7. THE RUSSIAN FEDERATION

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7.1. Introduction

This research project, entitled "Initial analysis of different indicators for sustainable energy development on the basis of analysis of existing economic, energy and environmental trends in Russia," began in 2002 and was conducted by a research team representing the Centre for Energy Policy and the Ministry of Industry and Energy of the Russian Federation (RF). Its principal objectives were to evaluate the current status and prospects for energy policy in the Russian Federation, to identify its major priorities, and to examine their correlation with the main principles and indicators for sustainable energy development. This project was implemented under the patronage of the International Atomic Energy Agency (IAEA) within the Agency's work programme on Sustainable Energy Development.

The following components are included in the final version of the study:

Overview of the energy sector

The main trends and indicators of the current state (1992-2001) and prospects (up to 2020) for development of the energy resource base, primary energy and electricity production, international trade and consumption by fuels and branches of economy are analyzed. A brief analysis of energy from the standpoint of the three dimensions of sustainability (i.e., social, environmental, and economic) as well as the institutional dimension is performed.

The situation in the domestic energy sector is also analyzed with respect to accessibility, security, efficiency, and the environment, as well as institutional and infrastructure problems associated with its functioning.

Review of the energy statistical data capability

The main problems the research team faced during the project implementation are described and discussed. The problem of statistical data collection for sufficient time series, as well as ensuring needed quality and comparability of collected data, are emphasized. It is emphasized in this section that statistical data on ISED were collected from a variety of sources, including governmental decrees, information published by the State Committee for Statistics, Ministry of Economy, Ministry of Industry and Energy, etc.

Identification of major energy priority area

On the basis of detailed analysis of the main governmental decrees on energy policy problems, as well as Energy Strategy of Russia to 2020[1] (hereafter "Strategy"), the major priorities of the national energy policy are identified, and explanations for these priorities are outlined.

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[1] Energy Strategy of Russia to 2020 (Strategy) was prepared by the Ministry of Energy of the Russian Federation in cooperation with a number of leading scientific and research institutions and approved by Government in 2003.

Implementation of ISED framework

The indicators of the ISED package related to selected energy policy priorities (including state indicators, and direct and indirect driving forces) are identified. The ISED database constructed with collected statistical data and classifications based upon the dimensions of sustainability to be analysed, is discussed.

Assessment of current energy policies in priority areas

A critical overview of the current status and prospects for energy policy priorities is outlined. A critical analysis of the effects and effectiveness of the country's energy policy in selected areas is discussed.

Strategy for improvements in priority areas

The principal strategies and measures aimed at making improvements in priority areas of the country's energy policy over the long-term are given.

Conclusions and recommendations

The main results of implemented research are listed. A brief evaluation of the current state and prospects of energy policy in priority areas from the standpoint of sustainability is given. Recommendations on improving energy policy are elaborated.

7.2. Overview of the Energy Sector

7.2.1. Current state and prospects of economic development

The period of economic reforms in the Russian Federation can be divided into a phase of depression and a period of recovery. In 1992-1996, the total amount of GDP, calculated in billion US$ at 1995 prices and PPPs had declined by 26% (Table 7.1). By comparison with the 1992 level, the indicator of GDP per capita had fallen almost US$ 1900 per person.

Continuation of such negative economic trends was finally halted in 1997, when some economic growth took place (1% in comparison with 1996). However, the economic crisis of 1998 resulted in another GDP decline of 5.4%.

The country's economic performance since August 1998 has been impressive. In 1998-2001, GDP grew by 20.6% (GDP growth peaked at 9% in 2000). Inflation has been tamed, with consumer prices rising by less than 13% in 2003, compared to 84% in 1998. Unemployment has fallen steadily, down to a little over 8% of the workforce by the end of 2003 (OECD, 2004). The general government budget, which ran deficits of over 3% of GDP in 2000 and 2001, moved into surplus in 2003. Capital investments finally started to pick up, growing by 12.5% in 2003.

Prudent fiscal policy, including a broadening of the tax base and a general reduction in taxes, coupled with tight controls on government spending, has fuelled consumption and helped to sustain economic growth. Political stability over the past five years has encouraged both investors and consumers.

Nevertheless, positive trends in the country's economy in recent years must be considered a consequence of surging oil production and exports, buoyed by very high oil prices. The oil and gas sectors in particular contributed more than half of the increase in GDP growth in the past few years.

The year 1999 was a landmark, demonstrating (at least according to official statistics) real economic growth (5.4%), and the dynamism of the domestic economy's development has given political leaders grounds for optimism. Economic growth continued in 2000-2001 (Table 7.1), as well as in 2002 and 2003.

Economic problems in the first years of the economic reforms influenced the output of the industrial and transportation sectors. Industrial output in 2000 was only equal to 60% of the level of 1990. Activity in freight transport in 1992-2000 declined by 28% (Table 7.2), and distance travelled per capita by passenger transport by 27% (Table 7.3). According to preliminary evaluations, both the industrial and transportation sectors demonstrated growing activity in 2001-2003, which reflected positive trends in the domestic economy.

The Russian Federation has made considerable progress in its transition to a market economy, but many legacies of the old centrally planned system are still evident and many serious problems remain. A number of institutional, regulatory and legal reforms still need to be implemented. The restructuring of key sectors of the economy, including energy, has yet to be completed. There are various projections for future economic growth.

President Putin set an ambitious goal in his State-of-the-Nation Address in May 2003. He noted: "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."

According to the Strategy document noted earlier, the two main scenarios for economic development are considered moderate and optimistic.

A broad range of conditions including the main forecasting trends for the world's economy, needed payments in accordance with the external debt of the country, continuation of economic reforms, expected inflation rates, as well as the transformation of GDP structure were taken into account in the above scenarios.

In the optimistic scenario, higher intensity and effectiveness of economic, fiscal and price reforms are planned. According to this scenario, the level of GDP in 2020 will increase by a factor of 3.3 in comparison with 2000. This scenario assumes a high (world) price level for oil (USD30 per barrel) and natural gas (USD138 per 1,000 m^3) in 2020.

In its moderate scenario, the Strategy assumes a GDP growth rate of 5% to 6% per year to 2020. The total amount of GDP produced in 2020 will increase by a factor of 2.3 in comparison with the level in 2000. Oil prices within the forecasting period were assumed to be constant (at USD18.5 per barrel). Natural gas in this scenario would cost USD119 per 1,000 m^3.

The dynamics of the main macroeconomic indicators in the optimistic and moderate scenarios are given in Table 7.4. It follows from the figures given in Table 7.4 that a relatively high rate of economic, industrial and investment growth are expected during the next two decades, under either scenario. If the country is to meet these ambitious goals over the forecasting period, the Russian fuel and energy complex (FEC) will face the challenge of meeting rapidly growing domestic energy demand.

7.2.2. Current state and prospects of the Fuel and Energy Complex

7.2.2.1. Energy resource base

The Russian Federation has one of the largest, most highly developed and widely diversified energy systems in the world. Holding abundant, large proven recoverable reserves of fossil fuels, as well as technically-exploitable hydro potential, the country cannot only fully satisfy its internal energy needs, but also can act as one of the major energy suppliers in the world market.

During the 1990s, the size of the energy resource base remained relatively stable (WEC, 1998, 2001). Table 7.5 provides data on the available volume of proven recoverable reserves of fossil fuels and uranium, as well as the fraction of technically exploitable capabilities for hydropower not currently in use. Table 7.6 presents the energy potential of renewable energy sources.

TABLE 7.1 MAIN MACROECONOMIC AND ENERGY INDICATORS IN RUSSIA IN 1992-2001

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
GDP (billion US$ at 1995 prices and ex. rates)	441.203	402.957	352.307	337.709	326.227	329.163	313.034	329.938	359.632	377.613
GDP (billion US$ at 1995 prices and PPPs)	1,089.617	995.163	870.074	834.022	805.665	812.916	773.083	814.829	888.164	932.573
Population (millions)	148.689	148.52	148.336	148.141	147.739	147.304	146.899	146.309	145.555	144.752
Share of urban population, %	73.7	73.3	73.1	73.0	73.1	73.1	73.1	73.1	73.1	73.1
GDP per capita (1,000 US$ at 1995 prices and ex. rates)	2.967	2.713	2.375	2.280	2.208	2.235	2.131	2.255	2.471	2.609
GDP per capita (1,000 US$ at 1995 prices and PPPs)	7.328	6.7000	5.866	5.630	5.453	5.519	5.263	5.569	6.102	6.443
Energy Production/TPES	1.444	1.401	1.504	1.518	1.536	1.549	1.597	1.576	1.574	1.603
TPES/GDP (toe per thousand 1995 US$ PPP)	0.711	0.75	0.749	0.753	0.765	0.732	0.752	0.74	0.691	0.666
TPES/Population (toe per capita)	5.211	5.015	4.392	4.242	4.174	4.04	3.958	4.122	4.218	4.293
Electricity consumption/GDP (kWh per 1995 US$ PPP)	0.833	0.854	0.885	0.907	0.922	0.898	0.926	0.903	0.859	0.801
Electricity Consumption/Population (kWh per capita)	6107.479	5724.091	5190.729	5109.639	5030.743	4956.104	5029.773	5235.615	5235.615	5318.98
Floor area per capita, m^2/person	16.8	17.4	17.7	18.1	18.3	18.6	18.9	19.1	19.3	19.5

Sources: OECD/IEA (2003), Ministry of Industry and Energy (MIE) of the Russian Federation (2003a)

TABLE 7.2 FREIGHT TRANSPORT ACTIVITY IN RUSSIA IN 1992-2000, BILLION TONNES -KM

Transportation mode	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total	4,697.8	4,157.6	3,566.5	3,532.6	3,370.1	3,255.5	3,147.0	3,256.1	3,367.3
Rail	1,967	1,608	1,195	1,214	1,131	1,100	1,020	1,078	1,145
Road	42	53	36	31	26	25	21	24	28
Pipeline transport	2,146	2,019	1,936	1,899	1,913	1,844	1,888	1,904	1,916
International navigation	541	476	398	387	298	284	216	248	276
Air	1.8	1.6	1.5	1.6	2.1	2.5	2.0	2.1	2.3

Source: MIE (2003b), State Committee for Statistics (SCS) of the Russian Federation (2003)

TABLE 7.3 DISTANCE TRAVELED PER CAPITA BY TRANSPORTATION MODE IN RUSSIA IN 1992-2000, KM/PERSON[1]

Transportation mode	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total transport	4,581	4,451	4,019	3,732	3,572	3,472	3,276	3,295	3,351
Rail	1,703	1,833	1,531	1,297	1,226	1,156	1,045	1,012	1,025
Air	792	560	487	484	437	417	378	403	425
International navigation	20	13	10	9	7	6	5	4	2
Bus	1,428	1,349	1,306	1,270	1,227	1,217	1,220	1,223	1,225
Road (taxi)[2]	26	13	9	7	4	3	2	2	2
Tram	175	177	175	171	171	170	174	172	173
Trolleybus	176	191	183	182	185	189	192	190	191
Metro	261	315	318	312	315	314	260	289	308
Urban transport, total	1,414	1,442	1,432	1,405	1,396	1,403	1,385	1,358	1,383
Bus	771	745	747	733	713	726	700	705	709
Urban navigation	1	1	1	0.5	.5	0.5	0.5	0.5	0.5
Road (taxi)	26	13	9	7	4	3	2	2	2
Tram	175	177	175	171	171	170	174	172	173
Trolleybus	176	191	183	182	185	189	192	190	191
Metro	261	315	318	312	315	314	260	289	308

Source: MIE (2003b), SCS (2003)
1 Ratio of travelled distance/population
2 Excluding private cars

TABLE 7.4 MAIN MACROECONOMIC INDICATOR FORECASTS[3]

Indicator	2000	2005		2010		2015		2020	
		(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
GDP	100	127	125	173	157	242	192	334	231
Industrial production	100	125	123	165	153	220	186	288	222
Investment	100	142	139	227	200	408	271	699	360
GDP per capita	100	131	128	181	165	257	207	356	255
Real income of the population	100	150	147	247	196	316	248	441	301
Expenditures on energy use per capita	100	169	169	194	192	215	206	235	233
Energy intensity of GDP	100	82	82	72	74	55	64	42	56

Source: MIE (2003b)
Values for the year 2000 = 100
(1) – optimistic scenario
(2) – moderate scenario

TABLE 7.5 CURRENT STATE OF ENERGY RESOURCE BASE

Indicator	Unit of measure	Value
Fraction of technically exploitable capability of hydropower not currently in use	%	90.7
Proven recoverable fossil fuel reserves		
Coal	Mt	157,000
Oil	Mt	6,700
Gas	Bm^3	48,000
Lifetime of proven recoverable fossil fuel[2] reserves		
Coal	Years	600
Oil	Years	36
Gas	Years	80
Proven uranium reserves	Kt	145
Lifetime of proven uranium reserves	years	56

Source: MIE (2003a), World Energy Council (WEC) (1998), WEC (2001)

TABLE 7.6 POTENTIAL OF RENEWABLE ENERGY SOURCES IN RUSSIA, MTOE/YEAR

	Gross potential	Technical potential	Economic potential
Small Hydro	252	87	46
Geothermal	N.a	N.a	80
Biomass	7,000	37	25
Wind	18,200	1,400	7
Solar	1.6×10^6	1,600	9
Low Potential Heat	367	80	25
Total	1.63×10^6	3,204	192

Source: IEA (2003b)

TABLE 7.7 GROWTH AND EXTRACTION OF PROVEN RECOVERABLE FOSSIL FUEL RESERVES

Energy carrier	1996	1997	1998	1999	2000
Oil and condensate					
annual growth of reserves, Mt	216.7	276	232	200	295
percentage of production, %	71.9	92	76.6	65	91
Natural gas					
annual growth of reserves, Bm^3	180	398.5	128	210	450
percentage of production, %	29.9	69.8	21.7	35.6	77
Coal					
annual growth of reserves, Mt	590.3	255	252	250	N.a
percentage of production, %	229	104.2	108.6	100	N.a

Source: MIE (2003a), MIE (2003b)

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[2] Ratio: proven recoverable reserves/ current overall production including exports

The Russian Federation owns 45% of the world's natural gas reserves; 13% of the oil reserves; 23% of the coal reserves; and 14% of the uranium reserves (Strategy, 2003). The lifetime of proven recoverable reserves of hydrocarbons will allow the country's energy carriers to continue to play an important role in world trade.

However, the state of the energy resource base for the past 8-10 years has exhibited significant deterioration and exhaustion. More than 50% of the estimated oil resources, and 80% of the natural gas resources, lie in remote areas (i.e., East Siberia, continental shelf of the Arctic seas, etc.). The share of difficult-to-recover oil and gas reserves is still growing, and this will make it inevitable that large-scale investment for exploration and exploitation of these new oil and gas fields will be required.

Similarly, the volume of the most economically effective proven recoverable reserves of oil and gas has substantially declined (see Table 7.7). It follows from the figures given in this Table that the annual growth of proven recoverable oil and gas reserves will only partly compensate for annual production. This negative trend continued in 2000-2002.

During this 2000-2002 period, proven recoverable oil reserves grew by 849 Mt. For the same period, oil production accounted for 1,052 Mt. Therefore the correlation between proven recoverable reserves growth and production in the oil industry for the past three years was about 80%. As far as natural gas is concerned, this percentage was about 85-87%. The most economically efficient fields have gradually been depleted, especially those large oil fields with initial recoverable reserves over 100 Mt. The share of these major oil fields in the total structure of oil production in Russia now stands at 57% (in 1990 this share was about 70%). Oil production in these oil fields has been constantly declining. There is a lack of investment for exploring and exploiting the new oil fields. This has been especially evident in the effort to open up valuable oil and gas fields in the northern European part of the Russian Federation and Western Siberia – the Timan-Pechora basin, the Barents Sea shelf, and the Yamal peninsula, where the energy resources produced will be of importance primarily for export. The Strategy estimates resources of oil at 44 Bt; natural gas at 127,000 Bcm; and geological resources of coal at 4,450 Bt (i.e., 30% of the world's resources of this category).

Depletion of the most economically effective part of the energy resource base and deterioration of its condition have not yet noticeably affected either the volume of proven reserves (and thus self-sufficiency in fossil fuels), nor energy export opportunities. However, if urgent measures are not undertaken, it will become a serious obstacle to energy and economic development. Developing the country's huge energy resources requires massive investment. According to the Strategy, US$ 40-50 billion should be invested in the energy resource base before the year 2020 in order to ensure reliable fuel supplies in the domestic market, as well as economically justified export. A set of legislative measures aimed at creating a favourable investment climate for domestic and foreign investors is to be introduced.

7.2.2.2. The role of the FEC in Russia's economy

The FEC has traditionally played an important role in the economy due to national climatic conditions (i.e., more than 60% of Russian territory is located in the permanent frost zone), as well as socio-economic and historical factors. The FEC supplies energy to all the sectors of the economy, and plays a decisive role in the main financial and economic indicators of the country. During recent years of reform, its role in accomplishing social and economic progress has increased significantly.

Currently the FEC accounts for 20.2% of GDP; 30% of industrial production (against 11.6% in 1991); 54.5% of exports; and 16.5% of the personnel involved in industrial production. The FEC enterprises supply 39% of the tax collected in the budget (Table 7.8).

Despite existing economic problems, the Russian FEC has retained the bulk of its production potential and keeps high standards in providing the economy with energy and currency resources. During the years of reform, the FEC became a unique contributor, almost at the cost of weakening itself. It facilitated, to a large extent, the functioning of market forces during the transition period. As a result of the non-payment of energy services and relatively low tariffs for energy carriers regulated by government, its joint stock societies and companies subsidized hundreds of millions of dollars every year for other sectors of the economy.

According to the optimistic scenario of the Strategy, the share of the FEC in domestic industry will decrease in 2020 to 19.8% (moderate scenario assumes 18.7%).

TABLE 7.8 THE ROLE OF THE FEC IN DOMESTIC ECONOMY IN 2001, %

Economic structure	Energy Industries				
	Oil[1]	Gas	Electricity production	Coal	FEC, total
GDP	49.4	32.7	14.3	3.6	20.2
Export	64.1	33.2	0.5	2.2	54.5
Tax, collected in the budget	58.8	30.3	9.2	1.7	38.5

Source: MIE (2003b)

[1] Share of each particular sector in the FEC

7.2.2.3. Energy production

The collapse of the Soviet Union and the ensuing economic crisis had a negative impact on the country's fuel and energy complex. By 2001, primary energy production in the Russian Federation had fallen almost 11% in comparison with the level of 1992; the output of coal had fallen about 15%; of oil, almost 13%; and of natural gas, more than 9% (Annex 7.1). For the same period, electricity production had decreased by 119 BkWh, or by 11.8% (Table 7.9).

The principal reasons for the declining output in the FEC included:

- A decline in the paying capacity of consumers;
- A reduction in the GDP;
- A decline in industrial production (i.e., industry is the largest energy consumer among the sectors of the domestic economy).

The decline in energy production mostly took place between 1992 and 1997, the lowest year of energy production during the period of economic reform. The period from 1998 through the present time can be characterized as a recovery period for the domestic FEC. The average annual growth rates of primary energy production in 1998-2001 were 2.4%, the same growth rates exhibited by electricity generation. Production of oil has rebounded strongly since 1999, in response to higher world prices and the devaluation of the ruble after the 1998 financial crisis. At the same time, however, gas production volumes have declined.

At the beginning of 2001, the production potential of the FEC comprised almost 142,000 oil wells, 6,400 gas wells, and 25 oil refineries with a total capacity of 257 million tonnes. The installed capacity of power stations amounted to 215 million kW (at the beginning of 2002), and the length of transmission lines exceeded 2.5 million km. There were 151 coal mines and 75 open-pit mines, with a total capacity of 313 million t/year (Ministry of Industry and Energy, 2003).

Fuel and energy supply in the country is provided by a system of pipelines: 47,300 km of oil pipelines, 149,000 km of gas pipelines, and about 20,000 km of petroleum product pipelines, numerous oil tank farms, fuel yards, etc.

Natural gas is a leading source of primary energy in the Russian Federation. For the period 1992-2001, the share of natural gas in primary energy production mix increased from 46.2% to 47%. At the same time, the share of other fossil fuels (oil and coal) had declined. In general, fossil fuels dominate in primary energy production, covering over 94% of its total volume.

Natural gas also dominates in the structure of electricity production (Table 7.9). However, in 1992-2001, both the physical amounts of electricity produced by gas-based power plants and the share of natural gas as a source of electricity generation had a tendency to decline.

