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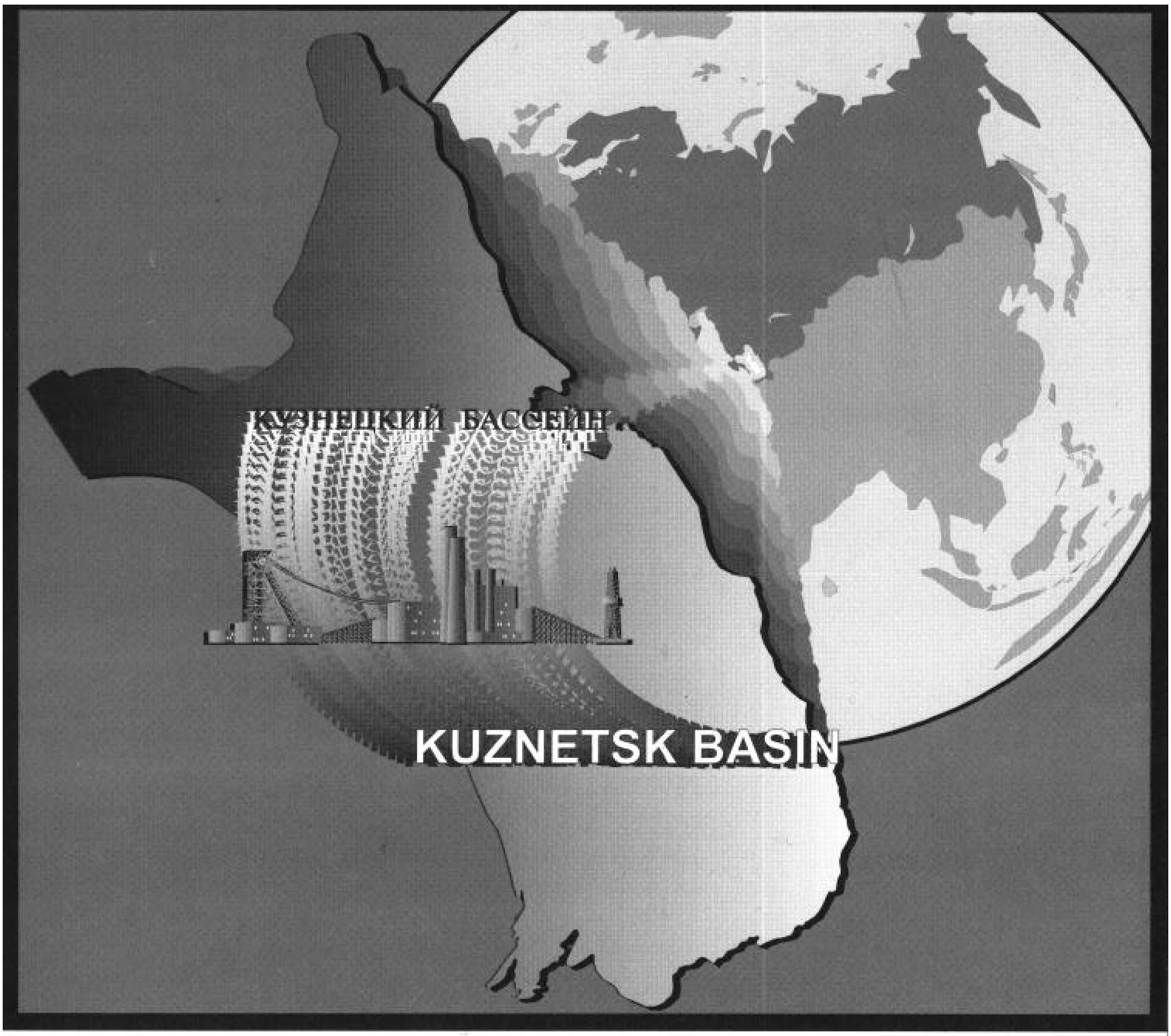
REDUCING METHANE EMISSIONS FROM COAL MINES IN RUSSIA:

A HANDBOOK FOR EXPANDING COALBED METHANE RECOVERY AND USE IN THE KUZNETSK COAL BASIN



Public Review Draft

REDUCING METHANE EMISSIONS FROM COAL MINES IN RUSSIA: A Handbook for Expanding Coalbed Methane Recovery and Use in the Kuznetsk Coal Basin

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ATMOSPHERIC POLLUTION PREVENTION DIVISION

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Leninskugol Coal Production Association

Abashevskaya Mine

Baidaevskaya Mine

Chertinskaya Mine

Kirov Mine

Komsomolets Mine

Oktyabrskaya Mine

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ABBREVIATIONS AND ACRONYMS

Weights and Measures: All units are metric system (S.I.)

Gcal	gigacalorie = billion calories = 10^9 calories
Gwh	gigawatt hours = billion watt hours = 10^9 watt hours
kcal	kilocalorie = thousand calories = 10^3 calories
kg	kilogram = thousand grams= 10^3 grams
km	kilometer
km^2	square kilometer
kt	kilotons = thousand tons = 10^3 tons
MWh	megawatt hours = million watt hours = 10^9 watt hours
m^3	cubic meters
PJ	petajoules
t	tons

Acronyms

CIS	Commonwealth of Independent States
CPA	coal production association
CO_2	carbon dioxide
EEER	East European Energy Report
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
GDP	gross domestic product
GEF	Global Environmental Facility
IC	internal combustion
IEA	International Energy Agency
IFC	International Finance Corporation
JV	joint venture
NIS	Newly Independent States
PIER	Partners in Economic Reform
ROM	run-of-mine
TDA	Trade Development Agency
USAID	United States Agency for International Development
USDOE	United States Department of Energy
UNECE	United Nations Economic Commission for Europe
WB	World Bank
VAT	value added tax

OVERVIEW AND SUMMARY

This report provides basic information concerning the potential for expanding coalbed methane development in the Kuznetsk Basin (or Kuzbass, as it is commonly known) of Russia. The US Environmental Protection Agency (EPA) prepared this study to focus attention on the need for development of the coalbed methane resources present in the Kuzbass. Although US companies have expressed some interest in the Kuzbass, it remains relatively unknown to many potential investors and funding agencies.

This study follows up a previous EPA report, titled *Reducing Methane Emissions from Coal Mines in Russia and Ukraine: The Potential for Coalbed Methane Development,* which focused on general aspects of the potential for coalbed methane development in these republics. The previous study, published in 1994, indicated that there appear to be many opportunities for Kuzbass mines to develop profitable projects to expand the recovery and use of coalbed methane. Coalbed methane is a valuable resource needed by the region as an alternative to more polluting fuels, particularly lignite and low-quality hard coal. Currently, some of the coal mines recover methane, but no mine uses it, and more than 1 billion cubic meters of methane are released to the atmosphere annually.

The study estimated that, using demonstrated technologies such as pre-mining degasification and gob well recovery, Kuzbass coal mines could recover and use 50 percent or more of the methane currently being liberated by mining. Additional recovery could be achieved by employing an integrated approach to methane recovery, including drainage prior to, during, and after mining. There is significant potential for increased methane use, moreover, even without expanding methane recovery. Currently, Kuzbass mines recover and release nearly 196 million cubic meters of medium-quality methane annually. Introduction of methods to improve gas quality, and use medium-quality fuel for power generation other purposes, could reduce these emissions.

The present study identifies attractive coalbed methane projects in the Kuzbass and explores the key issues related to project development. This report concludes that:

- Local mining industry officials want to recover more coalbed methane and use it to meet some of their fuel and energy requirements;

- Local and regional government officials support development of this local natural gas resource, viewing it as a necessary step toward rehabilitation of the environment, and the local mining industry;

- Development of coalbed methane resources will require not only the participation of private enterprise, but comprehensive technical and developmental assistance programs that will provide expertise and technology;

- Funding is needed for implementation of new projects to develop coalbed methane resources owned by coal mining enterprises. Limited funding for development of new technology, or simply the implementation of existing technology, is available from the Russian government.

This handbook discusses the impact of prevailing economic and political conditions on the development of coalbed methane projects. It provides information on three coal production associations and six mines that are part of these associations. This information should help companies and institutions become familiar with some aspects of the mining operations and associated coalbed methane projects that could be developed. The information in this handbook can help potential project developers identify the best projects that will demonstrate the economic, environmental and safety benefits of coalbed methane.

PART ONE: COALBED METHANE POTENTIAL OF THE KUZBASS

CHAPTER 1. THE RUSSIAN COAL INDUSTRY

The ability to develop attractive coalbed methane projects in Russia depends on the state of its coal industry. This chapter describes the Russian coal industry, with emphasis on conditions in the Kuznetsk Coal Basin (Kuzbass). Located in south-central Russia (Figure 1-1), the Kuzbass is the republic's largest and most important coal producing basin, and the sustained production and economic efficiency of its mines are significant to Russia in both economic and political terms. In addition to improving mine safety, increasing the recovery and use of methane from Kuzbass mines will increase profitability, an especially important benefit as the coal industry struggles to adjust to a market economy.

1.1 STATUS OF THE INDUSTRY

The Russian coal industry has been affected by restructuring and reorganization processes that have intensified since 1991. Although the industry continues to be financially controlled from Moscow, regional officials within both local governments and the coal industry now wield greater influence over policy implementation. The roles of the "center" and the "regions" in administering the industry, and the need for and progress of reform, are described below.

1.1.1 <u>Structure of the Coal Industry</u>

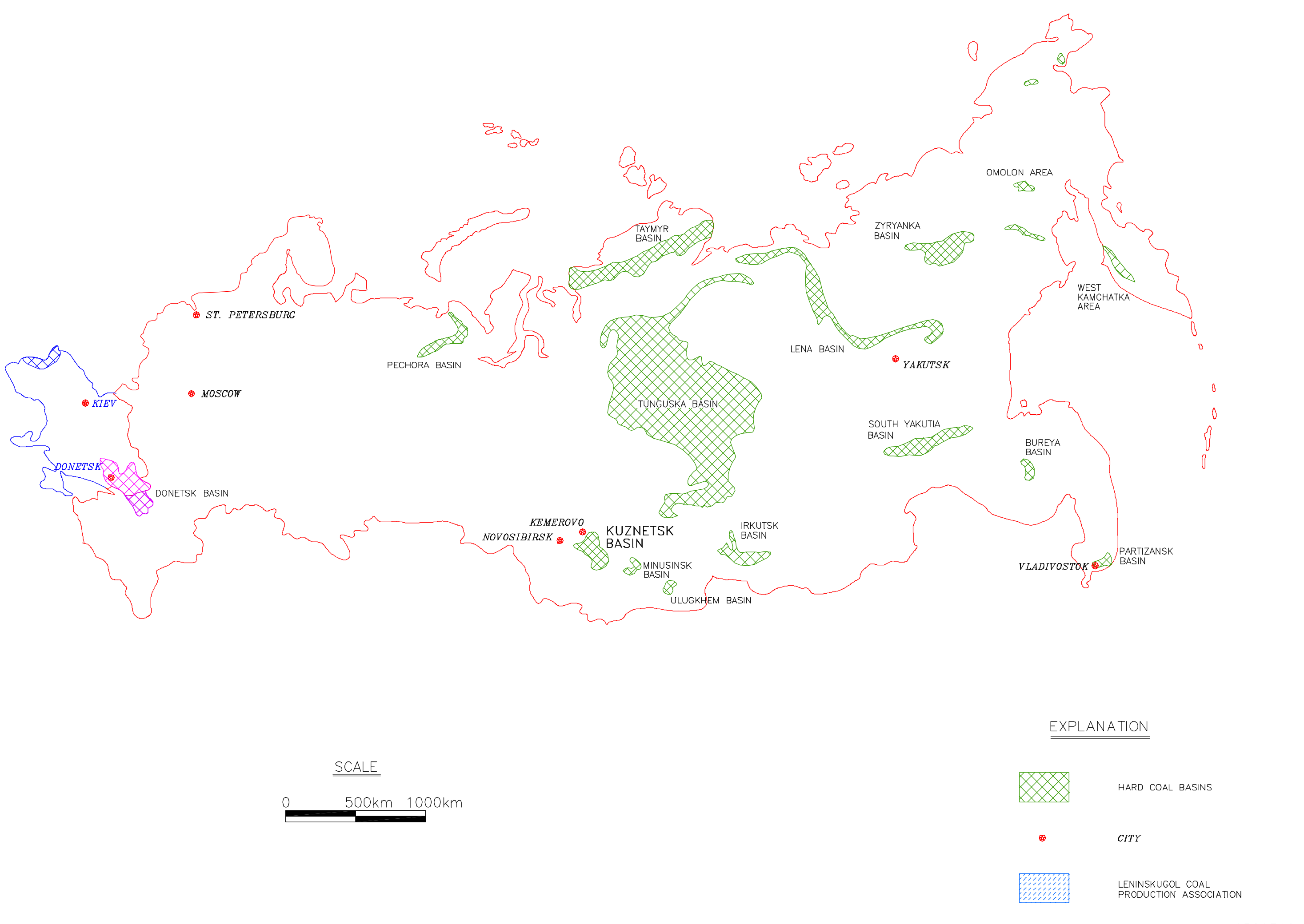
In recent years, the coal industry has been undergoing a dramatic transition from a centrally planned system to one based on free market principles. Since early 1992, the Russian coal industry has been under the auspices of a Coal Committee within the Ministry of Fuel and Energy (PIER, 1993). RosUgol was established in December 1992 to help with the transition of the Russian coal industry to a market-based economy.

The functions of the institutions guiding the restructuring of the Russian coal industry include (PIER, 1993):

Ministry of Fuel and Energy:

- oversees the coal industry;
- acts as a conduit between RosUgol, coal associations, Ministry of Finance, and other Ministries of the Russian Federation; and,
- coordinates with other energy sector development organizations.

FIGURE 1-1. MAJOR HARD COAL BASINS OF RUSSIA



RosUgol:

- allocates subsidies
- oversees exports and marketing
- oversees equipment purchases
- coordinates coal association directorship
- addresses social guarantees
- implements mine closure programs
- oversees accounting systems

Coal production associations (CPAs) also play an important role in guiding policy decisions concerning the coal mining industry. The general director of a CPA often holds more power than political leaders within a region (Sherer and Clarke, 1994). The primary responsibilities of a coal production association, each of which administers one or more mines, are:

- to address problems common to the mines, such as safety and health conditions, and age and condition of the mining equipment;
- procurement for the mines;
- negotiations with government agencies; and,
- implementation of safety and environmental regulations.

Within each CPA are coal mines and related enterprises. Russia has approximately 245 underground mines, 66 surface mines, 70 preparation plants, and 1,200 ancillary enterprises for the construction and repair of mining equipment, industrial work, and rail and road transport. The Kuzbass contains 73 active underground coal mines, 24 surface mines, and more than 200 related enterprises. Many of Russia's coal industry enterprises have recently been transformed into joint stock companies, as described in Section 1.1.3 below.

1.1.2 Economics of the Industry

In order to comprehend the severe problems facing the Russian coal industry, it is necessary to examine several factors that have contributed to its lack of profitability. These include "social guarantees", inter-industry indebtedness, subsidies, and price controls.

Coal production associations historically have provided goods and services (or, as they are called in Russia, "social guarantees") such as housing, heating, education, agricultural products, medical care, and pre-school care to the local mining community. For example, the Mine Director of the Volvok Mine, which employs 1,885 people, is required to provide social services to a settlement of 8,000, many of whom are pensioners from other areas. This large degree of social services provision is a key factor contributing to the economic inefficiency of the mining industry.

Inter-industry indebtedness has had a devastating effect on the coal industry. Because of late subsidy payments and other economic problems, coal mines have had to borrow heavily to pay their bills for industrial expenses (energy and equipment), as well as the provision of basic needs: As of 1993, Russian coal mines owed 1.5 billion rubles to other industries for items ranging from food to mining equipment (Moscow Times, 1993). In addition, similar problems plague the industries that buy the coal. The result has been a cycle of indebtedness: the customer can't pay for the coal, so the mines cannot pay their workers on time, purchase supplies, or replace or maintain equipment.

One of the primary factors prompting reform of the Russian coal industry is that it is heavily subsidized, a problem that contributes to low productivity and inefficiency. Subsidies to the coal industry consume more than 1.2 percent of GDP (Craig et al, 1994), and in 1994 amounted to the ruble equivalent of $US 2 billion (IEA, 1995). The need to deal with the budget crisis resulting from these subsidies has been a driving force in the Russian government's desire to restructure the coal industry. The International Monetary Fund (IMF) and World Bank are also urging reform of the subsidy system; a World Bank report (Craig et al, 1994) asserts that the current system of coal subsidies is blocking rather than assisting the process of restructuring.

Traditionally, subsidies have been based on production costs, in addition to the operating costs of other enterprises and social services provided by the mine (or its coal production association). Therefore, the highest subsidies were provided to the highest-cost mines, providing a strong disincentive to improve efficiency. Subsidies were acquired by RosUgol from the government, which then distributed them to the coal mines, without any government monitoring.

With the "liberalization" of coal prices, however, the system of federal subsidies was reorganized (IEA, 1994). The liberalization law (Government Decree No. 727, July 1993) effectively states that as of July 1, 1993, coal prices are no longer directly fixed by the government; instead they are fixed indirectly by the amount of subsidies paid to the producers. The new system makes an attempt not to pay indiscriminately on a per-ton basis for all the losses of an enterprise. The government is monitoring coal production associations, and urging them to improve their cost record or to reduce production.

1.1.3 Restructuring of the Coal Industry

In light of the severe problems facing the coal industry, the Russian government is undertaking a restructuring program that includes a plan to close the most inefficient mines and reorganize the remainder. Estimates of the resulting impact on employment range as high as a loss of 300,000 jobs in the industry over the next ten years (PIER, 1993). The prospect of these dramatic personnel reductions is further complicated by the fact that mine employees are dependent on the mining enterprises for the social guarantees described above.

According to a RosUgol (1994) document, the main elements of its proposed coal industry restructuring program are:

1. Increasing efficiency by narrowing the criteria for coals that are considered mineable. The criteria include those related to seam thickness, dip, ash content, and gas hazard.

2. Adopting pricing, taxation, and customs policies that will ensure that a sufficient amount of coal is sold in international and domestic markets.

3. Closing the most unprofitable mines, and giving profitable mines the highest priority for financial assistance.

4. Providing new jobs for displaced workers, and paying off pensions.

5. Removing auxiliary enterprises (such as agricultural units, medical facilities, dining facilities, coal industry equipment manufacturing plants) from the responsibility of the mines.

6. Mitigating environmental problems associated with the coal industry, using experts in environmental remediation as well as displaced mine industry personnel.

7. Establishing property ownership and stock companies to provide effective use of capital.

8. Reducing the state's role in controlling enterprises, optimally combining market and state mechanisms.

9. Modifying the coal industry statistics reporting system to one which fully discloses the financial and economic aspects of the industry, in conformance with systems used by Western-style economies.

10. Creating a legal framework to secure the industry's structural modification, giving first priority to the legal confirmation of state-supported status for the coal industry through the federal budget, and creating legislation for solving social, technical and economic problems.

RosUgol estimated that accomplishing the above will result in:

- Producing 366-374 million tons of coal per year, enough to meet the public's needs of 280-285 million tons per year through the year 2000, while providing additional coal for sale on the world market.

- Improving coal industry productivity, by closing 38 failed enterprises[1]. Presently, profitable mines account for 49 percent of all coal production, stable mines for 41 percent of the production, and unprofitable mines for 10 percent of all production. By the year 2000, these proportions will change so that profitable mines will account for 61 percent of all coal production, stable mines for 38 percent, and unprofitable mines for only 1 percent.

- Reducing the number of workers involved in the coal industry to 30 percent of present levels by the year 2000, and increasing labor efficiency by at least 3 times its 1993 level.

- Improving overall socioeconomic and environmental situations in coal mining regions by diversifying their economies, creating about 30,000 new jobs by the year 2000. Some of the workers displaced by mine closures will be involved in developing new, highly productive deposits, while others will be employed in environmental cleanup efforts. The RosUgol document does not provide further details regarding creation of jobs for displaced mine workers.

As part of its efforts to improve efficiency, RosUgol began working in 1993 to buy more mining equipment from Russian companies. As a result, imports from Ukraine and Kazakhstan decreased from 40 percent in 1992 to 27 percent in 1995. According to Rosugol Deputy

[1] According to a more recent (July 1995) press release, RosUgol's director Yuri Malyshev stated that the program intends to close 70 coal mines by 1998, and a total of 100 mines in the long term (about five to ten years) (EEER, 1995). It costs about 60 to 70 billion rubles ($US 14-16 million) to close one mine. Federal budget spending to support the closure program is expected to reach 14 to 22 trillion rubles ($US 3-5 billion).

Director Yanovsky (1996), more than 40 types of formerly imported mining equipment are now produced in Russia.

In addition to increasing the efficiency and profitability of coal mining, another primary goal of industry restructuring is to lay the foundation for privatization of the industry. The government has been transforming coal industry enterprises into joint-stock companies, more than 500 of which have been established thus far (Yanovsky, 1996). According to an agreement with the State Property Committee, RosUgol exercises commercial management of the state-owned stock in 337 of these companies.

RosUgol itself was reorganized into a joint stock company in February 1996. The purpose of this reform, according to the presidential press service, is to improve the structure of the coal industry, encourage competition in coal markets, attract investment, and speed up reforms (EEER, 1996). Company stock will be retained in federal ownership for three years; no decision has yet been taken on ownership after the three-year period.

