

Environmental Problems in the Energy of Eastern Regions of Russia and Ways of their Solution

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(1) Current environmental problems and energy sector

A large fuel and energy basis has been created in East Siberia and the Far East. The installed capacity of power plants in these regions makes up above 49 mln kWh. The regions produce 19% of Russia's electricity, 13% of heat, 36% of coal, 2.9% of oil, 1.7% of natural gas; and refine 11.7% of Russia's oil [1].

The pollutant emissions to the atmosphere depend on the quantity and quality of fuel and energy resources consumed in different sectors of the economy. East Siberia and the Far East burn fossil fuel, including up to 75% of coal (Table 1).

In 2008 according to the indices, that characterize the environmental impact, the contribution of the eastern regions made up: 21% of the total emissions to the atmosphere by stationary sources of RF, about 14% of all the polluted discharges of Russia and 16% of the total amount of production and consumption waste. However, the amount of pollutants per capita in East Siberia and the

Far East is about 1.5-2 times higher than average for Russia (Table 2).

Based on the data from state reports in 2007-2008 [4] the most environmentally unfavorable areas in East Siberia and the Far East are Krasnoyarsk Territory, Irkutsk Region, Primorie Territory and the Sakha Republic (Yakutia).

Each of the considered regions has their specific environmental problems and, accordingly, the facilities that have a negative impact on the natural environment (Fig.1).

The considered territories are characterized by concentration of production potential in the large industrial centers and cities. Therefore the residents of these cities (about 6.2 million people or 73% of the total population of East Siberia and the Far East) are exposed to the highest negative impact.

The most difficult task is to estimate the energy sector contribution to the environmental impact since, as a rule, all sectors of the economy are responsible for the environmental pollution in the industrial centers. The

Table 1. Consumption of fuel and energy resources in the eastern regions of Russia (in 2008)

Index	East Siberia	Far East	TOTAL
Fuel, mln tce, total	43.4	26.1	69.5 (100)
including:			
Coal	33.7	17.9	51.6 (75)
Natural gas	4.2	4.4	8.6 (12)
Oil products	2.6	2.9	5.5 (8)
Others	2.9	0.9	3.8 (5)

Source: [2, 3]; in brackets - in percent of all considered regions

Table 2. The environmental impact of the economic activities by region (in 2008)

Index	Eastern regions			Russia
	East Siberia	The Far East	TOTAL	
Pollutant emissions to the atmosphere, stationary sources, mln t/year	3.4	0.9	4.3	20.1
per capita, t/person.	0.414	0.130	0.290	0.142
Polluted discharges, bln m ³ /year	1.5	0.9	2.4	17.1
per capita, m ³ /person	179.0	132.3	158.5	120.6
Production and consumption waste, million t/year	358	281	639	3877
per capita, t/person	43.0	43.3	43.1	27.3

Source: [1, 4, 5]

energy sector has a great influence on each element of the environment at all production stages: from extraction of energy resources and their transportation to production and distribution of final products.

Based on the current statistical reports the energy sector activities include production of energy resources; production and distribution of electricity, gas and water.

Thus, according to the data of Statistical Bulletin of the Federal State Statistics Service [5] in 2008 pollutant emissions from production and distribution of electricity, gas and water in East Siberia and the Far East made up 1337 thousand t or 31% of the total emissions from the considered regions. In East Siberia the emissions to the atmosphere from energy facilities amounted to 763.8 thousand t/year which is 22% of the total emissions from East Siberia (3.45 million t/year). In the Far East of 842 thousand t of total emissions from stationary sources 572.9 thousand t of emissions came from production and distribution of electricity, gas and water, which makes up nearly 68%.

The contribution to the impact on the water bodies is assessed on the basis of data concerning polluted water discharges from several large energy enterprises operating in East Siberia and the Far East. The main volume of sewage water is discharged from the coal producing enterprises operating in the Far East (16.8% of the total sewage water discharges) and East Siberia (11.7%) [4].

Besides, a great amount of polluted discharges comes to the water bodies from the enterprises of housing and public utilities (HPU) which, according to the aggregated estimations, makes up nearly 40% in East Siberia and up to

50-55% in the Far East.

Five large coal enterprises operating in East Siberia and the Far East were responsible for 22.5% (200.4 million t) of waste in 2008. These are: JSC "Yakutugol" (57.2 million t), "Sibir-ugol" Ltd (48.6 million t), JSC "LuTEK" (34.6 million t), Krasnoyarsk branch of JSC "SUEK" (30.4 million t), "Razrez "Yuzhny" Ltd (29.6 million t).

Along with the waste from coal enterprises the quantity of slag and ash waste from thermal power and boiler plants using coal as a fuel rises considerably every year.

