The Russian Far East and Northeast Asia: Aspects of Energy Demand and Supply Cooperation

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An Overview of Energy Demand and Supply for Northeast Asia

Northeast Asia (NEA), which in this report covers China, Japan, South Korea, North Korea and the Russian Far East, is one of Asia's most dynamic sub regions. With the exceptions of North Korea and the Russian Far East, the region has demonstrated spectacular economic growth at various times for over four decades. As a consequence, the region's economic growth was accompanied by explosive growth in energy demand despite energy consumption's low GDP elasticity.

NEA's economic development over the past 15 years has been accompanied by a constant increase in the region's share of global energy consumption. In 1985, NEA's share of global energy consumption slightly exceeded 14%; in 1997 it almost reached 20%.

Global and Northeast Asian energy supplies are heavily dependent on commercial non-renewable fossil energy sources (hard and brown coal, crude oil, condensate, natural and liquefied natural gas). Fossil fuel consumption continues to increase despite periodic oil price shocks, government energy efficiency policies, and debate on the environmental problems associated with carbon/nitrogen/sulfur/solid waste-related fuel combustion.

Table 1 shows commercial energy consumption figures for NEA and the rest of the world. In the figures for global energy sources, oil remains prominent at nearly 40 percent - down more than 5 percent from its 1970 share while natural gas' share rose from 18 percent in 1970 to more than 23% in 1997.

Table 1. Energy Consumption in Northeast Asia and the World, 1997* (Unit: million tonnes of oil)

Country	Oil	Natural Gas	Coal	Nuclear Energy	Hydro	Total	As a % of NEA Total Consumption	As a % of Total Global Consumption
China	185.6	17.4	681.8	3.7	16.2	904.6	55.0%	10.6%
Japan	266.4	58.6	89.8	83.4	8.1	506.3	30.8%	6.0%
South Korea	105.9	14.8	34.0	19.9	0.5	175.1	10.6%	2.0%
North Korea	2.0	-	27.7**	-	1.3	31.0	1.9%	0.4%
The RFE	9.8	2.7	12.7	0.01	2.2	27.4	1.7%	0.3%
Total NE Asia	**569.7**	**93.5**	**846**	**107.0**	**28.3**	**1644.4**	**100%**	**19.3%**
As a % of NEA's Energy Use	34.6	5.7	51.4	6.5	1.7	100%		
Total World Consumption	3395.5	1977.3	2293.4	617.4	225.9	8509.2		
As a Global Energy Source (in %)	39.9	23.2	27.0	7.3	2.7	100%		

* 1997 figures from BP World Energy Statistics, 1998, (except for North Korea and the RFE). 1996 North Korea figures from D. Von Hippel, and P. Hayes, 1997. Demand for and Supply of Electricity and other Fuels in the DPRK: Results and Ramifications for 1990 through 2005. Nautilus Institute for Security and Sustainable Development, Berkley, California, USA. 1997 RFE figures from Khabarovsk Economic Research Institute (ERI).

** including biomass and charcoal.

Coal, with a 27 percent share, remained the second-largest energy source. Nuclear power rose spectacularly from 0.4 percent in 1970 to 7.3 percent in 1997, combining with hydro to account for 10 percent of global energy consumption.

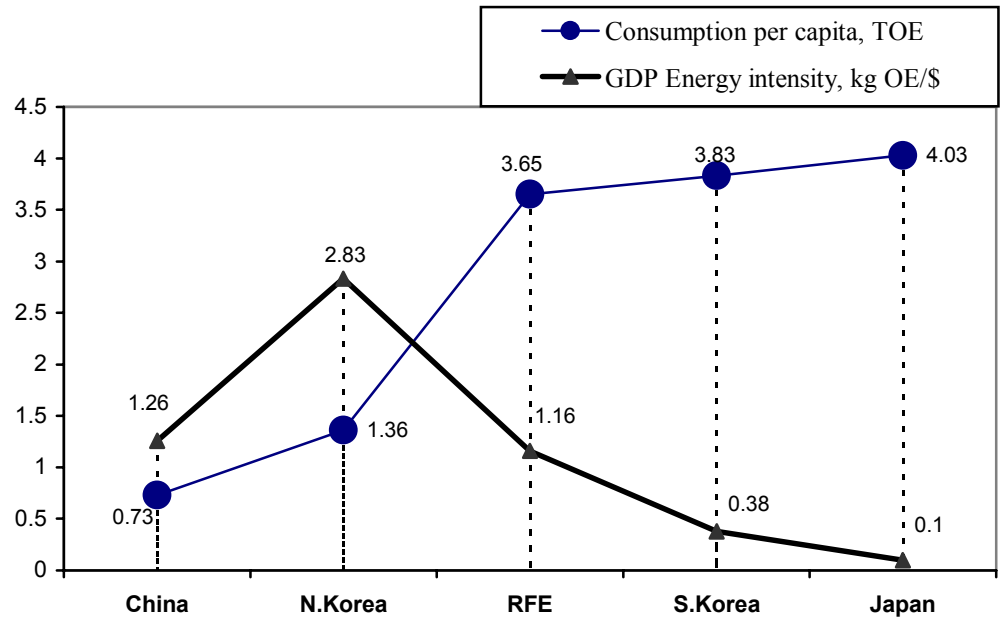
The NEA region, in contrast, has been heavily dependent on coal for many years. At present, coal accounts for nearly 51.5 percent of the region's total energy consumption, followed by oil at 34.5 percent and natural gas and LNG at only 5.5 percent, while nuclear power and hydroelectricity constitute 6.5 percent and 1.5 percent respectively. It should be noted that the high percent of coal use in Northeast Asia is due to China, which accounts for 55 percent of the region's energy consumption and 80 percent of the region's coal use.

Within Northeast Asia, each country's energy demand and supply situation is unique. Oil accounts for more than half the total commercial energy consumption in Japan and South Korea. Oil and natural gas[1] resources exceed 65 percent of total energy consumption in Japan and South Korea. How-

1 Japan and South Korea import and consume natural gas as liquefied natural gas (LNG).

ever, both countries have a near total dependence on imported fossil fuel energy (Table 2). North Korea produces and consumes a relatively large percent of coal, and also a sizable portion of non-commercial fuels such as biomass and charcoal, but the country is completely dependent on imported oil. The country also needs to import a certain amount of coal for its steel industry. North Korea is the only country in the region which does not use natural gas at all.