Recently, there have been indications of an upturn in the coal industry. According to RosUgol director Malyshev (Moscow Times, 1995; EEER, 1995), data from the second quarter of 1995 indicate that state subsidies decreased from 80 percent of revenue in 1994 to 24 percent in 1995, as the industry proceeds with mine closures, layoffs and reductions in output. But miners' demands for unpaid wages and Russia's nonpayment crisis still saddle the industry with heavy burdens. For example, Ministry of Fuel and Energy officials have often failed to make subsidy payments to coal concerns on time. Russian miners have gone on strike several times in the past few years to protest arrears in wage payments. A recent example is the February 1996 coal miners' strike, where miners protested the 970 billion rubles owned by the government for overdue wages in 1995 and January 1996. In this case, the government's response to the strike was immediate, and within five days most of the miners had returned to work. President Yeltsin has instructed the government to set up special funds and reserves for payment of salaries to the staff of budget-financed coal enterprises. The miners are not convinced that the government will pay its debts, however, and are prepared to walk out again if the schedule for the payment of wages is broken (EEER, 1996).

RosUgol considers restructuring of the Kuzbass to be a priority. Since 1994, it has been directing support to selected enterprises as part of its restructuring strategy (Yanovsky, 1996). This includes considerable assistance to two Kuzbass coal production associations (Kirov and Komsomolets) and one independent mine (Raspadskaya). Additional plans call for closure of 11 unprofitable Kuzbass mines, whose total output is currently 10 million tons per year, and opening of new mines with an annual production of 25 to 30 million tons. RosUgol says that these new mines will operate without subsidies.

1.1.4 <u>Environmental Issues in the Coal Industry</u>

Mining activities and waste disposal from mines have caused environmental damage to areas surrounding mines throughout Russia. Impacts such as soil damage, depletion of water resources, contamination of underground and surface water reservoirs, and air pollution are some of the leading environmental problems caused by the mining industry.

Taken as a whole, the environmental damage in Russia's mining regions, and the Kuzbass in particular, is significant; however, improvements are possible. The use of coalbed methane as a substitute for coal offers several types of opportunities for reducing the impacts associated with coal production and consumption. Methane, like conventional natural gas, is a remarkably clean burning fuel. It emits virtually no sulfur or ash, and only about 32 percent of the nitrogen oxides, 35 percent of the carbon dioxide, and 43 percent of the volatile compounds emitted by coal burning (Oil and Gas Journal, 1991; EPA, 1986). Using coalbed methane to displace coal consumption in Russia's coal mining regions could thus be a cost-effective way to help reduce air quality problems. Examples of coalbed methane use options that would benefit the environment include:

- **Heating mine facilities.** Currently, Kuzbass mines use coal fired boilers to produce steam heat for drying coal, heating mine facilities, and heating ventilation air. The Ministry of Fuel and Energy (1992) estimated that one Kuzbass coal production association burns more than 500,000 tons of unwashed bituminous coal in its boilers each year. These boilers have no air pollution abatement systems installed. They emit an estimated 5,000 tons of particulate matter and nearly 500 tons of sulfur to the atmosphere annually. This exceeds the norms established by environmental protection authorities by more than ten times.

  Elimination of the particulates and sulfur from the effluents of those boilers could significantly improve the local environment. Boilers at the majority of coal mines in the basin are capable of conversion to gas use, making use of coal mine methane an attractive option.

- **Power generation at mine facilities.** Most Kuzbass mines purchase electricity from the power grid, most of which is generated from low-quality coal. Use of coalbed methane to generate electricity on-site may be a more economical option for these mines. Boilers, gas turbines, and internal combustion engines can use coalbed methane to generate electricity. A typical Kuzbass mine consumes approximately 73 GWh of electricity per year, the energy equivalent of about 8 million cubic meters of methane. Use of coalbed methane would benefit regional air quality by reducing demand for coal-generated electricity.

- **Using coalbed methane to fuel mine water desalination plants**. According to the Ministry of Fuel and Energy (1992)***,*** the Russian government considers the discharge of polluted mine water in the Kuzbass a particularly acute problem. While some water from mines can be used for productive purposes, much of it requires desalination before it is pure enough to discharge.

  The coal industry plans to install new, effective water purification equipment, but will need to keep the costs of operating this equipment as low as possible. Desalination facilities can use coalbed methane directly as a heat source for evaporation and concentration of salts, and indirectly as an energy source to fuel other phases of the desalination process.

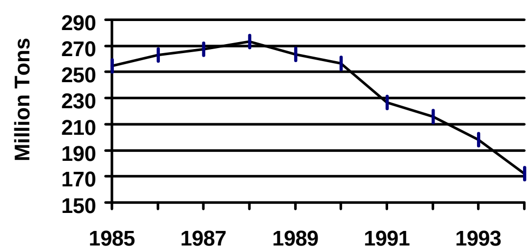
CHAPTER 2. COAL AND THE ENERGY SECTORS OF RUSSIA AND THE KUZBASS

In order to assess the opportunities for increasing coalbed methane consumption and production in the Kuzbass region, it is useful to examine coal production and consumption in Russia as a whole, as well as within the region. In the short to medium-term, coal is likely to remain a strategically important resource for Russia, for reasons described below. Russia cannot afford to ignore its coal mining industry, and is placing industry restructuring and modernization of production methods among its top priorities for the coming years.

2.1 ENERGY TRENDS IN RUSSIA AND IMPLICATIONS FOR THE KUZBASS

As in other segments of the Russian energy sector, production in the coal industry has significantly declined since the late 1980's (Figure 1-2). Hard coal production fell from 274 million tons in 1988 to 172 million tons in 1994, a decrease of 37 percent (PlanEcon, 1994a; IEA, 1995b). The Kuzbass accounts for about one-third of the hard coal mined in Russia. The basin produced about 58 million tons from its underground hard coal mines in 1994, down from 64 million tons in 1993.

FIGURE 1-2. HARD COAL PRODUCTION IN RUSSIA



This decline has been caused, in part, by factors such as increasingly difficult mining conditions, equipment shortages resulting from the breakup of the former Soviet Union, increasing labor costs, and organizational and managerial problems stemming from the changing political and economic system, as discussed previously.

Consumption of hard coal has also fallen, though less dramatically. In 1993, Russia consumed 220 million tons of hard coal. Hard coal accounts for approximately 15 percent of Russia's total primary energy consumption, making it the country's third most utilized energy source, behind natural gas (46 percent) and oil (27 percent) (USDOE EIA, 1994). Within the Kuzbass, however, coal is the predominant fuel, comprising a much higher percentage of the region's primary energy mix.

In the long run, Russia is expected to pursue a national energy strategy that relies heavily upon developing its natural gas industry, and less upon its coal industry (Oil and Gas Journal, 1992). Consumption of natural gas in Russia has increased 75 percent in the last decade (PlanEcon, 1994b). In addition, it is cheaper to produce than coal on an energy-equivalent basis (PlanEcon, 1992). Natural gas is also a cleaner burning fuel, which may become an increasingly significant factor in national energy planning if Russia succeeds in strengthening its national environmental protection program. Russia has long been the world's leading exporter of natural gas, exporting 117.4 million cubic meters in 1995 (PlanEcon, 1996).

In the short to medium-term, however, coal is likely to represent a strategically important resource for Russia for several reasons:

- Coal can be used to meet domestic energy needs as increasing shares of oil and gas produced are exported for hard-currency earnings.

- A substantial share of electricity plants, district heating plants, and other facilities are currently equipped with coal-fired technology.

- The coal industry employs a large number of people who live in remote areas, many of whom have few alternative employment opportunities. Even if reducing coal consumption and production is adopted as a national objective, this process is likely to occur gradually to prevent massive displacement of mine workers.

- Stabilization of the nuclear industry, which will halt plans for expansion of some nuclear facilities and/or may result in closure of others, will contribute to the domestic energy shortage.

There is little doubt that the Kuzbass coal industry, given the global significance of its reserves, will continue to be of major national strategic significance (PIER, 1993). The Kuzbass produces 65 percent of all coal (both hard and brown) used by Russia's power industry, and 75 percent of all of Russia's coke annually (Interfax, 1995). The region has been developed to meet Russia's energy and industrial needs, however, with little attention having been paid to an effective regional economy. Limited opportunities for employment outside the declining coal and primary manufacturing industries exist.

A number of initiatives are underway to develop the region. In February 1993, the Kemerovo Regional Administration prepared a draft decree for Boris Yeltsin requesting a 203 billion ruble aid package for the region's coal enterprises. In addition, the decree calls for local authority over mineral concession rights and profits for natural resource use; and for a government guarantee of a $US 50 million credit from an Italian bank to buy food processing equipment in exchange for earnings from aluminum and coal exports (Interfax, 1993a).

The Russian Supreme Council has designated the Kuzbass region a "free economic zone" (Box 1) designed to stimulate foreign investment. The government has also decided to provide economic incentives to help mitigate the severe environmental problems in the region. While these types of initiatives are encouraging, a major policy shift that will help the region move away from its dependence on federal subsidies is necessary (PIER, 1993).

One impact of restructuring of the Kuzbass coal industry is an overall reduction in the number of mineworkers. Mining leaders in the Kuzbass are well-organized, and are influential in national politics, given their proven ability to sustain large-scale strikes affecting national energy supplies. During recent years, numerous Russian leaders and government officials have expressed an interest in maintaining stability and employment in the Kuzbass. According to the Kemerovo representative of the Ministry of Fuel and Power, there are approximately 400,000 people employed in mining and allied industries in the region, and many more are employed in enterprises indirectly linked to the coal mining industry.

Box 1: Free Economic Zones

The government has approved the development of free economic zones (FEZs) in Russia and a number of incentives exist to encourage foreign investment. FEZs will receive top priority for privatization. Incentives associated with investing in FEZs vary according to the FEZ, but, in general, the following types of incentives apply to the foreign investor, depending on the nature of the venture (Price Waterhouse, 1994).

- Goods imported into and re-exported from FEZs are exempt from customs duty.
- Compulsory sales of hard-currency earnings are lower than elsewhere in Russia.
- Tax rates for foreign investors and enterprises for foreign investors are up to 50 percent lower than those existing elsewhere in Russia.
- Tax holidays may also be applied.
- Tax rates for using land an natural resources may be lower than in other parts of Russia.
- Goods produced in a FEZ are exempted from licenses and quotas when exported within certain limits.

Clearly, any means of making coal mining more profitable in the Kuzbass should provide more employment stability in the region. Increased coalbed methane recovery and use could play a role in this endeavor, benefiting the Kuzbass economy and reducing the need for subsidies from the overburdened Russian government.

2.2 THE ENERGY NEEDS OF THE KUZBASS REGION

The Kuzbass is the second largest producing hard coal basin in the CIS, and the largest in Russia. It contains an estimated 637 billion tons of coal, of which 548 billion tons are balance resources. There are 76 underground and 20 surface mines in the region. Coal produced by Kuzbass mines is high-quality, bituminous coal. Over 70 percent of the region's coal is sent to other parts of the country, or exported for hard currency (Shakmatov, 1993).

Coal dominates the fuel mix of the Kuzbass region. Despite the large production of high-quality coal in the Kuzbass, however, some parts of the region actually suffer energy shortages (Yevtouchenko, 1993). As mentioned above, most of the coal produced from Kuzbass mines is exported outside the region, while low-quality coal and coke oven gas are used locally. Natural gas comprises only about 17 percent of the region’s fuel mix. The Kuzbass region consumes about 5.5 million cubic meters of natural gas annually, transported from the Tyumen gas fields approximately 400 km to the northwest. According to a member of the Skochinsky Mining Institute, the amount of natural gas supplied to the Kuzbass is only one-third of the amount requested by the regional government per year.

Table 1-1 shows energy balance data for the Kemerovo Oblast[2], which effectively comprises the Kuzbass region. These data are reported using categories that refer to the types of fuel used by various sectors of the regional economy. The four broad categories of fuels listed in Table 1-1 are:

- Natural fuels such, as oil and natural gas (includes LNG and CNG), are those fuels that are extracted in more or less natural form and used directly without conversion to other fuel types or forms of energy;

- Processed fuel products, such as methanol and syngas, are those forms of energy fuels which have been converted from natural fuels, such as natural gas, and usually have higher heating values;

- Byproduct fuel and energy from industrial processing, such as coke-oven gas or blast furnace gas;

- Converted energy--electricity, steam and hot water that is produced from the use of the fuels listed above.

As might be expected, the industrial sector is the largest consumer of fuel in the oblast, accounting for more than 72 percent of total energy consumption. Residential consumers and community facilities consumers are responsible for nearly 17 percent of the oblast's energy consumption. Transportation and agriculture use the remaining 11 percent of the region's fuel.

The majority of the coal that is consumed within the oblast is used for heating in residences and community facilities. This sector consumes more than 77 percent of the coal produced from the mines located within the oblast, but only 0.4 percent of the natural gas. The heavy use of coal by this sector contributes significantly to air pollution in the region, a situation that could be mitigated by substituting methane for some of the coal.

As shown in Table 1-2, the metal industry (producing steel and other metals) consumes more than 60 percent of all energy used by the industrial sector. The majority of the fuel consumed by this industry is processed fuel and byproducts, including coke, coke oven gas, and blast furnace gas. The metal industry is also the largest consumer of natural gas, consuming 69 percent of the gas imported into the region. In addition, it is the largest consumer of electricity. Some of the oblast's power is generated by coal, while much of it is produced by hydroelectric plants.

The coal industry is the next largest consumer of energy (115 PJ, or 14 percent). In addition to consuming large amounts of diesel fuel, this industry uses more unprocessed coal than any other; 43 percent of the unprocessed coal used by the industrial sector is consumed by the coal industry itself. The industry consumes no natural gas.

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[2] An oblast is an administrative unit organized on geographic or industrial lines. Oblasts are responsible for administrative matters within their boundaries, such as collecting taxes, setting local taxes, and administering legal affairs. The Kemerovo Oblast, one of 46 Russian oblasts, is 95,500 km^2 and has a population of about 3.2 million.

TABLE 1-1. FUEL AND ENERGY CONSUMPTION BY SECTOR IN THE KEMEROVO OBLAST

Type of Fuel	Industrial		Community and Residential		Transportation		Agriculture, Construction and Other		Total	
	Petajoules	%	Petajoules	%	Petajoules	%	Petajoules	%	Petajoules	%
Coal	19.6	18.8	81.0	77.4	0.1	0.1	3.8	3.7	104.6	100.0
Wood	0.4	15.8	2.0	81.7	0.0	0.0	0.1	2.5	2.4	100.0
Natural Gas	78.2	99.5	0.3	0.4	0.1	0.1	0.0	0.0	78.6	100.0
Underground Gasified Coal	0.2	83.3	0.0	16.7	0.0	0.0	0.0	0.0	0.2	100.0
Total Natural Fuels	**98.3**	**52.9**	**83.4**	**44.9**	**0.2**	**0.1**	**3.9**	**2.1**	**185.8**	**100.0**
Metallurgical Coke	150.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	150.3	100.0
Dry Breeze Coke	22.4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	22.4	100.0
Fuel Oil	19.2	97.7	0.2	1.1	0.0	0.2	0.2	1.1	19.7	100.0
Diesel Fuel	8.1	19.3	0.4	1.0	21.0	50.1	12.4	29.6	41.8	100.0
Gasoline	1.0	3.9	3.5	13.6	19.1	74.2	2.1	8.3	25.7	100.0
Coke Gas	42.8	99.8	0.0	0.0	0.0	0.0	0.1	0.2	42.9	100.0
Other	8.9	59.8	0.5	3.4	5.2	35.2	0.2	1.6	14.8	100.0
Total Processed Fuels	**252.6**	**79.5**	**4.6**	**1.5**	**45.3**	**14.3**	**15.1**	**4.7**	**317.6**	**100.0**
Blast Furnace Byproducts	49.1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	49.1	100.0
Other	0.4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	100.0
Total Byproducts	**49.5**	**100.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**49.5**	**100.0**
Electrical Energy	266.8	81.1	31.9	9.7	18.6	5.7	11.6	3.5	328.9	100.0
Steam and Hot Water	175.5	61.6	74.2	26.0	5.1	1.8	30.2	10.6	285.0	100.0
Total Converted Energy	**442.2**	**72.0**	**106.2**	**17.3**	**23.7**	**3.9**	**41.8**	**6.8**	**613.9**	**100.0**
GRAND TOTAL	**842.7**	**72.2**	**194.1**	**16.6**	**69.2**	**5.9**	**60.8**	**5.2**	**1166.8**	**100.0**

Source: Energy Research Institute of Russia. The year for which these data are valid is unknown, but is probably either 1991 or 1992.

TABLE 1-2. FUEL AND ENERGY CONSUMPTION BY THE INDUSTRIAL SECTOR, KEMEROVO OBLAST (IN PETAJOULES AND PERCENT)

Type of Fuel	Steel and Other Metals		Coal		Chemical Industry		Building Materials		Machinery and Equipment		Other		Total	
	PJ	%	PJ	%	PJ	%	PJ	%	PJ	%	PJ	%	PJ	%
Coal	4.9	24.8	8.5	43.3	0.0	0.0	5.2	26.3	0.2	1.1	0.9	4.6	**19.7**	100.0
Wood	0.1	25.7	0.0	0.0	0.0	0.0	0.2	65.7	0.0	0.0	0.0	8.6	**0.4**	100.0
Natural Gas	53.9	69.0	0.0	0.0	7.4	9.5	16.0	20.5	0.7	0.9	0.0	0.0	**78.2**	100.0
Underground Gasified Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	100.0	**0.2**	100.0
Total Natural Fuels	**58.9**	**59.9**	**8.5**	**8.6**	**7.4**	**7.6**	**21.4**	**21.8**	**0.9**	**1.0**	**1.1**	**1.1**	**98.3**	**100.0**
Metallurgical Coke	148.3	99.2	0.0	0.0	0.0	0.0	0.5	0.3	0.7	0.4	0.0	0.0	**149.4**	100.0
Dry Breeze Coke	22.4	99.2	0.0	0.0	0.0	0.0	0.2	0.7	0.0	0.1	0.0	0.0	**22.6**	100.0
Fuel Oil	13.3	78.3	0.3	1.6	0.9	5.2	2.1	12.6	0.3	1.7	0.1	0.7	**17.0**	100.0
Diesel Fuel	1.2	14.8	5.5	65.4	0.0	0.0	0.1	1.4	0.5	6.4	1.0	12.0	**8.3**	100.0
Gasoline	0.4	23.2	0.3	16.8	0.4	23.2	0.0	0.0	0.4	18.4	0.4	18.4	**1.9**	100.0
Coke Gas	42.6	99.4	0.1	0.1	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.1	**42.8**	100.0
Other	9.0	81.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	18.9	**11.1**	100.0
Total Processed Fuels	**237.2**	**93.7**	**6.1**	**2.4**	**1.5**	**0.6**	**2.9**	**1.1**	**1.9**	**0.7**	**3.6**	**1.4**	**253.2**	**100.0**
Blast Furnace Byproducts	49.1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**49.1**	100.0
Other	0.0	0.0	0.0	0.0	0.4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.4**	100.0
Total Byproducts	**49.1**	**99.2**	**0.0**	**0.0**	**0.4**	**0.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**49.5**	**100.0**
Electrical Energy	122.4	46.0	66.6	25.0	20.1	7.6	8.1	3.0	14.2	5.3	34.8	13.1	**266.2**	100.0
Steam & Hot Water	42.1	24.0	34.1	19.4	46.9	26.7	12.4	7.1	23.9	13.6	16.1	9.2	**175.5**	100.0
Total Converted Energy	**164.5**	**37.2**	**100.7**	**22.8**	**67.0**	**15.2**	**20.4**	**4.6**	**38.1**	**8.6**	**50.9**	**11.5**	**441.7**	**100.0**
TOTAL	**509.7**	**60.5**	**115.3**	**13.7**	**76.3**	**9.1**	**44.7**	**5.3**	**40.9**	**4.9**	**55.7**	**6.6**	**842.7**	**100.0**

Source: Energy Research Institute of Russia. The year for which these data are valid was is unknown, but is probably either 1991 or 1992.

2.3 THE ROLE OF COALBED METHANE IN THE KUZBASS

2.3.1 Potential Contribution of Coalbed Methane to the Mining Economy

Use of coalbed methane can help the Kuzbass meet its goals of improving mine profitability. Under the past system of controlled coal prices in Russia, it has been difficult for an individual mine to enjoy increased profitability from improved mining efficiency. The traditional system of subsidizing coal production provided no incentive to the mine to decrease mining costs. However, as has been discussed previously, subsidies are being decreased or eliminated as part of the mine restructuring program. Mines are thus being compelled to increase efficiency in order to increase profitability.

One means of lowering mining costs and directly increasing benefits to the mine is by the development of the coalbed methane resource that is presently being wasted by mines in the region. Expanded methane recovery and use could have significant economic benefits for the coal mines, including: lower investment and operating costs for ventilation; reduced "down-time" due to methane concentrations above the working limit; higher safety margin; and higher and more stable concentrations of methane in recovered gas.

The experience at Jim Walter Resources mines in Alabama, US has shown a direct relationship between the decrease in the concentration of methane in mine workings via economic recovery of the gas, and mining efficiency (Dixon, 1990). In turn, increased mining efficiency lowers the cost of production. A comparative analysis of three hypothetical ventilation and degasification systems conducted by Kim and Mutmansky (1990) further supports these results; the study concludes that the greatest economic benefits resulting from methane drainage are increased coal production and lower coal production costs.

