Energy Outlook and the Role of Coal in Northeast Asia[1]

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Basic Concerns on Coal's Role in Northeast Asia

1) Coal is the major energy source of Northeast Asia, and there is no doubt that we shall continue to depend on coal in satisfying the primary energy requirement. In Northeast Asia, the share of coal in the primary energy supply is high compared to other regions of the world. This is derived fundamentally from the abundant reserves of coal in the Region, and coal has played an important role in primary energy supply in order to meet domestic energy requirements. The Region also needs more coal supply in the future. The Region may face a problem whether coal production would enable to meet its demand of over three (3) billion tons in the coming decades. The Region might be confronted with coal supply constraints.

2) Within Northeast Asia, the eastern coastal zone of China, Japan and South Korea forms the biggest coal-consuming region of over 800 million tons yearly, which account for 20 percent of the global coal consumption. This region should play the role of coal consumption center in the world to lead the stable coal supply and demand relationship. On the other hand, this region also has enough economic margin for energy saving and environmental protection through technical cooperation.

3) Nowadays coal issues cannot be discussed without considering the related environmental concerns. Excessive emission levels of dust and soot affect the health of local inhabitants. Emissions of sulfur oxides (SOx) and nitrogen oxides (NOx) have an influence of typical atmospheric problem affecting wide areas across national borders. However, the contemporary flue gas treatment technologies can resolve the air pollution problems originated from fuel burning, conspicuously SOx, NOx and soot/dust emissions.

4) The sustainable development of coal mining industry can be attained by rational production, the environmental improvement of mining areas and safe operation of coal mines without illegal or excessive production. Coal will remain as an essential energy source looking far ahead into the future, because of its abundant resources.

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1. Current Situation in Northeast Asia

1.1 Socioeconomic and Energy Indicators

Spanning Eastern Siberia, the Russian Far East, Mongolia, China, North Korea, South Korea, and Japan, the Region of Northeast Asia supports an immense population over its vast area and is situated in the different stages in respect of economic development and energy supply / demand structure. Table 1.1 shows the main social, economic, and energy indicators for the Region in 2002. The population in the Region is 1.5 billion, which accounts for around 25 percent of the world total, and the 2002 GDP (nominal) reached 5,858 billion U.S. dollars (around 20 percent of the world total). Total Primary Energy Supply (TPES) and power supply were 1,858 million toe (tons of oil-equivalent) and 3,224 TWh (terawatt-hours), accounting for around 20 percent of the world total, respectively.

Table 1.1 Main Socioeconomic and Energy Indicators in Northeast Asia (2002)

		(Russia)	Eastern Siberia	Russian Far East	Mongolia	China	North Korea	South Korea	Japan
Area	Thousands of km^2	17,075.4	4,094.7	6,215.9	1,566.5	9,558.0	122.8	99.5	378.9
Population	Millions of people	144.5	9.0	7.0	2.5	1284.5	22.5	47.6	127.5
Population density	People/km^2	8.5	2.2	1.1	1.6	134.4	183.6	478.6	336.5
Nominal GDP	Billions of dollars	346.5	23.6	20.8	1.1	1,266.0	17.0	546.9	3,982.8
Exchange rate	Dollar-based rates	31.35 (Ruble)			1,110 (Tugrik)	8.28 (RMB)	2.20 (Won)	1,251 (Won)	125 (Yen)
TPES	ktoe	621,349	50,179	27,382	2,022	1,010,231	19,430	208,636	543,557
Power Supply	GWh	889,333	123,000	41,600	2,464	1,633,150	20,200	306,474	1,097,167
GDP/Capita	Dollars/person	2,398	2,618	2,963	449	986	754	11,481	31,242
TPES/GDP	toe/millions of dollars	1,793	2,130	1,317	1,823	798	1,143	381	136
TPES/Capita	toe/person	4.30	5.58	3.90	0.82	0.79	0.86	4.38	4.26
Power supply/GDP	Wh/dollar	2,566	5,220	2,001	2,222	1,290	1,188	560	275
Power supply/capita	kWh/person	6,154	13,667	5,928	998	1,271	896	6,433	8,607

Note: TPES = Total primary energy supply; ktoe = thousand tons of oil-equivalent
Figures of TPES and power supply in Russia, Mongolia and North Korea are 2001 values

(Source) "International Financial Statistics" IMF,
"Key Indicators of Developing Asian and Pacific Countries", ADB
"Energy Balances of Non-OECD Countries" (2002 Edition), IEA
“China Energy Statistical Yearbook (2000-2002)”, China Statistics Press
“Energy Info. Korea 2003.11”, Korea Energy Economics Institute (KEEI)
SEI (Energy System Institute, Russian Academy of Science, Siberian Branch)
“Handbook of Energy & Economic Statistics in Japan”, IEEJ

The economic growth rates in 2002 were 4.3 percent in Russia, 8.0 percent in China, 3.7 percent in Mongolia, 6.3 percent in South Korea, and 1.4 percent in Japan. As for North

Korea, the economic growth rate made an upturn from 1999 and recorded 1.3 percent in 2000, 3.7 percent in 2001 and 1.2 percent in 2002, estimated by the Bank of Korea.

The 2002 figures for GDP per capita show regional differences from around 450 dollars in Mongolia to 12,000 dollars in South Korea, excluding Japan. In addition, economic gap is still in existence between rural and urban areas in developing countries. In China also, the figure varies substantially depending on the provincial areas, from 4,900 dollars in Shanghai and 3,400 dollars in Beijing to 540 dollars in Gansu Province and 380 dollars in Guizhou Province (China Statistical Year Book, 2003).

