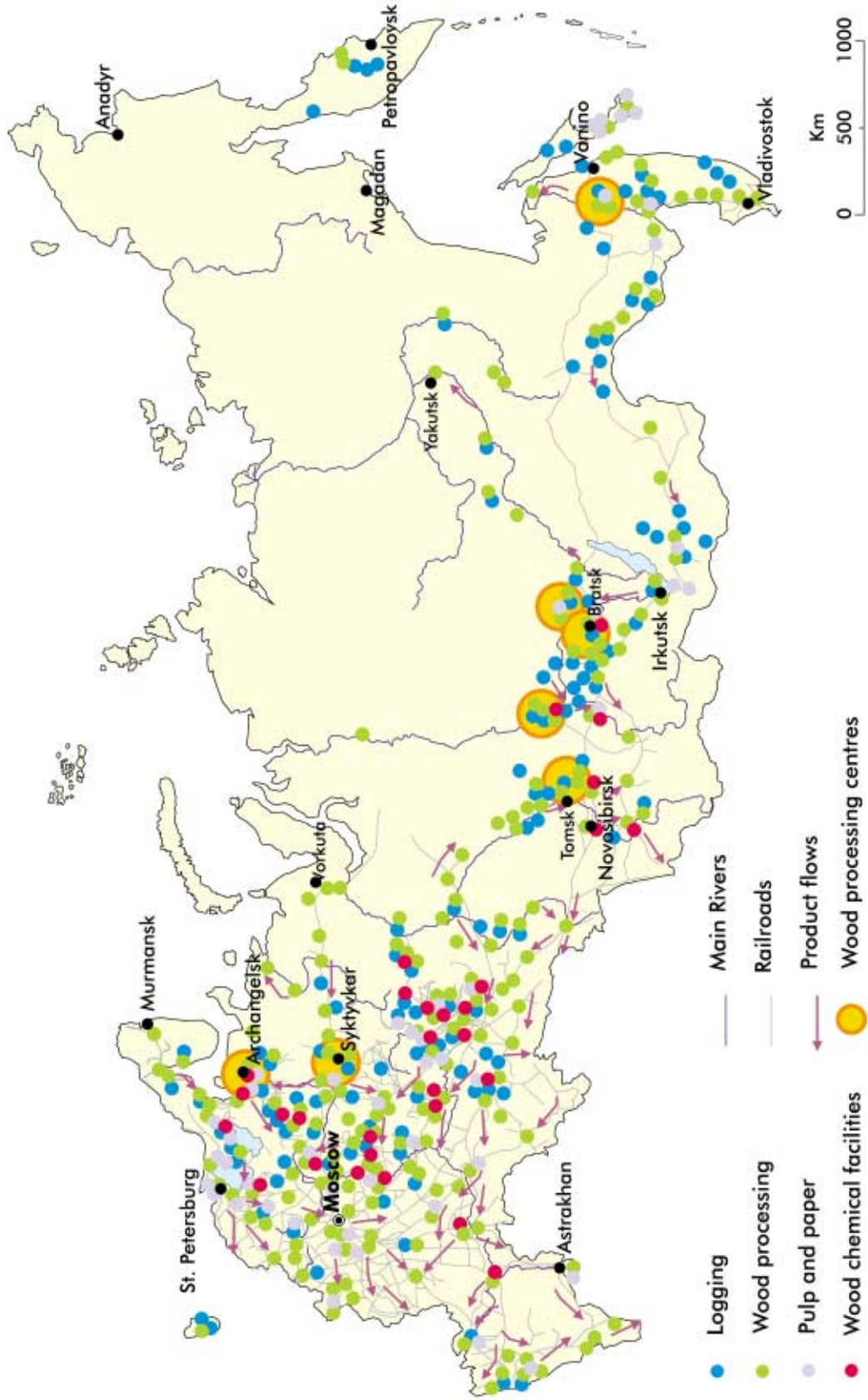
Source: <http://ecoclub.nsu.ru/allenergy/images/karta2.gif>

Figure 3 Dominant Forest Species



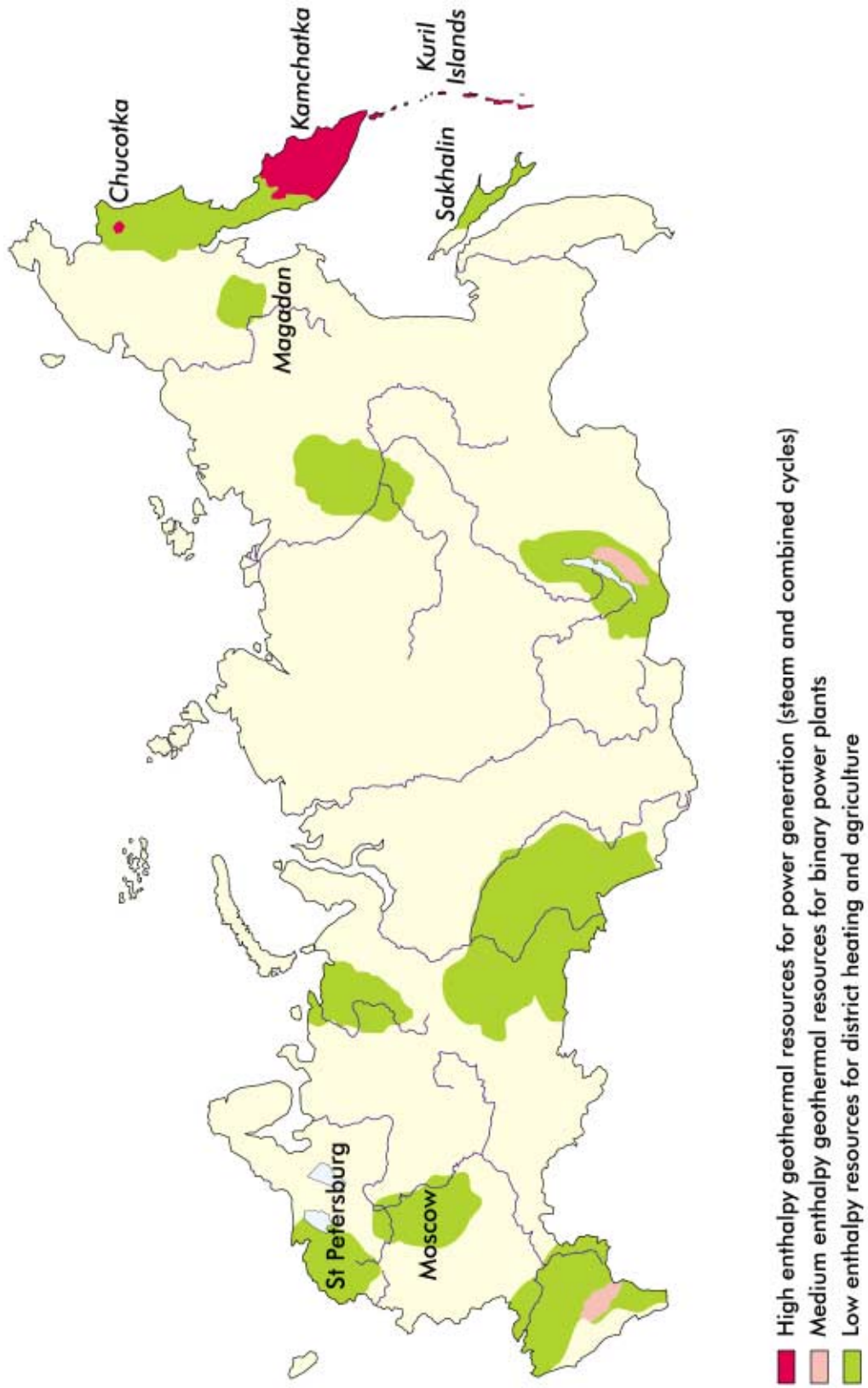
Source: Stalbovoi V., and I. McCallum (ed) (2002) CD-ROM Land Resources of Russia, International Institute for Applied Systems Analysis and the Russian Academy of Science, Laxenburg, Austria, http://www.iiasa.ac.at/Research/FOR/russia_cd/forestry_maps.htm#ind

Figure 4 Wood Industry Locations and Wood Flow Patterns of the Russian Federation



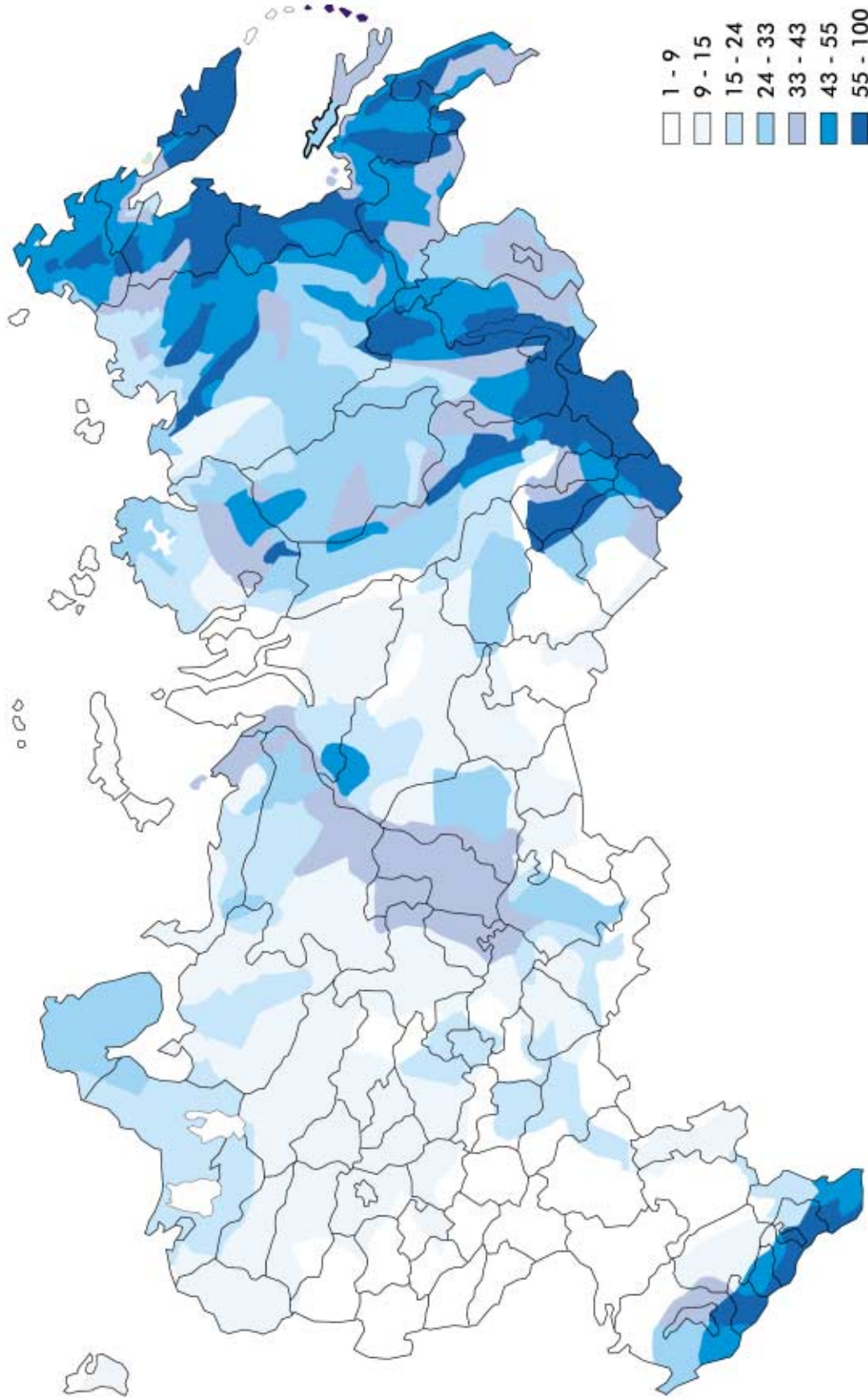
Source: Nilsson, S. and Shvidenko, A. Is sustainable Development of the Russian Forest Sector Possible, *IUFRO Occasional Paper No. 11*, <http://iufro.boku.ac.at/iufro/publications/occ11/index.html>

Figure 5 Geothermal Resources of Russia



Source: Роваров О.А., Бритин О.У., Никольский А.И., Томаров Г.В., Васильев Г.Р. (2002) "Использование тепла земли для локального теплоснабжения" (Use of the Earth heat for local heat supply). In Труды по Машиностроению N8, 2002. <http://www.geotherm.ru/1m/art2.htm> and EBRD, Strategic Renewable Energy Assessment. Renewable Energy Country Profile: Russian Federation, version 0.6b, <http://projects.bv.com/ebrd/profiles/Russia.pdf>

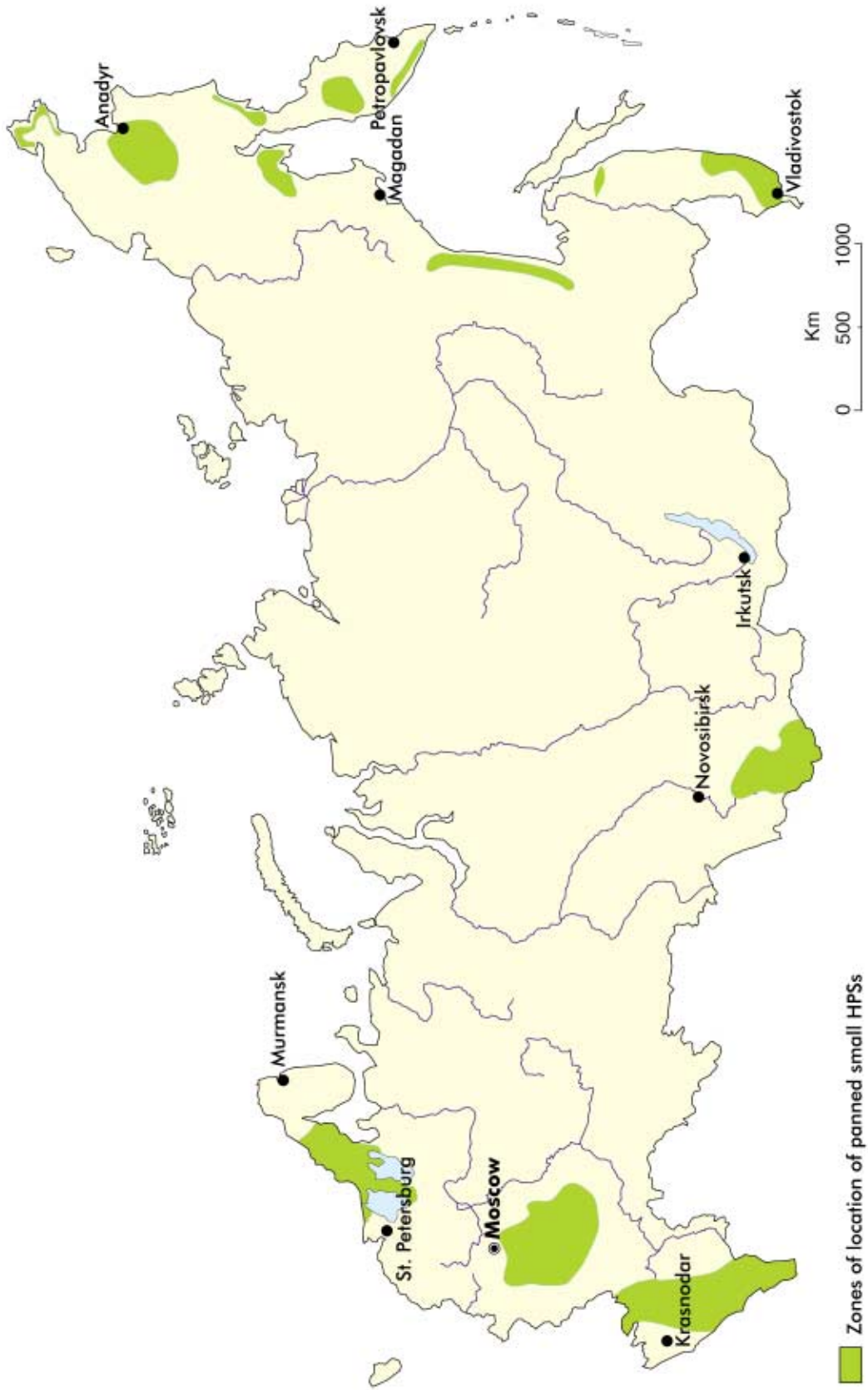
Figure 6 Hydro-Energetic Resources of Russia



Note: grades 1-3 – territories with the poorest hydro-energetic resources; grades 60-100 – territories with the richest resources.

Source: <http://www.sci.aha.ru/RUS/wadb01.gif>

Figure 7 Location of Planned Small Hydropower Stations



Source: EBRD, Strategic Renewable Energy Assessment. Renewable Energy Country Profile: Russian Federation, version 0.6b, <http://projects.bv.com/ebrd/profiles/Russia.pdf>

PART I

RENEWABLE ENERGY MARKET OPPORTUNITIES

CHAPTER 1

RENEWABLE ENERGY

RESOURCES AND POTENTIAL

OVERVIEW

Russia has vast renewable energy resources. Because of its geographic size and the variation in its climate and terrain, the type of renewable energy available varies considerably. This makes Russia different from many smaller countries where one potential form predominates because of the homogeneity of geographic conditions. Large portions of Russia are undeveloped and unpopulated. Some 80% of its 145 million inhabitants live in the European part of the country.¹ Population density varies from 26.6 persons/km² in the European part to 2.4 persons/km² in the Asian part. About three-quarters of the population live in urban areas², with the Central, Ural, Northern Caucasus and Volga economic regions the most densely populated areas.

Russian experts have estimated the potential of renewable energy in Russia, taking into account resource availability, technical feasibility and economic viability of renewable energy technologies. Gross potential (also referred to as available resources) is the energetic equivalent of the total amount of renewable energy available for extraction. Technical potential represents the part of the gross potential which can be effectively used with known technologies, taking into consideration social and ecological factors. Economic potential is 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. In 1993, Bezrukikh estimated the economic potential of renewable energy in Russia at more than 270 million tonnes of coal equivalent (Mtce) per year³ (see Table 1). In 2001, Russia's total primary energy supply was 887 Mtce (621 Mtoe).⁴ Thus, the estimated economic potential of renewable energy was some 30% of total primary energy supply.⁵ Only some 1% of TPES, however, was derived from non-hydro RE in 2001.

The economic potential is higher today than the estimate provided in Table 1. According to the new Energy Strategy of Russia, the economic potential of renewables has grown

1. Tarkhov S. (2002), "Population", in Stolbovoi V., and I. McCallum (2002), *CD-ROM Land Resources of Russia*, International Institute for Applied Systems Analysis and the Russian Academy of Science, Laxenburg, Austria, http://www.iiasa.ac.at/Research/FOR/russia_cd/pop_des.htm
2. Goskomstat (State Statistical Committee), *Preliminary Estimates of the 2002 Census*, http://www.gks.ru/PEREPIS/tab1_1.htm, 23 April 2003.
3. 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. (2002), *Resources and Efficiency of the Use of Renewable Sources of Energy in Russia*, SPb, Nauka (in Russian).
4. IEA (2002), *Energy Balances of Non-OECD Countries*, OECD/IEA, Paris.
5. The technical potential of renewable energy (4593 Mtce) is estimated to be more than five times greater than TPES.

Table 1 Potential of Renewable Energy Sources in Russia
(million tones of coal equivalent per year)

| | 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 | 2,000 | 10.0 |
| Solar Energy | 2.3 × 10 ⁶ | 2,300 | 12.5 |
| Low Potential Heat | 525 | 115 | 36 |
| Total Renewable Energy Sources | 2.34 × 10⁶ | 4593.0 | 273.5 |

* Geothermal energy resources are estimated to be 180 Mtce/y down to the depth of 3 km. The technical potential is approximately 20 Mtce/y.

** The economic potential comprises hot waters and steam-water fluids of geocirculating technology.

Notes: For a detailed methodology of the assessment of the gross, technical and economic potential of renewable energy, see Bezrukikh, P.P., Arbutov, 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. (2002), Resources and Efficiency of the Use of Renewable Sources of Energy in Russia, SPb, Nauka. This table is based on the Russian definition of renewable energy, which differs slightly from the IEA definition. Unlike the Russian definition, the IEA one does not include heat pumps (low potential heat). According to the IEA definition, small hydropower includes plants with a capacity of less than 10 MW. In the Russian definition, small hydropower includes plants with less than 30 MW capacity. Source: Ministry of Fuel and Energy et al. 1999, The Role of Renewable Sources of Energy in Power Strategy of Russia. In Yanovsky, A., P. Bezrukikh (ed.), Business and Investment for Renewable Energy in Russia, Proceedings of the Congress, Moscow, 31 May-4 June 1999.

in recent years because fossil fuel prices have increased while the cost of renewable energy technologies has fallen.⁶

WIND ENERGY POTENTIAL

Wind energy potential varies over Russia. The Russian Wind Atlas⁷ shows that there are numerous areas where the annual mean wind speed exceeds 6.0 metres per second (m/s). Figure 1 shows wind resources at 50 metres above ground-level for five different topographic conditions. The colours in the first column of the table match the colours in the figure.

See Figure 1: Wind Resources, page 19.

The highest mean wind speeds are found along the coasts of the Barents and Kara seas, the Bering Sea and the Sea of Okhots. Other areas with relatively high wind speed (5-6 m/s) include the coasts of the East-Siberian, Chukchi and Laptev seas to the north and the Japan Sea to the east. Slightly lower wind speeds (3.5-5 m/s) are found on the coasts of the Black, Azov and Caspian seas in the south and on the White Sea in the north-west. Good resources are also found in the low and middle Volga regions, the Urals, the steppe areas of West Siberia, and around the Baikal Lake. The lowest mean wind speed occurs over East Siberia in the Lena-Kolyma core of the Asian anticyclone.

6. Ministry of Fuel and Energy, *Energy Strategy of Russia until 2020*, Moscow, Approved 22 May 2003.

7. Starkov A., L. Landberg, P.P. Bezrukikh, M.M. Borisenko (2000), *Russian Wind Atlas*. Riso National Laboratory (Denmark) and The Russian-Danish Institute for Energy Efficiency. Wind speeds are based on 8 observations (every 3 hours) at 332 meteorological stations in Russia over 10 years.

Over most of Russia, wind speeds are greater in the daytime than at night, although this variation is much less pronounced in the winter. The annual variation in mean wind speed (i.e. the difference between the maximum and minimum mean daily speeds) is insignificant for most parts of Russia. The annual amplitude varies from 1 to 4 m/s, making up 2-3 m/s on the average. Amplitudes are higher over the center of the European part of Russia, East Siberia, West Siberia (except for northern areas) and especially in the Far East where amplitude reaches 4 m/s. Annual amplitude of less than 2 m/s is observed over the south-west and south-east of the European part of Russia and over Central Siberia.⁸ In most of Russia, wind speed is greater in winter or autumn, except for the southern part of Central Siberia where maximum wind speeds occur in warmer months. The highest speeds over Yakutia and the Trans-Baykal Region are observed in April-May.

Several attempts have been made to estimate the exact potential of wind energy in Russia, beginning with the Wind Atlas published in the Soviet Union in the 1930s. More recently, Bezrukikh et. al. have estimated gross wind potential at 26,000 million tones of coal equivalent, technical potential at 2,000 mtce, and economic potential at 10 mtce.⁹

Perminov and Perfilov¹⁰ estimate the potential for electricity generation from wind to be $80 \cdot 10^{15}$ kWh per year (gross), $6.2 \cdot 10^{15}$ kWh/year (technical) and $31 \cdot 10^{12}$ kWh/year (economic). According to their analysis, about 30% of the economic potential is concentrated in the Far East, about 16% in West Siberia and another 16% in East Siberia. Eco-Accord reckons that 37% of gross wind resources are found in the European part of Russia, and 63% in Siberia and Far East (Table 2).¹¹

Table 2 Wind Energy Resources in Russia (TWh per year)

| | Gross | Technical |
|--------------------------------|--------------|-------------|
| European part of Russia | 29600 | 2308 |
| <i>of which:</i> | | |
| North | 11040 | 860 |
| North-West | 1280 | 100 |
| Central | 2560 | 200 |
| Volgo-Vyatsky | 2080 | 160 |
| Central-Black Soil | 1040 | 80 |
| Volga | 4160 | 325 |
| North Caucasus | 2560 | 200 |
| Ural | 4880 | 383 |
| Siberia and Far East | 50400 | 3910 |
| Total | 80000 | 6218 |

Source: Dmitriev G. (2001), Wind Energy in Russia, VetrEnerg Report for Gaia Apatity and INFORSE-Europe First Part, June 2001 http://www.inforse.dk/europe/word_docs/ruswind2.doc

8. Starkov A., L. Landberg, P.P. Bezrukikh, M.M. Borisenko (2000), *Russian Wind Atlas*. Riso National Laboratory (Denmark) and The Russian-Danish Institute for Energy Efficiency, 2000.
9. Ministry of Fuel and Energy et al. (1999), "The Role of Renewable Sources of Energy in Power Strategy of Russia". In Yanovsky, A., Bezrukikh P., *Business and Investment for Renewable Energy in Russia*, Proceedings of the Congress, Moscow, 31 May - 4 June 1999.
10. Perminov E, O. Perfilov (1999), "Технико-экономические показатели сетевых ветроэлектростанций и возможности их финансирования", in *Business and Investment for Renewable Energy in Russia*. Proceedings of the Congress. Moscow 31 May - 4 June 1999 Part III.
11. Dmitriev G. and Gunnar Boye Olesen (2001). *Biomass and Windpower Opportunities in Russia*, ECO-Accord Center, Moscow, and Forum for Energy and Development, Denmark, August 2001.

Wind energy can be exploited in many parts of Russia, including Arkhangelsk, Astrakhan, Volgograd, Kaliningrad, Magadan, Novosibirsk, Perm, Rostov, the Tiumen regions, Krasnodar, Khabarovsk, the maritime territories, Dagestan, Kalmykia and Karelia.¹² The majority of the potential is found in the territories, where population density is less than one person per square kilometre. Thus, in many of the windiest places, wind energy can be used as an energy source for small isolated consumers. Large-scale system application of wind energy is also possible in certain areas (see Chapter 3).

SOLAR ENERGY POTENTIAL

Solar radiation depends largely on latitude, i.e. it is strongest at the equator and diminishes towards the poles. Russia is located between 41 and 82 degrees north latitude, and solar radiation levels vary considerably. According to Russian estimates, the average solar radiation in the remote northern areas is 810 kWh/m² per year, while in the southern regions it is more than 1400 kWh/m² per year.¹³ Solar radiation levels also exhibit great seasonal variations. For example, at latitude 55 degrees solar radiation is 1.69 kWh/m² per day in January, and 11.41 kWh/m² per day in July.

See Figure 2: Solar Resources, page 20.

Bezrukikh et al. estimate gross solar energy potential in Russia at 2,300,000 mtce, technical potential at 2,300 mtce and economic potential 12.5 mtce per year¹⁴ (see Table 1). Solar energy potential is greatest in the south-west (North Caucasus, the Black and Caspian Sea regions) and in Southern Siberia and the Far East. Regions with good solar resources include: Kalmykia, Stavropol, Rostov, Krasnodar, Volgograd, Astrakhan and other regions in the south-west, and Altay, Maritime, Chita, Buryatia and other regions in the south-east. In some parts of Western and Eastern Siberia and in the Far East, the annual solar radiation is 1300 kWh/m², exceeding levels in the Southern regions of Russia. For example, incoming solar energy reaches 1340 kWh/m² in Irkutsk (52 degrees latitude), and 1290 kWh/m² in Yakutia-Sakha (62 degrees latitude).¹⁵

Tables 3 and 4 show annual data for solar radiation incident for five locations in different climatic zones. Astrakhan and Sochi are located in the Southern European part of Russia, Kyzil in Southern Siberia, Mangut in the Southern Transbaicalia, and Vladivostok in the Far East.