Use of the methane resource could bring additional revenues to the individual mines. For example, using coalbed methane to displace hard coal in mine boilers would free up additional coal for sale. An EPA analysis of the potential for cofiring methane in boilers at the Kirov Mine estimates if methane were cofired in three of the mine’s boilers, it would save 11,100 tons of coal annually, which could be sold for $US 214,000. Another option may be to sell recovered methane to nearby industries as a substitute for coal, coke oven gas, or conventional natural gas for a variety of uses.

One way to illustrate the potentially strong market for coalbed methane in the Kuzbass is to consider the energy content of the gas. The 1 billion cubic meters of methane emitted by Kuzbass mines annually is equivalent to about 41 PJ of energy. Referring to Table 1-2, this is equal to the energy content of nearly all of the steam and hot water consumed by the coal industry annually; or, about the same amount of energy that is consumed in the form of coke oven gas by the metallurgical industry; or, more than half the total natural gas consumed in the oblast each year, all of which must be imported from outside the region.

Some Kuzbass mines are simply so unprofitable that no amount of coalbed methane recovery and use will offset losses enough to make the coal mining operation viable. These mines will be closed, and without alternative sources of energy and employment, the economic and social costs of these closures may impose unacceptable burdens on the residents of mining communities. Coalbed methane can be recovered from inactive mines, however, as well as from virgin fields that lie outside the boundaries of mining areas. Therefore, development of this resource independent of active mining operations could help create jobs in the region, while providing an alternate source of fuel.

2.3.2 Encouraging Development of Coalbed Methane

The Russian government and coal industry recognize the potential benefits of increased coalbed methane recovery and use and are interested in increased development of this resource. RosUgol's Department of Perspective Development and Technical Policy oversees coalbed methane research projects. Under the direction of this department, research is currently underway at the Skochinsky Mining Institute near Moscow, and at the Moscow Mining Institute.

EPA and Partners in Economic Reform (PIER) have established the Russian Coalbed Methane Center in conjunction with the Russian Coal Institute's Siberian Branch, to provide information to local coal mines about opportunities to expand methane recovery. The Center serves as a point of contact for multilateral agencies and US companies seeking to develop coalbed methane projects (the addresses of PIER and other useful government and industry contacts are in Appendix B). It creates domestic industry networks and information exchange, as well as serving as an information resource for Western companies exploring project opportunities in Russia.

Russia views foreign capital investment as a critical element to restoring the productivity of its energy industries. The government has been sorting out a number of issues (e.g., property rights, regulations on sales/exports of output) affecting investment in this sector. The Russian Law on Mineral Rights, enacted by the parliament in February 1992, helps clarify the basic rules governing the ownership of mineral rights and the allocation of royalties earned from licensing of such rights to commercial entities.

Existing Russian legislation that specifically mentions methane focuses on the negative impacts of methane emissions, rather than the positive impacts of methane use. A decree issued by the Russian Ministerial Council Decree in 1991[3] addresses discharge of methane and other pollutants (such as NO_x) to the atmosphere (Tailakov, 1995). This document does not limit the allowable concentration of methane discharged to the atmosphere from an environmental standpoint, but does state that the "rough safe level of effect" (RSLF) on human health is 50 mg methane/m^3 of air. Given the relatively low penalties for discharge of methane, it appears that, in examining the environmental and economic benefits of using methane to displace coal, the resulting avoidance of sulfur dioxide and NO_x emissions is more compelling than the avoidance of methane emissions alone.

It may be more effective to enact other types of measures or policies that will encourage development of this unconventional fuel, as have other countries. Poland, for example, divided its major coal-producing basin into coalbed methane licensing blocks and invited energy companies to bid on these concessions. As a result, several firms, both domestic and foreign, have initiated coalbed methane exploration programs in Poland. Poland is also attempting to provide a sound, clear legal framework that will further attract private investment in energy projects, including coalbed methane projects. Its Geological and Mining Law, passed in 1994, designates coalbed methane as one of the so-called "basic minerals", thus clearly defining the regulatory procedure for undertaking coalbed methane projects (Ronne, 1994). Poland's draft

[3] This decree is titled "Specifications on Outbursts of Polluting Substances on the Natural Environment and Acts About Their Application".

Energy Law, currently awaiting passage, sets out the principles for the regulation of supply and use of energy fuels. An important provision of the Energy Law allows natural gas producers operating in Poland to have third party access to networks distributing electricity, gas, and district heating. This should make it easier to distribute methane produced from coal seams.

Government-provided financial incentives are another means of encouraging coalbed methane development. The Section 29 Unconventional Fuels Tax Credit stimulated tremendous growth of the US coalbed methane industry throughout the 1980's, and was eliminated as soon as coalbed methane became competitive with conventional natural gas. In China, coalbed methane projects are eligible for low-interest government loans. China also exempts coalbed methane projects from paying resource taxes, and reduces value-added taxes and income taxes on coalbed methane production (Sun et al, 1996).

The individual requirements and opportunities faced by companies investing in Russia depend on specific circumstances. However, it is possible to identify several general categories of issues and obstacles that foreign companies investing in the Russian energy sector should consider:

- Ill-defined tax rate structure;[4]
- Informational barriers;
- Russian legal and financial environment;
- Environmental conditions;
- Deteriorating industry structures; and,
- Potential for corruption.

The government's investment policy encourages any form of investment that will provide significant technical re-equipping, modernization of industry, improvements in production, and training of labor. Because coalbed methane projects would involve both technology transfer and capital investment, they should be especially welcome. While investment in the fuel and energy sector is heavily controlled at present, the mineral resource and energy industries are considered to be relatively good investment prospects (Price Waterhouse, 1994). The Kuzbass is a free economic zone, moreover, offering a number of incentives to encourage foreign investment.

At present, it appears that the greatest obstacles to foreign investment in Kuzbass methane projects are 1) lack of markets that can pay for methane with hard currency, and 2) lack of support by Gazprom, the state-owned gas company. Foreign energy companies are starting to recognize the vast potential of the Kuzbass methane resource, however, and given Russia's desire for foreign investment, it is likely that the government will begin to address these barriers to its development.

Different estimates show that the coalbed methane resources associated with balance coal reserves in all mines of the Kuzbass are substantial, ranging from 184 to 344 billion cubic meters. These estimates were established through two different methods of calculating methane resources. These methods are discussed briefly below; the EPA (1994) report on coalbed methane in Russia and Ukraine contains a more in-depth discussion.

[4] For a discussion of taxes and legal requirements applicable to energy enterprises, see Appendix A.

CHAPTER 3. COALBED METHANE RESOURCES OF THE KUZBASS

Historically, Russian miners, like miners everywhere, have known that the control of methane liberation into the mine workings is necessary for safety reasons; however, the mining industry is now recognizing that coalbed methane is a valuable resource that may potentially be recovered profitably. The current restructuring of the coal mining industry in Russia offers a unique opportunity to consider coalbed methane as an important component in the energy balance of the Kemerovo Oblast.

In order to evaluate the potential to develop coalbed methane in the Kuzbass, it is necessary to estimate the magnitude of the resource. The estimates in this study are based on an evaluation of coal resources, including methane content and other characteristics of the coal that can affect the production of coalbed methane. This chapter provides an assessment of coal resources in the Kuzbass, and estimates its coalbed methane resources.

3.1 KEY CHARACTERISTICS OF KUZBASS COAL PRODUCTION ASSOCIATIONS

Table 1-3 summarizes key characteristics of Kuzbass hard coal production associations. In 1994, seven CPAs administered 75 active underground mines; these CPAs, together with the independent Raspadskaya mine, produced more than 58 million tons of hard coal. Production is forecast to decline by as much as 50 percent by 1997, as CPAs phase out extraction from unprofitable seams and mines.

According to the Skochinsky Mining Institute (1993), the Kuzbass contains about 16 billion tons of hard coal reserves. As shown in Table 1-3, active mines contain nearly 10 billion tons of this coal, of which 5.7 billion tons are classified as industrial reserves. Industrial reserves comprise that portion of the balance reserves designated for extraction according to mine plans (for a more detailed explanation of the Russian mineral resource classification system, see Appendix C).

In 1994, Kuzbass mines liberated more than one billion cubic meters of methane (Table 1-3). Of this total, ventilation systems emitted 860 million cubic meters, and methane recovery systems emitted 196 million cubic meters following collection. The recovered methane is predominantly of medium quality, but none of it is used.

3.2 COALBED METHANE RESOURCE ESTIMATES

To fully evaluate the development potential of a coalbed methane project, reliable estimates of coalbed methane resources are necessary. Accurate estimates of methane resources use methods based on detailed information on the coal resources generated by a carefully designed coalbed methane exploration program. Because no large-scale coalbed methane exploration program has been completed in the Kuzbass, less accurate or rigorous methods help give a reasonable estimate.

TABLE 1-3. KEY CHARACTERISTICS OF KUZBASS COAL PRODUCTION ASSOCIATIONS AND RASPADSKAYA MINE

COAL PRODUCTION ASSOCIATION	UNDERGROUND COAL PRODUCTION (Data from 1994)		BALANCE HARD COAL RESERVES (10^6 TONS) (Data from 1991)		METHANE LIBERATION (10^6 m^3) (Data from 1994)		
	NO. OF ACTIVE MINES	HARD COAL MINED (10^6 TONS)	ACTIVE MINES	INDUSTRIAL RESERVES	DRAINED	VENTED	TOTAL EMITTED
KUZNETSKUGOL	18	17.0	3,532	2,327	43.6	423.4	467.0
LENINSKUGOL	9	11.0	1,558	912	83.8	130.0	213.8
PROKOPIEVSKUGOL	13	7.3	1,498	725	10.5	104.1	114.6
BELOVOUGOL	6	4.5	778	593	52.2	61.4	113.6
SEVEROKUZBASSUGOL	12	5.0	1,016	481	2.7	67.1	69.8
KISELEVSKUGOL	9	4.1	1,572	683	1.5	23.8	25.3
OBLKEMEROVOUGOL[5]	8	4.9	n/a	n/a	n/a	n/a	n/a
RASPADSKAYA MINE	1	4.4	n/a	n/a	1.4	50.2	51.6
TOTAL	**76**	**58.3**	**>9,955**	**>5,720**	**195.7**	**>860.0**	**>1,055.7**
Shaded rows indicate coal production associations profiled in Part II of this report							
SOURCE: SKOCHINSKY INSTITUTE, 1993; INTERFAX, 1995; PIER, 1995							

Average Methane Content Method

Under this method, resource estimates were prepared using methane content data published by the Skochinsky Mining Institute (1991) and developed for the coal resources that were scheduled for mining through year 2000. The Skochinsky reports contain measured gas contents and coal reserves of each seam slated for mining. Using this data, an average gas content, weighted on coal reserves, was developed for each CPA and profiled mine. Methane content values were then multiplied by the balance coal reserves of each CPA (or mine), to estimate coalbed methane resources.

This method can yield reasonably accurate resource estimates because it relies on measured methane contents. Uncertainty associated with these estimates and the data on which they are based is related to two factors:

- First, methane content data were only reported by the Skochinsky Mining Institute for those coal seams that are scheduled to be mined through the year 2000. These data may not include appropriate estimates of methane occurring in other coal seams, or in the same seams in areas lying outside the boundaries of the study.

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[5] Oblkemerovougol differs from the other six coal production associations in that 1) it is independent of RosUgol (the Russian Coal Company) and 2) it has no defined boundary; its nine mines (one of which is inactive) and eight open pits are scattered throughout the Kuzbass. During Soviet times, Oblkemerovougol belonged to the Ministry of Fuel Industry, whereas the other six coal production associations belonged to the Ministry of Coal Industry (Tailakov, 1996). Coal seams in the Oblkemerovougol mines reportedly contain methane, but methane liberation data were unavailable.

- Second, the techniques used for measurement of lost gas (unmeasured gas that desorbs during the time that elapses from the moment the coal sample is cut from the seam, until the moment it is sequestered in an airtight container) are unknown. As a result, it is not clear how accurate the reported measured gas content data are, or how they compare to methodologies for determining gas content developed in the U.S.

<u>Specific Emissions Method</u>

The second method for estimating coalbed methane resources is used by the Skochinsky Mining Institute. It relies on the specific methane emissions associated with coal mining, which refers to the volume of methane liberated per unit weight of coal mined during a given time period (in this case, one year), commonly expressed in cubic meters per ton. Specific emissions can be calculated for any CPA or mine by dividing total methane emissions by coal production. Resource estimates are developed by multiplying coal resources by specific emissions.

The specific emissions method can be useful for the most preliminary of estimates. However, it can lead to inflated resource estimates in that this method can also potentially overestimate resources when adjacent coal seams included in the coal resource estimate are the source of some of the methane that is emitted into the mine workings.

<u>Overall Resource Estimates</u>

Table 1-4 summarizes the methane resource estimates for each coal production association in the Kuzbass. The low end of the ranges was calculated using the “Average Methane Content” method[6]. The average methane contents in Table 1-4 were multiplied by the various types of coal reserves (total, active mines, and industrial reserves) to estimate methane resources. The high end of the ranges was calculated using the “Specific Emissions” method. To prepare these estimates, the specific emissions associated with each CPA were multiplied by its coal reserves.

To put these resource estimates into perspective, 184 to 344 billion cubic meters of methane is 43 to 81 percent of the annual consumption of conventional natural gas in Russia. It is the approximate equivalent of 6,200 to 11,500 PJ of energy, which, based on the data in Tables 1-1 and 1-2, is equivalent to 79 to 146 times the annual natural gas consumption of the Kemerovo Oblast, and 22 to 40 times the annual steam and hot water consumption of the Oblast. It could therefore help meet the energy needs of the region for years to come.

[6] The only exception is Kiselevskugol, whose average methane content (11.1 m^3/ton) is higher than its specific emissions.

TABLE 1-4. ESTIMATED METHANE RESOURCES ASSOCIATED WITH KUZBASS COAL PRODUCTION ASSOCIATIONS

COAL PRODUCTION ASSOCIATION	AVERAGE METHANE CONTENT (m^3/T) (1991 data)	SPECIFIC EMISSIONS (m^3/T) (1994 data)	ESTIMATED METHANE RESOURCES (10^9 CUBIC METERS) ASSOCIATED WITH BALANCE RESERVES OF COAL IN:		
			ALL MINES	ACTIVE MINES	INDUSTRIAL RESERVES
KUZNETSKUGOL	13.3	27.5	93 - 192	47 - 97	31 - 64
LENINSKUGOL	9.4	19.5	31 - 64	15 - 30	9 - 18
PROKOPEVSKIDROUGOL	11.7	15.7	19 - 26	18 - 23	9 - 11
BELOVOUGOL	13.1	24.9	10 - 19	10 - 19	8 - 15
SEVEROKUZBASSUGOL	12.4	13.9	20 - 23	12 - 14	6 - 7
KISELEVSKUGOL	11.1	6.1	11 - 20	10 - 18	4 - 8
TOTAL			**184 - 344**	**112 - 201**	**67 - 123**
Shaded rows represent coal production associations profiled in Part II of this report					
SOURCE: SKOCHINSKY INSTITUTE, 1993 AND 1991; PIER, 1995; VOSTNII, 1995					

3.3 METHANE RECOVERY AND USE

Coalbed methane use would clearly benefit the Kuzbass by helping it to meet increasing energy needs with a less polluting, local energy source. Some fuels that coalbed methane could replace are brown coal, low-quality hard coal, coke oven gas, and natural gas imported into the region. Coalbed methane extracted during mining will be most valuable when used locally in situations where high compression, enrichment, or long distance transmission is not required. Methane could thus be used to produce heat and power for use by mine facilities, local industries, and nearby residences. Among the most attractive options for methane use in the Kuzbass are:

Heating mine facilities. Currently, Kuzbass mines use coal-fired boilers to produce steam heat for such purposes as drying coal, heating mine facilities, and heating ventilation air.[7] In some cases, mine boilers also supply thermal energy to the surrounding communities. Typically, low-quality, highly polluting coal is used for these purposes; higher-quality coal is reserved for sale. Coalbed methane could be directly fired for use in coal drying facilities. For heating purposes, boilers could be retrofitted to burn methane intermittently with hard coal, or to co-fire methane with coal. Should methane become unavailable for any reason, the boilers would maintain their ability to operate entirely on coal. A typical Kuzbass mine may consume 50,000 to 700,000 tons of coal per year in its boilers. This is the energy equivalent of approximately 44 to 526 million cubic meters of methane. The amount of methane drained by each mine profiled in Chapter 3 of this report ranges from 5 to 38 million cubic meters annually, enough to significantly offset the amount of coal presently being consumed.

Use in furnaces in the metallurgical industry. Another strong candidate for methane use is the metallurgical industry. The city of Novokuznetsk, in the southern portion of the Kuzbass, contains numerous gassy mines. It is one of the biggest centers of metallurgy in Russia, moreover, producing thousands of tons of steel, cast iron,

[7] Because of the extreme Siberian winters, much more energy is required for mine heating in this region than in temperate climates.

aluminum and other metals annually. As shown in Table 3, the metallurgical industry consumes about 54 PJ of natural gas annually, which is equivalent to about 1.4 billion cubic meters of methane.

Power generation at mine facilities. Most Kuzbass mines purchase electricity from the power grid. Use of coalbed methane to generate electricity on-site may be a more economical option for these mines. Boilers, gas turbines, and internal combustion engines can use coalbed methane to generate electricity. One potentially attractive use of coalbed methane is powering mine water desalination plants, which require large amounts of both electrical and thermal energy for operation. A typical Kuzbass mine consumes approximately 73 GWh of electricity per year, the energy equivalent of about 8 million cubic meters of methane.

A trend toward better enforcement of environmental legislation is developing in Russia, and mines and other industries that are able to substitute gas for coal will fare better than those who cannot. The Russia Coalbed Methane Center has developed a database containing information on boiler stations in four Kuzbass cities: Belovo (141 boiler stations), Kemerovo (99 boiler stations), Kiselevsk (67 boiler stations), and Mezhdurechensk (64 boiler stations). It contains data on the type, thermal capacity, and coal consumption of each station. The Center is using this database to determine the quantity of various pollutants released to the atmosphere as a result of coal combustion by these boilers; and, to ascertain technical requirements for converting the boilers to gas use (Tailakov, 1995).

3.4 COALBED METHANE PROJECT OPPORTUNITIES

Given the economic and political issues described in this report, it is likely that coalbed methane will be developed in a phased fashion. The short, medium, and long-term project types listed in Table 1-5 are meant to provide conceptual guidelines for development. In addition, the table lists types of assistance that are perceived to be needed, and suggested sources for funding.

There are three general categories of projects that a mine can undertake: projects to improve the quality of methane recovered, projects to increase the quantity of methane recovered, and projects to increase methane use. Some of the best opportunities for improving methane quality are related to reducing the amount of air that is drawn into the underground piping system. Relatively simple measures such as properly installing, sealing, and maintaining the underground piping network will minimize leaks in the system. Such projects require relatively little capital.

Projects to increase the quantity of methane recovered require coordinating mining activities with gas production activities to optimize methane production concomitant with coal extraction. For instance, drilling vertical pre-drainage wells requires coordination between drilling and mining departments to ensure that methane is drained well in advance of mining. Each mining property confronts the planner with a set of site-specific conditions that may require unique solutions to the problem of optimizing gas production without reducing the effectiveness of the overall mining plan.

TABLE 1-5. SHORT, MEDIUM, AND LONG-TERM COALBED METHANE RESOURCE DEVELOPMENT PROJECT TYPES FOR THE KEMEROVO OBLAST

PROJECT TYPE	ANTICIPATED RESULTS/BENEFITS	ASSISTANCE TYPE	FUNDING SOURCE
SHORT-TERM (One to Two Years)			
Enhanced Recovery*	Increased volume and concentration of methane / Increased safety	Technical assistance, followed by development projects	USAID/PIER; Local government; Russian Investment Bank
Increased use: Upgrading existing systems Supplying immediate needs (information, repairs, etc.)	Use existing delivered methane at current concentrations and volume / Safety benefits; environmental benefits; enhanced mine productivity and profitability	Technical assistance, followed by development projects	USAID/PIER; Local government; Russian Investment Bank
MEDIUM-TERM (Two to Five Years)			
Introduction of Recovery Systems or other New Technology	Improved production and quality of recovered methane / Safety benefits; enhanced mine productivity and profitability	Development projects; Technical assistance; Technology transfer	GEF; USAID; TDA; IFC; Local government
Construction of a gathering, transmission, and local distribution system	Increased methane supply to local industry; switching to cleaner fuels / Enhanced mine productivity and profitability; local economic development; environmental benefits	Development projects; Technical assistance; Technology transfer	GEF; USAID; TDA; IFC; Local government
LONG-TERM (Five to Ten Years)			
Conversion of one or more industries to coalbed methane use	Incorporation of coalbed methane into the energy balance of the region; development of coalbed methane independent of coal mining / Economic benefits to the region	Development projects; Technical assistance; Technology transfer	GEF; USAID; WB; TDA; IFC; Local, regional, and national government

* As discussed in the text, recovery can often be enhanced via relatively minor changes in methane drainage operations that require little or no outside funding.