There are substantial differences between the amounts and patterns of energy consumption among the Northeast Asian countries. Picture 1 shows that the region's members' energy consumption levels vary substantially. The countries with relatively high levels of per capita energy consumption, in contrast, have low GDP energy intensity parameters.



Pic. 1. Energy Intensity Figures of the NE Asian Countries, 1997

The amount of energy reserves each country possesses differs strongly. As shown in Table 3, North Korea, and especially Japan and South Korea, lack primary fuel reserves, having only substantial confirmed coal reserves. In fact, no substantial oil and natural gas reserves have been discovered in these countries. If the Russian Far East is not taken into account, China is the only energy resource-rich country in the region. China is the region's only country that has a relatively balanced energy consumption/production structure, although its energy consumption is heavily dependent on coal. Since 1993, China has been a net oil importer, and experts predict that the country will soon join the ranks of Japan and South Korea as one of Northeast Asia's major oil importers.

Table 2. Actual Imports (+) and Exports (-) of Energy by NE Asian Countries in 1995 (Unit: Million Tonnes of Oil)

	Oil	Natural Gas	Coal
China	8.1	0	-20.1
Share of energy consumption, %	5.1	0	3.2
Japan	262.3	49.9	79.2
Share of energy consumption, %	99.7	96.2	95.7
South Korea	90.4	8.3	27.2
Share of energy consumption, %	100	100	91.7
North Korea*	1.8	X	-1.0
Share of energy consumption, %	100	X	5.2

* Estimates for 1996.

Source: North Korea figures from D. Von Hippel, and P. Hayes, 1997. Demand for and Supply of Electricity and other Fuels in the DPRK: Results and Ramifications for 1990 through 2005. Nautilus Institute for Security and Sustainable Development, Berkley, California, USA. Other figures from K. Fujime, "The Long-Term Energy Outlook for Northeast Asia" in Russia's Eastern Energy Policy and Integration Problems in the Energy Sector of the Asia-Pacific Region. Conference Proceedings, Irkutsk, Russia, 1998.

Table 3. Confirmed Energy Reserves in Northeast Asia (For the end of 1997)

	Coal, (million tonnes)	Oil, (million tonnes)	Natural Gas, (billion m^3)
China	114,500	3,300	1,160
Japan	821	-	-
South Korea	600	-	-
North Korea	183	-	-
Far East	30,554	699*	2,307*

* Data for the end of 1994.

Source: BP Statistical Review of World Energy; ERI.

Table 4 provides an overview of projected scenarios for future energy use among several different countries. For each prediction, the table shows the average annual growth rate of commercial energy consumption from the early 1990s (base years vary among the groups) projected until 2010.

The results of various national and international scenarios for regional energy development vary somewhat, however, the overall pattern of stable growth in energy use is uniform. The region's predicted energy consumption growth rates are lower when compared to actual rates from the past period.

Table 4. Projections for Commercial Energy Consumption in Northeast Asian Countries
(Annual average growth rates from early 1990s projected until 2010, %)

Source of Projection	China	Japan	South Korea	North Korea
Institute of Energy Economics, Japan	3.5	1.8	3.4	
East-West Center, USA	3.6	1.7	3.4	
RAINS-Asia	4.5	1.8	5.0	5.3

Source: P. Hayes, and D. Von Hippel. 1997. "Regional Approaches for the Cooperative Development of a Clean, Efficient Electric Power System" in Regional Economic Cooperation in Northeast Asia. Proceedings of the Seventh Meeting of the Northeast Asia Economic Forum. Edited by Mark J. Valencia. Hawaii Asia-Pacific Institute. K. Fujime, 1998. "The Long- Term Energy Outlook for Northeast Asia" in Russia's Eastern Energy Policy and Integration Problems in the Energy Sector of the Asia-Pacific Region. Conference Proceedings, Irkutsk, Russia, 1998. F. Fesharaki, S. Banazak, and Wu Kang. 1998. "The Outlook for Energy Supply and Demand in Northeast Asia" in Energy and Security in Northeast Asia: Supply and Demand; Conflict and Cooperation. Policy Paper # 36, February 1998. IGCC. University of California.

It is obvious that each country's energy policy and energy demand-supply outlook is influenced by a variety of factors and national priorities. In NEA countries as a whole, most energy consumption will continue to be derived from fossil fuels. In structural terms, the leading NEA energy consumers (Japan, China and South Korea) intend to diversify their energy sources, although coal and oil will remain their primary energy sources. According to a forecast by the Institute of Energy Economics of Japan (IEEJ), these countries share a similar policy of increasing their atomic energy[2] use (Table 5). For example, in Japan, the IEEJ predicts the amount of energy supplied by nuclear energy will increase from 15.5 percent in 1995 to 19 percent in 2010; in South Korea, from 12 percent to 17.5 percent, respectively for the same period. Within these countries, however, increased reliance on nuclear power faces obstacles over the issue of appropriate locations for nuclear reactors and opposition among the general public.

2 North Korea plans to construct a nuclear power plant in accordance with the KEDO framework.

Table 5. Energy Supply Projections in Key Northeast Asian Countries

(Energy supplies and annual average growth rates from 1995 through 2010, %)

Source: IEEJ.

	Coal	Oil	Natural Gas	Hydro	Nuclear	Total
China						
1995	75.5	18.9	1.8	2.0	0.4	100
2010	65.6	24.0	3.9	2.7	2.3	100
AAGR	*2.6*	*5.2*	*8.9*	*5.7*	*16.1*	*3.5*
Japan						
1995	17	53.9	10.6	1.5	15.4	100
2010	17.5	44.8	14.7	1.7	19.0	100
AAGR	*2.0*	*0.5*	*4.0*	*2.9*	*3.2*	*1.8*
South Korea						
1995	20.2	61.8	5.7	0.3	11.9	100
2010	21.5	49.2	11.5	0.2	17.6	100
AAGR	*3.8*	*1.8*	*8.4*	*-1.4*	*6.1*	*3.4*

According to estimates by a number of national and international research groups, in the 21st century NEA energy consumption patterns will be affected by an increase in natural gas use. As noted by Fesharaki, Banzak, and Wu Kang[3], Fujime[4], Hirata[5], Sui Shuo Bao[6], natural gas will account for a larger share of the region's energy consumption. According to their estimates, between 1995 and 2010, natural gas consumption will increase as follows:

in China - by 705%

in South Korea - by 330-360%

in Japan - by 180-215%.