12. Intersolar Centre, European Commission (2001), *Ветроэнергетика. Руководство по применению ветроустановок малой и средней мощности (Wind Energy. A Guide for Small to Medium-sized Enterprises)*, Moscow, http://www.intersolar.ru/downloads/Wind_r.pdf

13. Karabanov, S. (2001), "The Prospects for Photovoltaic Development in Russia," *Renewable Energy 2001*, World Renewable Energy Network.

14. Ministry of Fuel and Energy et al. 1999, "The Role of Renewable Sources of Energy in Power Strategy of Russia". In Yanovsky, A., Bezrukikh P., *Business and Investment for Renewable Energy in Russia*, Proceedings of the Congress, Moscow, 31 May - 4 June 1999.

15. Kukharin N. (1992), "Energy on the Eve of the New Millennium: Estimation of Renewables' Potential in Russia", Institute of Physics and Technology, Moscow, Presented at the Fourth International Summer School *Science and World Affaires*, Shanghai, China, August 22-31, 1992.

Table 3 Total Solar Radiation Incident on Horizontal Surface (MJ/m²)

| | I | II | III | IV | V | VI | VII | VIII | 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 4 Direct Solar Radiation Incident on Surface Normal to Sunlight Beams (MJ/m²)

| | I | II | III | IV | V | VI | VII | VIII | 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 | 646 | 572 | 657 | 596 | 556 | 583 | 560 | 550 | 425 | 351 | 6461 |
| Vladivostok | 437 | 461 | 535 | 433 | 478 | 341 | 326 | 361 | 487 | 495 | 423 | 383 | 5160 |

Source: EBRD, Strategic Renewable Energy Assessment. Renewable Energy Country Profile: Russian Federation, version 0.6b, <http://projects.bv.com/ebrd/profiles/Russia.pdf>; M.M. Borshchevsky and V.V. Stadnik (ed.) (1997), *Atlas of Wind and Solar Climates in Russia*, Saint Petersburg.

BIOMASS ENERGY POTENTIAL¹⁶

Russia's biomass resources include vast forests, open woodlands and agricultural and wood waste. As of 1 January 2001, Russia had 406 million hectares of agricultural land (23.8% of total land area) and 1,097 million hectares of forested land (64.1% of total land area).¹⁷

According to the Intersolarcenter, a Russian organisation which focuses on renewable energy issues, Russia produces some 15 billion tons of biomass every year - equivalent on an energy basis to 8 billion tce.¹⁸ Biomass available for energy production includes: up to 800 million tons of wood, 250 million tons of agricultural wastes, 70 million tons of wood wastes (from forestry and pulp and paper industries), up to 60 million tons of municipal solid wastes; and 10 million tons of sewage wastes. These resources could potentially provide some 100 mtce of biogas (120 billion m³) and between 30 and 40 mtce of ethanol per year.

16. Biomass is defined as non-fossil organic material, directly or indirectly produced by photosynthesis and having an intrinsic chemical energy content. Biomass includes all water- and land-based vegetation and trees, or virgin biomass, and all waste such as municipal biosolids (sewage) and animal wastes (manure), forestry and agricultural residues. Some classifications consider municipal solid waste (MSW) and certain types of industrial waste as renewable energy sources, and classify them together with biomass.

17. Loiko, P. and Tretiakov, V., "State Land Account", In: Stolbovoi V., and I. McCallum (2002), CD-ROM "Land Resources of Russia", International Institute for Applied Systems Analysis and the Russian Academy of Science, Laxenburg, Austria, http://www.iiasa.ac.at/Research/FOR/russia_cd/agr_des.htm#sla

18. Intersolarcenter (2002), Обзор современных технологий использования биомассы (Overview of Modern Technologies for Biomass Use), Moscow.

The Swedish organisation NUTEK estimates that biomass resources in the European part of Russia alone are equivalent to 400 TWh per year. These resources include:

- 265 TWh per year of unused wood that potentially could be taken from forests and used e.g. as woodchips for heating;
- 109 TWh per year that is already used as firewood;
- 58 TWh per year of agricultural residues, including unused straw and residues already used for energy purposes today;
- 37 TWh per year of surplus wood residues from wood industries.

In northwest Russia, residues from sawmills and the pulp and paper industry could supply as much as 45 to 50 TWh/y in the oblasts of Murmansk, Arkhangelsk, Kerelia, Vologda, Komi, Pskov, Novgorod and Leningrad.¹⁹ The Leningrad Oblast Forest Committee estimates that the total annual production of wood waste in Leningrad Oblast is 250,000 m³ (12% of annual wood processing), of which one third to one half remains unused.²⁰ Karelia, Vologda, Komi and Arkhangelsk each produce 2.5 to 7.5 million m³ of wood waste annually.

Forestry

Russia has more than 20% of the world's forests. It is the most forested country in the world.²¹ Forest coverage, density and composition vary throughout the country. Figure 3 shows the large variation in tree species across Russia.

See Figure 3: Dominant Forest Species, page 21.

Russia publishes its forestry statistics every 5 years. In 1998, the most recent year for which official Russian data are available, forested land²² was estimated to be 881.97 million ha. The UN Food and Agriculture Organisation (FAO) reported Russian forest cover to be 851.4 million ha in 2000.²³

Russia's annual net growth in forested areas is nearly 1 billion cubic metres. The allowable cut, however, is only about 540 million m³. Much of Russia's forest potential is not exploited because of environmental constraints, low standing volumes, the remoteness of forests from domestic and international markets, the absence of a transportation network and technological limitations. According to Strakhov, exploitable

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

20. Martinot, E. (1999), "Renewable Energy in Russia: Markets, Development and Technology Transfer", *Renewable and Sustainable Energy Reviews*, Vol. 3: 49-75, http://www.martinot.info/re_publications.htm

21. World Bank (1997), *Russia: Forest Policy During Transition*, World Bank country study, Washington, D.C.

22. Forested lands include both lands covered with forest (Forested Areas or Stocked Lands), and also lands which are temporary not covered, but intended for forest restoration cutovers, burned forests, perished forest stands, open stands, wastelands, glades, forest nurseries, forest cultures with non closed canopy, etc. Source: Shvidenko A. (2002), "Dynamics of Russian Forests from 1961 to 1998", in Stolbovoi V., and I. McCallum (2002), CD-ROM "Land Resources of Russia", International Institute for Applied Systems Analysis and the Russian Academy of Science, Laxenburg, Austria, http://www.iiasa.ac.at/Research/FOR/russia_cd/for_des.htm

23. Food and Agriculture Organisation of the United Nations (FAO), *Forestry. Russian Federation. Resources*, http://www.fao.org/forestry/fo/country/index.jsp?lang_id=1&geo_id=166

Table 5 Forest Resources

| | unit | European Russia and the Urals | Asian Russia | Total |
|----------------------------------------------------------|-----------------------------|----------------------------------|--------------|-------------|
| Forested (stocked) area | Min. hectare | 167 | 603 | 770 |
| Total growing stock | Billion cubic metres | 22 | 59.9 | 81.9 |
| <i>Of which: Coniferous stands</i> | <i>Billion cubic metres</i> | <i>13.2</i> | <i>48.3</i> | <i>61.5</i> |
| Growing stock of mature and overmature stands | Billion cubic metres | 9.6 | 34.2 | 43.8 |
| <i>Of which: Coniferous stands</i> | <i>Billion cubic metres</i> | <i>6.4</i> | <i>28</i> | <i>34.4</i> |
| Annual growth | Min. cubic metres | 380 | 600 | 980 |
| Allowable cut | Min. cubic metres | 208 | 334 | 542 |

Source: Petrov, A. (2001), *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, <http://www.cifor.cgiar.org/fsfm/Papers/25Petrov.pdf>

forests comprise about 55% of the areas under state management for Russia as a whole.²⁴ They comprise some 85% for the European part of Russia.

Forest management practices, inherited from the Soviet era, are often unsustainable and undermine forest regeneration efforts in Russia today. Forest fire protection and forest regeneration programs are under-funded. Frequent fires contribute to the continuing degradation and devastation of forest resources. Illegal logging and trade have increased in recent years, adding to the problem of deforestation. These problems are exacerbated by corruption and criminalization in the sector, lack of congruence between central and regional levels of decision-making related to forests and the lack of effective mechanisms to implement the forest management rules.²⁵

Table 6 Timber Industry Output from 1990 to 1998

| | Unit | 1990 | 1995 | 1998 | 1990 – 1998 (% change) |
|----------------------|-----------------------|------|------|------|---------------------------|
| Timber removal | Min. cubic metres | 304 | 115 | 83.2 | -27.4 |
| Industrial timber | Min. cubic metres | 256 | 92 | 67 | -26.2 |
| Sawn wood | Min. cubic metres | 75 | 26.4 | 19.5 | -26.0 |
| Plywood | Thousand cubic metres | 1597 | 930 | 968 | -60.6 |
| Particle board | Thousand cubic metres | 5568 | 2210 | 1463 | -26.3 |
| Fibre board | Thousand cubic metres | 483 | 234 | 197 | -40.8 |
| Pulp (after cooking) | Thousand tons | 7525 | 4200 | 3168 | -42.1 |
| Paper | Thousand tons | 5240 | 3270 | 2230 | -42.5 |
| Paper board | Thousand tons | 3085 | 1300 | 1102 | -35.7 |

Source: Petrov, A. (2001), *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, <http://www.cifor.cgiar.org/fsfm/Papers/25Petrov.pdf>

24. Strakhov, V. (1998), *Sustainable Forest Management*, VNIIZlesresurs, Moscow, cited in Nilsson, S. and Shvidenko, A. *Is sustainable Development of the Russian Forest Sector Possible?*, IUFRO Occasional Paper No.11, p. 14, <http://iufro.boku.ac.at/iufro/publications/occ-p11/index.html>

25. Carlsson, L. (1999), "Towards a Sustainable Russian Forest Sector", Presented at *WORKSHOP IN POLITICAL THEORY AND POLICY ANALYSIS*, Bloomington, Indiana, June 9-13, 1999.

From 1946 to 1996, an average of 313 million m³ of commercial wood was harvested per year in Russia.²⁶ Production of timber, however, declined dramatically in the 1990s (Table 6). In 1997, there were 2,830 large and medium-sized enterprises in the forestry industrial sector, of which 153 were pulp and paper mills, 18 were wood chemical industries, 1,384 were major wood mechanical mills and 1,277 logging companies.²⁷ Forest industry locations are presented in Figure 4.

There is significant growth potential in timber industry production. Today, Russia's share of the global timber market is only 3%,²⁸ despite the fact that it has more than one fifth of the world's forest resources. The Russian government estimates that some sectors of the timber industry could increase output by 5-7%.²⁹

See Figure 4: Wood Industry Locations and Wood Flow Patterns of the Russian Federation, page 22.

GEOTHERMAL ENERGY POTENTIAL

Geothermal energy is energy derived from the natural heat of the earth. Geothermal resources can be classified as low temperature (less than 90-100°C), moderate temperature (90-100°C to 150°C), and high temperature (greater than 150°C). The highest temperature resources are generally used for electric power generation. Low and moderate temperature resources can be used for direct use and for ground-source heat pumps. Direct use involves using the heat in the water (without a heat pump or power plant) for heating of buildings, industrial processes, greenhouses, aquaculture (growing of fish) and resorts. Direct use projects generally exploit resource temperatures between 38°C to 149°C. Ground-source heat pumps use the earth or groundwater as a heat source in winter and a heat sink in summer. Using resource temperatures of 4°C to 38°C, the heat pump transfers heat from the soil to the house in winter and from the house to the soil in summer.³⁰

Commercial large-scale use of geothermal energy is possible in areas where the earth's natural heat flow is near enough to the surface to bring steam or hot water to the surface. These areas are most often located close to crustal plate margins or at rifting locations and are generally characterized by the presence of volcanoes, hot springs and other thermal phenomena.

Exploration of geothermal resources started in the Soviet Union in 1957 when the first bore holes were drilled on the Pauzhetsk thermal field in Kamchatka. Most of

26. Nilsson, S. and Shvidenko, A., *Is sustainable Development of the Russian Forest Sector Possible?*, UIFRO Occasional Paper No.11, <http://iufro.boku.ac.at/iufro/publications/occ-p11/index.html>

27. Nilsson, S. and Shvidenko, A., *Is sustainable Development of the Russian Forest Sector Possible*, UIFRO Occasional Paper No.11, <http://iufro.boku.ac.at/iufro/publications/occ-p11/index.html>

28. Pravda (June 18, 2002), Prime Minister: Russian timber industry is on brink of crisis, <http://english.pravda.ru/politics/2002/06/18/30554.html>

29. Ibid and Business Day (July, 1, 2002), Russia Shifts Focus from Oil to Timber, <http://www.bday.co.za/bday/content/direct/1,3523,1110163-6078-0,00.html>

30. Geothermal Resources Council, *What Is Geothermal?*, <http://www.geothermal.org/what.html>

Russia's geothermal potential has been explored today, and a significant number of fields have been discovered. The Kamchatka peninsular and the Kuril islands are seismically active and hold the largest geothermal resources. Kamchatka has 127 volcanoes, 22 of which are active. The Kuril islands have 100 volcanoes, including 21 active ones.³¹ Kamchatka has some 150 thermal spring groups and 11 high-temperature hydrothermal systems.³² Other areas of Russia also have substantial geothermal resources, with temperatures ranging from 50 to 200 C° at depths of 200 to 3000 metres. These areas include the Northern Caucasus, Dagestan, the Central region of Russia, the West Siberian plate, lake Baikal, Krasnoïarsk territory (Krai), Chukotka, and Sakhalin (see Figure 5). The Caucasus segment of the Alpine tectonic belt and the recent Baikal rift zone have geothermal reservoirs in fractured rocks. The North Caucasus and the West-Siberian plate contain thermal waters (with temperatures of between 100 and 200 C) within the sedimentary cover. In addition, some geothermal resources are available in the East-European and Siberian platforms, in the belts of Ural, Altai and Saiany, as well as in the Chukotka-Casian volcanic belt. These regions contain inter-granular and fissure hydrothermal systems with temperatures of 50-70 C° at a depth of about 3 kilometres.

See Figure 5: Geothermal Resources of Russia, page 23.

Potential energy production from geothermal resources, found at a depth of less than 3 km, is estimated to be about 180 mtce per year.³³ Of this potential, some 20 mtce are suitable for use. If geocirculating technology is applied, however, the economic potential of resources of hot waters and steam-water fluids would be 115 mtce per year. Oleg Povarov estimates that geothermal energy could theoretically produce 16.9 billion kWh, or almost 2% of Russian electricity production.³⁴ Available resources in Kamchatka alone (excluding Kronotskii Reservation) could supply 1,345 MWt.³⁵

HYDRO ENERGY POTENTIAL

Russia has the second highest level of mean annual river runoff³⁶ in the world, after Brazil. The number of rivers exceeds two million, and there are countless lakes and storage reservoirs.³⁷ The bulk of the stream flow is concentrated in the eastern part of the country. The European part of Russia accounts for less than 25% of the country's water resources.

31. Battocletti, L., *Geothermal Resources in Russia*, Bob Lawrence and Associates, Inc., November 2000. p. 18, http://www.bl-a.com/ECB/PDF%20Files/Geo%20Res%20Russia_2000.pdf

32. 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.

33. Ministry of Fuel and Energy et al. 1999, "The Role of Renewable Sources of Energy in Power Strategy of Russia" In Yanovsky, A., Bezroukikh P. *Business and Investment for Renewable Energy in Russia*, Proceedings of the Congress, Moscow, 31 May - 4 June 1999.

34. Povarov, O., CSC Geoterm Vice President, cited in Battocletti, L. (2000), *Geothermal Resources in Russia*, Bob Lawrence and Associates, Inc., November 2000.

35. 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.

36. Mean Annual Runoff (MAR) is the common measure of water resources of a territory. It is measured in km³/year or in mm of layer, i.e. in the water volume transported by rivers over a year, related to the drainage area. The water volume running through an actual cross-section of the river flow per a time unit is called water discharge. It is usually measured in m³/second. MAR in Russia is 4,043 km³/year, representing nearly 10% of the world's total stream flow.

37. Koronkevitch, N., "Water Resources of Russia", in: Stolbovoi V., and I. McCallum (2002), CD-ROM *Land Resources of Russia*, International Institute for Applied Systems Analysis and the Russian Academy of Science, Laxenburg, Austria, http://www.iiasa.ac.at/Research/FOR/russia_cd/hydro_des.htm

Table 7 Distribution of Water Resources

| | Local Flow (formed within the territory) | | Inflow from neighbouring countries | Total | Per capita | |
|--------------------------------|------------------------------------------------|---------------------------------------------------------------------|------------------------------------------|-------------|--------------------------------------------------------|--------------------------------------------------------|
| | Km ³ per annum | M ³ *10 ³ per annum per km ² | | | Local, M ³ *10 ³ per annum | Total, M ³ *10 ³ per annum |
| North | 494 | 337 | 18 | 512 | 85.39 | 88.5 |
| North-west | 47.7 | 243 | 42.5 | 90.2 | 5.97 | 11.29 |
| Centre | 88.6 | 183 | 23.4 | 112 | 2.99 | 3.78 |
| Volgo Vyatsky | 47.8 | 180 | 105 | 153 | 5.71 | 18.27 |
| Central Black Soil | 16.1 | 96 | 4.8 | 20.9 | 2.05 | 2.66 |
| Volga | 32 | 60 | 244 | 276 | 1.9 | 16.34 |
| North Caucasus | 44 | 124 | 27 | 71 | 2.48 | 4.01 |
| Urals | 122.7 | 149 | 9.3 | 132 | 6.01 | 6.47 |
| West Siberia | 513 | 211 | 70 | 583 | 33.95 | 38.59 |
| East Siberia | 1097 | 266 | 27 | 1124 | 120.93 | 123.91 |
| Far East | 1538 | 247 | 312 | 1850 | 209.65 | 252.18 |
| Kaliningrad region (oblast) | 2.71 | 179 | 20.4 | 23.1 | 2.87 | 24.5 |
| Total | 4043 | 237 | 219 | 4262 | 27.48 | 28.97 |

Source: Malik, L.K., Koronkevich, N. I., Zaitseva, I.S., Barabanova, E.A. (2000), *Development of Dams in the Russian Federation and Other NIS Countries*, a WDC Briefing Paper prepared as an input to the World Commission on Dams, Cape Town, www.dams.org.

The average runoff varies considerably across the country. Over the Northern Caucasus the runoff exceeds 2000 mm, in the North Urals, in the Altai and in the mountains of Eastern Siberia it is close to 1000 mm. In the European part of Russia, the runoff is considerably lower, ranging from 300 to 400 mm in the north-west to zero in the south-east.³⁸ River runoff levels vary by season. In most of the country, 50-70% of the annual runoff occurs over two or three month, normally between April and June. River flow levels also vary annually, particularly in the south of Russia where water resources are limited.

See Figure 6: Hydro-Energetic Resources of Russia, page 24.

Figure 6 shows the hydro-energetic potential of different territories in Russia. According to the World Commission on Dams, Russia's hydropower potential is 2,900 billion kWh per year, of which 83% is from large and medium-sized rivers. The technical potential is estimated to be 2,030 billion kWh per year. The economic potential, which embodies

38. Malik, L.K., Koronkevich, N. I., Zaitseva, I.S., Barabanova, E.A. (2000), *Development of Dams in the Russian Federation and Other NIS Countries*, a WDC Briefing Paper prepared as an input to the World Commission on Dams, Cape Town, www.dams.org, p. 6 and Koronkevich, N., "Water Resources of Russia", in: Stolbovoi V., and I. McCallum (2002), CD-ROM *Land Resources of Russia*, International Institute for Applied Systems Analysis and the Russian Academy of Science, Laxenburg, Austria, www.iiasa.ac.at/Research/FOR/russia_cd/hydro_des.htm

Table 8 Hydro Power Resources of Russia

| Characteristics | Indices | | |
|--------------------------------------------------------------------------------|-------------|----------------------------------------------|---------------------------------|
| | Total | Including small HPPs of capacity up to 30 MW | Share of HPPs, % from the total |
| 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 |
| – North and North-West regions | 99 | 48,6 | 49,1 |
| – North Caucasus | 108 | 50,1 | 46,4 |
| Eastern regions: | 2002 | 921,7 | 46,0 |
| – West Siberia | 144 | 74,5 | 51,7 |
| – East Siberia | 849 | 395,2 | 46,5 |
| – Far East | 1009 | 452 | 44,8 |
| 2. Technically feasible hydropower capability | | | |
| – Billion kWh/year | 1670 | 357,1 | 21,4 |
| European Part and Urals: | 229 | 58,1 | 25,4 |
| – North and North-West regions | 55 | 15,1 | 27,5 |
| – North Caucasus | 53 | 15,5 | 29,3 |
| Eastern regions: | 1441 | 299 | 20,7 |
| – West Siberia | 93 | 24,6 | 26,5 |
| – East Siberia | 664 | 128,4 | 19,3 |
| – Far East | 684 | 146 | 21,4 |
| 3. Economically feasible hydropower capability | | | |
| – Billion kWh/year | 852 | Not determined | Not determined |
| European Part and Urals: | 162 | | |
| – North and North-West regions | 43 | | |
| – North Caucasus | 25 | | |
| Eastern regions: | 690 | | |
| – West Siberia | 46 | | |
| – East Siberia | 350 | | |
| – Far East | 294 | | |

Source: EBRD, Strategic Renewable Energy Assessment. Renewable Energy Country Profile: Russian Federation, version 0.6b, <http://projects.bv.com/ebrd/profiles/Russia.pdf>

the level of economic development, economic efficiency, ecological and other factors, is estimated at 35% of the gross potential, or 1015 billion kWh/year.³⁹

Most of the potential hydropower resources are located in Central and Eastern Siberia and in the Far East. The North Caucasus and the western part of the Urals also have good hydropower potential.⁴⁰ The Far East and Eastern Siberia combined account for more than 80% of hydropower potential. Ivanov estimates that these regions could produce about 450-600 billion kWh per year.⁴¹

39. Malik, L.K., Koronkevich, N.I., Zaitseva, I.S., Barabanova, E.A. (2000), *Development of Dams in the Russian Federation and Other NIS Countries*, a WDC Briefing Paper prepared as an input to the World Commission on Dams, Cape Town, www.dams.org

40. Martynov, A., Artukhov, V., Vinogradov, V., *Гидроэнергетические ресурсы и размещение ГЭС*, www.sci.aha.ru/RUS/wadb6.htm

41. Ivanov, V., *Energy Mega-Projects Will Change Northeast Asia*, <http://www.tumenprogramme.org/tumen/publications/speeches/1999-06%20Ulaanbaatar/ivanov>

The Russian Ministry of Fuel and Energy estimates the gross potential of small hydropower to be 360.4 mtce per year, the technical potential to be 124.6 mtce and the economic potential 65.2 mtce.⁴² The World Dam Commission estimates the economic potential of small-scale hydropower to range between 80,000 GWh and 493,000 GWh.⁴³

See Figure 7: Location of Planned Small Hydropower Stations, page 25.

42. Ministry of Fuel and Energy et al. 1999, "The Role of Renewable Sources of Energy in Power Strategy of Russia". In Yanovsky, A., Bezroukikh P., *Business and Investment for Renewable Energy in Russia*, Proceedings of the Congress, Moscow, 31 May - 4 June 1999.

43. Malik, L.K., Koronkevich, N.I., Zaitseva, I.S., Barabanova, E.A. (2000), *Development of Dams in the Russian Federation and Other NIS Countries*, a WDC Briefing Paper prepared as an input to the World Commission on Dams, Cape Town, www.dams.org

CHAPTER 2

RUSSIAN ENERGY MARKET*

OVERVIEW

The Russian energy mix is dominated by natural gas, oil and coal (Table 9). Russia currently uses very little of its huge renewable energy potential. In 2001, renewable energy accounted for 3.5% of TPES. This includes hydro which accounted for 2.4% of TPES. Over 40% of the electricity fuel mix is gas-fired. Another quarter is oil- or coal-fired (Figure 8).

Table 9 Total Primary Energy Supply, 1992-2001, mtoe

| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|----------------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|---------------|---------------|
| TOTAL SUPPLY (TPES) | 774.8 | 746.3 | 651.5 | 628.4 | 616.6 | 595.1 | 581.4 | 603.03 | 613.98 | 621.35 |
| Coal ¹ | 132.2 | 133.4 | 125.4 | 116.7 | 118.9 | 106.7 | 100.7 | 109.08 | 110.81 | 106.59 |
| Oil | 221.0 | 200.4 | 150.7 | 147.0 | 132.2 | 130.0 | 124.1 | 127.23 | 129.98 | 132.97 |
| Gas | 364.2 | 355.9 | 327.6 | 316.5 | 318.2 | 311.5 | 310.9 | 314.47 | 318.92 | 325.22 |
| Comb. Renewables & Wastes ² | 12.4 | 11.8 | 8.7 | 8.5 | 6.9 | 6.5 | 5.8 | 7.52 | 6.90 | 6.85 |
| Nuclear | 31.5 | 31.4 | 25.9 | 26.2 | 28.8 | 28.6 | 27.8 | 32.12 | 34.42 | 36.05 |
| Hydro | 14.8 | 14.9 | 15.0 | 15.1 | 13.2 | 13.5 | 13.6 | 13.80 | 14.11 | 14.96 |
| Geothermal | 0.025 | 0.024 | 0.027 | 0.026 | 0.024 | 0.025 | 0.026 | 0.024 | 0.050 | 0.078 |
| Solar/Wind/Tide | - | - | - | - | - | - | - | 0.00017 | 0.00017 | 0.00026 |
| Electricity Trade ³ | -1.4 | -1.6 | -1.8 | -1.7 | -1.7 | -1.7 | -1.5 | -1.22 | -1.21 | -1.36 |
| Shares (%) | | | | | | | | | | |
| Coal | 17.1 | 17.9 | 19.3 | 18.6 | 19.3 | 17.9 | 17.3 | 18.1 | 18.1 | 17.2 |
| Oil | 28.5 | 26.9 | 23.1 | 23.4 | 21.5 | 21.9 | 21.4 | 21.1 | 21.2 | 21.4 |
| Gas | 47.0 | 47.7 | 50.3 | 50.4 | 51.6 | 52.3 | 53.5 | 52.2 | 51.9 | 52.3 |
| Comb. Renewables & Wastes | 1.6 | 1.6 | 1.3 | 1.4 | 1.1 | 1.1 | 1.0 | 1.3 | 1.1 | 1.1 |
| Nuclear | 4.1 | 4.2 | 4.0 | 4.2 | 4.7 | 4.8 | 4.8 | 5.3 | 5.6 | 5.8 |
| Hydro | 1.9 | 2.0 | 2.3 | 2.4 | 2.1 | 2.3 | 2.3 | 2.3 | 2.3 | 2.4 |
| Geothermal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Solar/Wind/Other | - | - | - | - | - | - | - | - | - | - |
| Electricity Trade | -0.2 | -0.2 | -0.3 | -0.3 | -0.3 | -0.3 | -0.3 | -0.2 | -0.2 | -0.2 |

Source: IEA Statistics based on IEA Methodology.