1.2 Energy Demand Structure

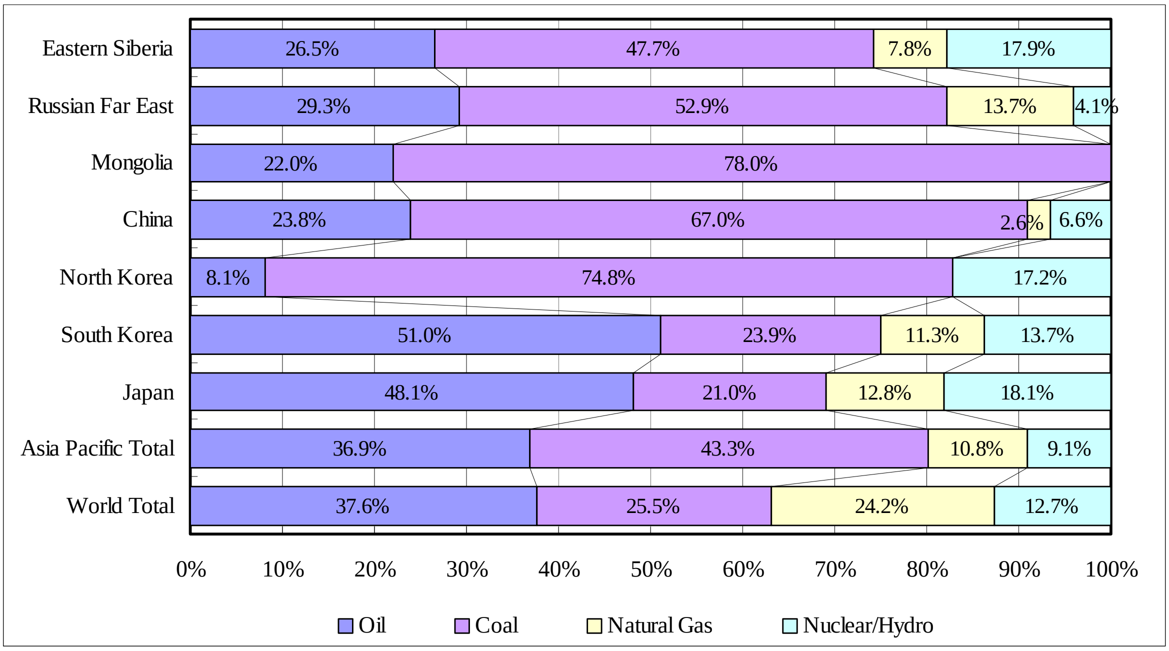
1.2.1 Primary Energy

Northeast Asia is a net energy import region. The energy trade in 2002 worked out to a net import of 35 million toe (tons of oil equivalent) in China, 450 million toe in Japan, 180 million toe in South Korea. Mongolia and North Korea are also importers of oil and petroleum products, about 0.5 and 1.2 million toe per year respectively. Looking at by energy source, China is a net coal exporter, and the coal productions of North Korea and Mongolia are essentially directed only to the domestic market.

Figure 1.1 shows the primary energy demand structure in Northeast Asia. Excluding the resource-poor countries of Japan and South Korea, the countries and territories of Northeast Asia have energy supply and demand structure depending fairly heavily on coal. In Asia as a whole, the share of coal in the primary energy consumption is high, due to the presence of China and India, which are big coal producers and consumers. In the entire Asian Pacific as well, the coal’s share is much higher than the global average. Considering the distribution of energy resources in the Region, this coal dependency in energy mix will continue in the future.

In contrast, the share of natural gas is lower than the global average. It does not even appear in the statistics for Mongolia and North Korea. The oil’s share reflects circumstances prevailing in each country or territory. It is high in Japan and South Korea, which have high levels of oil import and consumption. The Russian Far East has just started the production of crude oil, but due to the lack of transportation infrastructure, it still need to ship in about twice of the production to meet its domestic oil demand. Mongolia and North Korea import all of their oil requirements.

Figure 1.1 Primary Energy Demand Structure (2002)



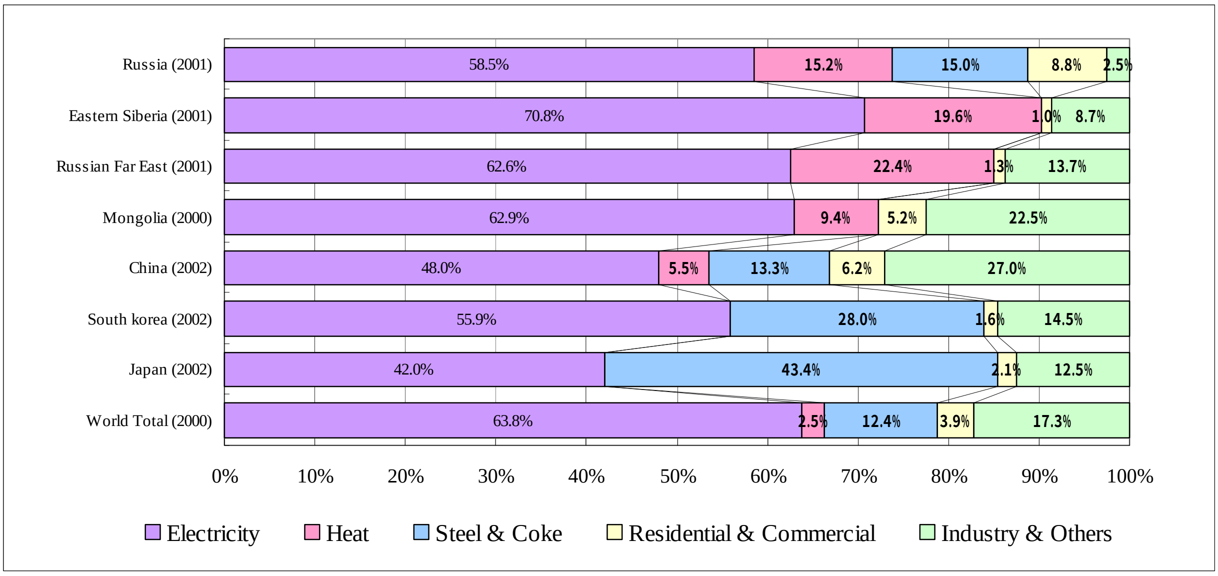
(Source) Eastern Siberia and the Russian Far East (2001): SEI data,
North Korea (2001): "Energy Balances of Non-OECD Countries, 2003 Edition", IEA
Mongolia (2000): "Energy Statistics Yearbook", UN
Others (2002): "BP Statistical Review of World Energy June 2004", BP

1.2.2 Coal

Figure 1.2 shows the coal demand structure in Northeast Asia (the observation year varies slightly depending on the country or territory). In each country/territory, coal is mainly used for power generation. Furthermore, in Chinese statistics, captive power generation is classified into the industrial sector, and therefore the share of the coal for power generation in China is even higher. The share for the iron and steel industry is by far highest in Japan, followed in order by South Korea, Russia, and China. Coal demand for steel making is scarce in Eastern Siberia and the Russian Far East, which is different from the Russian average.

In Russia and China, coal demand is in large for combined heat and power plants (CHP) and boilers for district heat and hot water supply. Due to very severe winter season, the coal demand exclusively for supply of heat and hot water (i.e., excluding power generation plants and CHP plants) accounts for about 20 percent of the coal supply in Eastern Siberia and 22 percent in the Russian Far East (as compared to the average of about 15 percent in Russia as a whole). The corresponding value in Mongolia is about 10 percent. In the East-north China, its value is relatively high (over12 percent) compared with average value of 5.5 percent in whole country.

Figure 1.2 Coal Demand Structure in Northeast Asia



(Source) Russia and the world: "Energy Balances of Non-OECD Countries", IEA

Eastern Siberia and the Russian Far East: SEI data

China: “China Energy Statistical Yearbook (2000-2002)", China Statistics Press

Mongolia: IEEJ estimated

1.3 Coal Resources and Production

1.3.1 Coal Resources

The definition of coal reserves is different from countries and their figures cannot necessarily compare on the same level. Table 1.2 shows the classification of coal reserves.

Table 1.2 Classifications of Coal Reserves

<table>
<tr><td colspan="2">International Standard</td><td colspan="2">Russia</td><td colspan="2">China</td></tr>
<tr><td rowspan="2">Measured</td><td rowspan="3">P1 Proved</td><td colspan="2">A</td><td rowspan="3">Developable (Industrial Reserves)</td><td>(A) Detailed</td></tr>
<tr><td colspan="2">B</td><td>(B) Proofing</td></tr>
<tr><td>Indicated</td><td colspan="2">C1</td><td>(C) Approximated</td></tr>
<tr><td>Inferred</td><td>P2 Possible</td><td rowspan="3">C2</td><td>P1 Possible</td><td colspan="2">(D) Geological estimate</td></tr>
<tr><td rowspan="2"></td><td>P3 Provable</td><td>P2 Provable</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>P4 Potential</td><td>P3 Potential</td></tr>
</table>

(Note) Each category isn’t completely matched.