Projects to increase methane use might include:

- conversion of boilers located at the mines from coal-fired to gas-fired using coalbed methane extracted from the mine;

- mobile power generation facilities that can be connected to gob wells drilled behind the advancing face, that supply energy to the mobile pumping stations and ventilation booster stations;

- implementation of pre-mine and gob well drainage systems that can be connected to gathering and transmission systems thereby increasing the volume and quality of gas that can be supplied to nearby and allied industries; and,

- development of storage facilities to make optimal use of the resource drained during the summer months.

All of these project opportunities will require technical and developmental assistance from private enterprise and funding agencies.

PART TWO: PROFILES OF SELECTED COAL PRODUCTION ASSOCIATIONS

COAL PRODUCTION ASSOCIATION AND MINE PROFILES USER'S GUIDE

FORMAT

This section profiles three Kuzbass coal production associations (Kuznetskugol, Belovougol, and Leninskugol) and six affiliated mines, summarizing key features of their coal and coalbed methane resources. Each CPA profile is followed by profiles of a selected mine or mines. Three appendices follow the profiles. Appendix A discusses some of the steps that most companies must take to form a joint venture in Russia. Appendix B lists Russian government and mining contacts, along with their functions and addresses, which may be useful to the potential foreign investor. Appendix C explains Russian terminology regarding resource classification, coal rank, and mining hazards. *Please consult Appendix C for information which, to avoid repetition, is not included in the individual mine profiles*.

Below is a brief explanation of selected items that appear in this section.

MINE LOCATIONS AND STRATIGRAPHIC SECTION

Figure 2-1 shows the locations of the CPAs and profiled mines. Figure 2-2 is a general stratigraphic section of the coal-bearing sequence of the Kuzbass.

MINING ECONOMICS

With the exception of the Kirov Mine, coal production costs were not available because most mines consider this information confidential. Coal sales prices for individual mines are more readily available than production costs, and are reported in the mine profiles.

Unless otherwise noted, exchange rates used in this report are (rubles equivalent to $US 1):

1991: 1.8 **1993:** 1,000 **1994:** 2,320 **1995:** 4,900

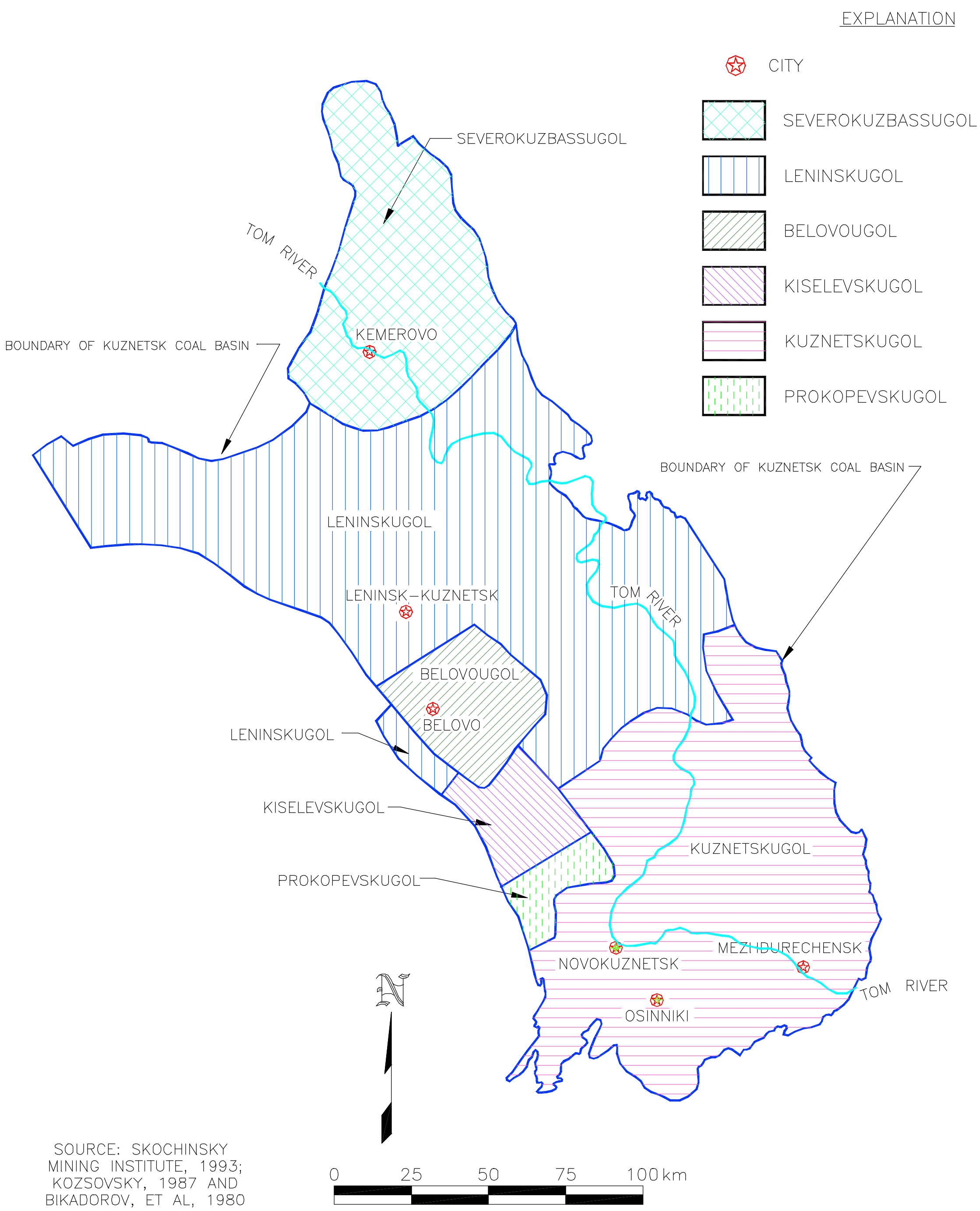
METHANE RESOURCE ESTIMATES

This report presents methane resources for each of the three profiled coal production associations and six profiled mines. Estimates are presented as a range. In most cases, the lower ends of this range were calculated using a weighted average methane content; the higher ends of the range were calculated using specific emissions. Section 3.2 in Part 1 of this report details these estimation methods.

SALINE WATER DISCHARGE

Data concerning the quality and quantity of water discharged as a result of normal mining operations are also presented. The reason for providing these data is that water is typically produced when methane drainage boreholes are drilled from the surface in advance of, or unrelated to, mining operations. Since surface drainage of methane has never been performed in the Kuzbass, it is difficult to predict the amount of water such operations will produce. Mine water discharge data, however, provide an indication of the quality and quantity of water that methane boreholes may yield. This information must be considered in planning coalbed methane recovery projects in advance of (or outside of) mining, because saline water may need to be treated prior to disposal to avoid polluting local water resources.

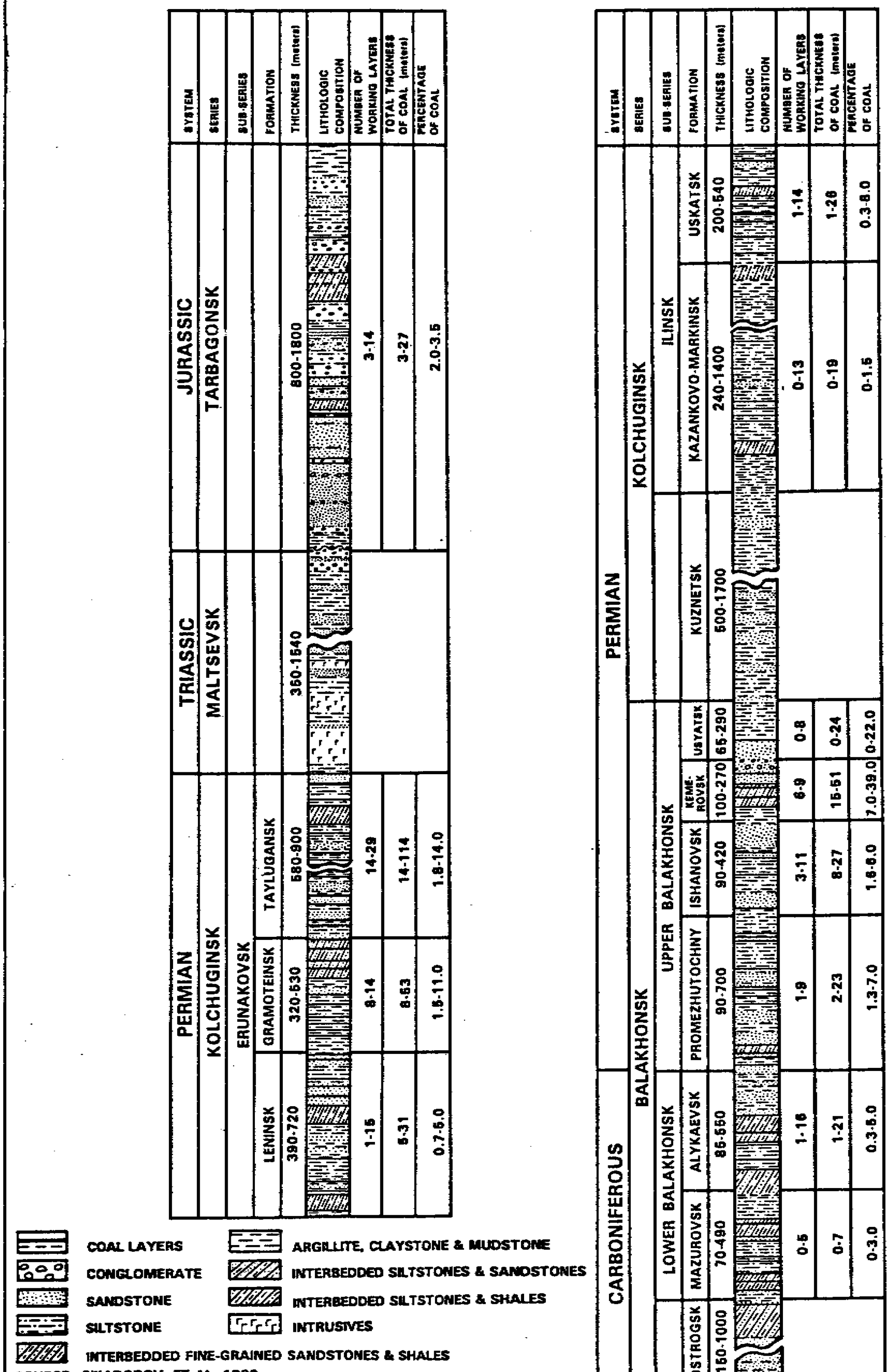
FIGURE 2-1. LOCATION OF COAL PRODUCTION ASSOCIATIONS IN THE KUZNETSK COAL BASIN, RUSSIA



SOURCE: SKOCHINSKY MINING INSTITUTE, 1993; KOZSOVSKY, 1987 AND BIKADOROV, ET AL, 1980

05837005

FIGURE 2-2. GENERAL STRATIGRAPHIC SECTION OF COAL BEARING SEQUENCE OF THE KUZNETSK COAL BASIN, RUSSIA



SOURCE: BIKADOROV, ET AL, 1980

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GEOTHERMAL GRADIENT

In each mine profile, data on the mine's geothermal gradient are provided. The reason for noting the geothermal gradient (typically in ° C per 100 m) is that the higher the gradient, the faster gas desorbs from the coal, requiring more ventilation.

CARBON DIOXIDE EQUIVALENTS

Investing in a coalbed methane recovery project may be a very cost-effective way to reduce greenhouse gas emissions. A number of US entities are initiating projects overseas to reduce greenhouse gas emissions as part of voluntary programs, such as the Department of Energy's *Climate Challenge* program with electric utilities. These organizations report their reductions under a program administered by the Department of Energy enacted under Section 1605(b) of the Energy Policy Act of 1992.

Under the 1605(b) guidelines, methane emissions reductions should be reported in units of methane. Methane is a very potent greenhouse gas, estimated to be between 19 and 43 times more potent than carbon dioxide (CO_2) on a weight basis over a 100-year period. In this report, a factor of 22 was used because this is the U.S. Government's current view of the relative potency of methane as compared to CO_2. This factor implies that each ton of methane emissions avoided is equivalent in impact to reducing CO_2 emissions by 22 tons[8].

For more information on the Section 1605(b) voluntary reporting program, contact the U.S. Department of Energy, Voluntary Reporting of Greenhouse Gases Program, Energy Information Administration, EI-81, 1000 Independence Avenue, SW, Washington, DC 20585.

[8] 52 billion cubic feet (Bcf) of methane is equal to 1.49 billion cubic meters and one million metric tons.

KUZNETSKUGOL COAL PRODUCTION ASSOCIATION

The Kuznetskugol Coal Production Association (Figures 2-1 and 2-3) operates in and around the city of Novokuznetsk, in the southern Kuzbass. The CPA was established in 1975, originally as Yuzhkuzbassugol (Flegon, 1995). The region encompasses about 10,000 km^2 of mostly hilly terrain, and its total population is 850,000.

The CPA contains 18 active coal mines, all of which are underground; there is no open cast mining at Kuznetskugol. The CPA also includes repair works, a computing center, and a research section. There are 47 departments in all, located in the cities of Novokuznetsk (the administrative headquarters), Mezhdurechensk and Osinniki.

The Abashevskaya and Baidaevskaya Mines are profiled in this report because each liberates and drains relatively large volumes of methane.

COAL GEOLOGY, RESERVES, AND PRODUCTION

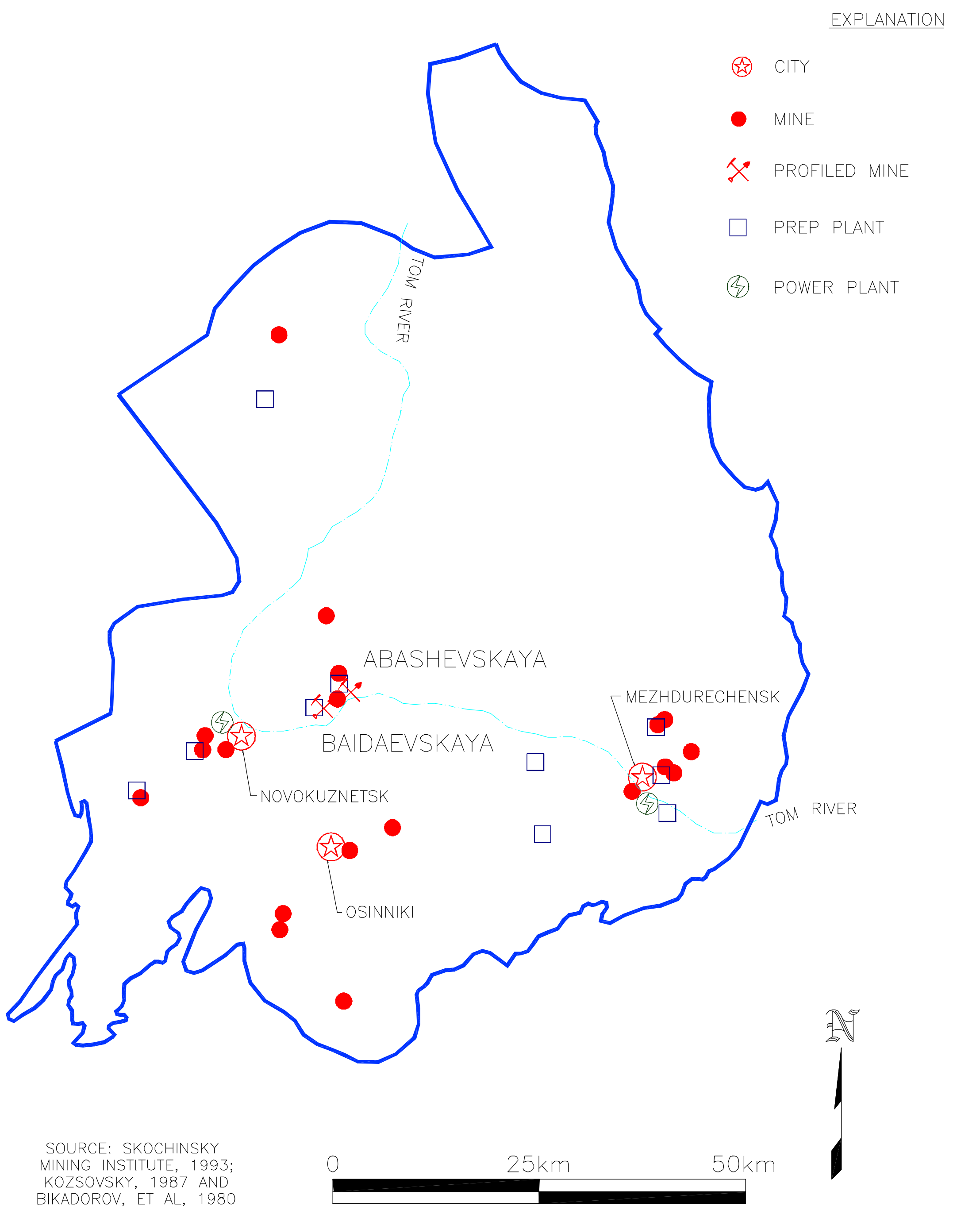
Geologic Setting. All coal deposits are complexly folded and faulted, manifest as *en echelon* (overlapping) folds and thrust faults along the western and southern borders. The main coal-bearing horizons occur in Permo-Carboniferous Balakhonsk and Kolchuginsk sediments (Figure 2-2) which crop out along the southern and eastern borders of the association, which are superimposed on the margin of the basin. Jurassic Tarbagansk sediments were deposited in synclinal features in the center.

The mine’s working seams include gently sloping, inclined and steep seams whose thickness ranges from 0.8 m to 10 m. Average mining depth is 230-250 m.

Coal Reserves and Rank. Balance coal reserves of all mines in the association total 7.0 billion tons; of this, active mines account for 3.5 billion tons. Coal reserves consist predominantly of gas and fat coal (high volatile bituminous B) with some coking coal (high volatile bituminous A) and lean-caking coal (medium volatile bituminous). There are also some Jurassic Tarbagansk deposits containing brown coal. These deposits are not included in the reserve calculations, however, as they would be mined by surface techniques.

Coal Production. In 1994, Kuznetskugol CPAs produced 17.0 million tons of coal (Interfax, 1995), down 6 percent from 18.0 million tons in 1993 (Table 2-1). The CPA contains 6 coal preparation plants which process 7.6 million tons of coal annually.

FIGURE 2–3. KUZNETSKUGOL COAL PRODUCTION ASSOCIATION



SOURCE: SKOCHINSKY MINING INSTITUTE, 1993; KOZSOVSKY, 1987 AND BIKADOROV, ET AL, 1980

TABLE 2-1. SUMMARY DATA FOR ACTIVE MINES OF THE KUZNETSKUGOL COAL PRODUCTION ASSOCIATION (1994)

MINE	COAL PRODUCTION (10^3 TONS)	METHANE LIBERATED (10^6 m^3)			SPECIFIC EMISSIONS (m^3/ton)	METHANE HAZARD
		VENTED	DRAINED	TOTAL		
ABASHEVSKAYA	1,561	88.8	4.5	93.3	59.8	High
ALARDA	1,847	13.4	0.7	14.1	7.6	High
BAIDAYEVSKAYA	736	21.4	12.8	34.2	46.4	Very High
BUNGURSKAYA	457	1.2	0	1.2	2.6	High
DIMITROV *	229	29.8	1.2	31.0	135.4	Very High
KAPITAL'NAYA	1,667	67.5	2.9	70.4	42.2	Very High
LENIN	1,535	24.7	5.2	29.9	19.5	Very High
NAGORNAYA	740	31.2	0	31.2	42.2	High
NOVOKUZNETSKAYA	931	1.3	0	1.3	1.4	High
POLOSUKHINSKAYA	1,474	9.0	0	9.0	6.1	High
SHEVYAKOVA *	157	0.5	0	0.5	3.2	Medium
SHUSHTALEPSKAYA	487	9.1	0	9.1	18.7	High
TOMSKAYA	869	39.2	0.1	39.3	45.2	Very High
USINSKAYA	538	24.0	0.3	24.3	45.2	Very High
VYSOKAYA	509	12.2	0.0	12.2	24.0	High
YESAUL'SKAYA	791	10.2	0.0	10.2	12.9	High
YUBILEINAYA	1,605	23.8	10.4	34.2	21.3	Very High
ZYRYANOVSKAYA	877	15.9	5.5	21.4	24.4	High
TOTAL	**17,010**	**423.4**	**43.6**	**467.0**		
RASPADSKAYA MINE**	4,418	50.2	1.4	51.6	11.7	Very High
GRAND TOTAL	**21,428**	**473.6**	**45.0**	**518.6**		
AVERAGE (WEIGHTED)					**24.2**	

Shaded mines indicate those profiled in this report.

* Mines marked with an asterisk are currently in the process of closure.

**The mine “Raspadskaya”, although independent of any coal production association, is included here as it is located in the Kuznetskugol region and may join the CPA in the future. Raspadskaya is Russia’s largest underground coal mine.

Source: PIER (1995)

METHANE LIBERATION, RECOVERY, AND RESERVES

In 1994, 467 million cubic meters of methane were liberated from coal mines of the Kuznetskugol CPA (Table 2-1). Of this, 423 million cubic meters were emitted via ventilation systems, and the remaining 44 million cubic meters were emitted after being recovered by drainage systems.

Only ten of the CPA's 18 active mines drained methane. The mines drain methane from both surface and in-seam boreholes. The two mines profiled in this report (Abashevskaya and Baidevskaya) together accounted for nearly 40 percent of the methane drainage.