As of the beginning of 2008 the contribution of energy facilities operating in the eastern regions of Russia to the impact on the atmosphere is estimated at 31%, on the water bodies - at 60%, and to the waste formation - at 40%. Including 22, 51 and 18%, respectively, in East Siberia, and 68, 75 and 48%, respectively, in the Far East (Fig.2).

The major contributors to the environmental pollution in Russia's eastern regions are large-capacity thermal power plants operating in the regional and territorial centers, numerous boiler plants using coal as a fuel, and coal producing enterprises.

Besides, the energy sector enterprises are the main emitters of greenhouse gases to the atmosphere. During the period of 1990-1998 the emissions from all sectors of the economy shrank due to economic recession. After 1998 as the economy started to recover and production and consumption started to rise, the emissions started to grow as well. Today energy sector is still dominating in the contribution to the greenhouse gas emissions which makes up 80-82.6% or 1786.8 million t.

Fig.1. Environmental problems of the eastern regions of Russia

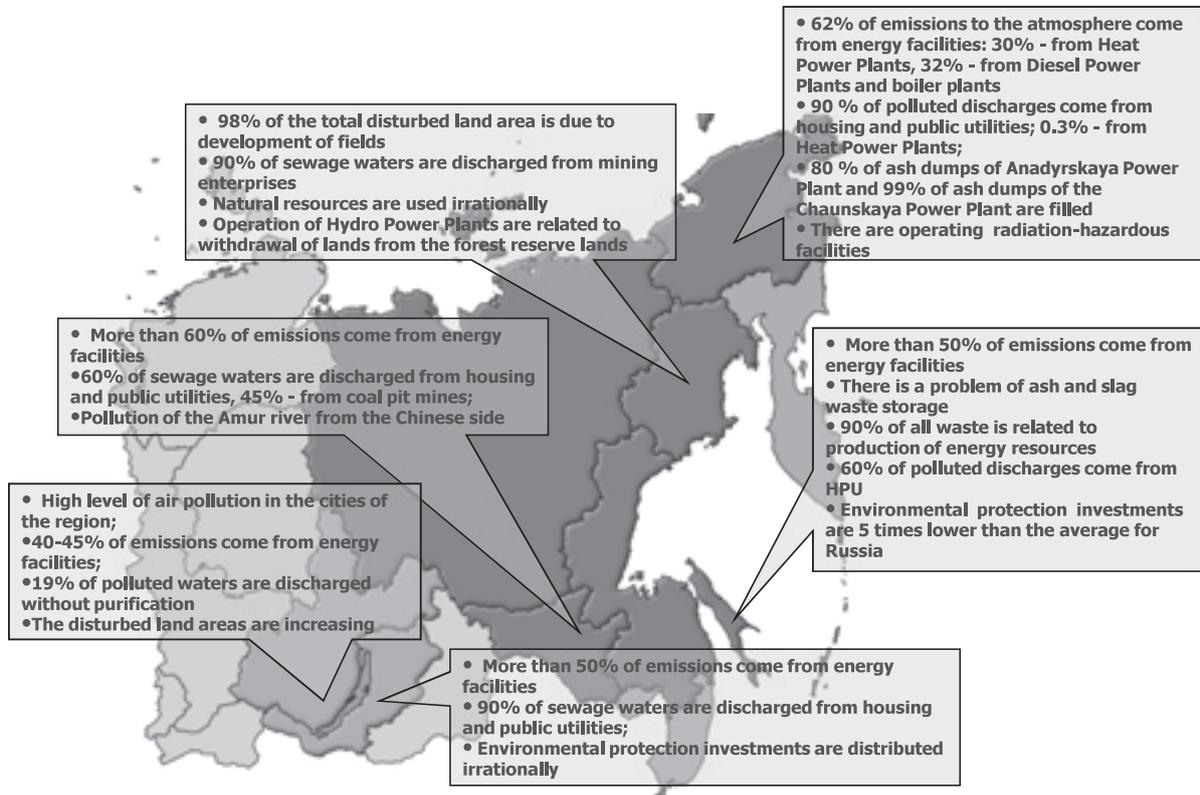
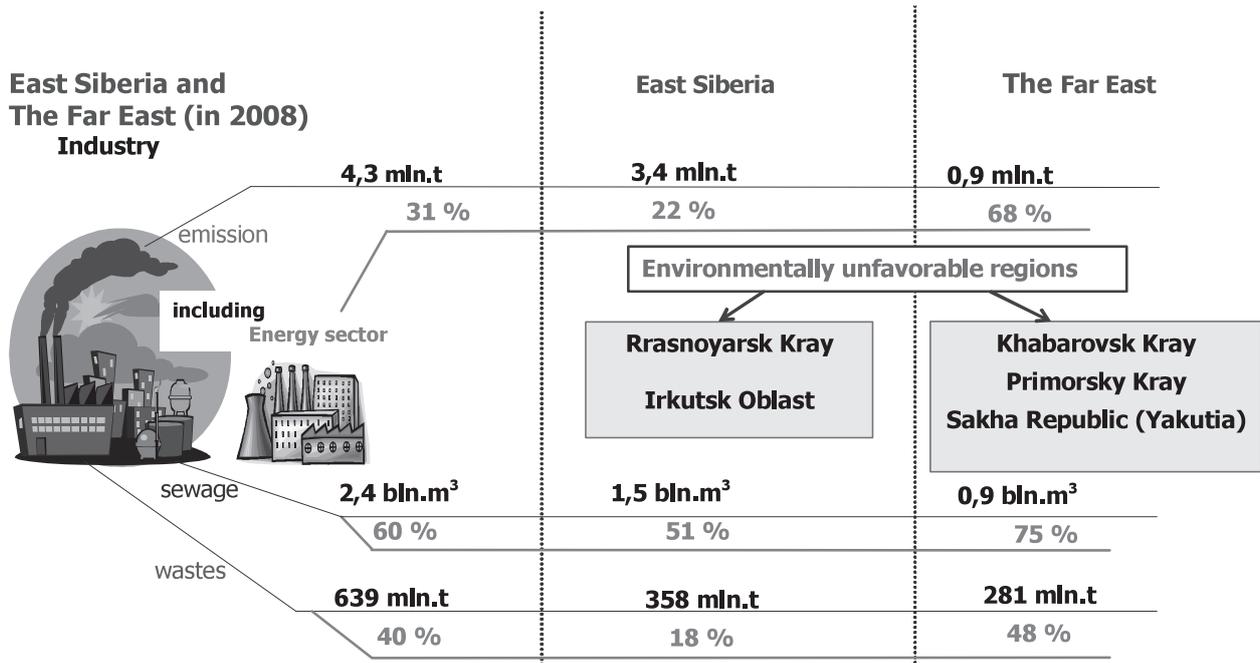