(Source) China Science Press, “Estimation and Evaluation of Coal Resources in China, 1999”

IEEJ & SEI, “Study on Comprehensive Energy Plan in East Siberia and Far East of the Russian Federation 1995”

Table 1.3 shows the estimated coal reserves in main regions of Northeast Asia. Looking at the usable coal reserves (A+B+C+D in the Table) by province in China, Shanxi province accounts for 25 percent of the total, followed by Inner Mongolia (share of 22 percent), Shaanxi (share of 15 percent) and Xinjiang (share of 11 percent). These four (4) provinces occupy 73 % of China total. As for the developable reserves (A+B+C in the Table), around 66 percent is accounted for by three (3) provinces of Shanxi, Inner Mongolia and Shaaanxi. Coal reserves in China are widely distributed, however, major coal rich provinces are located in the northwestern side. Coal property is from lignite to anthracite.

Table 1.3 Coal Reserves in Northeast Asia

Coal Reserves (Billion tons)					
	A+B+C1	A+B+C1+C2		A+B+C	A+B+C+D
East Siberia			China		
Krasnoyarsk	47.70	68.70	Shanxi	196.3	250.1
Khakassia	4.90	5.30	Inner Mongolia	135.2	222.7
Tuva	1.10	1.12	Shaanxi	103.9	155.4
Irkutsk	8.10	14.30	Xinjiang	17.7	113.5
Buryatia	2.30	2.70	Guizhou	22.5	50.8
Chita	3.30	3.40	Ningxia	11.8	30.9
Total	67.40	95.52	Anhui	20.9	27.3
Russian Far East			Shandong	25.9	26.7
Sakha	9.20	14.60	Yunnan	23.4	24.1
Amur	3.90	4.00	Henan	21.9	23.8
Khabarovsk	1.20	2.00	Heilongjiang	14.8	20.0
Primorsky	2.70	4.20	Hebei	17.4	18.6
Sakhalin	1.80	2.40	Sichuan	10.9	13.8
Kamchatka	0.10	0.30	Gansu	6.3	9.3
Magadan	0.80	2.90	Liaoning	6.8	7.1
Total	19.70	30.50	Qinghai	3.4	4.2
Mongolia			Jiangsu	3.7	3.8
West	0.18	0.22	Henan	3.1	3.3
Middle-North	0.03	0.06			
Middle-South	4.17	7.82			
Middle-East	1.44	7.42	Others	11.0	12.2
East	0.41	1.22			
Total	6.23	16.74	Total	656.9	1,017.6

(Source) China Science Press, “Estimation and Evaluation of Coal Resources in China, 1999”
IEEJ & SEI, “Study on Comprehensive Energy Plan in East Siberia and Far East of the Russian Federation 1995”
Geologic Information Center, Mineral Resources Authority of Mongolia, “Brief Information on Mineral Commodities of Mongolia, 2003”

In Russia, the coal reserves in East Siberia and Russian Far East is estimated around 126 billion tons and account for 60 percent in the Russia’s total of about 202 billion tons.

Speaking of coal property, lignite accounts for around 75 percent in East Siberia and over 60 percent in the Russian Far East.

Coal classification of Mongolia is the same to Russian classification. Coal reserves in Mongolia is estimated around 17 billion tons at “A+B+C1+C2” value. The maximum proven reserves is in Omnogovi province bordering on China. At present the operating coal mines are limited at Baganuur (Tov province), Shivee-Ovoo (Dornogovi province) and Sharyn-gol (Selenge province) near Ulaanbaatar.

1.3.2 Coal Production and Consumption

Coal Production in Northeast Asia recorded 1,471 million tons and accounted for 38 percent of the world total (2001). On the other hand, coal consumption in the Region was 1,587 million tons and accounted for 41 percent of the world total. Within the Region, China accounted for 88 percent of the production and 76 percent of the consumption.

Figures 1.3 and 1.4 show coal production and consumption maps in the Region. Looking at China, coal is produced over many regions, but provinces with surplus potential for shipment to other regions are limited. The biggest shipper is the Shanxi Province, which shipped 211 million tons to other regions in 2000. The main coal producing area consisting of Shanxi, Inner Mongolia and Shannxi shipped out or exported 257 million tons. The other major provinces supplying coal to other provinces or to other countries were Heilongjiang Province in the Dongbei Region, which had an ex-province shipment of 23 million tons, Shandong Province in the Huadong Region, and Guizhou Province in the Xinan (Southwest) Region, both of which had the shipment of 14 million tons.

As for coal demand, main consuming provinces are located to the east of Shanxi Province. In 2000, the provinces with a consumption of at least 70 million tons were Shanxi (109 million tons), Hebei (101 million tons), Liaoning (82 million tons), Jiangsu (81 million tons), Shandong (75 million tons), and Henan (73 million tons). The coal consumption in Shanxi Province is mostly for the coke production for shipment to other provinces. Excluding this shipment, the province's domestic consumption is around 45 million tons.

The eastern coastal zone of China combined with Japan and South Korea forms huge coal-consuming region and is expected to increase its coal demand in line with lively power demand and industrial activities, despite tackling fuel shift in positive policies. Coal for the regional use is now imported from other areas or countries and its stable supply is the problem, which confronts us over the future.

Figure 1.3 Coal Production Map (2000)

