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Energy and Security in Northeast Asia: Supply and Demand, Conflict and Cooperation

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Introduction by Susan L. Shirk and Michael Stankiewicz

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ENERGY AND SECURITY IN NORTHEAST ASIA: SUPPLY AND DEMAND, CONFLICT AND COOPERATION

INTRODUCTION

by Susan L. Shirk and Michael Stankiewicz

The economic crises in Thailand, South Korea, Indonesia, and Japan have focused attention on the region's economic problems as well as its well-documented success. One potential problem is satiating these economies' increasing demand for energy. This problem has been made even more pressing by deep devaluations that substantially raised imported energy prices in local currency terms. IGCC Policy Papers 35-37, *Energy and Security in Northeast Asia*, seek to examine the international implications of the longer-term energy situation in Northeast Asia, including the decisions that government policymakers are likely to make to address their economies' pressing energy needs.[1]

Policy Paper 35, *Fueling Security*, debates the fundamental issue of whether rising energy demand generates new security dilemmas or whether efficient energy markets mitigate potential security risks arising from increased competition for energy resources. Kent Calder argues that energy rivalry might deepen tensions among the major powers in Northeast Asia, while Fereidun Fesharaki sees market competition where Calder sees rivalry. This paper examines the market assumptions behind these analyses, including the current status and projections for overall regional energy demand (Fesharaki, Sara Banaszak, and Wu Kang) and fossil fuel use (Wu).

Fesharaki et al. note that Northeast Asia's rapid economic growth has been accompanied by an even more rapid growth in energy demand, and seek to project future energy supply and demand for Japan, China, and South Korea. They conclude that the dramatic increases in energy demand that have accompanied economic growth are likely to continue in the next 15 years. Moreover, all of the countries in Northeast Asia will continue to be dependent on fossil fuels to meet these increased demands. However, Asian regional supplies of oil will make only a small dent in projected needs, forcing all Asian countries to become major oil importers. Even China, which is the only energy resource-rich country in the region and which relies heavily upon local supplies of coal for energy, will join the ranks of oil importers. While the United States has cut its dependence on the

Middle East, relying more heavily on Latin America, Canada and the North Sea, most of Asia's oil imports (by 2010, 93 percent) will come from there, in part because of huge investments in refineries requiring low-sulfur crude.

Although Middle East oil imports dominate the story of energy trends in Northeast Asia, gas will supply as much of 10 percent of the region's energy demand, a notable shift in the fuel mix in Northeast Asia. Growth in the share of total energy needs met by gas implies significant expansion in gas field development and gas exploration in the region. Several large natural gas projects that are currently on hold such as the Natuna field in Indonesia and Sakhalin in Russia are likely to be developed.

Given their lack of domestic energy resources, it is not surprising that Northeast Asian countries also have ambitious nuclear power programs. However, their realization will be constrained by capital shortages, public resistance, and concerns about safety, storage and proliferation.

Continued reliance on fossil fuels raises a number of policy problems. The growth in demand for oil and gas in the region will affect global energy markets and raise anew issues such as the safe and environmentally-sound transport of ever-larger amounts of oil and gas. Dependence on fossil fuels also threatens further degradation of the environment of Northeast Asia; this is especially the case in China where most factories operate on dirty coal-burning furnaces.

Many proposals for multilateral energy cooperation in Northeast Asia revolve around building pipelines to transport natural gas from the considerable reserves in Russia, China, and Central Asia to the major consumers in Japan, China, Taiwan, and South Korea, who also have the capital and technology to help develop untapped energy resources. A realistic analysis of the various grand schemes for pipelines and grids indicates that most of them will never materialize. They all face formidable political, economic, technical, and environmental obstacles. The visions for regional cooperation in constructing pipelines are motivated more by the desire to cement good relations among neighbors than by energy planning in utility companies.

Keeping in mind these policy challenges for energy planning policymakers, Policy Paper 36 addresses existing efforts at international cooperation. It supports Fesharaki's contention that markets can solve looming energy crises much better than attempts at multilateral solutions. This is clear after examining the evidence related to supply and demand projections and fossil fuel usage, as well as the inefficacy of ambitious proposals for regional cooperation regimes and pipelines. But Policy Paper 36 also confirms the potential political value of regional cooperation--the opportunities provided by the confluence of shared national interests in ensuring stable supplies of energy for growing economies.