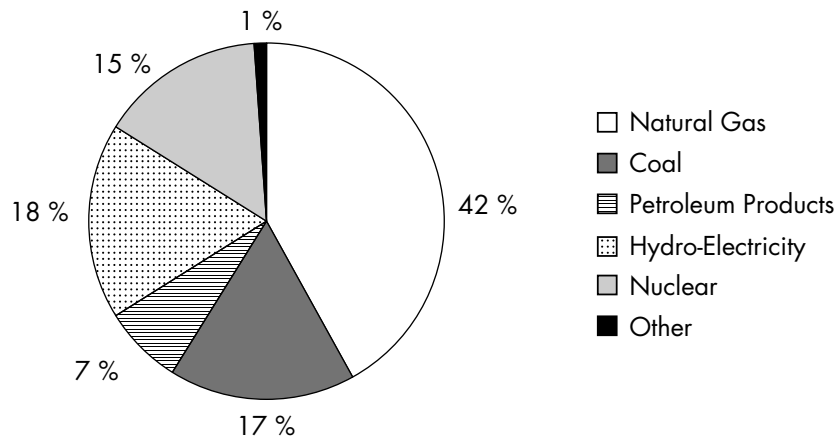
Notes: 0 is negligible, - is nil

1. Includes lignite and peat.

2. Comprises solid biomass, biogas, industrial and municipal waste. Data are based on partial surveys.

3. Total supply of electricity represents net trade. A negative number indicates that exports are greater than imports.

* For a more detailed discussion of the Russian energy sector see IEA/OECD *Russia Energy Survey*, Paris 2002.

Figure 8 Electricity Fuel Mix, 2000

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

The fact that the energy sector was state-controlled in Soviet times has left a legacy of inefficiency and distorted prices. Domestic prices for natural gas, which represents over half of total energy demand, are still state-controlled and kept artificially low. Electricity and heat tariffs are also regulated by the state. Subsidies and cross-subsidies are common. When the cost of using renewable energy resources is compared with the cost of conventional energy sources in this environment, it is not surprising that renewable energy is viewed unfavourably.

Energy Pricing and Accession to the WTO

Artificially low domestic energy prices have been one of the most debated questions in the negotiations of Russia's entry into the World Trade Organisation. 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.

Over the last decade significant reforms have taken place in the Russian energy sector aimed at privatisation, de-monopolisation and the introduction of cost-based pricing. Energy market reform is still evolving and its pace differs from sector to sector.

The *oil sector* was restructured and privatized in the 1990s. Today, several large vertically integrated companies, numerous small independent producers and many joint ventures operate in a competitive market. Large investments have been made over the last few years in short-term enhancement of oil fields.

Coal sector restructuring, with financial and technical assistance from the World Bank, resulted in the closure of many unprofitable mines and significant reductions in subsidies. The sector is being rapidly privatized. Many problems, however, still need to be addressed, including the profitability of mines, the competitiveness of Russian coal with other fuels and with imported coal, social problems and the technical security of mines.

The Russian *gas sector* is dominated by the state monopoly Gazprom. Domestic prices for natural gas are still state-controlled. There is much debate surrounding the restructuring of the gas sector in Russia. Most likely, however, there will be no major developments until after the Presidential elections in spring 2004. Meanwhile, independent gas producers and oil companies continue to press for more transparent, as well as for fair access to Gazprom's pipeline network and for export access.

The *electricity sector* is currently monopolised and state-regulated in Russia, but major steps have been made in the reform process. The Ministry of Economic Development & Trade is leading the electricity reform process. The Ministry is keen to create well-functioning electricity markets and to provide a good governance and regulatory structure for the operation of the grid and for dispatch, which are to remain state-controlled in view of their natural monopoly character.

OIL

In 2002, Russian oil production continued its climb by just over 9% to an estimated 7.66 mb/d, an increase of 1.5 mb/d since 1999. Yukos (34%), Sibneft (13%) and Surgutneftgaz (13%) together accounted for 60% of 2001 increases. Almost 70% of Yukos' 2001 production increase are attributed to placing idle wells back into production (19%), fracturing (19%) and enhancement of production (30%). The recent production growth is a result of increased drilling driven by:

- higher international and until recently domestic oil prices and the drive to make gains and gain market share;
- rouble devaluation of 1998 which reduced costs dramatically;
- partnership with foreign service companies to access advanced production technologies including improved reservoir management methods (Schlumberger by Yukos and Sibneft and Haliburton by TNK).

Many producing fields require modern reservoir management to remedy some of the damage caused by over-production, which in many cases involved quasi-systematic water injection. Employed in West Siberia since the beginning to boost output to maximum levels quickly, this has resulted in an increasingly large water cut. By 1990, the water cut was 76% for Russia as a whole, up from about 50% as recently as 1976. The share of oil produced from free-flowing wells dropped from 51.8% in 1970 to only 12.0% by 1990 and 8.4% by 1999. Modern tertiary recovery techniques will be required to maximise reservoir drainage as well as oil reservoir formation and well treatment in less permeable reservoirs. The maturity of the Russian basins is reflected in the low average flow rate of wells: 7 tons/day in Russia versus 243 tons/day in the Middle East and 143 tons/day in the North Sea. This raises two questions: how much of the recent oil production increases have been "low-hanging fruit" and will this strong growth be sustainable?

A new oil basin with reserves similar in size to those of West Siberia does not seem to be on the horizon. In the short term, therefore, Russian oil output hinges essentially on how long West Siberia's current plateau of 200-220 Mt can be maintained. Better reservoir management and development of small and difficult fields could attenuate its depletion. Production costs and international oil prices will be crucial in this regard.

The medium-term outlook will depend on how fast new reserves can be put into production in less mature provinces, such as Timan-Pechora and Sakhalin. In the long term, new provinces such as East Siberia, the Pechora Sea or the Russian sector of the Caspian could make sizeable contributions to the overall production profile. Thus the medium-term outlook will depend on Russia's ability to attract longer-term investments, i.e. fiscal and legal reforms to guarantee and attract investments and not simply ride the wave of higher oil prices and rouble devaluation.

NATURAL GAS

An estimated one-third of the world's natural gas reserves remain in Russia's super-giant fields and in smaller fields adjacent to the super-giants, which ensure the availability of future supply. Russia also has a range of opportunities to import gas on commercially attractive terms from Central Asian and Caspian countries through established pipeline networks. On 10 April 2003 Gazprom signed a long-term agreement with Turkmenistan for gas purchases of 5-6 bcm in 2004 increasing to 70-80 bcm/year by 2009 out to 2028. Prices are set at \$44/tcm until 2006 at which time they will be renegotiated. Clearly, this agreement will relieve pressure on Gazprom to develop less-promising areas in order to ensure supplies for the domestic and export market. More importantly, this also dampens any momentum for reforming and restructuring the gas sector and for providing transparent and stable terms for third party access to oil companies and independent gas producers.

The main source of uncertainty for Russian gas production is the rate of decline in the output from the Urengoy, Yamburg and Medvezh'ye fields in the Nadym-Pur-Taz region of Western Siberia. These fields currently account for over 75% of national output. There is considerable uncertainty about how rapidly production from existing fields will decline. Projections by Gazprom and the Russian Government foresee a sharp acceleration in decline rates. This may reflect damage inflicted on reservoirs through precipitate production increases during the Soviet era, but, with appropriate investment in production infrastructure, the decline in output has been staved off at the Medvezh'ye field. It is likely that the same programme can be implemented at the Urengoy and Yamburg fields. The key judgement is whether the required investments will be made; that will depend on the expectation of adequate returns on investment.

If the Urengoy and Yamburg fields do decline as projected in the Government's Energy Strategy, nearly 300 bcm of new production capacity would be needed in the next 20 years to meet expected demand. Future supply developments will depend on the ability and willingness of customers – domestic² and foreign – to pay high enough prices

2. Domestic customers currently pay subsidised prices. See IEA *World Energy Outlook - 1999 Insights: Looking at Energy Subsidies Getting the Prices Right*, Chapter 6.

needed to support new investments. Heavy foreign investment and technology will undoubtedly be needed, not only for new-field developments and the building of transportation infrastructure, but also to deal with the exceptionally difficult geological and climatic conditions. Although the country is widely perceived as a high-risk place to do business, the enormous gas potential is beginning to attract foreign investors through Production Sharing Agreements.

While reserves are clearly adequate to meet projected domestic demand and to support higher exports over the next two decades, developing those reserves will depend on whether investors can make adequate returns. Given the current economic and business environment in Russia, the prospect for such returns is, at best, unclear. Major uncertainties surround prices, payments, terms of payment, taxation and the new regulatory framework. The Russian Energy Strategy to 2020 foresees gas price increases by 2006 and beyond, when Russian domestic gas prices are expected to be at parity with European export prices. This is an immensely challenging and important target, especially for the period to 2003-2005, when prices are meant to around \$39-\$46/Mcm. It is uncertain whether these increases, accompanied by the elimination of non-payment and the enforcement of prompt cash payment, can be implemented without bankrupting some large companies and causing serious unemployment. Yet the overall rewards will be considerable in terms of:

- unlocking the huge potential for energy efficiency, which can lead in time to demand reduction and consequent reduction in supply requirements;
- providing opportunities and incentives for domestic and foreign companies to invest in gas supply, and in demand reduction, in the Russian market.

Successful implementation of reforms of the gas sector will be critical for Russia to meet increasing domestic needs and to meet increasing export demand from both Europe and emerging Eastern markets. Both independent gas producers and oil companies who produce gas will play an increasing role in meeting total gas demand (both domestic and foreign). This increase will only be possible through effective implementation of both upstream and downstream reforms. The International Energy Agency has broadly elaborated these issues within its Russia Energy Survey 2002. Its on-going co-operation with Russia highlights these important issues in this period of strong GDP growth within Russia and increasing European import dependence.

COAL

The Russian Energy Strategy adopted in 2003, is based on a vision to reduce domestic consumption of natural gas with a longer term view to ensuring natural gas availability for future generations as well as to ensure natural gas availability to meet its current and future export contracts. The share of coal in the domestic energy supply is thus projected to increase from estimated 15.1% in 2002 to between 18.1% - 20.8% in 2020, with a consequent decrease in the share of gas from 50% to between 46.8% -

44.8% over the same period.³ According to IEA projections, total primary demand for coal will rise by only 0.4% a year over the next three decades, and the share of coal in TPES will fall. The IEA projects that the share of gas will rise from 52% in 2000 to 56% in 2030. The share of gas in total electricity generation is expected to reach 60% by 2030, compared to 42% in 2000.⁴

Many experts question how realistic it is to replace gas with coal given the opposite trends in all other industrialized countries based on economic and environmental factors. First, coal is actually more expensive than gas for electricity generation. The Ministry of Energy plans to gradually raise gas prices and expects that gas and coal prices will reach parity by 2006. However, the cost of coal transportation may make it still too expensive for many consumers. About 93% of the coal produced in Russia is transported via railway, according to the Ministry of Transport. Today coal benefits from reduced railway tariffs, like other “1 category” goods such as wood and steel. From 1996 to 2000, the government spent more than 75 billion rubles in subsidies to the coal industry through reduced rail tariffs.⁵ Rail transport sector liberalization will cause a reduction or elimination of coal transport subsidies. In this case the high share of transportation cost in the final cost of coal produced in remote regions of Siberia and Far East will make it hard to compete with other energy sources.

Second, despite showing signs of modest recovery, the coal industry is still in great difficulty. Reform, undertaken in 1993, has resulted in the closure of many unprofitable mines and the privatization of two-thirds of the remaining mines. The World Bank provided Russia with more than \$1.3 billion since 1993 for coal sector restructuring, but the original plan of reform has yet to be implemented. Many social problems related to coal sector restructuring still need to be solved, such as job replacement of workers from closed mines, a major increase in wages and pensions. Russian coal competes not only with gas, but also with lower-cost imported coal. Russia imports annually more than 25 million tons of coal (notably from Kazakhstan), or roughly 10 per cent of total coal consumption.⁶

Finally, the replacement of gas by coal in the energy sector will require important expenses. A shift from gas to coal would require changes in the established patterns of fuel supplies, the energy infrastructure and power station equipment. According to estimates from the Russian electricity monopoly RAO UES, it would cost nearly \$1 billion to refit 27 power stations currently fuelled by gas to burn coal, including introducing environmental safeguards to deal with hazardous emissions.⁷ It would cost even more to develop the transport infrastructure needed for coal deliveries.

Increasing the share of coal would have a negative impact on the environment and on public health. Since coal is the most carbon-intensive of fossil fuels, its increased consumption would raise the level of Russia's CO₂ emissions. This may reduce the amount of CO₂ quotas that Russia could trade under a Kyoto mechanism. Apart from

3. Ministry of Fuel and Energy, *Energy Strategy of the Russian Federation*, Annex 1, www.mte.gov.ru

4. IEA (2002) *World Energy Outlook*, OECD/IEA, Paris.

5. Internet Agency of the Ministry of Transport www.mps.ru/agency, 8 October 2002.

6. Ministry of Fuel and Energy, *Energy Strategy of the Russian Federation*, Annex1, www.mte.gov.ru

7. Korchagina V., “Putin Pledges Coal Revival”, *The Moscow Times*, 30 August 2002.

aggravating the global greenhouse effect, increased coal consumption would also contribute to the problem of acid rain and local air pollution. According to the department of environmental economics of Moscow State University, even a gradual rise in coal use would result in an additional 10,000 deaths and illnesses from pollution per year.⁸

ELECTRICITY AND HEAT TODAY

Electricity

Electricity production, transmission and distribution are controlled by the state monopoly Unified Energy Systems (RAO UES). According to RAO UES, it controls 72% of the total electricity generation capacity in Russia, and owns 2.7 million km of transmission lines, 96% of the total in Russia.⁹ The Russian government owns 52.6% of RAO UES. As of 2003, the RAO UES holding is comprised of 73 Energos, 32 UES-owned large generation plants, 59 research and development companies, 35 affiliates responsible for the energy complex maintenance, and 26 non-profile affiliates. The holding does not include Irkutskenergo (2.6% of overall domestic generation), and Tatenergo (6.4%).

Nuclear power generation is independent of RAO UES, as all Russian nuclear power plants are 100% owned by the Ministry of Atomic Energy¹⁰, and are operated under the state company RosEnergoAtom¹¹. Nuclear power generation currently accounts for over 15% of overall domestic generation. Figure 9 illustrates how the Russian electricity sector is organised and regulated.

The Russian government, through the authority of the Federal Energy Commission, sets the maximum level of electricity tariffs to different groups of consumers (industrial or residential), while the regional energy commissions (REC) regulate electricity retail tariffs in the regions, based on these set maximums. Although formally independent, in practice the regional energy commissions tend to be closely connected to the regional governments. Moreover, most RECs receive financing from regional budgets. All of these factors encourage the Regional Energy Commissions to take into account regional political agendas and to give the long-term fiscal needs of the distribution companies lower priority.

Typically, residential electricity tariffs are artificially low, often below generation cost, and are compensated for by high tariffs to industrial consumers.¹² This structure is the opposite of normal practice in market economies, where residential prices are

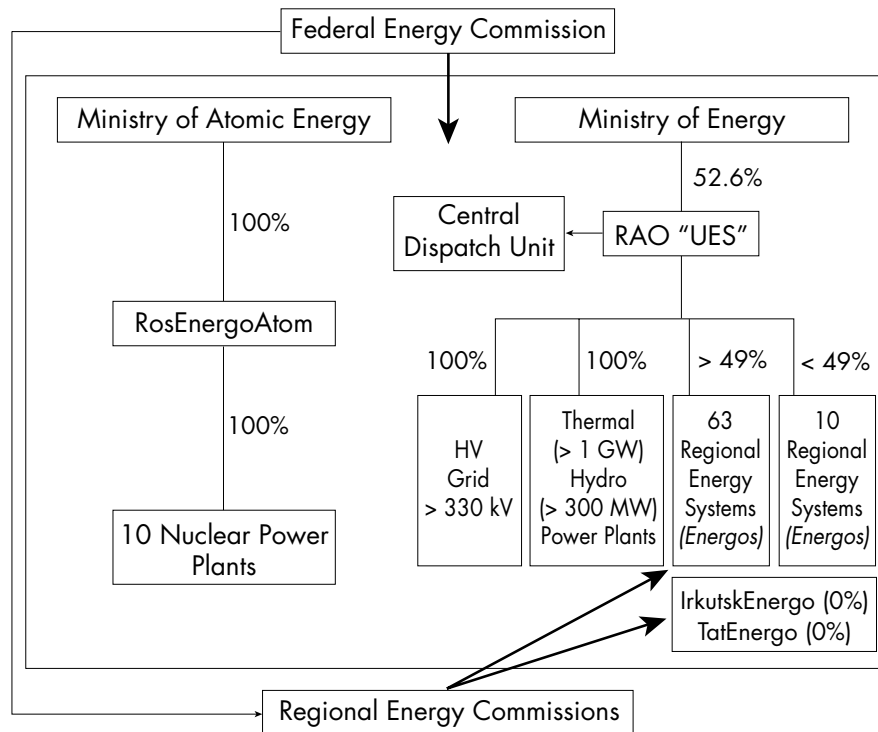
8. Korchagina V. (2002) "Putin Pledges Coal Revival", *The Moscow Times*, 30 August 2002.

9. Chubais, A. (2002) *Presentation at the Informal Seminar of EU Energy Ministers*, 28 April 2002, <http://www.rao-ees.ru/abc/en/show.cgi?280402chub.htm>

10. One of the concerns emerging in this context is that the commencing reform of the electricity sector will not touch nuclear power generation, leaving unresolved a lot of issues regarding the place of the unreformed nuclear power sector in the transformed electricity market.

11. The Leningrad nuclear power plant has been a subsidiary of RosEnergoAtom since April 2002. Previously, the power plant had special status and was owned and operated directly by the Ministry of Atomic Energy.

12. Hubert F. (2002) *Cross Subsidies in Russian Electric Power tariffs Not as Bad as Their Reputation*, April 2002, <http://hubert.hse.ru/th/p-tariff.htm>

Figure 9 Russian Power Sector before Restructuring

greater than prices for industrial consumers given the higher distribution costs for residential consumers and economies of scale generated by large industrial consumers. In 2001, the average RAO UES tariff to industrial consumers was 1.7 cents per kWh, and to residential users, 1.2 per kWh.¹³ Tariffs vary significantly among regions. In 2002, tariffs per kWh for industrial consumers were 0.6 cents in Irkutskenergo, 1 cent in Krasnoyarskenergo and 2.8 cents in Buryatenergo.¹⁴ Electricity tariffs are gradually increasing. Between December 2002 and May 2003, the average RAO UES tariff for residential consumers increased by about 31%, and the average tariff for industry by 12%. The overall average tariff reached 76.54 kopecks (2.5 cents) per kWh in May 2003.¹⁵

There is a wholesale power market *FOREM* in Russia, but it does not operate according to market rules. Transactions on this market are regulated and influenced by political, social and monopolistic factors.¹⁶ The present monopolistic structure is unfavourable to the entrance of Independent Power Producers (IPPs), including those based on renewable energy. The sellers on *FOREM* are RAO UES plants, nuclear plants, and regional utilities (*energOs*) with an electricity surplus. The buyers are regional *energOs* in deficit and large industrial consumers. Since the Central Dispatch Unit is a RAO UES wholly owned subsidiary, it has a vested interest to dispatch RAO UES plants

13. RAO UES www.rao-ees.ru

14. Hubert F. (2002) *Cross Subsidies in Russian electric power tariffs not as bad as their reputation*, April 2002, <http://hubert.hse.ru/th/p-tariff.htm>

15. RAO UES, <http://www.rao-ees.ru/ru/reporting/current/tarif0503.htm>, July 2003.

16. Kennedy D. (2003) "Liberalisation of the Russian Power Sector", *Energy Policy* 31; IEA (2002) *Russia Energy Survey*, OECD/IEA, Paris.

before other competitors. Though generators and large consumers can theoretically conclude bilateral contracts, these have been undermined by difficulties in gaining access to the distribution network owned by RAO UES.¹⁷

Heat

Heating accounts for a large proportion of energy use, especially in the residential sector. In 1999, the share of heat in total final consumption was 33%, while the share of electricity was only 12.4%.¹⁸ In the residential sector, heating and hot water combined represent over half of total energy consumption.

The heat sector is closely linked to the electricity sector: thermal power stations produce over 60% of electricity and nearly 32% of heat.¹⁹ About one third of electricity produced at thermal power stations is co-generated. The existing allocation of costs between power and heat production is not efficient and hinders the development of CHP.

Centralised heating systems with the capacity more than 20 Gcal/hour produce about 72% of all heat. The remaining 28% is produced by decentralised heat sources (18% of which is produced by autonomous and individual systems). Heat distribution systems are obsolete and badly maintained, leading to significant heat losses. About 50% of the network needs major repair or replacement. Heat prices to residential consumers still do not reflect supply costs in many Russian cities. High tariffs to industrial consumers are used to cross-subsidize the losses from residential heat supply.

POWER SECTOR REFORM²⁰

The electricity reform which is underway in Russia offers both an opportunity and a challenge for renewables. The opportunity is related to the size of the various markets in which renewables can participate, and the expectation that electricity prices will better reflect costs in the near future. In such markets, renewables will enjoy an advantage compared to the present circumstances, and might expand. As the existing energy infrastructure is upgraded, economic comparisons among different technologies will favour those renewable energy technologies that are cost-competitive. The challenge is that the regulations in the reformed power sector may fail to be non-discriminatory in seeking to achieve the goals of the Federal law. Chapter 5 of this publication suggests some policies and measures that could be taken to avoid the possible discrimination against renewable energy sources on the electricity and heat markets.

Calendar

Actual reform of the national monopoly RAO UES commenced in June 2001, when the Russian government approved the “Basic Guidelines of the Governmental Policy on Reforming the Power Sector of the Russian Federation”. The reform process has been delayed by strong political and industrial opposition and by the necessity to resolve social issues related to an increase in power prices. After lengthy debate, the Russian

17. Kennedy D., “Liberalisation of the Russian Power Sector”, *Energy Policy* 31 (2003).

18. IEA (2002), *Russia Energy Survey*, IEA/OECD, Paris.

19. Ministry of Fuel and Energy, *Energy Strategy of Russia*, Moscow, Adopted May 2003 www.mte.gov.ru

20. Sources: *Basic Guidelines of the Governmental Policy on Reforming the Power Sector of the Russian Federation*, Moscow, 2001; *Federal Law of Russian Federation on Electricity*, Moscow March 2003; IEA/OECD *Russia Energy Survey*, 2002 pp. 212-213; and <http://www.eia.doe.gov/emeu/cabs/russrest.html>

parliament approved a package of laws on electricity sector reform, and President Putin signed the package on 31 March 2003.²¹ Work on the secondary legislation needed to implement the electricity laws is underway and expected to be finalized by end-2003.

The wholesale power market is expected to be liberalized by 2006. Until then, the power tariffs will remain state-controlled, but 5-15% of electricity generation will be allowed to be traded at liberalized prices. Even after liberalization, the state may continue to regulate electricity tariffs in the isolated energy systems of the Far East.

Market Structure Under the restructuring process, the vertically integrated companies – RAO UES and regional energos – are to be dismantled and the generation, transmission and distribution functions unbundled. Generation and distribution and supply will become more market-based through price liberalisation and competition. The state monopoly will retain control of transmission and dispatching.

Generation Under the reform plan, RAO UES's generation assets are to be spun off into ten *wholesale* generation companies (gencos), six based on thermal plants and four based on hydro. The nuclear power stations operated by *Rosenergoatom* will remain state-owned. These nuclear stations and one hydro station will be placed under the control of the System Operator (SO). This will allow the SO to control some generating capacity in the interests of system stability. After 2006, the ten gencos as well as regional energy companies will compete against each other in the open market. Currently it is not clear to what extent hydropower generation companies will be privatized. Some thermal power stations whose main function is to produce heat may be reclassified as boilers to ensure heat supplies.

The regional utilities (Energos) will be unbundled and the generation components of several Energos will be merged, creating large inter-regional (territorial) generating companies.

Transmission Transmission lines and assets controlled by regional Energos will initially be transferred to regional transmission network companies, and then to the Federal Network Company. The state will keep control over the national transmission grid and the System Operator.

Distribution/Supply After restructuring, distribution and supply will be open to competition and an unlimited number of companies will be able to operate in a competitive retail electricity market. Distribution and supply companies will be created largely on the basis of the unbundled regional *energos*. New companies may also be created. Some retail companies will be granted the status of “guaranteed suppliers”, which obliges them to enter into power supply agreements with all interested consumers within their service area. Guaranteed suppliers will supply power at regulated tariffs. Details of guaranteed suppliers' functions are to be defined. Until 2008, generation companies will be required to sell up to 35 percent of all power produced to one or more ‘guaranteed suppliers’ under long-term contracts at government regulated prices. This regulation is intended to control the price to households and public services after liberalization. The difference between the regulated contract and market prices is to be gradually eliminated.

21. Five of the six bills were approved. The bill on energy efficiency is still being amended.

The legislative and regulatory base of the reform needs to be finalised. The government is to issue decisions, which will serve as additional by-laws to regulate the electricity industry.

Figure 10 Russian Power Sector after Restructuring

| | | |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Wholesale Market Infrastructure | <ul style="list-style-type: none"> ➤ System Operator – Central Dispatch Unit | predominantly government |
| Generation | <ul style="list-style-type: none"> ➤ 6 thermal wholesale generation companies (8-10 GW each) ➤ Inter-regional generation companies ➤ Independent Power Producers ➤ RosEnergAtom (installed capacity 32 GW to 2010) ➤ 4 wholesale hydro generation companies | <p>predominantly private</p> <p>government (100% Federal Property)</p> <p>predominantly government?</p> |
| Transmission | <ul style="list-style-type: none"> ➤ Federal Grid Company ➤ Inter-regional Grid Companies | predominantly government (75% + 1 voting share) |
| Distribution/Supply | <ul style="list-style-type: none"> ➤ Unlimited number of distribution/retail companies ➤ Guaranteed suppliers (until 2008) | predominantly private |

CHAPTER 3

POTENTIAL MARKETS FOR RENEWABLE ENERGY TECHNOLOGIES

There is considerable “low-hanging fruit”, i.e. applications where renewable energy sources have an immediate competitive advantage over conventional energy sources. Given Russia’s rich renewable energy resources and the renewable energy technologies that already exist in the global marketplace, investment in renewable energy in Russia could generate large economic returns. This chapter considers renewable options for bulk electricity, off-grid electricity and heat services, and heat and hot water. Success stories are sprinkled throughout the chapter and appear in boxes in the text.

BULK ELECTRICITY

Russia is the world’s largest producer and exporter of energy but most of its regions produce less energy than they need. Many of them import it from energy-rich regions, like Western Siberia.

Table 10 Russia’s Regional Fossil Fuel Balance, 2000
(million tonnes of coal equivalent)

| Region | Gas | Oil | | Coal |
|--------------------|-------|----------------------------------|--|-------|
| | | <i>Deficit (-) / surplus (+)</i> | | |
| North | -14.2 | 7.5 | | 2.0 |
| North-west | -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 |
| West Siberia | 534.3 | 293.2 | | 45.4 |
| East Siberia | 0 | -15.0 | | 5.3 |
| Far East | 0 | -9.1 | | -0.8 |

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

In Russia, the distance between energy consumers and producers is often great. Many remote regions are not connected to the grid or gas network, and they rely on “imported” coal or heavy fuel oil (mazut). Transportation costs increase the total cost of fuel, which has topped \$350 per tonne of coal equivalent in some regions such as Kamchatka, Republic Tuva and Republic Altai. More than half of these territories’ budgets is spent on fuel.¹ The high cost of imported fuel and the consequent high electricity rates make renewable energy technologies commercially attractive. The potential competitiveness of renewable energy may change, however, if the grid is expanded to these regions.

In the medium and longer term, on the other hand, fuel supply concerns will not be limited to regions with isolated energy systems. When gas prices are liberalized, other energy-deficient regions may have more incentive to develop locally available renewable energy sources. Electricity generation from geothermal plants, wind, small hydropower stations, as well as biomass-fuelled CHP generation, may become economically viable in many Russian regions.