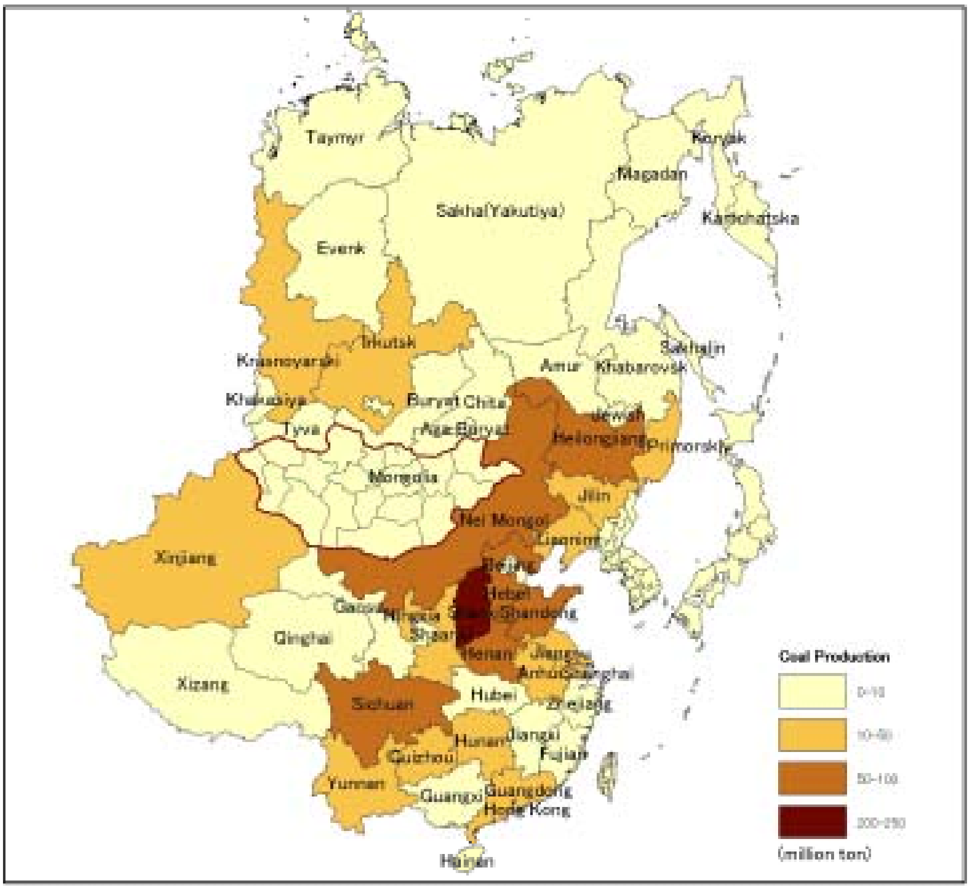
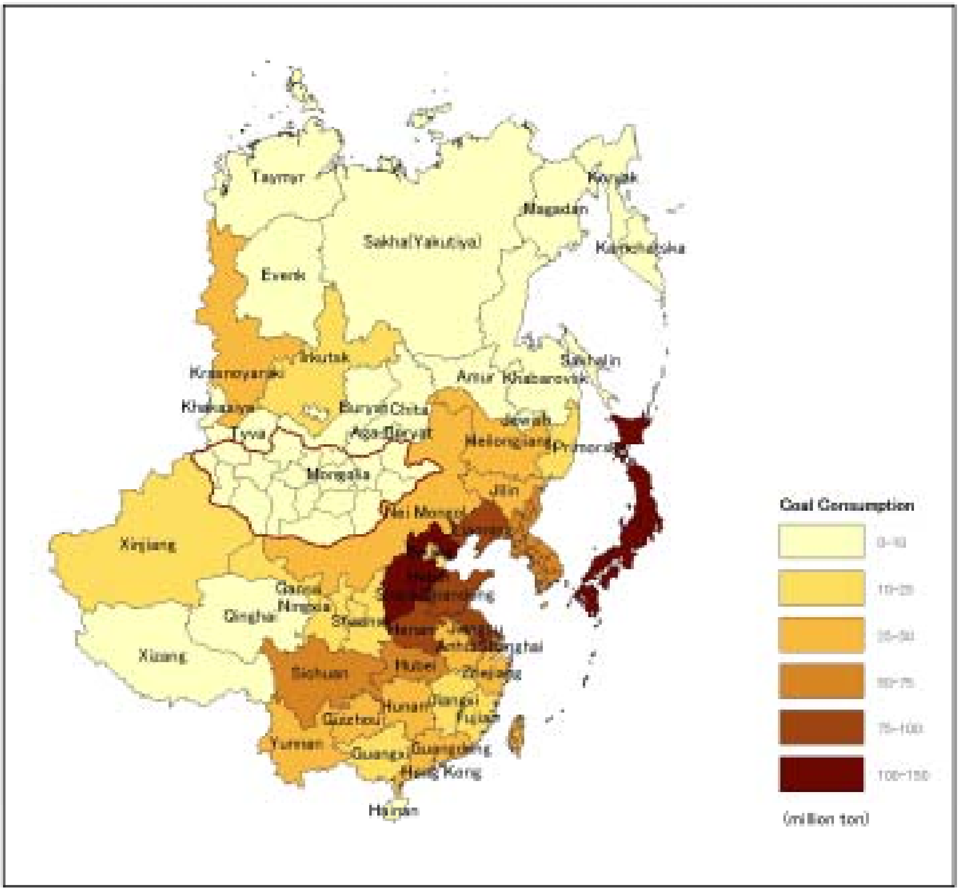


Figure 1.4 Coal Consumption Map (2000)

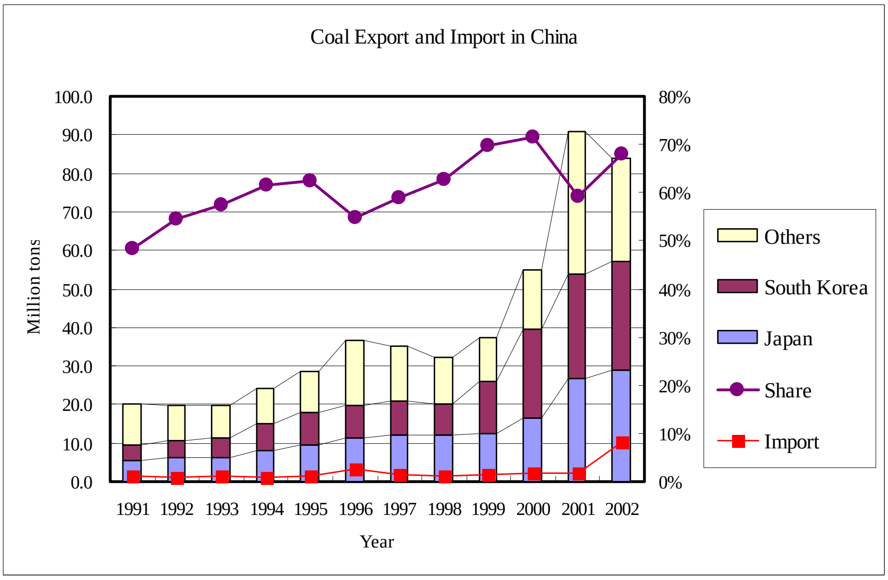


1.3.3 Coal Trade

In Northeast Asia, coal importers are Japan and South Korea, and exporters are China and Russia. Figure 1.5 shows the actual performances of coal export by destination and the import of China. The exported coal of China reached 91million tons in 2001 from 55 million tons in 2000. In 2001, China came to the second exporter in the world, over Indonesia and South Africa. Entering 2002, China's export decreased to 83.9 million tons and the import increased to 10.2 million tons from 2.5 million tons in 2001.

The share plotted in polygonal graph in the Figure 1.5 shows the ratios for Japan and South Korea, which have kept 60-70 percent in recent years. Market for Chinese coal is approximately equally divided among Japan, South Korea and other Asian region. Chinese coal for export is mainly thermal coal (steaming coal).

Figure 1.5
Historical Trends of Coal Trade in China



(Source)
China Energy Statistics Yearbook,
Japan and South Korea: Customs Statistics

As for China's coal trade, the northeast provinces (Shanxi, Inner Mongolia and Shandong) export and the southern coastal provinces import coals from abroad. Coal import in these provinces will increase in the near future, depending on even balancing policy of domestic coal and imported coal. From the viewpoint of sea borne transportation, the southern part of China is closer to Indonesia and Australia than the northeast inland China and both countries as coal exporters are sufficiently competitive in sales power.