TABLE 7.9 ELECTRICITY GENERATION IN RUSSIA IN 1992-2001

	Years	Coal	Petroleum Products	Gas	Nuclear	Hydro	Geothermal, Solar. etc.	CRW	Total
BkWh	1992	154.273	100.157	460.67	119.626	171.843	0.029	1.852	1,008.45
	1993	148.591	82.998	429.744	119.186	173.399	0.028	1.756	955.702
	1994	162.741	73.387	364.315	97.82	174.978	0.031	1.609	874.881
	1995	160.528	67.889	354.057	99.532	175.411	0.03	1.579	859.026
	1996	160.901	56.603	364.724	109.026	153.328	0.028	1.556	846.166
	1997	157.258	51.869	357.404	108.498	156.584	0.029	1.532	833.174
	1998	162.51	52.793	345.52	105.32	158.497	0.03	1.519	826.189
	1999	161.341	40.901	358.634	121.874	160.492	0.028	2.075	845.347
	2000	175.615	33.091	370.372	130.715	164.077	0.058	2.538	876.468
	2001	168.773	30.02	376.744	136.935	173.899	0.091	2.868	889.333
% of total	1992	15.3	9.93	45.68	11.86	17.04	0.01	0.18	100
	1993	15.55	8.68	44.97	12.47	18.14	0.01	0.18	100
	1994	18.6	98.39	41.64	11.18	20.0	0.01	0.18	100
	1995	18.69	7.9	41.22	11.59	20.41	0.01	0.18	100
	1996	19.02	6.69	43.1	12.88	18.12	0.01	0.18	100
	1997	18.87	6.23	42.9	13.02	18.79	0.01	0.18	100
	1998	19.67	6.39	41.82	12.75	19.18	0.01	0.18	100
	1999	19.09	4.84	42.42	14.41	18.98	0.01	0.25	100
	2000	20.0	3.78	42.26	14.91	18.72	0.04	0.29	100
	2001	18.97	3.38	42.32	15.4	19.55	0.06	0.32	100

Source: MIE (2003b)

Petroleum products had consequently decreased their share in the fuel balance of electricity generation (from almost 10% in 1992 to 3.4% in 2001). Coal, nuclear and hydropower had demonstrated an increase of the physical amount of electricity generated as well as definite growth within the electricity generation mix.

The total share of non-fossil fuels and energy resources in the electricity generation mix is much higher than in the primary energy production mix. For 2001, it was equal to 35.33%.

The technical and economic state of the FEC's enterprises is far from perfect. A high share of exhausted, old and inefficient equipment remains in place (Table 7.10). This negative situation has not been addressed to date.

Distribution losses of electricity, 84.1 TWh in 1992, increased by an additional 19.3 TWh in 2001, and their share of total electricity generation increased from 8.3% in 1992 to 11.6% in 2001. The capacity factor of domestic electric power plants declined from 54.8 % in 1992 to 48% in 2001 (Table 7.11).

The economic crisis which accompanied the transition to a market–driven economy, the ineffective state policies in energy prices and taxes, and non- payments for energy carriers in the first years of reforms all affected the financial state of the FEC's branches. The distinct evidence is a high share of unprofitable enterprises in Russia's fuel and energy complex (Table 7.12). In the FEC, this share in 2000 was 39.5% (8.7% in 1992); in the electric power industry, 40.7% (compared to 6.6%); and in the coal industry, 54.3% (compared to 20.8%).

The Strategy assumes that an essential growth of primary energy production will occur within the forecasting period. It will affect both total primary energy and all energy sources (Table 7.13). Total primary energy production growth rates in 2000-2020 will be 1.2 % per year in the moderate scenario and 1.8% in the optimistic scenario. Electricity production growth rates will be higher (i.e., 1.65% per year in the moderate and 2.3% in the optimistic scenarios).

TABLE 7.10 DYNAMICS OF WEAR OF EQUIPMENT IN THE FUEL AND ENERGY COMPLEX IN 1995-1998, IN %

Branch	1995	1996	1997	1998
Electric power industry	58	58	61	64
Oil industry	51	53	56	59
Oil refining industry	75	74	79	81
Gas industry	59	62	67	70
Coal industry	52	57	58	60

Source: MIE (2003b)

TABLE 7.11 GENERATING CAPACITIES AND THEIR TECHNICAL CHARACTERISTICS

	Unit of measures	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Installed capacities: Total	GW	212.0	213.4	214.9	215.0	214.5	214.2	214.1	205.4	214.0	214.7
Plants using:											
Fossil fuels		148.4	148.8	149.7	149.7	149.1	149.0	148.7	140.0	148.9	148.2
Hydro		43.4	43.4	44.0	44.0	44.1	43.9	44.1	44.1	43.9	44.3
Nuclear		20.2	21.2	21.2	21.3	21.3	21.3	21.3	21.3	21.2	22.1
Hours of used installed capacity: Total	Hours	4,810	4,545	4,209	4,079	4,078	4,008	3,968	4,056	4,217	4,159
Plants using:											
Fossil fuels		5,085	4,714	4,254	4,092	4,089	3,964	3,935	3,934	4,080	3,897

Hydro		4,043	4,097	4,126	4,113	3,596	3,672	3,692	3,720	3,803	3,970
Nuclear		n.a.	n.a.	n.a.	n.a.	n.a.	5,098	4,872	5,650	6,067	6,240
Capacity factor	%	54.8	51.9	45.8	46.6	47.3	45.8	44.1	48.5	48.2	48.0
Distribution losses	TWh	84.1	80.6	79.0	83.5	84.5	84.4	93.2	96.8	101.6	103.4
	% of total generation	8.3	8.4	9.0	9.7	10.0	10.1	11.3	11.5	11.6	11.6

Source: MIE (2003b)

TABLE 7.12 SHARE OF UNPROFITABLE ENTERPRISES IN THE FUEL AND ENERGY COMPLEX, IN %

Years	Total industry	Total FEC	Coal industry	Oil industry	Oil refining industry	Gas industry	Electric power industry
1992	7.2	8.7	20.8	8.0	n.a	17.9	6.6
1993	7.8	26.0	30.5	10.4	n.a	27.6	5.2
1994	22.6	20.6	49.4	15.8	2.7	30.8	7.5
1995	26.4	21.9	44.9	24.5	1.9	10.7	13.6
1996	43.5	29.8	53.9	18.7	13.7	13.3	20.9
1997	46.9	34.2	60.8	28.2	23.3	32.2	23.2
1998	49.2	39.8	63.7	40.4	31.1	51.5	30.9
1999	39.2	42.3	60.0	27.1	22.7	35.1	40.7
2000	38.7	39.5	54.3	14.4	17.1	32.5	40.7

Source: MIE (2003b)

TABLE 7.13 PRIMARY ENERGY PRODUCTION FORECASTS

	Unit of measure	2000	2002	2010		2020	
				Moderate scenario	Optimistic scenario	Moderate scenario	Optimistic scenario
Total primary energy	Mtoe	996.5	1,060	1,190	1,270	1,265	1,420
Electricity generation	TWh	876	892	1,015	1,070	1,215	1,365
Oil production	Mt	324	379	445	490	450	520
Motor fuels production	Mt	83	88	100	110	115	135
Natural gas production	Bcm	584	595	635	665	680	730
Coal production	Mt	258	253	310	330	375	430
Centralized heat production	MGcal	1,452	1,437	1,570	1,625	1,720	1,820

Source: MIE (2003a)

Oil production will increase by 126-196 Mt (39-60%) within 2000-2020, gas production by 96-146 Bm^3 (16-25%), and coal production by 117-172 Mt (45-67%).

It is anticipated that 25,000-35,000 km of electricity transmission lines over 330 kV will be put in operation before 2020. New generation capacities will be needed to ensure forecasted levels of electricity and heat production. Taking into account the modernization of existing and replacement of exhausted capacities, 121-177 GW of generating capacities should be created in 2003-2020, including 7-11.2 GW of hydropower plants, 17-23 GW of nuclear power plants, and 97-143 GW of thermal power plants.

7.2.2.4. The role of energy exports

In the Russian Federation, explored and prospective reserves of fossil fuels allow both domestic demand to be met for years ahead and its role in the world arena to be maintained and strengthened. As an example, the country accounts for 11-12% of the world trade in energy resources, and in particular, 3%-3.5% of the trade in liquid fuels and 35% of the trade in natural gas. Available statistical data on energy export revenue within the period 1995-2000 are given in Table 7.14.

Since the Russian Federation is primarily oriented towards raw materials export (including energy carriers), export revenue depends upon world energy prices. A comparative analysis of net oil and gas export volumes and energy export revenues for 1998 and 2000 illustrates this fact.

According to available statistics, the total volume of crude oil net export in 1998 was equal to 132.3 Mtoe, while in 2000 it was 139.2 Mtoe, an increase of 5.2 %. Oil export revenues during the same period rose by a factor of 2.6, however. For natural gas, the volume of its net export decreased in 1998-2000 by 9.8%; however, the gas net export revenue indicator for this period had a completely opposite trend: +27.4%.

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 change in GDP, with a change in fiscal revenue amounting to \$0.8-\$0.9 billion/year.

Crude oil plays a leading role in the structure of the country's net energy export. The total volume of net energy export had increased its share from 40.3% in 1992 to 43% in 2001.

TABLE 7.14 ENERGY EXPORT REVENUE OF THE RUSSIAN FEDERATION[1] IN 1995-2000, MLN USD[2]

Energy carrier	1995	1996	1997	1998	1999	2000
Crude oil	11,005	14,063	13,002	8,768	12,823	22,911
Coal	735	810	702	491	432	972
Petroleum products	4,137	7,146	6,939	3,886	4,628	10,151
Natural gas	8,541	9,653	10,707	9,024	10,950	11,500
Electricity	18,303	206.14	152.1	170	146	101.95
Total energy export	24,601.3	31,878.14	31,502.1	23,339	28,979	45,635.95

Source: MIE (2003b)
1 Excluding CIS countries
2 In current dollars

A decline in the natural gas share also occurred over the same period (i.e., from 46.3 to 39%).

Almost half of the net energy export revenue is captured by crude oil. The export of energy resources satisfies almost 80% of the demand of the Baltic countries and Eastern Europe, and essential volumes of gas and oil are delivered to Western European countries.

One important geographical feature of the Russian Federation energy export is worth noting— the share of CIS countries as a final destination for energy carriers dramatically declined over the period 1992-2001 (Figure 7.1).

This can be explained primarily in terms of economic and financial reasons—especially the low purchasing power of consumers in CIS countries, non-payments for energy carriers, and the decrease in energy demand in CIS countries due to economic development problems.

The indicator "Energy net import dependency" is included within the ISED indicator listing. As a large-scale energy exporter, Russia has a negative energy net import dependency (Figure 7.2), or the share of energy net imports in the total amount of energy supply. In 1992-2001, the share of net export in TPES in Russia increased from 42.2% to 59.1%; in conventional energy consumption, from 43.1% to 59.7 %; in crude oil consumption, from 50.5% to 83.5%; and in natural gas consumption, from 42.9% to 54.4%.

Over the long term, the Russian Federation will remain one of the largest players on the world energy scene. The country's importance in global energy supply and trade will grow over the outlook period (i.e. through 2020), with major implications for world supply security. The country is planning to increase the volume of its energy exports. According to the Strategy, the total volume of energy exports will increase from 383 Mtoe in 2000 to 556 Mtoe in 2020 under the moderate scenario, and to 626 Mtoe under the optimistic scenario (Figure 7.3). The volume of energy exports in considering such prospects will depend mostly on energy prices in world markets. In the case of world oil prices in the 18-20 USD/barrel range during the forecasting period, the total volume of primary energy exports will increase in 2010 by 23-25% in comparison with 2000, and by 25-30% in 2020.

In the case of oil prices rising to 30 USD/barrel by 2020, economically justified energy exports in 2010 will be more than in 2002 by 30-35%, and in 2020 by 45-50%.

In the short term, real revenues from energy exports are likely to remain sufficiently high to stimulate economic growth. But over the long term, the Russian Federation will need to reduce its reliance on energy exports by developing other industries. To diminish its excessive dependency on energy export revenues, the country urgently needs to improve the quality and diversity of other manufacturing industries and internationally traded services. Such improvements will depend to a large extent on the country's completing and fully implementing its ambitious programme of market reforms.

7.2.3. Primary energy supply

In 1992-2001, the total consumption of primary energy in the Russian Federation declined by 20% or by 153.5 Mtoe (Annex 7.1). Coal consumption for this period dropped by 19%, oil consumption by 28%, and natural gas consumption by 8%.

As noted above, the principal factor explaining declining consumption (as well as production) of fuel and energy in the country was the economic downturn, which reduced solvent demand for energy.

Natural gas accounts for more than half of the total primary energy supply mix. For the period 1992-2001, its share increased from 47% to 52.3%. Oil kept a second place in that structure, with a 28.5% share in 1992 declining to 21.4% in 2001. The relative growth of the share of nuclear power (from 4.1% to 5.8%) should also be noted.

The indicator of energy self-sufficiency (i.e., the ratio primary energy production/TPES) is traditionally high, taking into account the country's status as a large net energy exporter. The ratio increased from 1.44 in 1992 to 1.6 in 2001.

Available data on the per capita consumption of primary energy and electricity exhibited a declining trend in 1992-1998, but some growth in 1998-2001 (Table 7.1 and Figure 7.4). A comparative quantitative analysis of this indicator shows that the Russian Federation is at a level comparable to leading industrially developed countries (e.g., European Union countries). Statistical data on motor fuels and combustible renewables and waste (CRW) per capita are given in Figure 7.5.

However, the problem is that EU countries having comparable indicators of per capita primary energy and electricity consumption can boast of much higher levels of GDP per capita (22,218 USD/person in 2001 in the EU, versus 6,442 USD/person in the Russian Federation). In other words, relatively high indicators of per capita primary energy and electricity consumption alone cannot provide evidence of sustainability in energy development. How efficiently primary energy and electricity are used remains an important question.

It is interesting to evaluate per capita energy consumption in the residential sector. Table 7.15 provides information on per capita consumption of fossil fuels, electricity, heat and CRW in the residential sector in 1992 and 2001.

Comparison of GDP energy and electricity intensities in the Russian Federation and in EU countries is given in Figure 7.6. According to available statistics, in 1992 the Russia/EU ratio in GDP primary energy intensity was 3.66, but in 2001 it was 3.76; as far as electricity intensity is concerned, the ratio between the Russian and EU relevant indicators was 2.77, in both 1992 and 2001.

The energy supply efficiency is low, mostly because of the technical state of equipment in FEC's branches. The share of distribution losses in TPES is 2.8 times higher than in the EU. A huge difference in electricity supply efficiency also exists. In terms of gas supply efficiency, 17 Bcm of natural gas were lost in pipelines in 2001—a figure comparable to annual natural gas consumption in Poland, or annual natural gas production in Italy.

"Fossil fuel efficiency for electricity generation" is included in the list of ISED indicators, and along with distribution losses, this indicator shows the level of energy supply efficiency in the country. Local statistics give some information on specific fuel consumption for electricity and heat generation produced by thermal power plants (including CHP) (Table 7.16).

As is well known, utilizing CHP contributes to an improvement in the efficiency of heat and electricity generation. The combined method of heat and electricity production is widely-used in the Russian Federation. About 65% of total electricity and 50% of heat were produced by CHPs in 2001.

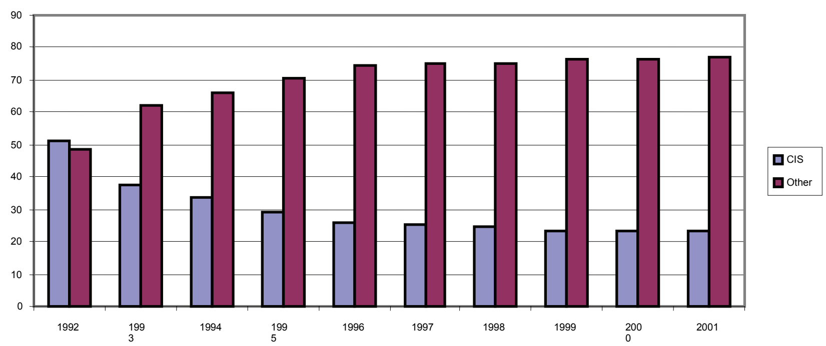

Figure 7.1 Geographic structure of Russia's energy export, %

Figure 7.2 Russia's energy import dependency, %

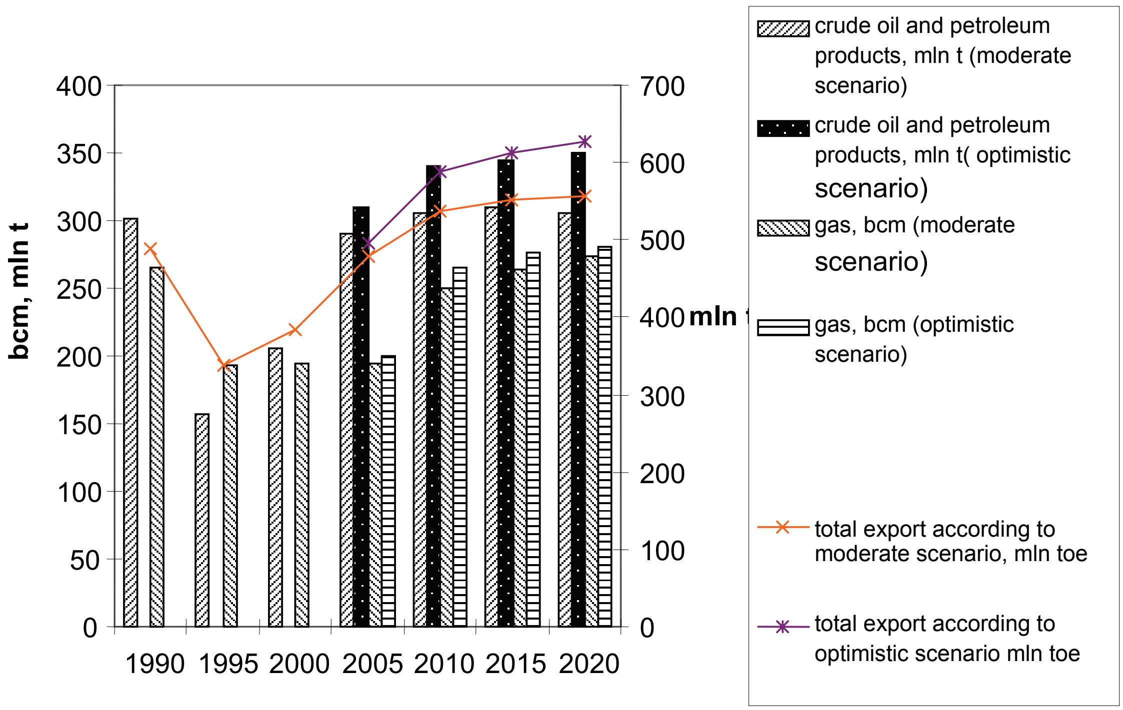

Figure 7.3 Energy export from Russia

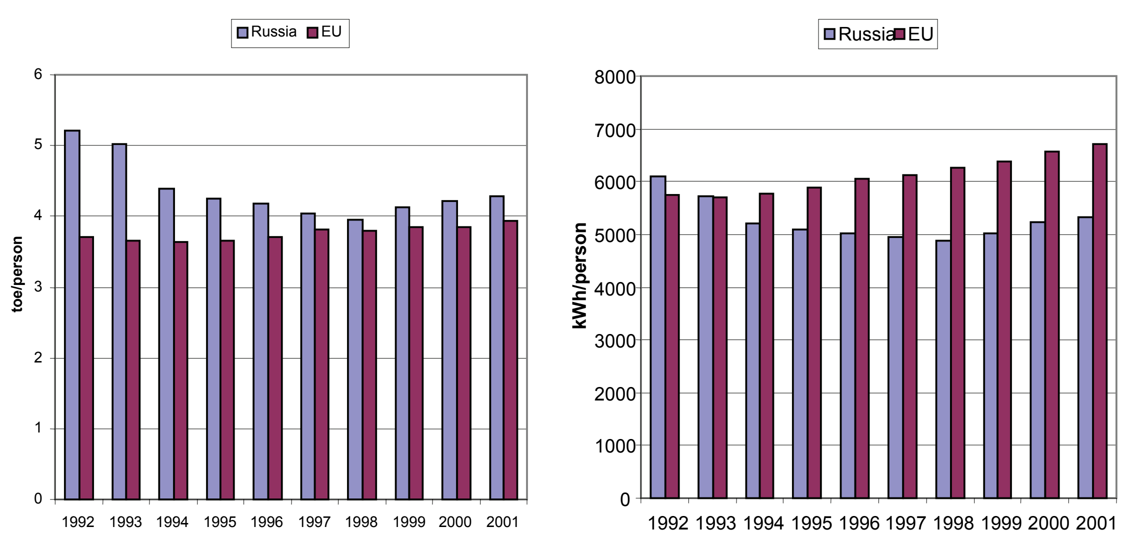

Figure 7.4 Per capita primary energy and electricity consumption in Russia and EU countries.