None of the mines currently use the methane they recover. One of the most promising options for using the methane is in boilers at the mines, which provide heat for mine facilities, and in some instances, the surrounding community.

Methane reserves are estimated to range from 93 to 192 billion cubic meters for the balance coal reserves of all mines in the Kuznetskugol CPA, and 47 to 97 billion cubic meters for the balance coal reserves of active mines in the Kuznetskugol CPA. The lower end of these ranges was calculated using an average gas content of 13.3 m^3/ton. The higher end of these ranges was calculated using an average specific emissions value of 27.5 m^3/ton.

ABASHEVSKAYA MINE

The Abashevskaya Mine is operated by the Kuznetskugol CPA and is located in the southwestern portion of the Kuzbass, approximately 15 km east of the city of Novokuznetsk (Figure 2-3). The mine area occupies 32.0 km^2. Terrain and land use in the area are varied; some areas are populated, some cultivated. In addition to coal mining, metallurgical and construction industries predominate. Mining operations began in 1943.

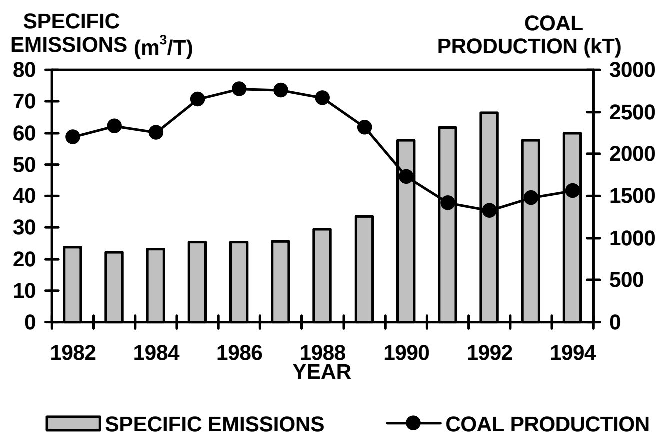
Geologic Setting. Coal is found within the southeast flank of a northeast plunging syncline. The coal is extracted from the upper Kazankovo-Markinsk, Uskatsk, and lower Leninsk Formations of the Permian Kolchuginsk Series (Figure 2-2). Mined seams dip from 6 to 25°; most of the seams are relatively flat. The average geothermal gradient is 2.8° C per 100 meters.

COAL PRODUCTION AND SPECIFIC EMISSIONS

The mine has one working level accessed by 5 shafts. Coal is mined by longwall methods, using shearing machines.

As shown in Graph 1, coal production peaked in 1986 when 2.8 million tons were produced. Output declined sharply from 1989 through 1992, presumably due to the same conditions affecting nearly all Russian mines during that time period-sharply reduced demand for coal, labor unrest, and financial difficulties related to the collapse of the Soviet system. Production has since increased slightly, and in 1994, the mine produced 1.6 million tons.

GRAPH 1. COAL PRODUCTION AND SPECIFIC EMISSIONS, 1982-1994

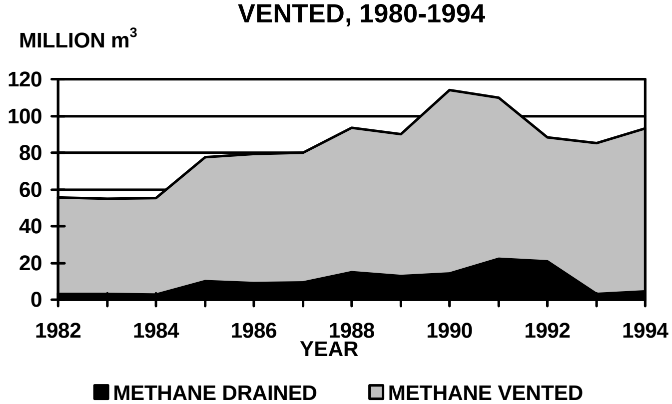


Graph 1 also shows that high specific emissions correspond with the low production of recent years. This indicates that the decrease in coal production has not proportionally reduced the flow of methane into the mine workings. Specific emissions were 59.8 m^3/ton in 1994.

METHANE LIBERATION, DRAINAGE, AND RESERVES

Trends in methane ventilation, drainage and total liberation at Abashevskaya are shown in Graph 2. Methane liberation peaked in 1990, when 99.7 million cubic meters were released. Emissions have remained relatively high, despite declining coal production. In 1994, a total of 93.3 million cubic meters of methane were liberated from the Abashevskaya mine (more than any other Kuzbass mine). Of this, 88.8 million cubic meters were emitted to the atmosphere via the ventilation system, and 4.5 million cubic meters were emitted after being collected by the drainage system.

GRAPH 2. METHANE DRAINED AND VENTED, 1980-1994



Methane Drainage. Abashevskaya drained 5 percent of the methane it liberated in 1994. The principal recovery method is in-mine drainage via horizontal drilling into coal seams; this typically occurs less than six months prior to mining, although methane is apparently recovered from soufflard-prone seams 2 years or more in advance of mining. Abashevskaya also uses horizontal boreholes to recover methane from gob areas. The mine does not employ surface drainage methods, because surface access to the mine is difficult since three other mines lie above Abashevskaya.

There are presently 10 vacuum pumps operating from seven stations. Four of these are on the surface and drain gas via wells drilled into the gob area of Seam 26, which is in the lower Leninsk Formation of the Permian Erunakovsk sub-series; the remaining three are underground and drain gas from the soufflard-prone seams of Seam 14, which lies at the boundary between the Kazankovo-Markinsk and Uskatsk Formations (Figure 2-2). Abashevskaya has performed only preparatory work on Seam 14 to date.

Methane Reserves. Methane reserves are estimated to range from 2.3 to 9.7 billion cubic meters for all balance coal reserves, and 1.4 to 5.7 billion cubic meters for the industrial coal reserves. The lower end of these ranges was calculated using a weighted average methane content of 14.4 m^3/ton. The higher end of these ranges was calculated using a specific emissions value of 59.8 m^3/ton.

OPPORTUNITIES FOR USE OF MINE METHANE

None of the recovered methane is currently used, so it is all emitted to the atmosphere. At the present time, mine management has no definite plans for future methane utilization, due to low methane concentrations in the recovered gas. If quality can be improved, however, gas could be used on-site in boilers to produce heat for the mine and the surrounding region.

The mine has three boiler houses, one of which is small and is expected to close. The two larger boiler houses contain 3 boilers each. One of the large boiler houses provides heat to the region; each of its three boilers consumes about 30 tons of coal per day, and output is about 20 Gcal per hour (this boiler house is being renovated with Chinese equipment to make it more efficient). The other large boiler house provides heat for the mine. One of its boilers has an output of 20 Gcal per hour; output of the other two is currently unknown.

Presently, the mine is purchasing heating coal from other mines to use in its boilers. If it used methane in these boilers, the cost of purchasing this coal could be reduced. The methane could be cofired with coal.

Without additional information, it is difficult to accurately estimate the amount of methane that could be consumed by the mine's boilers. The potential demand for methane can be illustrated, however, by the following example: if the boilers consume 180 tons of coal per day (65,700 tons per year), they consume the energy equivalent of 49 million cubic meters of methane annually; this is more than ten times the methane currently drained by the mine, and 82 percent of the total amount of methane liberated by the mine.

The mine sells its coal to a nearby preparation plant that is central to the Abashevskaya, Nagornaya and Novokuznetskaya mines. This prep plant is another potential consumer of coalbed methane, for coal drying and heating purposes.

MINING ECONOMICS

The 1993 average market price for Abashevskaya coal was 8,616 rubles ($US 8.62) per ton. As of October 1, 1994, fat coal from Abashevskaya sold for 30,800 rubles ($US 13.28) per ton, and gas fat coal sold for 33,100 rubles ($US 14.27) per ton. Production costs exceed sales prices; the mine received 19.7 billion rubles ($US 8.5 million) in subsidies during the first 8 months of 1994.

MINE DISCHARGE WATER

The Abashevskaya Mine produces about 760 m^3 of water per hour, with a mineral content averaging 2.6 grams/liter. Between 30 and 50 percent of this water is used in the beneficiation plant, as well as for dust control in the mine, fire control on the terracones or waste piles, and in the boilers. Discharge information for the unused percentage was not available, however, all mines of the Kuznetsk Basin are reported to have various facilities for mine water purification, such as concrete sedimentation tanks and filtering stations.

SUMMARY DATA TABLES

COAL RESOURCES

Number of Coal Seams		Thickness of Mined Seams (m)		Overburden		Balance Coal Reserves (Million Tons)		
Now Mining	Total	Average	Range	Thick-ness (m)	No. of Seams	Total	Industrial	Prepared for Mining
4	15	1.88	1.3 - 3.0	0-540	10	161.7	95.7	24.2

COAL QUALITY AND RANK

Ash (%)	Heating Value (kcal/kg)	Moisture (%)	Sulfur (%)	Volatile Matter (%)	Rank
24.7	8,343	6.2	0.44	39.5	fat, gas fat, gas (hvBb)

MINE CHARACTERISTICS

Hazard Classifications		% of Coal that is Extracted	Current Mining Depth	Surface Elevation of Mine Shaft	Annual Power Consumption (MWh)
Gas and Rock Outburst	Dust Hazard				
Sudden Outbursts	Dangerous	27%*	550 m	212 - 400m	58,080

LABOR

All Employees of Mining Complex			Employees Involved in Coal Production Only				
Laborers	Professional	Total	Active Mining	Prep. Work	Other Underground	Surface	Total
3,156	499	3,655	878	643	588	893	3,002

AMOUNT OF COAL SENT TO PREP PLANT (THOUSAND TONS)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2170	2362	2204	2697	2692	5806	2575	2396	1800	1413	1400	1531

LITHOLOGIC DATA

Lithology of Overburden	Lithology of Roof Rock
Aleurolite/siltstone-66.9%; Sandstone 21.9%; Argillite 6.3%; Coal 4.9%	Sandstone, aleurolite, argillite

DEMETHANIZATION SYSTEM

Pipeline		Gas Output	
Length (km)	Diameter (mm)	Avg. Gas Output (m^3/min)	Methane Concentration (%)
5.7	100 - 150	40	2-14

CARBON DIOXIDE EQUIVALENTS (Million Tons)

CO_2 Equivalent of Total Methane Liberated (Vented and Drained), 1994	CO_2 Equivalent of Methane Drained, 1994
1.39	0.67

*****This figure is very low compared to the other profiled mines and may be erroneous.

BAIDAEVSKAYA MINE

The Baidaevskaya Mine is operated by the Kuznetskugol CPA. It is located in the southwestern portion of the Kuzbass, approximately 32 km northwest of the city of Novokuznetsk, in the Ordzhonikidze industrial region (Figure 2-3). The mine area occupies 11.2 km^2. The terrain is hilly, and the area is inhabited by about 70 thousand people. Mining operations began in 1940.

Geologic Setting. The coal deposits are found in a west-northwest trending asymmetrical syncline, bounded on the southwest by at least two large reverse-angle faults which extend to the surface, and numerous smaller reverse-angle faults occurring only in the subsurface. Currently, coal is extracted from the Leninsk Formation of the Permian Kolchuginsk Series (Figure 2-2). Mined seams dip from 6 to 28°; about one-third of the seams are relatively flat, while the remaining two-thirds are inclined and steeply inclined. The average geothermal gradient is 2.8^o C per 100 m.

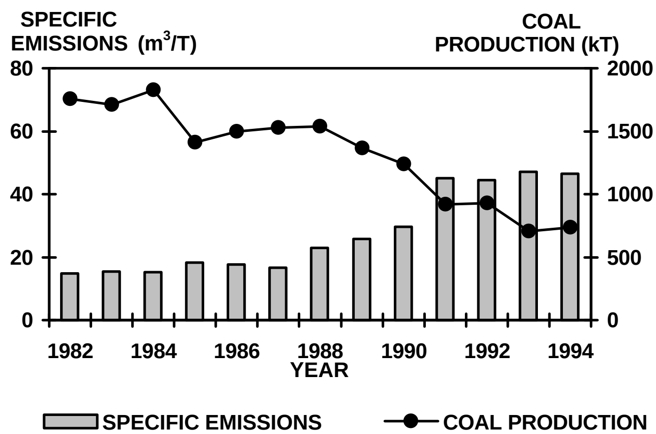
COAL PRODUCTION AND SPECIFIC EMISSIONS

The mine has one working level accessed by 2 shafts. Coal is mined by longwall methods, using shearing machines.

Coal production peaked in 1979 when 2.3 million tons of coal were produced. As shown in Graph 1, production began a long decline in 1989, and in 1994, only 0.7 million tons were mined. Difficult geologic conditions, as well as the collapse of the Soviet system, have contributed to the decline.

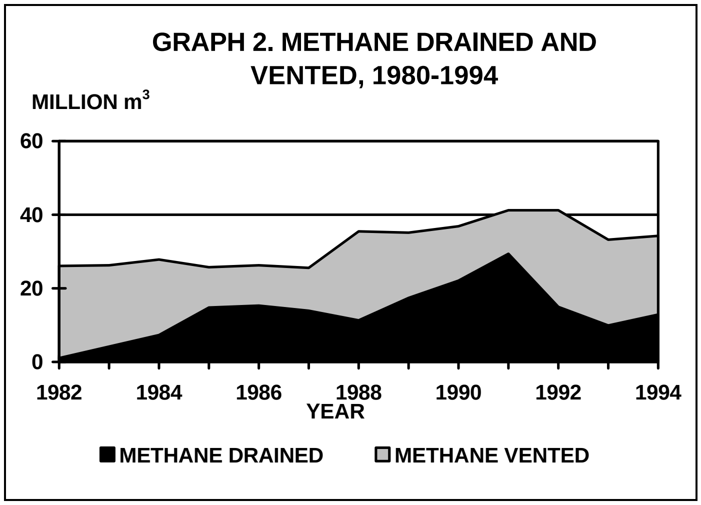
Graph 1 also shows that high specific emissions correspond with low coal production of recent years. This indicates that the decrease in coal production has not proportionately reduced the flow of methane into the workings. Specific emissions were 46.4 m^3/ton in 1994.

GRAPH 1. COAL PRODUCTION AND SPECIFIC EMISSIONS, 1982-1994



METHANE LIBERATION, DRAINAGE, AND RESERVES

As shown in Graph 2, a total of 34.2 million cubic meters of methane were liberated from the Baidaevskaya Mine in 1994. Of this, 21.4 million cubic meters were emitted to the atmosphere via the ventilation system, and 12.8 million cubic meters were emitted after being recovered from drainage systems. The total amount of methane liberated increases as the amount drained increases, indicating that fluctuations in the amount of methane liberated in the mine workings occur in regions where drainage systems are used.



Methane Drainage. The primary means of methane recovery is from horizontal boreholes drilled into gob areas. Numerous gob wells have been drilled in Seam 29, which is in the Leninsk Formation of the Erunakovsk sub-series. There are six vacuum pumps, all located on the surface; two of these are currently in operation; they are designed to drain gas from gob areas only.

Methane Reserves. Methane reserves are estimated to range from 1.2 to 4.3 million cubic meters for all balance coal reserves, and 1.0 to 3.5 million cubic meters for industrial coal reserves. The lower end of these ranges was calculated using a weighted average methane content of 13.0 m^3/ton. The higher end of these ranges was calculated using a specific emissions value of 46.4 m^3/ton.

OPPORTUNITIES FOR USE OF MINE METHANE

None of the recovered methane is used. It is all emitted to the atmosphere. Mine management is considering using coalbed methane in the mine's boilers, however they state that this will require a more systematic approach to recovery of higher quality gas.

The mine has 2 boiler stations, which consume a total of 700,000 tons of coal per year. One of these stations contains 8 boilers and has a total output of 40 gigacalories per hour. The other station currently contains 3 boilers whose output is 30 gigacalories per hours; it will soon expand to 5 boilers, whose total output will be 70 gigacalories per hour.

Without additional information, it is difficult to accurately estimate the amount of methane that the mine's boilers could consume. The potential demand for methane can be illustrated, however, by the following example: an annual coal consumption of 700 thousand tons[9] is the energy equivalent of 611 million cubic meters of methane, which is nearly 48 times the amount of methane currently being drained at the mine each year, and 18 times the methane liberated by the mine each year.

The mine's coal preparation plant is another potential consumer of coalbed methane. While it does not thermally dry the coal, it does recover fine coal, an energy-intensive process which could potentially be fueled by coalbed methane.

MINING ECONOMICS

In the 4th quarter of 1993, Baidaevskaya coal prices ranged from 15,900 rubles ($US 6.85) per ton for gas-fat coal to 18,400 rubles ($US 7.93) per ton for gas-coking coal. Production costs exceed sales prices; between January 1, 1993 and August 1, 1994, the mining complex received 2.85 billion rubles (approximately $US 1.2 million) in subsidies.

MINE DISCHARGE WATER

The Baidaevskaya Mine produces about 9,300 cubic meters of water per day, with an average mineral content of 2.8 grams/liter. Of this, about 5,580 cubic meters per day are used at the mine. This includes 12 cubic meters per day consumed at the mine's beneficiation plant.

[9] This coal consumption rate is considerably higher than that reported at any other mine. The reason for this relatively high rate of consumption is unknown.

SUMMARY DATA TABLES

COAL RESOURCES

Number of Coal Seams		Thickness of Mined Seams (m)		Overburden		Balance Coal Reserves (Million Tons)		
Now Mining	Total	Average	Range	Thick-ness (m)	No. of Seams	Total	Industrial	Prepared for Mining
3	24	3.31	2.6-3.7	50	8 - 17	92.5	74.6	9.4

COAL QUALITY AND RANK

Ash (%)	Heating Value (kcal/kg)	Moisture (%)	Sulfur (%)	Volatile Matter (%)	Rank
24.7	8,343	5.4	0.44	39.5	fat, gas fat, gas (hvBb)

MINE CHARACTERISTICS

Hazard Classifications		% of Coal that is Extracted	Current Mining Depth	Surface Elevation of Mine Shaft	Annual Power Consumption (MWh)
Gas and Rock Outburst	Dust Hazard				
Sudden Outbursts	Dangerous	84.5	400 - 600 m	210 - 370 m	50,000

LABOR

All Employees of Mining Complex			Employees Involved in Coal Production Only				
Laborers	Professional	Total	Active Mining	Prep. Work	Other Underground	Surface	Total
NA	NA	2000	NA	NA	NA	NA	NA

AMOUNT OF COAL SENT TO PREP PLANT (THOUSAND TONS)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1023	1045	1124	743	1011	899	758	651	564	361	119	41

LITHOLOGIC DATA

Lithology of Overburden	Lithology of Roof Rock
sandstone, 30-40%; shale 60-70%; no limestone	aleurolite, siltstone, sandstone

DEMETHANIZATION SYSTEM

Pipeline		Gas Output (of pumping units)	
Length (km)	Diameter (mm)	Avg. Gas Output (m^3/min)	Methane Concentration (%)
NA	NA	12-14	25-38

CARBON DIOXIDE EQUIVALENTS (Million Tons)

CO_2 Equivalent of Total Methane Liberated (Vented and Drained), 1994	CO_2 Equivalent of Methane Drained, 1994
0.51	0.19

BELOVOUGOL COAL PRODUCTION ASSOCIATION

The Belovougol Coal Production Association (CPA) operates in and around the city of Belovo (Figures 2-1 and 2-4), in the Kemerovo region of the west-central Kuzbass. The CPA was formed in 1990 as a result of reorganization. It comprises mines formerly belonging to Leninskugol CPA, and one mine formerly of Prokopevskidrougol CPA.

The CPA contains six active hard coal mines, all which are underground mines. Belovougol also contains numerous other enterprises, including a machine-building plant. The main consumers of coal produced at Belovougol are coking plants, metallurgical plants, heat and power stations, and municipal services.

The Chertinskaya mine is profiled in this report because it liberates and drains relatively large volumes of methane.

COAL GEOLOGY, RESERVES, AND PRODUCTION

Geologic Setting. All coal deposits are complexly folded and faulted, manifest as en echelon folds and thrust faults, striking approximately northwest. The main coal horizons occur in Permo-Carboniferous Balakhonsk and Kolchuginsk sediments (Figure 2-2) which crop out along the western border. Most of the coal is produced from deposits situated in closed synclinal features.

Coal Reserves and Rank. All mines of the association are currently active, with documented balance coal reserves totaling 778.4 million tons. Coal reserves consist equally of coking (fat) coal (high volatile bituminous B); and energy coals (gas coal-high volatile bituminous B, and long flame coal-high volatile bituminous C).