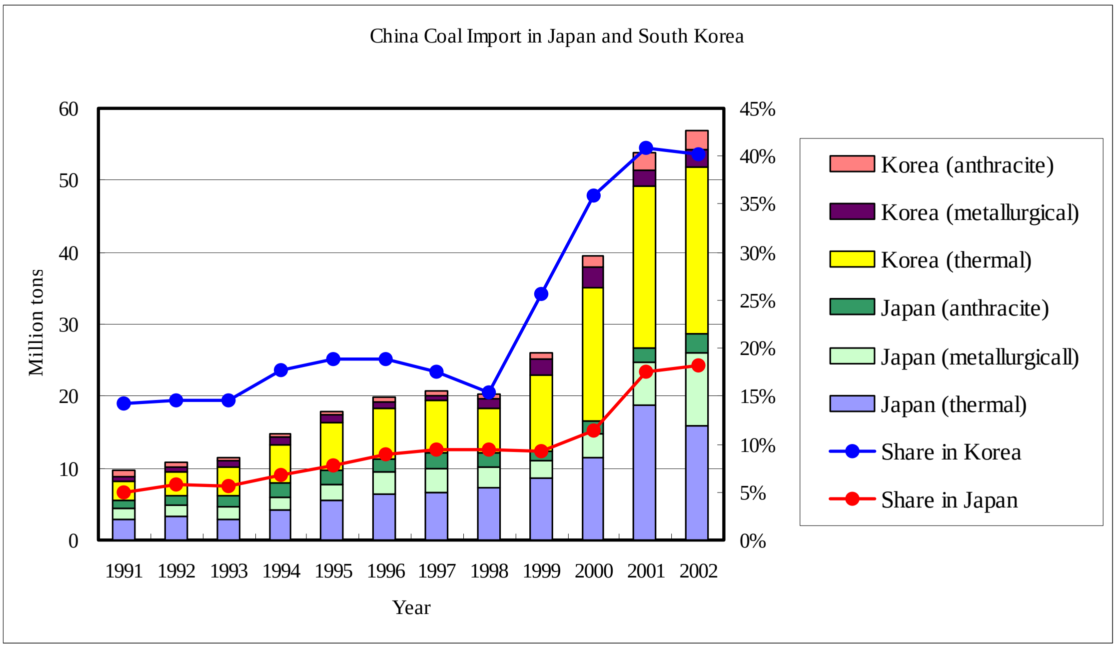
Coal trade of Russia is relatively large, that is, export of 41 million tons and import of 36 million tons (2001). The most part of coal import/export is performed within countries of Former Soviet Union and the net export to other regions is toward Pacific countries of Japan and South Korea.

On the other hand, looking at importing countries, coal import of Japan in 2002 was 158 million tons and the share by country was from Australia 56 percent, China 18 percent, Indonesia 12 percent, Canada 6 percent, Russia 4 percent.   In 2002, South Korea imported coal of 70 million tons, which was from China (sharing 40 percent), Australia (38 percent), Indonesia (10percent), Canada (6 percent) and Russia (4 percent).

Figures 1.6 and 1.7 show the historical trends of coal import from China and Russia by Japan and South Korea.   In both Figures, polygonal lines show the shares of Chinese and Russian coals over the total coal imports in Japan and South Korea.   In recent years, the import of Chinese coal has an increasing tendency in Japan and South Korea; especially in South Korea, Chinese coal has occupied the first position over Australian coal since 2000; mainly due to price competition including freight cost.

South Korea imported Chinese coal of 28.2 million tons, consisting of thermal coal of 23.1million tons, metallurgical coal of 2.3 million tons and anthracite of 2.8 million tons. Japan also imported Chinese coal of 28.8 million tons (thermal coal 15.8 million tons, metallurgical coal 10.2 million tons and anthracite of 2.8 million tons).   Russian coal import of Japan was 6.3 million tons (thermal coal 3.7 million tons, metallurgical coal 2.6 million tons).   South Korea imported Russian coal of 2.9 million tons (thermal coal 2.6 million tons, metallurgical coal 0.3 million tons in 2002.

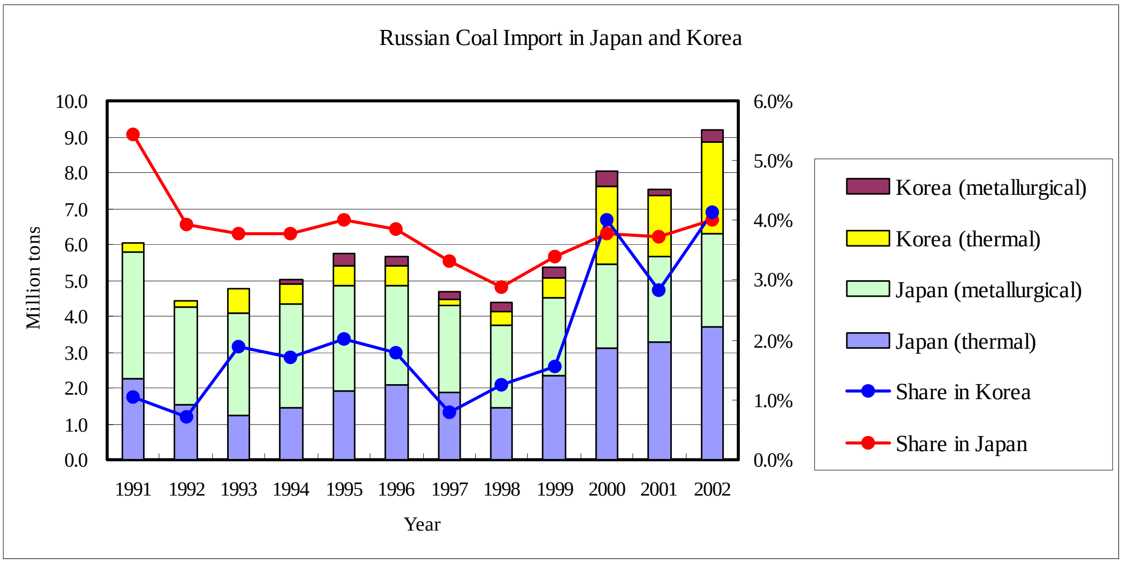
Figure 1.6 Historical Trends of Chinese Coal Import in Japan and South Korea



(Source) same as Figure 1.5

Russian coal now shares only a small quantity in Japan and South Korea, while it is increasing little by little in recent years as shown in Figure 1.7. Russia has a large scaled coal development plan of 20-30 million tons (2004-2009) in Elginskoye (Sakha) for export, which includes metallurgical and thermal coal. Its export to Japan and South Korea is expected in the future. For the expansion of export, however, it is necessary to improve the infrastructure of railway transportation and port facilities.

Figure 1.7 Historical Trends of Russian Coal Import in Japan and South Korea



(Source) Customs Statistics in Japan and South Korea

Speaking of coal transportation toward Pacific coast, there are some problems to be solved in both countries of Russia and China. In Russia, long-distance rail transportations are needed for coal shipping ports, for instance, the distance from Elginskoye (just mentioned before) to Vanino port is 1,480 km and to Vostchny port is 1,920 km. The distance from Neryngri coal mine (South Yakutsk) to Vostchny is counted to be 2,560 km. That from Irkutsk and Achinsk (Kemerobo) coal fields amounts to far over 4,000 km and 5,000 km respectively.

As for China's inland transportation, huge amount of coal is transported from main coal fields (Shanxi and Inner Mongolia) to East and South China and its volume is over 235 million tons in 2000. The sea transport from Qinhuangdao, Rizhao, Tianjin and Huanghua coal loading ports is over 120 million tons. Coal loads on the total freight transportation system under the present limited capacity. Supposed that coal demand continues to increase, this kind of constraints related to coal transportation will be unable to resolve easily.