For the entire NEA region (taking into account the Russian Far East) natural gas consumption will rise spectacularly, with usage doubling in 2010 to more than 250 billion m^3 (compared to 104 billion m^3 in 1997).

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3 F. Fesharaki, S. Banazak, and Wu Kang. 1998. East-West Center, USA. The Outlook for Energy Supply and Demand in Northeast Asia. In: Energy and Security in Northeast Asia: Supply and Demand; Conflict and Cooperation. Policy Paper # 36, February 1998. IGCC. University of California.

4 K. Fujime, 1997. Institute of Energy Economics of Japan. Prospects and Issues of Energy Demand and Supply in Northeast Asia. Summaries of Reports for the Northeast Asia Economic Conference in Niigata '97. Electronic version.

5 M. Hirata, 1998. Asian Pipeline Research Society of Japan. Prospects of Natural Gas Demand in Asia Based on Advanced Power Generation Technologies to Reduce CO_2 Emissions. In: Eastern Energy Policy of Russia and Problems of Integration into the Energy Space of the Asia-Pacific Region. Proceedings of Conference. Irkutsk, Russia.

6 Sui Shuo Bao, 1998. National Petroleum Company of China. Perspective Plan of the Chinese Gas Industry Development. In: Eastern Energy Policy of Russia and Problems of Integration into the Energy Space of the Asia-Pacific Region. Proceedings of Conference. Irkutsk, Russia

Another key aspect of the region's projected growth in energy use is the shift in energy import patterns. The key NEA countries' dependence on energy imports will persist in the future and even grow (Table 6). Despite the increase in the use of atomic and hydro energy in the region, as well as increases in the production of coal, oil and natural gas in China, the "total energy production/consumption" balance in Japan, South Korea and China is predicted to be negative. Of particular concern is China's projected shift over the first decade of the 21st century from being a fairly small net importer of oil in 1995-1997 to being a rather large net importer, second only to Japan. Also, Chinese experts predict that China's natural gas imports will rise to South Korean levels in 2010.

Table 6. Import (+) and Export (-) Projections of Primary Energy by Key NE Asian Countries in 2010

	Oil	Natural Gas	Coal
China, million TOE	140	16-45	-35
Share of energy consumption, %	42	30-40	4
Japan, million TOE	285	90-105	112
Share of energy consumption, %	99.8	99	100
South Korea, million TOE	118	28-30	50
Share of energy consumption, %	100	100	98

Source: K. Fujime, 1998. Institute of Energy Economics of Japan. "Long term Energy Outlook for Northeast Asia. In: Eastern Energy Policy of Russia and Problems of Integration into the Energy Space of the Asia-Pacific Region." Proceedings of Conference. Irkutsk, Russia. M. Hirata, 1998. Asian Pipeline Research Society of Japan. Prospects of Natural Gas Demand in Asia Based on Advanced Power Generation Technologies to Reduce CO_2 Emissions. In: Eastern Energy Policy of Russia and Problems of Integration into the Energy Space of the Asia-Pacific Region. Proceedings of Conference. Irkutsk, Russia. Sui Shuo Bao, 1998. National Petroleum Company of China. Perspective Plan of the Chinese Gas Industry Development. In: Eastern Energy Policy of Russia and Problems of Integration into the Energy Space of the Asia-Pacific Region. Proceedings of Conference. Irkutsk, Russia

The Ramifications of Energy Demand and Supply for International Cooperation in Northeast Asia

Since the 1970s, energy issues have become tightly interwoven with economic, social and political problems, largely determining the development process of global and regional economies, as well as influencing national security and political stability.

The end of the Cold War has brought positive political changes in the NEA region and the opening of the Chinese and Russian economies has enhanced multilateral economic cooperation. However, there is no widely recognized conception of economic cooperation in the region. Even the geographic definition of "the NEA region" itself remains rather "vague", lacking definite territorial identification. Policy-makers and researchers have included

a variety of countries along with various sub regions with different economic and political characteristics to the NEA region's definition.

The concept of regional economic cooperation in NEA still lacks a basic driving force behind economic cooperation. It is also necessary to take into account the existing political tensions among the region's members as well as cultural, ethnic and institutional obstacles. NEA has no general economic or sectorial institutional agreements or unions like the European Union, ASEAN, OPEC, the European Energy Charter, or the ASEAN Council on Petroleum (ASCOPE, NORDEL, etc.).

Despite recent positive political and economic trends, Northeast Asia lacks sufficient mechanisms to facilitate economic cooperation as well as those to facilitate trade, technology and investment transfers.

The NEA energy demand-supply sector holds significant potential for multilateral resource cooperation. Such interaction goes beyond simple export-import trade relations; the ramifications and implications of such interaction could link the region in an "energy community" and thus contribute to the process of regional integration.

Similar to the International Energy Agency's[7] approach, three key policy challenges derived from the ramifications and implications of energy demand-supply can be applied to Northeast Asia. These are the so-called "Three Essential E's":

- *E nergy security,*
- *Economic development,*
- *Efficiency and environmental sustainability.*

Energy Security:

The central point for providing energy security is diversification. Diversification implies diversification of energy sources in the energy balance and diversification of energy supplies. The largest energy consuming NEA countries (China, Japan, South Korea) have identified natural gas as a cleaner and/or underutilized source of energy and plan to increase its share as a percentage of total energy consumption. These three countries, along with North Korea, also have ambitious nuclear power programs to meet electricity demand but face problems due to financing and public opinion. A failure to meet nuclear power targets will affect future oil, coal and gas demand in these countries and the region.

Within the region, Japan and South Korea have long been dependent on imported fossil fuels to meet their energy demands. Among fossil fuels, Japan's import dependence on oil is almost 100 percent, 96 percent for coal, and 100 percent for LNG. Over the next 15 years, Japan will continue to import nearly all of its fossil fuels. Like Japan, South Korea is completely dependent upon imported oil and LNG, and 92 percent dependent upon imported coal. Through 2010, the country will retain its high dependence on imported fossil fuels.

In 1993, China became a net oil importer, dramatically changing the Northeast Asian energy picture. Over the next 10 to 15 years, China will

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7 J. Ferriter, 1998. International Energy Agency. World Energy Outlook Implications for International Cooperation. In: Energy and Society Forum. Priorities and Possibilities of Sustainable Development. Proceedings of International Conference. Vedomosti MTEA. #22.

expand its own oil production, but the growth rates in production will be obviously lower than the predicted rates of oil consumption. In 2010, China will join the ranks of Japan and South Korea as Asia's largest oil importers.