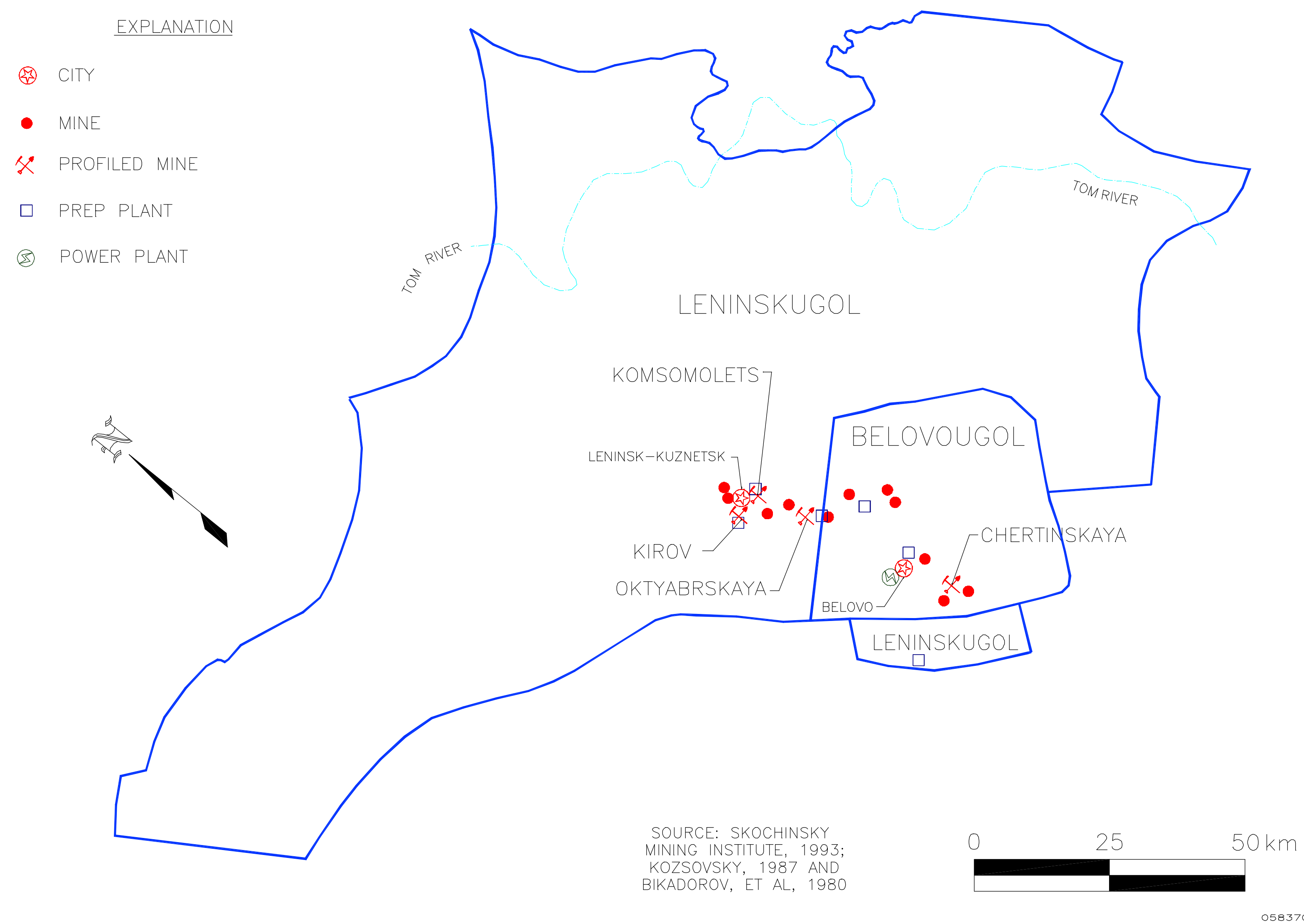
Coal Production. In 1994, mines of the Belovougol Coal Production Association produced 4.5 million tons of coal, down 17 percent from 5.4 million tons in 1993 (Table 2-2). The CPA contains 2 coal preparation plants (Belovskaya and Chertinskaya), and coal separation is carried out at the Inskaya mine.

METHANE LIBERATION, RECOVERY, AND RESERVES

In 1994, coal mines of the Belovougol Coal Production Association liberated nearly 114 million cubic meters of methane (Table 2-2). Of this, 61 million cubic meters were emitted from mine ventilation systems, and the remaining 52 million cubic meters were first recovered by drainage systems, and then emitted. Of the four mines at Belovougol CPA that have methane drainage systems, Chertinskaya drains the most (Table 2-2).

Belovougol mines use both surface and underground methane recovery methods. Wells are drilled from the surface in front of the active face. These wells are connected to the vacuum pumping stations after mining activities have moved past the well. These wells also drain the thin overlying seams through perforations in the standpipe. Underground methods include cross-measure boreholes drilled from the roadway into the overlying strata, and boreholes drilled into the seam prior to mining.

FIGURE 2. LOCATION OF THE KIROV MINE



None of the mines currently use the methane they recover. One of the most promising options for using the methane is in boilers at the mines, which provide heat for mine facilities, and in some instances, the surrounding community.

Methane reserves associated with the coal reserves at all Belovougol mines are estimated to range from 10 to 19 billion cubic meters. The lower end of this range was calculated using a weighted average gas content of 13.3 m^3/ton. The higher end of the range was calculated using an average specific emissions value of 24.9 m^3/ton.

TABLE 2-2. SUMMARY DATA FOR MINES OF THE BELOVOUGOL COAL PRODUCTION ASSOCIATION (1994)

MINE	COAL PRODUCTION (10^3 TONS)	METHANE LIBERATED (10^6 m^3)			SPECIFIC EMISSIONS (m^3/T)
		VENTED	DRAINED	TOTAL	
CHERTINSKAYA	880	27.6	34.1	61.7	70.1
INSKAYA	1,720	3.0	0.0	3.0	1.7
KOLMOGOROVSKAYA	255	3.4	0.0	3.4	13.3
NOVAYA	789	11.7	3.3	15.0	19.0
PIONERKA	465	2.0	2.5	4.6	9.9
ZAPADNAYA	433	13.6	12.3	26.0	60.0
TOTAL	**4,542**	**61.4**	**52.2**	**113.6**	
AVERAGE (WEIGHTED)					**24.9**
Chertinskaya Mine is profiled on the following page.					Source: PIER, 1995

CHERTINSKAYA MINE

The Belovougol CPA operates the Chertinskaya Mine, which is located in the west-central portion of the Kuzbass, approximately 8 km south of the city of Belovo (Figure 2-4). The mine area occupies 29.8 km^2. Belovo is an industrial city with refinery plants, a tin enterprise, iron casting plant and other manufacturing plants, in addition to coal mining. Coal production began in 1952.

Geologic Setting. Coal is found within the eastern flank of a north-northwest trending closed synclinal structure. The coal is extracted from Permian Kolchuginsk sediments (Figure 2-2), dipping between 0 and 25 degrees. The average geothermal gradient is 2.8^o C per 100 m.

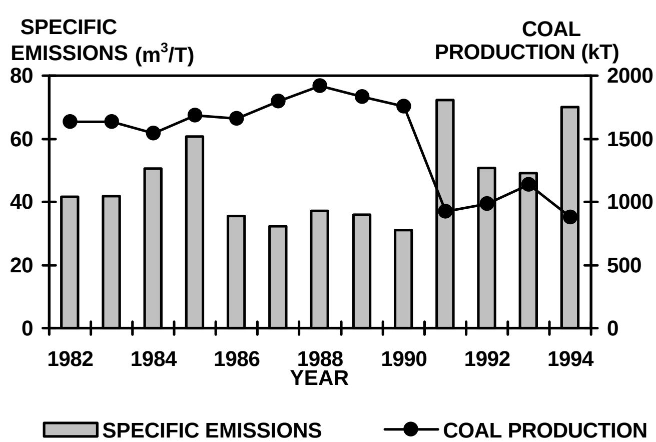
There are three seams being mined from two levels, with seam thicknesses averaging 2.14 m. The average overall thickness of the coals is 7.5 m, and the thickness of the overburden strata varies from 50 to 365 m.

COAL PRODUCTION AND SPECIFIC EMISSIONS

The mine has two working levels accessed by three shafts. Coal is mined by longwall methods.

As shown in Graph 1, coal production peaked in 1988 when 1.9 million tons were produced. Output declined sharply in 1991 with the collapse of the Soviet economy. The mine produced less than 0.9 million tons of coal in 1994. Graph 1 also shows that high specific emissions correspond with the low production of recent years. This indicates that the decrease in coal production has not proportionally reduced the flow of methane into the mine workings. Specific emissions were 70.1 m^3/ton in 1994, higher than any other profiled mine.

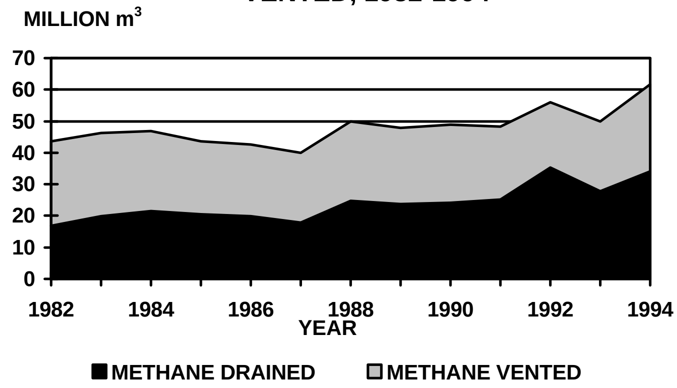
GRAPH 1. COAL PRODUCTION AND SPECIFIC EMISSIONS, 1982-1994



METHANE LIBERATION, DRAINAGE, AND RESERVES

In 1994, a total of 61.7 million cubic meters of methane were liberated from the Chertinskaya Mine. Of this, 27.6 million cubic meters were emitted to the atmosphere via the ventilation system, and 34.1 million cubic meters were emitted after being recovered by the drainage system.

Graph 2 shows trends in methane ventilation, drainage, and total liberation from 1982 through 1994; the mine liberated more methane in 1994 than any of the previous years.



GRAPH 2. METHANE DRAINED AND VENTED, 1982-1994

Methane Drainage. The principal degasification method at Chertinskaya is in-mine drainage via cross measure and horizontal boreholes drilled into the seam as they are preparing the panel for development. They also drain methane from gob areas.

The Chertinskaya mine drains methane with eight vacuum pumping stations. The methane output of each pumping station varies from 1.2 to 6.4 m^3/min, and the concentration of methane in the mixture varies from as low as 6 to 55 percent. In addition, there are two surface pumping stations located at the mine headquarters. These pumping stations are designed to pump the gas mixture from the remote surface pumping stations through a pipeline (see utilization section) for use at the mine. The overall length of the underground methane pipeline system is 19.5 km.

Methane Reserves. Methane reserves are estimated to range from 1.3 to 4.9 billion cubic meters for all balance coal reserves, and 1.0 to 3.8 billion cubic meters for the industrial coal reserves. The lower end of these ranges was calculated using a weighted average methane content of 18.2 m^3/ton; the higher end of these ranges was calculated using a specific emissions value of 70.1 m^3/ton.

OPPORTUNITIES FOR USE OF MINE METHANE

None of the recovered methane is used, so it is emitted to the atmosphere. The mine has plans to use gas recovered from gob wells for power generation, but these plans have not yet been implemented. When complete, the proposed system would be able to use a maximum of 150 m^3 of methane per minute; 40 m^3/min to supply fuel to a boiler for thermal heat, and the remainder to fuel a diesel motor to generate electricity.

Presently, the mine has one boiler station containing 6 boilers. Four of these boilers consume 6.5 tons of coal per hour, and produce 10 tons of steam per hour; the other 2 consume 13 tons of coal per hour, and produce 10 tons of steam per hour. Mine management would like to convert one of these boilers to utilize gas.

Without additional information, it is difficult to accurately estimate the amount of methane that could be consumed by this boiler. The potential demand for methane can be illustrated, however, by the following example: A boiler that consumes 6.5 tons of hard coal per hour would consume 56,940 tons per year if operated full-time; this is the energy equivalent of 49.8 million cubic meters of methane annually. Similarly, a boiler that consumes 13 tons of hard coal per hour (113,880 tons per year) uses the energy equivalent of 99.6 million cubic meters of methane annually.

MINING ECONOMICS

In 1991, the sales price the mine received for its unprocessed coal was estimated to be 5.3 rubles ($US 2.94) per ton. In addition, the mine received 52.9 rubles ($US 29.39) per ton in subsidies from the government. More recent data were unavailable.

MINE DISCHARGE WATER

The Chertinskaya Mine produces about 420 m^3 of water per hour, with an average mineral content of 3.0 grams/liter. From 30 to 50 percent of this water is used in the beneficiation plant, as well as for dust control in the mine, and fire control on the terracones or waste piles. Discharge information for the non-used percentage was not available, however, all mines of the Kuznetsk Basin are reported to have various facilities for mine water purification, such as concrete sedimentation tanks and filtering stations.

COAL RESOURCES

Number of Coal Seams		Thickness of Mined Seams (m)		Overburden		Balance Coal Reserves (Million Tons)		
Now Mining	Total	Average	Range	Thick-ness (m)	No. of Seams	Total	Industrial	Prepared for Mining
3	4	2.14	1.5-3	50-365	N/A	70.5	54.5	2.4

COAL QUALITY AND RANK

Ash (%)	Heating Value (kcal/kg)	Moisture (%)	Sulfur (%)	Volatile Matter (%)	Rank
29.5	8370	6.6	0.30	38.8	gas (hvAb)

MINE CHARACTERISTICS

Hazard Classifications		% of Coal that is Extracted	Current Mining Depth	Surface Elevation of Mine Shaft	Annual Power Consumption (MWh)
Gas and Rock Outburst	Dust Hazard				
Sudden Outbursts	Dangerous	N/A	500 m	N/A	N/A

LABOR

All Employees of Mining Complex			Employees Involved in Coal Production Only				
Laborers	Professional	Total	Active Mining	Prep. Work	Other Underground	Surface	Total
N/A	N/A	2600	N/A	N/A	N/A	N/A	N/A

AMOUNT OF COAL SENT TO PREP PLANT (THOUSAND TONS)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
5768	5342	1471	1451	1248	1500	1579	1426	1186	N/A	N/A	N/A

LITHOLOGIC DATA

Lithology of Overburden	Lithology of Roof Rock
N/A	N/A

DEMETHANIZATION SYSTEM

Pipeline		Gas Output	
Length (km)	Diameter (mm)	Avg. Gas Output (m^3/min)	Methane Concentration (%)
19.5	N/A	43.9	6-55

CARBON DIOXIDE EQUIVALENTS (Million Tons)

CO_2 Equivalent of Total Methane Liberated (Vented and Drained), 1994	CO_2 Equivalent of Methane Drained, 1994
0.92	0.51

LENINSKUGOL COAL PRODUCTION ASSOCIATION

Leninskugol Coal Production Association (CPA) is located in and around the city of Leninsk-Kuznetsk (Figures 2-1 and 2-4), an industrial center in the central Kuzbass. In addition to mines, Leninsk-Kuznetsk contains numerous manufacturing enterprises, including those that make fire-fighting equipment, chemicals, furniture, and textiles.

Leninskugol currently operates nine underground mines and one surface mine. This report profiles the Kirov, Komsomolets, and Oktyabrskaya Mines because each liberates and drains relatively large volumes of methane. The CPA also contains enterprises that repair mining equipment and produce granulated carbon powder.

GEOLOGY, RESERVES, AND PRODUCTION

Geologic Setting. The CPA is bounded by the Altai Mountains to the east, and the Salarian Range to the west. The deposits along the southwestern boundary are complexly folded and faulted, manifest as en echelon folds and thrust faults, striking approximately northwest. The main coal horizons occur in Permo-Carboniferous Balakhonsk and Kolchuginsk sediments (Figure 2-2) which crop out along the eastern and western borders, which are superimposed on the margin of the basin. Jurassic Tarbagansk sediments were deposited in discontinuous synclinal features in the center.

Coal Reserves and Rank. Documented balance coal reserves of all mines of the association total 3.3 billion tons; of this, active mines account for 1.6 billion tons. Coal reserves consist predominantly of gas coal (high volatile bituminous B), with some coking coal (high volatile bituminous A). There are also some Jurassic Tarbagansk deposits containing brown coal; these deposits are not included in the reserve calculations, however, because they do not contain methane and are therefore not relevant to this study.

Coal Production. In 1994, Leninskugol CPA produced 11.0 million tons of coal, down 11 percent from 12.4 million tons in 1993.

METHANE LIBERATION, UTILIZATION, AND RESERVES

Methane Liberation. In 1994, mines of the Leninskugol CPA liberated nearly 214 million cubic meters of methane (Table 2-3). Of this, 130 million cubic meters were emitted via ventilation systems, and the remaining 84 million cubic meters were emitted after being recovered by drainage systems.

Six of the nine active mines drained methane in 1994, using wells drilled from the surface in front of the active face. These wells are hooked up to a mobile vacuum pumping system after mining activities have moved past the well. This type of gob gas drainage is typical of that used in the Kuzbass, but much different from that employed in the US. Strong suction is used to remove the methane from the seams, resulting in the entrainment of large amounts of air in the gas mixture. The wells also drain the thin overlying seams through perforations in the stand-pipe. None of the mines currently use this recovered methane. One of the most promising options for using the methane is in boilers at the mines, which provide heat for mine facilities, and in some instances, the surrounding community.

Methane Reserves. Methane reserves associated with the coal reserves of all mines in the Leninskugol CPA are estimated to range from 31 to 64 billion cubic meters, and that the coal reserves of active mines in the CPA range from 15 to 31 billion cubic meters. The lower end of these ranges was calculated using an average gas content of 9.4 m^3/ton. The higher end of these ranges was calculated using an average specific emissions value of 19.5 m^3/ton.

TABLE 2-3. SUMMARY DATA FOR ACTIVE MINES OF THE LENINSKUGOL COAL PRODUCTION ASSOCIATION (1994)

MINE	COAL PRODUC-TION (10^3 TONS)	METHANE LIBERATED (10^6 m^3)			SPECIFIC EMISSIONS
		VENTED	DRAINED	TOTAL	
7 NOVEMBER	1,550	17.8	0	17.8	11.0
KIROV	2,565	25.0	5.3	30.3	11.8
KOLCHUGINSKOYE	933	5.3	2.2	7.5	8.0
KOMSOMOLETS	1,543	18.3	38.1	56.4	36.6
KUZNETSKAYA	1,067	15.9	0	15.9	14.9
OKTYABRSKAYA	1,013	18.5	25.4	43.9	43.3
POLYSAYEVSKAYA	1,153	12.7	10.4	23.0	19.9
YAROSLAVSKOGO	1,010	11.2	1.3	12.5	12.4
ZARECHNAYA	122	6.0	0	6.0	49.2
TOTAL	**10,956**	**130.7**	**82.7**	**213.3**	
AVERAGE (WEIGHTED)					**19.5**
Shaded mines are those profiled in this report.					
Source: PIER, 1995; Tailakov, 1995					

KIROV MINE

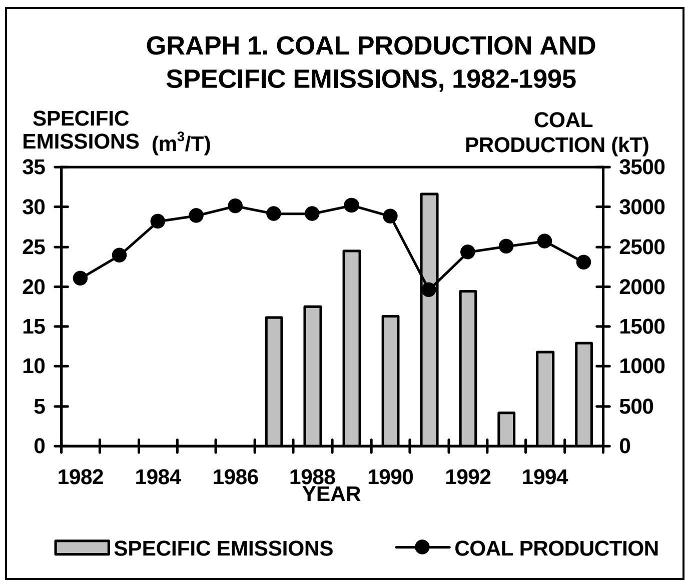
The Kirov Mine is operated by the Leninskugol CPA and is located in the west-central part of the Kuzbass. Coal production began in 1930, making it one of the oldest mines in the Kuzbass. The mine area occupies 60.2 km^2.

The Kirov mine is in the southwest section of the city of Leninsk-Kuznetsk, which has a population of 146,000. In addition to mining, textile and construction enterprises are Leninsk-Kuznetsk's major industries. There is thus a high demand for energy near the mine.

Geologic Setting. The coal deposits are found within the northern flanks of a north-northwest trending closed synclinal structure. Several thrust faults intersect the property, trending roughly north-south and dipping to the west. The coal is extracted from the Uskatsk, Leninsk, and lower Gramoteinsk Formations of the Permian Kolchuginsk Series (Figure 2-2). Mined seams dip from 3 to 15°. Seventy-three percent of the seams are flat-lying, while the remaining 27 percent are inclined. The average geothermal gradient is 2.8^o C per 100 m.

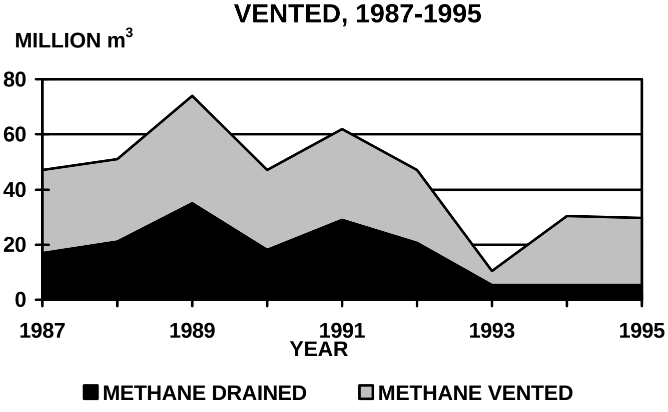
COAL PRODUCTION AND SPECIFIC EMISSIONS

Coal is mined by mechanized longwall methods from two working levels, using shearing machines. As shown in Graph 1, coal production remained fairly steady during the period 1984 through 1990, when the mine consistently produced 2.8 to 3.0 million tons of coal annually. In 1991, strikes at the mine resulted in a sharp drop in output. Production has since rebounded, with nearly 2.6 million tons produced in 1994 and 2.3 million tons in 1995. Production should increase further when mining of a new area, the Central Field, begins. Preparation for mining the Central Field is to begin soon. The mine plans to produce 2.5 million tons of coal annually from this field. Methane content of the seams to be mined averages 15 to 17 cubic meters per ton.