Geothermal Energy

In Kamchatka and the Kuril Islands, geothermal power competes with conventional sources today, even without government incentives. In 2001, the average cost of electricity generation in Kamchatka was about 3 roubles/kWh. The tariff for residents was some 2 roubles/kWh, and was cross-subsidised by the industrial tariff of 4.20 roubles/kWh.² In February 2003, the residential electricity tariff was increased to 2.30 roubles/kWh (\$0.076/kWh), still below cost.³ According to World Bank estimates, the average cost of geothermal-generated electricity is \$0.05 per kWh.⁴

Geothermal Power Stations in Kamchatka

In 1997, the European Bank for Reconstruction and Development granted a credit of \$99.9 million for the construction of a 50 MW Mutnovsky geothermal power station. The total cost of the project was \$150 million, and the Russian investors financed the remainder. The first 25 MW unit of this station was put into operation in 2001, and the second in October 2002.

Today, the electricity generation capacity based on geothermal energy in Kamchatka is 73 MW, accounting for a quarter of the region’s power supply and reducing the region’s dependence on expensive imported fuel. In late 2002, AO “Kamchatenergo” paid 5750 roubles (\$182) per ton of black oil (mazut), which is the highest price among the plants within RAO UES.⁵ Kamchatenergo used to import 480 000 tons of fuel per year for power generation. The use of Mutnovsky geothermal plant has meant that fuel imports fell to 390,000 tonnes in 2002.⁶

There are plans to further extend 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.⁷

1. Bezrukikh, P. *Нетрадиционные возобновляемые источники энергии [Non-Traditional Renewable Energy Sources]*, Analytical Report, Russian Ministry of Fuel and Energy, http://www.mte.gov.ru/ntp/energo/analit_doc.htm
2. Mashkovtsev, M.B., governor of Kamchatka region, Presentation, Moscow, Kremlin, 29 May 2001, <http://www.kremlin.ru/text/appears/2001/05/19318.shtml>
3. Financial Times, 9 January 2003.
4. World Bank, www.worldbank.org/html/fpd/energy/geothermal/markets.htm
5. RAO UES, http://www.rao-ees.ru/en/news/pr_depart/show.cgi?101002mut.htm
6. Platts, *RE Report* No 45, November 2002.
7. RAO UES, http://www.rao-ees.ru/en/news/pr_depart/show.cgi?101002mut.htm

Several studies show that geothermal energy can be commercially attractive in the North Caucasus, particularly the republic Dagestan, in Krasnodar and Stavropol Krai.⁸

Wind

In the 1990s, the Russian Ministry of Fuel and Energy estimated the potential demand for grid connected wind power stations with 100 to 1000 kW turbines to be 470 MW per year.⁹ Large-scale applications of wind energy are possible in areas where extremely favourable wind conditions coincide with existing power infrastructure in the form of conventional electrical power stations and large-scale industrial consumers. Such areas include the Eastern seashore of Sakhalin island, the extreme south of Kamchatka, surroundings of the settlements Pevek and Bilibino in the Chukotka peninsula, the seashore of Magadan region, the zone of the high-voltage network of "Magadanenergo", the southern seashore of the Russian Far East, the steppes along the Volga river near the Volga hydropower stations high-voltage lines, the Northern Caucasus steppes and mountains and the Kola Peninsula.¹⁰ RAO UES has identified 17 regions where grid-connected wind power development can be particularly viable: Murmansk, Arkhangelsk, Astrakhan, Leningrad, Volgograd, Kaliningrad, Magadan, Krasnodar, Stavropol, Khabarovsk, Maritime, Dagestan, Kalmykia, Karelia, Komi, Sakhalin, Kamchatka.¹¹

Experience in European countries demonstrates that the cost of electricity production from on-shore wind is about 0.04-0.07 euro/kWh. Costs are expected to fall to less than 0.035 euros /kWh by 2008.¹² Due to the very favourable wind conditions, the cost would tend to be in the lower ranges in Russia.

Russia's Largest Wind Power Station in the Kaliningrad Region

The largest wind power station in Russia, with a total power capacity of 5.1 MW, is operating in the village of Kulikovo in the Kaliningrad Region. The first 600-kW wind turbine was erected in the Kaliningrad region in April 1998 in the framework of Russian-Danish co-operation. It generates on average 900,000 kWh per year. Following this first demonstration project, 20 more Danish Vesta V27 turbines, each with the capacity of 225 kW, had been put into operation by July 2002. The wind farm produces about 8,200,000 kWh of electricity per year. By replacing fossil fuels for electricity generation, this wind farm could reduce CO₂ emissions by 7380 t/year. In the future, the region plans to build its first commercial off-shore wind power station, which will have a capacity of 50 MW. It will consist of 25 wind turbines, which will be erected 500 meters from the shore on the Baltic shelf near the village of Primorsk. The new project will be carried out by a joint Russian-Danish company.¹³

8. Danish Environmental Protection Agency, *Geothermal Energy Systems Assessment – A Strategic Assessment of Technical, Environmental, Institutional and Economic Potentials in Central and Eastern European Countries*, http://www.mst.dk/homepage/default.asp?Sub=http://www.mst.dk/udgiv/publications/2002/87-7972-037-4/html/heelpubl_eng.htm and Russian Joint Stock Company Nauka, www.geotherm.ru
9. Bezrukikh P.P., "The Russian Wind Energy Market", 1996, presentation at a seminar organised by RDIEE and VIESH; cited in Risø National Laboratory, *Modern Wind Energy Technology for Russian Applications*, Main report, May 1999.
10. Dmitriev, G. and Gunnar Boye Olesen (2001), *Biomass and Wind Power Opportunities in Russia*, Eco-Accord Center, Moscow, August 2001, <http://accord.cis.lead.org/cooperation/energy-engl/8.htm>
11. Martinot E. (1999), *Renewable Energy in Russia: Markets, Development and Technology Transfer*, *Renewable and Sustainable Energy Reviews* 3: 49-75, http://www.martinot.info/re_publications.htm
12. EU CORDIS, "Scientific and Technological References. Energy Technology Indicators", ESTIR Working document, December 2002.
13. Sucksdorff, J., "Wind Turbines in Russia", Presentation at the conference "Russia Power", Moscow, 11-12 March 2003, and Pravda <http://english.pravda.ru/region/2002/07/23/33035.html>, 2002-07-23.

Biomass

The use of biomass and waste for combined electricity and heat generation is commercially viable in many Russian regions. Agricultural, municipal and industrial wastes are currently underused for energy production. Economically exploiting these resources using currently available modern technologies could bring numerous economic benefits to industries and municipalities. It would solve the problem of waste treatment and would improve energy efficiency.

Using wood to produce energy is particularly attractive in the north and north-west of the European part of Russia. In Finland, which has a similar climate and resource capability as this part of Russia, wood fuels represented 20% of total primary energy consumption and 9.3% of electricity generation in 2000.¹⁴

Biomass Use in Finland¹⁵

Extensive use of biomass for energy production in Finland is driven to a large extent by the partnership between forest-sector companies and power utilities and municipalities. Forestry is Finland's largest industry: pulp, paper and other wood products account for more than 35% of the country's export revenue. Many Finnish pulp and paper mills have their own boilers to co-generate electricity and heat from wood wastes and liquors from the pulping process. Some wood is also specifically grown for energy production. Fluidized bed boilers, widely used in forestry, allow the use of multiple fuels and combustion of biomass with a high moisture content.

CHP plants, which are often built in co-operation with municipalities and power utilities, can supply heat to local district heating systems and electricity to the local grid.

The biggest biomass fired cogeneration plant was built in the city of Jacobstad / Pietarsaari on the western coast of Finland in December 2001 by the energy company Alholmens Kraft. The major functions of this plant are: efficient utilization of biomass by-products from the neighboring pulp, paper and saw mills; electricity generation for sale on the market (capacity 240 MW); production of process steam for the use at the mills (100 MW); and supply of heat to the mills and the city's district heating system (60 MW). This co-generation plant uses the mixture of wood-based biofuels such as bark, sawdust, wood chips, cut peat, and also coal as a reserve fuel.

In Russia's north-west regions, the forestry and pulp and paper industries are very important. The northwest produces 60% of the country's paper. Forestry and pulp and paper industries are large potential suppliers of biomass wastes to power generation companies and to local utilities. They are also big potential users of biofuels for their own energy purposes. The pulp and paper industry in Russia relies on biofuels to meet only some 20-30% of its energy needs. In Europe, the pulp and paper industry relies on biofuels for 52%.¹⁶ Increasing the share of biofuels would increase the reliability of electricity and heat supply to the pulp and paper industry. It could also reduce costs.

14. BASREC, *Future of Bioenergy in the Baltic Sea Region*, Workshop report, Jyvaskyla, Finland, 6-7 March 2002.

15. Fujita Research, <http://www.fujitaresearch.com/reports/biomass.html>; James & James, *Co-generation and On-site Power Production*, http://www.jxj.com/magsandj/cospp/2002_03/world.html

16. BASREC, *Development of the Use of Bioenergy in the Baltic Sea Region*, October 2002.

Small Hydro

Exploiting small hydropower¹⁷ (SHP) is one of the very “promising” renewable energy developments in Russia. Small-scale hydropower stations (SHPS) have fewer environmental and social impacts than large stations. These systems can solve energy deficiency problems at the local level, especially in mountainous and foothill regions with high waterfall levels and little seasonal variations in water discharge. Small hydropower systems can be constructed, not only in small rivers, but also in larger ones using a part of their water discharge and functioning channels. Systems can also be constructed in ship passages and at water reservoirs built for non-power purposes.¹⁸

In the near term, the best option would be for Russia to reconstruct and rehabilitate its existing SHP stations. In many Russian regions, there are abandoned SHP stations, with preserved hydro-technical bases (dams, engineering constructions, buildings). Reconstruction is on average 50% less expensive than building new ones.¹⁹ In the medium term, construction of new small hydropower stations can become economically viable over a large part of Russia, particularly in the North Caucasus, the Far East, the North-West (Arkhangelsk, Murmansk, Karelia, Kaliningrad, etc.), Altai, Tuva, Yakutia, Tiumen.²⁰ A small HPS can be constructed in 15-18 months, with a payback period of three and a half to five years.²¹

Prospects for Renewables-based Bulk Electricity Generation

The development of bulk renewable energy technologies could be economically viable, especially in energy-deficient regions of Russia. Several groups of potential investors can be identified: industries, electricity companies, regional administrations and municipalities. Improving the investment climate and increasing access to financial resources will enhance the likelihood of renewable energy development.

As in IEA countries, industrial companies in Russia have started building independent power plants in order to increase the reliability of electricity supply and to reduce costs. Today, generation costs in Russia account for about 50% of the average structure of retail electricity tariffs, AO-Energos costs account for another 15%, and payments for transmission and distribution for 35%.²² By building their own generation capacity, large industrial companies can cut costs substantially. Power sector reform will likely strengthen these incentives. In general, this process should be favourable to renewables, because some industrial self-suppliers will choose cost-effective renewable options such as biomass-fired co-generation plants and small hydro stations.

Power companies are important potential investors in large-scale renewable energy systems in cases where developing renewable energy is economically justifiable. That was the case in Kamchatka, where RAO UES contributed about 506 million roubles (\$16.5 million) to the construction of the Mutnovskaya geothermal plant.²³ However,

17. According to Russian classification, small hydro stations are those with installed capacity up to 30 MW (IEA classification – up to 10 MW).

18. Malik, L.K., Koronkevich, N.I., Zaitseva, I.S., Barabanova, E.A. (2000), *Development of Dams in the Russian Federation and Other NIS Countries*, a WDC Briefing Paper prepared as an input to the World Commission on Dams, Cape Town, www.dams.org

19. Interview with P.P. Bezrukikh, head of the Department of Technological Progress, Russian Ministry of Fuel and Energy, 11 March 2003.

20. Presniakov P., “Малая Гидроэнергетика” (Small Hydro), *Энергетика и Промышленность России (Energy and Industry of Russia)*, No 3 (7), March 2001, www.eprussia.ru

21. Bliashko, J., “Малые ГЭС: хорошо забытое старое”, *Индустрия (Industry)*, www.industry.spx.ru/25/smallges.htm

22. Bashmakov, I., *Electricity Sector Restructuring in Russia: Mismatching Goals and Strategies*, Cenef, Moscow.

23. Most of the project was financed by an EBRD loan of \$99.9 million. Source Energoprogress, Science Technology Newspaper, Special Issue, March 2003.

the current tariff structure is unfavourable to investment in general, not only investment in renewable energy. If the investment climate improves, generation companies will invest in renewable energy projects that yield an economic return.

Those regional authorities that spend a significant part of their budget on fuel supply could also be potential investors in renewable energy systems. Today, these authorities do not have the financial resources available. Current regulations forbid using local budgets for investing in RE systems, regarding such investments as “non-targeted spending”.²⁴ Regulatory provisions are necessary to allow regional and local administrations to have the option of renewable energy systems in cases where such investments could reduce fuel subsidies.

OFF-GRID ELECTRICITY AND HEAT SERVICES

In North America and in some European countries, renewable energy systems have already demonstrated their cost-competitiveness with traditional systems in remote isolated settlements. Even the “most expensive” of renewable technologies – such as solar PV – can compete with diesel generators in remote areas. In over 300 remote Canadian communities, diesel-generated electricity costs between \$0.30 and \$1.50 per kWh. The cost of solar PV-based electricity is between \$0.30 and \$0.60 per kWh in the same communities.²⁵ Many renewable energy applications, such as stand-alone wind or hybrid wind-diesel systems, and bioenergy generators, are also cost-competitive, or nearly so, with traditional fossil fuel technologies.

Remote Areas

In Russia, approximately 22 to 25 million people live in remote regions that are not connected to the centralized grid or where the centralized supply is unreliable.²⁶ Some of the territories that are not served by the centralised grid are connected to smaller, autonomous power grids, but 8 to 10 million people are served by stand-alone generation systems using either diesel fuel or gasoline.²⁷ Most of the stand-alone systems are found in the far northern regions of Russia, in the Far East and in Siberia.

In areas not connected to the grid, approximately 10% of people live in small single-family farms. The majority live in larger collective farms, villages or small settlements.²⁸ In the late 1990s, about 10,000 diesel-generator systems of capacity up to 1000 kW served collective farms and settlements, and about 60,000 smaller gasoline generator systems (500 W-5 kW) served smaller farms and installations. In 1999, nearly half of these diesel and gasoline systems were reported to be no longer operating because of

24. Interview with P.P. Bezrukikh, head of the Department of Technological Progress, Russian Ministry of Fuel and Energy, 11 March 2003.

25. The average cost of electricity in Canada is \$0.06/kWh. http://www.eya.ca/mainresources/Infobooklet_pdfs/SOLARBOOKLET.pdf

26. Bezrukikh P. et al. (2002).

27. Bezrukikh, P. *Нетрадиционные возобновляемые источники энергии (Non-Traditional Renewable Energy Sources)*, Analytical Report, Russian Ministry of Fuel and Energy, http://www.mte.gov.ru/ntp/energo/analit_doc.htm; Martinot, E. (1999), “Renewable Energy in Russia: Markets, Development and Technology Transfer”, *Renewable and Sustainable Energy Reviews* 3: 49-75, http://www.martinot.info/re_publications.htm

28. Martinot, E. (1999), “Renewable Energy in Russia: Markets, Development and Technology Transfer”, *Renewable and Sustainable Energy Reviews* 3: 49-75, http://www.martinot.info/re_publications.htm

fuel delivery problems or high fuel costs.²⁹ In many cases, these systems operate only a few hours per day to save on fuel costs. In the third quarter of 2002, the average producer price for diesel was around 5000 roubles per ton.³⁰ Wholesale prices, taking into account transportation costs, reached 10 000 roubles (\$314.5) per ton in the regions of Khabarovsk, Irkutsk, Yakutia and Buriatia in early 2003. Transporting fuel to the most isolated settlements further increases costs to final consumers.

Individual Country Houses

An important potential application of renewable energy systems is for use in the Russian *dacha* (summer country house). Sixteen million families and ten million individuals reportedly 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.³¹ Some 70-80% of the population is involved in individual gardening and farming. Reportedly five million individual farms and vegetable growers are not connected to the electricity grid.³² For many low-income families, their summer country-house is the only destination for holidays. Many families spend practically every weekend from April till October in their dachas.

Wind

The cost of electricity from diesel generators in off-grid areas in Russia is 10 cents per kWh or more. The estimated cost of electricity generated by wind systems varies from 4.2 cents/kWh on the island of Vaalam and 4.52 cents/kWh in Kalmykia to 8.9 cents/kWh in Sakhalin.³³ Two 250 kW wind turbines installed in the settlement Nikolsky (island Beringa, Far East) have complemented the existing 800 kW diesel generator cost-effectively. In 2000, these turbines accounted for more than 40% of electricity generation and reduced the cost of electricity production threefold.³⁴

The National Renewable Energy Laboratory (NREL) analysed a 10 kW hybrid wind-diesel system for a specific site in the Murmansk region. The study found that a new wind-diesel system would be more efficient than the existing 16 kW diesel generator. The estimated electricity production cost from the diesel system was \$0.30-0.75/kWh, while the levelised electricity cost from the wind-diesel hybrid was \$0.23-0.27/kWh.³⁵

Several small-scale wind projects in Russia's northern territories implemented by the Russian Ministry of Energy, the US DOE, and the USAID, showed that wind-diesel hybrid systems saved 40-80% on the cost of diesel fuel. The average simple payback period of these systems is 3 to 4 years.³⁶

According to the Intersolarcenter, the estimated potential demand for low-capacity (less than 10 kW) autonomous wind turbines for decentralized electricity supply is

29. Ibid.

30. This price excludes VAT, excise and other taxes and transportation costs. Source: CURRENT STATISTICAL SURVEY, 2001-2002 (A Quarterly Issue of the State Committee of the Russian Federation on Statistics).

31. Strebkov, D. (1999), *Trends in Russian Agriculture and Rural Energy*, All-Russian Research Institute for Electrification of Agriculture (VIESH), Moscow.

32. Karabanov S. (2001), "The Prospects for Photovoltaic Development in Russia", *Renewable Energy Report*, UNESCO.

33. Perminov, E., Perfilov O., "Technical and Economic Indicators of Grid Wind Power Stations and Possibilities for Their Financing", in *Business and Investment in RE in Russia. Proceedings of the Congress*, Moscow, 1999.

34. Intersolarcenter, *Renewable Energy Bulletin*, December 2000.

35. Martinot, E. (1999), "Renewable Energy in Russia: Markets, Development and Technology Transfer", *Renewable and Sustainable Energy Reviews* 3: 49-75, http://www.martinot.info/re_publications.htm

36. IEA/OECD, "Wind-Diesel Project Brings Renewable Energy to Northern Russia", *Cadet Technical Brochure*, No 106, 1999.

more than 500,000 units.³⁷ In the 1990s, the Russian Ministry of Fuel and Energy made the following demand projections for small and medium wind systems:

- 0.1-0.5 kW individual use wind turbines: 1000-1500 systems per year;
- 5-50 kW turbines for collective use: 1000-1500 per year;
- systems for collective use that consist of one or more 50 to 500 kW turbines: 85 MW per year during 5 years.³⁸

Biomass

Electricity generated from biomass could also be cheaper than diesel-fuelled generation in remote forested areas. A pre-feasibility study, described by Martinot, suggested that, if a 470 kW biomass-waste plant was substituted for three existing diesel generators in a small logging settlement in the Arkhangelsk region, 87% of the diesel-fuel consumption would be displaced. The study estimated a financial return of over 17%. In addition, waste steam from this plant would be fed into the existing district-heating system, reducing biomass consumption by 50% in the district-heating boiler in the winter.³⁹

Biomass is also widely used in the countryside for space heating, for cooking and for water heating – especially in Russian saunas (“banyas”). Although district-heating systems provide heat and hot water to most of the urban population and to industry, many rural settlements have no centralized heat supply. According to official estimates, 5 million Russian households are heated by firewood and they use more than 50m³ of wood per year.⁴⁰ According to another estimate, only 2 million rural households are connected to the gas supply grid, while the remaining 12.6 million households are heated by burning wood, peat or coal.⁴¹ Families spend a significant part of their income or/and of their time providing themselves with fuel for winter. In addition to these costs, in-door burning of wood or other fuels is inefficient and may be harmful for human health and for the environment. These consumers represent a potential market for modern technologies for small-scale (individual) heat and hot water production from biomass, which could improve efficiency.

Hydropower

In isolated villages and farms that are situated on rivers or near dams (natural or artificial), small hydropower stations can be cost-effective compared to electricity generated from expensive imported fuels. Micro hydropower stations (with capacity up to 100 kW) can be installed practically everywhere in Russia, wherever there are small or large rivers.

Solar Energy

Solar collectors and biomass boilers can be used for heat and hot water supply for individual houses or communities in rural areas. Primitive installations for heat production from renewable energy are already widely used in the Russian countryside

37. Intersolarcenter, *Renewable Energy Bulletin*, December 2000.

38. Bezrukikh P.P., “The Russian Wind Energy Market”, 1996, presentation at a seminar organised by RDIEE and VIESH; cited in Risø National Laboratory, *Modern Wind Energy Technology for Russian Applications*, Main report, May 1999.

39. Martinot, E. (1999), “Renewable Energy in Russia: Markets, Development and Technology Transfer”, *Renewable and Sustainable Energy Reviews* 3: 49-75, http://www.martinot.info/re_publications.htm

40. Ministry of Fuel and Energy, *Energy Strategy of the Russian Federation to 2020*, May 2003.

41. Strebkov, D. Энергетическое использование биомассы (Energy Use of Biomass), www.intersolarcentre.ru

Prospects for Renewables-based Off-Grid Electricity and Heat

(Figure 11). The simple solar water heater consists of a black metal container of 50-200 litres. It is placed in the sun, often in a high position to create water pressure for a tap or a shower.

In rural areas, renewable energy sources can provide the most cost-effective, and sometimes the only way of providing energy services to consumers. Utilities may be interested in building renewable energy systems. But due to the tariff structure and non-payment problem, the financial situation of many utilities is dire. Although significant progress has been made in the last couple of years, non-payment is still an issue.



Figure 11 Primitive Solar Water Heater

Lack of available resources and limited or unfavourable access to credit impedes individual and small industrial/agricultural users from investing in renewable energy technologies. While most of the population in rural areas cannot afford individual RE systems, a number of relatively wealthy families could invest in a RE installation to get reliable electricity, heat and/or water supply in their primary residence or secondary (summer) country house. These potential consumers should be the first ones addressed by RE companies when they market their products.

Newly privatized farms are also potential investors in off-grid RE. In the past, the Soviet collective farms were connected to electricity supply grids free of charge, but today farms have to pay for the connection. When building distribution lines to the farms is too expensive, farmers have to choose another option. Many of them would opt for renewable energy if they knew about the potential resources and the existing technologies.

Recreational stations and health resorts, companies in the forest and fishery industries, and meteorological, archaeological and geological stations are other potential investors in renewable energy systems in Russia.

Wind Power for Farmers

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 part of a conversion programme for companies previously producing military equipment. The generator has a power output of about 300 W. 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.⁴²

42. INFORSE, <http://www.zpok.hu/inforse/24.html>

HEAT AND HOT WATER

Geothermal Energy Direct Use

Geothermal energy is widely used for heat and hot water production in many countries, such as the United States, Philippines, Iceland, Mexico, Italy and Turkey. The average heat production cost from geothermal energy in Western countries is 0.005-0.035 euros/kWh (th).⁴³

Direct use of geothermal energy for space heating, hot water production, warming of greenhouses, crop drying and fish and animal farming is commercially viable in Kamchatka, Kuril Islands, Chukotka and the North Caucasus. In the North Caucasus, geothermal energy has been widely used for these purposes for many years, and today nearly 500,000 people use geothermal for hot water. According to Russian estimates, Russia could save 20-30% of fossil fuels over the next 5-10 years, by using geothermal energy for heat supply in cities and smaller settlements.⁴⁴

The Earth's heat can be used in the European part of Russia where there are no high-temperature hydrothermal systems. Heat pumps using low-potential heat are commercially used in Canada, Sweden, Austria and Switzerland.

Bio-fuel District Heating Boilers

An important renewable energy application for heating is the conversion of coal or mazut-fired district heating boilers to biomass fuels (particularly wood wastes). Since Russia faces Western-level mazut (heavy fuel oil) prices, use of wood wastes for heat production could be cost-competitive. A study of fuel switching in the Leningrad oblast demonstrated that replacing coal with wood would reduce fuel expenditures for heat production by 2.2 times, and replacing mazut with wood would reduce expenditures by 3.6 times.⁴⁵ The study was based on prices in March 2001, so there will be even greater savings when energy costs are rationalized. Small and medium-sized boilers (with a capacity of less than 10 MW) have already been converted to biomass use in Estonia, Latvia, Lithuania and some regions of Russia.⁴⁶ Calculations made for Estonia show that a switch from heavy fuel oil to wood for heat generation reduces fuel costs from US\$10-12 to US\$4.5-8 per MWh. Hazardous emissions of CO₂, SO₂, NO_x, and solid particles are also reduced.

Ignalina Bio-fuel District Heating Project (Lithuania)⁴⁷

Ignalina is a city with 7500 inhabitants in north-east Lithuania. Ignalina district heating company installed a wood-fired 6 MW boiler in 1999, which allowed it to reduce its heat production costs. Earlier heat production was based 40% on light oil and 60% on heavy fuel oil. Today, 25,000 MWh/year are produced from biofuels and only 10,000 MWh/year from mazut. The company still uses mazut for peak load and as reserve capacity, but the major fuel is sawdust and wood chips from industries in the municipality area.

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

44. Povarov O., "Achievements and Prospects of Geothermal Power Engineering Development in Russia", *Energoprogress*, Science Technology Newspaper, Special Issue, March 2003.

45. ECD, *Situation in Fuel and Energy Balance in Leningrad Oblast Area*, www.ecd.dk/baltic/saintenergy.htm

46. 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.

47. Abaravicius J., "Bio-fuel Based District Heating in Lithuania. Towards Sustainability", LUMES, November 2001; Swedish Energy Agency, "The Ignalina Biofuel Boiler House and District Heating Rehabilitation Project".

Economic Benefit: Heat production costs fell by 26.5% from 1998 to 2000. The percent of fuel costs in total heat production costs dropped from 47.6% (1998) to 21.4% (2000) or by 22.7%. Heat production costs per unit of output decreased by 17.7%.

Local Development Benefit: Originally the fuel for heat production was imported from other municipalities, but today the company uses bio-fuel, which is produced locally. Between 1998 and 2000, expenses for fuel imports decreased by 93.4%. Thus LTL 1,908,000 (US \$624,000) remained in the municipality due to avoided fuel import.

Environmental Effects: The new boilers reduced CO₂ emissions by 8112 ton/year; SO₂ by 123 ton/year, and NO_x by 3 ton/year.

Solar Heating/ Hot Water

Heating is one of the most inefficient forms of energy supply and consumption in Russia. The energy efficiency of heat supply is especially low in district heating systems with heat-only boilers, which account for roughly 52% of total heat generation. In such systems, centralized boiler plants operate to produce heat and hot water in winter, and only hot water in summer. During the summer months the energy consumption to produce this hot water is especially inefficient: boilers are operated at low loads and distribution losses are high, whether hot water is demanded or not. In these applications solar hot water collectors on roofs of buildings could replace the existing traditional source of hot water and allow the district-heating boilers to be shut down in the summer months.⁴⁸ According to Suslov,⁴⁹ Russian-designed solar collectors cost from \$60-100/m² to \$200-240/m². A one square metre solar collector can produce 400-600 kWh of heat per year within the temperate belt.