Looking at coal export potentials, Russian exportable volume is limited by long-distance transportation; therefore, metallurgical coal (coking coal) of high price and low mining cost will open up the Asian market.

Chinese coal's export will depend on the future demand and prices in the domestic market. Considering the growing domestic demand in the recent years, export will remain at current level of around 80 million tons.

2. Energy Demand Outlook

2.1 Primary Energy

Table 2.1 shows the simulation results of the primary energy demand forecasting by country/territory. The primary energy demand in the Region is forecast to increase from 1,700 million toe in 2000 to about 2,310 million toe in 2010 and to 3,170 million toe in 2020.

Table 2.1 Outlooks for Primary Energy Demand in Northeast Asia

(Unit: millions of oil-equivalent tons)

	2000	2010	2020	Average annual growth rate	
				2010/2000	2020/2010
Russia	(639.9)	(862.0)	(1,200.1)	(3.02)	(3.36)
Eastern Siberia	46.6	65.0	94.2	3.37	3.78
Russian Far East	22.0	34.8	51.9	4.69	4.08
Mongolia	2.1	2.7	3.7	2.70	2.90
China (BAU)	859.1	1,343.2	2,088.8	4.57	4.51
North Korea	18.3	25.5	37.4	3.37	3.90
South Korea	192.9	263.6	311.8	3.17	1.70
Japan (Base case)	558.7	575.7	586.3	0.30	0.18
Northeast Asia total	1699.7	2310.5	3174.1	3.12	3.23

(Note) GDP growth rates for Eastern Siberia and Russian Far East: 5.9-5.5 % (2003-2020), Mongolia and North Korea: 3 % (2003-2020), and China: 6.5 % (2004-2020)

Outlook for South Korea: The Korea Energy Economics Institute, Japan: IEEJ

The primary energy demand in China may expand its share from around 50 percent in 2000 to 58 Percent in 2010 and to 66 percent in 2020. China's energy demand in 2020 will be 2.4 times of the demand in 2000, which suggest another Northeast Asia is emerging in terms of the demand.

2.2 Coal

Although the aforementioned primary energy demand treats coal in oil-equivalent terms, this section employs the original units (metric tons) for coal. The types of coal are lignite in Eastern Siberia, the Russian Far East, and Mongolia, and mainly bituminous and sub-bituminous coal with some anthracite in other countries.

Table 2.2 shows the results of the coal demand forecast for Northeast Asia. The Region's demand is expected to increase from 1,570 million tons in 2000 to 2,280 million tons in 2010 and to 3,270 million tons in 2020. With the huge population and the vast land, China accounts for an extremely high proportion of the Northeast Asia total; indeed, the trend of the Region's coal demand may be represented by China's demand. Moreover, China's share in the regional total is forecast to expand from 78 percent in 2000 to 81 percent in 2010 and 84 percent in 2020.

In 2020, the shares of Eastern Siberia and the Russian Far East will keep their shares of 3.8 and 1.9 percent, respectively. The shares of Japan and South Korea are projected to decline to 5.2 and 2.9 percent, respectively, in 2020.

Table 2.2 Outlooks for Coal Demand in Northeast Asia

	Millions of toe			Millions of tons of coal			Growth rate (%)		Calorific value (kcal/kg)
	2000	2010	2020	2000	2010	2020	10/00	10/20	
Russia									
Eastern Siberia	22.6	30.8	44.1	63.9	87.3	124.9	3.17	3.65	3,532
Russian Far East	11.4	16.7	24.5	30.1	44.3	65.1	3.92	3.93	3,770
Mongolia	1.7	2.2	2.9	5.2	6.8	9.0	2.66	2.87	3,250
China (BAU)	612.9	922.8	1,375.9	1,225.7	1,845.6	2,751.8	4.18	4.08	5,000
North Korea	16.8	22.8	33.5	27.3	37.1	54.5	3.10	3.92	6,150
South Korea	42.9	61.5	62.6	65.5	93.6	95.2	3.64	0.17	*1
Japan (Base case)	100.2	107.8	110.9	152.0	164.1	169.7	0.77	0.34	*2
Northeast Asia total	808.4	1,164.6	1,654.4	1,569.7	2,278.7	3,270.2	3.80	3.68	

(Note) *1: Bituminous coal: 6,600 kcal/kg, Anthracite: 6,000 kcal/kg

*2: Coking coal: 6,900 kcal/kg, Steaming coal: 6,354 kcal/kg

2.2.1 China

Figure 2.1 shows the outlook for China's coal demand by sector (BAU case). Suppose that China will continue high economic growth, its coal demand is forecast to increase from 1,230 million tons in 2000 to 1,850 million tons in 2010 and 2,750 million tons in 2020. The power sector will account for the largest share in the coal demand. This share will increase from 45 percent in 2000 to about 55 percent in 2010 and 60 percent in 2020. The second-largest share in the coal demand will be followed by the manufacturing industrial sector. On the other hand, coal consumption in the residential and commercial sector may decrease in line with the introduction of natural gas.

Figure 2.1 China's Coal Demand by Sector

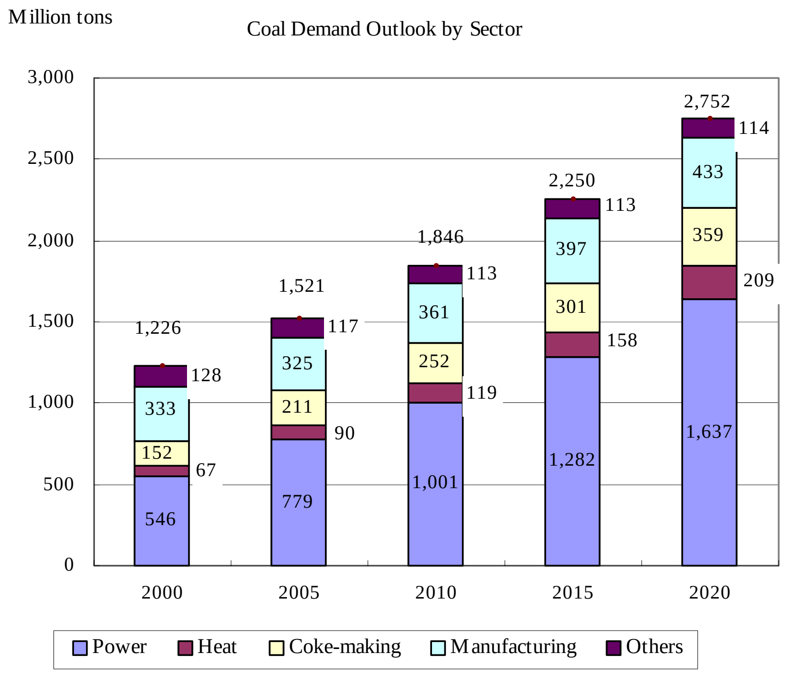


Table 2.3 shows the outlooks for power capacity commensurate with demand. The total installed capacity is forecast to rise from 357 million kilowatts in 2002 to 894 million kilowatts (a 2.5-fold increase) in 2020. The installed capacity of coal-fired thermal power is forecast to rise from 220 million kilowatts in 2002 to 571 million kilowatts (a 2.6-fold increase) in 2020. The fund required for construction of additional thermal power plants over the years 2002 - 2020 will be huge, estimated to be 406 billion dollars in the BAU case.