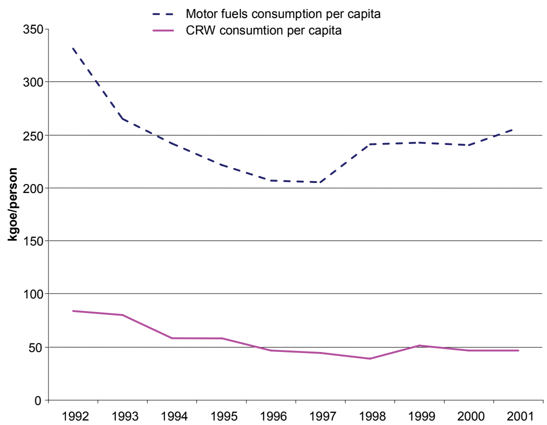

Figure 7.5 Motor fuels and CRW consumption per capita in Russia, kgoe/person

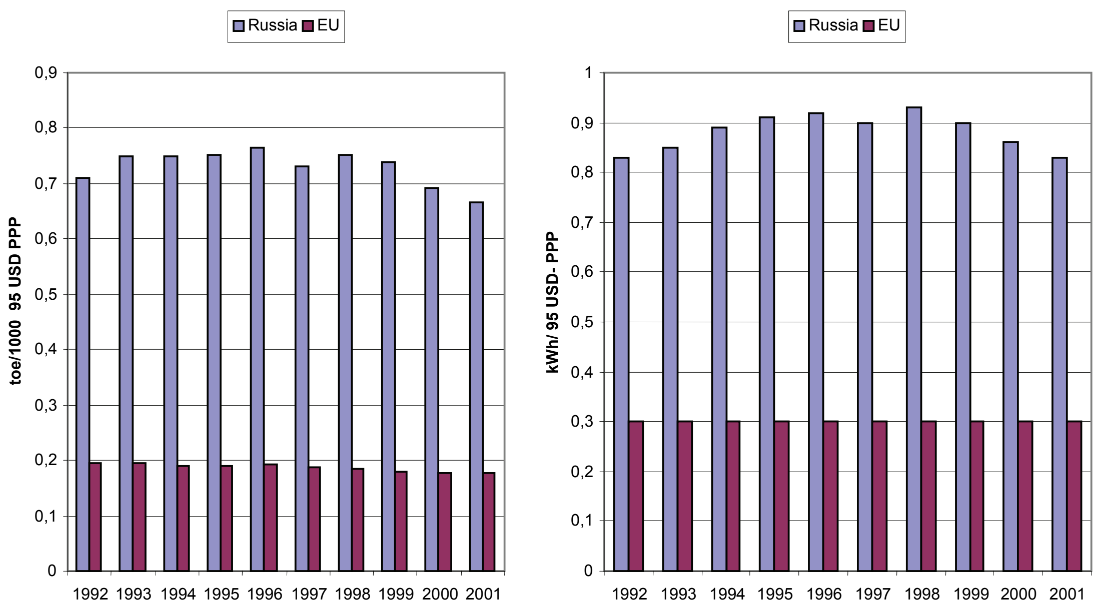

Figure 7.6 Energy and electricity intensities of GDP in Russia and EU

TABLE 7.15 PER CAPITA ENERGY CONSUMPTION IN RESIDENTIAL SECTOR

Energy carrier	Unit of measure	1992	2001
Fossil fuels	toe/ person	0.395	0.408
Electricity	KWh/ person	905	958
Heat	toe/ person	0.58	0.49
CRW	toe/ person	0.04	0.01

Source: OECD/IEA (2003)

7.2.3.1. *Energy demand forecasts*

Expected economic growth in the Russian Federation during the next two decades will require an additional consumption of primary energy. The Strategy gives the following forecasting estimations for the prospects of 2020 (Table 7.17). According to the moderate scenario, total primary energy demand in 2002-2020 will grow by 1.25% per year, while the optimistic scenario assumes 1.8% per year.

Natural gas will remain a basic fuel in the structure of internal primary energy demand. Its share in the TPES mix will decline from 50% in 2002 to 45-46% in 2020 (Table 7.18). Crude oil and petroleum products will represent 22% of primary energy demand, and solid fuels about 20%. The share of TPES from heat and electricity produced by nuclear and hydropower plants, as well as renewables, will remain relatively stable.

Motor fuels consumption will grow faster than the consumption of other energy carriers. In comparison with the year 2000 levels, motor fuel consumption will rise by 20-22% in 2010 and by 33-55% in 2020.

Electricity demand in 2000-2020 will grow at higher rates than total primary energy demand because of the high intensity of electrification in industry, agriculture and the residential sector. Moderate growth of centralized heat demand is expected, with an increase of 18-25% by 2020 (in comparison with 2000). This growth will be connected with structural change in the domestic economy, implementation of heat conservation potentials, and decentralized source development.

TABLE 7.16 ENERGY SUPPLY EFFICIENCY IN RUSSIA

	1992	1995	1997	1999	2001
Distribution losses as percentage of TPES, %	3.2/1.3 [1]	4.2/1.3	3.9/1.3	4.1/1.3	3.6/1.3
Distribution losses as percentage of total electricity generation, %	8.3/6.0[1]	9.7/6.0	10.1/5.0	11.4/5.8	12.3/5.7
Own use and losses in gas pipelines as percentage of total gas production, %	9.3/7.1 [1]	9.1/6.1	8.4/6.6	8.6/6.8	8.1/7.1
Specific fossil fuel consumption for electricity generation, kgoe/kWh	0.217	0.218	0.24	0.24	0.241
Specific fossil fuel consumption for heat generation, kgoe/kWh	0.121	0.122	0.103	0.102	0.102
Share of CHP's in total electricity generation, %	70.6	67.5	67.7	66.2	64.7
Share of CHP's in total heat generation,%	56.3	48.4	51.3	47.6	49.6

Source: MIE (2003b)
1 Numerator : Russia; denominator: EU

TABLE 7.17 ENERGY DEMAND FORECASTS IN RUSSIA, MTOE

	Natural gas	Crude oil and petroleum products	Solid fuel	Other[1]	Total
2002	324	127	120	69	640
2005	326[2]-336[3]	136-143	126-129	72-73	660-681
2010	348-371	150-180	134-149	82-86	714-765
2015	357-390	165-180	150-157	90-98	762-825
2020	367-406	176-198	162-178	96-106	801-888

Source: MIE (2003a)
1 Nuclear, hydro and renewables
2 Moderate scenario
3 Optimistic scenario

TABLE 7.18 ENERGY DEMAND FORECASTING STRUCTURE IN RUSSIA, %

	Natural gas	Crude oil and petroleum products	Solid fuel	Other[1]	Total
2002	50.6	19.8	18.8	10.8	100
2005	49.4[2]-49.3[3]	20.6-21.0	19.1-18.9	10.9-10.8	100
2010	48.7-48.5	21.0-20.8	18.8-19.5	11.5-11.2	100
2015	46.8-47.3	21.7-21.8	19.7-19.0	11.8-11.9	100
2020	45.8-45.7	22.0-22.2	20.2-20.0	12.0-12.1	100

Source: MIE (2003a)
1 Nuclear, hydro and renewables
2 Moderate scenario
3 Optimistic scenario

7.2.3.2. Energy demand structure

The heat and electricity production sector is one of the largest consumers of primary energy. In 1992, this sector consumed 119 Mtoe, or 15.4% of the total volume of primary energy resources used by the domestic economy; in 2001, the quantity of primary energy used for heat and electricity generation purposes was 116 Mtoe (Annex 7.1), or 18.6% of TPES.

In 1992-2001, total final energy consumption declined by 159 Mtoe, or by 27%. For the same period, petroleum products demand by final consumers decreased by 33.4%; for natural gas, by 12%; for electricity, by 18.3%; and for heat, by 34.2%. The ratio of total final energy consumption/ TPES fell from 76% in 1992 to 69% in 2001.

Heat is a leading energy resource in the final energy mix. Its share in 2001 accounted for about one-third of the total final energy consumption. The share of natural gas increased from 23.1% in 1992 to 28% in 2001 .

TABLE 7.19 THE MAIN SECTORS OF RUSSIA'S GDP PRODUCTION IN 1998

Sector of GDP production	Share in total GDP, %
Industry	26.8
Agriculture	5.4
Construction	6.6
Transport	8.8
Trade (wholesale and retail)	18.5
Residential sector	2.6
Communication	1.8
Financial sector (credits, insurance)	0.35
Science	0.75
Education, culture and art	3.5
Defense	1.7
Management	3.3
Real estate activities	3.0
Net taxes on products (excluding subsidies)	8.0
Other sectors	8.9
Total GDP	100.0

Source: SCS (2003)

The industry and residential sectors are the largest consumers of final energy. Over three-quarters of energy consumption in industry today is covered by the four most energy intensive branches: iron and steel (21.4% in 2001), chemical and petrochemical (31.3%), non-ferrous metals (12.6%) and machinery (11%).

The share of industry in the aggregated structure of GDP has declined during recent years (Figure 7.7) according to official statistics. A more detailed structure of GDP (available for 1998 only) is given in Table 7.19.

Within industrial energy consumption, heat has the highest share. In 2001, for example, it was about 34%. The transportation sector mostly uses petroleum products, including motor fuels (56.5% in total energy consumption in this sector in 2001) and natural gas (used mostly for ensuring the functioning of gas pipelines). The most actively consumed energy resource in agriculture is petroleum products (46%), while the commercial/public services and residential sectors have 50% and 49% dependence on heat, respectively.

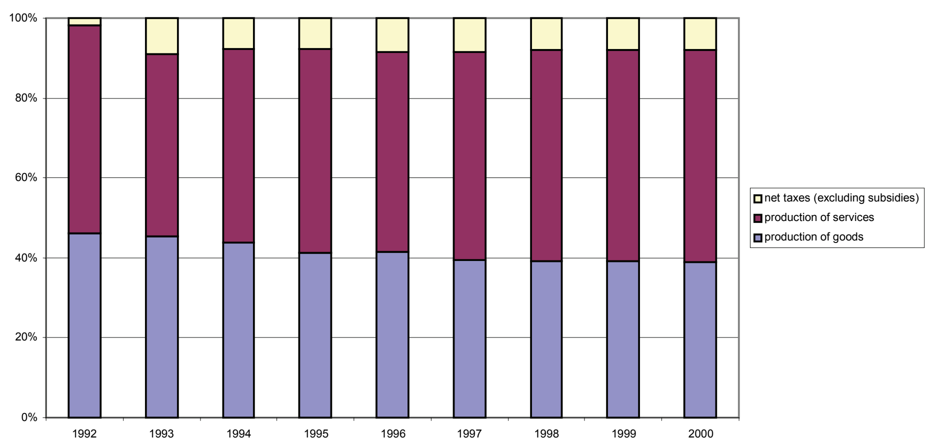

Figure 7.7 Aggregated structure of Russia's GDP in 1992-2000, %

The heat and electricity generation sector is the largest consumer of solid fuel. Fully 74% of coal used by the domestic economy in 2001 was consumed by CHP's, heat and electric power plants. The transportation sector consumed about 38% of the total liquid fuel supply, while 58% of total natural gas consumption was aimed at heat and electricity generation. The largest fraction of final electricity is used by industry (52% in 2001), while the residential sector is the largest consumer of heat (53% in 2001).

7.2.3.3. Investment problems of Russia's FEC

One of the most serious problems for sustainable energy development in the Russian Federation is a lack of investment.

According to the Ministry of Energy, a negative trend of investment took place in the FEC in 1992-1998 (Table 7.20). Some growth of investment activity, strongest in the oil industry, occurred in 1999 and 2000 (as well as in 2001-2002).

The contribution of various sources of financing for domestic energy has dramatically changed during recent years (Figure 7.8).

Internal (i.e., "own") financial resources of FEC enterprises is now the main source of investment for domestic energy. At the same time, central budgetary funding has sharply declined.

Despite the high potential attractiveness of Russia's energy for foreign investment, their share in total investment in the FEC's branches is relatively low—about 13% of the total investment in energy, of which 95% is directed at the oil industry alone. The principal reason for the low investment activity of foreign investors is an unfavourable investment climate.

Some figures are available addressing investment forecasts in the country's energy sector.

Investment forecasts developed by the IEA are outlined in Table 7.21. In 2001-2010, the gas industry will have the highest share of total investment in energy (38%). In 2011-2020 and 2021-2030, the electricity sector will become the most capital-intensive branch of domestic FEC (40.7% and 39%, respectively). IEA economic forecasts would require a total amount of investment of about 1,050 billion dollars in 2001-2030, or 35 billion dollars annually.

The Strategy gives the following forecasts (Table 7.22): 660 to 770 billion dollars (according to moderate and optimistic scenarios, respectively) will be needed in 2001-2020 in order to meet forecasted economic growth in the country and to ensure economically justified energy exports in external markets. It will account for 33-38.5 billion dollars per year (i.e., quite close to the IEA forecasts).

In the optimistic scenario, the total investment in energy in 2020 will increase by a factor of 7 in comparison with 2000; the moderate scenario assumes an increase by a factor of 3 to 6.

TABLE 7.20 INDICES OF EXPENDITURE ON ENERGY USE (PERCENTAGE OF PREVIOUS YEAR IN COMPARABLE PRICES)

Branches of the fuel and energy complex	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total expenditures	60.3	88.0	76.0	87.0	82.0	95.0	93.3	104.5	117.7
Power engineering	66.7	84.0	66.7	103.6	88.7	97.3	72.0	90.1	83.8
Oil industry	66.6	53.4	79.5	93.5	74.3	96.6	72.7	125.1	173.1
Petroleum refining	66.6	180.0	102.2	81.5	82.0	56.2	81.0	74.0	201.6
"Gazprom"	55.2	75.7	135.7	78.9	94.5	101.5	66.3	135.2	88.4
Coal industry	58.8	73.3	60.0	76.5	79.0	82.3	64.9	95.1	67.0

Source: MIE (2003b)

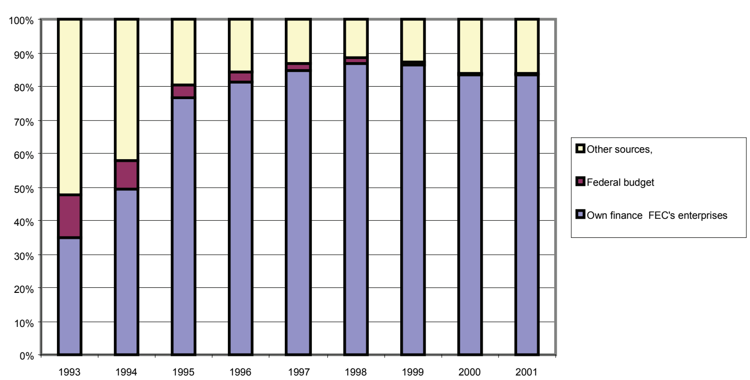

Figure 7.8 The main sources of investment in Russia's energy

TABLE 7.21 INVESTMENT FORECAST IN RUSSIA'S ENERGY SECTOR.

Investment (billion dollars)		2001-2010	2011-2020	2021-2030	2001-2030
	Total Country Investment	269	391	389	1,050
Oil	Total	97	111	120	328
	Exploration and development	90	104	114	308
	Non-conventional oil	-	-	-	-
	Refining	7	7	6	20
Gas	Total	103	117	111	332
	Exploration and development	52	65	70	187
	LNG liquefaction	2	1	0	4
	LNG degasification	-	-	-	-
	Transmission	33	34	24	92
	Distribution	7	11	14	32
	Underground storage	8	7	2	17
Coal	Total	6	4	6	13
	Total mining	5	4	4	13
	new mining capacity	3	1	2	7
	sustaining mining capacity	2	2	2	6
	Ports	0.2	0.0	0.0	0.3
Electricity	Total	64	159	153	377
	Generating capacity	15	69	72	157
	of which renewables	7	15	8	30
	Refurbishment	5	9	7	21
	Transmission	10	20	15	45
	Distribution	34	61	59	154

Source: IEA (2003a)

TABLE 7.22 ENERGY STRATEGY EVALUATIONS OF INVESTMENT IN ENERGY SECTOR [1, 2]

FEC's branch	Needed investment in 2001-2020, billion USD
Total	660-770
Gas industry	170-200
Oil industry	230-240
Electricity industry	120-170
Coal industry	20
Heat supply sector	70
Energy conservation	50-70

Source: MIE (2003a)
1 Investment in reconstruction and development
2 Including own financial means of fuel and power supplying companies and enterprises, budget and out-of budget investment, foreign investment and other sources.

The largest potential investment projects include: construction of nuclear power plants in European parts of the country; oil and gas pipeline construction; the installation of new electricity transmission lines; and oil field exploration and exploitation in East Siberia, and in the Far East. Large-scale investment will be needed for modernizing existing production and generation capacities, as well as development of infrastructure.

Options available to accumulate needed investment capital into the FEC include improving the investment legislation which would allow the creation of favourable conditions for domestic and foreign investors, and optimizing an energy pricing and fiscal policy, which would enable fuel and power supply companies to accumulate their own investment capital. Another important measure would be to improve the functioning efficiency of FEC enterprises.

Investment activity in other sectors of the domestic economy is going to be high in coming decades. Thus the share of the FEC in total investment in the domestic economy, currently at 33-35% in the 2001-2005 period, will decline to 31-33% in 2006 – 2010, and to 20-24% by 2020.

The Strategy assumes that investment growth in the FEC will contribute to enhancing investment activity in the other economic sectors, in particular within manufacturing industry.

7.2.3.4. End-use energy prices, taxation, and subsidies

Financial and investment problems of the FEC are closely linked with end-use energy prices and taxation policy, as well as energy subsidy levels. A problem of paramount importance for the Russian Federation is determining how to optimize the energy pricing and taxation mechanisms, taking into account the interests of all affected participants (including state, regional and local budgets, FEC enterprises and final consumers), and developing a reasonable approach to eliminating energy subsidies. The approach must aim at introducing the proper end-use energy prices, while simultaneously protecting the poorest part of the population.

In the early 1990s the government artificially kept down end-use energy prices, which increased much more slowly than the prices of industrial products. However, in recent years they have been constantly and rapidly growing (Table 7.23). Coal and petroleum product prices are already free from state control; however, end-use electricity, heat and natural gas prices are still state-controlled.

Statistical data on end-use energy prices and subsidies are very limited and fragmentary.

End-use prices as well as payments for energy bills vary among the different regions of the country. In some northern regions of the Russian Federation, end-use energy prices (especially for heat and electricity) are much higher than in the European part of the country. There are also considerable differences because of climate distinctions; the duration of the heating season in the Komi Republic, for example, is about 300 days annually.

In this connection, the financial burden to pay for energy resources and to maintain the energy supply systems becomes onerous for consumers (in particular, for regional budgets). Some regions spend up to 40% of their budgets on energy, mostly for electricity and heat supply systems.

As far as the general population is concerned, the fraction of disposable income spent on fuel and electricity has increased significantly in recent years, and is still growing.

Energy prices for the general population are still subsidized. Unfortunately, official statistics on energy subsidies and end-use energy prices are not available. An attempt to research this problem was undertaken by IEA in a study on energy subsidies, published in 1999 (IEA, 1999). It conducted a detailed analysis of energy prices and subsidies in the Russian Federation (and some other countries), and made certain conclusions concerning the current rate of energy subsidy in the country, the potential energy and financial savings due to energy subsidy removals, and also on the level of right (reference) prices (i.e., without subsidy) for electricity and natural gas for industry and households in 1997 (Table 7.24).

According to their results, the subsidy share of electricity and natural gas in the Russian Federation in 1997 was more than 40%. The estimated average level of the right price of natural gas for households should be about 10 times higher than the current price.

IEA estimated that actual electricity prices for households in 1997 were about 2.5 times lower than the right price. Unfortunately, recommendations addressing how to protect the poorest part of population from end-use energy prices growth were not provided.

TABLE 7.23 END-USE ENERGY PRICE INCREASES FOR INDUSTRIAL ENTERPRISES (PERCENTAGE OF PREVIOUS YEAR).

