HELIO INTERNATIONAL

Sustainable Energy Watch
2005/2006

Energy and Sustainable Development in the Russian Federation

Report by:
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Summary of Report
Russia is one of the biggest exporters of energy and energy resources in the world. However, the development of the clean renewable energy technologies is still at the preliminary stage.

Introduction

This is the first Sustainable Energy Watch report for Russian Federation (RF).

The report was compiled by Vladimir Karghiev, senior expert of the Solar Energy Center "Intersolarcenter", Moscow (http://www.intersolar.ru/). It is the author's hope that these indicators, while by no means definitive or comprehensive, will stimulate debate within Russia on energy and sustainable development goals. As a work in progress, comments from stakeholders and experts in the Russian Federation and beyond are welcome. This feedback will help to improve the accuracy of the data, as well as the quality of the policy conclusions that are drawn from the data.

For the years 2002-2003 estimates have been developed for the eight indicators, similarly for the years 1990-1992. Only some data is available to calculate all indicators for 2005.

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Executive Summary

This report was prepared for HELIO's Sustainable Energy Watch (SEW) to assess Russian energy use in relation to the impact on global climate. SEW methodology[1], based on eight indicators, was used for assessment. For each of these indicators, the value of 1 is either the global average or the historical trend for Russia, while the value of 0 is the sustainability target.

Russia is the closest to the sustainability target on the indicators for access to electricity and resilience to external impacts (energy exports). Mass electrification of Russia was carried out in Soviet times from the 1930s -1950s. Currently, about 95 % of the population has access to central grid or local energy system.

However, the energy supply is ensured mainly by fossil fuels – coal and natural gas. A notable share of the energy supply is from nuclear and large hydro power stations. Development of small hydro and other renewable energy sources is at the very beginning stage. There is no policy framework for renewable energy technologies in Russia; as a result renewable energy development in Russia is still in its infancy.

Russia is a carbon-intensive country. This is due to various factors: its northern location; low annual temperatures; and low energy efficiency. Indicator value for emissions per capita is 3.6 which is far beyond the sustainability target of zero.

Russia experienced a significant decline in its economic development during the 1990s. Russia still has not achieved the 1990 GDP levels (this is expected in 2007[2]). This is main reason why CO2 emissions are lower now than in 1990 not, unfortunately, to the improved energy efficiency of the economy. It is expected, that Russia will reach the 1990 emissions level by 2008-2012. If no wide-spread measures towards improving energy efficiency and introducing clean renewable energy technologies are undertaken, Russia will exceed the base 1990 level of carbon emissions.

In 2004 Russia ratified the Kyoto Protocol, making it come into force. Because there is ambitious plan for doubling of GDP by 2010[3] there are serious concerns that Russia will not be able to remain within Kyoto Protocol commitments over the next decade.

Renewable energy is a key way to keep emissions level within the limits and to meet at least part of increasing demand for energy supply. The potential for increasing the renewable energy supply in Russia is huge, however it is currently very low - about 4% of total energy and about 0.5% of electricity comes from RES (this does not include large hydro).

[1] Sustainable Energy Watch of Helio International. See http://www.helio-international.org
[2] Statement of Minister of Finance of RF Kudrin A. made on 11.07.2005
[3] Illarionov, A. (2004), "Economic consequences of Kyoto protocol ratification by RF", Ecomony issues, #11, 2004, pp.34-59

Moreover, the current *Energy Strategy*[4] doesn't consider renewable energy as a notable input into Russia's energy mix. The main share will be fossil fuels – coal, oil and natural gas. Nuclear energy and large hydro will be also developed.

Investments in clean energy are almost zero compared to "traditional" energy. Russia's only utility company RAO UES plans to complete large hydro power stations construction started in Soviet times. The deterioration of coal and gas fired stations is about 50-75%, and this, combined with requirements to introduce clean fossil fuels technologies, will require significant investments in "traditional" energy.

Russia's economy is energy-intensive and almost completely relies on fossil fuels. The primary energy generation will increase by 1,515 million tce in 2002 to 1700, to 1,820 million tce in 2010 and to 1,810 – 2,030 million tce[5] in 2020 as a result of anticipated economic development. Russia will have to ensure exports of oil and gas (to CIS and Europe), which will create an additional load on the extractive industry. This poses a challenge to policy makers, industry and civil society alike to find appropriate measures that ensure increased energy production while decreasing carbon emissions. Though there are several signs that Russia will eventually have appropriate energy policies in place, it is not evident that opportunity for introducing clean energy technologies will seized.

Table 1: Eight Indicators of Energy Sustainability for Russian Federation

Indicator	1990		2003		% change	
	Metric	Vector	Metric	Vector	Metric	Vector
1. Carbon emissions, kgC/cap	4137	4.8	3220	3.64	-22	-24
2. Particulate concentrations*, kgSO2/cap	69.6	1	34.5	0.44	-50	-56
3. Access to electricity**, %	98.22	0.018	98.48	0.015	0	0
4. Clean energy investment, %	0.008395	1	0.00652331	1	0	0
5. Energy trade – exports	53.1	0.531	55.3	0.553	4	4
6. Burden of energy investments	3.49%	0.349	3.43%	0.343	28	28
7. Energy intensity (PPP)****	13.66	1.315	13.68	1.317	0	0
8. Renewable energy****	0.04%	1.1	0.07%	1.11	0	0

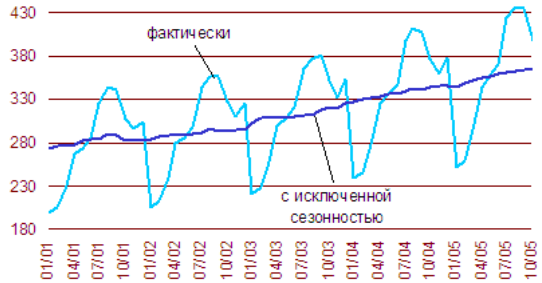
[4] Energy Strategy of Russian Federation, 2003
[5] Energy Strategy of Russian Federation, 2003

Geographic and Economic Setting

The Russian Federation gained independence in 1991 after the disintegration of Soviet Union. Russia inherited from the former USSR an economic system deep in crisis. The 1990s experienced a significant decrease in economic activity as well by political and social fragmentation. So called "privatization" was actually depredatory denationalization of economy. Until 1999 there was a decrease in GDP production and a worsening in the standard of living. International terrorism, stemming from southern Russia became a serious threat to the country's security and integrity. Russia's energy sector suffered from a serious decline in extraction and generation.

In 2000 there was a radical turnabout in Russia's economy. For the first time since 1990 economic production began to rise and with it the GDP and income levels (Figure 1). The demand for more energy, both for heat and power and energy exports increased. Long-term contracts with neighbouring countries for the supply of oil and gas were negotiated. The Energy Dialogue with the European Union was initiated.

Figure 1: Increase of GDP 2001-2005, in billion rubs, PPP 1998



Source: http://www.forecast.ru/

Today there is steady economic growth in Russia (5-7% annually, with peak 10% in 2000). For the Russian economy the post-crisis period of 1999-2002 was the most successful economic period since World War II. During these four years the GDP increased by 28%, industrial production by 35%, market turnover by 23%, and investments to capital assets by 40%. Production efficiency also increased significantly: labour productivity rose by 33%, and energy efficiency improved by 17%.[6]

High prices for oil and energy carriers on the world markets allowed Russia to move from a budget deficit to a budget surplus. A state stabilization fund was also created. However, over the past couple of years structural changes in economy have occurred. The government is moving its focus to the oil and gas sectors. Some experts maintain that this shift is what is causing a slowing of economic growth.[7]

[6] Belousov, A. (2003), "Development of Russian economy in post-crisis period", Economical policy, v.6, 2003, pp.3-22.
[7] Illarionov, A. (2004), "Economic consequences of Kyoto protocol ratification by RF", Ecomony issues, #11, 2004, pp.34-59

Profile of Russian Federation

The Russian Federation (RF) is one of the biggest countries in the world. Its land area totals 17,075 million km2 (the largest territory in the world).

The territory of the Russian Federation occupies the larger part of the Eastern Europe and Northern Asia. Longitudinal extent is in the range of 2.5-4.0 thousand km; latitudinal one is 9.0 thousand km. State borders of the country are: in the North-West – Norway and Finland, in the West – Poland, Estonia, Latvia, Lithuania and Belarus, in the South-West – Ukraine, in the South – Georgia, Azerbaijan, Kazakhstan and in the South-East – China, Mongolia and North Korea.

Russia is distinguished by different climates. Much of the country's surface is composed of Arctic deserts, tundra, taiga and steppe. A large part of the country is also covered by forests (about 51% of total area).

The following natural zones exist in Russia: a polar-tundra zone occupying up to 30 % of the country's area, a zone of coniferous forests (taiga) - 50 %, zone of deciduous forests - 8 % and a forest-steppe zone - 12 %. Surface waters, including wetlands, are another 12% of the country's area. Wide-ranging plains occupy about 70 % of the territory. The East-European plain outstretches to the west. Its eastern border is the Ural mountain system. The West-Siberian plain is located to the east from the Urals. Further to the east the Central Siberian plateau is located between the Yenisei and Lena rivers. The Central Yakutian plain continues on its eastern border.