A key issue regarding the region's oil imports is the dependence on supplies from the Middle East. In the 1990s, 70 to 80 percent of Japan's oil imports came from the Middle East. More than 70 percent of South Korea's current oil imports also come from this region. It is predicted that through 2010 the share of Middle East crude oil imports in the Asia-Pacific region as a whole will increase from 75% in 1995 to 90% and 93%, respectively, in 2005 and 2010[8].

Such a high degree of dependence on one region for oil supplies will make Northeast Asian economies especially vulnerable to oil price shocks. As well, instability in the Middle East or along the oil's transport routes could threaten the security of their supplies.

An important feature in strengthening energy security rests in developing and transforming the infrastructure of international shipments of energy resources. In recent years, various organizations have formed several large and, for the region, technologically advanced bilateral and multilateral international energy projects; some of them are as follows:

- The Asian Energy Community Trans-Asia Pipeline Grid (extending from Western and Eastern Siberia and Yakutia to Dampier in northwestern Australia connecting Russia, China, Korea, Japan, Taiwan, Turkmenistan, Uzbekistan, Alaska, Australia, and six ASEAN countries);
- The formation of an interconnected interstate electric power grid in Northeast Asia;
- The Irkutsk-China electricity link;
- The Irkutsk region gas project;
- Sakhalin gas-pipeline proposals;
- East Siberia-Yakutia-Sakhalin-Northeast Asia oil and gas projects.

The practical realization of these multinational and bilateral projects will reinforce the participant-countries' energy interdependence and expand the basis for the formation of a Northeast Asian "energy community.

Economic Development:

Energy is not simply a product or complex of products; it links other needs and issues. The energy industry is relevant to people in terms of the services it can render to them in terms of heating, cooling, light, and transportation. Energy is also an important and universal production factor for the manufacturing of a vast variety of non-energy commodities and services. Providing energy services and facilitating the production of other commodities and services are important economic goals.

On the other hand, in terms of economic development, international cooperation needs to focus on ensuring the availability of capital for large-scale

8 F. Fesharaki, S. Banazak, and Wu Kang. 1998. East-West Center, USA. The Outlook for Energy Supply and Demand in Northeast Asia. In: Energy and Security in Northeast Asia: Supply and Demand; Conflict and Cooperation. Policy Paper # 36, February 1998. IGCC. University of California.

investments with long repayment periods to meet increasing energy needs. A country's ability to mobilize sufficient capital for its energy investment needs will depend on the quality of its investment, fiscal and regulatory policies. Investor confidence is also a critical factor.

The NEA countries' combination of interrelated production characteristics represents an ideal and unique combination. Table 7 illustrates the point that regional cooperation can take place in Northeast Asia because of complementary conditions among the principal countries and sub regions[9]. These production characteristics can ensure profitable economic-related energy cooperation in the region. As shown, each country and sub region has certain comparative advantages which complement each other. Resource-rich and capital-poor and managerial-expertise-poor and energy-demand-scale-poor areas exist alongside resource-poor and capital-rich and managerial-expertise-rich and demand-scale-rich regions.

Table 7. Qualitative Comparison of Northeast Asian Countries' Production Characteristics

	Scale of Energy Demand	Oil and Gas	Coal and Minerals	Labor	Capital	Technology	Managerial Expertise
RFE	P	VR	VR	P	VP	P	P
China	VR	R	VR	VR	P	P	P
N. Korea	P	A	R	R	VP	VP	VP
S. Korea	R	A	P	P	R	R	R
Japan	VR	VP	P	P	VR	VR	VR

Note: VR= Very Rich; R = Rich; P=Poor; VP = Very Poor; A = Absent.

Source: revised version from Keun-Wook Paik, 1993. Multilateral Energy Cooperation in Northeast Asia: a Focus on oil and Natural Gas Development. J. Dorian et.al. (eds.). CIS Energy and Minerals Development. Prospects, Problems and Opportunities for International Cooperation. Kluwer Academic Publishers in cooperation with East-West Center. Honolulu, Hawaii.

Efficiency and Environmental Sustainability:

Along with regional economic development, energy growth in Northeast Asia has resulted in a host of regional and global environmental problems, including:

- high emissions of sulfur and nitrogen oxides - these gases that are major contributors to "acid rain" - particularly as a result of coal usage and increasing transport-sector activity;
- increasing emissions of carbon dioxide, methane and other greenhouse gases that contribute to global climate change.

9 M. Valencia, J. Dorian. 1998. East-West Center, USA. Multilateral Cooperation in Northeast Asia's Energy Sector: Possibilities and Problems. In: Energy and Security in Northeast Asia: Supply and Demand; Conflict and Cooperation. Policy Paper # 36, February 1998. IGCC. University of California. Keun-Wook Paik, 1993. Multilateral Energy Cooperation in Northeast Asia: a Focus on oil and Natural Gas Development. J. Dorian et.al. (eds.). CIS Energy and Minerals Development. Prospects, Problems and Opportunities for International Cooperation. Kluwer Academic Publishers in cooperation with East-West Center. Honolulu, Hawaii.

Fossil energy will continue to be major source of energy for every Northeast Asian country in the foreseeable future. Even a superficial reading of the Kyoto Protocol demonstrates that energy is central to the issue, although quantifying the exact level of required reductions in energy-related emissions is very difficult.

Carbon dioxide emissions from fossil fuel combustion represent about four-fifths of all greenhouse gas emissions in industrialized countries. Policies to reduce energy-related CO_2, SO_x, NO_x emissions in Northeast Asia and increase energy efficiency can be grouped into several categories:

- shifting to less carbon-intensive fossil fuels - from coal to oil or gas, from oil to gas;
- moving from fossil to non-fossil fuels;
- increasing the standards for refined petroleum product consumption;
- controlling and preventing SO_x and NO_x emissions from thermal power plants;
- switching to more energy efficient equipment;
- shifting expenditures to less energy-intensive products and services.