Energy carriers	1994	1995	1996	1997	1998	1999	2000
Electricity	251	322	139	103.8	100.8	121	142.9
Heat	412	383	133	100	98.6	115.1	136.6
Natural Gas	349.7	366.7	107	102.1	102.2	131.4	126.1

Source: MIE (2003b)

TABLE 7.24 NATURAL GAS AND ELECTRICITY SUBSIDIES AND END-USE PRICES IN 1997

	Natural gas	Electricity
Estimated rate of subsidy (% of reference price)	46.1	42.0
Potential primary energy saving from subsidy removal, %	36.6	24.3
Estimated annual economic-efficiency cost, due to subsidy removal (mln USD)	5,298	1,501
Estimated budget cost, (mln USD)	21,055	10,854
Natural gas end-use price (USD per 1,000m^3):		
Households	21.4/246.6[1]	
Industry	57.9/125.6	
Power generation	61.1/95.3	
Electricity end-use price (USD per kWh):		
Households		0.028/0.067
Industry		0.041/0.06

Source: OECD/IEA (1999)
1 Numerator: current price (with subsidy)
Denominator: reference price (without subsidy)

The problem of energy subsidy elimination has been actively discussed by domestic and foreign experts. Energy subsidies hamper the accumulation of investment potential of the FEC and, therefore, decrease reliability of the energy supply system. Cross-subsidization is a serious barrier for accelerating industrial and economic development in the country.

On the other hand, it makes energy services more affordable for the poorest (very essential) part of the population. In other words, the question concerning the future of energy subsidies is: "to be or not to be." The most popular opinion is that energy subsidies should be saved, but only for the poorest part of the population. Other categories of consumers should pay 100% for energy services.

One more problem in the field of end-use energy prices is the difference between internal and export prices. For example, the difference between the average price for imported (from Russia) gas in Germany and the price for natural gas for industrial consumers in 2001 was more than a factor of nine (Table 7.25). This difference makes foreign markets much more attractive for domestic fuel and energy supplying companies than internal ones.

Regional energy commissions (i.e., RECs, special governmental bodies) are responsible for electricity, heat and natural gas prices regulation. Each Russian region (totalling 89) has its own REC. Table 7.26 provides statistical data on electricity and gas tariffs for the population in the Moscow region introduced since the beginning of 2004 by the local REC.

On average, electricity tariffs for the population in Russia are 3.5-4 times less than in OECD countries (*Energy Prices and Taxes*, OECD/ IEA, 2003). Multi-tariff electricity meters allow residential consumers to pay four times less for 1 kWh of electricity in the period from 23.00-7.00 than during other parts of the day. These meters are mostly available in the new residential buildings, which have been put into operation during the last 5-10 years.

The unit of measure "ruble per person" is used in the system of residential payments for natural gas consumption. This is a fixed price for natural gas within the residential sector, regardless of consumption.

Residential consumers pay for electricity and natural gas in accordance with the set of equipment installed in the dwelling. Thus, electricity tariffs for households with gas and electricity stoves are different. A similar situation exists in the system of gas payment.

The tax policies of the state have played (and will continue to play in the future) an important role in stabilizing the financial position of FEC enterprises. The Ministry of Industry and Energy and the joint stock companies of the FEC have made considerable efforts for rationalizing the tax burden, and developing an appropriate approach to taxation on the various sectors. The government's position on this is clear: taxes have to be collected not where it is easy to collect, but rather where value is added.

For Russia, as for any other country, optimization of end-use energy prices and taxation, as well as a successful solution of the problem of removing energy subsidies, means:

- regular and stable payments in the budgets of different levels from the FEC's enterprises;
- reimbursement of expenditures and reasonable income of FEC's enterprises which will allow them to improve sustainability of development;
- affordable energy carriers for the consumers;

It also means:

- stimulation of energy conservation activity of consumers; and
- mitigating negative influence of the FEC on the environment.

TABLE 7.25 NATURAL GAS PRICES IN RUSSIA IN 1991-2001

	Export prices[1] $/1,000 m^3	End-use prices		
		Industry		Population
		Ruble/1,000 m^3	$/1,000 m^3	ruble/month [2]
1992	89.7	1,100	2.7	3.4
1993	88.3	21,875	17.6	29
1994	83.0	73,773	21.6	65
1995	95.0	257,151	55.7	951
1996	93.5	289,176	52.2	1,184
1997	99.5	327,000	54.9	2,449
1998	82.2	338[3]	16.4	3.18
1999	62.1	371	13.7	3.74
2000	116	390	13.7	4.3
2001	136	460	14.5	5.38

Source: IEA (2002)
1 Average prices for imported gas in Germany
2 Per person
3 After devaluation of Russian currency in August 1998

TABLE 7.26 END-USE ELECTRICITY AND NATURAL GAS PRICES FOR HOUSEHOLDS (BY 01.01.2004) IN MOSCOW REGION

End-use electricity prices			End-use natural gas prices		
Households with gas stoves	per kWh	1.22[1]/4.3 [2]	Households with gas stoves and centralized hot water supply system	per person	9.9[1]/34.7[2]
Households with electric stoves		0.86/3.0			
Households with gas stoves equipped with multi-tariff electricity meters (23.00-7.00)	per kWh	0.3/1.05	Households with gas stoves and gas water heater (without centralized hot water supply system)	per person	24.2/84.9
Households with electric stoves equipped with multi-tariff electricity meters (23.00-7.00)	per kWh	0.22/0.8	Households with gas stoves only (gas water heater and centralized hot water supply system are not available)	per person	13.3/46.6
Households in rural areas	per kWh	0.86/3.0	Households heated by gas heaters	per m^2 of heated space	4.4/15.0
			Households equipped with gas meters	per m^3	1.18/4.1

Source: Regional Energy Commission of Moscow (RECM) region (2000-2003)
1 Russian rubles
2 US cents using current exchange rates (1 USD=28.5 rubles)

7.3. Review of the energy statistical data capability

During project implementation, the research team was faced with the problem of statistical data collection. There are several main aspects of this problem:

- Availability;
- Accessibility; and
- Quality of statistics.

Statistical data related to some ISED indicators could not be obtained from official sources of information. The main difficulties in the construction of these indicators are associated with necessity to collect information from 89 regions (indicators 20 and 21) and various branches of the FEC (indicators 33 and 34). There are some evaluations made by independent experts or governmental officials, but it was not possible to use these evaluations in order to construct indicators in any event (especially for time series). The list of such indicators is given in the Table 7.27.

Nevertheless it was possible to obtain some information on the structure of consumption in PPP terms for 1998, related to indicator 21.

One other part of the needed statistical database on ISED can be considered inaccessible (at the moment) (Table 7.28). There is confidence that this information exists, but there is no access to a relevant database. Moreover, statistics for certain indicators are only partially available.

The main problem in collecting these statistics is that needed data are concentrated in various governmental structures, including:

- State Committee for Statistics;
- Ministry of Industry and Energy;
- Ministry of Science and Education;
- Ministry of Nuclear Energy;
- State Committee on Hydrometeorology, etc.

This makes the process of collecting information a very time consuming and complex task.

Another problem is the regional breakdown of the country. For example, end-use energy prices in Moscow and the Komi Republic (one of the northern regions of the country) are completely different. It thus becomes a significant problem to summarize the fragmentary information from 89 regions of the country, as well as to obtain the information itself. There are also several kinds of energy subsidies. For example, in Moscow disabled people and some other categories of the population are only required to pay 50% of their energy bills. Transforming such information into statistical data is extremely difficult.

It is also very difficult to obtain needed information about the energy intensity of the main economic sectors. Data on energy consumption is available. The problem is to find reliable statistics on GDP produced in these sectors, or the physical volumes of production. There is also no access to data for some environmental indicators.

The problem of ensuring necessary data quality (first of all, comparability) for the statistical data which is obtained is very real, particularly for recent data. This is a concern in certain macroeconomic indicators as well as information on energy production and supply in 2002-2003. For example, information on GDP growth in 2002 and even 2003 (preliminary) data are available in some publications, including official ones (note that the data are presented in terms of a percentage of the previous year). But there is no confidence that the data on GDP for 2001 given in the Table 7.1 and in the above publications are the same.

That is why the time series of macroeconomic and energy indicators are limited through 2001.

The main information sources for this project were the database of the IEA and Russia's Energy Strategy. Some parts of needed statistical data have been obtained through periodical issues and surveys available in the scientific and technical literature. An essential part of the statistics was obtained through personal contacts in the Ministry of Industry and Energy and the Ministry of Science and Education.

Given the relatively short history of the Russian Federation as an independent state, a short time series for ISED has been employed in the project (1992-2001), but it is nonetheless enough to evaluate the main trends and developments in the economy and the FEC of the country.

There is no doubt that active steps aimed at incorporating the ISED package into national databases should be undertaken. Moreover, it would be useful if comparable statistics within the ISED package were collected with the intellectual and statistical resources of the State Committee for Statistics, and that ISED were employed for constant monitoring of Russia's energy policy implementation.

TABLE 7.27 STATISTICAL ISED INFORMATION NOT AVAILABLE

N[31]	Indicator
20	Ratio of daily disposable income/private consumption per capita of 20% poorest population to the prices of electricity and major household fuels
21	Fraction of disposable income/private consumption spent on fuel and electricity by average population; group of 20% poorest population (partly)
33	Land area taken up by energy facilities and infrastructure
34	Fatalities due to accidents with breakdown by fuel chains

Source: IAEA/IEA (2003)
31-number in the list of ISED

TABLE 7.28 STATISTICAL ISED INFORMATION NOT ACCESSIBLE

N[32]	Indicator
3	End-use energy prices with and without tax/subsidy (partly)
8	Manufacturing value added by selected energy intensive industries
9	Energy intensity (partly)
15	Expenditure on energy use (partly)
24	Ambient concentration of pollutant in urban areas(partly)
25	Land area where acidification exceed critical load
27	Radionuclides in atmospheric radioactive discharges
28	Discharges into water basin (partly)
29	Generation of solid waste (partly)
30	Accumulated quantity of solid waste
31	Generation of radioactive waste
32	Accumulated quantity of radioactive waste

Source: IAEA/IEA (2003)
32 – number in the list of ISED

7.4. Identification of Major Energy Priority Areas

The FEC in Russia is one of the most important sectors of the economy, which determines the main parameters of its functioning. It is responsible for ensuring national security and strengthening the position of the Russian Federation in the international arena. Energy policy includes a broad range of measures designed to solve institutional, legislative, socioeconomic, scientific and technical as well as environmental problems of domestic energy development. Each of these areas is very important as a component of energy policy as a whole.

Nevertheless there are five aspects of national energy policy that can be considered as top priorities:

- Ensuring national energy security;
- Securing stable, uninterrupted and affordable energy supplies for the economy and households;
- Increasing the energy efficiency of the economy;
- Developing and improving the energy resource base;
- Decreasing the negative environmental impacts of the energy system.

These key priorities of energy policy are stated in the Energy Strategy of the Russian Federation. The main quantitative targets and benchmarks for each priority are already determined, clearly declared and widely presented.

7.4.1. Ensuring national energy security

The most important and dominating priority of energy policy is to ensure national energy security. National energy security is a state of society and a national energy system that would preserve the country's national security under external and internal threats and destabilizing factors caused by economic, socio-political or manmade origins. It would accomplish this by eliminating and compensating for the negative impacts of the above threats and factors by:

- Ensuring the reliable functioning of the energy system and securing guaranteed energy supplies to consumers;
- Creating necessary conditions for the development of the economic and social basis of society;
- Maintaining economically justified energy exports;

- Maintaining the technological and environmental safety of energy facilities;
- Assisting in strengthening the links that promote internal and external integration.

The paramount importance of energy for the system of economic and national security of the country makes ensuring national energy security the highest in the list of energy policy priorities.

Among the most serious economic threats to energy security, the following items deserve attention:

- A shortage of investment, limiting the possibility of compensating for the loss of productive capacity in the FEC, and modernizing and refurbishing the basic plant and equipment (most of which is worn out);
- The high level of energy intensity of the economy and, consequently, enormous non-productive losses of fuel and energy, which lead to additional expenditures for energy suppliers and consumers, as well as environmental hazards, measured in millions of dollars;
- A sharp decline in the amount of geological prospecting, and the associated deterioration of the raw-material base (in particular in the oil and gas sector).

Given that the bulk of the plant and equipment in the FEC is in a very poor state of repair, there is a high probability of major accidents or breakdowns at energy supply facilities, and with that an increased danger to industry and the environment.

The most important external destabilizing factors may be considered to include:

- Discriminatory actions by foreign countries (or their associations) in relation to the Russian Federation and its subjects in international energy markets;
- The dependence of some border areas of the Russian Federation on energy supplies from foreign States;
- Limitations on the transport of energy resources exported by the Russian Federation, the blockade of oil and gas pipelines in the territories of transit States, non-observance of the Convention on freedom of navigation through straits, etc.

Internal factors include possible socio-economic threats (associated primarily with conflicts on the grounds of nationality or religion), the manifestation of separatism in individual regions of the country, and strikes and labour disputes at companies of the FEC and related infrastructure. Industrial, social and political disputes may present a particularly serious threat, since, like natural or individual emergencies occurring in fuel-producing regions, they may close off the energy flows that are of vital importance in supplying both domestic and external consumers. Any serious worsening of the social situation may also exacerbate personnel problems, with a negative impact on the incidence of accidents and breakdowns in various energy branches. A rise in social tension may also be provoked by shortages of energy resources and the interruption of energy supplies to individual regions of the Russian Federation (e.g., the Far East, remote and northern regions).

The country's energy security is multi-sectoral in nature, and the internal and external links between the FEC and other branches of the economy must be taken into account.

When speaking about energy security as a priority of energy policy of the Russian Federation, its primacy can be considered as a priority of the macro-level, while the four other priorities can be considered as merely components.

7.4.2. Securing stable, uninterrupted and affordable energy supplies for the economy and households

Despite a large energy resource base and its status as a large energy net-exporter, the Russian Federation in recent years has been faced with the problem of ensuring internal energy requirements. The principal problem is that energy resources are unevenly spread throughout the country. Because of this, several regions are heavily dependent on energy imports from other regions. For the most part, 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 the fossil-fuel-deficient regions face frequent disruptions in fuel supplies, due to rugged weather and transportation conditions and to the suppliers' preferences for export markets. Given the long distances between regions, transportation costs can dramatically increase the total cost of fuel. Some remote territories such as Kamchatka, Republic Tyva and Republic Altai spend more than half of their budget on fuel.

In this regard, an important aspect of realizing this priority is the need to have an effective system of administration and regulation for state-owned and private enterprises responsible for energy supplies for the regions. Weak administration and control was the reason for the energy crisis in the Kamchatka region in previous years.

Another problem is to keep energy systems in good technical repair. Technical accidents in heat supply systems during the winter season became a frequent phenomenon in Russia in recent years. The solution for the problem depends on administrative action and constant control, as well as investment in the modernization of equipment and pipelines, and associated new construction.

About ten million people in remote areas are not connected to the electricity grid and are currently served by stand-alone generation systems using either diesel fuel or gasoline. Nearly half of these diesel and gasoline systems are reported to be no longer operating because of fuel delivery problems and/or high fuel costs. Remote Northern and far Eastern areas get their fuel by rail or road, and even sometimes by helicopter. These suppliers are unreliable and expensive.

In principle, off-grid energy supply systems have proven to be very cost effective in many OECD and developing countries because electricity suppliers can avoid the cost of extending transmission and distribution systems. Because of the sheer size of the Russian Federation, wind or hybrid wind-diesel systems, biomass-fired steam boilers with turbine-generators and small-hydro power stations could be cost-competitive with traditional fossil fuel technologies in remote areas, and their use can and should contribute to improving the energy self-sufficiency of these regions.

The above analysis suggests that solutions for the problem of securing stable, uninterrupted and affordable energy supplies to all economic sectors and households will require serious administrative, technological and financial efforts.

7.4.3. Increasing the energy efficiency of the economy

According to the Strategy, the level of energy intensity of the country's GDP is 23 times higher than the world's average and 31 times higher than in the European Union. In the past 20 years in industrially developed countries, the annual growth rate of TPES was 0.4% per 1% growth of GDP. As a result, the level of GDP energy intensity in these countries has declined by 21-27%.

Table 7.1 shows that the situation in the Russian Federation was completely different, with constant or increasing energy intensity in many years of the analysis. However, in recent years (due to economic recovery, and in particular industrial output growth and an increase of the share of services in GDP value added), the level of energy intensity of GDP has declined by 2-3% annually.

Across the country, the economically viable potential for energy conservation currently stands at nearly 250-300 Mtoe, or 39%-47% of the overall primary energy use. Approximately one third of this potential is accumulated in the FEC, 35-37% in industry, and 25-27% in the residential sector.

About 20% of available energy conservation potential can be realized due to low-cost measures (i.e., less than 14 USD per toe). Fifteen percent of the evaluated potential can be realized for 35 USD and more per toe. The remaining two-thirds of considered potential require 14-35 USD per toe.

The Strategy assumes that economic restructuring and technological and organizational energy efficiency measures will decrease the level of GDP energy intensity by 26-27% by 2010 and by 45-55% by 2020 in comparison with 2000 (Figure 7.9).

About 50% of the forecasted economic growth is to occur due to restructuring, without increasing the energy demand.

The growth of energy use per unit of GDP (Table 7.1) was primarily caused by the growth of energy intensity in manufacturing industry, while in the services sector this indicator tended towards reduction. Unfortunately, a sectoral breakdown of energy intensities measured in monetary or physical units is not available.

The increase in energy intensity in manufacturing industry was caused by:

- increasing levels of industrialization, accompanied by a decrease in low energy intensive industries and a growth in high energy intensive and resource-driven industries focusing on exports;

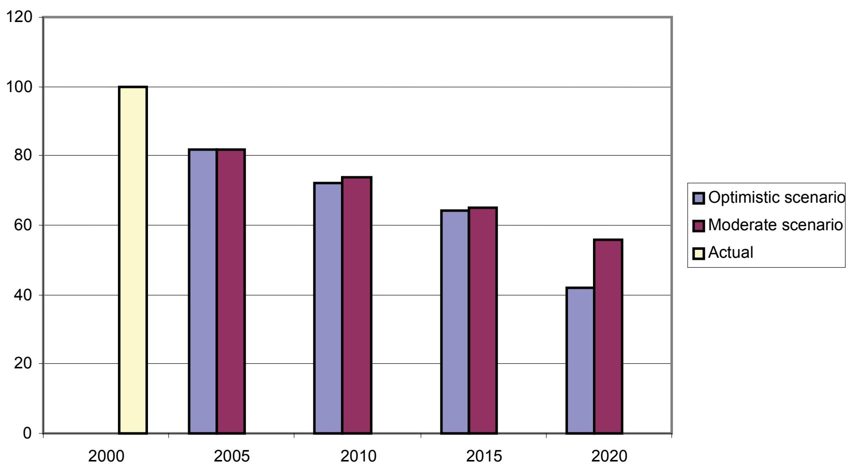

Figure 7.9 Energy use per unit of GDP in Russia in 2000-2020 (2000 = 100%)

- a two or threefold decrease in industrial capacity levels, which sharply increased the total energy intensity of the so-called "fixed energy" cost components, such as heating, lighting, etc.;
- a significant (up to 25%) “unaccounted-for” element of industrial production, mainly in the manufacturing sector, hidden from taxation and hence not reported by official statistics; and
- the use of outdated technologies.

Nevertheless, in some branches of the manufacturing industry there is progress towards decreasing energy intensity. One positive example is the iron and steel industry. For the period 1995-1999 alone, the level of specific energy consumption in this branch declined by 20%. However, the gap between specific energy consumption in steel production and leading foreign countries still remains (Table 7.29).

The reasons for the specific energy consumption decline in steel production can be explained by the following main factors:

- Many economically (and energy) inefficient steel-producing enterprises have been closed;
- Like oil or gas, steel is a very important export product. Its export allows steel-producing enterprises (almost all of them are already privatized) to accumulate the needed investment for modernization and energy efficiency improvements.

Some information on the final energy intensity of selected energy intensive products is provided in Table 7.30. Unfortunately, the statistical data available are not comprehensive and do not allow for definitive conclusions about the dynamics and regularities of final energy intensities over time.

Decreasing non-productive energy losses during transportation and distribution (which are higher than in developed countries) can and must contribute to increasing the energy efficiency of the economy. The implementation of energy saving measures would enable the country to prolong the lifetime of the most efficient component of its energy resource base (i.e., proven recoverable reserves), to extend the energy export potential, and to mitigate negative environmental impacts.

Among the principal obstacles for increasing energy efficiency, the following topics deserve particular attention:

- Disadvantages of institutional structures;
- Weakness of legislative base;
- Lack of investment;
- Ineffective pricing and taxation policy (including existing energy subsidies);
- Deterioration of scientific and research base;
- Limited and inefficient information support.

TABLE 7.29 SPECIFIC ENERGY CONSUMPTION IN STEEL PRODUCTION IN THE RUSSIAN FEDERATION AND IN THE UNITED STATES.