The mountain areas prevail in the eastern and southern parts of the country. These are the northern chains of the Great Caucasus in the European part and are home to the highest point in the Russian Federation - a mountain of Elbrus, of 5,642 meters above the sea level. Mountains of Southern Siberia extend along the State border include: Altai, Kuznetsky Alatau, Western Sayan, Eastern Sayan, mountains of Tuva, Baikal-side, Transbaikalia, and Stanovoe Nagorie. Medium-altitude mountain chains prevail in the north-eastern part of Siberia, and in the Far East. The mountains of Kamchatka and Kuril Islands are extended along the Pacific coast of Russia. (Third National Report, 2001)

Russia is rich with natural resources – forests, waters, minerals, oil and natural gas. It is also an industrial country were in 2003 the share of industrial products in GDP was 64% in.[8] A significant share of the industry is located in European part of Russia and the Urals.

Arable land in Russia is 193.8 million ha (2003), or about 11.5% of the country's total land mass. The principal agricultural crops are: grains (33.9 million t in 2003, incl. wheat 19.4), sugar beat (11484 million t), sun flower seeds (3029 million t), potato (34.1 million t), vegetables (11.8 million t).

[8] Statistic Yearbook for Russian Federation (2005)

Russia's population, according to the latest population census in 2002, is 145,167 million, a decrease from 144, 168 million in 2004 (sixth in the world in terms of population).[9]

The average population density is 8.4 persons per square km. Most of Russia's population lives in the European part of the country (Eastern Europe) which has a population of 105,317 million or 73% of the total population. The density in the North-West region is 8.2 persons per km2. The Central region has a population density of 58 persons per km2. The total population of Russia declined over the past decade because of low level of fertility and high death-rate (see Table 2).

In 2004 there were 105,818 million people (73.4% of the population) living in urban areas and 38,35 million people (26.6%) living in agricultural areas.

Table 2: Population and Rate of Growth

Year	Population (thousand)	Rate of growth, per 1000 persons
1970	129,941	5.9
1979	137,410	5
1989	147,022	3.9
2002	145,167	-6.5
2003	144,964	-6.2
2004	144,168	

There is universal schooling in Russia and it has a literacy level of 99.9%. Education levels were dramatically increased during Soviet times prior to World War II. Current education levels can be broken down as follows: higher education - 16%, incomplete high education - 3.1%, secondary education - 52.9%, general education -18.2%, basic education - 7.7%

After dissolution of the USSR, there has been a widening gap between income levels in Russia. The beginning of 1990s was characterized as period of "primary accumulation of capital". Industrial enterprises and other national economy objects were privatized, often for a symbolic price. Most of the population received nothing and their standard of living dropped below the poverty line. In the late 1990s serious measures were undertaken by the state government to address this crisis. Over the past five years there has been stable economic growth in Russia (see Figures 1 and 2 as well as Table 3).

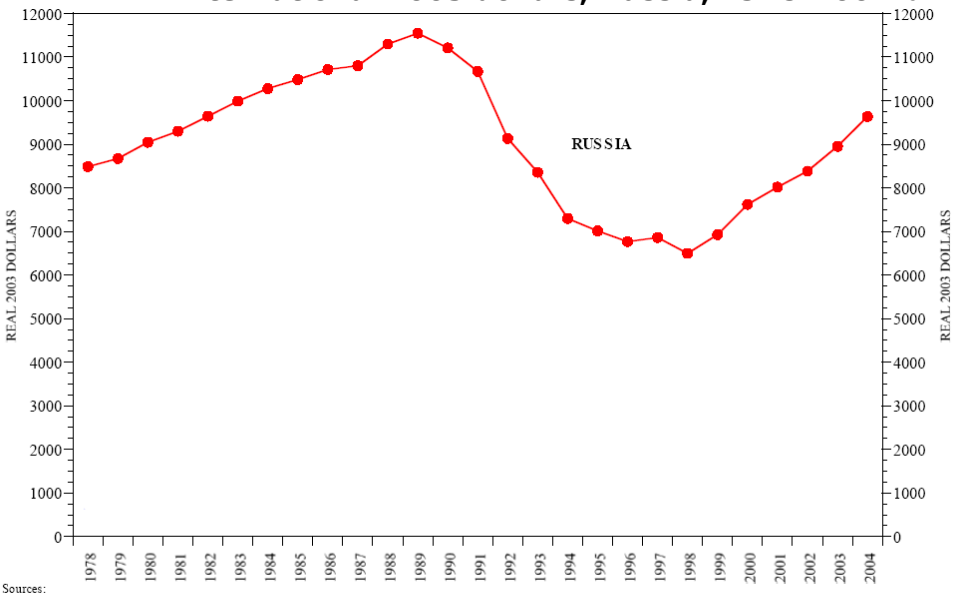
[9] Statistic YearBook for Russian Federation (2005)

Table 3: Data on GDP and GDP per capita (absolute and PPP numbers)

Year	GDP, billion RUB		GDP per capita, RUB		Power generation, million RUB	Monthly Income per capita, RUB	Industry production billion RUB
	absolute*	1998 prices**	absolute*	1998 prices**	absolute*	absolute*	absolute*
1990		4598		31279		0.215	0.6
1991		4368		29714			
1992		3735		25495			
1993		3410		23276			
1994		2977		20390			
1995	1429	2843	9643	19473	121404	515.5	1108
1996		2740		18767			
1997	2343	2778	15903	19053	218202	942.2	1626
1998	2630	2630	18038	18038	245985	1013	1707
1999	4823	2797	32966	19197	269551	1664	3150
2000	7306	3078	50192	21155	375088	2290	4763
2001	8944	3233	61785	22251	519993	3078	5881
2002	10834	3372	75294	23228	700735	3972	6868
2003	13285	3618	91897	24958	886190	5161.8	8498

Sources:
*Statistic Yearbook (2005); before 1998 – in trillion rubs/thousand rubs
** Illarionov, A. (2004), "Economic consequences of Kyoto protocol ratification by RF", Ecomony issues, #11, 2004, pp.34-59

Figure 2: Gross National Income per Capita at PPP: in Real International 2003 dollars, Russia, 1978-2004[10]



Sources:
Gross National Income per capita at purchasing power parity in 2003: The World Bank, *World Development Indicators Database*, April 2005, at www.worldbank.org/data/wdi2005/
Annual growth rates ofreal Gross Domestic Product (GDP) per capita:
Russia, GDP growth rates and population growth, 1990-2004: Russian State Committee on Statistics, various releases; Russia, GDP growth rates, 1978-1989: RussianState Committee on Statistics, *Rossiiskii Statisticheskii Ezhegodnik 1994* (Moscow, 1995), p. 262; Russia, population growth, 1978-1990: Russian State Committee on Statistics, *The Demographic Yearbook of the Russian Federation1993* (Moscow, 1994), p. 9.

[10] Bernstam, M., Rabushka A. (2005). "China vs. Russia: wealth creation vs. poverty reduction". Available: http://www.russianeconomy.org/comments/042505.pdf (Accessed: 2006, January 13).

However, 1990 levels have still not been achieved (see Table 4). The Russian Federation is also an exporter of energy resources and exports about one-third of its extracted/generated energy sources (see Tables 5 and 6)

Table 4: Principal Imports and Exports (non-CIS + CIS)

Year	Total imports, billion USD	Total exports, billion USD
1995	44.3+18.3	65.4+17
1997	53.4+18.6	67.8+19.1
1998	43.7+14.3	58.7+15.8
1999	29.2+10.4	63.6+12
2000	31.4+13.4	90.8+14.3
2001	40.7+13	86.6+15.3
2002	48.8+12.2	90.9+16.4
2003	60.3+15.2	114.6+21.4

Table 5: Electricity Generation and Import/Exports in billion kWh

Year	Electricity generated	Electricity imported	Exported
1990	1082.2	35	43.4
1999	846.2	8.4	22.5
2003	916.3	8.2	21.6

*source: Statistic yearbook, (2005)

Table 6: Energy Balance in 2002, Million tce

	Fossil fuels	Electricity	Fossil fuels products	Flammable by-products	Heat
Extraction/generation	1409.6	307	312.5	31.2	214.9
Import	33.3	1.8	0.2	-	-
Export	517.1	6.2	111.3	-	-

*source: Statistic yearbook, (2005)

There has been much debate over Russia's possible entry to WTO. One argument is that the Russian economy is not yet strong enough to compete successfully with other economies. Moreover, there is an overall higher cost of goods produced in Russia due to northern location of the country.

Indicator	Value	
Human development index	0.77911	
Human poverty index		
Environmental sustainability index		
GHG emissions	2.23 billion tons CO2	
GDP and GDP per capita in 2003- according to Russian statistic yearbook, 2004 GDP and GDP per capita in 1998 prices	432.87 billion USD 603 billion USD	3002 USD 4159 USD

* 2003 exchange rate: USD 1 USD=RUB 30.6928 RUB

Overview of National Sustainable Development Strategy

Russia, with 2.8% of the world population and 12.8% of the world territory, has 12-13% of the world unexplored resources. It has about 12% of explored reserves of oil, 42% resources and 34% reserves of natural gas, about 20% reserves of coal and 32% reserves of brown coal. The total volume of the extracted fuels amounts to 17% of potential extractable oil resources and 5% of gas. The reserve-to-production ratio is estimated at several dozens years for oil and gas, and much more for coal. The uranium mineral base can meet the requirements need to develop nuclear energy.[12] Russia's wealth of reserves gives it a significant presence on the world energy markets and geopolitical influence.