Energy Development in the Russian Far East and Comparative Advantages for Cooperation with Northeast Asia

The Fuel-and-Power Complex (FPC)[10] is represented in the Russian Far East (RFE) by the coal, oil and gas, oil refinery industries, and also by electricity enterprises. Historically, the RFE's energy sector has mainly supplied energy for local development, with virtually no significant achievements in the production of fuel and power products for interregional and external economic exchange. The modest general economic parameters of the Russian Far East, compared nationally, demonstrate its lack of national importance in the production and consumption of energy resources[11].

The period from 1980 to 1990 saw dynamic growth in the Russian Far East's production and consumption of primary energy, and also of final energy products. The demand for energy has continuously grown at an average annual rate of 2.7 percent, for electricity - 4.5 percent. Over ten years, energy production grew by 35 percent, and electricity - by 57 percent. Still, the Russian Far East has constantly experienced a lack in production capacity to meet the growing energy demand.

Between 1980 and 1990, the RFE energy sector's current technological pattern was formed, which, in the 1990s, has not undergone any substantial modifications (except for the coal industry).

The RFE's current energy balance is largely the result of Soviet-era energy policies. In the Russian Far East, the energy balance's specific structure was historically based on a high dependence on energy (Table 8). In 1990, 46 percent of total energy consumption in the Russian Far East was based on domestic imports of energy. Thus, energy consumption was dominated by

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10 According to terminology adopted in Russia, "Fuel-and-Power Complex", "energy sector", and "energy" refer to commercial enterprises dealing with the extraction, production, processing, conversion, and specialized transportation of fuel and power resources.

11 The RFE accounted for 2 and 4.6 percent, respectively, of Russia's total energy production and consumption in 1996. Electricity production accounted for 4.3 percent (in 1997).

coal (36.9 %), and petroleum fuels (46.5 %) with a low share for natural gas (6.2%) and hydro-power (6%). Energy consumption has long exceeded energy production.

Economic changes have resulted in an overall reduction in the scale of the RFE's energy balance. The reduction in the region's energy balance affected all stages of the energy flow. In 1997, in comparison with the maximum levels achieved during the 1985-1991 period, coal production accounted for 57 %, oil - 75 %, natural gas - 100 %, electricity production - 78 %, oil refining - 40 %. According to studies, on the whole, the RFE's energy production in 1997 was 67% of the 1990 level, gross energy consumption - 65%, industrial production fell by 43 %.

Activating the distributive function of prices has had a positive result in improving energy consumption efficiency in the RFE. The orientation toward market-based efficiency measures for using energy resources has resulted in structural shifts in the RFE's gross energy consumption. This has resulted in a concentration on the utilization of relatively inexpensive coal resources with a simultaneous reduction in the share of expensive petroleum fuels. Petroleum fuel's share in total energy consumption for the RFE fell from 46.5% in 1990 to 34.4 % in 1997.

The overall reduction in energy consumption between 1992 and 1997 lowered the volume and degree of the RFE's energy dependence. However, in 1996 more than 36% of the RFE's total energy consumption was still supplied by energy resource imports from other regions.

The current situation in the RFE's energy sector is characterized by a number of factors that are crucial for developing the region's energy balance. Among them, the following factors should be noted:

- uncertain prospects for the economy's internal growth and, consequently, growth in the region's energy consumption;
- the prolonged economic crisis in the RFE and Russia;

the opportunity for RFE energy resources to enter global energy markets via the Asia-Pacific region, and, primarily, Northeast Asia;

Table 8. Basic Structural Indicators of the RFE's Energy Balance (as of 1990, 1997)

Primary Energy Production							
		Coal	Natural Gas	Oil	Hydro and Nuclear	Others	Total
Structure, %	**1990**	68.8	9.2	7.1	9.0	5.8	100
	1997	61.6	14.1	8.5	11.4	4.3	100
Gross Primary Energy Consumption							
		Coal	Natural Gas	Petroleum Nuclear	Hydro and	Others	Total
Structure, %	**1990**	36.9	6.2	46.5	6.1	4.4	100
Share of Imports in Consumption, %		*11.7*	*0*	*89.7*	*0*	*0*	*46.0*
Structure, %	**1997**	45.1	9.7	34.4	7.9	3.0	100
Share of Imports in Consumption, %		*17.4*	*0*	*83.0*	*0*	*0*	*36.4*
Final Energy Consumption							
		Coal	Petro-leum	Natural Gas	Electricity	Commercial Heat	Others	Total
Structure, %	**1990**	11.1	40.7	1.9	9.9	32.9	3.4	100
	1997	13.0	32.8	2.3	12.6	35.6	3.5	100

Source: Figures from ERI.

In general terms, the basic strategic steps necessary for the formation of an effective energy balance structure in the RFE call for:

- an increase in energy and economic efficiency during all stages of the production, conversion, distribution and final use of energy;
- a sharp increase in the share of natural gas and crude oil energy resources in regional production and expansion of their use for internal energy consumption. The basis for this step is the large-scale development of oil and gas resources on the Sakhalin shelf and in the Sakha Republic (Yakutia);
- the active utilization of the RFE's fuel and energy resources in the energy markets of the NEA and APR countries;
- a stabilization and then increase in coal production volumes, mainly in open mines; and an increase in coal quality by developing enrichment processes;
- an intensification in the development of local energy resources and non-traditional sources of energy;
- a rational system of combining and concentrating local and central energy supply systems;
- further development in electrification; diversifying electricity sources via the balanced use of coal, natural gas, hydro, and possibly, nuclear and non-traditional sources of energy in electricity generation; development of electricity trade with NEA countries, and purchase of

the results of joint (parallel) work from interconnected power systems in Siberia, the Russian Far East, China, Japan, North and South Korea;
- modernizing the types of generating equipment in thermal power plants by using ecologically safe coal-firing power generating units; introducing modern types of equipment with steam-and-gas cycles and gas turbine units.
- increase the region's energy potential via increased exploration and prospecting;
- improving the ecological and technical safety of energy sources and power supply reliability for consumers.

International cooperation in the RFE energy sector occupies an important place in the structural transformation of the NEA region's energy sector and economy as a whole. This is mainly due to the presence and interaction of a number of comparative advantages in the Russian Far East, as well as the capabilities that lie in the Northeast Asian countries.

The internal *comparative advantages* of the Russian Far Eastern energy sector can be examined by focusing on the following determinants:

I. Geopolitical:
I.1. General Geopolitics
I.2. Energy Geopolitics
II. Economic:
II.1. Basic factor conditions
II.2. Supporting infrastructure availability
II.3. Domestic demand conditions
II.4. Competitive conditions inside the region
III. Institutional

This approach to classifying the above determinants is rather conditional, since they exist not as a set of isolated components, but as a dynamic system.