	1995	1996	1997	1998	1999
RUSSIAN FEDERATION					
Primary energy consumption, Mtoe	38.6	35.3	31.6	29.8	30.8
Steel production, Mt	51.6	49.3	48.5	43.8	51.5
Specific energy consumption, toe/t	0.75	0.72	0.65	0.68	0.6
UNITED STATES OF AMERICA					
Primary energy consumption, Mtoe	25.0	24.9	26.7	27.0	2.61
Steel production, Mt	95.5	95.5	98.5	97.7	97.4
Specific energy consumption, toe/t	0.26	0.26	0.27	0.28	0.27

Source: IEA (2002)

TABLE 7.30 SPECIFIC FUEL AND ENERGY CONSUMPTION RUSSIA'S INDUSTRIAL BRANCHES, KGOE/T

Branch; Product / Energy use	1992	1993	1994	1995	1996	1997	1998	1999	2000
Iron and steel									
Pig iron									
fossil fuels	408.1	413.7	414.5	417.0	411.3	408.3	405.5	403.6	404.2
heat	5.69	5.78	5.82	5.76	6.09	5.56	5.88	5.77	5.78
Chemical and Petrochemical									
Synthetic Rubber									
fossil fuels	874.1	863.6	804.8	754.0	734.4	712.3	738.0	636.4	668.5
electricity	753.0	778.1	803.7	666.4	724.3	737.5	769.4	694.2	672.4
heat	2,709.2	2,909.8	2,693.9	2,398.2	2,400.1	2,441.2	2,433.0	2,217.0	2,166.9
Pulp and paper									
Pulp									
electricity	153.5	158.0	187.3	169.1	172.0	163.8	169.1	164.9	154.3
heat	503.0	519.7	558.7	515.31	513.1	464.2	481.0	453.2	429.9
Paper									
electricity	158.8	160.0	204.4	183.29	232.7	231.3	220.4	278.3	259.0
heat	219.7	217.9	274.9	226.3	282.9	258.63	245.4	230.1	212.32
Construction materials									
Cement (clinker)									
fossil fuels	144.1	148.4	149.5	150.2	154.0	159.7	154.8	149.2	150.8
electricity	27.2	27.4	29.9	29.9	31.0	30.2	32.4	31.1	31.4

Source: MIE (2003b)

7.4.4. Developing and improving the energy resource base

The economic potential of the Russian Federation depends heavily on the volume, structure and geography of its energy resource base. Energy resource availability, accessibility and the cost of extraction and delivery are the key factors that will define the future development and performance of FEC, which plays an important role in energy and hard currency supplies for the domestic economy.

To date, the extent of exploration in the European regions of the Russian Federation and West Siberia is as high as 70% for oil and 45% for gas, while East Siberia and the Far East have been explored only 6-8% onshore and 2% offshore. Importantly, the remote regions of the latter (including North Tyumen and Arkhangelsk provinces) have about 46% prospective energy resources of the country.

Eighty percent of total proven recoverable reserves of coal are concentrated in Siberia, and only 10% in the European part of the Russian Federation, the largest coal-consuming region.

According to the Strategy, about 1 Mt of predicted uranium resources are located in the Russian Federation's territory. Today, 55 uranium fields are registered in the country. The total uranium production from these fields in 2020 will account for 6,500 to 7,000 tonnes, in comparison with an expected national uranium demand of 10,000 to 12,000 tonnes. The difference will be covered by uranium stocks and nuclear fuel recovery, as well as by nuclear fuel production from fast breeder reactors (by the end of forecasting period).

An essential growth of proven recoverable reserves of hydrocarbons should be achieved by 2020; for oil by 7.5-10 Bt, for natural gas by 11,200-18,800 Bcm.

In order to realize such a programme of energy resource base expansion, serious efforts in institutional, legislative and investment, as well as improvements in scientific and technical policy in the field of exploration and exploitation of energy resources, should be made.

7.4.5. Decreasing the negative environmental impacts of the energy system

In 1999, the Head of the State Committee for Environmental Protection of the Russian Federation reported that 250,000 people die prematurely in Russia every year from health problems caused by the environmental situation.

Environmental policy is directed towards the reduction of the burden of the FEC on the environment, as that sector accounts for a high share of hazardous atmospheric emissions and effluents, and over 30% of solid wastes. It is also responsible for the bulk volume of radioactive wastes.

That is why reducing the negative environmental impact of energy is one of the key priorities of Russia's energy policy. The FEC must accomplish a reduction in the emission of pollutants, the dumping of wastes, and other risks to the environment and human health to levels that would not have negative environmental implication.

Because of economic and industrial output declines, the principal indicators characterizing the environmental situation have decreased in the last 10 to 12 years.

Unfortunately, a well-developed and strictly oriented environmental protection policy at federal and regional levels cannot be considered the reason for the above decline.

In accordance with the Kyoto Protocol, the Russian Federation will have to keep its GHG emissions during 2008-2012 at the level of 1990. The Strategy forecasts that GHG emission in 2010 will account for only 75-80% of 1990 levels, however. Even in 2020, taking into account the forecasted energy demand growth, the level of GHG emission will still not exceed the level of 1990.

A significant reduction of environmental pollution can be accomplished through optimization of the fuel and energy balance, by means of: maximum energy conservation, wide use of the most environmentally compliant fuels like natural gas, nuclear power and renewables; and rational content and allocation of industrial facilities, with provisions for regional environmental resources.

Achieving environmental targets will require enhancing activity in R&D in the field of environmentally sound technologies; constant monitoring of the environmental situation; improving the legislative base for environmental protection; developing financial incentives to accomplish environmental goals; and stimulating energy consumers to minimize the negative environmental consequences of their activities.

7.4.6. Review of data availability to perform the analysis using the ISED scheme

The above analysis identified which statistical data for ISED were available or not available. The majority of indicators from the ISED listing can be constructed and described by means of obtained statistical data.

Each of the selected energy policy priorities can be represented through the ISED framework.

7.5. Implementation of ISED Framework

Progress achieved in implementing key energy policy priorities can be monitored and measured through the ISED indicators.

Agenda 21, the Rio Declaration on Environment and Development, adopted by the United Nations Conference on Environment and Development (i.e., UNCED, commonly called the Earth Summit) in Rio de Janeiro, Brazil in 1992, is dedicated to implementing sustainable development. This is seen as a focus for addressing today's pressing problems, and preparing the world for the challenges of the next century. Agenda 21 covers all issues that have significant bearing on one or more of the three key dimensions of sustainability (i.e., social, economic, and environmental), as well as the institutional dimension necessary for implementation. One of the most significant issues is energy.

Energy is an essential factor of social and economic development. As noted earlier, energy development is an important factor of environmental degradation at the global, national and local levels.

Chapter 9 of the Agenda states:

"Energy is essential to economic and social development and improved quality of life. Much of the world's energy, however, is currently produced and consumed in ways that could not be sustained if technology were to remain constant and if overall quantities were to increase substantially. The need to control atmospheric emissions of greenhouse and other gases and substances will increasingly need to be based on efficiency in energy production, transmission, distribution and consumption, and on growing reliance on environmentally sound energy systems, particularly new and renewable sources of energy. All energy sources will need to be used in ways that respect the atmosphere, human health, and the environment as a whole."

7.5.1. The FEC and the dimensions of sustainability

The above dimensions of sustainability include the following 16 topics:

Social dimension:

- Energy disparities;
- Energy affordability and accessibility

Economic dimension:

- Economic activity levels
- Energy production, supply and consumption
- Energy pricing, taxation and subsidies

- End-use energy intensities
- Energy supply efficiency
- Energy security

<u>Environmental dimension:</u>

- Global climate change
- Air pollution
- Water pollution
- Wastes
- Energy resource depletion
- Land use
- Accident risks
- Deforestation

The institutional dimension must address all of the above issues taken individually, as well as collectively.

A brief analysis of the FEC in the context of sustainable development is provided below.

7.5.1.1. Social dimension

Energy disparities

According to available statistics, the richest 20% of the world's population uses 55% of primary energy, while the poorest 20% uses only 5%. As far as the Russian Federation is concerned, statistical data on such disparities are not available.

Energy disparities are, in any event, a consequence of economic disparities—different living standards for the richest and poorest parts of the population. Large flats (or individual cottages), numerous electrical appliances, air conditioning in summer, and comfortably warm temperatures inside the dwelling in winter are now inevitable features of life for the richest part of the population (i.e., the so-called "new" Russians).

A small flat (often just one room per household), limited quantities of electrical appliances, and a sole electric bulb in the ceiling are the main attributes of living standards for the poorest part of the population.

According to experts' evaluations, the gap in personal income between the richest 20% and the poorest 20% of population in 2000 was as high as a factor of 10.3.

Indeed, as elsewhere, the poorest part of the population in Russia consumes much less energy than the richest one. However, one cannot say that there is a shortage of energy for the poorest people because of excessive energy consumption by the richest part of country's population. It depends on both the quantity and quality of energy services that are affordable.

Energy affordability

Under the conditions of market reforms, the question of energy affordability for various categories of consumers is becoming more and more relevant.

A brief analysis of current levels of end-use energy prices has been provided above. The principal forecast is that end-use energy prices will continue to grow for all categories of domestic consumers, and accordingly, one major concern is: how affordable are these prices for industry, the transportation sector, the service sector, and households?

In the case of end-use energy price growth, industrial enterprises and enterprises and companies in the transportation and services sectors will normally just include this growth in the cost (and thus consumer's price) of industrial products, tickets for transportation means, or various services. In turn, this contributes to increased inflation rates.

As far as population is concerned, the financial burden associated with energy use (i.e., payments for energy bills) is consuming a higher and higher fraction of disposable income of domestic households.

Table 7.31 demonstrates a structure of consumption in PPP terms (including the share of expenditures of households on fuel and power) in the Russian Federation and several OECD countries. It can be seen that the Russian Federation has the highest share of fuel and power expenditures within the structure of household consumption. This is linked to the current low level of income in households, because end-use energy prices for the population in the country are actually lower than in OECD countries.

It is also very important to mention once again that the ordinary population not only pays for end-use energy prices growth directly in energy bills, but also for the general price growth in the country associated with rising end-use prices.

The Strategy provides some forecasts of energy affordability for the population.

It is emphasized in the Strategy that one of the main tasks of the state's energy policy is to ensure affordable energy supplies for the general population as well as socially and strategically important entities (i.e., within the budgetary sphere and the military-industrial complex). It also notes that the fraction of disposable income spent on fuel and electricity by the poorest part of the population is relatively high. However, the level of social support for this part of the population is not sufficient.

TABLE 7.31 STRUCTURE OF HOUSEHOLDS' CONSUMPTION IN 1998, % (BASED ON PPP VALUES)

Household Consumption	Russia	USA	Japan	UK	Germany
Food	28	13	12	14	14
Clothing and footwear	11	9	7	7	6
Fuel and power	16	9	7	9	7
Health care	7	4	2	3	2
Education	15	6	22	3	10
Transport and communications	8	8	13	6	7
Other consumption	16	51	37	58	53

Source: World Bank (2000)

In such a case, the problem is to minimize the negative economic effects of end-use energy price growth. As shown in Table 7.4, total expenditures (or payments) on energy use per capita in 2020 will be 233-235% of those in 2000. At the same time, the Strategy assumes that the real income of the population in 2020 will be 300-440% of the level in 2000. Thus, according to the Strategy, the more rapid growth of disposable income will compensate for the end-use energy price growth.

One additional problem of paramount importance is to ensure an effective social protection system for the poorest part of the population. This system should be transparent and operate in the least bureaucratic manner possible. Existing systems of social protection (e.g., energy subsidies, as well as those for other services such as waste management, maintenance and telephone) are very time consuming, complex, and bureaucratic.

Energy accessibility

According to official statistics, the FEC meets the entire energy requirements of the domestic economy and population.

The fraction of households heavily dependent on non-commercial energy is about 1-2%, and probably comparable with the share of CRW in the final energy mix in the residential sector (i.e., 1.3% in 2001). Officially, the fraction of households without electricity is 0%.

Nevertheless there are some problems in ensuring 100% access for the population to energy carriers.

Although the Russian Federation is a large net energy exporter, certain energy-limited regions depend on energy imports to a level of 70-80%, or more. At the same time, local energy resources including renewables are only weakly used. If this situation continues in the future, it is going to be a very serious social and political problem for the Russian Federation.

Interruptions in energy supplies, both in energy-limited and other regions of the country, are often caused by non-payments by energy consumers because of a reduction of their paying capacity, and problems in the financial interrelations between fuel and energy companies.

Another element influencing energy accessibility is the technical state of energy supply systems. Technical accidents in heat supply systems, for example, have been a frequent phenomenon in Russia in recent years. The solution to this problem depends upon administration activity and constant organization and technical control, as well as investment in the modernization of equipment and infrastructure.

One can thus say that the problem of energy accessibility is not a problem of energy resources or relevant infrastructure availability. It is not even connected with geographical distinctions of the country. Energy accessibility is an organizational, institutional and financial problem.

Regional leaders, federal officials, and the heads and owners of the fuel and energy supplying companies must ultimately take responsibility for ensuring reliable energy supplies for all categories of energy consumers throughout the Russian Federation.

7.5.1.2. Economic dimension

The level of energy development as well as its sustainability in any country is closely linked with the economic state of its energy system, and the situation in the national economy as a whole.

In Russia the state of the FEC reflects the main trends of economic development in the country.

The collapse of the centrally planned system, economic crisis, and the transition to a market-driven economy have negatively affected the economic state and functioning of the FEC.

The level of the country's GDP as well as the GDP per capita have tended to decrease, associated with the general decline in economic activity levels (in particular in industrial output, passenger and freight transport activities). Correspondingly, there was a decline in energy demand from economic sectors, and an essential reduction of internal energy production. At the same time, the decrease in internal energy consumption contributed to increasing the net energy export share in TPES (Figure 7.2).

In the past 2-3 years, economic growth has resumed, as well as growth in energy production and consumption (Table 7.1).

One of the most serious problems the FEC faced in recent years is a lack of investment. This concerns virtually all sectors of domestic energy, including production, transmission, distribution, consumption, R&D, environmental protection, etc. As shown in Table 7.32 the total amount of private investment in the energy sector is lower than in some developing countries.

As mentioned above, the FEC today relies mostly on internal financial resources.

TABLE 7.32 INVESTMENT IN ENERGY PROJECTS WITH PRIVATE PARTICIPATION, MLN USD

Country	1990-1995	1996-2002
Russia	1,100	2,295
Argentina	12,035	13,470
India	2,889	9,680
Indonesia	3,202	7,544
Philippines	6,831	7,031
Morocco	2,300	4,820

Source: World Bank (2000)

At the same time, ineffective pricing and taxation policy in energy carriers and the unresolved problem of energy subsidy removal do not allow domestic energy enterprises to create the needed investment potential.

Because of that, the technical state of the FEC has substantially deteriorated. In turn, the low technical level of equipment is the main reason for low energy supply efficiencies, the relatively high level of end-use energy intensity, and the increasing risk of potential technological accidents.

In recent years, some positive trends in energy efficiency improvements have taken place (especially in some branches of the manufacturing industry). This was mostly connected with growing industrial output, and closing non-profitable and economically uncompetitive enterprises; it was only partly related to the direct implementation of available energy conservation potential.

The material and energy intensive structure of the GDP (with traditionally large shares of heavy industries) has been reformed during recent decades. In 1992-2000, there was some decline in the industrial share of the country's GDP value added, and simultaneously growth of the share of services and taxes.

The concluding analysis of the FEC with respect to its economic dimension suggests that the economic and financial framework for domestic energy in the country needs serious improvements, and cannot be considered sustainable.

7.5.1.3. Environmental dimension

The FEC's functioning and development is an important reason for the environmental problems faced in the country in recent years. Global climate change, air and water pollution, waste generation, existing risks (sometimes very high) of technical accidents in various energy industries, the large areas of lands used for energy purposes, and non-renewable energy resource depletion are the principal negative consequences of the FEC's influence on the environment.

According to official statistics, most categories of air pollutant emissions for the years of economic reforms have essentially declined (Table 7.33). This decline was mostly associated with the diminishing internal demand for energy resources. Power engineering is a leader in the industrial structure of air pollutant emissions (Figure 7.10). Its share is more than the share of the oil, coal and gas industries all combined.

TABLE 7.33 QUANTITIES OF AIR POLLUTANT EMISSIONS IN RUSSIA IN 1993-1999 (THOUSAND TONS)

	1993	1994	1995	1996	1997	1998	1999	1993-99
Oil sector	962	796	758	770	828	951	877	-9%
SOx	16	15	19	20	23	23	23	46%
CO	618	497	438	490	541	657	627	2%
NO_x	17	16	17	18	21	22	24	39%
VOCs	275	236	254	210	202	189	143	-48%
Particulates	36	32	30	32	41	60	60	64%
Oil production, Mt	352	316	307	301	306	303	305	-13%
Natural gas sector	497	511	304	293	306	292	314	-37%
SOx	47	47	47	48	48	51	61	30%
CO	248	241	206	200	216	204	213	-14%
NO_x	62	51	28	24	24	24	25	-60%
VOCs	136	168	18	17	13	5	7	-95%
Particulates	4	4	5	4	5	8	8	93%
Natural gas production, Bm^3	618	604	595	601	571	591	591	-4%
Coal sector	243	243	216	197	166	140	118	-51%
SOx	56	55	50	42	33	26	20	-63%
CO	63	67	64	62	50	42	34	-45%
NO_x	15	16	16	16	14	11	10	-33%
VOCs	N.a	N.a	N.a	N.a	N.a	N.a	N.a	N.a
Particulates	109	105	86	77	69	61	54	-50%
Coal production, Mt	285	273	263	257	245	232	249	-13%
Petroleum Refineries	906	770	691	671	731	683	637	-30%
SOx	197	181	159	144	148	134	136	-31%
CO	87	64	59	59	49	50	47	-46%
NO_x	22	21	21	21	22	21	20	-9%
VOCs	589	494	441	438	502	469	427	-27%
Particulates	11	10	11	9	10	9	7	-34%
Petroleum products production	219	181	180	176	178	163	169	-23%
Power engineering	5.887	5.231	4.973	4.705	4.382	4.297	3.887	-34%
SOx	2.498	2.255	2.134	2.006	1.833	1.818	1.618	-35%
CO	191	219	248	259	254	238	242	27%
NO_x	1.384	1.200	1.137	1.109	1.055	1.021	961	-31%
VOCs	1	1	1	1	1	1	1	39%
Particulates	1.813	1.556	1.453	1.330	1.239	1.219	1.065	-41%
Electricity generation, TWh	957	876	860	847	834	827	846	-12%
Total energy	8.590	7.551	6.939	6.635	6.411	6.364	5.836	-31%
SOx	2.813	2.553	2.408	2.259	2.084	2.051	1.858	-34%
CO	1.206	1.088	1.015	1.070	1.110	1.191	1.163	-4%
NO_x	1.501	1.304	1.218	1.187	1.135	1.100	1.041	31%
VOCs	1.097	899	713	666	718	665	579	-47%
Particulates	1.973	1.707	1.585	1.453	1.364	1.357	1.195	-39%

Source: State Committee on Environmental Protection (SCEP) (2003)

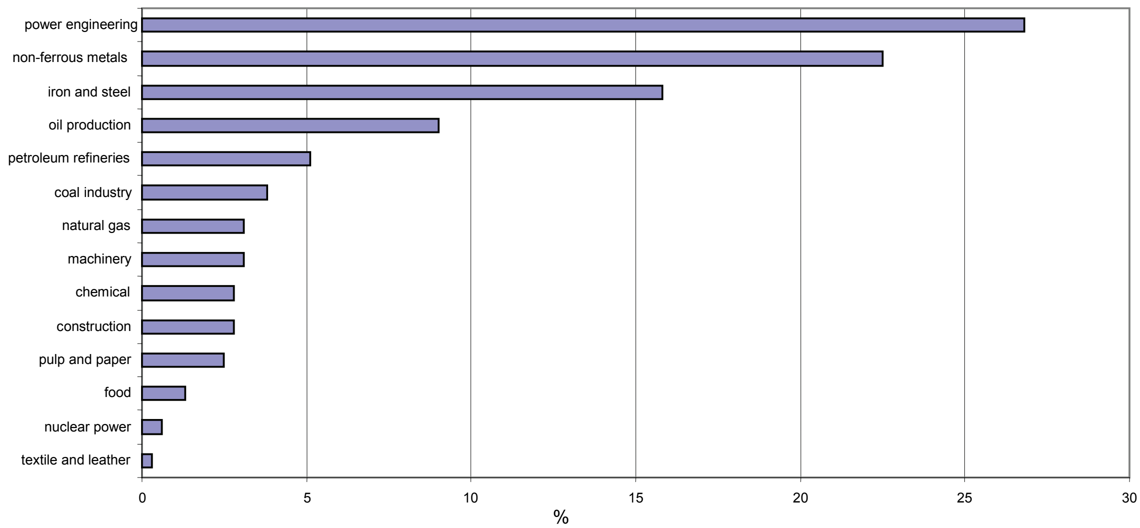

Figure 7.10 Industrial structure of air pollutant emissions (including SOx, CO, NOx, VOC and Particulates) in 1999, %

The same situation took place with respect to CO_2 emissions (Table 7.34). The level of primary energy consumption in Russia in 1992-1998 declined by 19.8%, and CO_2 emissions by 28.6%.