The energy sector is also a very important part of national economy; it consolidates regions and influences many of the country's financial and economic parameters. The effective operation of the energy sector is one of pre-conditions for sustainable development of the country. The energy sector contributes a quarter of the GDP and a third of all industrial production, thus contributing to approximately half of budget income.

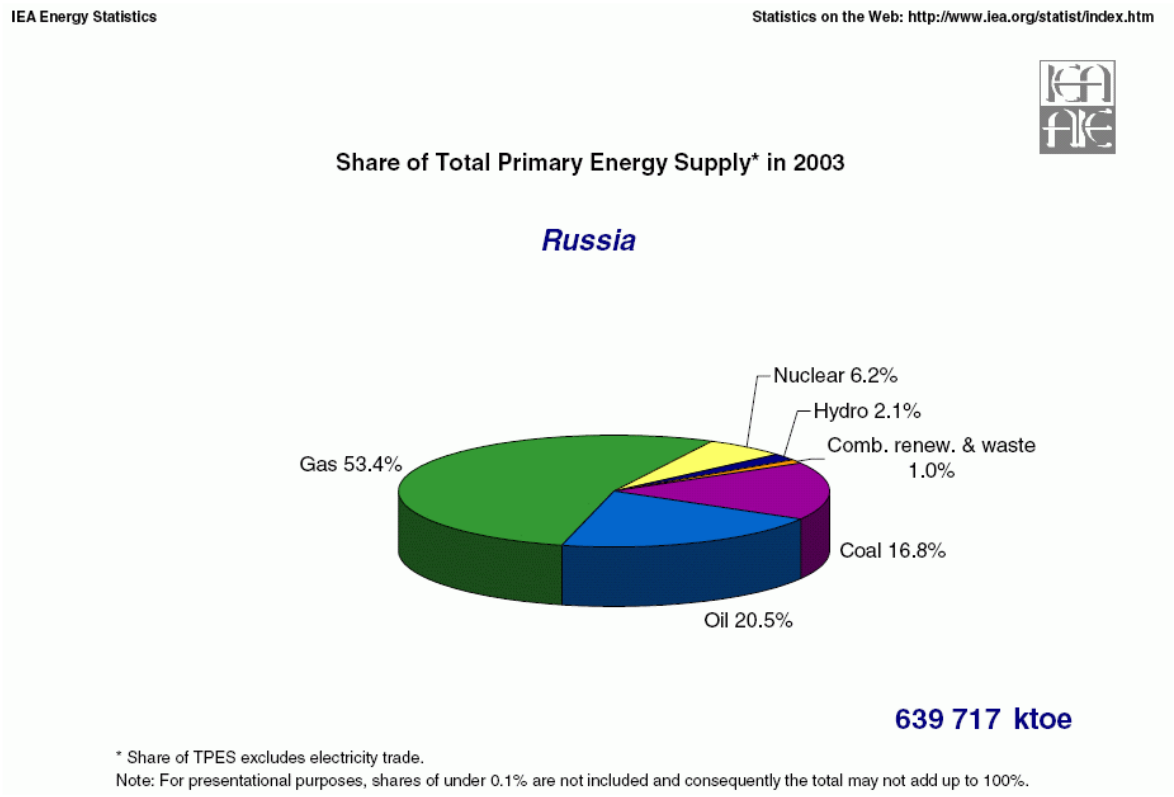
Since 1999 Russia has experienced rapid economic growth and the corresponding increase in energy production. To meet the increasing demand a number of problems must be solved.

Energy Strategy of Russia up to 2020 was endorsed in May 2003 and was approved by the Government decree №1234-r on 28.08.03. One of the basic statements of the *Strategy* is to encourage GDP growth by 5-6% annually. It is possible that energy sector will not be able to meet the growth of demand for energy resources. Therefore, the *Strategy* emphasises increased use of energy efficiency, as well as implementation of proper energy pricing policy.

[11] Human Development indicators, 2003. Available at http://hdr.undp.org/reports/global/2003/indicator/cty_f_RUS.html (Accessed on February 28, 2006)
[12] Inter-Agency Commission of the Russian Federation on Climate Change. (2002). Third National Communication of the Russian Federation. Moscow, 2002

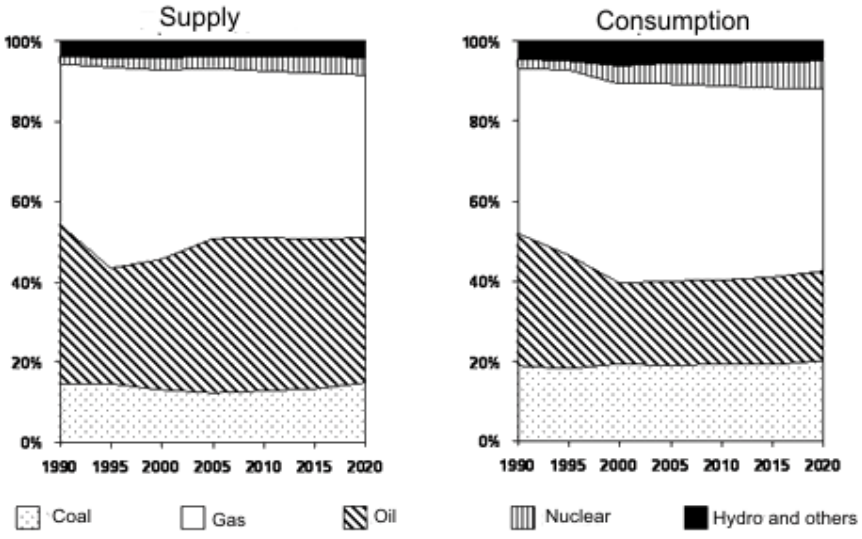
Russia is very heavy dependent on natural gas. Its share in energy balance in 1990s was about 50% (see Figure 3). The *Energy Strategy* proposes a wider use of coal and nuclear energy. It is anticipated that their share in 2020 will be 21-23% and 6% respectively. (see Figure 4).

Figure 3: Share of Total Primary Energy Supply in 2003



source: International Energy Agency

Figure 4: Primary Energy Production and Consumption in Russia with Forecast till 2020.



Source: Energy Strategy of RF (2003)

Because of Russia's huge territory, there is an unbalance in the generation and consumption of energy in many of the regions. Remote regions of Siberia possess a significant share of the country's fossil fuel resources, which must be transported to more dense populated regions. This generates market instability as transportation costs vary according to the price of energy resources. Over the next decade, the European part of Russia will be more dependent on fuels from Siberia.

The Energy Strategy presents two scenarios regarding the country's economic development. One is optimistic and is based on successful economic reforms and a favourable global oil and gas markets. The second is pessimistic and is based on anticipated problems with both internal and external energy markets.

Depending on the rate of economic growth, the *Energy Strategy* envisages a 1.14-1.36-fold increase in domestic consumption of primary energy over the period 2001-2020 (for lower and favourable variants of the economic development, respectively) with a corresponding 1.7-2.1-fold decrease in the energy intensity of the GDP.

More than half of the heat is produced by heat-power stations, which ensure a centralized heat and power supply to Russian cities and settlements. However, there are territories which are located in remote regions that are not connected to the central heat and power grid. Here the energy supply is ensured mainly by regional diesel power stations. Fossil fuels are delivered to these remote regions every year with a part of the cost being borne by the state budget. The energy cost in these regions is very high (20-50 times more than energy costs covered by the central grid). This fact restrains economic development in remote regions.

The Energy Strategy also outlines the development of a long-term power policy of Russia. This policy is aimed at ensuring energy security during the transition of the country to a market economy as well as the long-term sustainable public supply of energy and protection of the country's energy independence.

The priorities of the *Energy Strategy* include:

- providing a complete and reliable power supply; the price of energy should be affordable, but at the same time stimulate the introduction of energy efficiency technologies;
- decreasing energy generation and distribution costs by reducing consumption, increasing energy efficiency, and minimising losses during the extraction and transportation of fuels;
- ensuring financial stability of power sector, increasing labour efficiency and supporting the social and economic development of country; and,
- minimising the environmental impacts from energy sector by introducing of new technologies in all stages of energy generation – from extraction to consumption.

Among measures for improving energy sector, the *Energy Strategy* also envisages the creation of market conditions, improving of overall

management, introducing new standards to ensure accountability and stimulating innovation and energy efficiency.

Although the *Energy* Strategy attempts to balance development with improved energy services, there are also serious problems in the energy sectors which threaten the country's ability to compete in the new market For example:

- there is a high degree of deterioration (more than 50%) of key assets;
- additional capacity is two to six fold lower than in 1990s;
- there is a lack of good management;
- there is a lack of investment (investment in the energy sector is about 13% of total investments; 95% of which are in the oil sector);
- there is inadequate pricing for energy sources, which leads to low internal prices for gas and electricity and high prices for coal;
- there is obsolete equipment in extracting and electricity generating sectors. The use of modern steam-gas turbines, emissions controls and renewable energy installations are scarce;
- there is an absence of a mature energy market;
- the energy sector has a high negative environmental impact; and,
- there is a high dependence of oil and gas sectors on situation on world markets.