In 1995, a total of 29.6 million cubic meters of methane were liberated from the Kirov Mine. Of this, 24.3 million cubic meters were emitted to the atmosphere via the ventilation system, and 5.3 million cubic meters were emitted after being recovered by the drainage system.

GRAPH 2. METHANE DRAINED AND VENTED, 1987-1995



Trends in methane ventilation, drainage, and total liberation from 1987 through 1994 are shown in Graph 2. The apparent decrease in methane liberation beginning in 1993 may reflect different data sources, rather than an actual decrease. Data for years 1987 through 1992 were obtained from the Leninskugol Coal Production Association, whereas data for 1993 through 1995 were obtained from the Kirov Mine. According to the Russian Coalbed Methane Center, the data for 1993 through 1995 are probably more precise as they include only pure methane, whereas the data for 1987 through 1992 may include air in addition to methane.

Methane Drainage. Methane is drained at the Kirov from the surface, by pumping it from gob areas through vertical boreholes. The mine does not used underground drainage methods. There are 6 vacuum pumping stations operating from the surface.

Methane Reserves. Methane reserves are estimated to range from 2.6 to 3.6 billion cubic meters for all balance coal reserves, and 1.6 to 2.3 billion cubic meters for the industrial coal reserves. The lower end of these ranges was calculated using a weighted average methane content of 8.5 m^3/ton. The higher end of these ranges was calculated using a specific emissions value of 11.8 m^3/ton.

OPPORTUNITIES FOR USE OF MINE METHANE

None of the methane recovered by the Kirov drainage system is used; it is all emitted to the atmosphere. EPA, in cooperation with the Kirov mine, is evaluating the potential for converting two or more boilers at the Kirov mine to cofire methane with coal. Methane available from the current mine degasification system could fuel three boilers at the optimal percentage of 35 percent gas. Future improvements to methane drainage practices at the mine, resulting in increased quality and quantity of the drained methane, could justify the addition of a fourth boiler.

Another possibility for on-site methane use is at the mine's coal preparation plant. The beneficiation process does not include fine coal recovery and thermal drying. These processes, if implemented, could potentially consume large amounts of coalbed methane.

There is also a potential demand for methane in the surrounding region. A lamp factory, only 4 km from the mine, is a potential consumer, as is a cement production factory in Topki, 120 km from the mine. Other local industries with process heat needs are those that produce bricks and reinforced concrete. The nearest natural gas pipeline is only 20 km away.

MINING ECONOMICS

In 1995, coal production costs at the Kirov mine averaged 93,000 rubles ($US 18.97) per ton of ROM coal. The State coal buying company paid 179,000 rubles ($US 36.53) per ton for this coal, whereas free market customers paid 86,000 rubles ($US 17.55) per ton. The main consumers of the coal are power stations and coking factories.

MINE DISCHARGE WATER

The Kirov Mine produces about 3,750 cubic meters of water per hour, whose mineral content averages 2.5 grams/liter. Approximately 6-7 percent of this water is used; about 200 cubic meters per hour for fire prevention, and about 300 cubic meters per hour in the beneficiation plant.

COAL RESOURCES

Number of Coal Seams		Thickness of Mined Seams (m)		Overburden		Balance Coal Reserves (Million Tons)		
Now Mining	Total	Average	Range	Thick-ness (m)	No. of Seams	Total	Industrial	Prepared for Mining
4	24	2.4	1.3-2.8	0-500	2	306.3	190.8	19.0

COAL QUALITY AND RANK

Ash (%)	Heating Value (kcal/kg)	Moisture (%)	Sulfur (%)	Volatile Matter (%)	Rank
18.5	7,980	7.1	0.64	40.0	gas

MINE CHARACTERISTICS

Hazard Classifications		% of Coal that is Extracted	Current Mining Depth	Surface Elevation of Mine Shaft	Annual Power Consumption (MWh)
Gas and Rock Outburst	Dust Hazard				
Not Dangerous	Dangerous	70	500 m	170-200 m	120

LABOR

All Employees of Mining Complex			Employees Involved in Coal Production Only				
Laborers	Professional	Total	Active Mining	Prep. Work	Other Underground	Surface	Total
N/A	N/A	4075	2230	398	N/A	968	N/A

AMOUNT OF COAL SENT TO PREP PLANT (THOUSAND TONS)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1715	1980	2307	2227	2541	2599	2447	2412	2184	1512	2052	2159

LITHOLOGIC DATA

Lithology of Overburden	Lithology of Roof Rock
Sandstone 30-40%; Shale 50-55%; Coal 5%	N/A

DEMETHANIZATION SYSTEM

Pipeline		Gas Output (of pumping units)	
Length (km)	Diameter (mm)	Avg. Gas Output (m^3/min)	Methane Concentration (%)
N/A	N/A	0.6 - 60	4-40

CARBON DIOXIDE EQUIVALENTS (Million Tons)

CO_2 Equivalent of Total Methane Liberated (Vented and Drained), 1994	CO_2 Equivalent of Methane Drained, 1994
0.46	0.08

KOMSOMOLETS MINE

The Leninskugol CPA operates the Komsomolets Mine which is located in the west-central part of the Kuznetsk Coal Basin, two km south of the city of Leninsk-Kuznetsk (Figure 2-4) The mine area occupies 15.5 km^2. Coal production began in 1933.

COAL GEOLOGY, RESERVES, AND PRODUCTION

Geologic Setting. The coal deposits are found within the outer northeastern flank of a north-northwest trending closed synclinal structure. The coal is extracted from Permian Kolchuginsk sediments, dipping to the southwest between 4 and 40 degrees.

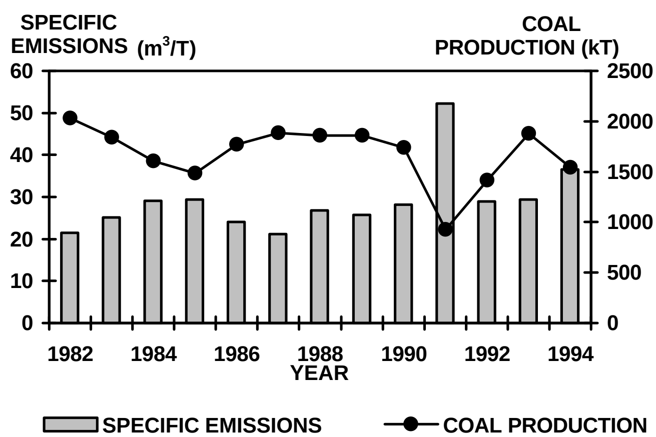
There are 13 seams being mined from one level, with seam thicknesses averaging 2.65 m. The average overall thickness of the coals is 20.1 m and the thickness of the overburden strata varies from 0 to 450 m. The average geothermal gradient is 2.8^{o}C per 100 m.

HARD COAL PRODUCTION AND SPECIFIC EMISSIONS

The mine has one working level accessed by 4 shafts. Coal mined by longwall methods, using shearing machines.

As shown in Graph 1, coal production remained fairly steady in the late 1980's at nearly 1.9 million tons of coal annually, then declined sharply in 1991, reflecting the collapse of the Soviet economy. Production rebounded in 1993, then decreased slightly to 1.5 million tons in 1994. The relatively high specific emissions of 1991 and 1994 correspond with production lows, indicating that decreased production has not reduced the flow of methane into the mine workings.

GRAPH 1. COAL PRODUCTION AND SPECIFIC EMISSIONS, 1982-1994

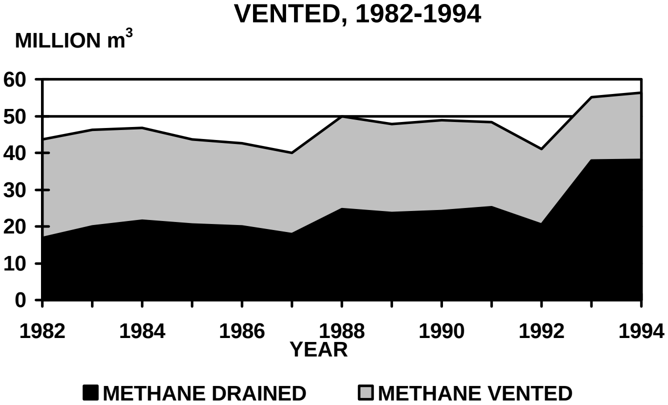


METHANE LIBERATION, DRAINAGE AND RESERVES

In 1994, the Komsomolets mine liberated a total of 56.4 million cubic meters of methane, more than any previous year. Of this, 18.3 million cubic meters were emitted to the atmosphere via the ventilation system, and 38.1 cubic meters were emitted after being recovered by the drainage system.

Trends for methane ventilation and drainage from 1982 through 1994 are shown in Graph 2. In 1994, recovery efficiency was 68 percent, the highest reported recovery efficiency of any of the mines profiled.

GRAPH 2. METHANE DRAINED AND VENTED, 1982-1994



Methane Recovery. There is no underground drainage at Komsomolets. Methane is drained from gob areas only, by pumping the gas through boreholes drilled from the surface. The boreholes are about 150 mm in diameter, and are spaced about 150 m apart. There are three vacuum pumping stations operating from the surface which are designed to drain gas from gob areas.

Komsomolets mine will soon be installing new gas recovery equipment that will drain gas from mine pillars. This project was developed at the Moscow Mining Institute, under the direction of RosUgol's Department of Perspective Development and Technical Policy.

Methane Reserves. Methane reserves are estimated to range from 2.6 to 6.7 billion cubic meters for all balance coal reserves, and 2.4 to 6.2 billion cubic meters for the industrial coal reserves. The lower end of these ranges was calculated using a weighted average methane content of 13.9 m^3/ton. The higher end of these ranges was calculated using a specific emissions value of 36.6 m^3/ton.

OPPORTUNITIES FOR USE OF MINE METHANE

None of the recovered methane is currently used; it is all emitted to the atmosphere. In the near future, Komsomolets officials plan to use recovered methane for power generation. They are also interested in using the methane as fuel for compressed natural gas vehicles.

The mine has two boiler stations. One contains four boilers, each of which produces 6.5 Gcal of steam per hour, for a total output of 26 Gcal per hour. Total coal consumption at this boiler station is 25,000 tons per year. The other boiler station contains three boilers, each of which produce 6 Gcal of steam per hour, for a total output of 19.5 Gcal per hour. Total coal consumption at this boiler station is 20,304 tons/year.

Without additional information, it is difficult to accurately estimate the amount of methane that could be consumed by the mine's boilers. The potential demand for methane can be illustrated, however, by the following example: if the boilers consume 45,304 tons of hard coal per year, they consume the energy equivalent of 40 million cubic meters of methane annually. This volume is roughly equal to 71 percent of the total amount of methane liberated at Komsomolets in 1994, and more than the methane currently recovered by the mine's drainage systems.

MINING ECONOMICS

In 1991, the price the mine received for its unprocessed coal was estimated to be 5.3 rubles ($US 2.94) per ton. Production costs exceeded sales prices; the mine received 14.6 rubles ($US 8.11) per ton in subsidies from the government in 1991. More recent data were unavailable.

MINE DISCHARGE WATER

The Komsomolets Mine produces 470 m^3/hr of water associated with mining operation, the mineral content of this water averages 2.4 grams/liter. From 30-50 percent of this water is used in the beneficiation plant, as well as for dust control in the mine, fire control on the terracones or waste piles, and in the boilers. Discharge information for the non-used percentage was not available, however, all mines of the Kuzbass have various facilities for mine water purification, such as concrete sedimentation tanks and filtering stations.

COAL RESOURCES

Number of Coal Seams		Thickness of Mined Seams (m)		Overburden		Balance Coal Reserves (Million Tons)		
Now Mining	Total	Average	Range	Thick-ness (m)	No. of Seams	Total	Industrial	Prepared for Mining
13	NA	2.65	NA	0-450	N/A	183.9	170.2	15.0

COAL QUALITY AND RANK

Ash (%)	Heating Value (kcal/kg)	Moisture (%)	Sulfur (%)	Volatile Matter (%)	Rank
19.0	8,055	7.2	0.56	43.0	gas

MINE CHARACTERISTICS

Hazard Classifications		% of Coal that is Extracted	Current Mining Depth	Surface Elevation of Mine Shaft	Annual Power Consumption (MWh)
Gas and Rock Outburst	Dust Hazard				
Not Dangerous	Dangerous	N/A	450	N/A	N/A

LABOR

All Employees of Mining Complex			Employees Involved in Coal Production Only				
Laborers	Professional	Total	Active Mining	Prep. Work	Other Underground	Surface	Total
N/A	N/A	2150	N/A	N/A	N/A	N/A	N/A

AMOUNT OF COAL PROCESSED AT PREP PLANT (THOUSAND TONS)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1390	1501	1544	1254	1629	1680	1579	1725	1535	N/A	N/A	N/A

LITHOLOGIC DATA

Lithology of Overburden	Lithology of Roof Rock
N/A	N/A

DEMETHANIZATION SYSTEM

Pipeline		Gas Output (of pumping units)	
Length (km)	Diameter (mm)	Avg. Gas Output (m^3/min)	Methane Concentration (%)
N/A	N/A	44	25-30

CARBON DIOXIDE EQUIVALENTS (Million Tons)

CO_2 Equivalent of Total Methane Liberated (Vented and Drained), 1994	CO_2 Equivalent of Methane Drained, 1994
0.84	0.57

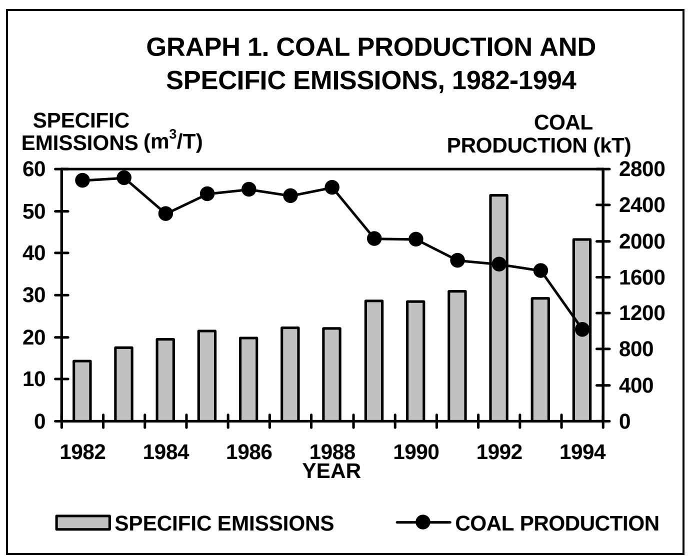
OKTYABRSKAYA MINE

The Oktyabrskaya Mine, operated by the Leninskugol CPA, is situated in the west-central portion of the Kuznetsk Coal Basin. The mine is 14 km south of the city of Leninsk-Kuznetsk (Figure 2-4), within the Leninsk geological-industrial region. The mine area occupies 15.6 km^2. Coal production operations began in 1951.

Geologic Setting. The coal deposits are found within the northern flank of a north-northwest trending closed synclinal structure. The coal is extracted from the Gramoteinsk Formation of the Permian Kolchuginsk Series (Figure 2-2). Mined seams dip from 0 to 12°.

COAL PRODUCTION AND SPECIFIC EMISSIONS

The mine has one working level accessed by accessed by 4 shafts. Coal is mined by longwall methods, using shearing machines.

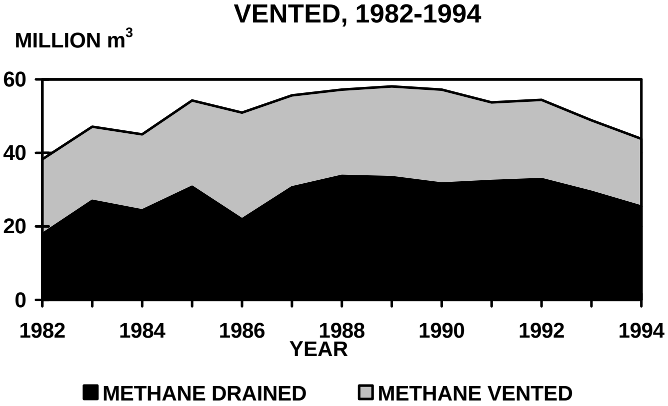


As shown in Graph 1, coal production peaked in 1983 when the mine produced nearly 2.7 million tons. Output dropped rather sharply in 1989, presumably due to the collapse of the Soviet economy, and has since declined even further. In 1994, Oktyabrskaya produced about 1.0 million tons of coal. Graph 1 also shows that specific emissions peaked in 1992, possibly reflecting new development at the mine. Specific emissions were 43.3 m^3/ton in 1994, indicating that decreasing coal production has not proportionately reduced the flow of methane into the mine workings.

METHANE LIBERATION, DRAINAGE, AND RESOURCES

In 1994, a total of 43.9 million cubic meters of methane were liberated from the Oktyabrskaya Mine. Of this, 18.5 million cubic meters were emitted to the atmosphere via the ventilation system, and 25.4 million cubic meters were emitted after being recovered by the drainage system. Methane emissions have been declining since 1989, due to decreasing coal production.

GRAPH 2. METHANE DRAINED AND VENTED, 1982-1994



Methane Recovery. There is no underground drainage of methane at Oktyabrskaya. The mine drains gob areas only, using seven gas pumping units that recover gas through vertical boreholes drilled from the surface. The output of the pumping stations varies from 1.5 to 5 m^3/min of methane, and the concentration of methane in the mixture varies from as low as 2-10 percent to as high as 30-40 percent.

Methane Reserves. Methane reserves are estimated to range from 2.4 to 10.5 billion cubic meters for all balance coal reserves, and 2.0 to 8.5 billion cubic meters for the industrial coal reserves. The lower end of these ranges was calculated using a weighted average methane content of 10.0 m^3 per ton. The higher end of these ranges was calculated using a specific emissions value of 43.3 m^3 per ton.

OPPORTUNITIES FOR USE OF MINE METHANE

Presently, none of the recovered methane is used; it is all emitted to the atmosphere. Mine management has proposed the use of mine methane to power internal combustion (IC) engines for generation of auxiliary power, and potentially to power the portable surface pumping stations. Ultimately, the mine would like to use methane for varied power applications to lower fuel and power costs at the mine.

The mine has 1 boiler station containing 5 boilers, each of which is capable of producing 10 tons of steam, or 35 Gcal, per hour. Coal consumption at the boiler station ranges from 20 tons per day during the summer to 200 tons per day in the winter. The mining complex uses 2,400 cubic meters of hot water per day.

Without additional information, its is difficult to accurately estimate the amount of methane that could be consumed by the mine’s boilers. The potential demand for methane can be illustrated, however, by the following example: if the boilers consume an average of 120 tons of coal per day (40,150 tons per year), they consume the energy equivalent of 35.1 cubic meters of methane annually. The methane currently drained from coal seams annually at the mine could thus meet about 72 percent of the boilers’ needs.

There is no preparation plant at Oktyabrskaya. Most of the coal produced from the mine is ultimately consumed by heat and power plants, and is also used directly by those nearby residences and industries that don't use steam heat.

The potential demand for natural gas in the surrounding community appears to be high. There are several local industries with process heat needs. In addition, there are cement kilns and glass factories in the towns of Topki and Osinniki, located 120 km and 200 km from the mine, respectively.

MINING ECONOMICS

The 1993 average market price for Oktyabrskaya coal was 6,464 rubles ($US 6.46) per ton. In the third quarter of 1994, ROM coal sold for 24,000 rubles ($US 10.34) per ton, while concentrate sold for 30,000 rubles ($US 12.93) per ton. As of October 1, 1994, ROM coal from Oktyabrskaya Mine sold for 50,000 rubles ($US 21.55) per ton. Production costs exceed sales prices; the mine received 4.1 billion rubles ($US 4.1 million rubles) in subsidies in 1993.

MINE DISCHARGE WATER

The Oktyabrskaya Mine produces about 5.1 million cubic meters of water per year. Of this, about 0.6 million cubic meters are used for production needs. The remaining 4.5 million cubic meters are discharged to the river after treatment.