It should be noted that the comparative advantages of the energy sector in the RFE have a contradictory character and are not absolute.

I. Geopolitical Determinants.

I.1. General Geopolitics.

At present, the trends and opportunities for energy cooperation and interacton in the Russian Far East with the NEA countries can be viewed as part of Russia's general economic and political strategy of shifting its geopolitical direction eastwards.

Until the mid-1980s, the main commodity flows from the territory of the former Soviet Union were mainly oriented towards the countries of Western and Eastern Europe, while trade and economic relations with the APR countries lagged behind.

Russia has a strategic problem in the APR, a problem of consolidation

in the Northeast Asian subregion, and in the Asia-Pacific region as a whole. The interests of Russia as an Euro-Asian power, undoubtedly, face not only the West, but also the East. The APR's growing importance in the global economy will lead to an increase in the RFE's significance.

One positive concrete example of the RFE's internal geopolitical shift towards the APR is the 1996 Federal Program for the Social and Economic Development of the Russian Far East (hereafter referred to as the Program). The Program consolidates Russia's strategic interests and long-term priorities with regard to its eastern regions. Although the Program has faced obstacles in its implementation, it is a political and institutional recognition of the Russian Far East's importance as a region that has affected the country's eastward geopolitical shift.

I.2. Energy Geopolitics.

Russia as a whole has a powerful industrial and energy resource potential. However, the last few years have seen a marked deterioration in the expansion and maintenance of energy reserves in the traditional energy-producing regions of Russia, especially in West Siberia, where, for a long time, investments in prospecting and production had been made. For example, 20 years ago, average crude oil reserves, calculated per deposit, amounted to about 50 to 53 million tonnes, the average daily extraction of oil from one well was 29 tonnes; in 1996 the average reserves were only 1.5 million tones, and daily production was 10 to 12 tonnes.

The details indicated above are necessary for understanding the geostrategic meaning of the Russian Far East's energy potential, for the necessity of increasing exploration, and for reassessing its role in the 21st century. At present, the amount of potential oil resources explored in the Russian Far East is less than 2.5%, for natural gas - about 10%, for coal - less than 2%. Of these, the average recoverable oil reserves calculated per deposit, for example, in the northeastern areas of the Sakhalin shelf, exceed 32 million tonnes.

II. Economic Determinants.

II.1. Basic factor conditions.

Immense reserves of diverse energy resources are concentrated in the Russian Far East's vast territory. In the region there are not only traditional - commercial energy resources - coal, oil, natural gas, hydropower - but also a wide range of non-traditional energy sources (tidal, geothermal, wind, solar, etc.). The general amount of potential oil resources is estimated to be 29 billion tonnes, for natural gas - 23 trillion m^3, for coal 2.2 to 3.5 trillion tonnes. Geological exploration of these potential resources remains low. The discovered reserves of solely commercial energy resources in the RFE amount to almost 23 billion tonnes of coal equivalent (tce), of which over 4 billion tce represents actual transportable crude oil and natural gas resources. The probable output from the RFE's rivers is estimated to be 1008.2 billion kWh an-

nually.

The RFE's known energy reserves are sufficient to provide for the production of primary and transformed energy resources, vastly exceeding the region's maximum internal energy consumption by tens or hundreds of times (Table 9).

Table 9. Reserves/Consumption* Ratio for the Russian Far East

Coal	Oil	Natural Gas	Hydro	Total
830	35	785	90	380

*- consumption as of 1990.

Source: Data from ERI

II.2. Supporting infrastructure availability.

The RFE's vast territory and uneven economic development has resulted in the formation of several local types of general-purpose infrastructure in the region. In the more-developed southern districts there is a fairly developed general-purpose infrastructure consisting of railroad networks (the Trans-Siberian and Baikal-Amur railways), seaports, roads, and communications that have unused potential. On the other hand, most of the RFE's prospective energy reserves are concentrated in the remote and less-developed northern districts, as well as the shelf zones of the Far Eastern and Arctic seas, which lack adequate infrastructure and developed transport links with concentrations of industrial districts, population and external markets.

II.3. Domestic demand conditions.

Domestic demand conditions for energy have so far exerted a restraining influence on the establishment of comparative advantages in the production of energy resources.

The RFE's enormous territory, uneven industrial development, and location of key industrial centers in various localities separated by large undeveloped spaces, have hindered the creation of integrated fuel-and-power systems like those in Siberia and European-Russia. The small concentrations of energy consumers (particularly in the vast northern and north-eastern districts) have resulted in the development of relatively small (with some exceptions) energy supply industries. The relatively low demand for homes, which has been decreasing recently, has restricted the RFE power industry's potential economy of scales effect, which is traditionally high in the energy sector.

Proceeding from the most optimistic assessment of internal energy consumption dynamics, it is not possible to rely on the creation of powerful fuel-and-energy projects on the basis of the Elginskii hard coal deposit, the Western and Central Iakutiia hydrocarbon deposits, the eastern and Arctic shelves (including the Sakhalin offshore projects), the Uchur hydro-power plants, the powerful thermal power plants in Sakhalin, and the Tugur tidal power plant. However, even taking into account the grave infrastructure restrictions, these projects are, on the whole, commercially viable due to economies of scale.

II.4. Competitive conditions inside the region.

The region's internal competitive conditions are an important determinant since a strict competitive environment stimulates and promotes the development of comparative advantages.

At present, there is competition in all branches of the energy sector in

Russia and the RFE, although there are substantial differences and variations. In terms of operation, strict competitive conditions are present in the oil, and oil-refining sectors, and somewhat less in the coal industry. In the electric power industry a natural monopoly is in force (although not recognized by legislation). However, at the strategic decision-making level, competition in the electric power industry has an influence on the structure of potential investments.

In terms of internal competitive conditions in the RFE's energy sector, it is important to single out one more competitive aspect that results from the Russian Federation's peculiar political and administrative structure. The Russian Far East is an economic zone which has no special administration system, but there are legislative, executive and financial systems which exist at the regional level in the Federation which are included in the Far East.