In the *Energy Strategy* long-term priorities for the energy policy focus on energy and ecological security, as well as energy and financial efficiency. The central elements for implementing this policy will be a set of economic measures: pricing, taxation, custom duties and anti-monopoly measures. The government will also use its rights as owner of natural resources and as shareholder in power enterprises.

Energy security is considered an important part of national security. The *Energy Strategy* therefore also outlines measures to ensure reliable fuel and energy supply of the country.

The main principles of energy security are:

- secure and reliable energy supply;
- federal and regional control of energy supply stocks;
- compensation of fuel reserves (rates of resources consumption should not exceed the development of substitute energy sources); diversification of fuels – economy should not rely on one energy source;
- ecological security (energy sector development should meet requirements of environment protection);
- avoid ineffective use of energy sources; and,
- maximum use of domestic equipment in power generation and distribution.

To ensure energy security, two key problems must be solved. First, it is necessary to modernize deteriorated equipment. Over the next decade modernization of existing equipment will occur. Following this, obsolete equipment will be replaced and new capacity added. Second, the structure

of fuel consumption and energy generation has to be changed. Nuclear and large hydro will be developed; the share of coal in the energy mix will be also increased. Renewable energy will also be developed.

Currently, the Russian economy is characterized by high energy intensity; 2-3 times higher than in other industrialised countries. The reasons for this, beyond severe climate conditions, are: 1) the obsolete structure of the economy, 2) the inefficiencies of the energy sector and 3) the housing and communal services. Moreover, prices for energy resources are low (primarily for gas), which does not encourage energy savings. The *Energy Strategy* sets specific targets for energy efficiency and determines ways for achieving these targets.

The power sector is one of the main polluters, particularly oil and it by-products. Waste utilization is insufficient and infrastructure for preventing and reducing negative environmental impact is not developed. Serious ecological problems must be solved during the development of new oil and gas field in East Siberia and Far East.

The implementation of the an environmental policy is anticipated via the application of clean technologies, utilization of wastes, tightening of ecological control, creation of clean energy and energy efficient technologies, rational use of natural resources, reducing emissions of GHG and other harmful emissions. Clean coal technologies will also be introduced. This is important as the share of coal in energy mix will be increased. Oil-well gas and mine methane will also be used. The impact from the construction of large hydro power plants will also be addressed and mitigated.

All of these tasks require that a legislative and standard base be set and one that will stimulate investments and allow for the introduction of new clean technologies.

Integration of Russia into the world energy market, international cooperation, increased energy efficiency and the introduction of new energy markets are important priorities. Also strategically important is strengthening Russia's position in the world oil and gas markets. Key will be ensuring the provision of secure energy resources to its neighbouring countries (both in Europe and Asia). Russia is expected to play a major role in ensuring the world's energy supply security.

Other Energy-Related Developments

Since 1990s, there have been significant efforts undertaken in Russia to develop a new policy for environmental protection and sustainable development. Unfortunately, many of the reforms introduced faced serious implementation problems due to the general economic decline, high level of inflation and a lack of state financial support.

Although there has been a significant reduction of emissions level compared to 1990 levels this has been primarily due to the general crisis

in the economy. To maintain the emissions level set by the Kyoto Protocol effective measures must be developed and implemented.

The following sustainable policy documents are in effect in Russia today:

- Sustainable Development Concept, accepted in 1996
- Energy Strategy until 2020, (2003)
- Ecological Doctrine (2002)
- Energy Efficiency Law

The Complex Action Plan of the Russian Federation designed to meet the requirements of the Kyoto Protocol envisages a two-fold increase of use of renewable energy sources (RES) by 2010. Targets for increasing the use of RES are set in the following federal programmes: "Energy efficient economy for 2002-2005 and period until 2010" (adopted by state government on 17.11.2001); "South of Russia" (adopted by State Government on 8.08.2001); "Economic and social development of Far East and Baikal region" (adopted on 15.04.1996); and other programs.

Also under development are the following energy related law concepts:

- Renewable Energy Law
- Small (decentralised) Energy Law

In the federal programme *Energy Efficient Economy* the aim was to introduce a wide range of energy efficiency measures and to develop renewable energy capacity. However, the programme did not meet its objectives due to a lack of financing. The targets were only partially achieved. It is anticipated that this programme will be replaced by a similar programme, slated to start Spring 2006.

The concept for Development of the Agriculture in Russia was elaborated in 2001. It envisages a wide range of energy efficiency measures to secure food supply and social sustainability.

The implementation of the energy strategy requires solving a number of interrelated problems including the increase efficiency of energy use, which is of a special importance for the UNFCCC. These should be accomplished with a view to achieving energy sustainability based on energy saving technologies and structural optimization of power generating facilities, while at the same time ensuring growth of energy supply and improvement in working and living standards, reducing the load on the environment and improving national productive forces for raising economic efficiency and market competitiveness.

In addition to increasing the energy efficiency of the economy and managing growth rates, the restructuring of the economy and technological advances will also determine the level of energy efficiency. Restructuring the economy could reduce in half the anticipated energy demand.

Aside from structural modifications, the *Energy Strategy* envisions intensive institutional and technological measures to ensure fuel and energy savings, i.e. targeted energy saving policy. Russia has a high

potential for organizational and technological energy savings. Achieving domestic and world-wide (low and upper values respectively) organizational and technological measures for saving energy resources would enable current consumption within the country to be reduced by 40–48% or by 360–430 Mtce/yr.[13]

Environmental Sustainability

Indicator 1: Per Capita Energy Sector CO2 Emissions

Russia is continent-size country. Its area almost equals to Europe and Australia together and hence plays very important role in environmental dynamics not only in the Northern hemisphere, but globally. Russia also has large expanses of natural and quasi-natural ecosystems, especially forests. In Russia there are 1/5 of world forests; only South America has a larger area covered by forests.[14] As forests are important consumers of CO2 they can play a part in reducing CO2 emissions

Russia is responsible for 17% of world GHG emissions. Anthropogenic emissions of CO2 in Russia are mainly due to the consumption of fossil fuels: coal, oil, natural gas, peat (in very small quantities), and to the use of secondary organic fuels.[15]

Russia's total emissions of CO2 in 1990 according to different sources were 2.23-2.36 Mt. In 2004 the CO2 emissions were 1.7 Mt[16].

Carbon content in CO2 is 27 or 27%.

Population of Russia in 1990 and 2004 was accordingly 147 and 144 million people.

Thus, the carbon emissions per capita were: in 1990 about 4137 kg/capita, in 2004 – 3220 kg/capita.

Vector values:
I11990 = (4137-339)/791 = 4.8
I12004 = (3220-339)/791 = 3.64

The reduction in CO2 emissions is caused by a dramatic decrease of industrial production which ensued after the disintegration of USSR. There are projections that by 2012 Russia will have 1990 emission levels and they are projected to increase. Special measures to reduce the emissions are needed such as introduction of energy efficient technologies and development of renewable energy.

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[13] Inter-Agency Commission of the Russian Federation on Climate Change. (2002). Third National Communication of the Russian Federation. Moscow, 2002
[14] Losev, K.(2004), "Meaning of Kyoto protocol for Russia", On the way to sustainable development of Russia, Bulletin, vol. 27, VINITI RAS, MSU.
[15] Inter-Agency Commission of the Russian Federation on Climate Change. (2002). Third National Communication of the Russian Federation. Moscow, 2002
[16] Statistic yearbook of RF, (2005).

Below are data indicating the structure of the emissions in Russia. Calculations of GHG emissions using Base approach of was made by Gritsevich I. and Kolesov A. (2004).[17] Results for CO2 emissions from burning of fuels are presented in Table 7.

Total emission of CO2 in 2000 was 35% less than 1990 levels. Emissions from burning of solid fuels decreased 36% by 2000 and slightly increased in 2001.

From 1990 to 2001 the share of emissions from the power sector increased from 54% to 57%. Over the same time period, liquid fuel emissions decreased 53% while emissions from the burning of natural gas decreased 19%. Thus, in absolute values, total emissions decreased. With the increase in industrial production, emissions levels have begun to rise with transport responsible for 16-18% of emissions (40% of transport emissions are from automobiles).

The future carbon intensity of energy consumption (ratio of CO2 emissions to the total domestic energy resources consumption) will depend upon the evolution of the fuel and energy balance of the country. According to the *Energy Strategy*, the share of gas in the primary energy consumption will decrease from 48 % in 2000 to 42 – 45 % by 2020. The contribution of oil is expected to be stable (22 – 23 %) with the share of coal expected to increase from 20 % to 21 – 23 %. The contribution of NPP-produced electricity is expected to increase to 5.7 - 6.0 % while the share of non-conventional renewable energy resources is anticipated to increase 1.1 - 1.6 %.

Despite a decrease in the gas share and an increase in coal, the carbon intensity of energy consumption should remain approximately constant as the share of non-carbon energy resources (nuclear energy and non-conventional renewable energy) is anticipate to increase.[18]

Table 7: Emissions of CO2 in Russia, estimated using Base approach, Mt CO2.