Table 2.3 Outlooks for Power Source

(Unit: millions of kW, billions of dollars)

	Installed capacity			Additional capacity		Requisite funding	
	2002	2010	2020	2010/2002	2020/2010	2010/2002	2020/2010
BAU case							
Total capacity	357	528	894	171	367		
Thermal power	266	403	674	137	271	138	268
(Coal-fired)	220	341	571	122	230	128	241
Share of coal-fired							
to total capacity	61.6%	64.7%	63.9%	71.1%	62.7%		
to thermal power	82.8%	84.8%	84.8%	88.8%	84.8%		

(Note)

1. Capacity factor: 60 % for all thermal power (average), 68 % for coal-fired thermal power, 40 % for hydropower, 25 % for renewable energy and 85 % for nuclear power

2. Construction cost: US$1,050/kW for coal-fired thermal power (with desulfurizers and denitrizers costing US$150/kW) and US$650/kW for gas combined cycle facilities

2.2.2 Other Territories/Countries

Coal production in Eastern Siberia is expected to be 1,050 million tons in 2010 and 1,420 million tons in 2020. Eastern Siberia is another net shipper of coal; in 1999, it shipped out 16.7 million tons and received 1.30 million tons. In 2010 and succeeding years, it may have a net outbound shipment in the order of 17 million tons. The Russian Far East, on the other hand, has a net inbound shipment of coal (in 1999, it had inbound shipments of 4.35 million tons and outbound shipments of 1 million tons). It is projected to require a net inbound shipment of about 6 million tons in 2010 and 20 million tons in 2020.

Mongolia's coal demand depends on the power sector’s requirement. The total power supply in Mongolia is met to the domestic demand by adding the import of about 10 percents from Russia. As such, the demand for coal will vary depending on whether the power demand is supplied by the coal thermal power plants domestically or is continued to import power partially. The domestic coal production will also vary, because it meets the domestic coal demand mainly depending on power generation and heat supply. In this report, the coal demand forecasting is made by assuming continued power import from Russia.

In South Korea, it is forecast to increase from 65.5 million tons in 2000 to 93.6 million tons in 2010 and 95.2 million tons in 2020. Anthracite demand is supposed to remain on the current level of 18 million tons, and that of steaming coal is expected to increase by 27 million tons, from 49 million tons in 2002 to 76 million tons in 2010. Thereafter, it is considered that coal demand will shift to LNG and nuclear power, due to the environmental considerations on newly starting power plants.

In Japan, the demand is expected to increase from 152 million tons in 2000 to 164 million tons in 2010 and 170 million tons in 2020. The demand for coking coal is forecast to decline only slightly from the area of 66 million tons, and that for steaming coal is expected to expand steadily from 86 million tons in 2000 to 99 million tons in 2010 and 108 million tons in 2020.

3. Environmental Issues in Northeast Asia

Historically, environmental countermeasures have been given priority as the following order.

- (1) Water quality (especially drinking water)
- (2) Harmful waste matter
- (3) Air quality
  - 1) Soot and dust (especially emissions from industrial sector)
  - 2) SOx (especially fixed emission sources)
  - 3) NOx (fixed emission sources and moving emission sources)

(4) Global warming (GHGs)

3.1 Air Quality

Table 3.1 shows the recent results of atmospheric measurements in cities in China, South Korea, and Japan (selected with consideration of regional spread). Although statistics of these concentrations in Japan and South Korea are shown in volume terms (ppm, parts per million), these figures are converted into weight terms (milligrams per cubic meter) in Table 3.1, which are used in Chinese statistics.

The SO_2 concentrations in Chinese cities are several times higher than those in Japanese and South Korean cities. The level in Beijing is on a par with that experienced in Seoul in the early 1990s and in Tokyo in the early 1980s. Regarding NO_2 concentrations, there are little differences among the cities. The trend over time indicates one of flatness or increase, because the NO_2 concentrations in urbanized areas today are mainly originated from the exhausted gas from moving emission sources.

Table 3.1 Atmospheric Environments in Cities in Northeast Asia

	SO_2 (mg/m^3)	NO_2 (mg/m^3)	TSP (mg/m^3)	PM-10 (mg/m^3)	Soot and dust fall (ton/km^2/month)
Beijing (2000)	0.071	0.071	0.353		15.1
Jilin (2000)	0.067	0.063	0.557		25.0
Lanzhou (2000)	0.060	0.053	0.668		21.1
Shanghai (2000)	0.046	0.061	0.156		8.9
Chongqing (2000)	0.126	0.044	0.261		11.5
Guangzhou (2000)	0.049	0.068	0.185		7.3
Seoul(2002)	0.014	0.074		0.076	
Busan(2002)	0.020	0.060		0.069	
Tokyo (2001)	0.000	0.000		0.042	4.6
Fukuoka (2001)	0.000	0.000		0.033	2.8

(Note) SO_2: 1ppm = 2.857 mg/m^3, NO_2: 1ppm = 2.054 mg/m^3

(Source)

- China: China Environment Press, "China Environment Yearbook 2001"
- South Korea: Korean National Statistical Office (KNSO)
- Japan: "Environmental GIS Data", National Institute for Environmental Studies

For suspended particles, statistics contain data for total suspended particles (TSP) in China and suspended particulate matter with a diameter of ten (10) micro millimeters or less (SPM, PM-10) in Japan and South Korea. While the two definitions above therefore cannot be compared without qualification, it appears that the concentration of suspended particles is fairly high in China. It may also be noted that the TSP values in Chinese cities are at least one digit higher than the TSP guideline of the World Health Organization (WHO; 0.04 - 0.06 milligrams per cubic meter). Despite the fact that the amount of soot and dust fall includes yellow sand and other particles from natural sources and its value is higher in the northern part of China, the absolute lack of environmental measures at industrial plants is making the situation from worse to worst.

3.2 Atmospheric Pollutant Emissions

Table 3.2 shows the past trends of SO_2 emissions in China, South Korea, and Japan based on official published data. It indicates a trend of increase in China and significant decrease in South Korea. In Japan, SO_2 emissions decreased from the order of 1.3 million tons in the late 1970s and have been in the range of 600–700 thousand tons since the late 1980s. It should be noted that, in the case of Japan and South Korea, the value in the 2000 column is actually for 1999. NO_2 emissions from fixed emission sources have remained on roughly the same level in Japan, and are likely to decline in South Korea. Available published data in China are not found out this time.

Table 3.2 Historical Trends of SO_2 and NO_2 Emissions

(unit: thousand tons)

		1980	1985	1990	1995	2000 (1999)
SO_2	China	n.a	13,250	14,990	18,900	19,927
	South Korea	n.a	n.a	1,611	1,532	951
	Japan (fixed sources)	1,158	795	615	708	629
NO_2	South Korea	n.a	n.a	926	1,153	1,136
	Japan (fixed sources)	819	699	780	878	837

(Source) China: China Environment Yearbook, Japan: Ministry of Environment
South Korea: KNSO (Korean National Statistical Office)

Table 3.3 shows the comparison of atmospheric pollutant emissions in China and Japan in recent years. In the Table, the industrial sector in parenthesis indicates the subtotals of the total emissions in China. Chinese statistics contain data for dust emissions in the industrial sector as well as soot emissions. The figures for dust emissions in the Table are for those deriving from the industrial sector.