The structure of the main sources of CO_2 emissions in 1998 is given in Figure 7.11. This proportional share has been more or less constant in recent years.

Some information on ambient concentrations of pollutants in urban areas (for Moscow and Omsk) has been obtained (Table 7.35). Comparison with foreign cities shows that the environmental situation in urban areas is not the worst in the world, but far from being perfect.

Statistical data in Table 7.36 show definite activities in introducing technologies aimed at decreasing the negative influence of the FEC on the environment, as well as investment growth in environmental protection measures taking place. However, according to some experts' evaluations, both the introduction of new environmentally sound technologies and the investment in environmental protection measures undertaken in Russia do not meet the current requirements of the country.

As mentioned above, the lack of investment does not allow the FEC enterprises to ensure the needed refurbishment and modernization of their technological base. That is why the risk of technological accidents leading to fatalities and environmental damage is relatively high. Official statistics (e.g., time series) on the fatalities due to accidents in the energy sector throughout the country are not available. Nevertheless, such fatalities do take place, especially in the coal industry.

The Russian Federation has more than 20% of the world's forests. It is the most forested country in the world. They publish the forestry statistics every 5 years. In 1998, forested land was estimated to be 881.97 million hectares. The annual net growth in forested areas is nearly 1 billion cubic meters, above the allowable cut (according to official statistics) of 540 million m^3 (Table 7.37). However, some parts (probably, very essential) of deforestation in the country is uncontrollable.

Five million households in the country use forest resources as a fuel, and the annual consumption of woods for fuel purposes is about 50 Mm^3. These figures have been more or less constant for the most recent 10-12 years. It is emphasized in the Strategy that local energy sources, including fuelwood and residential and agricultural wastes, should be included in national and regional fuel and energy balances, and should contribute to the diversification of energy supplies and the solution of environmental problems.

TABLE 7.34 CO_2 EMISSIONS IN RUSSIA IN 1992-1998

		1992	1993	1994	1995	1996	1997	1998	1998/ 1992[1]
Total CO_2 emissions[2]	Mt CO_2	1,983.33	1,822.54	1,569.94	1,531.67	1,513.02	1,461.62	1,415.78	-28.6
CO_2 emissions/TPES	tCO_2 /toe	2.56	2.44	2.41	2.44	2.45	2.46	2.43	-5
CO_2 emissions/GDP using PPP's	tCO_2/ 1,000$	1.82	1.83	1.8	1.84	1.88	1.8	1.83	0.5
CO_2 emissions/population	tCO_2/ person	13.34	12.27	10.58	10.34	10.24	9.92	9.63	-27.8

Source: OECD/IEA (2000)
1 % change
2 These data are only energy related CO_2, not for any other greenhouse gases.

TABLE 7.35 AMBIENT CONCENTRATION OF POLLUTANTS IN URBAN AREAS IN 1995

Country	City	City population, Thousands	Total suspended particulates, microgram per cubic meter	Sulfur dioxide, microgram per cubic meter	Nitrogen dioxide, microgram per cubic meter
India	Delhi	9,948	415	24	41
Mexico	Mexico City	16,562	279	74	130
Philippines	Manila	9,286	200	33	n.a
Russian Federation	Moscow	9,269	100	109	n.a
Russian Federation	Omsk	1,199	100	9	30
Thailand	Bangkok	6,547	223	11	23
Sweden	Stockholm	1,545	9	5	29
United Kingdom	London	7,640	n.a	25	77
United States	New York	16,332	n.a	26	79
United States	Los Angeles	12,410	n.a	9	74

Source: UNEP (2004)

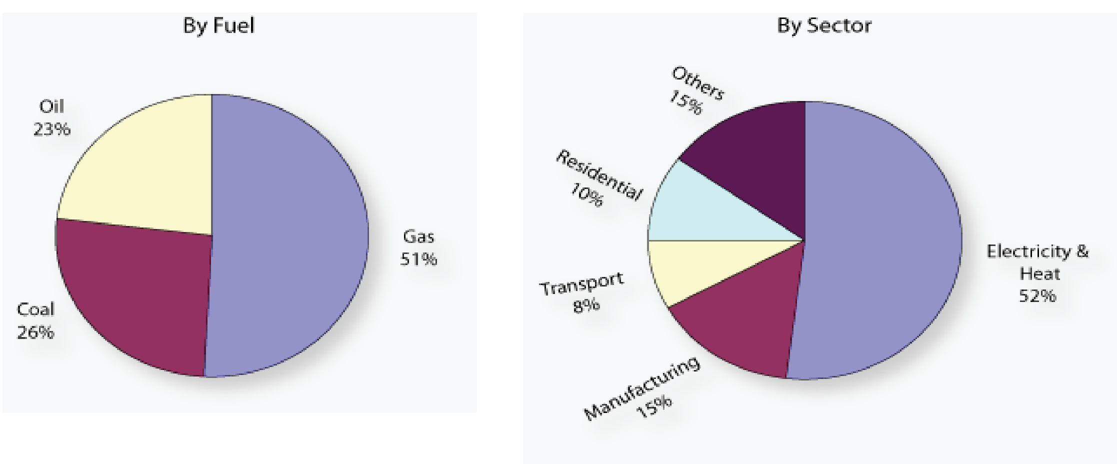

Figure 7.11 CO2 emissions by fuel and by sector in Russia in 1998

TABLE 7.36 STATUS OF DEVELOPMENT OF ENVIRONMENTAL PROTECTION TECHNOLOGIES IN RUSSIA.

Indicator	1993	1994	1995	1996	1997	1998	1999	2000
Sewage effluents, total, Bcm	27.2	24.6	24.5	22.4	23.0	22.0	20.6	20.3
FEC, Bcm	2.34	2.2	2.14	1.73	1.87	1.48	1.65	1.58
Air pollutant emissions, total, Mt	24.8	22	21.3	20.2	19.3	18.7	18.5	18.8
FEC, Mt	11.5	11.5	10.3	10.84	9.94	9.3	9.5	9.64
Sewage effluents abatement technologies total, Mm^3/day [1]	1.3	1.4	1.4	0.8	1	0.6	0.4	0.2
FEC, Mm^3/day	0.1	0.2	0.46	0.25	0.15	.08	0.04	0.14
Pollution abatement technologies total, Mm^3/h [1]	4.3	5.9	7.5	6.3	3.1	1.2	3.8	3.1
FEC, Mm^3/h	1.3	N/a	3.86	3.47	1.66	1.15	0.85	1.3
Investment in environmental protection, total, % [2]	N/a	109	102.7	76.4	95.6	100.4	95.3	139.1
FEC, %	94.2	119	178	144.7	78.8	96.8	123	154

Source: MIE (2003b)
1 Annual commissioning
2 Percentage of previous year

TABLE 7.37 FOREST RESOURCES, REFORESTATION AND DEFORESTATION IN RUSSIA

	Unit	European Russia and the Urals	Asian Russia	Total
Forested (stocked) area	Million hectare	167	603	770
Total growing stock	Billion cubic metres	22	59.9	81.9
Of which: Coniferous stands	Billion cubic metres	13.2	48.3	61.5
Growing stock of mature and overmature stands	Billion cubic metres	9.6	34.2	43.8
Of which: Coniferous stands	Billion cubic metres	380	600	980
Annual growth	Million cubic metres	380	600	980
Allowable cut	Million cubic metres	208	334	542

Source: IEA (2003b)

7.5.1.4. Institutional dimension

The institutional dimension can affect all three other dimensions—social, economic and environmental—through corrective response policy actions affecting the sustainability of the whole energy system.

The correct or incorrect institutional framework defines to a considerable extent the current state and prospects for any sector of the FEC, and the direction of national energy policy.

The unfavourable investment climate in the economy and in the FEC in particular was noted above. Weaknesses in investment legislation and the limited use of advanced investment mechanisms (e.g., production sharing, leasing, etc.) are the major factors restricting the use of foreign investment in domestic energy.

Ineffective regulation in energy prices and taxes, and the unsolved problem of energy subsidy removal are the main obstacles standing in the way of creating internal investment potential in the FEC.

Developing the right set of institutional measures is very important for successfully implementing market reforms in the power engineering and gas industries.

The weakness of the Law "On Energy Conservation" and the limited financial incentives guaranteed by the government for energy conservation activity have not contributed to decreasing the energy intensity of the domestic economy.

The Strategy assumes an essential improvement in the institutional framework of the national energy policy.

More detailed explanations of the influence of institutional measures on the results of the FEC functioning and energy policy implementation, as well as measures that are going to be implemented in the future are, as outlined in sections below.

7.5.1.5. Energy policy priorities and ISED

The priorities for Russian energy policy are addressed and described by the various dimensions of sustainability (Table 7.38).

The priority connected with securing stable, uninterrupted and affordable energy supplies is related to the social dimension of sustainability; increasing energy efficiency and ensuring energy security are linked with the economic dimension; and the two remaining priorities are within the environmental dimension. The results of the above analysis show that institutional activities and policy implementation are important necessary conditions for realizing selected priorities.

The indicators presented in the list of ISED are divided into the three groups:

- State Indicators;
- Direct Driving Forces;
- Indirect Driving Forces.

The main priorities of the energy policy presented through the indicators from the list of ISED are given in Table 7.39.

As noted earlier, energy security is one of the most important components of economic and national security for the country. Development of the economy and improving the well-being of the population depend very heavily on both indigenous energy production (with the FEC providing energy for the economy) and the share of net energy import (i.e., net energy exports for the Russian Federation) in the country's TPES.

Among the driving forces which have a direct influence on the State Indicators relevant to this priority, the following should be noted:

- Expenditures on the energy sector, or investment in ensuring needed volumes of energy production in order to meet internal energy requirements and economically justified export supply;

TABLE 7.38 RUSSIA'S ENERGY POLICY PRIORITIES AND DIMENSIONS OF SUSTAINABILITY

Energy policy priorities	Dimension of sustainability
Securing stable, uninterrupted and affordable energy supply for the economy and households	Social dimension: Energy disparities Energy affordability and accessibility
Increasing energy efficiency of the economy Ensuring national energy security	Economic dimension: Economic activity levels Energy production, supply and consumption Energy pricing, taxation and subsidies End-use energy intensities Energy supply efficiency Energy security
Decreasing the negative environmental impacts of the energy system Developing and improving the energy resource base	Environmental dimension: Global climate change Air pollution Water pollution Wastes Energy resource depletion Land use Accident risks Deforestation
	Institutional dimension: All of the above issues as well as priorities taken individually as well as collectively

Source: MIE (2003a), IAEA/IEA (2003)

TABLE 7.39 THE MAIN PRIORITIES OF RUSSIA'S ENERGY POLICY PRESENTED THROUGH THE LIST OF ISED.

Priorities	State indicators	Direct Driving Forces	Major Indirect Driving Forces
Ensuring national energy security	17. Indigenous energy production 18. Net energy import dependence	14. Energy use per unit of GDP 15. Expenditure on energy sector	2. GDP per capita 3.End-use energy prices with and without tax/subsidy 4.Shares of sectors in GDP value added 12. Energy supply efficiency
Securing stable, uninterrupted and affordable energy supply for the economy and households	16. Energy consumption per capita 17. Indigenous energy production 22. Fraction of households heavily dependent on non-commercial energy, without electricity	14. Energy use per unit of GDP 15. Expenditure on energy sector 21. Fraction of disposable income/ private consumption per capita spent on fuel and electricity by average population, group of 20% poorest population	2. GDP per capita 3. End-use energy prices with and without tax/subsidy 4.Shares of sectors in GDP value added 5.Distance traveled per capita 6.Freight transport activity 7.Floor area per capita 8.Manufacturing value added by selected energy intensive industries
Increasing the energy efficiency of the economy		14. Energy use per unit of GDP	2. GDP per capita 3. End-use energy prices with and without tax/subsidy 4. Shares of sectors in GDP value added 5. Distance traveled per capita 6. Freight transport activity 7. Floor area per capita 8. Manufacturing value added by selected energy intensive industries 9. Energy intensity: manufacturing, transportation, agriculture, services, residential sector 10. Final energy intensity of selected energy intensive products 12. Energy supply efficiency
Developing and improving the energy resource base	17. Indigenous energy production 37. Lifetime of proven recoverable fossil fuels reserves 39. Lifetime of proven uranium reserves	15. Expenditure on energy sector 35. Fraction of technically exploitable capability of hydropower currently not in use	
Decreasing the negative environmental impacts of the energy system	24. Ambient concentration of pollutants in urban areas 25. Land area where acidification exceeds critical load 30. Accumulated quantity of solid wastes to be managed 32. Accumulated quantity of radioactive wastes awaiting disposal 34. Fatalities due to accidents	23. Quantities of air pollutant emissions from energy related activities 27. Radionuclides in atmospheric radioactive discharges 26. Quantities of greenhouse gas emissions from energy related activities 28. Discharges into water basin associated with energy activity 29. Generation of solid wastes 31. Generation of radioactive wastes from nuclear power cycle chain 33. Area of land taken up by energy facilities and infrastructure	2. GDP per capita 3. End-use energy prices with and without tax/subsidy 4. Shares of sectors in GDP value added 5. Distance traveled per capita 6. Freight transport activity 7. Floor area per capita 8. Manufacturing value added by selected energy intensive industries 9. Energy intensity: manufacturing, transportation,

			agriculture, services, residential sector 10. Final energy intensity of selected energy intensive products 11. Energy mix 12. Energy supply efficiency 13. Status of deployment of pollution abatement technologies

Source: MIE (2003a), IAEA/IEA (2003)

TABLE 7.40 LIST OF ISED: COMPACT FORM.

N	Indicator	Current state (1992-2001)	Forecast (to 2020)
1	Population: total; urban	Decreased by 2.65%. Share of urban population within 73-75%.	Future declining. Moving rural population into urban areas in case of continuation of economic hardships.
2	GDP per capita	Decreased by 12.2%	231% of 2000 in moderate scenario. 334% in optimistic scenario.
3	End-use energy prices with and without tax\subsidy	End-use energy prices have been constantly growing. Energy subsidies exist.	End-use energy prices will continue growing to achieving cost-based level. Energy subsidies will be eliminated.
4	Shares of sectors in GDP value added	Share of services increased. Share of industry decreased.	Further optimization of GDP structure directed at developing services sector and low energy intensive industries.
5	Distance traveled per capita: total, by urban public transport mode	Practically repeats dynamics of GDP and GDP per capita.	It will grow along with GDP growth and improving living standards of the population
6	Freight transport activity: total, by mode	Practically repeats dynamics of GDP and GDP per capita.	It will grow along with GDP growth and improving disposable income of the population
7	Floor area per capita	Some increase within 15-20% used to take place. Today this indicator is equal to 20 sq. m/person	This indicator will grow up to the level of leading industrially developed countries.
8	Manufacturing value added by selected energy intensive industries	Manufacturing value added: Food and tobacco- 17% Textiles and clothing- 4% Machinery and transport equipment- 20% Chemicals- 9% Other manufacturing- 51% (1997)	The share of energy intensive industries in manufacturing value added will have a trend to decline.
9	Energy intensity: manufacturing, transportation, agriculture, commercial & public services, residential sector	One can speak about growing trends because of the energy intensity of GDP increase. It concerns mostly manufacturing industry.	This indicator is growing but will decline.
10	Final energy intensity of selected energy intensive products	In 1995-1999 energy intensity of steel production had declined by 20% because of increasing industrial output and closing inefficient enterprises. The similar situation takes place for the other energy intensive products in the latest years	It will have a trend to decline due to further growth of production and technical improvements in energy efficiency.
11	Energy mix: final energy, electricity generation, primary energy supply	Final energy mix: heat – 32%, gas – 28%. Electricity and primary energy mix: dominating role of natural gas (42% and 52%, respectively).	Electrification and motor fuels consumption growth. Declining share of natural gas in the fuel and energy balance. Primary energy consumption

		Final energy consumption decreased by 27%, electricity generation – by 11.8%, Primary energy supply – by 19.8%.	and electricity generation growth.
12	Energy supply efficiency: fossil fuel efficiency for electricity generation	Energy supply efficiency is much lower than in leading developed countries. High level of distribution losses.	Modernization and rehabilitation of equipment and infrastructure of energy supply systems are going to be implemented.
13	Status of deployment of pollution abatement technologies: extent of use, average performance	Current activity is not enough to deal with negative environmental consequences of energy development.	Enhancing activity in R&D, improving legislative base and additional investment will be undertaken.
14	Energy use per unit GDP	Increased by 6.3%. In the last 2-3 years some decline took place.	56% of 2000 in moderate scenario. 42% of 2000 in optimistic scenario.
15	Expenditure on energy sector: total investment, environmental control hydrocarbon exploration & development, R&D, net energy import expenses	Lack of investment practically in all sectors of Russia's FEC used to take place.	Planning investment in 2000-2020: gas industry – 170-200 bln USD; Oil industry – 230-240 bln USD; Electricity – 120-170 bln USD; including 25-35 bln USD in nuclear power plants; coal industry – 20 bln USD; heat supply systems – 70 bln USD; energy conservation - 50-70 bln USD.
16	Energy consumption per capita Primary energy, toe/person Electricity, kWh/person	1992 2001 primary energy 5,211 4,293 electricity 6,107.5 5,319	The dynamics of these indicators will correlate with the growth rates of primary energy and electricity demand.
17	Indigenous energy production Electricity generation	Decreased from 1,118.7 mln toe in 1992 to 996.2 mln toe in 2001 (-10.95%) Decreased from 1,008.4 bln kWh in 1992 to 889.3 bln kWh in 2001 (-11.8%).	Moderate scenario – 1,265 mln toe. Optimistic scenario – 1,420 mln toe. Moderate scenario – 1,215 bln kWh. Optimistic scenario –1,365 bln kWh.
18	Net energy import dependence	Relatively sharp decrease in energy demand used to contribute to increasing share of net energy export in TPES from 42.4% in 1992 to 59.1% in 2001.	The share of net energy export in TPES will account for 55-60%.
19	Income inadequate	40 times in 2000 according to the World Factbook 2002.	Serious efforts are going to be undertaken by government in order to decrease existing gap.
20	Ratio of daily disposable income/private consumption per capita of 20% poorest population to the prices of electricity and major household fuels	Official statistics are not available; however, it is clear that financial burden of payments for energy use is getting heavier.	In 2020 expenditures on energy use (per capita) will reach 233-235% of 2000.

21	Fraction of disposable income/private consumption spent on fuel and electricity by: average population; group of 20% poorest population	16% for average households.	Energy Strategy assumes increase of personal income by 3.4-3.7 times in comparison with expenditures on energy use by 2.3-2.4 times.
22	Fraction of households: heavily dependent on non-commercial; without electricity	About 1.5%; 100% electrification	Increasing use of local (mostly non-commercial) energy resources is very important for ensuring reliable and stable energy supply in remote areas.
23	Quantities of air pollutant emissions (SO_2, NO_x, particulates, CO, VOC).	Decrease because of declining energy demand.	Active measures of environmental protection are to be implemented.
24	Ambient concentration of pollutants in urban areas: SO_2, NO_x, suspended particulates, CO, ozone	Not worst in the world but far from being perfect	Environmental protection measures will be needed
25	Land area where acidification exceeds critical load	Official statistics are not available.	Official statistics are not available.
26	Quantities of greenhouse gas emissions	Decreased due to energy demand reduction.	75-80% of 1990 by 2010. Will not exceed the level of 1990 in 2020.
27	Radionuclides in atmospheric radioactive discharges	Official statistics are not available.	Official statistics are not available.
28	Discharges into water basins: waste/storm water, radionuclides, oil into coastal waters	The problem is very current	Urgent legislative and technical measures are needed.
29	Generation of solid waste	36 mln t in 1995, 19.6 mln t in 2000	It will grow along with energy consumption
30	Accumulated quantity of solid wastes to be managed	Official statistics are not available.	Official statistics are not available.
31	Generation of radioactive waste	Official statistics are not available.	Official statistics are not available.
32	Accumulated quantity of radio-active wastes awaiting disposal.	Official statistics are not available.	Official statistics are not available.
33	Land area taken up by energy facilities and infrastructure	Official statistics are not available.	Official statistics are not available.
34	Fatalities due to accidents with breakdown by fuel chains	Official statistics are not available.	Official statistics are not available.
35	Fraction of technically exploitable capability of hydropower currently not in use	90.7%	It will decline due to hydropower production growth.
36	Proven recoverable fossil fuel reserves	coal 157,000 Mt oil 6,700 Mt gas 48,000 bcm	Proven recoverable reserves growth: oil – by 7.5-10 bln t natural gas – by 11,200-18,800 bcm
37	Life time of proven recoverable fossil fuel reserves	coal 600 years oil 36 years gas 80 years Additions to explored domestic proven recoverable reserves of fossil fuels were below the production volumes.	The objective is to ensure a high level of energy resource self-sufficiency in the long term.
38	Proven uranium reserves	145,000 t	Compensation of annual production is to be

			ensured.
39	Life time of proven uranium reserves	56	Positive trend is to be achieved
40	Intensity of use of forest resources as fuelwood	5 million households use forest resources as fuelwood, at a rate of about 50 mln m^3 annually.	Woods are going to be an important source of decentralized energy supply for the future (for remote areas).
41	Rate of deforestation	Annual growth- 980 mln m^3 Allowable cut- 542 mln m^3 Unauthorized cut takes place.	It is necessary to strive for rehabilitation of forest resources, to their renewability.