If grandiose pipeline schemes are more likely to be pipe dreams, in what other way can multilateral cooperation be achieved? This question is addressed in Policy Paper 37, *Proposals for Nuclear Cooperation*, which details some of the multilateral energy cooperation schemes most popular in regional security-making circles, namely, proposals for nuclear cooperation.

For a related discussion of the relationship between economic growth and the environmental impact of fossil fuel consumption, see IGCC Policy Paper 32.

Endnote

1. Many papers in this collection first were presented to a September 1996 Northeast Asia Cooperation Dialogue (NEACD) workshop on Northeast Asian energy and security held in Seoul, Korea. IGCC founded NEACD in 1993 as an informal track two dialogue exploring the potential for cooperation on security issues among China, Japan, Russia, the Republic of Korea, the Democratic People's Republic of Korea, and the United States. This workshop on energy and security offered participating government officials and private experts an opportunity to explore the ramifications of increasing energy demand on future relations among their countries. After the workshop, IGCC solicited additional papers to fill gaps and analyze basic premises among our initial contributions.

The Outlook for Energy Supply and Demand for Northeast Asia

by Fereidun Fesharaki, Sara Banaszak, and Wu Kang

Introduction

The 1980s were the Pacific decade. Spectacular economic growth rates in the Asia-Pacific region, the emergence of the export-oriented newly industrialized economies of Singapore, South Korea, Taiwan, and Hong Kong, the opening of the Chinese economy, and the rise of Japanese economic power have placed the region in a pivotal position within the world economy. In the 1990s, the momentum of the Asia-Pacific region's high economic growth continues, as economic reforms in China deepen and Southeast Asian economies continue to grow rapidly.

Northeast Asia, which includes China, Japan, South Korea, and North Korea, is one of the most dynamic subregions in Asia. Except for North Korea, every country in this subregion has enjoyed spectacular economic growth at various times for more than four decades. The economic growth rate was accompanied by explosive growth in energy demand.

Every commercial form of energy consumption in Asia has risen spectacularly and the oil demand growth rate is the fastest of any region in the world. Pressure will come to bear on the region's oil and gas markets, since demand growth will take place concurrently with a decline in the availability of local, low-sulfur crudes. The region will become even more dependent on imports of Middle Eastern crude, which will result in a higher-sulfur crude slate. Moreover, we expect that the existing and planned refinery complexes will lack the capacity and the flexibility to fully satisfy product demand. The consequence will be a higher level of refined product imports.

The global and Asian energy markets are heavily dependent on fossil energy (see Wu). Fossil fuel consumption continues to increase despite oil price shocks, active government policies to reduce energy demand through efficiency gains, and the environmental debate on the problems associated with carbon-related fuel combustion (Wu and Fesharaki 1994).

Figure 1-1 provides a comparison between the global and Asia-Pacific primary commercial energy demand patterns. In the global energy pattern, oil remains prominent at 40 percent--down 5 percent from its 1970s share. The share of natural gas has risen somewhat from 19 percent in 1970 to 23 percent in 1995.

Coal, with a share of 27 percent, remains the second-largest energy source. Nuclear power and hydroelectricity account for 7 percent and 3 percent of the total, respectively. In contrast, the Asia-Pacific is heavily coal dependent. Coal accounts for 46 percent of total regional energy consumption, followed by oil at 38 percent. Natural gas makes up 9 percent, while nuclear energy and hydroelectricity constitute 5 percent and 2 percent, respectively, of energy use. The region's energy demand structure, especially the high share of coal consumption, is heavily affected by China, the largest energy and coal consumer in the region.

Within Northeast Asia, each country's energy demand and supply situation is unique. Oil's share in total primary commercial energy consumption is more than half in Japan and South Korea. Both countries have a near total dependence on imported energy. North Korea produces and consumes a large amount of coal, but the country is completely dependent on imported oil. The country also needs to import certain amount of coal for its steel industry. China is the only energy resource-rich country in the region. However, the country is now a net oil importer and will soon join the ranks of Japan and South Korea as one of Northeast Asia's major oil importers. In this paper, we examine some of the long-term energy issues facing Northeast Asian countries. The prospects of energy demand over the next 25 years and the supply security issues will be discussed for each country except for North Korea. The current situation and future prospects of energy demand and supply in China, Japan, and South Korea are discussed first, followed by an examination of Asia's rising dependence on and vulnerability to energy imports, and finally, a summary of the regional issues and concluding remarks.