In a pragmatic sense, regional development aims to maximize the territory's value, increase the region's budget revenues, and secure employment for the population. Thus, the Far Eastern territories are seeking to develop their own energy resource production projects to generate revenues and create employment. Strategically, the regional authorities are compelled to compete strictly for the distribution of resources in favor of their own territory's energy projects, using, together with the concerned energy companies' managers, a diverse set of influential measures in order to distinguish and enhance the comparative advantages of their own projects. In the RFE, the "regional element" behind the internal competitive background is, at present, quite strong and influential.

III. Institutional Determinants.

Russia is performing a fundamental transition from a centralized social-political model to the principles of a democratic state. Russia has adopted a new Constitution that proclaims the citizens' rights and freedoms and guarantees diversity in the forms of property, including private property. Although the institutional transformations still face a number of problems aggravated by the country's economic crisis, the attributes of a democratic state and principles of a market economy are being firmly established in Russia.

The role of institutional factors in the establishment of comparative advantages is varied. Here, the peculiarities of the Russian tax system as applied to the mineral resources sector, including the mineral fuels sector are an institutional advantage. This issue deals with the "Production Sharing Legislation (PSL) Regime", which was completed in March 1999. The PSL Regime in Russia extends the system of civil relations to the use of mineral resources. The government and investors act as equal partners: they establish a contractual relationship and create a pattern of production sharing which satisfies the two parties. The PSL Regime is distinct from the existing administrative system for mineral resource use. For the RFE, the specific nature of the "Production Sharing Legislation Regime" is essential; its flexibility allows the government to regulate the boundaries of the effective use of energy resource deposits, turning complex, remote deposits into profitable development. This is a valuable advantage of the PSL Regime in comparison with a strict fiscally oriented taxation system.

The Sakhalin Projects as a Positive Example of the Integration of the RFE Energy Sector's Comparative Advantages and the Ramifications for Northeast Asian Energy Supply-Demand

A brief outline of the Sakhalin projects:

At the present time, there are three major projects at different stages of development in the northeastern sector of the Sakhalin shelf, which are to be implemented under the "Production Sharing Legislation Regime".

Sakhalin-1 Project: At present, the investor's interests in the Sakhalin-1 Project agreement are represented by a consortium of four companies: Sodeco, a Japanese company; Exxon, an American company; and Rosneft' and Rosneft'-Sakhalinmorneftegas, Russian companies. The contract covers three oil, gas, and condensate deposits (Chaivo, Odoptu, Arkutun-Daginskoe) with overall estimated oil and condensate reserves of 320 million tonnes, and 420 billion m^3 of gas.

The project's strategy calls for three stages. The first stage calls for the preparation of marketing agreements and additional study of the deposits with the aim of precisely estimating reserves' amount and structure. The second stage will initially extract oil from the most promising part of the Arkutun-Daginskoe deposit (presumably, from the year 2000). The third stage will be the project's full development. The prospective volume of fixed asset investment in the project is about 20 billion USD.

Sakhalin-2 Project: This contract covers the Lunskoe deposit (mostly gas, estimated reserves of 495 billion m^3) and the Piltun-Astokhskoe deposit (mostly oil, estimated reserves of 100 million tonnes). The investor's interests (Sakhalin Energy Investment Company) in the Agreement are represented by a consortium of four foreign companies: Mitsui, Mitsubishi, Marathon, and Royal/Dutch Shell. The project's strategy calls for two stages. During the first stage, oil will be extracted through development of the Piltun-Astokhskoe deposit. The second stage calls for the project's full development. The prospective volume of fixed asset investment in the project is 15 billion USD.

The Sakhalin-2 Project is closer to practical development. Currently, the first offshore platform in the Piltun-Astokhskoe License Area has already been installed. The primary complex for extracting oil, named "Vityaz", comprises of a marine drilling platform, "Molikpaq", a floating oil storage and offloading tanker, and a sub-sea pipeline. This year, three production wells are planned and oil production will be initiated (up to 1 million tonnes per year).

Some of the figures for the Sakhalin-1 and Sakhalin-2 projects are shown in Table 10.

Table 10. Sakhalin-1 and Sakhalin-2 Status and Projected Figures

	Sakhalin-1	Sakhalin-2
License Areas	Chaivo, Odoptu, Arkutun-Daginskoe	Lunskoe, Piltun-Astokhskoe
Shareholders and Interest	Exxon Neftegas Limited ?30%, Japan's Sakhalin Oil and Gas Development Company (SODECO) - 30%, Rosneft'-Sakhalin - 23%, Sakhalinmorneftegas-Shelf - 17%	Marathon Sakhalin Ltd. - 37.5%, Mitsui Sakhalin Development Ltd. - 25%, Shell Sakhalin Holdings B.V. - 25%, Diamond Gas Sakhalin B.V. - 12.5%
Projected Recoverable Reserves	Oil+condensate - 324 million tonnes; Gas - 421 billion m^3	Oil+condensate - 100 mlln. tonnes Gas - 494 billion m^3
Maximum production per year 1 stage Total development	 Oil+condensate - 5.3 million tonnes. Oil+condensate - 24.1 mlln tones, Gas - 19.7 billion m^3	 Oil+condensate - 2.1 mlln tonnes Oil+condensate - 7.9 mlln tonnes Gas - 16.4 billion m^3
Estimated total cost	20 billion USD	15 billion USD
Actual investments and subsidies (1996-1998)	Approximately 535 million USD	Approximately 1 billion USD

Source: Data from JSC "Rosneft'- Sakhalinmorneftegas". S. Stefanopoulos, 1998. The Oil and Gas Industry of Sakhalin Island. An Introduction. Russian Far East Update and Pacific Russia Oil and Gas Report. Elisa Miller, editor and publisher. Seattle, USA.

Sakhalin-3 Project. Overall, the Sakhalin-3 Project covers three license areas. In May 1999, a Federal law was enacted permitting the development of the Kirinskiy Area under a PSL Regime. At present, the investors' interests in the Kirinskiy License Area are represented by four companies: Mobil, Texaco, Rosneft' and Rosneft'-Sakhalinmorneftegas. The consortium is called "Pegastar"; each company has a 33.3 percent interest[12]. The Kirinskii License Area covers six fields. All the fields are prospective only; there are no discovered deposits. Seismic data indicates that the Kirinskiy Area potentially contains oil and condensate deposits of 100 million tonnes, and 700 billion m^3 of natural gas. The project's agreement is still in the preparatory stage and requires ratification by a special Federal law.

The estimated natural gas and oil production levels and supply schedules to domestic and NEA markets for Sakhalin-1, Sakhalin-2, and Sakhalin-3 are given in Table 11.