Solar collectors could be used as the only source of hot water throughout much of Russia at least from May until August, and for longer periods in southern regions. In winter and spring and autumn months they could be used as additional water heaters, thus reducing the boiler's load, improving their reliability and increasing their service life. By saving fuel and reducing other operational and maintenance costs of boilers in summer periods, solar collectors create an opportunity to reduce the costs of providing heat and hot water in cold winter months. If comparative economic costs were ascertained for hot water production in summer months, solar collectors would most likely be cost-effective.

Potential investors in geothermal heat systems, district heating boiler conversion and solar collectors are municipal or privatized district heating companies, or local or regional administrations. The prospects of the near and medium term development of renewable energy will largely depend on the investment capacity of these market actors.

48. Martinot, E. (1999), "Renewable Energy in Russia: Markets, Development and Technology Transfer", *Renewable and Sustainable Energy Reviews* 3: 49-75, http://www.martinot.info/re_publications.htm; Suslov A. "Возможность, от которой мы вряд ли имеем право отказаться", АВОК 2/2001.

49. Suslov A. "Возможность, от которой мы вряд ли имеем право отказаться", АВОК 2/2001.

COMPETITIVE INDUSTRIAL MARKETS

Frequently, industry needs small amounts of power at locations far from the grid, or a certain type of power that cannot easily be obtained from high voltage lines, even if nearby. In these circumstances, renewable energy technologies, particularly solar PV and small wind, can be more economical than conventional energy sources. Such applications include:

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

The use of renewables for these cost-effective applications can play an important role in starting a renewable energy market. Using the RE technologies that have already proved to be competitive, companies can make a profit today, while creating a path for the future technological advantages of renewable energy in other applications. In some countries, these industrial applications have provided an economic base to allow sufficient volume and profitability to pursue wider markets. In Germany, for example, solar PV generating capacity grew on average at 44.6% per year between 1990 and 2000, and wind at 62.3% per year over the same period. Solar PV generating capacity grew from 2 MW to 80 MW, and wind from 48 MW to 6,095 MW.⁵⁰ Total electricity generating capacity in Germany was nearly 120 GW in 2000. Thus, the share of solar and wind is still relatively small, but demand is growing rapidly.

With sufficient government support and adequate legislation, Russian companies, through international partnerships, could take advantage of the experience that OECD countries gained in the field of renewable energy over the last two decades.

50. IEA (2003) *Renewables Information 2002*, OECD/IEA, Paris. It should be noted that renewable energy in Germany benefits from governmental financial support.

PART II

MARKET DIFFUSION OF RENEWABLE ENERGY

CHAPTER 4

RENEWABLE ENERGY TODAY

INTRODUCTION

The Russian proverb “the new means the well forgotten old” can well apply to renewable energy in Russia. Russia has developed numerous renewable installations, beginning in the early twentieth century. Research on modern wind turbines started in Russia in 1920 in Kushino, near Moscow.¹ In the early 1930s, the Soviet Union was the first in the world to start constructing utility-scale wind turbines (i.e. the Bataclava Wind Turbine). The first “Atlas of Wind Energy Resources” was published in 1935. In the six years following the end of the Second World War, Russia increased its small hydro capacity by 1,500 MW by installing 7,000 small hydropower stations.² Research in solar photovoltaic cells was one of the best-developed technologies in Russia due to the Soviet space programme. The first solar powered satellite Sputnik 3, fuelled by solar cells, was sent into orbit in 1958. The Puzhetkaya geothermal power station with installed capacity of 5 MWe was built in Southern Kamchatka in 1967, and has been in operation since then, with actual capacity of 11 MWe. A 450 kW tide power station was put into operation on the Kola peninsular in 1968.³ A 10 kW PV system with plastic parabolic concentrators was installed in Ashkhabad in 1984. A “solar village” with a 40 kW capacity was built in the Krasnodar Krai (Territory) in 1989.⁴

As central planning came into fore in the energy industry in the 1950s and 1960s, fossil fuel resources were further exploited. 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. But without ready markets, a commercial industry has been slow to develop.

There is a renewables industry to work from in Russia, with a long history. It needs encouragement by the government in the form of national goals and legislation, and partnership with the international industry to kick-start a viable market.

1. Dmitriev G. (2001), *Wind Energy In Russia*, VetrEnergо for Gaia Apatity and INFORSEE-Europe, First Part, June 2001.
2. Malik, L.K., Koronkevich, N.I., Zaitseva, I.S., Barabanova, E.A. (2000), *Development of Dams in the Russian Federation and Other NIS Countries*, a WDC Briefing Paper prepared as an input to the World Commission on Dams, Cape Town, www.dams.org
3. Britvin O. et al. (1999), *Состояние и перспективы развития нетрадиционной энергетики в РАО ЕЭС России, Business and Investment for Renewable Energy in Russia*, Proceedings of the Congress, Moscow, 31 May-4 June 1999, part III.
4. Intersolarcentre *Renewable Energy Bulletin*, February 2001.

RENEWABLE ENERGY R&D AND MANUFACTURING

Except for large capacity wind turbines, Russia has developed nearly every renewable energy supply technology. Russian companies have especially valuable experience in large hydro and geothermal power development. Russian supply technologies are comparable to foreign technologies in function and in scientific and technical characteristics, but they are produced at much lower cost. The cost of manufacturing RE technologies in Russia is on average 30 to 50% lower than the cost of western analogues.⁵ The quality and reliability of most Russian RE equipment, however, are often inferior to western equivalents.⁶

According to the Intersolarcenter, a Russian organisation which focuses on renewables issues, some Russian renewable energy equipments meet global technological requirements. For example, Russian-made PV solar cells from mono- and poly-crystalline silicon have efficiency exceeding 15%, at a cost of some \$5 per Watt (peak). This corresponds to the average cost of similar devices in the international market. Further R&D will likely bring the cost down to \$2-3 per Watt.⁷

Russian enterprises have the engineering and technical skills sufficient for mass production of renewable energy systems. Following the decline in industrial production in the 1990s, many idle plants and factories, especially in the military complex, converted to production of more modern technologies, including renewable energy systems. Today, there are 100 to 150 Russian enterprises which can manufacture small and large-scale RE systems. Among them are many ex-military enterprises, such as “Electropribor” (St. Petersburg), Tushino machine-building factory, Kovrov mechanical factory and Kaluga turbine factory. These enterprises can produce:⁸

- wind energy systems from 0.04 to 16 kW;
- water pumping wind energy systems;
- autonomous solar PV-system of capacity from 0.06 to 1 kW;
- solar collectors and water heating solar systems;
- micro hydro electric stations of capacity from 4 to 100 kW;
- small hydro electric stations;

5. Bezrukikh, P. *Нетрадиционные возобновляемые источники энергии (Non-Traditional Renewable Energy Sources)*, Analytical Report, Russian Ministry of Fuel and Energy, http://www.mte.gov.ru/ntp/energo/analit_doc.htm

6. Martinot (1995), *Energy Efficiency and Renewable Energy In Russia: Perspectives and Problems of International Technology Transfer and Investment*, PhD Dissertation, University of California, Berkeley, p.89; interviews with Russian RE industry participants.

7. Ministry of Fuel and Energy et al. (1999), “The Role of Renewable Sources of Energy in Power Strategy of Russia”. In Yanovsky, A., Bezroukikh P., *Business and Investment for Renewable Energy in Russia*, Proceedings of the Congress, Moscow, 31 May - 4 June 1999.

8. Ministry of Fuel and Energy et al. (1999), “The Role of Renewable Sources of Energy in Power Strategy of Russia”. In Yanovsky, A., Bezroukikh P., *Business and Investment for Renewable Energy in Russia*, Proceedings of the Congress, Moscow, 31 May - 4 June 1999.

- individual biogas modules;
- heat pumps⁹ (see Annex 2 for the list of RE manufacturers).

Very few of these enterprises, however, are commercially active due to low demand for renewables in the Russian domestic market. Many technologies still remain at the R&D or demonstration stage, while analogous western technologies are already more or less commercialised. The low demand for renewable technologies is due to comparatively low prices for conventional energy and the lack of information and awareness about renewables. If the demand for renewables grows, Russian manufacturers will increase their quality and reliability by gaining experience in domestic markets.

Another barrier to the penetration of renewables is that Russian manufacturers of RE systems still lack the managerial, financial, legal and market-transaction skills to successfully advertise and sell their products.¹⁰ The lack of “commercial know-how”, combined with lower quality and reliability of Russian-made equipment, reduces the competitiveness of Russian renewable energy systems compared with more mature technologies. Foreign-manufactured systems are, as a rule, more expensive and thus less affordable for Russian consumers. Technological partnership between Russian and foreign companies could reduce this barrier (see Chapter 5).

There is considerable potential for developing a market for renewable energy technologies within Russia but governmental support is necessary to facilitate the commercial deployment of these technologies. By acquiring commercial skills and improving the quality of their products, Russian RE manufacturers could compete with foreign companies in Russia and eventually also in global markets. But clearly the economic deployment of renewables in Russia will be shaped by the nature and pace of reform in Russia’s conventional energy sources markets and supporting institutions.

RENEWABLE ENERGY IN RUSSIA – PATTERNS OF USE

Despite the available technologies and an industrial base sufficient for the mass production of RE systems, the actual use of renewable energy (except for large hydro) is quite small in Russia. According to IEA statistics, non-hydro renewable energy accounts for slightly over 1% of total primary energy supply (TPES).¹¹ According to official Russian statistics, renewable energy (excluding large hydro) accounted for 0.5% of total electricity generation in 2000 and 2001.¹² Russian experts estimate that heat based on renewables¹³ amounts to about 4% of the total heat demand in Russia.

9. For detailed description of equipment see: Ministry of Fuel and Energy and JSC “New and Renewable Sources of Energy”, *Оборудование нетрадиционной и малой энергетики (Equipment of small and non-traditional power engineering) Catalogue*, Second edition, Moscow 2000 and www.intersolar.ru

10. Martinot (1995), *Energy Efficiency and Renewable Energy In Russia: Perspectives and Problems of International Technology Transfer and Investment*, PhD Dissertation, University of California, Berkeley.

11. Including biomass, municipal and industrial waste, geothermal, wind, and solar. IEA/OECD, *Energy Balances of Non-OECD Countries*, 2002.

12. Interview with P.P. Bezrukikh, head of the Department of Technological Progress, Russian Ministry of Fuel and Energy, 11 March 2003.

13. Including biomass and wastes, low potential heat (heat pumps), solar thermal.

The use of renewable energy sources appears to be growing in Russia. Official statistics were not published when this report was prepared, but electricity production from renewables is expected to have grown by 10% in 2002 compared to 2001.¹⁴

Given the extremely rich RE resources in Russia, and large potential demand, growth in renewable energy production in Russia could be substantial, if necessary policies and measures to support renewables are considered in the broad restructuring of Russia's energy sector. In OECD countries, where renewable energy benefits from policy support¹⁵, installed capacity of renewables grew by 1.7% between 1990 and 2000, and gross electricity generation from all renewables grew approximately by 4.5% between 1995 and 2000. The largest increases were in wind and solar photovoltaics. Albeit from a low base, gross electricity generation from solar PV grew by 28.9% from 1990 to 2000, and from wind by 22.4% over the same period.¹⁶

LARGE HYDRO ENERGY

Compared with other sources, hydro is the most extensively used renewable energy source in Russia, accounting for 18% of total electricity generation in 2000. There are 98 large hydropower stations (HPS) in Russia, with a total installed capacity of nearly 44,000 MW. These systems generate, on average, 156-170 billion kWh of electricity per year.¹⁷ Russia has developed only some 23% of its economic hydropower potential (see Table 11). The United States and Canada have developed some 50 to 55% of their hydropower potential. In some countries of Western Europe and in Japan, 60-90% has been developed.¹⁸

In the European part of Russia, nearly half of the hydropower resources have been developed. But, in Siberia, only some one-fifth have been developed, and, in the Far East, only 3.3%.¹⁹ Development has largely been concentrated in the densely populated regions. The Volga River is the most developed. As illustrated in Table 11, hydropower development (taking into account operating HPS and those under construction) is 68 to 74% of its potential in the Volga-Viatsky and Povolzhsky regions, whereas in the Western-Siberian region only 2% of its resources have been developed.

Hydropower stations in operation in Russia are old and their equipment is in poor condition. According to Russian sources, in 2000 about 56% of the operating hydropower installations (45% of total installed capacity) were using equipment whose design life had been significantly exceeded.²⁰ The World Dam Commission is even more pessimistic: in 2000, the Commission found that 70% of installations had been in service longer than the designed service period.²¹ This situation is related to the

14. Interview with P.P. Bezrukikh, head of the Department of Technological Progress, Russian Ministry of Fuel and Energy, 11 March 2003.

15. See Database of Renewable Energy Policies and Measures: <http://library.iea.org/renewables/index.asp>

16. IEA/OECD, *Renewable Energy Information*, 2002.

17. RAO UES Rossii, Гидроэнергетика (Hydroenergy), www.rao-ees.ru/ru/tech/show.cgi?niokr3.htm

18. Malik, L.K., Koronkevich, N.I., Zaitseva, I.S., Barabanova, E.A. (2000), *Development of Dams in the Russian Federation and Other NIS Countries*, a WDC Briefing Paper prepared as an input to the World Commission on Dams, Cape Town, www.dams.org

19. RAO UES Rossii, Гидроэнергетика (Hydroenergy), www.rao-ees.ru/ru/tech/show.cgi?niokr3.htm

20. Ivashintsov, D. Дело нашей жизни – гидроэнергетика, <http://www.vniig.ru/ru/pdf/news2/ivashintsov.pdf>

21. Malik, L.K., Koronkevich, N.I., Zaitseva, I.S., Barabanova, E.A. (2000), *Development of Dams in the Russian Federation and Other NIS Countries*, a WDC Briefing Paper prepared as an input to the World Commission on Dams, Cape Town, www.dams.org

Table 11 Regional Distribution and the Level of Economic Hydropower Potential Development in Russia

| Economic regions | Economic hydropower potential, 10 ⁹ kW per hour | Developed economic hydropower potential at HPSs in operation and under construction, 10 ⁹ kW per hour | Level of potential development, % |
|--------------------|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| Total in Russia | 852 | 199,9 | 23,4 |
| Including regions: | | | |
| North | 37 | 9,3 | 25 |
| North-West | 6 | 3,6 | 60 |
| Central | 6 | 1,5 | 25 |
| Central Black Soil | – | – | – |
| Volgo-Vjatsky | 7 | 4,8 | 68 |
| Povolzhsky | 41 | 30,5 | 74 |
| Northern Caucasus | 25 | 8,5 | 34 |
| Urals | 9 | 4,4 | 49 |
| West-Siberia | 77 | 1,7 | 2 |
| East-Siberia | 350 | 116,6 | 33 |
| Far East | 294 | 19,0 | 6 |

Source: Malik, L.K., Korankevich, N.I., Zaitseva, I.S., Barabanova, E.A. (2000), Development of Dams in the Russian Federation and Other NIS Countries, a WDC Briefing Paper prepared as an input to the World Commission on Dams, Cape Town, www.dams.org, p. 25.

inefficient way that hydropower stations are financed. Given the electricity tariff structure and inefficient centralised financing, the hydropower stations, as the whole electricity system, lack funds to replace obsolete equipment, thus decreasing the security of their operation.

In 2001, there were 16 RAO-UES hydropower plants under construction in Siberia, in the Far East, in the north-west and the south of European Russia. These stations have projected capacity of 9 000 MW and would generate 36 billion kWh per year.²² Lack of investment has slowed down or suspended the construction of many HPS. Environmental and social issues have also begun to play an important role in the realisation of new hydropower projects. The Katunskaya HPS in Altai was rejected for ecological reasons. There were attempts to freeze the construction of the Beloporozhskaya HPS in Karelia because it was likely to displace indigenous people.²³ The largest project today is the Bureiskaya HPS (Amour region, Far East), planned for 2008, with the projected installed capacity of 2000 MW and yearly power generation over 7000 million kWh. The first unit of it was put into operation in June 2003.²⁴ The construction of the station started in 1983, but was suspended due to lack of financial resources.

There are important motivations for the development of medium and large hydropower projects in Russia. Large hydropower stations can increase security of energy supply

22. RAO UES Rossii, Гидроэнергетика (Hydroenergy), www.rao-ees.ru/ru/tech/show.cgi?niokr3.htm,

23. Gubernia, Гидроэнергетика еще может подняться с колен, Губерния (Gubernia) No 25, www.onego.ru/win/pages/gubernia/25/2528.html

24. Pravda, 30 June 2003, <http://newsfromrussia.com/main/2003/06/30/48826.html>

by providing a relatively cheap, renewable, non-polluting source of energy. They could also be an important source of foreign exchange, by producing electricity for export. The ecological and social impacts of large hydropower systems, however, are an obstacle to their development. Thus, Russia could focus on the modernisation of existing HPS and, perhaps, completing those already under construction. Building new HPS on existing water reservoirs (natural or artificial) could also be viable. In each case, “best practices” suggest that preliminary studies of possible environmental and other impacts should be carried out before a project begins.

SMALL HYDRO ENERGY

Only about 1% of Russia’s small hydro potential is currently being exploited.²⁵ There are 89 small HPPs with combined capacity of 550 MW.²⁶ In China, for comparison, the capacity of small hydro stations is close to 20,000 MW.²⁷

Russia intensively developed small hydro stations after the Second World War. In the 1950s and 1960s the focus switched to large hydro power development. Thousands of small power stations were then closed, and design, construction and production of equipment and spare parts for small-scale hydro engineering stopped. As a result today there are many abandoned small hydropower stations in Russia. They no longer produce electricity, but their buildings and installations remain intact.²⁸ Russian experts estimate that the restoration of these “abandoned” hydropower facilities could be up to two times less expensive than building new ones.²⁹

GEOTHERMAL³⁰

There are currently over 8000 MW of generating capacity in geothermal resources in the world (including almost 3000 MW in the USA and almost 2000 MW in Philippines). Globally, there is another estimated 12000 MW installed capacity for direct use.³¹ Geothermal energy is used on a relatively small scale in Russia, either directly for heat production or indirectly for electricity generation.

25. Presniakov P. (2000) “Малая Гидроэнергетика” (Small Hydro), *Энергетика и Промышленность России (Energy and Industry of Russia)*, No 3 (7), March 2001, www.eprussia.ru

26. EBRD, *Strategic Renewable Energy Assessment. Renewable Energy Country Profile: Russian Federation*, version 0.6b, <http://projects.bv.com/ebrd/profiles/Russia.pdf>

27. International Small Hydro Atlas, http://www.small-hydro.com/Country_Details.cfm?country_id=15

28. Malik, L.K., Koronkevich, N.I., Zaitseva, I.S., Barabanova, E.A. (2000), *Development of Dams in the Russian Federation and Other NIS Countries*, a WDC Briefing Paper prepared as an input to the World Commission on Dams, Cape Town, www.dams.org

29. Bliashko, J., “Малые ГЭС: хорошо забытое старое”, *Индустрия (Industry)*, www.industry.spx.ru/25/smallges.htm

30. Unless otherwise stated, this sector is adapted from: Battocletti, L. (2000), *Geothermal Resources in Russia*, Bob Lawrence and Associates, Inc., November 2000, http://www.bl-a.com/ECB/PDF%20Files/Geo%20Res%20Russia_2000.pdf

31. World Bank, www.worldbank.org/html/fpd/energy/geothermal/markets.htm

In January 2000, installed geothermal power generation capacity in Russia was estimated at 34.8 MW:

- 12 MW at Verkhne-Mutnovsky;
- 11.3 MW at Pauzhetka;
- 8 MW at Okeanskaya (Iturup Island);
- 2 MW at Ebeko (Paramushir Island);
- 800 kW at Paratunka;
- 700 kW at Goriachy Plyazh (Kunashir Island).

The plants at Ebeko, Okeanskaya, Goriachy Plyazh and Paratunka are reportedly not operating. Additional capacity that was either under construction in 2000 or scheduled to be on line by 2005 includes:

- 9 MW at Verkhne-Mutnovsky;
- 18 MW at Pauzhetka;
- 32 MW at Okeanskaya;
- 250 MW at Mutnovsky.

In 2001 and 2002, two 25 MW units of Mutnovsky geothermal power station were put into operation, thus increasing the total geothermal operating capacity in Russia to 73 MW. All this electricity generation capacity is situated in Kamchatka.

As of end 1999, Russia had a total direct use installed capacity of 307 MW, yielding 6132 TJ/year of energy. Direct use includes space and district heating, agricultural purposes (e.g. greenhouses, soil heating, fish and animal farming and cattle-breeding), and industrial applications (e.g. manufacturing, wool washing, wool drying, paper production, oil extraction, etc.). Direct use of geothermal energy is widespread in the Kurils, Kamchatka, the North Caucasus, West Siberia, and the Baikal region.

Table 12 Geothermal Direct Uses in Russia (January 2000)

| | Installed capacity (MW) | Annual energy use (TJ/year) |
|-------------------------|-------------------------|-----------------------------|
| Space heating | 110 | 2 185 |
| Greenhouse heating | 160 | 3 279 |
| Fish and animal farming | 4 | 63 |
| Agricultural drying | 4 | 69 |
| Industrial process heat | 25 | 473 |
| Bathing and swimming | 4 | 63 |

Source: Danish Environmental Protection Agency / Danish Ministry of the Environment (2002) *Geothermal Energy Systems Assessment. A Strategic Assessment of Technical, Environmental, Institutional and Economic Potentials in Central and Eastern European Countries. Country Profiles and Case Studies* <http://www.mst.dk/homepage/>

The Russian Academy of Science and the Special Scientific Council on Geothermal Problems co-ordinate research on geothermal issues. Research is conducted by 14 research centres, which include 26 scientific institute laboratories, three universities and five project bureaus. Several private companies are involved in the exploration and utilisation of geothermal resources, such as Geotermneftegas, Geoterm, Neftegasgeoterm and Energiya-M.

BIOMASS

According to IEA statistics, Russia used 7.5 Mtoe of combustible renewables (biomass) and wastes in 1999, and 6.9 Mtoe in 2000.³² This figure is approximate, because there are no official statistics on traditional biomass use for heat and hot water production by individuals in the countryside. Strebkov estimates that individuals in rural areas use 30 Mtce (21 Mtoe) of wood each year, and people in semi-rural industrial settlements, meteorological and geological sites, and in the fishing industry use another 10 Mtce (7 Mtoe).³³

About 40 thermal power stations use biomass (mostly waste from the wood processing industry) along with other fuels. Biomass is also used as solid fuel in certain district heating boilers. Russia has some 100 plants that convert biomass and agricultural wastes into biogas today. Municipal and industrial wastes are utilised at large incineration plants.³⁴ The city of Moscow has two incinerators, which provide many benefits: removing wastes, improving energy efficiency, improving sanitation and consequently the health of the population. The Ministry of Natural Resources is in the process of drafting a new law on municipal wastes.

WIND

In early 2002, total installed capacity of wind power systems was estimated to range from 4 MW³⁵ to 5 MW,³⁶ including a 2.5 MW wind farm “Zapoliarnaya” (ten 250 kW turbines) 30 km from Vorkuta. In July 2002, final units were put into operation in the wind farm in the village of Kulikovo in the Kaliningrad Region, increasing its capacity to 5.1 MW³⁷ (see Chapter 3). The operating capacity of wind today is estimated at 7 MW. For comparison, the USA had 2365 MW of wind in 2000,³⁸ and India had 1167 MW.³⁹

32. IEA (2002), *Energy Balances of Non-OECD Countries*, IEA/OECD, Paris. Note: The data on biomass and waste in non-OECD countries should be treated cautiously because they are often from secondary sources.

33. Strebkov, D., *Энергетическое использование биомассы* (Energy Use of Biomass), www.intersolarcentre.ru

34. Interview with P.P. Bezrukikh, head of the Department of Technological Progress, Russian Ministry of Fuel and Energy, 11 March 2003.

35. Bezrukikh et al. (2002).

36. EBRD, *Strategic Renewable Energy Assessment. Renewable Energy Country Profile: Russian Federation*, version 0.6b, <http://projects.bv.com/ebrd/profiles/Russia.pdf>; Dmitriev G., *Wind Energy in Russia*, VetrEnergo for Gaiana Apatity and INFORSE-Europe. First Part, June 2001.

37. Pravda, <http://english.pravda.ru/region/2002/07/23/33035.html>, 2002-07-23.

38. IEA (2002) *Renewable Energy Information*, OECD/IEA, Paris.

39. Tata Energy Research Institute, <http://www.teriin.org/renew/estpot.htm>

Feasibility studies have been made for wind projects with total planned capacity of at least 200 MW.⁴⁰ Russian specialists have estimated the technical and economic feasibility of wind farm construction in Karelia, on the Kola Peninsula, on the Sakhalin peninsula, in Magadan, Leningrad and Kaliningrad regions, near the town of Anapa and in other sites. They elaborated commercial proposals for constructing several wind farms with capacity from 3 to 50 MW and with estimated cost of 4.2 to 8.9 cents/kWh.⁴¹ There are also commercial proposals to construct hybrid wind-diesel electric power stations in the city of Vorkuta, in Kamchatka, Yamal and Taimyr.

SOLAR

A "solar village" with 40 kW capacity was built in the Krasnodar Krai (Territory) in 1989.⁴² A 1 MW grid-connected solar photovoltaic power plant was under development in Stavropol in the early 1990s (using 50 kW of panels and 20x concentrators), but this project was postponed due to the lack of funding.⁴³ The actual installed capacity of solar PV is only 0.5 MW; and there are some 0.1 million m² of installed solar collectors.⁴⁴ For comparison, Germany had 80 MW of PV, and 2.89 million m² of solar collector surface.⁴⁵

40. Perminov E, O. Perfilov (1999), "Технико-экономические показатели сетевых ветроэлектростанций и возможности их финансирования", in *Business and Investment for Renewable Energy in Russia*. Proceedings of the Congress. Moscow 31 May - 4 June 1999, Part III.

41. Perminov E, O. Perfilov (1999), "Технико-экономические показатели сетевых ветроэлектростанций и возможности их финансирования", in *Business and Investment for Renewable Energy in Russia*. Proceedings of the Congress. Moscow 31 May - 4 June 1999. Part III, pp. 274-276; Intersolarcentre, *Renewable Energy Bulletin*, December 2000.

42. Intersolarcentre, *Renewable Energy Bulletin*, February 2001.

43. Martinot, E. (1999), "Renewable Energy in Russia: Markets, Development and Technology Transfer", *Renewable and Sustainable Energy Reviews* 3: 49-75.

44. Bezrukikh et al. (2002).

45. IEA (2002), *Renewable Energy Information*, OECD/IEA.

CHAPTER 5

BUILDING RENEWABLE ENERGY MARKETS

INTRODUCTION

The previous chapters demonstrated the multitude of opportunities for market diffusion of renewable energy technologies in Russia. They provided quantitative evidence of the vast undeveloped RE potential, showed numerous applications of RE technologies suitable for Russian consumers and looked at the current RE industry in Russia. However, the players on the emerging RE market operate today in confused market conditions. As all sectors of the economy, the renewable energy sector faces major barriers to investment, including lack of transparency; energy prices not reflecting costs; and a weak financial sector. The lack of a specific national RE strategy, of adequate legislation and regulatory framework for RE projects further restrains the development of renewable energy markets. Improving the overall investment climate, by continuing the economic, financial, legal, regulatory and fiscal reforms, is vital. It is also important to maintain and extend the reforms to the electricity sector and to eliminate subsidies for conventional energy sources.¹

In addition to broad economic reforms, Russian policy makers could also introduce specific measures to enhance the development of renewable energy. This should not require substantial budget expenditures. Experience in IEA member countries as well as many countries with economies in transition show that there are practical low-cost measures that could stimulate investment in renewable energy technologies and could lead to considerable economic returns. In the short term, Russian policy makers could concentrate on measures that would enhance the use of RE systems that already have competitive advantages in specific applications. These applications, such as biomass boilers, wind turbines in remote areas, solar hot water heaters, small hydro power stations and geothermal sites, are discussed in Chapter 3. As Russian businesses become experienced with installation and maintenance on a large scale, new markets for these technologies will open up, creating even more competitive opportunities.