As shown in Table 3.3, the level of SOx emission per capita in China is about three times as high as that in Japan overall and 2.5 times higher even in the case of industrial sector taken separately. The level of soot emission in China is about 14 times higher per capita and about six times higher per square kilometer as compared to these of Japan. In China, dust emissions are about on the same level as soot emission. Taken together, they came to some 19 million tons in 2001.

Table 3.3 Comparisons of Atmospheric Pollutant Emissions in Japan and China

		SO_2 emissions			Soot emissions			Monthly average fall of soot and dust
		Total emissions (thousands of tons)	/Capita (kg/person)	/area ($tons/km^2$)	Total emissions (thousands of tons)	/Capita (kg/person)	/area ($tons/km^2$)	($tons/km^2/month$)
China (2001)	Total emissions	19,472	15.36	2.04	10,700	8.44	1.12	14.21
	(Industrial sector)	15,660	12.35	1.64	8,619	6.80	0.90	
	Dust emissions				8,175	6.45	0.86	
Japan (1999)	Fixed emission sources	629	4.97	1.66	75	0.59	0.20	3.60

(Note) Figures for soot and dust fall are averages for 44 cities in China and seven cities in Japan

(Source) China: "China Environment Yearbook 2002"

Japan: "FY2003 Environmental White Paper and "FY2002 Survey of Fixed Emission Sources related to the Atmospheric Environment", Ministry of Environment

Table 3.4 shows the estimated results of SO_2 and NO_2 emissions without flue gas treatment by additional desulfurizers and denitrizers. Figures for Japan and South Korea are excluded from the Table, because their emissions have already leveled off or are in decline. In the case of China, the difference of 4.5 million tons from the 2000 figure of 19.93 million tons reported in the “China Environment Yearbook” was handled as the amount of removal. According to the annual editions for the years in question, the amount of SO_2 removal over the years 1996 - 2001 was in the range of 4.0-5.5 million tons (for a removal ratio of about 20 percent), with removal of emissions from fuel combustion accounting for 1.2-1.5 million tons of this (for a removal ratio of about 10 percent). Therefore, the figures for China in Table 3.4 indicate the amount of SO_2 derivation.

Table 3.4 Outlooks for SO_2 and NO_2 Emissions

		SO_2 emissions					NO_2 emissions				
		2000	2010	2020	Multiplier		2000	2010	2020	Multiplier	
		(A)	(B)	(C)	(B/A)	(C/A)	(A)	(B)	(C)	(B/A)	(C/A)
Russia											
	Eastern Siberia	660	902	1,290	1.37	1.95	469	661	970	1.41	2.07
	Russian Far East	361	527	774	1.46	2.14	281	421	637	1.50	2.26
Mongolia		55	71	94	1.30	1.73	44	58	77	1.31	1.74
China	(BAU case)	24,358	37,420	57,050	1.54	2.34	13,714	22,180	35,985	1.62	2.62
North Korea		376	513	751	1.36	2.00	225	311	465	1.38	2.07

(Note)

Emission factors are quoted by "Energy Utilization in Asia and the Global Environment" edited by the National Institute of Science and Technology Policy, Science and Technology Agency. For sulfur contents, analytical data are adopted if available and applied assumed figures in the absence of such data. As for emissions from lignite, it was obtained by substructed the total moisture from the amount of input multiplying the remainder by the emission factor, considering that the analytical figures are on the air-dried basis and that the lignite has high moisture content on the received basis.

Conclusion

Northeast Asia is a vast region spanning Eastern Siberia, the Russian Far East, Mongolia, China, North and South Korea, and Japan. These countries and territories represent diversity in respect of economic circumstances and energy utilization. In light of their geopolitical situation, however, they should cooperate with each other in aspects including worldwide energy trade and the technical cooperation on energy saving and environmental protection. The Region is expected to keep high economic growth and an accompanying increase in the energy demand. Coal demand, as the major source of energy supply, is forecast to expand into the future.

In the simulation results made in this report, the primary energy demand in the Region is forecast to increase from 1,700 million toe in 2000 to 2,310 million toe in 2010 and to 3,170 million toe in 2020 at the average growth rate of 3.2 percent as shown in Table 2.1. Coal demand is also expected to increase from 810 million toe (1,570 million tons) in 2000 to 1,160 million toe (2,280 million tons) in 2010 and to 1,650 million toe (3,270 million tons) in 2020 at the average growth rate of 3.8 percent (See Table 2.3). Coal will keep on playing an important role in the primary energy supply accounting for around a half. Especially in China, the coal’s share would likely be over 60 percent in the BAU case though it trends toward the decrease. The biggest problem is how to supply or who can supply its coal to meet the regional demand of 3,270 million tons.

China’s coal demand may reach 3,000 million tons sooner or later around 2020. We have an awareness of the issues whether Shanxi, Inner Mongolia and Shaanxi provinces as the biggest supply region could produce coal of over 1,200 million tons, in which region produced 440 million tons in 2000. Same point of question arise on other major provinces supplying coal, Heilongjiang Province in the Dongbei Region, Shandong Province in the Huadong Region, and Guizhou Province in the Xinan (Southwest) Region.

The balancing of coal supply and demand will be realized only through energy conservation and the systematic demand structure change, which will be secured by integrated energy policies including thoughtful incentives for the introduction of modernized technologies and facilities. Coal mining industry can be attained by realizing rational production, which enables the sustainable development of the industry, the environmental improvement of mining areas and the insurance of mine safety, without illegal or excessive mining. Environmental countermeasures are not against coal mining industry but will add up value of coal through clean coal technologies. Sustainable coal mining operation will be achieved by forming a trinity of energy conservation, environmental protection and stable supply. In addition, the expenditures for environmental improvements will create an opportunity to promote the growth of the environmental industry and totally of GDP.

In china, combustion of coal is the source of about 75 percent of the CO_2 emissions, 90 percent of the SOx emissions, and 75 percent of the NOx emissions. In other words, it will be impossible to curtail emissions of pollutants causing acid rains to the current level or below solely by policy measures to promote energy conservation, fuel conversion, fuel controls, and new energy development. The circumstances require the installation of flue gas desulfurizers and denitrizers in line with exacting controls for total emissions. In this connection, there are important roles to be played by the coastal area, which is the most economically advanced, as well as coal-fired thermal power and industrial sectors as the sources of about 50 and 35 percent, respectively, of the SO_2 emissions.

China now emits more SO_2 than any other country in the world, and more NO_2 and CO_2 than any other except the United States. If its emissions continue in the current trend, it will become the world's biggest source of emissions of the latter as well. Environmental measures in China are now going beyond the stage of fuel controls, and fundamental solutions cannot be found with the recent steps on the order of relocating plants from cities to locations on their outskirts. Acid rain cannot be overcome without the reduction measures in the total emissions. The prevailing economy-oriented development in China may consequently be pressured from the global environmental concerns.

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