12 Rosneft' and Rosneft'-Sakhalinmorneftegas jointly own 33.3% of Pegastar's equity.

Table 11. Projected Hydrocarbon Extraction and Distribution under Sakhalin-1, Sakhalin-2, and Sakhalin-3

	Oil and condensate*, million tonnes			Natural gas, billion m^3		
	Extraction	Export	Domestic	Extraction	Export	Domestic
1997 (actual)**	1.7	1.0	0.7	1.8	0	1.8
2000	2.7	2.5	0.2	0	0	0
2005	14	9	5	27.2	14.4	12.8
2010	25.5	20.5	5	36.3	19.0	17.3
2016	16.0	11	5	45.2	24.3	20.9
2020	7	2	5	46.0	24.3	21.7

*- Data for Sakhalin-1&2 only.
**- Current hydrocarbon production from on-shore Sakhalin
Source: Data from JSC "Sakhalinmorneftegas".

The Sakhalin-1, Sakhalin-2, and Sakhalin-3 projects have unique economic and energy ramifications, not only for the Russian Far East, but also for Russia as a whole.

Firstly, the Sakhalin projects represent a recognition of the RFE's comparative advantages. Secondly, despite the persistent political and legal risks, for the first time in the post-Communist era, Russia has managed to receive billions of dollars in foreign investment (about 25 to 35 billion USD just for the Sakhalin-1 and Sakhalin-2 projects). It has managed to attract this investment without direct financial guarantees from the Russian government. Foreign direct investment in the RFE's economy between 1988-1996 amounted to approximately 600 million dollars (in Russia as a whole, it was approximately 6 billion USD between 1992-1998).

The Sakhalin projects are well suited for the "3 Essential E's" of energy cooperation in Northeast Asia.

Energy Security Option:

The Sakhalin projects undoubtedly contribute to the key strategy of the *diversification of energy sources*. Key alternative fuels which can contribute to energy security in Northeast Asia are nuclear energy and natural gas. The possibility of natural gas deliveries from the Russian Far East will maintain the incentives for increasing the substitution of coal and oil by natural gas in the region.

The Sakhalin projects' positive effect in terms of reinforcing energy security is demonstrated in the general and international diversification of the technological pattern of energy resource deliveries in the region. The strategy for the realization of natural gas, extracted under the Sakhalin projects, has no single resolution yet. Within the strategy framework, several variants are currently being considered, among which overlapping combinations are quite possible:

1) An traditional orientation towards LNG delivery technology in the region (by means of constructing a LNG plant south of Sakhalin);

2) The relatively short distances from natural gas extraction sites to sites of possible use (primarily Japan and China) promotes trunk pipeline technology. For example, investors under the Sakhalin-1 Project are examining a strategy of constructing export pipelines from Sakhalin to Hokkaido and Honshu and from Sakhalin to China's northeastern provinces;
3) The use of natural gas from the Sakhalin shelf for electricity generation, with further transportation of electricity to Japan, China and North Korea. This variant, offered by the JSC "Unified Power Grid of Russia" (RAO "EES Rossii"), envisages the construction of two major modern electric power plants on Sakhalin Island with a combined output of 24 billion kWh, as well as the unification of the electric power systems of the Russian Far East, Japan, China and North Korea.

Diversification of energy supplies: 85-90 percent of the crude oil imports from outside the NEA region will be from the Middle East. This dependence will make the Northeast Asian economies vulnerable to sharp oil price increases; as well, instability in the Middle East or along transport routes could threaten the very security of their supply.

The development of oil-and-gas projects on the Sakhalin shelf expands oil and gas production in the NEA region. The consumption/production ratios in the leading countries of Northeast Asia (Japan, China, South Korea) show their high dependence on imports of primary energy resources - oil, natural gas, and coal. So far, the RFE's role in supplying energy resources to the NEA countries has been symbolic. The development of oil and gas projects on the Sakhalin shelf will make it possible to increase current annual crude oil export volumes from the Russian Far East by 10 to 20 times, opening a new area of natural gas exports inside NEA.

Economic Development Option:

The Sakhalin shelf projects require broad international cooperation in a general economic context for the following reasons:

1) The absence of oil and gas demand in the RFE comparative with a scale of profitable output of Sakhalin projects;
2) A large volume of investments, the absence of sources in Russia for their financing;
3) The lack of sufficient international authority and image in Russian companies for successful competition in international markets for capital;
4) The absence of effective and ecologically safe technologies, facilities and services for the extraction of hydrocarbons in complex natural conditions and ice conditions from the sea shelf in Russia. This refers to the lack of experience and necessary organization skills necessary for work in the sea shelf's complex natural conditions.

These reasons are at the same time international exchange trends for the realization of the Sakhalin projects for economic development in the region.

Efficiency and Environmental Sustainability Option:

The extraction of oil and, especially, natural gas on the Sakhalin shelf, and its inclusion in the NEA's regional energy balance meet the Kyoto Agreement's challenge of reducing greenhouse emissions, primarily carbon dioxide emissions, from fossil fuel combustion. Also, the natural gas supplied from Sakhalin offshore production will help alleviate the problem of acid rain.

Natural gas is the most efficient and environmentally sound energy source among the fossil fuels. Natural gas is much better as a fuel source because of its cleanness. Natural gas does not contain sulfur. CO_2 emissions from natural gas combustion are almost half of coal and two-thirds of oil combustion as shown in Table 12.

Table 12. Cleanness of Natural Gas Compared to Other Fuels

	Natural Gas	Oil (Sulfur content 1%)	Coal (Sulfur content 1%)
SO_x (kg/ ton of oil equiv.)	0	20.0	29.2
NO_x (kg/ ton of oil equiv.)	2.3-4.3	8.2	11.5
CO_2 (kg C/ GJ)	13.78	19.94	24.12

Source: M. Hirata, 1998. Asian Pipeline Research Society of Japan. Prospects of Natural Gas Demand in Asia Based on Advanced Power Generation Technologies to Reduce CO_2 Emissions. In: Eastern Energy Policy of Russia and Problems of Integration into the Energy Space of the Asia-Pacific Region. Proceedings of Conference. Irkutsk, Russia.

Providing for the diversification of energy sources, natural gas will have a positive influence on the solutions to the problems of greenhouse gas emissions from countries in the region, as well as trans-boundary acid rain.