Each renewable energy technology will require specific measures to facilitate its market deployment, but a number of general actions are suggested here based on IEA member country experience that could enable the development of a market for RE technologies. These actions would increase awareness and attract investment. Contrary to subsidies

1. For a more detailed discussion of the reform process in Russia see IEA (2002), *Russia Energy Survey*, IEA/OECD, Paris.

and direct funding of renewable energy, the following measures are low-cost investments that will reap near-term benefits and reduce energy expenditures at the regional level. They must be consistent with the logical progression of broader reform to avoid having stranded high cost projects if, for example, grid expansion makes them less competitive.

POSSIBLE INITIAL STEPS TO IMPLEMENT RENEWABLE ENERGY IN RUSSIA

The typical pattern that many IEA countries have followed to develop a renewable energy market is to implement a strategy in three main steps: adopt a renewable energy strategy (identify goals); adopt relevant laws (set up market structure); and specify implementation mechanisms (establish rules). It is possible, however, to set up actions in parallel: introduce some actions of each next step before the full implementation of the preceding one.

Step 1. National Renewable Energy Strategy

International experience demonstrates that an integrated supply and demand approach to energy policy, which encourages energy-efficient and environmentally friendly technologies, is the most appropriate context for renewable energy development. In this respect the Energy Strategy of Russia to 2020 adopted in May 2003 is a positive step given the central focus of the Strategy on meeting energy efficiency and environmental goals while ensuring the energy security of the country. Including renewable energy development in the national energy policy is an important step towards increasing the attractiveness of investment in renewable energy projects.

Growth in demand for renewable energy is highest in countries that have made RE development one of the focal points of the national energy strategy. In Russia, in the years following the break-up of the Soviet Union, renewable energy development was not a priority for the government. The first important step toward the recognition of the importance of renewable energy sources was the adoption of the Federal programme “Energy Efficient Economy in 2002-2005 and up to 2010” in November 2001. This programme includes the section “Effective Energy Supply of Regions, including Northern Territories, on the basis of Non-traditional Renewable Energy Sources and Local Fuels” (further: “Renewable Energy in Northern Territories”).

The national energy strategy², adopted by the Russian government in May 2003, stated the strategic goals of the development of renewable energy and local fuels (wood and peat):

- reduce the use of non-renewable energy sources;
- reduce the negative environmental impacts of the energy sector;
- stabilise energy supply in decentralized regions and for isolated consumers;
- reduce expenses on fuels that are transported over long distances.

2. *Energy Strategy of the Russian Federation until 2020* (in Russian), <http://www.mte.gov.ru/docs/32/103.html>

This is consistent with the position of the G8, which stated at the Genoa Economic Summit and reaffirmed later at the Energy Ministerial Meeting in Detroit in May 2002, that it recognized “the importance of RE for diversification of energy supplies...”. Renewable energy goals explicitly stated in a national energy strategy demonstrate a country’s determination to support the development of renewable energy markets. Of course, renewables can be supported without goals, but market players view such goals as encouraging signals, indicating that a country welcomes investments in renewable energy.

Some countries have chosen to quantify their renewable energy objectives in the form of Renewable Energy Targets (RETs) that set a minimum percentage of energy or electricity supply in a given country (or region) from renewables. For example, the European Union’s Renewable Energy Directive³ sets the target to achieve 22.1% of electricity produced from renewable energy and 12% of renewables in gross national energy consumption by 2010. To comply with the European target, individual member countries negotiated national targets, e.g. Belgium 6% of electricity by 2010 (compared to 1.1% in 1997), Denmark 29% (8.7% in 1997), etc. RETs have been introduced in all EU countries, as well as in Japan, Australia and in a number of states of the USA. The “EU-accession” countries also have to establish RE targets. The Czech Republic officially announced its target to generate 5-6% of total primary energy supply from RE sources by 2010⁴ and is implementing practical measures that will achieve this target.

The Russian energy strategy does not articulate official targets for renewable energy development, but it states that with adequate governmental support it is *possible* to put into operation 1000 MW of power generation capacity and 1200 MW of heat capacity based on renewables by 2010. The strategy does not, however, indicate how the government will support renewables.

The section “Renewable Energy in Northern Territories” of the Federal Programme “Energy Efficient Economy” does set precise targets, in particular:

- to replace 2 Mtce of organic fuel by all types of renewable energy sources by 2005, including replacing 1 Mtce of imported fuel in Northern and other remote territories;
- to put in operation the following generation capacity based on renewables (electricity and heat respectively): 100 MW by 2005, 800 MW by 2010; and 150 Gkcal/hour by 2005, 1000 Gkcal/hour by 2010.

The Federal Programme “Energy Efficient Economy” aims to allocate only 1.2 billion roubles (\$ 39.4 million at July 2003 rate) over the period 2003-2005 and 3.2 billion roubles (\$ 105 million) in 2006-2010 from the Federal Budget for the implementation of the sub-programme “Renewable Energy in Northern Territories”. It stipulates that the remaining funds necessary to achieve these targets – i.e. 10 billion roubles (\$329 million) over the first phase and 42.5 billion roubles (\$ 1.4 billion) over the second phase – will come from the “non-budget” (private) sources.⁵

3. Directive 2001/77/EC on the promotion of electricity from renewable energy sources in the internal electricity market, adopted by the Council of Ministers and the European Parliament in September 2001.
 4. IEA, *Renewable Energy Policies and Measures Database*, <http://library.iaea.org/renewables/index.asp>
 5. The total investment requirement for the Programme implementation are 7005 billion roubles (\$ 230 billion at July 2003 rate). Of them 50 billion roubles (0.7%) would come from the Federal budget, and the rest from the regional and local budgets and the private investments.

To attract private investment for the implementation of this sub-programme (and more generally of other renewable energy projects), it will be necessary to put in place a clear and comprehensive legal and regulatory framework as well as specific policies and measures to stimulate the renewable energy market diffusion.

Step 2. National Legal Framework (National Renewable Energy Law)

To meet renewable energy goals it is necessary to bring into force a coherent and progressive legal framework. Many countries have adopted specific laws that provide the legal basis for the mechanisms that allow market players to develop a renewable energy market. The renewable energy law or its equivalent usually specifies the legal status of the producers of renewable energy technologies, their rights and obligations. It also specifies the roles and responsibilities of the federal, regional and local bodies regarding such functions as establishing regulations, standards, licensing, taxation and other controls on project development.

The U.S. Public Utility Regulatory Policies Act

The Public Utility Regulatory Policies Act (PURPA-Public Law 95-617) was passed by the U.S. Congress in 1978 as one of five laws to help reduce the nation's dependence on imported oil. PURPA expressly encouraged the use of renewable and other alternative energy resources in electricity production to conserve oil and natural gas. The law removed several market and institutional barriers to the development of alternative generating sources. First, electric utilities were required to interconnect with and provide non-discriminatory backup power to projects. Second, utilities were required to purchase power from these developers at the utility's "avoided cost," or the cost that the utility would have incurred by generating or otherwise supplying the power itself. And finally, PURPA exempted these projects from federal and state utility regulatory requirements. It has been estimated that the law resulted in the development of more than 12,000 MW of new renewable energy projects during the 1980s and 1990s.

Current legislation in Russia is not favourable to the development of renewables. Renewable energy resources and their deployment are governed by a variety of laws, acts, decrees and regulations, many of which are conflicting or unclear. The situation will probably change within a few years. The new energy strategy points out the necessity to adopt a Federal Law on renewable energy sources and the corresponding governmental decree.

There was a recent attempt to adopt a specific law on renewable energy. The State Duma (lower house of the Parliament) adopted the Federal Law "About the State Policy in the Sphere of New Renewable Energy Sources" on 27 October 1999, and the Federation Council (the upper house) approved it on 11 November 1999.⁶ However, President Yeltsin vetoed the law. A group of specialists directed by the head of the technology department of the Russian ministry of energy P.P. Bezrukikh have elaborated

6. Bezrukikh, P. *Нетрадиционные возобновляемые источники энергии (Non-Traditional Renewable Energy Sources)*, Analytical Report, Russian Ministry of Fuel and Energy, http://www.mte.gov.ru/ntp/energo/analit_doc.htm

an improved draft of the renewable energy law.⁷ This draft law defines the different types of renewable energy, lists applications where it can be used, and identifies major requirements and obligations related to exploiting renewable energy resources. It also lists several financial and regulatory mechanisms to stimulate renewable energy markets. The next section of this publication describes these and other mechanisms, based on the experience in OECD countries and developing economies.

Step 3. Implementation

The next step in the RE strategy would be bringing into practice the mechanisms on the territorial, regional and local levels. This will require adequate regulatory and institutional frameworks to actually set the rules authorized under the national renewable energy policy. A set of regional laws or regulations and local provisions are necessary to guarantee the implementation of the national strategy. These regulations can either enforce the mechanisms outlined in the national law or can introduce specific regional/local initiatives in accordance with the national strategy.

Short-term measures to facilitate the development of renewable energy markets would aim at supporting domestic industry and stimulating demand for renewable energy systems. In the longer term, more fundamental changes to regulatory policy would further encourage the development of renewable energy markets.

STIMULATING DEMAND AND SUPPORTING DOMESTIC RENEWABLE ENERGY INDUSTRY

Creating a favourable investment climate is essential in order to generate investments in RE. It is also vital to increase potential stakeholders' awareness of the existing renewable energy resource base, technologies and benefits. A number of "awareness-increasing measures" could be introduced to stimulate interest in renewables.

At the same time, it is necessary to support the emerging domestic renewable energy industry, whose role is to meet this demand. Financial and regulatory measures to encourage RE industry on the first stages of its development help to form a "virtuous cycle" described as follows: due to governmental support renewable energy technologies improve and their costs go down; decreasing prices for RE systems attract new customers; larger sales further drive costs down, which opens new, larger markets for renewable energy systems.

Study of Local Renewable Energy Resources

Although off-grid renewable energy systems have numerous advantages over fossil-fuel based electricity generation in decentralized areas, the site-specificity of RE systems represents one of the major barriers to small-scale RE projects. The output of a RE installation depends primarily on resource availability. For example, in the case of wind, small differences in wind speed can mean great differences in power output. Site monitoring is recommended in order to place a wind turbine most effectively, taking into account the influence of obstructions and the wind speed seasonal patterns.

7. It can be found on the Intersolar web site http://www.intersolar.ru/law/law_concept.shtml (In Russian)

The estimates for Russia's RE resources provided in this study are approximate. They reflect the average availability of renewable energy resources over large territories. Since renewable energy technologies are very site-specific, the success of a RE project will depend on the exact resource conditions at the specific site. For this reason preliminary local site monitoring is very important to stimulate the development of RE projects.

A special regulation can oblige regional authorities to find ways to study renewable energy resources within their area of service to determine the most effective technologies and sites. They can do this by:

- providing fiscal incentives to local utilities to carry out such studies,
- employing external specialised companies.

Regional atlases of renewable energy resources should be published and disseminated for potentially interested parties, such as energy companies, electricity utilities, local industries and authorities, and the general public.

Information Dissemination

Many countries have succeeded in building public awareness through information campaigns to inform professionals and the general public about the existing renewable energy resources, technologies, applications and their environmental and public benefits. International experience demonstrates that increasing public awareness of RE can lead to a significant increase in the use of RE in the residential sector, especially in the case of biomass and solar thermal.⁸ Different means of disseminating information should be used: the mass media, organisation of conferences, publication of outlets, etc. Success stories should be widely presented to the mass media.

Another strategy being used to build awareness is a network of federal and regional renewable energy centres. These federal centres are responsible for coordinating the information and experience exchange between regional centres and international organisations. In a country as large as Russia, regional centres would be responsible for collecting, up-dating and disseminating information on local renewable energy resources, and on current and planned projects. They would also provide potential investors with information concerning the project registration and implementation procedures (national and regional laws, rules and regulations; documents to prepare; actions to take, etc). Since bureaucracy and corruption are the two of the largest barriers to renewable energy on the project implementation level, support to project developers may significantly increase the number of projects implemented.

In the longer-term, public awareness of the environmental and social benefits of renewable energy can favour its development. In many OECD countries, distribution companies selling electricity from RE sources distinguish themselves from competitors, underlying the environmental and social values of renewables. They base their marketing strategy not on costs, but on customers' values. This strategy is unlikely to succeed in Russia today, since a great deal of the population is extremely poor. As the economic situation improves, this approach may be more successful.

8. KWI and Energy Centre Bratislava, *Renewable Energy Action Plan*, Slovak Republic, July 2002.

International Technology Partnerships

While there is a sufficient base in Russia to support the development of a viable renewable energy industry, technology partnerships with international industries are necessary to allow Russian companies to improve the quality and reliability of their technologies and to gain practical experience in manufacturing, installation and maintenance of equipment. Joint ventures are an effective way of sharing technological expertise. Joint ventures also allow Russian companies to improve their managerial, financial and commercial skills, while providing foreign companies with a highly-skilled, low cost partner.

Role of International Co-operation In Renewable Energy Development

Many of the existing renewable energy projects in Russia have come about through joint ventures with foreign companies or through active collaboration with foreign partners. The 4.5-MW wind farm put into operation near Kulikovo in Kaliningrad region in June 2002 is an eloquent example of successful co-operation. The Kulikovo wind farm was financed by the Danish Energy Agency (9,6 MDKK) and the Russian utility OAO "Yantarenergo". The whole project was implemented jointly by the Danish company SEAS and Yantarenergo. SEAS' tasks included the overall planning of the project and project management, delivery of wind turbines, supervision and quality control, etc. Yantarenergo was responsible for geological surveys of the site, building the necessary site infrastructure, access roads, transmission lines, supply of steel parts for foundation, etc. Training of Russian personnel by Danish partners was an important component of the joint project. Having received the necessary training, Yantarenergo installed twelve out of sixteen turbines at the Kulikovo wind park. After the completion of the project, the Yantarenergo staff was fully qualified to design, construct, operate and maintain similar wind parks in Russian conditions.⁹

Another example of joint implementation. In the late 1990s, within the framework of Russian-American economic co-operation, the US government granted \$ 1.78 million for the purchase of American wind energy systems to be installed in remote Far North Russian areas. The project was coordinated by the Russian Intersolar center and the U.S. National Renewable Energy Laboratory. In 1997, the company "Bergey Windpower Co" supplied 40 turbines with the capacity of 1.5 and 10 kW (total capacity 315 kW). They were installed in Arkhangelsk region, in Chukotka peninsula, in Moscow region and in Cheliabinsk region.¹⁰

Based on actions taken by other countries to support domestic renewable energy industries, Russian authorities could consider:

- establishing fiscal incentives for a limited time to companies doing R&D on renewable energy technologies and manufacturing RE systems: e.g. tax credits, tax exemptions (see next section);

9. Sucksdorff Jacob, Wind Turbines in Russia, Presentation at *Russia Power Conference*, Moscow, 11-12 March 2003.

10. Intersolarcenter, *Renewable Energy Bulletin*, December 2000.

- reducing or eliminating customs duties for imported RE equipment;
- facilitating the registration procedures of joint ventures for manufacturing or installing and maintaining RE systems.

FINANCIAL MEASURES TO SUPPORT RENEWABLES

One of the greatest barriers to the market penetration of renewable energy technologies is their high capital cost. Potential consumers often do not have the necessary investment capital to buy RE installations, even if they did understand the long-term economic benefits of such an investment. Sound financial mechanisms can help to overcome this barrier. In Russia, financial sector reforms need to be continued. A transparent banking system is vital. Specific financial mechanisms can also be developed to lower the cost of renewable energy systems for final consumers.

Reduced or zero VAT for RE equipment. This mechanism is practised in many countries, e.g. Italy, France, UK and Czech Republic. In the Czech Republic, small hydropower (up to 0.1 MW), wind (up to 0.075 MW), all solar and biomass installations benefit from a 5% VAT rate, instead of 22%.¹¹

Investment tax incentives lower investors' capital expenditures. Investment tax credits allow the investor to reduce his tax burden by a portion of the amount that was invested in renewables. For example, in Ireland a tax relief scheme came into effect in March 1999.¹² Corporate equity investments in hydro power, solar power, wind power and biomass are eligible for tax relief in the form of a deduction for tax purposes from a company's profits for an investment in new ordinary shares in a qualifying company. The relief is capped at 50% of all capital expenditure (excluding land), net of grants, on a single project up to £7.5 million. The Department of Public Enterprise certifies qualifying renewable energy projects and thereafter the Revenue Commissioners administer the tax relief.

Accelerated depreciation of renewable energy equipment can significantly lower the tax burden during the initial stage of the project. This lightens the weight of the high initial capital costs of RE technologies. In the United States, Modified Accelerated Cost Recovery System (MACRS)¹³ allows businesses to recover investments in solar, wind and geothermal property through depreciation deductions. The MACRS establishes the time over which various types of property may be depreciated (5-50 years). The current MACRS allows wind, solar and geothermal property placed in service after 1986 to be depreciated over 5 years.

In addition to the MACRS depreciation, the United States' Job Creation and Worker Assistance Act of 2002 allows businesses to take an additional 30% depreciation on

11. IEA, *Renewable Energy Database*, <http://library.iea.org/renewables/index.asp>

12. <http://www.irigov.ie/tec/energy/greenpaper/0904.html>

13. IEA, *Renewable Energy Database*, <http://library.iea.org/renewables/index.asp>

solar, wind and geothermal property in the first year. The 30% depreciation only applies to property purchased after September 10, 2001 and before September 11, 2004, which is placed in service before January 1, 2005. The mechanism of accelerated depreciation is not foreign to Russia, and could be easily adapted to investments in the RE sector.

Favourable loans for individual and industrial buyers of RE systems can be established. Since the lack of financial resources is one of the biggest barriers to RE development in Russia, access to bank credit at low rates can be very effective in stimulating demand for renewable energy systems.

Demonstration Projects build confidence in renewable energy technologies. In some OECD countries, federal and regional governments or local authorities finance RE projects in public institutions (schools, hospitals, etc.), or provide financial support for the development of selective private RE projects. By demonstrating successful applications for renewable energy, these projects can raise awareness about and stimulate demand for RE systems.

The Russian government has financed several renewable energy projects from the Federal Budget in the framework of the National Programme “Energy Efficient Economy”, which was adopted in 2001. These projects include: Mutnovsky geothermal power station in Kamchatka (54 m roubles, or \$ 1.77 m at July 2003 rate), small thermal power station on wood wastes in Vytera, region of Vologda (12 m roubles), 3 small and micro hydropower stations (9 m roubles), conversion of 2 boiler houses in the Leningrad region to the use of local fuels (3.9 m roubles).

Russian authorities could continue support of selective RE projects that can be replicated by other investors. One of the financing sources that can be used for this purpose is described in the next section.

Environmental Funds have been established in a number of countries. They can be financed through the introduction of a special tax or levy on greenhouse gas (GHG) emissions. Market energy prices today do not capture the environmental and other social costs of energy sources. Hidden costs borne by the public, such as the risk of climate change, are not included in the prices of conventional energy sources. To make energy producers internalise these costs, many countries have adopted strict environmental regulations, e.g. emission standards and emission taxes. In the medium term, Russia could also enforce environmental regulations, which would benefit clean energy sources while banning polluting options. The revenues from “environmental” taxes and levies can be used to create a special fund for financing renewable energy, energy efficiency and other “environmental” projects. These measures would also reduce Russia’s GHG emissions, thus bringing additional revenue from International Emission Trading under Kyoto Protocol.

Such a system was in place up until recently in Russia, which provided the potential for separate delineated funds for environmental protection. Federal Environmental Fund and regional and local environmental funds in Russia were financed through environment-related levies and taxes, e.g. on air and water pollution, on the use of forest resources, etc. These funds financed environmental projects such as pollution

control, environmental R&D and institution building.¹⁴ The size of these funds depended on the number and size of polluting companies in the region or city/town. However these funds were not very plentiful given that the fines did not keep pace with inflation in the 1990s. As the system of environmental funds did not always work very well in practice, they have been recently eliminated, and the revenue from environmental levies and taxes has been included in the Federal Budget as a line item. This line item in the budget could act like the funds if the line item was used for targeted ecological projects. Renewable energy projects could also be financed with this budget line, especially in environmentally ravished regions.

Some countries have set up more specific *renewable energy funds*. For example, renewable energy funds have been established in 12 U.S. states to help build markets for renewable energy and other clean energy resources. These programs are generally funded through a “system benefit charge” (SBC) or “public purpose charge” collected from electricity customers. The funds are collected with the rationale that increased use of renewable energy provides benefits to all citizens. These state programs will make available nearly \$3.5 billion to support renewable and clean energy projects, invest in companies and build industry infrastructure over the next decade.¹⁵

KYOTO PROTOCOL

If Russia ratifies the Kyoto Protocol (see Annex 1 for more information), this will raise the fraction of emissions from Annex I countries that have ratified to above the 55% threshold needed to bring the Protocol into force. Participation could enhance Russia’s prospects for developing its renewable energy resources through the use of the flexibility mechanisms – Joint Implementation (JI) and International Emission Trading (IET). These mechanisms provide an important opportunity to realise technology transfer from western countries to Russia in renewable energy, energy efficiency and environmentally friendly energy technologies.

Joint Implementation

The summit on energy dialogue between the EU and Russia, which took place in Brussels in March 2002, recognised that it was important “to study the possibilities for common implementation of energy-saving and renewable energy projects, financed under the JI mechanism”.¹⁶

The following renewable energy projects are most likely to take advantage of possible financing under the JI mechanism: fuel switching from coal or diesel to biomass; solar hot water systems to replace or supplement conventional district heating boilers; and wind or hybrid wind-diesel systems to replace or supplement diesel generators in isolated settlements. By investing in RE projects in Russia, Annex II countries would increase the range of options available to them for meeting their Kyoto targets. Development

14. World Bank “*Environmental Funds*” Handbook 1998.

15. Clean Energy States Alliance, <http://www.cleanenergyfunds.org/about.html>

16. EC, Commission Staff Working Paper SEC(2002) 333, Brussels, 21 March 2002.

of new renewable technologies and markets may also have knock-on benefits for their domestic renewable energy industries.

If Russia wants to take advantage of the JI mechanism it should create opportunities for JI projects. Tangen and al.¹⁷ conclude that there are significant barriers to JI projects in Russia. *Institutional* barriers include the opaque structure of the Russian climate change administration, and unclear legislative, regulatory and taxation systems. Implementation-level barriers include difficulties in co-operation between foreign and local partners, the lack of local technical expertise, insufficient local infrastructure (including defective postal and telephone services) and the low quality of materials. Most funding-related problems are related to the unfavourable investment climate. Many projects have been cancelled due to the lack of funding and/or local economic support. An important barrier is the high transaction costs of projects due to general unpredictability of the economy, and also due to delays in negotiations, equipment imports and payments.

If the Kyoto Protocol enters into force, the signatories will be likely to choose the least costly options to comply with their established targets. JI projects in Russia will compete for funds with JI projects in other countries. They will also compete with Clean Development Mechanism (CDM) projects in non-Annex 1 countries. Potential investors will take into account all barriers and risks associated with projects in Russia and in other countries. Low energy prices make the Russian investment climate particularly unfavorable to environment-friendly energy investments. Government actions aimed at improving the overall investment climate will be favourable to JI projects.

International Emission Trading

Russia could be a major player in the emission trading market under the Kyoto Protocol. This is because Russia has been given an emission cap that is likely to be above its real emission level. In the period from 1990 to 2000, CO₂ emissions in the energy sector were reduced by about 33%.¹⁸ Most forecasts of Russian CO₂ emissions predict that they will not surpass their 1990 level by 2012. According to the IEA *World Energy Outlook* (2002), emissions in 2010 will be some 0.4 billion tonnes CO₂ (17%) below Russia's commitment.

However, the large drop in emissions in the 1990s happened mostly because of a sharp decline in economic activity, not because of reducing energy intensity. Without significant improvements in energy efficiency, the low level of CO₂ emissions is not likely to hold because it depends on GDP growth rates. An increase in CO₂ emissions was registered in 2001 and 2002, when Russia experienced high economic growth. If Russia is to meet the ambitious target set by President Putin to double GDP over the next decade¹⁹, it will have to improve its energy efficiency significantly to meet its Kyoto commitments and take advantage of the emissions trading market. Today, Russia is among the most energy-intensive economies in the world. In 2000 it was almost

17. Tangen K. et al. (2002), *Green Investment Scheme in Russia*, www.climate-strategies.org/gisfinalreport.pdf

18. Mastepanov, A. and al., "Post-Kyoto Energy Strategy of the Russian Federation, outlooks and prerequisites of the Kyoto mechanisms implementation in the country". *Climate policy* 1 (2001) 125-133; Pluzhnikov, O. *Energy Strategy of Russia: Mechanisms of Kyoto Protocol and Energy Efficiency*, Eco-Accord, 2001.

19. President Putin's State of the Nation Address, May 2003.

three times as energy intensive as OECD countries on average.²⁰ Bringing this down will depend largely on an effective implementation of price and economic reforms. Increased use of renewables, along with other measures, could help Russia to enhance its ability to reduce emissions and to trade more credits.

If Russia signs the Kyoto Protocol, one option for managing international emissions trading would be through a *Green Investment Scheme (GIS)*²¹. The *Green Investment Scheme* is designed to channel funds received from international emission trading into environmentally-related projects. The scheme is expected to attract potential buyers by ensuring that the revenues from emission trading are earmarked for environmental (or social) purposes, and that these revenues are subject to control and transparency. Potential buyers have different views on the nature and scope of projects that could be implemented under the GIS. Energy efficiency improvements and renewable energy development (including biofuels) are likely to be priority projects. From the sellers perspective, the GIS offers the opportunity of raising the value of the traded units, thereby increasing overall revenues.

On the other hand, opponents believe that the GIS would raise transaction costs, and limit emissions trading opportunities for Russia.²²

Prospects and Challenges

Without Russian ratification, the Protocol cannot enter into force. If Russia does ratify, it must meet the Protocol requirements on registry and reporting to be able to trade. To become eligible for emission trading, Russia must establish a national system to estimate the amount of its GHG emissions and removals, and a national registry for recording emissions transactions in line with the requirements set out in the Marrakech Accords. As all Annex I countries, Russia is obliged to present a National Communication describing its national system and registry and providing the emissions data needed to establish its formal assigned amount. These data are then assessed and approved by UNFCCC expert review teams. Russia is in the process of having its 3rd National Communication reviewed by an UNFCCC Review Team. Shortcomings in the earlier Russian national reports indicate that serious work has to be done before Russia can meet international reporting requirements.²³ Given that the Russian statistical system differs significantly from the systems established in most other Annex I countries, the revision and approval process may be lengthy.

REGULATORY POLICY OPTIONS

The following policies have proven to be effective in developing renewable energy markets in other countries. Russia could choose to implement these policies either at the national or regional level.

20. IEA (2002) *World Energy Outlook*, IEA/OECD, Paris.

21. For detailed information of GIS see Tangen K. et al. (2002). www.climate-strategies.org/gisfinalreport.pdf

22. Tangen K. et al. (2002).

23. Tangen K. et al. (2002).

Renewable Energy Portfolio Standards

Many countries have adopted Renewable Energy Portfolio Standards (RPS) or Renewable Energy Purchase Obligations which oblige power companies to supply, or customers to buy, a certain percentage of electricity from renewable energy sources. Frequently, this mechanism is combined with a national renewable energy target. For example, in 2000, Poland adopted a regulation which requires all power and heat companies to buy energy from renewable sources. To fulfill this obligation, each power company had to provide at least 2.4% of total electricity sales from RE sources in 2001. This percentage will rise annually, reaching 7.5% in 2010.²⁴

In some cases, RPS targets have been based on environmental goals, as in many OECD countries. However, many other RPS systems have been established to form a commercialization “bridge” for new, emerging technologies.