Fig. 2. Contribution of energy facilities to the environmental impact



Thus, the most urgent environmental problems of energy development in the eastern regions of Russia are:

1. Low level of investment in environmental protection and rational nature management (both nationally and regionally) due to a decreasing role of the state in solving the problems of nature protection (the share of investment makes up 0.4-0.6% of Russia's GRP, while in the developed countries this index ranges from 1 to 3%).
2. High coal share in the fuel balance of the regions.
3. High levels of air pollution in cities and industrial centers because of the increasing trend towards emission growth.

The revealed environmental problems in energy development in the considered regions form a "background" against which other problems related to development of existing energy centers and creation of new ones will arise in the future.

(2) Environmental assessment of prospects for energy development

The environmental assessment of energy development was carried out based on the perspective fuel balances of Russia's eastern regions that were drawn up by means of the programs of social and economic development of the considered territories.

In terms of the available results the perspective balance of fuel consumption by 2030 for large power plants in the eastern regions is characterized by prevailing coal share up to 80% in East Siberia and 60% in the Far East. Coal consumption by boiler plants will decrease in comparison with 2008 level and amount to 50% of the total consumption of fuel resources in the eastern regions.

The volumes of emissions/discharges, the ingredient composition of pollutants and the amount of waste from energy facilities are calculated on the basis of the state-

approved techniques, Resolutions of the Government of the RF and the statutory acts [6-8].

Besides, the environmental assessment of operation of energy facilities requires consideration of the planned perspective measures on updating or replacement of obsolete energy equipment, capacity commissioning and withdrawal from operation, equipping by advanced cleaning devices, etc.

The aggregated environmental assessment of energy development in Russia's eastern regions has shown that if the energy sector develops with considerable volumes of coal consumption as before and without essential introduction of nature-protection measures, by 2030 the air polluting emissions can increase by 2.0-2.5 times (Table 3).

The coal-fired thermal power plants will remain main polluting enterprises. Their share in the total emissions can reach up to 60%.

(3) Ways of solving environmental problems in the energy sector

It should be noted that at present when restructuring the energy sector of Russia is nearing completion, each business entity of the energy sector has worked out its own environmental policy which determines principal directions and programs of its implementation [9]. However, there is no common environmental policy in the energy sector as a whole so far.

The environmental policy aims to regulate a nature management process and provide conditions suitable for vital activity of life forms.