Source: MIE (2003a), IAEA/IEA (2003)

- Net energy export revenues, which provide a bulk of the investment for the energy system, and one of the most important sources of budget receipts;
- Energy use per unit of GDP, the decline of which, for example, both influences the energy export potential growth and allows a decrease in the level of indigenous energy production without any threats to energy security.

Indirect driving forces (IDF) affecting energy security levels are also shown in Table 7.39. Explanations suggesting why these IDF have been selected are provided below.

A specific level of the economic development (i.e., GDP per capita) requires both the relevant availability and quality of energy services, and their provision in turn requires corresponding expenditures.

The level of end-use energy prices in the Russian Federation is one of the key factors influencing the dynamics of energy exports and the state of energy security within the country. In particular, several gasoline crises have taken place in large cities. They were caused by a deficit of motor fuels within the internal market, which was created by private companies that benefited from a favourable situation in foreign markets.

The influence of the GDP structure (i.e., the shares of various sectors in GDP value added) also plays a role in Direct Driving Forces. The higher the share of raw material and energy intensive branches of the industry, the more investment required for the energy system (in particular, in the energy production sector), and the more problems that could emerge in addressing the energy export potential. The result will be a higher total energy intensity of GDP.

The energy supply efficiency affects the energy use per unit of GDP, and the establishment of the energy export potential. It should be noted that both the Direct and Indirect Driving Forces on some priorities of energy policy will be duplicated; therefore, these comments will not be repeated in the text. For example, in addressing concerns about ensuring energy security, the other energy policy priorities can all be considered as structural components.

Among the State Indicators related to the next energy policy priority (i.e., securing stable uninterrupted and affordable energy supply for the economy and households) the following ones can be noted:

- Energy consumption per capita (which is a very important indicator reflecting the level of energy and economic development);
- Indigenous energy production;
- Fraction of households heavily dependent on non-commercial energy, without electricity (this indicator reflects the level of accessibility and affordability of commercial energy resources for consumers).

The indicator related to the direct driving force is the fraction of disposable income/private consumption per capita spent on fuel and electricity by the average population and a group of 20% poorest population. In other words, this indicator shows how heavy the financial burden associated with payments for energy resources is for different groups of the population. As mentioned above, the share of expenditures for fuel and electricity should be reasonable in order to stimulate energy conservation activity in the population, and to ensure economic affordability of energy carriers for all groups of the population.

It is worth noting that if the total payments from households for a set of services provided for the residential sector (e.g., energy carriers, telephone, waste management, maintenance, etc.) exceed 25% of disposable income, then the difference is to be reimbursed by a subsidy.

Major Indirect Driving Forces related to considering energy policy priorities include mostly the indicators reflecting economic activity levels in the country. These are, in particular, transportation activity, living standards of the population (e.g., floor area per capita), as well as manufacturing value added by selected energy intensive industries.

As for increasing energy efficiency, a set of the IDF includes indicators characterizing the level of economic development; end-use energy prices (as a factor influencing the energy conservation activity of consumers); the structure of the economy (e.g., industry and transport); the energy intensity of various industrial branches; and energy supply efficiency.

According to the Strategy, end-use energy price growth is a principal factor for successful implementation of the national energy conservation policy.

The energy policy priority "Developing and improving the energy resource base" is described by the following State Indicators:

- Lifetime of proven recoverable fossil fuel reserves; and
- Lifetime of proven uranium reserves.

These indicators show the level of self-sufficiency for relevant fuel reserves. They show the ratio between the available level of proven recoverable fossil fuel (or uranium) reserves and the annual level of their production. Higher ratios indicate higher levels of self-sufficiency.

Direct Driving Forces related to energy policy priorities reflect the quantitative levels (volume) of proven recoverable fossil fuel (and uranium) reserves as well as the potential for hydropower development (i.e., the fraction of technically exploitable capability of hydropower currently not in use).

"Expenditure on hydrocarbons exploration and development" and "Indigenous energy production" could be referred to as IDF for the priority "Developing and improving the energy resource base." The growth of the first indicator contributes to an increase in proven recoverable reserves, and growth of the second one to their depletion.

The last priority indicated in Table 7.39 concerns the environmental impact of energy development (i.e., decreasing the negative environmental impacts of the energy system).

The State Indicators related to this priority mostly reflect the quantitative results of the negative impact of energy development on the environment. It concerns, in particular, accumulated quantities of solid and radioactive wastes, areas of land taken up by energy facilities and infrastructure, etc.

Among the Driving Forces directly influencing on the State Indicators related to the environmental priority of Russia's energy policy are the following:

- Quantities of air pollutant (and greenhouse gas) emissions from energy related activities;
- Generation of solid (and radioactive) wastes;
- Discharges into water basin; and radionuclides in atmospheric radioactive discharges.

Among the IDF linked to decreasing the negative environmental impacts of the energy system are indicators related to economic activity, since economic development causes increased energy consumption (and therefore a negative environmental impact); end-use energy prices (with or without subsidies and environmental taxes); energy intensities and supply efficiency; and the status of deployment of pollution abatement technologies and expenditures on their development.

7.6. Assessment of Current Energy Policies in Priority Areas

7.6.1. The main results of the ISED implementation

Implemented analysis of the ISED package is useful from the standpoint of better understanding the interrelationships between separate indicators and sustainability dimensions. It allows an evaluation of the level of effectiveness of various political measures undertaken to improve sustainability of energy and economic development, as well as energy policy as a whole.

Table 7.40 provides a vision of the current state (for the period 1992-2001) and prospects (to 2020) of ISED by means of brief quantitative and qualitative analysis. Considering retrospective dynamics (1992-2001) of most indicators from the ISED listing, the following negative trends can be observed:

- Available data on GDP per capita demonstrate a declining trend;
- End-use energy prices demonstrate constant growth, but have not yet stimulated energy conservation and environmental protection activities; energy subsidies still exist;
- Energy intensities in separate sectors of the economy and in selected energy intensive products are still high;
- The decline in GDP, primary energy production and consumption (including consumption per capita) has been accompanied by an increase in energy use per unit of GDP; therefore, Russia's economy has become more energy intensive;
- A sharp lack of investment has occurred within the FEC (and concerns practically all energy industries);
- Payments for energy bills are becoming a greater financial burden for the poorest portion of the population;
- The main environmental indicators reflecting the negative influence of energy development on the environment (in particular air pollutant emissions) have demonstrated some positive (i.e., declining) trends, mostly connected with a reduction in energy production and consumption (rather than from environmental protection policies);
- Low energy supply efficiency exists (i.e., there are high distribution losses);
- Despite a large energy resource base, additions to explored domestic proven recoverable fossil fuel reserves were below production volumes.

Among the positive trends and factors within ISED, the following should be noted:

- Service sector growth in GDP value added, and a simultaneous decline of industry's share (in 1998 the aggregated structure of GDP value added was: services, 58%; industry, 35%; and agriculture, 7%);
- Increase of energy export potential (i.e., the share of net export in TPES);
- High share of CHP in electricity and heat generation.

All selected priorities and relevant indicators were classified according to dimensions of sustainability (Table 7.38), as well as State Indicators, Direct and Indirect Driving Forces (Table 7.39).

The effectiveness of energy policy needs serious improvement, in order to ensure sustainable energy development in the long-term. A listing of the improvements related to each particular energy policy priority is outlined below.

7.7. Strategies for Improvements in Priority Areas

Achievement of identified energy policy priorities requires the implementation of relevant strategies and response actions.

7.7.1. Ensuring national energy security

Two major problems are to be solved in implementing this priority of Russia's energy policy:

- Modernization and refurbishment of the technological base of the FEC, as well as compensation for the loss of productive capacities and correlation between domestic proven recoverable reserves of fossil fuels and production volumes. The lack of investment will not ensure large-scale construction of new capacities in the current decade. In this regard, priority will be given to the technological modernization of existing capacities, and prolongation of their life times;
- Structural change in energy consumption directed towards increasing the share of hydro and nuclear power, renewables and coal (based on clean coal combustion technologies); and

diversification of the geography of hydrocarbons production (from West Siberia to East Siberia, Far East, the northern regions of the European part, and the Caspian region).

7.7.2. Securing stable, uninterrupted and affordable energy supply for the economy and households

Implementation of this priority could include planning and active social policies designed to minimize the negative consequences of end-use-energy price growth for the socially unprotected (i.e., the poorest) groups of population. The following measures are to be realized:

- Compensating end-use energy price growth by increasing the personal income of the country's population;
- Creating effective systems of social protection for the poorest part of the population;
- Ensuring effective use of budgetary and financial means aimed at social protections, and strict control over their spending.

Even in cases where necessary financial means are available for fuel, energy purchases, and the modernization and refurbishing of existing capacities and infrastructure (e.g., in preparation for the winter heating season), it is extremely important to ensure that such means are strictly controlled and effectively employed. It is a frequent practice that the financial means allocated from the federal budget to prepare for the winter season in various regions of the country are spent by local administrations for other purposes. As a result, some districts in the country could not be heated in winter because of a shortage of fuel for boilers and power plants, and technical accidents occurred in heat and hot water supply systems. Accordingly, it is also very important to strengthen the personal responsibility and accountability of the leadership of the fuel and energy supply companies, and regional and local administrations, if they break or interrupt energy supplies to consumers, or fail to implement contractual agreements and obligations.

7.7.3. Increasing the energy efficiency of the economy

The main quantitative target of the energy policy related to this particular priority, energy use per unit of GDP, is likely to decline in 2020 by 42-56% of the levels found in 2000. The set of measures to be implemented within this policy includes:

- Increasing the share of services within the GDP value added, and low energy intensive industries within manufacturing value added. Moreover, the share of manufacturing industries in the total industrial structure will be increased from 50% in 2002 to 64-65% in 2020;
- Achieving the technical potential of energy conservation.

In order to enhance energy conservation activity in the country, economically justified end-use energy price growth is necessary. This price growth should be profitable for federal and regional budgets, and FEC's enterprises, but affordable for the consumers. Energy prices should become an important stimulating factor for energy conservation in the Russian Federation.

At the same time, it is necessary to implement a package of measures with organizational, administrative, economic and information characteristics, including:

- Strengthening existing norms and standards defining specific volumes of fuel and energy consumption in various sectors of the domestic economy. Introducing these norms and standards for buildings (first addressing heat efficiency standards) and a number of residential electric appliances (in particular for refrigerators, consuming about 50% of total electricity in the residential sector) has already given promising results;
- Ensuring energy use efficiency in industry (in particular through regular energy audits);
- Organizing information and educational programmes for various categories of consumers;
- Creating workable and effective financial incentives;

- Enhancing activity in R&D aimed at creating and introducing advanced, energy efficient and environmentally sound technologies;
- Introducing advanced financial schemes for energy efficiency project implementation.

7.7.4. Developing and improving the energy resource base

A lack of investment was noted as being among the main reasons for the deteriorating state the country's energy resource base. The Strategy estimates the potential investment needed for improving the sustainability of the energy resource base at 40-50 billion USD through 2020.

The main problems to be solved within this energy policy priority are the following:

- Exploring new oil and gas fields;
- Creating new, efficient and environmentally sound technologies for fossil fuel extraction, directed at increasing the productivity of fuel production while simultaneously decreasing fuel costs;
- Improving the legislative base, especially in the field of licensing;
- Creating a favourable investment climate in the fuel producing sector;
- Enhancing activity for including local and renewable energy sources in the fuel and energy balance.

7.7.5. Decreasing the negative environmental impacts of the energy system

In recent years, there has been some decline in the negative influences of the FEC on the environment associated with the decreasing energy demand in the country. Nevertheless, the environmental consequences of energy development are still a very serious threat to environmental security in the country.

In this regard, the following measures are envisaged:

- Scientific R&D into environmentally secure technologies for energy production, transportation, processing, and use;
- Transition from a situation of pollutant releases, disposal, and recovery to the elimination of such pollutants through the introduction of modern technologies, minimization of wastes, and reduction of energy facility land degradation;
- Development of unified, industry-wide norms and rules, normative and technical documents and standards, the regulation of environmental protection and rational nature management; and
- Certification and licensing management with regards to innovative domestic and foreign technologies, equipment and materials that meet current environmental requirements.

Continuous environmental monitoring is essential for the main energy-producing regions, as well as for the transition from regulating maximum permitted emissions to maximum permitted impacts on nature. It is important to encourage the transfer to no-and-small-waste processes that require the recovery of associated gas at oil fields and coal-bed methane, and use the ash/slag wastes of power plants (both new wastes and those already in ash dumps) for construction and for the fabrication of construction materials.

7.7.6. Interrelationships amongst energy policy priorities

There are interrelationships amongst energy policy priorities, the principal response actions for implementing energy policy, and the ISED indicators positively affected by these response actions (Table 7.41).

Response actions given in Table 7.41 represent a broad range of directions for the energy policy. They include improvements in investment, legislative, environmental and structural directions. In addition to the positive influences on the identified targeted indicators (whose improvements lead to implementing the relevant energy policy priority), these response actions will also have a positive influence on other indicators in the ISED list.

For example, one of the targeted indicators related to the priority "Securing stable, uninterrupted and affordable energy supply for the economy and households" is the third listed for ISED (i.e., "End-use energy prices with and without tax/subsidy"). Indeed, end-use energy prices play an important role in ensuring stable, uninterrupted and affordable energy supply. Introducing the right energy prices will allow the FEC enterprises to obtain investment needed for ensuring normal functioning and development, including the modernization and refurbishment of existing productive capacities and infrastructure, and the construction of additional capacities.

TABLE 7.41 ENERGY POLICY PRIORITIES, RESPONSE ACTIONS AND TARGETED AND POSITIVELY AFFECTED ISED

Priorities	Targeted Indicators	Response Actions	Positively Affected Indicators as numbered in ISED list
Ensuring national energy security	15. Expenditure on energy sector	Increase expenditure on hydrocarbon exploration and development	17, 18, 36, 37
		Increase R&D expenditure for energy technology	9, 10, 12-14, 16-18, 21-41
Securing stable, uninterrupted and affordable energy supply for economy and households	11. Energy mix	Diversify energy supply	15, 18
		Increase share of renewables in fuel mix	15, 18, 20-32, 34-41
		Increase share of nuclear in fuel mix	23-26, 28-30, 34, 36, 37
	3. End-use energy prices with and without tax/subsidy	Include externalities in full cost of energy	5-7, 9, 10, 13,-16, 18, 23-29
		Eliminate energy subsides except for the poor population	5-7, 9, 10, 14-18, 23-24, 36-39
		Provide energy subsidies to the poor population	20-22, 40, 41
Increasing energy efficiency of the economy	3. End-use energy prices with and without tax/subsidy	Introduce taxes on polluting fuels (other response actions are given above)	5-7, 9, 10, 14-16, 18, 23-30
	4,8. Shares of sectors and sub-sectors in GDP value added	Optimize economic levels through reducing shares of energy intensive sectors/manufacturing industries	9, 14-18, 23-24, 36-39
	9,10. Energy intensity of economic sectors and selected energy intensive products	Decrease energy intensities through end-use energy efficiency improvement	14-18, 21-34, 36-41
	12. Energy supply efficiency	Increase efficiency of energy supply, in particular in electricity generation	14-18, 23-29
		Increase fraction of electricity supplied by CHP plants	14-18, 23-26, 28-30, 33, 36, 37
Developing and improving	11. Energy mix	Diversify energy supply	15, 18

the energy resource base	15: Expenditure on energy sector	Increase expenditure on hydrocarbon exploration and development	17, 18, 36, 37
Decreasing the negative environmental impacts of energy system	13. Status of deployment of pollution abatement technologies	Improve performance of pollution abatement technologies	23-25
		Extend use of pollution abatement technologies	23-25
	15. Expenditure on energy sector	Increase expenditure on radioactive waste management	31-33
		Increase expenditure on waste management	29-33
		Increase expenditure on air pollution abatement	13, 23-25
	29. Generation of solid waste	Decrease amounts of waste through recycling and reuse	30, 33, 36, 37
	31. Generation of radioactive waste from nuclear power fuel chain	Decrease amounts of radioactive waste through its recycling, treatment and conditioning	32, 38,39
	33. Land area taken up by energy facilities and infrastructure	Extend protected area as a percent of total land area	40, 41
	40. Intensity of use of forest resources as fuelwood	Extend managed forest area	41

Source: IAEA/IEA (2003)

That is why response actions related to this indicator include the following:

- Including externalities within the full cost of energy. This will allow the FEC enterprises to be reimbursed for all appropriate expenditures and investments, and to obtain economically justified profits necessary for further development;
- Eliminating energy subsidies. Along with the previous action, such a step will contribute to improving the financial state of the FEC, and stimulate rational and efficient approaches to energy use (including the implementation of energy conservation measures).

However, about 30% of Russia's population can be considered poor. These people will not be able to pay full cost of energy. That is why some form of financial support or other relevant measures of social protection should be made available for the poorest part of the population.

These actions will contribute to the decline of energy intensity of the GDP and its main sectors and industries, as well as improvements in the environmental situation, due to a decrease in non-productive energy losses.

However, the minimization of the influence of end-use energy price growth on the financial state of the poorest part of the population (Indicators 20-22 in particular) depends not only on saving some form of energy subsidies. The problem is that end-use energy price growth leads to general price growth for practically all industrial products and services which are not subsidized. For example, as soon as motor fuel prices increase, the population will clearly feel the influence of inflation. It will concern all aspects of the economy—including production in the food industry, for example.

Another targeted indicator affecting several priorities is the energy mix. To ensure stable and at the same time affordable energy supply in Russia's regions (including those suffering from energy shortages), it is necessary to diversify the sources of energy supply as much possible, and decrease the energy net import dependence by using local and renewable energy sources (and also increasing the share of nuclear power in the fuel mix).

These measures will also contribute to improving the environmental situation, saving the most economically effective part of fossil fuel reserves, as well as decreasing the financial burden on the population and other categories of energy consumers.

Concluding the above analysis, one finds that using indicators from the ISED list for describing the key priorities of Russia's energy policy can and should be very helpful for monitoring the national energy policy, and preparing strategies, programmes and governmental decrees on actual problems of energy development.

7.8. Conclusions and recommendations

1. Achieving sustainable energy development in Russia, as in any other country, can only be accomplished through well-developed and strictly-applied energy policies. The key priorities of such policies can be realized by analyzing the status of a broad range of indicators, including those in the ISED list, and representing all dimensions of sustainability (i.e., social, economic, and environmental), as well as institutional considerations.

2. The current state of the FEC is closely linked with the general economic situation in the country.

3. The 1992-2001 period considered in the study was characterized by a deterioration of the energy resource base, as well as a decrease in energy production and consumption.

4. This situation in domestic energy largely arose due to factors external to the FEC, and in particular the inconsistent implementation of macroeconomic reforms during 1992-1997.

5. As a result of economic hardships, energy demand declined, and a lack of investment in practically all sectors and branches of the FEC occurred.

6. Among the most serious problems in the FEC (as well as the main energy consuming sectors) is the problem of low energy supply efficiency; foremost is the problem of high distribution losses, and simultaneously high energy intensity within primary and final consumption.

7. One of the main reasons for the high energy intensity of the economy is the traditionally high share of material and energy intensive branches within domestic industry.

8. The decline of energy demand as a result of economic problems resulted in a definite decrease of air pollutant emissions and GHG emissions.

9. End-use energy prices, and in particular prices associated with the natural monopolies of electricity and natural gas, have been constantly growing during recent years. However, these have not yet stimulated energy conservation activities.