Grid Access

Expanding grid-connected bulk power generation from renewables depends to a large extent on the conditions and rates under which independent power producers can gain access to the transmission system.²⁵ Today independent power producers (IPPs) can legally operate in Russia but the present structure of tariffs and the terms of access to the grid are not favourable to them (see Chapter 2). Also, because power generation based on renewable energy is in many cases intermittent and location-dependent, the production level does not always coincide with demand. So it is vital for RE developers to be able to transmit all their generated electricity to utilities or third party consumers.

Specific regulations and implementation frameworks are necessary to allow IPPs to operate effectively in the market. The status and rights of independent power producers have to be clearly defined. Industries which produce their own electricity must have non-discriminatory access to the grid to transmit the generated electricity for their own use or for sale. The practical implementation of free access can be a challenge given the age and poor state of Russian transmission lines.

Even if access to the grid is assured for all IPPs, without specific regulation, developers of intermittent renewables-based generation are likely to be charged higher transmission prices than their dispatchable competitors:

*“...if the demand component of transmission charges is based on a generation facility’s capacity equivalence (for example, an average level of coincident peak capacity output per month) rather than maximum rated capacity, then intermittent resources would pay more than their fair share of transmission costs. The energy component of transmission costs should be based on a significant fraction of total investment in the transmission grid.”*²⁶

To stimulate the development of new renewable power generation, many countries have adopted specific measures to facilitate renewables’ access to the grid. For example, open wheeling policies have boosted the share of wind energy in India. Firms can produce wind power in areas with favourable resources and then transmit it to other regions for own use or for sales to a third party. Similarly, in Brazil, reduction of

24. Minister of Economy, *Green Power Purchase Obligation*, Ordinance, Poland, 15/12/2000.

25. For a detailed discussion see Kozloff (1998), *Electricity Sector Reform in Developing Countries: Implications on Renewables*, http://www.repp.org/repp_pubs/articles/kozloff/kozloff.html

26. Kozloff (1998).

transmission wheeling fees has had the positive impact on the booming small hydro industry there.²⁷

Russian legislation could ensure that renewable energy developers have equal or even priority access to transmission capacity. A special regulation could be adopted to guarantee that transmission rate structures are not biased against intermittent renewable capacity.

Net Metering

Net metering is a policy for customers with small, grid-connected renewable generating facilities. It allows the electric meters of these customers to operate in reverse when the systems produce energy in excess of the customer's demand. This enables customers to use this generation to offset their consumption over a longer period of time. Through the offset, customers receive the full retail value for the excess electricity they generate, similar to the value customers receive when they conserve electricity. Without net metering, a second meter is usually installed to measure the electricity that flows back to the utility, with the utility often purchasing the power at a rate much lower than the retail rate.

Net metering is a low-cost, easily administered method to encourage customer investment in renewable energy technologies. It increases the value of the electricity produced by the renewable generator and allows customers to "bank" the electricity for use at a different time. The policy also addresses the timing issue of matching renewable energy generation to customer usage patterns. Utilities may also benefit from net metering programs because system load factor is improved when customer-owned systems produce electricity during peak periods.

Power Purchase Agreements

Wholesale market competition, for which lowest-cost power is generally the primary driver, may reduce incentives to develop renewable energy because of the higher capital costs of many RE technologies. Also, the inability to dispatch power on demand with some renewables is a drawback in spot markets, in which a high premium is placed on generators that can assure power availability during peak periods.²⁸ The intermittent nature of some renewable electricity sources requires special rules governing its participation in competitive wholesale markets. Russia could consider mechanisms that would lessen the disadvantages that RE sources face in wholesale markets.

The "Basic Guidelines" of Russia's electricity reform program and the Federal Law "On Electricity"²⁹ acknowledge that "wholesale market participants should have the possibility to enter into bilateral forward and future contracts, execution of which should imply hedging of risks associated with sharp market price fluctuations". Such bilateral contracts are likely to prohibit renewables (other than large hydro) from competing with conventional fuels, unless provisions in these agreements are adjusted to the specific characteristics of renewable generation options. Kozloff (1998) concludes that "payment schedules and other terms in power purchase agreements (PPAs) may

27. Martinot, E., *Power Sector Restructuring and Environment: Trends, Policies and GEF Experience*, Discussion Paper, GEF, 2002.

28. For more details see Kozloff (1998), *Electricity Sector Reform in Developing Countries: Implications on Renewables*, http://www.repp.org/repp_pubs/articles/kozloff/kozloff.html

29. Adopted in July 2001 and March 2003 respectively.

create incentives for independent power producers to choose relatively low capital-cost-per-megawatt generation technologies over RE options with comparable life-cycle costs but higher capital costs.”³⁰ Other barriers to long-term power contracts for renewables include higher per megawatt transaction costs of participating in the bidding process (i.e. negotiating PPAs) and the discriminating treatment and allocation of risks in PPAs.

Some countries have developed standardised power purchase agreements that include provisions for how much the utility will pay for power over a specified period of time. In India, Indonesia and the Philippines, private power projects based on renewable resources have advanced comparatively well, largely because the terms of the power purchases and other policies have been aligned to the characteristics that distinguish renewables from conventional power sources.³¹ Adequate payment schedules are particularly critical for capital-intensive power generation options from renewable sources.

In Russia, power purchase agreements could also be shaped in a way to avoid discrimination against renewable energy technologies. The government authorities could adopt standard PPAs that provide incentives for renewable energy technologies.

Energy Supply in Rural Areas

Different countries have adopted special regulations to guarantee that electricity and heat services are provided in rural areas, where the cost of these services is generally higher than in urban areas. The sub-programme “Energy supply of Northern territories based on renewable energies and local fuels” as part of the Federal programme “Energy Efficient Economy in 2002-2005 and up to 2010”, adopted in 2001, is an important step in dealing with the problem of energy supply in remote rural areas in Russia. It is necessary to ensure that the measures planned within this programme are implemented.

The government could enact other concrete measures to attract private investment in electricity and heat services to rural consumers. These measures would clarify and strengthen the responsibilities of distribution service providers for rural electrification. The suppliers could have the obligation and/or incentive to provide distributed generation from indigenous renewable sources to areas within their assigned zone.

Present legislation obliges “guaranteed suppliers” to enter into a power supply agreement with any consumer located in an assigned area at the consumer’s request. However, according to the civil code, a power supply agreement can be signed only when power supply is technically possible, i.e. when the consumer is connected to the distribution grid and has the necessary interconnection and metering equipment. If utilities were legally obliged to provide electricity and heat services to all consumers, including off-grid, they would be more likely to opt for renewable energy options, particularly in areas where renewables have a comparative advantage.

30. Kozloff K. (1998), *Electricity Sector Reform in Developing Countries: Implications on Renewables*, http://www.repp.org/repp_pubs/articles/kozloff/kozloff.html

31. Kozloff K. (1998), *Electricity Sector Reform in Developing Countries: Implications on Renewables*, http://www.repp.org/repp_pubs/articles/kozloff/kozloff.html

Many countries with privatised utilities have adopted regulations to address these issues. For example, Brazil is considering a Resolution on Universal Electrification, which will oblige concessionaries to provide electricity to all inhabitants within their concession area. The new Brazilian electricity law³² creates important incentives for the use of RE in rural areas by opening rural markets for companies interested in supplying off-grid consumers. This law allows the regulator, the national agency for electrical energy (ANEEL), to grant public electricity service permissions through a bidding process in areas already covered by concessionaries whose contracts are not exclusive. The permissionaires are allowed to use solar, wind, biomass or CHP technologies for electrification. The same law allows consumers not connected to the electricity grid to accelerate their access to electricity by bearing in part or fully the associated financial costs of electrification. Their expenditures must be reimbursed by the concessionary utility company after a grace period determined by ANEEL. This regulation creates an incentive for the purchase of independent renewable energy systems by users.

32. Law 10.438 approved on April 26, 2002. Source: *Trade Guide on Renewable Energy in Brazil*, USAID, October 2002.

PART III

**RENEWABLE ENERGY IN RUSSIA: THE ECONOMIC, SOCIAL
AND ENVIRONMENTAL CONTEXT**

CHAPTER 6

ECONOMIC DEVELOPMENT

Russia's President Putin set an ambitious goal in his State-of-the-Nation Address in May 2003:

"We should at least double the gross domestic product in a decade. The doubling of the GDP is of course a large-scale task. It will call for a profound analysis and adjustment of the existing approaches to economic policy."

If Russia is to meet this ambitious goal to double GDP over the next decade, the Russian energy sector will face the challenge of meeting rapidly growing domestic energy demand. Renewable energy can contribute to this challenge, particularly in regions with a deficit of traditional energy sources. Renewables can also play a role in providing power to distributed consumers.

At the same time, one of the government's objectives is to diversify the economy by developing different economic sectors. If the government makes an effort to increase the share of renewable energy, this would stimulate the development of the domestic renewable energy industry. In the medium to long term, "green exports" could become a reality and help to diversify Russia's export base.

ENERGY SUPPLY AND DEMAND: HOW RENEWABLES CAN CONTRIBUTE

According to IEA projections, Russia's total primary energy demand is projected to grow by 1.4% per year to 2030, if GDP grows at 3% per year, and energy intensity declines on average by 1.6 per year.¹ For GDP to double by 2013, the economy has to grow at an average of over 7 to 8% per year. This means that the energy demand growth would be more important and more substantial improvements in energy intensity would be required. This increases the importance of energy efficiency and renewables.

The Energy Strategy of the Russian Federation to 2020 is based on two main scenarios of socio-economic development: "optimistic" and "moderate". In an optimistic scenario, economic, fiscal and price reforms are undertaken effectively and efficiently on the domestic front and there are no major perturbations on international energy markets or in the growth of external markets.

1. IEA (2002), *World Energy Outlook*, OECD/IEA Paris.

In its moderate scenario, the Energy Strategy to 2020 assumes a GDP growth of 5% to 6% per year to 2020. In this scenario, in order for the energy sector not to become a brake on economic growth, major gains in energy efficiency will need to be realized. TPES is assumed to grow within a range of 0.5% to 1.13% per year, much less than the expected GDP growth of 5%. This would mean improvements in energy intensity of 2.8% to 4% per year on average.

In the electricity sector the investment needs to meet the demand growth are challenging, particularly given the old age and poor maintenance of existing generation capacity.

As of the beginning of 2001, total installed capacity in the Russian Federation was 214 GW, of which 69% was thermal, 21% hydro and 10% nuclear. By the beginning of 2000, Russia had over 500 thermal power plants, over 90 hydro plants and 29 commercial nuclear reactors. RAO UES has operational installed capacity of 190 GW, with 175 GW available to meet base demand. Since the maximum peak load is currently 145 GW, the remaining 30 GW form the excess or idle capacity.² Other analysts estimate the idle capacity of RAO UES at 35-40 GW, or 33% of operational capacity.³ However, a large share of this capacity is old. About 40% of the installed capacity has been in service for more than 25 years.⁴ About 35 GW of current capacity will reach the end of its design life by 2005, and a further 30 GW by 2010.⁵

Russia's Generation Capacity

Nuclear power. There are 30 reactors in operation at Russia's 10 nuclear power sites. The working life of a reactor is set at 30 years. Nine are between 25 and 29 years old and due for retirement within the next 5 years, and another 6 are 20 to 24 years old and due for retirement within 10 years. As units, especially first-generation ones, near the end of their designed lifetimes, it will be up to Gosatomnadzor, or GAN, Russia's nuclear regulatory agency, to grant lifetime extensions or to oversee their decommissioning. GAN is aware of the situation and has already taken measures to adapt to it. Russia made considerable progress on nuclear safety during the 1990s, improving both design safety and operational safety, particularly for the first generation of NPPs. Much remains to be done. Many upgrades and safety-upgrading programmes continue or have not yet started. Considerable effort and financial resources are needed to implement them and to improve the level of safety to international practices.

Thermal power stations. Although the working life of the turbo-generators used at thermal power stations is set at 25 years, generators older than 25 years account for about half of total thermoelectric capacity. Many of the smaller generators are 40 to 50 years old, and some are even of pre-war vintage. Of the high-voltage electrical motors at the thermal power stations, only 10 to 15% belong to contemporary models.

2. IEA (2002), *Russia Energy Survey*, OECD/IEA, Paris.

3. Bashmakov, I., *Electricity Sector Restructuring in Russia: Mismatching Goals and Strategies*, Cenef, Moscow.

4. IEA (2002), *Russia Energy Survey*, OECD/IEA, Paris.

5. Troika Dialog Research, *UES: Undervalued Despite Overcapacity*, November 2002.

Hydroelectric power stations. About 60% of the 256 generators with a capacity of 50 megawatts and above at hydroelectric power stations are at least 25 years old and have not undergone substantial reconstruction. Some generators date back to the late 1950s; the oldest were produced in 1940-41.

Sources: IEA data and “Russia to De-monopolise Its Power Sector – but How and When?” World Bank, Transition Newsletter January – February 2002, <http://www.worldbank.org/transitionnewsletter/janfeb2002/pg43.htm>

There is clearly spare generating capacity, even at peak load, and the amount of spare capacity could increase if higher tariffs lead to more efficient usage and thus falling consumption. The age of much of the generating capacity, however, leads some observers to expect excess capacity to disappear by around 2008, even if demand remains flat. Indeed, there is some concern that the reform process will not proceed quickly enough to allow adequate investment before the supply and demand ‘scissors’ are expected to cross later in the decade. Given the variability among regions in terms of surplus or deficit electricity supply and demand patterns and outlook, the situation in specific regions could be quite serious.

Overall depreciation in the electricity sector is estimated at 60-65%. 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 some time between 2003 and 2008.⁶ Many individual and industrial consumers already face frequent limitations and cut-offs from the electricity and heat supplies. The Maritime region was ravaged by continuous blackouts and heating shortages during the winter of 2000-2001.⁷ The damage caused by power disruptions throughout the country is estimated in the billions of dollars.⁸ Mean losses from power supply disruptions in agriculture and in manufacturing industry with uninterrupted technological process are 25-30 times higher than the cost of non-supplied power.

In certain applications, renewable energy projects can replace obsolete nuclear or thermal capacity. Renewable energy projects are often the most economical choice because of their scale. Their smaller and modular nature means they can be deployed (and paid for) as the demand for energy grows, and can be embedded within the existing energy supply networks, if they exist. A small, modern windfarm, for example, can be constructed and operational in less than a year while a larger coal-fired or nuclear power plant can take several times as long to construct. In the United States, a 50 MW windfarm project was completed in only five months in 2001.⁹ By contrast, the use of large, centralized energy systems take much longer to build and are normally designed to supply a future demand that may not eventuate.

6. The Economist, “In Need of Shock Therapy”, *The Economist*, 22 August 2002.

7. ITAR TASS.

8. Bezrukikh, P. *Нетрадиционные возобновляемые источники энергии (Non-Traditional Renewable Energy Sources)*, Analytical Report, Russian Ministry of Fuel and Energy, http://www.mte.gov.ru/ntp/energo/analit_doc.htm

9. *Wind Power Monthly*, Dec 2001.

Renewable energy can contribute to improving energy security in two different ways: by reducing dependence of energy deficient regions on “imported” fuel and by reducing the need to build or upgrade transmission and distribution lines.

ENERGY SECURITY: THE REGIONAL DIMENSION

Most Russian regions “import” fossil fuels from other regions. This fuel dependency is an important incentive for the development of locally available renewable energy resources.

Renewable Energy Development in Kalmykia

Kalmykia was one of the first Russian regions to construct a large-scale renewable energy projects. A 1000 kW wind turbine, Raduga-1000, was built near Elista in Kalmykia. The plans were to install up to 22 MW of grid-connected wind power capacity, but the lack of investment delayed the construction. The president of the Kalmykia electric power utility mentioned the following reasons for the development of wind energy in the region¹⁰: 1) to increase regional independence; 2) to mitigate against increasing oil and gas prices in the future, 3) to reduce the influence of Gazprom over the economy and the enterprises in the region.

Even when willing to pay high costs for energy, some areas do not always get the fuel they need due to supply infrastructure failures. Remote Northern and Far Eastern regions, not connected to oil and gas pipelines, get their fuel by rail or road, and in some settlements, by helicopters. Such supplies are very unreliable and expensive. Regions connected to pipelines can also face fuel supply disruptions. The oil and gas infrastructure is very old and needs continuous repairs and upgrades. The pipeline accident rate is likely to increase in the future when rising oil and gas transmission volumes put higher stress on the system. Accidents cannot only cause economic losses, but also severe environmental damage. Nevertheless, any strategy to promote renewables would need to be carefully sensitised to other reform efforts that are designed to improve the functioning of conventional energy markets and to extend grids to isolated areas.

By increasing the share of renewable energy in their energy systems regional administrations can make their energy portfolios more secure and less dependent on fuel price fluctuations. One study of electricity use in California found that customers could save \$1.8 billion a year if the state diversified its electricity generation portfolio to include 20% from renewables.¹¹ Similar savings could be made in Russian regions that rely on “imported” fossil fuels.

10. Martinot (1995), *Energy Efficiency and Renewable Energy In Russia: Perspectives and Problems of International Technology Transfer and Investment*, PhD Dissertation, University of California, Berkeley (p. 77, Interview 4/28/94).

11. Donovan, D., S. Clemmer, A. Noguee and P. Asmus (2001), *Powering Ahead: A New Standard for Clean Energy and Stable Prices in California*, Union of Concerned Scientists.

DISTRIBUTED GENERATION

The electricity transmission network in Russia consists of 2.7 million km of transmission and distribution lines, including over 150,000 km of high-voltage lines.¹² Ageing and weak transmission and distribution lines create significant power losses. Overall depreciation in rural transmission lines is over 75%. About 30% of transformers and 43% of high-voltage switches (in the range of 110 to 500 kilowatts) have exceeded their planned working life of 25 years.¹³ A sharp decline in the reliability of the switches is expected in the next few years. Electricity supply disruptions due to breakdowns are especially frequent at local electric lines with the voltage 6-10 kV. Numerous consumers connected to such lines stay without electricity for many hours and their subsequent losses are not compensated for by the suppliers.

Table 13 The Hidden Benefits of Micropower

| Benefit | Description |
|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Modularity | By adding or removing units, micropower system size can be adjusted to match demand |
| Short lead time | Small-scale power can be planned, sited and built more quickly than larger systems, reducing the risks of excess demand, longer construction periods and technical obsolescence |
| Fuel diversity and reduced price volatility | Micropower's more diverse, renewables-based mix of energy sources lessens exposure to fossil fuel price fluctuations |
| "Load-growth insurance" and load matching | Some types of small-scale power, such as co-generation and end-use efficiency, expand with growing loads; the flow of other resources, such as solar and wind, can correlate closely with electricity demand. |
| Reliability and resilience | Small power plants are unlikely to all fail simultaneously; they have shorter outages, are easier to repair and are more geographically dispersed |
| Avoided plant and grid construction, and losses | Small-scale power can displace construction of new plants, reduce grid losses, and delay or avoid adding new grid capacity or connections |
| Local and community choice and control | Micropower provides local choice and control and the option of relying on local fuels and spurring community economic development |
| Avoided emissions and other environmental impacts | Small-scale power generally emits lower amounts of particulates, sulphur dioxide and nitrogen oxides, heavy metals and carbon dioxide, and has a lower cumulative environmental impact on land and water supply and quality |

Source: Adapted from Dunn, S. (2000), *Micropower: The Next Electrical Era*, Worldwatch Paper 151, Worldwatch Institute.

The investment requirement for modernisation of energy transmission and distribution systems will increase sharply over the next few years. Given the existing combination of significant bottlenecks in the grid and an uneven distribution of generating capacity, relatively modest investment in the grid over the next few years could go a long way

12. IEA (2002), *Russia Energy Survey*, OECD/IEA, Paris.

13. World Bank (2002), "Russia to Demonopolise Its Power Sector – but How and When?", World Bank Transition Newsletter, January-February, 2002.

towards making the market more efficient and meeting the needs of “energy-deficit” regions. There is a clear awareness within the government of the need for such investment.

There appears, however, to be a risk that transmission will receive too little attention and investment. The reformers in the government (and the electricity monopolist RAO UES) appear keen to ensure that reform attracts investment into new generating capacity. To this end, grid tariffs would be set so as to hold down rates of return, as too high a rate would attract investment into the Federal Network Company (FSK) and away from investment in private generating capacity.

In many applications, renewable energy power systems, due to their modular and distributed nature, can reduce the need for upgrading electricity distribution systems, or for expanding distribution or transmission capacity. Decentralized electrification also considerably reduces, if not completely eliminates, the potential for power theft. Capturing these and other benefits (Table 13), however, is not always straightforward and must be attempted in the context of local conditions and infrastructure.

ECONOMIC DIVERSIFICATION

Following the financial crisis of 1998, Russia experienced five consecutive years of economic growth. GDP growth was the highest in 2000 (9%), then declined to 5% in 2001 and reached only 4.3% in the 2002.¹⁴

Many experts consider that Russian GDP growth is due to high world oil prices and to the effects of a sharp devaluation of the rouble, rather than to the development of sustainable businesses. While many other industries have seen their output and profits decline, the energy sector has driven growth due to revenues from oil and gas exports at high prices. Russia’s share in global trade is still very small. Oil, gas and metals constitute the majority of Russian exports, while the share of manufactured goods is insignificant.

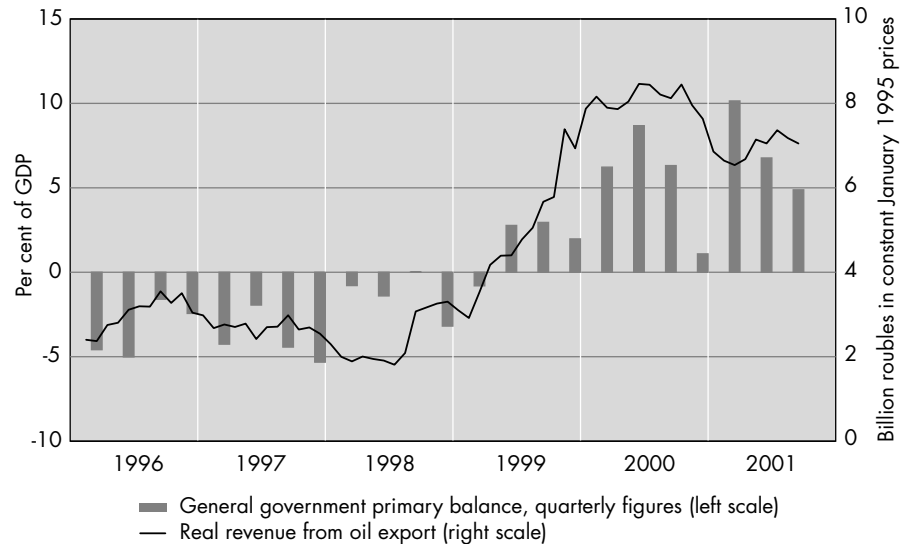
Russia’s energy sector accounts for about 28% of GDP, 26% of industrial output, 55% of federal budget revenues and 54% of all Russian exports. 1.8 million people work in the energy sector, which accounts for 2.5% of the labour force. Under President Putin, Russia’s strategy has been to boost oil production and exports in order to increase budget revenues. But the present administration has at the same time expressed an interest in diversifying the economy by developing other industries to reduce the country’s heavy dependence on oil revenues.

The impact of oil revenue on Russia’s fiscal balance is illustrated in Figure 12. According to UNECE, a change in world oil prices by one dollar is likely to be associated with a 0.4 to 0.6 percentage point change in Russia’s GDP and with a change in fiscal revenue amounting to \$0.8-\$0.9 billion.¹⁵

14. Goscomstat (State Statistics Committee) Year 2002 – preliminary estimates.

15. UNECE, *Russia: An Engine of Growth for the CIS*, Press Release, 2 May 2002.

Figure 12 Russia's Real Revenue from Oil Exports and the General Government Fiscal Balance, 1996-2001 (revenue in billion of roubles in constant January 1995 prices, fiscal balance as percentage of GDP)



Source: UNECE Secretariat calculations based on national statistics. UNECE, *Economic Survey of Europe*, 2002, No. 1, p. 73.

In the short term real revenues from energy exports are likely to remain sufficiently high to drive economic growth. But over the longer term, Russia will need to reduce its reliance on energy exports by developing other industries. Renewable energy can play a role in diversifying the economy, both directly – through the development of renewable energy industry; and indirectly – by stimulating agriculture and forestry as potential suppliers of biofuels.

Due to increased interest for energy diversification and clean energy technologies, the market for renewable energy technologies is the fastest growing energy market in the world today, albeit from a modest base. Markets for wind turbines and photovoltaics have been growing especially fast, at more than 25% per year over the past years.¹⁶ In Germany, for example, gross electricity generation from wind grew by 63% between 1990 and 2000, and from solar PV by 51%.¹⁷ The IEA's *World Energy Outlook 2002* projects the average annual growth rate of non-hydro renewable energies at 3.3% from 2000 to 2030, compared to 0.1% growth of nuclear power, or 1.4% growth of coal.¹⁸

Companies that have found their niche in the renewable energy market have seen their sales grow very fast. For example, sales of Danish wind turbines rose 60% in 2001

16. Annual growth rates for PV and wind are based on data from PV News, Vol. 20, No 2 (March 2001) and the American Wind Energy Association, *Global Wind Energy Market Report 2001*.

17. IEA (2002), *Renewable Energy Information*, OECD/IEA, Paris.

18. IEA, *World Energy Outlook 2002*.

and reached 3 452 MW of rated capacity. Total revenue of Danish manufacturers was € 3 billion in 2001, of which 95% came from foreign sales.¹⁹

Russian companies have the opportunity to compete in this fast growing worldwide market. 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. But they must get enough technical and commercial experience on the domestic market first to increase their competitiveness. For this to happen, policy support is necessary.

“GREEN” ENERGY EXPORTS

Because of Russia’s role as a key oil and gas exporter, the Russian energy sector is of key importance to the country’s economic success, as well as to world energy markets (Chapter 2). Reforms are essential to enable Russia’s energy sector to keep pace with domestic energy demand growth in a period of strong GDP growth, while yet seizing export opportunities.

If Russia manages to attract the necessary medium to long term investment to the energy sector, it will likely be able to increase its energy exports (Figure 13).