Energy Policies and Energy Demand in Northeast Asia

CHINA

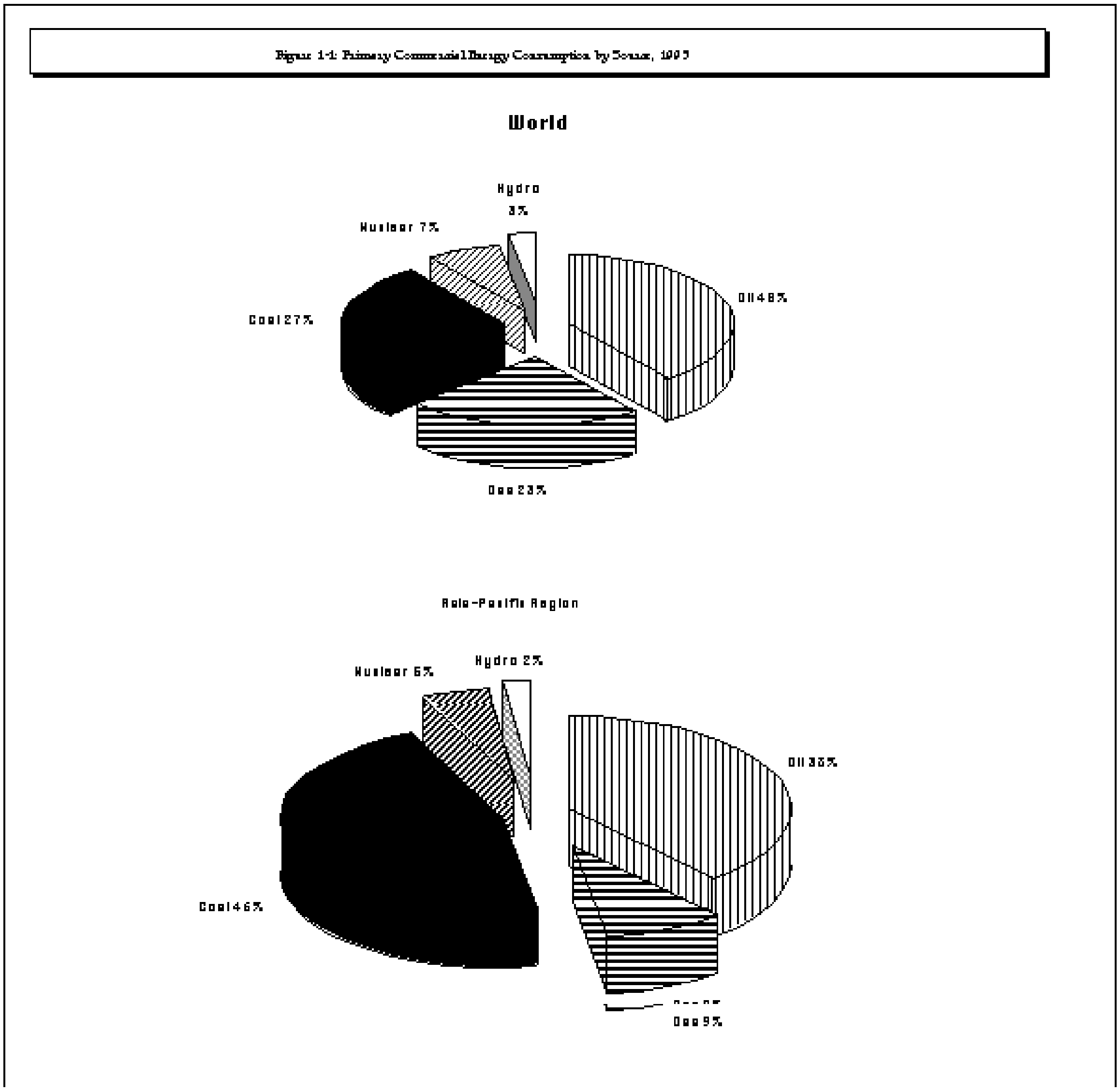
Energy Policies

China's energy policy has long been characterized by self-sufficiency and coexistence of both large- and small-scale production and consumption. The Chinese government repeatedly stressed the importance of developing its own energy resources, and its plans to meet most of the country's future energy demand with indigenous resources. Energy development is considered by policymakers as vital to the success of China's future economic development.