Year	Liquid fuels	Solid fuels	Gaseous fuels	Total
1990	779717.74	728550.79	855879.27	2364147.80
2000	369023.60	468676.24	697125.70	1534825.53
2001	381757.36	468733.62	743844.63	1594335.60

[17] Gritsevich, I. & Kolesov, A., (2004). "National inventory of GHG emissions from energy processes in Russia", On the way to sustainable development of Russia, Bulletin, issue 27.

[18] Inter-Agency Commission of the Russian Federation on Climate Change. (2002). Third National Communication of the Russian Federation. Moscow, 2002

Table 8: GHG emissions cause by power sector, Mt per year[19]

Year	Categories of emitters	CO2	CH4	N2O	NOx	CO	NMHC*
1990	Emissions, total	2316105	11779	18	7710	16818	2847
	(A) Burning of fuels	2297042	356	18	7710	16818	2847
	(1) Power generation and fuel industry	1249856	25	10	3438	398	89
	(2) Industry and construction activity	379034	25	3	919	306	42
	(3) Transport	358834	32	2	2313	11532	2160
	(4) Housing and communal services	68203	66	1	87	1460	166
	(5) Households	84544	177	1	86	1455	154
	(6) Agriculture	56115	19	1	772	819	148
	(7) Other	100456	12	1	95	846	87
	(B) Emissions due to losses	19063	11423	0.03	0	0	0
	(1) Solid fuels	0	2532	0	0	0	0
	(2) Oil and natural gas	19063	8891	0.03	0	0	0
2000	Emissions, total	1522009	10563	11	4795	10543	1829
	(A) Burning of fuels	1508053	240	11	4795	10543	1829
	(1) Power generation and fuel industry	888332	16	6	2422	303	66
	(2) Industry and construction activity	198347	14	2	487	171	24
	(3) Transport	267446	23	1	1710	8085	1521
	(4) Housing and communal services	46876	18	1	53	588	63
	(5) Households	70919	138	1	75	1044	108
	(6) Agriculture	16236	28	0	29	341	44
	(7) Other	19896	2	0	18	11	2
	(B) Emissions due to losses	0	10323	0.02	0	0	0
	(1) Solid fuels	0	1663	0	0	0	0
	(2) Oil and natural gas	13956	8660	0.02	0	0	0
2001	Emissions, total	1534600	10176	11	4902	9942	1704
	(A) Burning of fuels	1520162	196	11	4902	9942	1704
	(1) Power generation and fuel industry	869682	16	6	2367	292	64
	(2) Industry and construction activity	204797	15	2	514	197	25
	(3) Transport	248894	21	1	1667	7247	1364
	(4) Housing and communal services	84985	21	1	91	927	97
	(5) Households	74686	100	1	85	779	83
	(6) Agriculture	15037	9	0	158	258	41
	(7) Other	22080	14	0	20	242	29
	(B) Emissions due to losses	0	9980	0.03	0	0	0
	(1) Solid fuels	0	1776	0	0	0	0
	(2) Oil and natural gas	14438	8204	0.03	0	0	0

*Non-methane hydrocarbons

[19] Losev, K.(2004), "Meaning of Kyoto protocol for Russia", On the way to sustainable development of Russia, Bulletin, vol. 27, VINITI RAS, MSU

Indicator 2: Most Significant Energy-Related Local Pollutants

Due to the high level of CO2 emissions from fossil fuels consumption an emissions reduction strategy should focus primarily on reducing CO2 emissions in the power sector.

As the *Energy Strategy* envisages an increase in the share of the coal-fired power plants in its energy balance SO2 was choosen as the most significant energy-related pollutant.

According to Statistic Yearbook (2005) emissions of SO2 are about 30% of total harmful emissions and were (total / per capita):

- in 1990: 10.23 million tons / 69.6 kg/capita
- in 2003: 5 million tons / 34.5 kg/capita

Vector values:
I = (X-0.1W)/0.9W = (X – 6.69) / 62.64
I21990 = 1
I22004 = 0.44

The reduction in SO2 emissions was caused by the same reasons as outlined in Indicator 1, namely the decrease in industrial production during the 1990s. The total number of coal fired plants was dramatically decreased when power generation shifted to natural gas. This shift was facilitated by the poor state of coal fired power plants (about 60-65% deterioration) and the closing of numerous coal mines.

Social Sustainability

Indicator 3: Households with Access to Electricity

An important feature of energy system of Russia is its high degree of centralization. There are a number of big coal, oil and gas fields, which provide almost all the fossil fuel in the country. Almost all cities and all but small settlements are connected to central grids and gas pipelines; approximately 87% of population received its electricity from these central grids. About 90% of electricity is generated via very large (gigawatt range) power stations that use fossil fuels as well as nuclear and hydro energy. The heat supply system is also very centralized. In big cities, heat and hot water supply is provided by heat-power stations. In smaller cities there are district heating systems, which use natural gas, liquid gas (propane), coal or wood.

The European part of Russia is supplied via the central grid. Densely populated regions in the Asian part of Russia are either covered by the central grid, or have local energy grids. Power supply of these regions is implemented by local power stations or diesel generators.

However, big parts of Russia's territory are not linked to central heat and power supply grids. Approximately 10 million people live in these regions. Power supply is provided by diesel generators and fossil fuel boilers. As grid extension is not feasible for a number of very small settlements it is very likely that they don't have access to electricity. However there is no data to corroborate this. Estimates can be made using statistical data on settlements population in Russia. For estimation purposes it was assumed that settlements with population less than 50 people are not electrified. Data from 1989 and 2002 population census were used.

People living in a settlement	**Persons live in settlements, in thousands**		**Number of settlements**		**Share from the total population, %**	
	1989	2002	1989	2002	1989	2002
0-50	1305	1118	72214	85162	0.88	0.77
51-100	1312	1085	18094	14901	1.78	1.517

Vector values
I31990 = 1 – 0.9922 = 0.0078
I32004 = 1 – 0.9933 = 0.0067

Indicator 4: Investments in Clean Energy

The wider use of clean energy technologies and energy efficiency are outlined in the *Energy Strategy*. However due to the financial crisis in 1990s, clean energy was under-financed. In the early 1990s, there were several small research programs funded by Ministry of Science, and some under the Federal Program "Energy efficient economy", funded by Ministry of Fuel and Energy. Moreover as the Federal Program required 30-80% share of private or local investments in clean energy project, investment in clean energy technologies were almost non-existent during the 1990s. Investments have increased only minimally since.

Although there were several big projects on renewable energy (construction of geothermal plants in Kamchatka, commissioning of several wind farms and small and micro hydro power stations), the share of these investments compared to total investments in the energy sector are negligible.

There is no official data on renewable energy investments. Most investments were made in large hydro power stations. However, as SEW only considers hydro stations of 10 MW or less as clean and sustainable these investments are not counted.

Investments into renewable energy can be estimated using the data about power capacities introduced during a specific range of years. Below are very rough estimations.

For example, in 2000-2005 years the following stations were commissioned:

- Mutnovskaya and Verkhnemutnovskaya geothermal stations with capacity 50 MWe, investments about 150-200 million USD.
- Wind farm in Kaliningrad region with capacity 5.1 MW, investments about 30 million USD
- Wind farm in Chukotka, 250 kW, investments about 300-500,000 USD
- Several small hydro power stations in Siberia and North Caucasus, total capacity about 80-100 MW, investment was about 160-200 million USD
- Biomass power stations and others contribute another 10-15% from the above mentioned investments.

The investment total over 5 years is approximately 400-600 million USD, which averages out to 80-120 million USD per year.

Table 9 indicates official data for investments into energy sector from Static Yearbook (2005). The numbers are calculated using PPP for 1998.

Vector values
I41990 = (0.0084- 0.95)/(– 0.9499) ≈ 1
I42003 = (0.0065- 0.95)/(– 0.9499) ≈ 1

High export prices for oil and gas allow the government to keep domestic pries for energy low. Low domestic prices for gas and electricity depress the demand for energy efficiency.

Table 9: Capital investments in Russia's Fuel and Energy Sector in 1990 & 2003 (absolute/PPP 1998)

Investments in energy sector	1990		2003	
	billion RUB	million USD	billion RUB	million USD
Total	34.9	1163/1906	455.677/124.16	14920/4139
Electricity sector	6	200	92.682/25.25	3089/841
Fossil fuels sector	28.9	963	362.995/99	11831/3297
Renewable energy (expert estimation)		10**/16		100**/27

*source: Russian statistic yearbook, (2005)
** rough numbers

However, despite a lack of financing for energy efficiency and negligible financing of renewables, implementation of the Federal Program *Energy Efficient Economy* did improve the parameters of fuel and energy use efficiency; fuel consumption for electric and thermal power generation decreased by 1.8 and 0.7 g/kWh respectively. Energy consumption for internal needs was reduced by 520 GWh (or by 2.8%). Total fuel and energy conservation in 1999 increased to 3.8 Mtce (including 1.2 million tce from the energy saving program). This amounts to 0.02 % of the total fuel consumption, compared with 1998 levels. In comparison with 1998,

the CO2 emission reduction was 15 Mt CO2/yr (including 2.5 Mt CO2/yr obtained within the framework of energy saving program).