10. The Energy Strategy assumes that serious improvements in national energy policies will take place. It forecasts essential economic growth, social progress, enhanced industrial activity, and an improved institutional framework, legislative base, economic state and environmental characteristics for the FEC.

11. Collecting reliable statistics is very important for implementing a correct analysis following the ISED approach. Among the problems of collecting information related to ISED, the following are notable:

- Availability of statistics;
- Accessibility to needed statistical data;
- Quality of available statistics.

For the most part, relevant information has been collected. However, some statistical data are not available (or the probability of obtaining the data is very low), and remaining parts may not be accessible. The procedure necessary to obtain them may be very long and complex. The quality of some parts of the obtained information may not allow analysts to construct relevant indicators in time series, nor analyse their dynamics or influence on the energy situation within the country.

12. This report recommends incorporating the ISED package into national databases. The organization able to collect the necessary information and present it in the desirable units of measure (and in a form suitable for comparison on an international basis) is the State Committee for Statistics (Goscomstat). It is necessary for the Russian Government to decide the level of involvement of Goscomstat in collecting and providing such information.

13. A number of key priority areas for the energy policy have been identified. Among them:

- Ensuring national energy security;
- Securing stable, uninterrupted and affordable energy supply for the economy and households;
- Increasing energy efficiency of the economy;
- Developing and improving the energy resource base;
- Decreasing the negative environmental impacts of the energy system.

These priorities cover the most difficult issues of the FEC and the national economy as a whole. They will be of crucial concern at least within the period considered within the Strategy (i.e., until 2020).

14. All identified priorities have a close correlation with relevant dimensions of sustainability:

Securing stable, uninterrupted and affordable energy supply for the economy and households	Social dimension
Increasing the energy efficiency of the economy and ensuring national energy security	Economic dimension
Developing and improving the energy resource base and decreasing the negative environmental impacts of the energy system	Environmental dimension

All of these priorities are closely linked with the institutional dimension as well.

15. The ISED indicators related to each priority area have been identified. These indicators have been classified according to dimensions of sustainability and divided into three groups: State Indicators, and Direct and Indirect Driving Forces.

16. The analysis of the key priority areas in the energy policy demonstrates a good applicability of the ISED package for evaluation of the current state of, and prospects for, the FEC and monitoring the energy policy of the country. The analysis indicates that the current state of the energy situation, as well as the effectiveness of energy policies in recent years, is far from being sustainable. For the most part, ISED have been used to demonstrate negative trends. Economic recovery in very recent years has contributed to enhancing activity within the FEC. Nevertheless, serious improvements are needed.

17. The FEC cannot be considered sustainable separately from the economy as a whole. In this connection, economic recovery and market- driven reforms are the principal (i.e., necessary) condition for achieving sustainable energy development.

18. Pricing policies (including taxes and subsidies) occupy a special place within the economic and energy strategy.

19. Eliminating energy subsidies and including externalities in the fuel cost will stimulate energy conservation activities of consumers. However, energy resources could become unaffordable for the poorest portion of the population. Therefore, an effective system of social protection must be created for this group of the population.

20. Energy prices can (and must) contribute to decreasing the negative environmental impacts of the energy system. The problem is to supply the internal market with affordable, energy efficient and environmentally sound technologies that energy consumers might purchase.

21. It is necessary to create workable and attractive financial incentives for energy conservation and environmental protection activities.

22. The legislative base in fuel exploration and extraction, energy conservation and environmental protection should be substantially improved.

23. If the targets identified by the country's Energy Strategy are achieved, the level of sustainability of the energy will be significantly increased.

24. In order to identify the real level of sustainability in energy development, inter-country comparative analyses utilizing ISED (quantitative and qualitative) should be conducted. The countries which participated in this research project would be a good starting point for comparison.

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ANNEX 7.1. RUSSIA'S FUEL AND ENERGY BALANCE IN 1992-2001 (MTOE)

	Years	Coal	Crude oil	Petroleum Products	Gas	Nuclear	Hydro	Geothermal, Solar, etc.	CRW	Electricity	Heat	Total
Production	1992	143.924	398.841		517.166	31.523	14.778	0.025	12.449			1,118.707
	1993	135.066	353.254		498.934	31.418	14.912	0.024	11.797			1,045.406
	1994	123.347	317.347		490.058	25.859	15.048	0.027	8.41			980.096
	1995	117.049	306.633		480.414	26.249	15.085	0.026	8.505			953.96
	1996	112.126	300.996		485.384	28.768	13.186	0.024	6.873			947.356
	1997	106.636	305.405		460.75	28.613	13.466	0.025	6.766			921.662
	1998	107.633	302.912		477.018	27.784	13.631	0.026	5.417			928.421
	1999	115.342	304.755		477.097	32.119	13.802	0.024	7.447			950.587
	2000	117.02	323.3		470.605	34.419	14.111	0.05	7.008			966.512
	2001	122.123	347.57		468.637	36.05	14.955	0.078	6.747			996.161
Net imports/ exports	1992	-1.396	-132.414	-41.375	-152.09					-1.397		-328.667
	1993	0.623	-117.842	-40.359	-132.78					-1.611		-291.972
	1994	1.362	-122.506	-42.91	-147.31					-1.763		-313.128
	1995	-3.284	-114.401	-43.522	-151.07					-1.686		-313.96
	1996	3.786	-120.311	-51.791	-155.86					-1.676		-333.419
	1997	-2.715	-123.499	-52.045	-158.59				-0.329	-1.693		-338.871
	1998	-2.599	-132.319	-47.286	-161.84					-1.549		-345.595
	1999	-8.468	-130.561	-47.804	-162.51					-1.218		-350.564
	2000	-7.714	-139.2	-53.647	-146.03					-1.209		-347.808
	2001	-9.254	-157.775	-56.217	-142.72					-1.364		-367.336
Stock changes	1992	-10.295	-4.033	----	-0.889				----			-15.217
	1993	-2.282	0.862	4.495	-10.276				0.037			-7.164
	1994	0.695	-2.171	0.969	-15.186				0.25			-15.443
	1995	2.902	-2.899	1.172	-12.801				0.0.31			-11.595
	1996	10.555	1.333	2.004	-11.299				0.06			2.653

	1997	2.77	-0.077	0.258	9.316				0.092			12.359
	1998	1.643	-0.257	1.09	-4.303				0.388			-1.439
	1999	2.209	0.921	-0.083	-0.112				0.072			3.009
	2000	1.508	-0.236	-0.22	-5.664				-0.111			-4.722
	2001	-6.284	-.913	0.305	-0.69				0.106			-7.476
Total primary energy supply	1992	132.233	262.395	-41.375	364.192	31.523	14.778	0.025	12.449	-1.397		774.823
	1993	133.407	236.275	-35.865	355.875	31.418	14.912	0.024	11.834	-1.611		746.27
	1994	125.405	192.67	-41.94	327.559	25.859	15.048	0.027	8.660	-1.763		651.524
	1995	116.668	189.332	-42.35	316.545	26.249	15.085	0.026	8.535	-1.686		628.404
	1996	118.895	182.017	-49.786	318.228	28.768	13.186	0.024	6.933	-1.676		616.589
	1997	106.691	181.827	-51.786	311.476	28.613	13.466	0.025	6.529	-1.693		595.15
	1998	100.676	170.335	-46.197	310.874	27.784	13.631	0.026	5.805	-1.549		581.386
	1999	109.082	175.116	-47.887	314.473	32.1119	13.802	0.024	7.519	-1.218		603.031
	2000	110.815	183.85	-53.867	318.916	34.419	14.111	0.05	6.897	-1.209		613.981
	2001	106.585	188.881	-55.913	325.222	36.05	14.955	0.078	6.853	-1.364		621.349
Statistical differences	1992	4.273	3.429	-2.370	1.233							6.565
	1993	3.197	-0.535	-5.027	12.177							9.752
	1994	-1.669	-1.346	-2.238	12.888							7.635
	1995	8.987	-2.634	-4.008	6.528							8.874
	1996	5.493	-1.545	1.191	1.425							6.564
	1997	0.668	-2.545	-0.657	3.864							-6.397
	1998	3.945	-0.898	0	0							3.047
	1999	2.452	0	-0.079	2.450							4.823
	2000	0.001	0	-	2.455							2.456
	2001	2.457	0	-1.823	2.503							3.137
Heat and electricity	1992	-86.222	-1.224	-58.012	-217.51	-31.523	-14.778	-0.025	-4.337	86.728	207.756	-119.147

production by CHP. Electric and heat plants	1993	-87.449	-1.501	-55.812	-213.466	-31.418	-14.912	-0.024	-3.468	83.191	226.062	-99.801
	1994	-84.356	-0.382	-46.132	-201.837	-25.859	-15.048	-0.027	-3.56	76.239	206.118	-95.843
	1995	-80.917	-0.392	-37.741	-189.986	-26.249	-15.085	-0.026	-4.042	73.876	192.301	-88.259
	1996	-84.965	-0.599	-35.843	-189.31	-28.768	-13.186	-0.024	-2.993	72.77	160.194	-122.725
	1997	-75.759	-1.0	-29.872	-186.01	-28.613	-13.466	-0.025	-3.0	71.654	152.837	-113.256
	1998	-72.588	-1.055	-32.966	-182.128	-27.784	-13.631	-0.026	-2.999	71.052	151.575	-110.547
	1999	-76.022	-1.0	-26.439	-185.56	-32.119	-13.802	-0.024	-3.725	72.7	151.228	-114.767
	2000	-79.903	-1.066	-22.273	-186.361	-34.419	-14.111	-0.5	-3.764	75.376	154.905	-111.625
	2001	-78.64	-1.046	-21.369	-189.691	-36.05	-14.955	-0.078	-3.956	76.482	153.502	-115.8
Distribution losses	1992	-8.74	-2.492	-0.311	-5.891					-7.232	N.a	-24.667
	1993	-7.879	-1.766	-0.029	-5.932					-7.543	-7.061	-30.21
	1994	-6.645	-1.587	-0.023	-6.543					-7.348	-6.553	-28.669
	1995	-6.152	-0.719	N.a	-6.385					-7.179	-5.731	-26.166
	1996	-5.661	-1.116	N.a	-6.681					-7.263	-5.098	-25.819
	1997	-4.211	-1.281	N.a	-5.375					-7.257	-4.891	-23.015
	1998	-3.964	-1.623	N.a	-5.817					-8.018	-4.772	-24.194
	1999	-4.516	-1.710	N.a	-5.862					-8.27	-4.137	-24.45
	2000	-1.072	-1.607	N.a	-5.532					-8.741	-7.745	-24.698
	2001	-0.174	-1.738	N.a	-5.017					-9.072	-6.415	-22.416
Total final consumption	1992	29.631	0.187	140.018	135.885				8.035	65.047	207.756	586.559
	1993	30.367	0.169	119.28	141.787				8.316	60.696	204.459	565.074
	1994	24.005	0.163	92.248	124.391				5.091	54.635	185.101	485.634
	1995	27.663	0.181	83.371	118.117				4.45	53.176	171.893	464.851
	1996	22.648	0.222	84.061	114.060				3.903	51.701	142.645	419.24
	1997	18.343	0.39	83.503	108.72				3.524	50.73	136.477	401.686
	1998	17.826	0.402	74.989	111.839				2.76	49.753	135.579	393.148
	1999	19.634	0.541	82.775	114.543				3.751	50.965	136.251	408.459

	2000	20.691	0.845	91.714	117.14				3.051	52.333	136.774	422.548
	2001	21.226	0.622	93.193	119.739				2.83	53.151	136.697	427.458
Total industry sector	1992	13.38	0.026	24.61	52.162				0.879	36.047	N.a	127.14
	1993	13.589	0.05	22.254	48.204				0.485	32.373	98.337	215.293
	1994	12.086	0.024	12.668	37.977				0.388	27.38	79.398	169.921
	1995	16.452	0.038	10.293	39.739				0.542	27.005	73.3	167.369
	1996	14.412	0.038	9.743	37.686				0.384	25.293	56.111	143.668
	1997	10.522	0.067	12.312	38.952				0.385	25.075	52.14	139.453
	1998	10.512	0.041	9.284	35.602				0.525	24.35	48.818	129.133
	1999	10.702	0.043	10.546	37.631				0.71	25.46	50.101	135.192
	2000	10.472	0.045	19.043	42.751				0.59	26.867	50.271	150.038
	2001	10.456	0.021	15.916	43.489				0.451	27.657	50.448	148.438
Iron and steel	1992	10.393		2.272	14.963				N.a	5.948	N.a	33.576
	1993	9.97		0.436	14.088				N.a	5.439	9.588	39.521
	1994	8.964		0.339	12.852				N.a	4.901	7.74	34.796
	1995	13.408		0.37	12.655				N.a	4.697	7.441	38.570
	1996	11.717		0.992	11.571				N.a	4.778	6.276	35.333
	1997	9.038		1.193	10.579				N.a	4.826	5.941	31.577
	1998	8.623		0.919	9.673				0.002	4.673	5.879	29.769
	1999	8.242		1.007	10.657				0.002	5.03	5.841	30.778
	2000	7.93		1.055	11.748				0.135	5.422	5.812	32.101
	2001	7.379		1.024	11.987				0.14	5.477	5.827	31.834
Chemical and Petrochemical	1992	0.338		10.461	31.232					6.02	N.a	48.051
	1993	0.32		10.701	29.224					5.115	22.087	67.446
	1994	0.316		5.12	20.508					4.025	17.837	47.806
	1995	0.338		2.642	17.302					3.715	17.473	41.471

	1996	0.312		2.403	14.976					3.522	13.354	34.566
	1997	0.157		2.59	17.407					3.589	12.857	36.6
	1998	0.186		2.852	15.981					3.417	11.699	34.136
	1999	0.222		2.842	16.698					3.554	12.43	35.746
	2000	0.047		11.689	19.379					3.65	13.393	48.158
	2001	0.237		9.592	19.606					3.729	13.332	46.496
Non-ferrous metals	1992	0.855	N.a	0.848	1.551				N.a	8.507	N.a	11.761
	1993	0.928	N.a	0.61	1.568				N.a	8.223	7.011	18.34
	1994	0.773	0.001	0.487	1.585				N.a	7.529	5.663	16.039
	1995	0.855	0.002	0.52	1.603				N.a	7.273	5.406	15.659
	1996	0.766	0.005	1.044	1.621				N.a	7.904	4.489	15.829
	1997	0.415	0.009	1.208	1.639				N.a	8.083	4.215	15.569
	1998	0.727	0.003	1.138	1.657				0.002	7.973	4.22	15.72
	1999	1.142	0.002	1.963	1.951				0.001	8.18	4.265	17.504
	2000	1.389	0.002	1.838	1.865				0.025	8.567	4.391	18.077
	2001	1.626	0.002	1.213	1.96				0.006	8.928	4.937	18.672
Machinery	1992	0.686	0.004	1.129	1.18					7.029	N.a	10.028
	1993	0.894	0.003	0.667	1.021					6.021	22.883	31.49
	1994	0.861	0.003	0.418	0.932					4.764	18.475	25.452
	1995	0.816	0.005	0.395	0.786					5.733	15.773	23.507
	1996	0.656	0.005	0.488	1.595					3.815	12.58	19.14
	1997	0.333	0.009	0.555	1.697					3.74	11.422	17.739
	1998	0.238	0.003	0.402	1.576				0.006	3.534	10.397	16.156
	1999	0.244	0.002	0.393	1.683				0.004	3.655	9.713	15.693
	2000	0.307	N.a	0.424	2.345				0.005	3.795	9.186	10.061
	2001	0.329	N.a	0.379	2.424				0.004	3.888	9.214	16.237

Total transport sector	1992		0.035	75.699	33.943					7.463		117.141
	1993		0.03	57.677	32.801					5.784		96.256
	1994		0.013	50.386	31.533					5.65		87.582
	1995		0.01	46.878	29.36					5.604		81.852
	1996		0.09	43.995	28.55					5.584		78.139
	1997		0.016	42.459	24.153					5.458		72.085
	1998		0.012	46.778	30.931					5.163		82.885
	1999		0.011	47.605	30.726					5.213		83.555
	2000		0.011	47.77	26.932					5.239		79.951
	2001		0.006	50.066	27.082					5.344		82.498
Air transport	1992			15.017								15.017
	1993			12.729								12.729
	1994			10.601								10.601
	1995			9.874								9.874
	1996			9.232								9.232
	1997			9.139								9.139
	1998			8.576								8.576
	1999			8.865								8.865
	2000			9.32								9.32
	2001			9.586								9.586
Road transport	1992			49.266	1.051							50.317
	1993			39.428	0.583							40.01
	1994			35.833	0.79							36.622
	1995			32.849	0.322							33.171
	1996			30.643	0.222							30.865
	1997			30.25	0.186							30.436

	1998			35.478	0.18							35.658
	1999			35.523	0.174							35.697
	2000			34.913	0.81							34.994
	2001			37.137	0.26							37.164
Rail transport	1992			4.572						N.a		4.572
	1993			3.871						3.353		7.225
	1994			2.35						2.758		5.108
	1995			2.208						2.701		4.909
	1996			2.233						2.625		4.859
	1997			1.862						2.619		4.481
	1998			1.573						2.342		3.914
	1999			1.727						2.602		4.329
	2000			2.136						2.856		4.993
	2001			1.807						2.975		4.782
Pipeline transport	1992		0.035		32.893					2.441		35.369
	1993		0.03		32.218					1.945		34.193
	1994		0.013		30.743					1.712		32.468
	1995		0.001		29.038					1.557		30.605
	1996		0.009		28..328					1.625		29.962
	1997		0.016		29.966					1.482		25.464
	1998		0.012	0.031	30.755					1.536		32.334
	1999		0.01	0.058	30.551					1.503		32.122
	2000		0.01	0.027	26.851					1.96		28.847
	2001		0.006	0.028	27.056					1.508		28.598
Internal navigation	1992			2.496								2.496
	1993			2.099								2.099
	1994			1.602								1.602

	1995			1.231								1.231
	1996			1.192								1.192
	1997			1.07								1.07
	1998			0.96								0.96
	1999			1.019								1.019
	2000			1.17								1.17
	2001			1.228								1.228
Agriculture	1992	0.435		11.587	0.488				0.73	6.009	N.a	19.248
	1993	0.417		9.384	0.576				0.468	5.951	7.866	24.662
	1994	0.374		9.551	0.634				0.032	5.284	8.819	24.692
	1995	0.344		10.431	0.636				0.461	4.561	7.938	24.371
	1996	0.329		7.002	0.639				0.359	4.189	6.049	18.566
	1997	0.313		6.906	0.643				0.131	3.62	5.328	17.122
	1998	0.296	0.013	5.85	0.599				0.04	3.299	4.905	15.002
	1999	0.292	0.015	5.881	0.645				0.19	2.95	4.546	14.519
	2000	0.252	0.001	5.904	0.506				0.148	2.598	4.325	13.734
	2001	0.256	0.011	5.917	0.422				0.145	2.187	4.021	12.977
Commercial and public services	1992	5.257		0.334	7.795				0.654	5.572	N.a	19.612
	1993	0.358		0.321	6.416				2.527	5.353	13.203	28.178
	1994	0.873		0.356	5.281				0.684	5.249	17.927	30.37
	1995	0.802		0.375	4.346				0.42	5.164	14.345	25.453
	1996	0.648		0.304	3.577				0.322	5.281	14.414	24.546
	1997	0.683		0.179	2.945				0.264	5.141	13.053	22.264
	1998	0.741		0.249	2.424				0.125	5.367	15.586	24.492
	1999	0.905		0.956	2.452				0.209	5.94	16.163	25.978
	2000	0.370		1.016	2.455				0.018	5.527	13.262	22.648
	2001	0.34		1.051	2.503				0.014	5.705	10.201	19.814

Residential sector	1992	9.49	0.089	8.555	40.612				5.67	9.957	N.a	74.372
	1993	9.106	0.088	8.271	52.935				4.257	10.42	85.053	170.13
	1994	8.271	0.126	6.031	48.234				3.881	10.84	78.956	156.243
	1995	7.623	0.133	5.305	42.234				2.993	10.842	76.311	146.441
	1996	7.175	0.175	4.511	42.833				2.788	11.353	66.071	134.907
	1997	6.784	0.307	5.33	41.28				2.53	11.435	65.957	133.623
	1998	6.277	0.336	3.468	41.559				2.071	11.573	66.269	131.553
	1999	7.735	0.472	5.226	42.333				2.643	12.048	65.440	135.898
	2000	8.512	0.722	4.438	43.111				2.091	12.102	68.916	139.892
	2001	9.013	0.506	4.672	45.416				2.012	12.258	72.028	145.905

Source: OECD/IEA (2003)