COAL RESOURCES

Number of Coal Seams		Thickness of Mined Seams (m)		Overburden		Balance Coal Reserves (Million Tons)		
Now Mining	Total	Average	Range	Thick-ness (m)	No. of Seams	Total	Industrial	Prepared for Mining
4	13	2.8	1.6 - 3.4	0 - 400	9	242.5	195.9	10.0

COAL QUALITY AND RANK

Ash (%)	Heating Value (kcal/kg)	Moisture (%)	Sulfur (%)	Volatile Matter (%)	Rank
18	8000	8.1	0.32	44	gas fat

MINE CHARACTERISTICS

Hazard Classifications		% of Coal that is Extracted	Current Mining Depth	Surface Elevation of Mine Shaft	Annual Power Consumption (MWh)
Gas and Rock Outburst	Dust Hazard				
Not dangerous	Dangerous	76	120-320 m	173-220 m	64,397

LABOR

All Employees of Mining Complex			Employees Involved in Coal Production Only				
Laborers	Professional	Total	Active Mining	Prep. Work	Other Underground	Surface	Total
N/A	N/A	2750	N/A	N/A	N/A	N/A	N/A

AMOUNT OF COAL PROCESSED AT PREP PLANT (THOUSAND TONS)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

LITHOLOGIC DATA

Lithology of Overburden	Lithology of Roof Rock
40% sandstone; no shale or limestone	mudstone, siltstone, sandstone

DEMETHANIZATION SYSTEM

Pipeline		Gas Output (of pumping units)	
Length (km)	Diameter (mm)	Avg. Gas Output (m^3/min)	Methane Concentration (%)
N/A	N/A	1.5-5	2-40

CARBON DIOXIDE EQUIVALENTS (Million Tons)

CO_2 Equivalent of Total Methane Liberated (Vented and Drained), 1994	CO_2 Equivalent of Methane Drained, 1994
0.65	0.38

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APPENDIX A – FORMING A JOINT VENTURE

FORMING A JOINT VENTURE

The following is a general discussion of some of the steps that most companies must take when investing in an energy enterprise in Russia, issues to consider, and information about how to obtain support for this process.

Identifying an Investment Opportunity and a Russian Partner

Foreign investors often make contacts with Russian counterparts through business connections in their home countries, word of mouth, or information communicated by interested Russian parties. In addition, various U.S. government agencies have begun to gather and disseminate information about business opportunities in the NIS countries. In the United States, the U.S. Department of Commerce (DOC) sponsors a free business information service for NIS countries (BISNIS), through the International Trade Administration.[10]

Once a company has identified an opportunity and a partner, three types of enterprises are eligible for foreign investment in Russia:

- Enterprises (and their branches or subsidiaries) in which foreign investors hold stock in a Russian enterprise.[11]
- Enterprises (and their branches or subsidiaries) that are wholly owned by foreign investors.
- Branches of foreign legal entities established as part of a joint venture.[12]

Foreign investors are responsible for verifying the legitimacy of Russian enterprises with which they conduct their business, and must independently negotiate agreements with their Russian counterparts. There is no official Russian governmental support for these activities, nor any legal protection under Russian law for losses incurred due to corruption or false representation of financial and other information.

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[10] BISNIS provides free information on a variety of industry areas in Russia: BISNIS, Room H-7413, U.S. Department of Commerce (DOC), 14th Street and Constitution Avenue, N.W., Washington, D.C. 20230. Tel: (202) 482-4655; Fax: (202) 482-2293; E-mail: BISNIS@ACCESS.DIGEX.COM; Home Page: http:\\www.ita.doc.gov. In addition, DOC sponsors an Agent/Distributor Service through its district offices that helps American companies to locate, screen, and assess agents, distributors, representatives, and other Russian partners for $250.

[11] Joint ventures fall into this category; however, a "joint venture" is not actually a legal enterprise structure. Technically, the term "joint venture" means only that foreign investment or participation in enterprise operations is involved.

[12] Law of the Russian Federation "On Foreign Investments in the RSFSR," Article 3, July 4, 1991.

Registration

Once a foreign investor has reached an agreement to establish a joint venture enterprise or to invest in a Russian partner, the new enterprise must register with the Committee on Foreign Investments of the Ministry of Finance.[13]

Foreign investors are also permitted to buy Russian property, buildings, stocks, and securities, and to acquire rights to use land and natural resources.[14] Enterprises with foreign investments are permitted to create subsidiaries and branches both within Russia and in other countries.

"Expert Examinations"

The enterprise must present various forms of documentation in conjunction with an application for registering (see below). Before submitting this documentation, however, the government requires certain types of enterprises to obtain an "expert examination," which includes a "sanitary-hygienic" examination and/or an ecological assessment of the enterprise's property and holdings.[15] Russian Foreign Investment Law stipulates that "enterprises with foreign investments that involve large-scale construction or reconstruction" are required to obtain expert examinations; no further clarification is provided. In general, however, it is likely that most mining or gas enterprises would be subject to this requirement.

Enterprises in the oil and gas industries must obtain an additional approval from the Ministry of Fuel and Energy. Oil and gas enterprises with foreign investments must submit founding documents for consideration of the State Committee of Oil Industry or Gazprom.

Foreign investors must obtain official decisions on the results of any required state examinations before submitting registration applications.

Documentation

Enterprises must present documents for registration to the Committee on Foreign Investment of the Ministry of Finance. According to Russian Law on Foreign Investment, the Committee must issue a decision within twenty-one days of the submission of an application. In practice, however, this process can be time-consuming and costly.

Registration documents required for the three enterprise types identified above are listed in Table A-1.

[13] Supreme Soviet Decree No, 357, May 28, 1992.

[14] Law of the Russian Federation "On Foreign Investments in the RSFSR," Article 3, July 4, 1991.

[15] Law of the Russian Federation "On Foreign Investments in the RSFSR," Article 14, July 4, 1991.

TABLE A-1. DOCUMENTS REQUIRED FOR VARIOUS ENTERPRISE TYPES

Joint Venture	**Enterprise with 100 percent Foreign Ownership**	**Branches of Enterprises and Legal Affiliates**
Written application from foreign investor stating intention to establish JV	Written application from foreign investor stating intention to establish JV	Written application from enterprise requesting creation of the branch
Notarized founding documents	Notarized founding documents	Notarized founding documents
Formal findings of any required "expert examinations"	Formal findings of any required "expert examinations"	Formal findings of any required "expert examinations"
Certification of creditworthiness of foreign investor	Certification of creditworthiness of foreign investor	Notarized copy of the by-laws of the branch
Proof of registry/legal status of foreign investor in home country	Proof of registry/legal status of foreign investor in home country	Proof of registry/legal status of foreign investor in home country
Notarized statement from Russian JV partner regarding creation of JV		Notarized decision of administrative organ of enterprise to establish JV

Licensing Process

If a foreign company is engaging in a production share agreement with a Russian partner, it is necessary to obtain a license; otherwise a company must purchase a controlling interest in a Russian enterprise with mineral rights in order to be able to claim ownership over minerals produced by the enterprise. Three types of licenses are available: exploration, production, construction and operation, or a combination license for production and exploration (Ostrander-Krug and Krug, 1993).

In order to obtain a license, a company must apply to "GEOLCOM" either in Moscow or at one of the regional offices. License applications are required to contain the following information:

- Principal place of business;
- Business arrangements with Russian financial and/or production partners;
- Names of senior executives/owners;
- Financial statement;
- Technical capabilities of company and its contractors;
- Five-year history of countries where foreign investor has operated;
- Proposal for a license.

Upon submitting the license application and payment of the necessary fee, applicants receive geological and other information necessary to conduct a feasibility study (Ostrander-Krug and Krug, 1993).

Once a license is been approved, the company must register with the territorial geological fund within 30 days. The license goes into effect only after registration.

Taxes, Fees and other Costs

Value Added Tax

In December 1992, the Russian Federation established a 20 percent value-added tax (VAT) for all goods imported into Russia. This tax law applies to all goods imported into the country, and is enforced by the Russian State Customs Committee and the State Tax Service. This is of particular significance for foreign companies importing machinery for business purposes (e.g., natural resources extraction). The only items not covered by the VAT tax are items that are "re-exported" within six months, or items that are classified as "temporary imports," not for re-sale. (The maximum duration for which goods may be considered "temporary" imports has not yet been defined)(Ernst and Young, 1993).

The VAT is payable in rubles as soon as goods pass through customs. The 20 percent VAT is assessed against the sum of the value of imported items listed on the customs declaration plus any other taxes, tariffs, or duties already applied to the value of the goods.

Import and Export Duties

There is currently a 15 percent duty for importing equipment into the CIS. This means that an item purchased abroad valued at $100 will cost $15 plus 20 percent of $115 (=$22) to import, for a total of $37 of (effective) import taxes.

In early February 1993, the Russian Minister for Foreign Economic Relations announced that Russian export duties on raw materials, currently set at 10 to 15 percent of customs value, will be reduced and ultimately eliminated over the next two to three-year period. In addition, import duties for raw materials and equipment are expected to be reduced from 15 percent to 5 percent of customs value (Interfax, 1993b).

Withholding Tax

Companies are charged a 15 percent withholding on dividends, which can be applied against US withholding. There is a 20 percent withholding on foreign lease agreements.

Export and Import Rules

Enterprises whose foreign investment funds constitute 30 percent or more of the enterprise's total funds, or which are completely foreign-owned, are permitted to export production without an export license, and to import goods and equipment for their own use. According to the Russian Law on Foreign Investment, "the currency earnings of these enterprises from the export of their own production shall remain at their complete disposal," and other products are exported and imported according to general Russian laws.[16]

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[16] Law of the Russian Federation "On Foreign Investments in the RSFSR," Article 25, July 4, 1991.

Contributions to the Social Insurance fund
Both foreign and domestic companies are required to pay 39 percent of each worker's salary for "benefits" provided by the Russian government. These funds go toward pensions, social security, the economic stabilization funds, and other "social guarantees." However, foreign investors are not required to obtain health insurance, workman's compensation or other forms of insurance for Russian workers.

Insurance and Legal Guarantees

Property and Risk Insurance
The Russian Law on Foreign Investment has no substantive provisions concerning property and risk insurance. However, President Yeltsin signed a decree in 1993 establishing a "state investment corporation," to promote foreign investment in Russia. The corporation administers a fund consisting of $1 billion in property, $50 million and 200,000 rubles that provides "financial guarantees" to foreign investors in a variety of industries, including mining. The fund provides insurance against a variety of risks, including "political risks" (Interfax, 1993c).

Consulting Services

Russian organizations and consulting services have recently emerged to help foreign investors cope with complex and often contradictory Russian legal requirements. For example, foreign investors can obtain consulting services for the registration and licensing process and for conducting environmental assessments in conformance with Russian requirements. Even with this assistance, however, foreign investors cannot always expect to circumvent time delays and costs associated with registration (Bebchuk, 1993).

APPENDIX B – LIST OF CONTACTS

LIST OF CONTACTS

Christine Milligan
Project Director
Partners in Economic Reform (PIER)
15 Novy Arbat, Rooms 2101, 2235
21910, Moscow, Russia
Tel: (7) (095) 203-0598, 202-8234
Fax: 203-0593
E-mail: pier@glas.apc.org

Oleg Tailakov
Director
Russian Coalbed Methane Center
Rukavishnikova 21, Room 208
Kemerovo 650610, Russia
Tel: (7) (3842) 259-300, 259-366
Fax: (7) (3842) 211-838
E-mail: root@tailak.kemerovo.su

Gene V. George
Chief, Regional Office of Energy
US Agency for International Development
Bolshoi Deviatinsky, 6
Moscow 121099, Russia
Tel: (7) (095) 956-4281, x. 5653
Fax: 956-3406

Albert Guk
Technical Director
Kuznetzkugol Coal Production Association
Kurako Street, 33
Novokuznetsk 654079, Russia
Tel: (7) (3843) 42 21 84
Fax: 48 19 71

Stanislav S. Zolotykh
Technical Director
Belovougol Coal Production Association
12 Lenin Street
Belovo 652600, Russia
Tel: (7) (384) 522-1234
Fax: 522-3520

Leninskugol Coal Production Association
ul. Stroitelnaya, 1
Leninsk-Kuznetsk 215713, Russia
Tel: (7) (38456) 433-317, 424-00, 212-76
Fax: 424-90, 202-64

Ivan A. Ivlev
Director
Kirov Mine
3 Kirsanov Street
Leninsk-Kuznetsk 652503, Russia
Tel:(7) (38456) 219-00, 200-24
Fax: 204-45

Oktyabrskaya Mine
2 Makarenko Street
Polysajevo 652256, Russia
Tel: (7) (38456) 515-59
Fax: 255-95

Vladimir V. Sichow
Director
Chertinskaya Mine
Yuzhnaya Street
Belovo 652607, Russia
Tel: (7) (38452) 317-77, 362-00

Yuri Garlev
Chief Engineer
Komsomolets Mine
Leninsk-Kuznetsk 652519, Russia
Tel: (7) (38456) 208-57

Abashevskaya Mine
1 Shorskaya Street
Novokuznetsk 654013, Russia
Tel: (7) (3843) 310-372

Baidaevskaya Mine
Novokuznetsk 654033, Russia
Tel: (7) (3843) 310-137, 662-222

James S. Marshall
Raven Ridge Resources, Incorporated
584 25 Road
Grand Junction, CO 81505 USA
Tel: (970) 245-4088
Fax: (970) 245-2514
E-Mail: jmarshall@ravenridge.com

APPENDIX C – EXPLANATION OF RUSSIAN CLASSIFICATION SYSTEMS USED

EXPLANATION OF RUSSIAN RESOURCE CLASSIFICATION, COAL RANK, AND MINE HAZARD CLASSIFICATION SYSTEMS USED IN THIS REPORT

MINERAL RESOURCE CLASSIFICATION SYSTEM

The coal resource data presented in this report pertain to documented, or explored reserves. As in other countries, documented reserves are categorized according to the degree of assurance that they exist. In Russia, documented reserves comprise degrees of assurance A, B, C_1, and C_2. They are based on the degree of exploration that has been carried out. The classification terms used in Russia are equivalent to descriptive terms used in the U.S., as shown in Table C-1.

TABLE C-1. COMPARISON OF RESOURCE CLASSIFICATION SYSTEMS

<table>
<tr><th colspan="5">FORMER USSR RESERVE CLASSIFICATION SYSTEM</th><th>WESTERN RESOURCE CLASSIFICATION SYSTEM</th></tr>
<tr><td rowspan="5">RESERVES</td><td colspan="2">CATEGORIZED BY EXTENT OF STUDY</td><td colspan="2">GROUPED ACCORDING TO ECONOMIC SIGNIFICANCE</td><td></td></tr>
<tr><td rowspan="3">EXPLORED</td><td>A</td><td rowspan="7">BALANCE</td><td rowspan="7">NON-BALANCE</td><td rowspan="3">PROVEN</td></tr>
<tr><td>B</td></tr>
<tr><td>C_1 (30 percent)</td></tr>
<tr><td>PRELIMINARILY ESTIMATED</td><td>C_1 (70 percent) & C_2</td><td>PROBABLE</td></tr>
<tr><td rowspan="3">RESOURCES</td><td rowspan="3">PREDICTED</td><td>P_1</td><td rowspan="3">POSSIBLE</td></tr>
<tr><td>P_2</td></tr>
<tr><td>P_3</td></tr>
</table>

In Russia, documented reserves are further subdivided into balance and non-balance reserves. These terms are defined below.

Balance coal reserves: documented reserves that meet criteria related to quantity, quality, technology, geologic conditions, and mining conditions. Criteria vary according to basin. Balance coal reserves are further subdivided into industrial and non-industrial reserves.

Non-balance coal reserves: documented reserves that do not meet the balance criteria for one or more reasons.

Industrial coal reserves: that portion of the balance reserves that is designated for extraction according to the mine plans and using available technology.

Non-industrial coal reserves: balance reserves which are not intended for production using available technology and production systems.

COAL RANK

In Russia, as in other countries, coal is ranked according to various parameters, including its carbon content, volatile matter content, and heating value. Table C-2 shows the approximate correlating descriptive terminology used in U.S. and Russia. The U.S. rank equivalents are approximate in that the ranges of the parameters used in the former USSR (shown here) are not identical to those used in the U.S.

TABLE C-2: COMPARISON OF U.S. & FORMER USSR COAL CLASSIFICATION SYSTEMS

RANK	VOLATILE MATTER $V^{as\ received}$ percent	HEATING VALUE Q kcal/kg	CARBON CONTENT C percent	APPROXIMATE U.S. EQUIVALENT
LONG-FLAME	$\geq$ 35	7300-8100	77-83	HIGH VOLATILE BITUMINOUS C
GAS	$\geq$ 35	7000-8600	81-87	HIGH VOLATILE BITUMINOUS B
GAS-FAT	27-35	8300-8750	81-87	
FAT	27-35	8300-8750	85-88	
COKING	18-27	8500-8800	88-91	HIGH VOLATILE BITUMINOUS A
LEAN-CAKING	14-22	8500-8800	90-93	MEDIUM VOLATILE BITUMINOUS
LEAN	8-17	> 8400	91-94	LOW VOLATILE BITUMINOUS
ANTHRACITE	> 8	< 8400	94-97	ANTHRACITE

METHANE EMISSIONS CLASSIFICATION

Russian mines are classified according to their specific emissions (amount of methane liberated per ton of coal mined). The mines are classed according to outburst hazard. A brief description of each classification follows.

Non-gaseous: The mine has no measurable methane emission.

Category 1: The mine emits less than 5 m^3 of methane per ton of coal mined.

Category 2: The mine emits between 5 and 10 m^3 of methane per ton of coal mined.

Category 3: The mine emits between 10 and 15 m^3 of methane per ton of coal mined.

In Danger of Sudden Outburst: The mine has sudden outbursts of methane from soufflards.

COAL DUST CLASSIFICATION

Russian mines are also classified according to the amount of coal dust present. The criteria used for the classification were unavailable.

APPENDIX D – FOR MORE INFORMATION

FOR MORE INFORMATION...

For more information on coalbed methane recovery experiences, project potential, or program activities and accomplishments, contact:

Coalbed Methane Program Manager

US Environmental Protection Agency
Mail Code 6202J
Atmospheric Pollution Prevention Division
401 M Street, SW
Washington, DC 20460

Program Hotline: 1-800-952-4782
Facsimile: 202 233-9569
Automated Faxback: Call 202 233-9659 and enter #1740
Internet: schultz.karl@epamail.epa.gov
Home Page: www.epa.gov/coalbed.htm

Selected list of EPA Coalbed Methane Outreach Reports:

- USEPA (U.S. Environmental Protection Agency). **Reducing Methane Emissions From Coal Mines in China: The Potential for Coalbed Methane Development.** Office of Air and Radiation (6202J). Washington, D.C. EPA 430-R-96-005. July 1996.

- USEPA (U.S. Environmental Protection Agency). **Reducing Methane Emissions From Coal Mines in Poland: A Handbook for Expanding Coalbed Methane Recovery and Utilization in the Upper Silesian Coal Basin.** Office of Air and Radiation (6202J). Washington, D.C. EPA 430-R-95-003. April 1995.

- USEPA (U.S. Environmental Protection Agency). **Reducing Methane Emissions from Coal Mines in Russia and Ukraine: The Potential for Coalbed Methane Development.** Office of Air and Radiation (6202J). Washington, D.C. EPA 430-K-94-003. April 1994.

- USEPA (U.S. Environmental Protection Agency). **Assessment of the Potential for Economic Develoment and Utilization of Coalbed Methane in Czechoslovakia.** Office of Air and Radiation (6202J). Washington, D.C. EPA-430-R-92-1008. October 1992.

- USEPA (U.S. Environmental Protection Agency). **Finance Opportunities for Coal Mine Methane Projects: A Guide to Federal Assistance.** Office of Air and Radiation (6202J). Washington, D.C. August 1995.

- USEPA (U.S. Environmental Protection Agency). **Finance Opportunities for Coal Mine Methane Projects: A Guide for Vest Virginia.** Office of Air and Radiation (6202J). Washington, D.C. August 1995.

- USEPA (U.S. Environmental Protection Agency). **Finance Opportunities for Coal Mine Methane Projects: A Guide for Southwestern Pennsylvania.** Office of Air and Radiation (6202J). Washington, D.C. EPA-430-R-95-008. June 1995.
- USEPA (U.S. Environmental Protection Agency). **Economic Assessment of the Potential for Profitable Use of Coal Mine Methane: Case Studies of Three Hypothetical U.S. Mines.** Office of Air and Radiation (6202J). Washington, D.C. EPA-430-R-95-006. May 1995.
- USEPA (U.S. Environmental Protection Agency). **Identifying Opportunities for Methane Recovery at U.S. Coal Mines: Draft Profiles of Selected Gassy Underground Coal Mines.** Office of Air and Radiation (6202J). Washington, D.C. EPA-430-R-94-012. September 1994.
- USEPA (U.S. Environmental Protection Agency). **The Environmental and Economic Benefits of Coalbed Methane Development in the Appalachian Region.** Office of Air and Radiation (6202J). Washington, D.C. EPA-430-R-94-007. April 1994.
- USEPA (U.S. Environmental Protection Agency). **Opportunities to Reduce Anthropogenic Methane Emissions in the United States. Report to Congress.** Office of Air and Radiation (6202J). Washington, D.C. EPA-430-R-93-012. October 1993.
- USEPA (U.S. Environmental Protection Agency). **Anthropogenic Methane Emissions in the United States: Estimates for 1990. Report to Congress.** Office of Air and Radiation (6202J). Washington, D.C. EPA-430-R-93-003. April 1993.
- USEPA (U.S. Environmental Protection Agency). **Options for Reducing Methane Internationally - Volume 1: Technological Options for Reducing Methane Emissions.** Washington, D.C. EPA 430-4-93-006 A. July 1993.
- USEPA (U.S. Environmental Protection Agency). **Options for Reducing Methane Internationally - Volume 2: International Opportunities for Reducing Methane Emissions.** Washington, D.C. EPA 430-R-93-006 B. October 1993.
- USEPA (U.S. Environmental Protection Agency). **A Guide for Methane Mitigation Projects: Gas to Energy at Coal Mines.** Draft. February 1996.