In 2000, fuel consumption increased by 4.7 Mtce due to intensified thermal and electric energy production. Reduction of the CH4 emission in the coal mining sector was achieved by shifting from underground to open mining. In 1990, the share of the open coal mining was 55.5 % and was at 64.7 % by 1999. It is anticipated to reach 75% in the near future.[20]

Economic Sustainability

Indicator 5: Energy Resilience

Russia is net exporter of energy. Total foreign trade turnover in 1990 was 152 billion USD. In 1992 it was 71.1 billion USD and in 2003 it was 211.5 billion USD. There are no official data concerning on energy exports for 1990 (one of reason may be that in 1990 there was no Russian Federation, but Russian Soviet Socialistic Republic within USSR). 1992 data was therefore used. Exports of energy sources and energy in 1992 and 2003 were correspondingly 21254.2 and 75333.9 million USD.

Table 10: Energy Exports and Imports

	1992, million USD		**2003, million USD**	
	export	**Import**	**Export**	**Import**
Total	40000	35000	136000	75500
Energy resources, including	21254.2	452.7	75333.9	1161.9
Charcoal	747	0	1731	220
Coke and semi-coke	10.3	160	245	0.2
Lignite	88.9	0.1	1.9	1
Crude oil	8545	-	38816	488
Oil products	4171	267	14064	187
Natural gas	7583	20.1	19981	177
Electricity	109	5.5	495	88.7

*source: Russian statistic yearbook, 2005

To remove hydro energy as renewable energy from the electricity exported the share of hydro electricity was calculated. This share was then subtracted from the total electricity exported. Since the most energy exports were fossil fuels, there is very little change in the indicator value (for example for 2003 the indicator value changed from 0.554 to 0.553).

Share of hydro electricity was about 17% both in 1992 and in 2003.

[20] Inter-Agency Commission of the Russian Federation on Climate Change. (2002). Third National Communication of the Russian Federation. Moscow, 2002

Vector values:
I51992 = (21254,2-0,17*109)/40000 = 0,531
I52004 = (75333,9-0,17*495)/136000 = 0,553

In the past decade (1995-2005) Russia received about 50% of its budget income from the exportation of energy sources (oil and gas, mainly). The rise in oil and gas prices on the world market have increased revenues.

Indicator 6: Burden of Energy Investments

The need for investments in the energy sector is estimated at level of 550-700 billion USD for the period 2001-2020.[21]

Data for investments were taken from Russian Statistics Yearbook. (2005).

X = ratio between investments in non-renewable energy and GDP
I = 10X
X1990 = 34.9 billion rubs /1000 billion RUB =0.0349
X2003 = 455.677 billion rubs /13285 billion RUB = 0.034

Vector values:
I61990 = 0.349
I62003 = 0.34

Forecasted increase of internal and external energy consumption will require an increase in power generation in Russia. Required investments as outlined the *Energy Strategy* document (2003) are as follows:

- in the gas branch – from 170 to 200 billion USD (including 35 billion USD for the development of gas resources in East Siberia and Far East, and up to 70 billion USD for developing of the fields in Yamal peninsula). These investments will come from Gazprom and independent gas producers;
- in the oil branch – about 230-240 billion USD (investment by oil companies and private investors);
- in the electricity generation branch – 120-170 billion USD, including 100-140 billion USD for construction and modernization of generating capacities, from which 25-35 billion USD will go to nuclear power and 20-30 billion USD to development of the grid. The investment will come from electricity companies, private investments, and for nuclear and hydro power stations the required money will be included into the electricity tariff;
- in the coal branch – about 20 billion USD (private investments, coal industry investments, budget funds);
- in the heat supply sector – about 70 billion USD (money will come from local and municipal budgets, from private investors and from heat consumers); and,

[21] Energy Strategy of Russia (2003)

- in energy efficiency – 50-70 billion USD (regional energy efficiency funds, local budgets, private investments, increased tariffs for heat and electricity).

Total energy investments could be as high as 260-300 billion USD over the next decade (2001–2010) with 400-510 billion USD investment anticipated for the following next decade (2010-2020). It is estimated that the share of energy industry investments will be 33-35% of total investments in Russia from 2001-2005, 31-33% of total share in 2005-2010 and will decrease to 20-24% of total share by 2020.

Technological Sustainability

Indicator 7: Energy Productivity

According to the Statistic Yearbook (2005), total energy consumption in 2002 was 1647.5 million tons of coal equivalent. This corresponds to $1647.5X10^6$ X $29.3X10^9$J = $48271X10^{15}$ J.[22] This number, however double counts fossil fuels burnt for generation of heat and power in power stations.

According to Energy Strategy of Russia, in 1990 the energy consumption was 1286 tce and in 2002 – 945 tce

GDP in 2002 was $3372X10^9$ RUB, in 1990 – $4598X10^9$ RUB in 1998 prices. If PPP is used, the numbers are as follows: for 1990 – 1464 billion USD, for 2002 – 1229 billion USD.

Indicators if energy strategy data are used
X1990 = $37680X10^9$ MJ/ $1464X10^9$ USD = 25.74 MJ/USD
X2002 = $27688X10^9$ MJ/ $1229X10^9$ USD = 22.53 MJ/USD

Vector values:
I71990 = (25.74-1.06)/9.58 = 2.576
I72002 = (22.53-1.06)/9.58 = 2.241

If data from Russian statistical yearbook are used:
X2002 = $48271X10^9$ MJ/ $1229X10^9$ USD = 39.27 MJ/USD
I72002 = (39.27-1.06)/9.58 = 3.99

IEA data indicate that the energy productivity for Russia in the mid-90s was above 40 MJ/USD of GNP.

Reasons for high energy density are:
- bigger share of heavy industry and extraction industry in the country's industry structure;
- low domestic energy prices;
- severe climatic conditions over a large part of the Russia; and,

[22] 1 ton of coal equivalent is equal to 29,3 GJ.

- a huge territory meaning long transportation distances.

The *Energy Strategy* indicates that energy density per GDP in Russia is 3-3.5 times higher compared to industrialised countries. Other resources[23] estimate 30-40% in excess of this parameter when comparing Russia to industrialised countries. The IEA recommends comparing the energy density Russia to Canada, which shares some of the same parameters. Direct comparison gives ratio 2.3:1. However, most of Canada's industry is located lower than 55 degree northern latitude and average transportation distance is 500-600 km. In Russia most of the industry is located higher than 55 degree northern latitude and average transportation distances are 1000-1500 km (oil and gas pipelines transport fuels to 2000-2500 km from West Siberia to European part of Russia, and coal is transported to distance up to 4000 km). This results in approximately 30% greater energy density of GDP than in Canada. The remaining difference is potential for energy savings.

Potential of energy efficiency is estimated as at least 20% of total energy consumption.[24] Energy saving requires 2-3 times less investments than generation and distribution of the equivalent amount of energy.

At the same time, the value of energy consumption per capita in Russia is lower than in most industrialised countries (5.7 tce/cap in 1996[25] or 4.46 tce/capita in 2003[26]).

There is also a misbalance in prices compared to industrialised countries. In the 1990s, the price of natural gas was almost half the price than that in the EU and USA, but coal, oil and oil-products were more expensive.[27]

Indicator 8: Renewable Energy Deployment

Russia not only has extensive resources of fossil fuels, but also huge renewable energy resources (geothermal, solar, wind, ocean energy and biomass energy). Technical potential of renewable energy sources (RES) is about 4.6 billion tce.; approximately five times more than the current total energy consumption. The economical potential is 270 million tce., which is 25% of annual internal consumption of energy in Russia (see Table 11).

The share of RES (excluding large hydro) in electricity generation world-wide is about 10%, but in Russia its share is less than 1%.

[23] Volkonski, V., Kuzovkin, A. (2000). "How much cost fuel and energy?". Available at http://esco-ecosys.narod.ru/2003_6/art.19.htm (Accessed: 2006, January 15)
[24] Volkonski, V., Kuzovkin, A. (2000). "How much should cost oil, gas and coal?". Nezavisimaya Gazeta, issue from 21.11.2000
[25] Volkonski, V., Kuzovkin, A. (2001). "Interstate comparisons of energy density of GDP and energy carrier prices". Problems of prognosis. #5, 2001
[26] Country indicators, (2003), Available at http://www.iea.org/noncountryresults.asp?nonoesd=Russia (Accessed: 2006, January 30)
[27] Brodov, A., Sorokina, M.(2001), "Destructive increase", Metals of EurAsia, v.5, 2001

Table 11: RES Resources in Russia (Mtce per year)