Russian Siberia and the Far East hold huge untapped hydro, wind and geothermal resources and are situated close to energy-hungry neighbours. With the necessary policy and financial support, prospects for exports of Russian “green” electricity to north-east Asian countries could be realised if they are competitive with other options in the market. Ivanov V. concludes that Russian East could contribute to electricity supply in China, Mongolia and Democratic People’s republic of Korea (DPRK), especially if there is a trend towards liberalisation and privatisation of power production and distribution, allowing power purchase agreements between Russian independent power producers and foreign utilities.²⁰

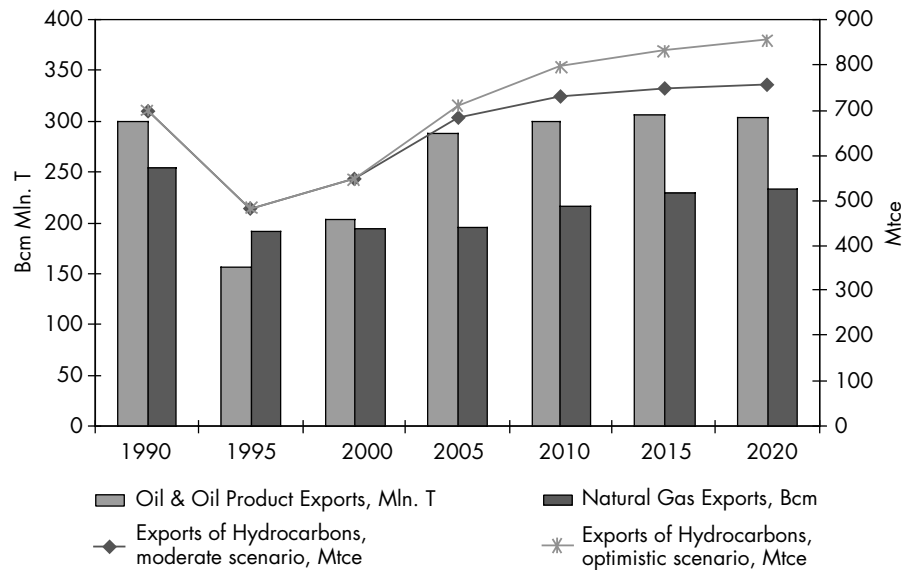
Electricity exports from Amurskaya Oblast, Khabarovskiy and Maritime Territories are quite feasible, due to their rich resources and close geographic location to potential importers. There are several large hydro power stations under construction or planned in the Russian Far East. If they are successfully completed, the distance from the power generating facilities in Amurskaya Oblast to Chinese cities such as Heihe, Qiqihaer and Harbin will range from one hundred to several hundred kilometres. In Khabarovskiy Krai, the range for power transmission lines is 165-300 kilometres, while in Primorsky Krai they are only 50-155 kilometres.²¹

New transmission lines would need to be constructed to allow large exports of Russian electricity to South-East Asia. There are projects for developing interstate electric ties

19. “Denmark’s Wind Industry Sets New Records”, *ReFocus*, July/August 2002.

20. Ivanov, V., *Energy Mega-Projects Will Change Northeast Asia*, <http://www.tumenprogramme.org/tumen/publications/speeches/1999-06%20Ulaanbaatar/ivanov>

21. Ivanov, V., *Energy Mega-Projects Will Change Northeast Asia*, <http://www.tumenprogramme.org/tumen/publications/speeches/1999-06%20Ulaanbaatar/ivanov>

Figure 13 Russian Energy Exports Outlook: 1990-2020

Source: Russian Energy Strategy, May 2003.

(ISET) between East Russia and South-eastern countries. These could allow both electricity exports from Russia and the realization of power interconnection effects.²² The future of these projects is, however, uncertain.

At the same time, Russia has many renewable resources within reach of European markets. These include wind, hydro and bioenergy. To bring substantial green electricity to Europe would also require enhancement of the transmission interconnection between the parties.

22. For a detailed discussion of ISET, see Podkovalnikov, S., *Power Grid Interconnection in Northeast Asia: Perspectives from East Russia*, <http://www.nautilus.org/energy/grid/papers/podkovalnikov.pdf>

CHAPTER 7

SOCIAL AND ENVIRONMENTAL BENEFITS

Renewable energy has significant environmental and social benefits over conventional energy sources. In Russia, increasing the use of renewable energy could to a certain extent reduce unemployment, improve living conditions, and reverse the depopulation of rural areas and of Northern and Eastern territories. Replacing conventional energy sources with clean energy technologies could reduce the rate of environmental degradation and improve the health and well-being of the population, but these options must be subjected to an assessment of the cost effectiveness of renewables versus conventional energy.

EMPLOYMENT EFFECT

The unemployment rate in Russia was 7.1% in August 2002.¹ Unemployment is the highest in rural areas, and it is generally higher in Siberia and in the Far East than in the European part of the country. The share of long-term unemployment (over 12 months) is particularly high: 40-50% of total unemployment.

Renewable energy technologies are generally more labour intensive than conventional energy ones, in delivering the same amount of energy output. A number of studies have attempted to quantify labour intensity of RE technologies, measuring it in jobs created per installed MW capacity or per million invested in the technology. These studies demonstrate that renewable energy technologies provide direct employment opportunities at different stages of their development: from research and demonstration to manufacturing, installation, operation and maintenance. Biomass technologies, in particular, create employment opportunities in the agricultural and forestry sectors. Labor intensity, however, will need to be taken into account when assessing the cost effectiveness of renewables in a competitive environment.

In 2001, a study by the Electric Power Research Institute (EPRI) for the California Energy Commission gave an overview of the status and prospects of renewable energies in California. The employment rates of different renewable energy sources and of natural gas, estimated by EPRI, are compared in Table 14. In every case, renewable energy technologies create more jobs than natural gas technologies during the construction phase. Also, all renewable energy technologies except solar PV are more labour-intensive than natural gas during the operation and maintenance phases.

1. Current Statistical Survey, 2001, 2002 (A Quarterly Issue of the State Committee of the Russian Federation on Statistics).

Table 14 Employment Rates by Energy Technology (jobs/MW)

| Technology | Construction Employment | Operating Employment |
|-----------------------|--------------------------------|-----------------------------|
| Wind | 2.57 | 0.20 |
| Geothermal | 4.00 | 1.67 |
| Solar PV | 7.14 | 0.12 |
| Solar Thermal | 5.71 | 0.22 |
| Landfill/Digester Gas | 3.71 | 2.28 |
| Natural Gas | 1.02 | 0.13 |

Source: Heavner, B., Churchill, S. (2002) Renewables Work: Job Growth from Renewable Energy Development in California, CALPIRG, June 2002 <http://www.calpirg.org/reports/renewableswork.pdf>

A study by Singh and Fehrs,² based on industry surveys among companies operating in the US, shows an employment coefficient of about 5.7 in the wind and PV industries per invested \$1 million. The conventional coal industry generates only 3.96 jobs. This means that \$1 million invested in renewables creates 40% more jobs than investments in conventional coal energy sources.

Table 15 Employment Created in Construction and Installation (C&I) and in Operation and Maintenance (O&M) (new net full time equivalent (FTE) employment relative to base in 1995)

| | FTE C&I | | | FTE O&M | | | Total FTE (C&I + O&M) | | |
|------------------|--------------------|-------------|-------------|--------------------|-------------|-------------|--------------------------------------|-------------|-------------|
| | 2005 | 2010 | 2020 | 2005 | 2010 | 2020 | 2005 | 2010 | 2020 |
| Solar thermal | 2,645 | 4,681 | 9,628 | 2,538 | 3,357 | 5,304 | 5,183 | 8,039 | 14,932 |
| Solar PV | 1,134 | 1,671 | 11,105 | -655 | -3,441 | 874 | 479 | -1,769 | 10,231 |
| Wind | 11,925 | 17,983 | 21,315 | -2,705 | -5,129 | 7,312 | 9,220 | 12,855 | 28,627 |
| Small Hydro | 699 | 1,501 | 2,248 | -12,091 | -2,496 | 5,728 | -11,391 | -995 | 7,977 |
| Biomass | 2,687 | 4,703 | 7,107 | 139,600 | 221,441 | 316,309 | 142,287 | 226,145 | 323,415 |
| Biomass Fuels | | | | 307,641 | 416,538 | 515,364 | 307,641 | 416,538 | 515,364 |
| (O&M only) Total | 19,090 | 30,541 | 51,404 | 434,328 | 630,271 | 849,142 | 453,418 | 660,812 | 900,546 |

Note: Employment effects are measured in Full Time Equivalents (FTEs). The number of FTE working in the economy is calculated from adding full-time workers to part-time and seasonal workers weighting the latter two according to how many hours a year they work. The definition of a full time worker is usually someone that works more than 30 hours a week all year round.

Source: EUFORES, The Impact of Renewables on Employment and Economic Growth, Altener Programme of the Directorate-General for Energy of the European Commission; <http://www.eufores.org/Employment.htm>

A study of the impact of renewable energy on employment in the European Union³ projects that about 900,500 jobs would be created by 2020, directly and indirectly by the renewable energy industry. Employment growth from renewable energy industries could also occur in Russia, if the government takes measures to stimulate RE growth.

2. Singh, V. and Fehrs, J., *The Work that Goes into Renewable Energy*, REPP Research Report No 13, November 2001.

3. EUFORES, *The Impact of Renewables on Employment and Economic Growth*, Altener Programme of the Directorate-General for Energy of the European Commission; <http://www.eufores.org/Employment.htm>

The EU study found that the development of renewable energy technologies results in long-term net job creation. Each technology generates a net increase in jobs during the construction phase, solar and wind technologies in particular. However, for some technologies, which require a low level of maintenance, such as small hydropower and solar PV, net employment losses occur during the operational phase. Total net job creation (including both construction and installation, operation and maintenance) is positive for all technologies. Job gains are greatest from biomass technologies – both in the biomass energy industry and in fuel supply (see Table 15).

Many employment opportunities related to renewable energy occur in rural and underdeveloped areas, where unemployment is the highest. Renewable energy technologies in general use less imported goods and services than conventional energy technologies,⁴ so their use can stimulate employment indirectly in the area where they are used.

By creating jobs, renewable energy technologies could, to a certain extent, contribute to social stability and reduce migration from underdeveloped regions.

The Russian National Programme “Energy Efficient Economy in 2002-2005 and up to 2010”, adopted in November 2001, contains a section entitled “Effective Energy Supply of Regions, including Northern Territories, on the basis of Non-traditional Renewable Energy Sources and Local Fuels” (see Chapter 5). This section stipulates that the increased use of local fuels (wood and peat) would create 20,000 jobs in rural and semi-rural zones by 2005 and 30,000 more jobs by 2010.

IMPROVED STANDARDS OF LIVING

The collapse of the Soviet system and the consequent economic decline resulted in the deterioration of living conditions for most Russian citizens. Since 1999, the economy has been recovering, but social problems in Russia remain acute.

Living conditions in Russian rural areas are rough by modern standards. Many rural areas have unstable electricity supply and power outages are common (see Chapter 6). A number of remote settlements have no access to electricity at all. Many rural households have no running water. People bathe in traditional “banyas” (saunas), heated by burned wood. Basic household activities, such as cleaning, clothes washing and dishwashing, are very time-consuming and require much effort, because their automation is impossible without running water. Most rural houses are heated by burning wood or, more rarely, peat and coal. Some households also use these fuels for cooking.

The Russian National Programme “Energy Efficient Economy in 2002-2005 and up to 2010” stipulates that measures outlined in the section “Effective Energy Supply of

4. EUFORES, *The Impact of Renewables on Employment and Economic Growth*, Altener Programme of the Directorate-General for Energy of the European Commission; <http://www.eufores.org/Employment.htm>

Regions, including Northern Territories, on the basis of Non-traditional Renewable Energy Sources and Local Fuels” would improve the conditions of life and work of more than 10 million people. These people live in remote decentralised regions with unreliable energy supply; particularly in rural areas, in the mountains and in northern territories.

Renewable energy technologies can improve the quality of life of people in such “difficult” areas by providing reliable electricity, heat and water supply. These technologies are an effective and sometimes the only means of bringing electricity to remote rural communities. Besides lighting, electricity can provide refrigeration and communication facilities (radio, TV, telephone, internet) and can allow the use of modern health and educational equipment, improve water supplies and agricultural efficiency.

Renewables in Remotes Villages

Village Shalotch in the Vologda region, 450 km North from Moscow, does not have a centralized electricity supply. The construction of a transmission line is difficult because of the boggy terrain. It would cost about \$380,000 to build a line and about \$12,000 per year to maintain it (excluding the cost of electricity.)

Until 1993 the inhabitants of the village used kerosene lamps for lighting and kerosene or gas-fuelled appliances for cooking. Basic services were absent: there was no telephone, radio, or post, and no medical services. Migration from the village was pronounced. In the 1930s the village had 50 houses and 140 hectares of cultivated land; but by the early 1990s, only 3 families lived there.

In 1993-1994, the “All Russian Institute for Electrification of Agriculture” and the Center “Electrdomotechnika” installed three 160 W wind turbines and 14 PV modules with peak capacity of 65 and 130 W in Shalotch. Initially the project was to be wholly financed from the state budget, but the village inhabitants paid 50% of the costs. The installed capacity is not sufficient to cover all needs of the inhabitants in electricity (e.g. refrigerators, washing machines), however it allows the use of energy-efficient electric lights, TV sets, water pumps, etc. As a result, people returned to the village and today it has about 45 families living there.

Other examples of small-scale renewable energy systems use in zones with decentralized electricity supply exist in the regions of Moscow, Kaluga, Rostov, Leningrad, Yaroslavl, Ryazan, Chelyabinsk, Arkhangelsk, Murmansk, Chita, Volgograd, Orenburg, in republics of Buriatia and Yakutia, and in territories of Altai, Chukotka and Krasnoarsk.

Source: Intersolar center, Renewable Energy Bulletin, December 2000

THE ENVIRONMENTAL BENEFITS OF RENEWABLE ENERGY

The well-known Soviet slogan “We cannot expect charity from nature: we must tear it from her” eloquently represented the Soviet state’s attitude towards the environment. The centrally planned economy, which focused on extensive industrial production at all costs, was characterized by inefficient and unsustainable use of natural resources, including mineral resources, land and water. As a result, Russia today faces severe environmental problems. Russia’s poor record on the environment has had a negative impact on people’s health. In 1999, the head of the State Committee for Environmental Protection reported that 250 000 people die prematurely in Russia every year from health problems caused by the environmental situation.⁵

Renewable energy is by and large more environmentally-friendly than traditional carbon-based energy sources. Increased use of renewable energy, along with improvements in energy efficiency, could contribute to reducing environmental degradation in Russia. To enhance energy efficiency and the use of renewables in Russia, there is a need to integrate these in an overall policy framework and to develop the effective support policy including institutional framework and sectoral policies.

One of the major environmental benefits of renewable energy is the reduction of GHG emissions achieved by replacing fossil fuel generation plants with RE-based plants. Renewables can also play a role in reducing local air pollution. Since they emit no or few local air pollutants, renewable energy systems can improve air quality in urban zones and in recreational areas. Tables 16 and 17 illustrate that, on a life-cycle basis, renewable energy technologies emit much less CO₂, SO₂ and NO_x than conventional fuels.

Virtually all renewable energy technologies emit only small amounts of carbon per unit of energy supplied throughout their life cycle. Most renewables contribute to carbon emissions only during their manufacture, and emit zero or very little CO₂ during operation. Biomass, open cycle geothermal steam and ocean thermal are exceptions since they release CO₂ during energy extraction.⁶ In the case of biomass, however, some or all of the CO₂ emitted during combustion is equivalent to what was sequestered from the atmosphere. Technologies using biomass can be considered “CO₂ neutral” in terms of their impact on global warming.⁷ Wider use of renewable energy would help

Table 16 Life Cycle Emissions from Renewables

| | Energy Crops | | Hydro | | Solar | Solar | Wind | Geothermal |
|-----------------|---------------------------------|--------------------------------|----------------------------|----------------------------|-------------------|---------------------------------|-------------|-------------------|
| | Current Practice (g/kWh) | Future Practice (g/kWh) | Small-Scale (g/kWh) | Large-Scale (g/kWh) | PV (g/kWh) | Thermal Electric (g/kWh) | | |
| CO ₂ | 17-27 | 15-18 | 9 | 3.6-11.6 | 98-167 | 26-38 | 7-9 | 79 |
| SO ₂ | 0.07-0.16 | 0.06-0.08 | 0.03 | 0.009-0.024 | 0.20-0.34 | 0.13-0.27 | 0.02-0.09 | 0.02 |
| NO _x | 1.1-2.5 | 0.35-0.51 | 0.07 | 0.003-0.006 | 0.18-0.30 | 0.06-0.13 | 0.02-0.06 | 0.28 |

5. EIA, *Russia: Environmental Issues*, www.eia.doe.gov/emeu/cabs/russenv.html

6. Kozloff K.L and Dower R.C. (1993) *A New Power Base. Renewable Energy policies for the Nineties and Beyond*, World Resources Institute.

7. IEA (1998) *Benign Energy? The Environmental Implications of Renewables*, IEA/OECD, Paris.

Table 17 Life Cycle Emissions from Conventional Electricity Generation in the UK

| | Coal | Oil | Gas | Diesel | |
|-----------------|------------------------------|---------------------------------------------|------------------------------|---------------------|-------------------------|
| | Best Practice (g/kWh) | FGD & Low NO_x (g/kWh) | Best Practice (g/kWh) | CCGT (g/kWh) | Embedded (g/kWh) |
| CO ₂ | 955 | 987 | 818 | 430 | 772 |
| SO ₂ | 11.8 | 1.5 | 14.2 | - | 1.6 |
| NO _x | 4.3 | 2.9 | 4.0 | 0.5 | 12.3 |

Source: ETSU (1995), cited in IEA (1998) *Benign Energy? The Environmental Implications of Renewables*, IEA/OECD, Paris.

Russia meet its Kyoto commitments in the medium term, and would allow it to benefit more from the international emission trade.

Apart from reducing air pollution and greenhouse gas emissions, renewable energy has other important environmental benefits. Where a shortage of drinking water exists, or where drinking water is not easily accessible, renewable energy can play a role in improving the security of the water supply in Russia. Hydroelectric schemes can be used for electricity generation, to supply water to settlements and cattle farms, and for irrigation, transport and recreational purposes.

The IEA publication “*Benign Energy? Environmental Implications of Renewables*” describes several other RE technologies that can also contribute to water supply.⁸ For example, wind energy is widely used for water pumping. There are over one million small wind turbines installed worldwide for pumping water from underground reservoirs. In addition, solar thermal technologies can be used to dispose of water pollutants such as agricultural and industrial wastes (solar photocatalytic water detoxification).

As a civil society has emerged gradually over the past decade in Russia, and there have been recent cases where industrial projects have been approached by environmental and consumer groups. For example, ecologists in Kaliningrad have sued a branch of Lukoil that is planning to extract oil from the Baltic Sea, because this project could possibly endanger plant and animal life in the national park, the Curonian Spit, a territory on UNESCO’s World Heritage List. This trend is likely to be favourable for the development of renewable energy technologies, which are more environmentally friendly than fossil fuel ones.

8. IEA (1998) *Benign Energy? The Environmental Implications of Renewables*, IEA/OECD, Paris.

ANNEX I

CLIMATE CHANGE

CONVENTION AND KYOTO

PROTOCOL: KEY CONCEPTS¹

Annex I of the United Nations' Convention on Climate Change currently includes 41 industrialized countries. The 24 countries that were members of the Organisation for Economic Co-operation and Development (OECD) in 1992 are also listed in the Convention's Annex II. All other countries (currently 145) are known as non-Annex I countries. Most of them are the developing countries.

ANNEX I COUNTRIES

All Annex II countries listed below plus Belarus*, Bulgaria*, Croatia*, Czech Republic*, Estonia*, Hungary*, Latvia*, Liechtenstein, Lithuania*, Monaco, Poland*, Romania*, Russian Federation*, Slovakia*, Slovenia*, *Turkey*, Ukraine*.

* Countries with economies in transition.

Notes: Turkey has not yet ratified the Convention. A decision taken at COP 7 deleted its name from Annex II and invited Parties to recognize its special circumstances, which will place Turkey in a different situation from that of other Annex I Parties when it becomes a Party.

Kazakhstan has announced its intention to be bound by the commitments of Annex I Parties, but is not formally classified as an Annex I Party under the Convention. It will, however, be considered an Annex I Party under the Kyoto Protocol, once it enters into force.

ANNEX II COUNTRIES

Australia, Austria, Belgium, Canada, Denmark, European Community, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States of America.

1. UNFCCC (2002), *A Guide to the Climate Change Convention and Its Kyoto Protocol*, Climate Change Secretariat, Bonn. For more information see <http://unfccc.int>

KYOTO PROTOCOL

The Kyoto Protocol to the United Nations' Convention on Climate Change contains a set of legally-binding emissions targets for industrialized countries. Annex I Parties that ratify the Protocol are obliged to cut their total emissions by at least 5% from 1990 levels by 2008-2012. The total cut is shared out so that each Annex I Party has its own individual emissions target. The three Kyoto mechanisms: Joint Implementation (JI), the Clean Development Mechanism (CDM) and International Emissions Trading (IET) are designed to help the parties meet their commitments.

JOINT IMPLEMENTATION

Joint implementation allows Annex I Parties to invest in an emissions reduction or removal project in another country to earn *emission reduction units* (ERU) that the investor can credit toward its emissions limit. Generally, this instrument encourages industrialised countries to invest in emissions reduction/removal projects in transition countries, where there are more possibilities to cut emissions at lower cost.

INTERNATIONAL EMISSION TRADING

International Emission Trading allows one Annex I country to sell some of its allowable emissions – *assigned amount units* (AAU) – to another Annex I country.

CLEAN DEVELOPMENT MECHANISM

The CDM allows Annex I Parties to implement projects that reduce emissions in the territories of non-Annex I Parties. The certified emission reductions – CERs – generated by such projects can be used by Annex I Parties to help meet their emissions targets, while the projects also help non-Annex I Parties to achieve sustainable development and contribute to the ultimate objective of the Convention.

ANNEX 2

COMPANIES

AND MANUFACTURERS

OF RENEWABLE ENERGY

EQUIPMENT IN RUSSIA¹

Note: This list includes designers and manufacturers who had at least experimental samples of renewable energy systems and equipment at the beginning of 1997 and who answered the questionnaire for the catalogue “Equipment of small and non-traditional power engineering”².

The complete list of the designers and manufacturers of the equipment and parts (generators, converters of frequency, inverters etc.) in total consists of more than 150 enterprises and organisations, according to the Russian Intersolarcenter (www.intersolar.ru).

WIND ENERGY

1. Tushino machine building factory, Moscow (manufacturer), State machine-building design bureau “Rainbow”, Dubna (designer) – wind installations with capacity 1; 8 and 1000 KW.
2. Joint-stock company “Tornado”, Istra, Moscow region – wind installations with capacity: 0.14; 0.25; 4.0 and 16.0 kW.
3. State science centre of Russian Federation – CRI “Electropribor”, St. Petersburg – wind installations with capacity: 0.04; 0.1; 0.2; 0.5 and 1.0 kW.
4. JSC research-and-production company “Vetrotok”, Ekaterinburg – wind installations with capacity 16 kW, solar water heaters.

1. Ministry of Fuel and Energy et al. 1999, “The Role of Renewable Sources of Energy in Power Strategy of Russia”. In Yanovsky, A., Bezroukikh P., *Business and Investment for Renewable Energy in Russia*, Proceedings of the Congress, Moscow, 31 May-4 June 1999.

2. Ministry of Fuel and Energy and JSC “New and Renewable Sources of Energy”, *Оборудование нетрадиционной и малой энергетики (Equipment of small and non-traditional power engineering) Catalogue*, Second edition, Moscow 2000.

5. JSC “Elektron”, Novosibirsk State technical university, Novosibirsk – wind installations with capacity: 1.0 and 2.0 KW.
6. JSC “Dolina” Kuvandyk, Orenburg region – wind installations with capacity: 2.0 and 5.0 KW.
7. Rybinsk factory of instrument making, Rybinsk, Yaroslavl area – wind installations with capacity: 0.15; 0.5; 1.0 and 5.0 KW wind pumping installations with productivity 200 and 300 l/hour.

PHOTOELECTRICITY

1. Firm “Metokom”, VO “Tyajpromexport”, Moscow – PV modules with capacity; 10-15-25-30-35-50-55-60-65 and 70 W.
2. All-Russia research institute of electrification of agriculture (VIESKH), Moscow – PV modules with capacity: 27 – 33 W.
3. JSC “Design bureau of Factory Krasnoe Znamya”, SMC “Rusant-Solar”, Ryazan – PV modules with capacity 10-15-25-30-33-35-40-45-50-55-60 W, system of autonomous solar supply with capacity 12-30-45 and 60 W, autonomous solar water pumping installations with capacity 120 W.
4. JSC “Saturn”, Krasnodar – PV modules with capacity 10-25 and 55 W, PV stations with capacity 10-100-200 and 500, universal PV stations with capacity from 0,06 up to 10 KW.
5. JSC “ELMA”, Moscow – solar cells, solar modules with capacity 0.72-0.8-1.0-1.3-1.5 W, solar PV installations with capacity 5-7-10-12-30-33-35-40-45-50 W.
6. JSC Pravdinski pilot factory of sources of current “Posit”, settlement Pravdinski, Moscow region – PC modules and batteries with capacity 4.5-5-8-9-10 W, thermoelectrical generators with capacity 2.5; 8 and 15 W.
7. SPF “Kvark”, Krasnodar – PV modules from 3 up to 60 W.
8. SPC “Solar wind”, Krasnodar – PV systems of household purpose from 3 to 200 W.
9. Physical-technical institute named after A. Ioffe, St. Petersburg – solar cells on the base of AlGaAg and solar modules with specific capacity up to 180 W/m².

SOLAR HEAT SUPPLY

1. Joint-stock company “Kovrovski mechanical factory”, Kovrov, Vladimir region – solar collectors and systems of solar heating and hot water supply (from 2 up to several hundreds collectors).

2. SPC “Konkurent (TsAGI)”, Jukovski, Moscow region – solar collectors and water heaters for two collectors.
3. SPA of “Mechanical engineering”, Reutov, Moscow region – solar collectors and water heaters with 200 l storage tank.
4. Joint-stock company “Solto”, Moscow – Solar collectors.

SMALL AND MICRO-HYDROELECTRIC STATIONS

1. Enterprise “Kebren”, St.-Petersburg – micro-hydroelectric stations with capacity: 1.0; 6.0; 7.5 and 30 kW.
2. Research-and-production association “RAND”, St. Petersburg – hydro agregats for micro-hydroelectric stations with capacity from 1.5 up to 75 KW, hydro agregats for small hydroelectric station with capacity from 120 kW up to 200 W, autonomous water pumping installation by productivity from 0.7 till 5.0 m³/hour.
3. Research-and-production cooperative society “Power and Ecology”, Novosibirsk – module of dumless hydroelectric station with capacity of 0.5-1.0 kW.
4. JSC “MNTO INSET”, St. Petersburg – derivation (dum less) micro-hydroelectric stations with capacity: 7.5; 10; 22; 45; 50 and 90 kW, hydro units for small hydroelectric stations with capacity from 100 kW up to 5 MW.
5. Russian association of small and non-traditional power “MAGI”, Moscow – hydro units for small hydroelectric stations with capacity from 100 up to 600 kW.

USE OF BIOMASS

1. Centre “ECOROSS”, Moscow – individual biogas installation IBGU-1, autonomous biogas module BIOEN-1.
2. VIESKH, Moscow – biogas installations BGU-2.0; BGU-25; BGU-50; BGU-150 and BGU-500.
3. “Energitechnolya” Ltd., St. Petersburg – thermochemical gas generators with capacity: 0.1; 0.6; 1.0 and 3.0 MW.

HEAT PUMPS

1. JSC “Energy” Novosibirsk – thermal pumps TN-300, TN-500, TN-1000, TN-300 with productivity 300, 500,1000 and 2500 kW.

2. Joint-stock company “Mashzavod”, Chita – machine for heating and air conditioning TN-100, productivity 88 kW.
3. JST Moscow factory of refrigerating mechanical engineering “Compressor”, Moscow – steam-water ejector refrigerating machines with productivity 350; 700 and 1400 kW, heat pumps with productivity 370 and 520 kW.
4. Joint-stock company “Insolar”, Moscow, heat pumps with capacity from 2.0 up to 15 kW.

GEOTHERMAL INSTALLATIONS

1. Kaluga turbine factory, joint-stock company “Science” – modular geothermal stations with thermal capacity 6 and 20 MW, small capacity modular geothermal electrical stations with capacity 0.5; 1.7; 2.5 and 4.0 MW, geothermal power plants with average capacity 6; 12; 20 and 23 MW.

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