When creating and developing large-scale energy centers in the East of Russia the environmental policy can be implemented on the basis of effective mechanisms. The first priority mechanism is *to elaborate a consistent and comprehensive legislative framework of nature protection from an adverse industrial impact*. Currently above 20

Table 3. Assessment of air polluting emissions in the eastern regions by 2030 as against 2008 level, mln t/year

Year	Index	East Siberia	Far East	TOTAL
2008	Emissions by stationary sources	3.4	0.9	4.3
	of which: Energy facilities plants	0.7	0.6	1.3
2030	Emissions by stationary sources	4.0÷4.2	1.8÷2.0	5.8÷6.2
	of which: Energy facilities plants	2.0÷2.2	0.9÷1.0	2.9÷3.2

Federal laws and numerous by-laws have been enacted in Russia and correspondingly in the Federation entities to protect natural environment. Virtually the legislation requirements to operating enterprises consist in compliance of standards on emissions, discharges, water use limits, waste disposal and effecting of payments.

It should be noted that the regulatory and legal framework of the RF in the area of environmental protection is ineffective, has internal contradictions, obsolete standards, etc. [10]. Adjustment of different by-laws requires much time and revision of the laws. Some documents that are mentioned in the laws have not been approved so far. As a result the legal framework can not perform its functions and implementation of environmental protection measures is complicated.

The environmental protection activities in East Siberia and the Far East can not be improved without essential progress in the state metering of the amounts of emissions, discharges of pollutants and waste. In this context it is urgent to *develop a system of the state inventory of emission sources* in the immediate future by the technologies on the basis of the classifier of production methods that is accepted in foreign countries.

Elaboration of the unified environmental policy in Russia's energy sector is an important mechanism for implementing the energy strategy.

Energy development in East Siberia and the Far East is characterized by large-scale production of fuel resources (coal and hydrocarbons), which gives rise to specific environmental problems: collection, storage and reclamation of drilling waste, thaw of permafrost rocks, formation of mining cavities, soil pollution by oil and oil products, growing emissions of pollutants, in particular CO₂ and methane, when burning associated petroleum gas in flares of the fields.

Besides, in the eastern regions of the RF one faces such a situation that a fair quantity of energy products is produced on some territory, which leads to formation of high pollution levels. The population there bears a burden of unfavorable environmental conditions, however has no either compensations or privileges to use these energy products (electricity, heat, derived products).

The most important direction in Russia's environmental policy in the energy sector is diversification of energy sources primarily by extensive development of renewable energy sources: wind power plants and small hydro power plants. They are most topical for the north-eastern areas of the considered regions of Russia.

The basic directions and measures of the environmental policy in the energy sphere can be implemented by the

increasing role of the state. The environmental priority implies first of all the state interest. And since the nature protection measures demand sizable financial expenditures, then these expenditures on improvement of people's health and support of natural environment quality in energy-producing regions should be taken into consideration at the state level (in the budget, special funds, national projects).

The priority direction in the environmental policy is application of up-to-date scientific and engineering achievements owing to close collaboration with scientific institutions.

Use of combined-cycle and gas turbine units with higher economic efficiency and better environmental indices in the energy sector is a perspective direction in solving environmental problems.

The man-induced impact of the energy sector on the natural environment can be reduced by changing the energy balance structure. In the context of environmental protection change in the structure of fuel burnt is due to decreasing use of coal and fuel oil and increasing combustion of natural gas. Large-scale gasification of large industrial centers and numerous boiler plants with parallel decrease in atmospheric emissions will make it possible to eliminate ash and slag waste.

In the immediate future the energy development will require elaboration of the effective mechanisms of nature-protection control that include organizational, environmental-economic and technological measures.

The organizational measures imply improvement of the state regulation system (increase of the state role), creation of the effective legal and regulatory system.

The environmental-economic measures aim to stimulate nature protection activity of enterprises by applying the economic mechanisms.

The technological measures are intended to improve production methods and nature protection measures in order to decrease a man-induced load on the environment elements.

Elaboration of projects and programs on development of the eastern regions of Russia obviously requires concentration of main efforts on the territories with a great number of large energy and industrial enterprises and residence of a high percentage of population.

Implementation of the nature protection activity depends to a great extent on professionalism and competence of local authorities that control the natural environment state, execution of rigid (from the environmental standpoint) regulation of the economic activity in realization of energy projects.

The continuing reforms in the energy sector require an

effective state environmental policy that:

- harmonizes activity of individual fuel and energy complexes of East Siberia and the Far East and Russia as a whole;
- allows coordinated decisions to be made for taking into account the interests of the state, producers and population with close cooperation among all the concerned structures: from the executive and legislative authorities to non-governmental organizations and scientific institutions; from producers to consumers.

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