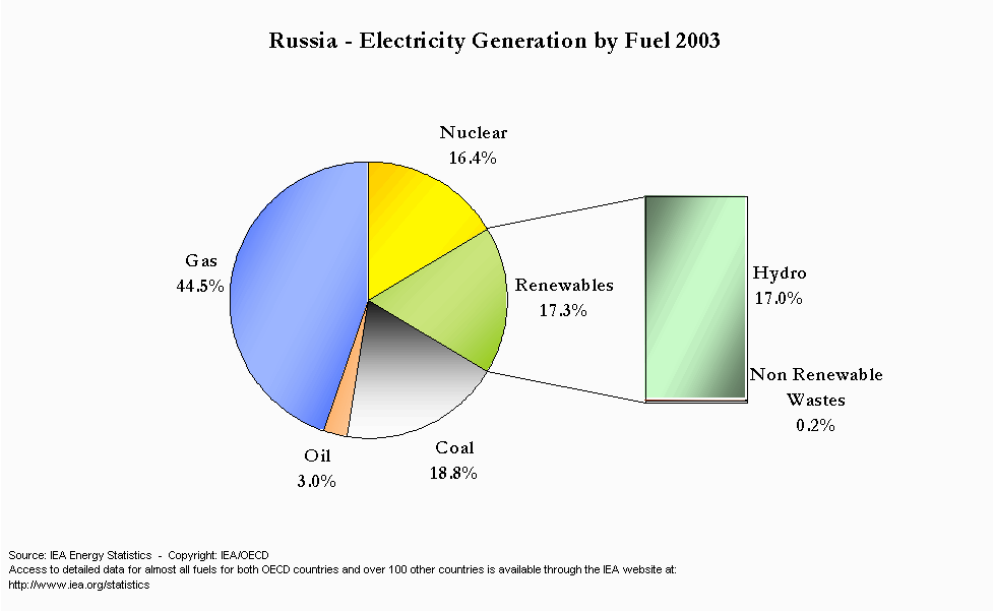
Resources	Gross Potential	Technical Potential	Economic Potential
Hydro, billion kWh	-	-	852
Small Hydro	360	125	65
Geothermal Energy	-	-	115
Biomass Energy	10x10³	53	35
Wind Energy	26x10³	2000	10
Solar Energy	2.3x106	2300	12.5
Low Potential Heat	525	105	31.5
Total RES (excluding large hydro)	2.3x106	4583	270

It should be noted that the above evaluation of RES potential was done at the beginning of the 1990s. Presently, given the lower cost of RES units and higher prices for fossil fuels, the RES economic potential may be much higher.

According to approximate estimates, geothermal resources (hot water and steam) in the upper stratum of the earth (3 km or less) amount to about 180 trillion tce., 20 trillion of which are suitable for energy use.[28]

Despite huge RES potential its use is insignificant. The RES share in the national energy balance in 2001 amounted to 3.5%. Figures on RES power generation (excluding large hydro) and its capacities (including forecasts up to 2010) are reflected in Tables 12 and 13.[29]

Figure 5: Electricity Generation by Fuel, 2003

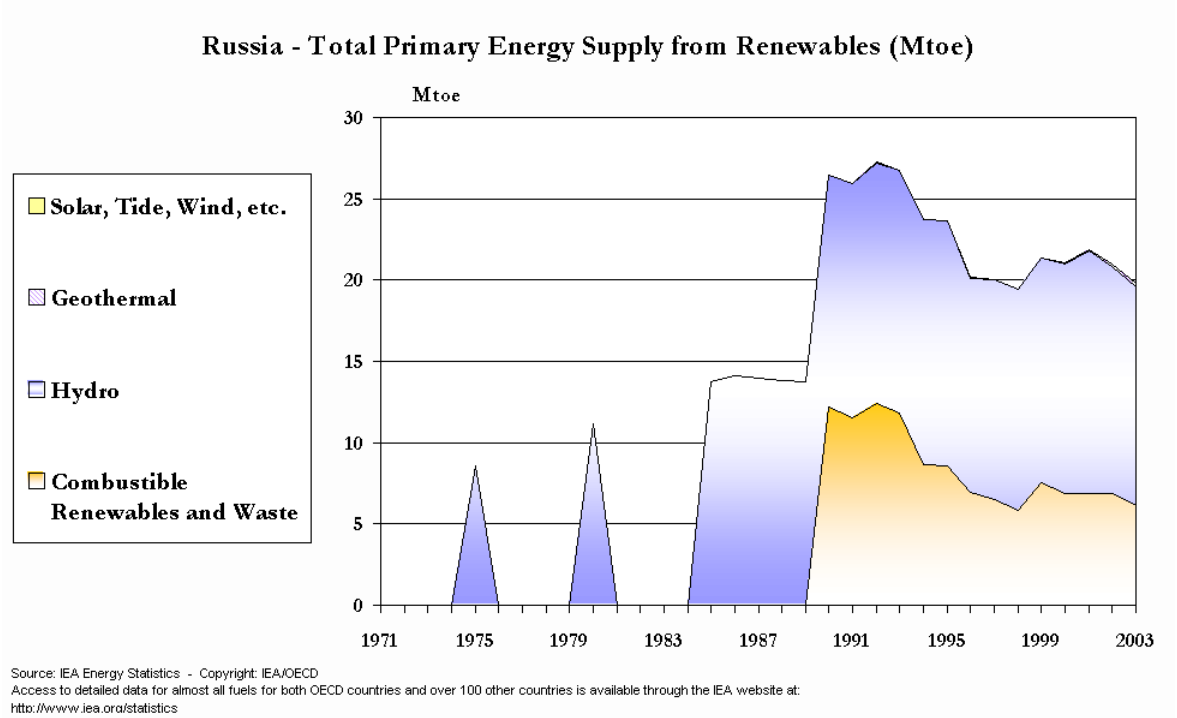


Source: International Energy Agency

[28] Povarov, O.(2003), "Heat of Earth - Efficient Energy Supply of Remote Regions and Housing in Russia" , Bulletin "Renewable Energy". Issue December, 2003

[29] Bezrukikh, P. and others (2002). Resources and Efficiency of using RES in Russia. Nauka, Saint Petersburg

Figure 6: Total primary Energy Supply from Renewables.



Source: International Energy Agency

Taking into account the current situation in the RES sector no significant increase in RES use can be expected without specific programmes for its development. Development of renewable energy is declared in the *Energy Strategy* (2003) however, despite the introduction of up to 1000 MW of electrical and 1200 MW of heat generating renewable energy capacities, RES share in energy balance will not exceed 2-3%. This level is not sufficient for achieving sustainability goals.

The experience of countries where renewables are rapidly developing shows that in order for renewable energy to have a notable increase in the energy balance, supporting legislation has to be in place. The need for legislation is especially strong for Russia where prices for fossil fuels are significantly lower than the world average ones.

In Russia there were several attempts to introduce such legislation. In 1999 the Renewable Energy Law was approved by State Duma (Parliament) however President Eltsyn vetoed it. Currently, a new Renewable Energy Law is being elaborated by RAO UES (state owned electricity generation and distribution monopoly).[30] It is expected that the new RE law will be discussed in 2006 at the State Duma sessions.

[30] Sinyugin, V., Kopylov, E. (2005). "Elaboration of renewable energy law for Russia: second attempt". Renewable Energy Bulletin. Intersolarcenter, issue October, 2005.

The RES share in total power generation amounts to about 0.6% including small hydro whereas RES heat production totals 4%31 (see Tables 12 and 13).

The development of renewable energy sources would help to:

- reduce consumption of fossil fuels;
- reduce environmental impact from energy sector;
- ensure energy supply for remote regions; and,
- decrease expenses for fuel delivery to remote regions (in Russia's Northern territories and similar regions about 7 million tons of oil products and more than 23 million tons of coal are delivered annually to these regions).

Except for large wind turbine, Russia has well developed technologies for renewable energy. It produces very good PV technologies and the existing geothermal plants use state of the art technologies.

Table 12: Renewable Electricity Production in Russia, Excluding Large Hydro, million kWh

Type	2000	2001	2002	2003
Wind turbines	2.917	4.12	6.65	12.3
Geothermal stations	58.199	91.196	149.051	308.16
Small hydro	2301.171	2371.163	2412.989	2500
Biomass electric stations	1895.304	2226.895	2426.54	2600
Total:	4256.588	4693.374	4995.23	5420.48
Total electricity production in Russia	876*103	888.4*103	892*103	914.5*103
RES share, %	0.5	0.53	0.56	0.6

Table 13: Production of Heat Energy from Renewables (thousand Gcal)

Type	2000	2001	2002	2003
Biomass electric stations	8900	9720	10668	11500
Small biomass boilers	45000	46000	46500	47600
Solar thermal	30	31	32	33
Heat pumps	380	390	400	410
Municipal wastes burning plants	300	300	300	300
Biogas installations and land-fills	2000	2000	2000	2000
Geothermal heat	1000	1000	1000	1100
Total	57610	69441	60900	62943
Total heat produced in Russia, without municipal heating	1420*103	1440*103	1426.9*103	1445.3*103
RES share, %	4.1	4.1	4.3	4.35

[31] Besrukikh, P., Strebkov, D. (2005), Renewable Energy: strategy, resources, technologies: VIESH, Moscow.

The data used in calculations are presented in Table 14.

Table 14: Calculation of the Indicator for Renewable Energy Deployment

Year	**1990**	**2003**
Electricity produced on hydro power stations	167 billion kWh	158 billion kWh
Total renewable electricity production	171 billion kWh or 615.6PJ	163.4 billion kWh or 588.24 PJ
Total renewable heat produced	55 TCal or 0.23 PJ	62.94 TCal 0.264 PJ
Total renewable energy, including large hydro	615.83 PJ	588.54 PJ
Total renewable energy, excluding large hydro	4 billion kWh, or 14,4 PJ	5.42 billion kWh, or 19.5 PJ
Total primary energy consumed	37680 PJ	27688 PJ
X=ratio of RE energy to total primary energy, large hydro included	0.0163	0.0213
X=ratio of RE energy to total primary energy, large hydro excluded	0.00038	0.0007

Indicator for RE deployment (large hydro excluded):
I = (X-0.95) / -0.8636

Vector values:
I81990 = 1.1
I82003 = 1.1

SEW Star for Russian Federation

Table 15a: Indicator Scale 1- 5

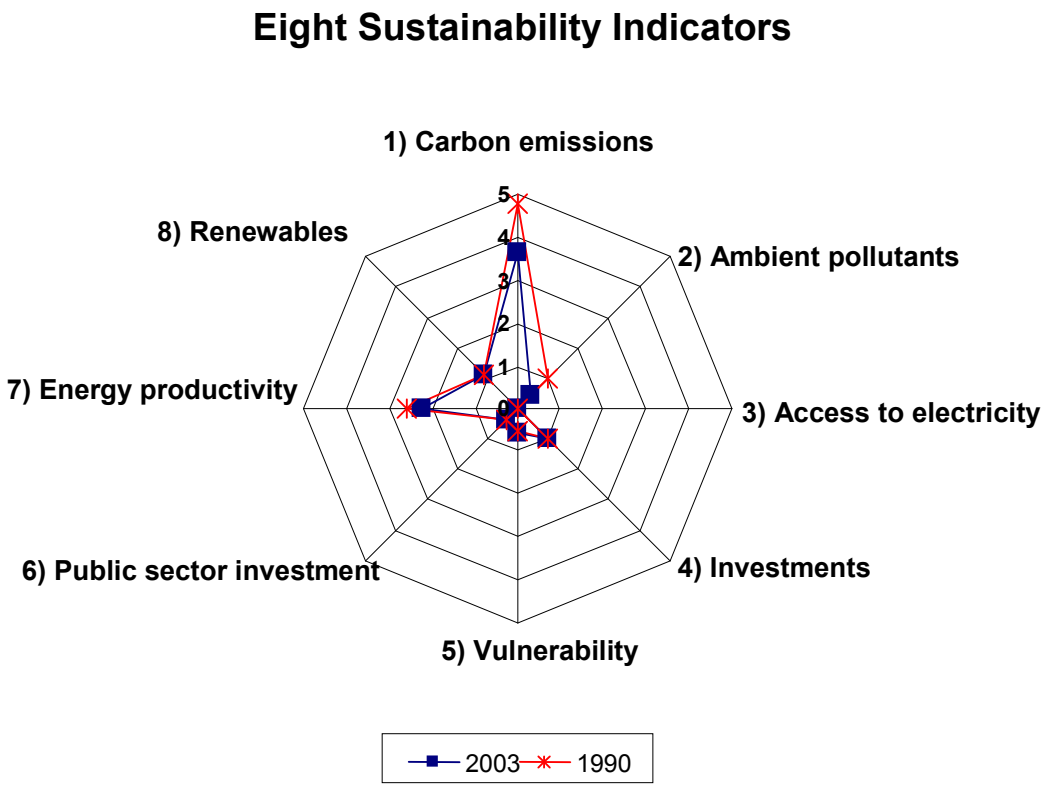
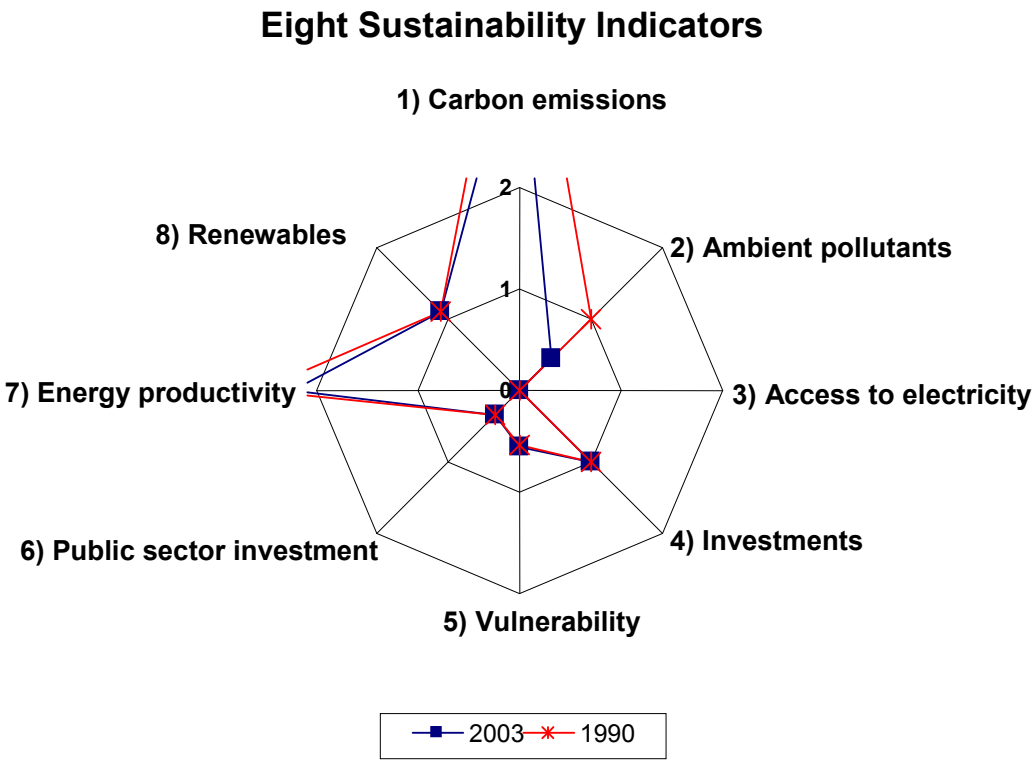


Table 15b: Indicator Scale 1- 2



Conclusions and Policy Recommendations

Looking at the Russia's stars for base and current year, one can see the decrease of the star's area. It is caused by reduction of carbon and energy related pollutants. Other indicators remained almost the same. However, the decrease in GHG and polluting gases emissions is not caused by the country meeting sustainability goals, but by a general decrease in energy production in Russia after 1990. Russia has only started to revive after a deep economic crisis which it inherited from the Soviet Union. Russia is still far from reaching the sustainability goals set by SEW on carbon emissions, ambient pollutant emissions, energy productivity, investments in clean energy and renewable energy deployment.

Russia is closest to the sustainability target with regards to access to electricity and public investments into energy sector. Access to electricity is due to the achievements of Soviet Union. Public investments in the energy sector are high for two key reasons. First the energy sector and fossil fuels extraction and export are core economy sectors ensuring survival of the country. Second, except for the oil and coal industries, the rest of energy sector is owned by the state (gas extraction, transportation and distribution, electricity generation and distribution, nuclear energy).

Russia performs poorly on the indicators for carbon emissions per capita, energy intensity, deployment of clean and renewable energy technologies and investments into clean energy technologies. The increase in GDP and energy production after 2000 led to the respective increase of GHC emissions and pollution. The negative impact on the environment is increasing. All these factors present a big problem for achieving sustainability.

Although there are several policy documents in place already – Energy Strategy, Ecological Doctrine, Concept of Sustainable development, Concept of National Security, Kyoto Protocol commitments etc. – their influence on stimulating and sustaining a movement towards a cleaner and more sustainable economy is not sufficient.

Cheap fossil fuels and electricity are, on one hand, good for economy. On the other hand, low prices are depressing the development of new sustainable technologies in renewable energy and energy efficiency. There is a lack of understanding at highest political levels that achieving sustainable development is more than increasing the extraction and exports of fossil fuels. Not enough attention and support is paid to the implementation of renewable energy and energy efficiency at the state level. Instead, the existing *Energy Strategy* sets targets to increase the use of nuclear energy. Public awareness about the possibilities and prospect of new clean technologies is also low. Although, opposition to nuclear energy deployment exists, renewable energy is not considered as a real alternative to fossil fuels and nuclear energy. Moreover, the possibilities for increasing employment through the implementation of new clean energy technologies are not known by the public.

Developments in the EU, which is highly dependent on energy imports, shows that share of renewable energy can be significantly increased within a short period of time. Energy efficiency has even greater potential in Russia because its economy is currently so energy intensive.

In conclusion, as Russia has started to emerge from its economicl crisis of the 1990s, there is an increasing understanding that the country should move to cleaner and less polluting power generation and that issues of environment protection are very important for the sustainable development of the country. However, legacies from the Soviet era coupled with lobbying by the oil, coal and nuclear industries restrains country's ability to develop clean energy. This poses major challenges to government, civil society and the energy industry.

Hopefully Russia will shift to the use of clean energy technologies before its fossil fuels reserves are depleted. Although the generation of electricity from nuclear energy is backed by the military and is an important part of the country's energy mix, it is not a long-term solution to meeting the increasing demands in energy.

Policy makers in Russia have to understand the importance of renewable energy and to act now in setting the conditions for the development of new clean technologies - both in R&D and its application.

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