For almost three decades before the "open-door" policy introduced by the Chinese government in 1978, energy policy was part of China's planned economy. Its formation was heavily rooted in the Soviet-style central planning system adopted during the early 1950s, and China's "self-reliant" development strategy, which lasted from 1960 to the late 1970s. Since the late 1970s, China's sweeping economic reforms achieved rapid economic growth and in 1980, the government announced its target of "quadrupling the national product by the year 2000." The huge energy requirements for China to realize this ambitious economic target led the government to officially recognize energy as the most critical issue in the development of the Chinese economy.

During the reform era, the Chinese government's terminology for its economy has evolved from "socialist commodity economy" to "socialist market economy." The latter assumes that state corporations can act as profit-making entities under loose government guidelines. Since the mid-1980s, this policy led to the breakup of the old centralized industry monopoly that had prevailed in the energy sector for the previous three decades. Today, China's upstream oil sector, downstream oil industry, coal industry, power industry, and chemical industry are all governed by different ministries and state energy corporations. Although the state oil corporations assume many of the functions held previously by ministries, they act increasingly like state oil companies elsewhere in the world, albeit with Chinese "characteristics."

Figure 1-1: Primary Commercial Energy Consumption by Source, 1995



Both central planning and a certain degree of marketing are at work in China's energy sector. The scope of central planning has been decreasing since the early 1980s. However, the government deems energy vital for economic development in China, and considers state control of energy important; progress in reforming and decentralizing the energy sector has been slow compared with other sectors.

China's energy planning is reflected in its five-year plans and long term social and economic development plans. 1996 was the first year of China's Ninth Five-Year Plan. In March 1996, the National People's Congress passed a resolution on the *Program on the Ninth Five-Year Plan and the 2010 Long-Term Targets for China's National Economy and Social Development*. Under this program, increasing coal production and ensuring coal transportation and consumption remain the cornerstone of China's energy policy. The government attaches great importance to integrated production, transportation, and consumption plans for the coal industry. A huge investment is allocated each year to strengthen production in traditional fields and to improve the infrastructure for coal transportation. Price reforms resulting in a rise in coal prices have been designed to provide incentives for developing coal mines, but the government also intends to close inefficient and unsafe small mines that caused many environmental problems.

In the petroleum sector, China's strategy is to stabilize production in the eastern fields, develop the western fields, lay equal emphasis on oil and gas, and further open the industry. The strategy reflects the realities that the oil fields in East China have reached their mature stage while gas exploration was neglected in the past. If successful, the strategy will prevent China's crude oil production from declining and will increase gas production.

In other areas, the development of hydropower is a traditional focus of China, exemplified by the construction of the Three Gorges Dam on the Yangtze River. In the long term, hydroelectricity production growth will be steady but moderate. The Chinese government recently sought to develop nuclear power in provinces where economic growth is limited by a shortage of energy resources. Two nuclear power plants are completed and more are in the planning stage. China's energy policy objectives include developing new energy resources such as solar energy. But given the limitations of Chinese investment in energy and the constraints of indigenous technologies, large-scale development of these new sources is unlikely in the foreseeable future in the country (Fesharaki and Wu 1992).

The future direction of China's energy policy centers on energy planning and the comprehensive and often very technical guiding policies for energy sector development. Under the Ninth Five-Year Plan and the long-term development targets mentioned earlier, the government plans for the electric power industry to be the center of China's energy development with coal the main energy supplier for the industry. The government also hopes to strengthen exploration and production of oil and gas, and to actively explore and develop new energy sources (*People's Daily,* March 20, 1996).

The Outlook for Energy Demand and Supply to 2020

China is the world's third largest energy producer and consumer. China has an abundance of coal, oil, and hydropower, and its potential reserves of natural gas are believed to be substantial. But on a per capita basis, the energy resources of China are below the world average. Coal dominates both energy production and consumption: measured in terms of tonnage, China is the world's largest coal producer and consumer. The modern oil industry arose in the late 1950s and 1960s, after giant oil fields were discovered and developed in northeastern China. The natural gas resources are presumed to be abundant, but are the least developed conventional energy sources in China, owing to the lack of transport and technology. In 1995, coal accounted for 77 percent of total primary commercial energy consumption followed by oil at 18.8 percent, natural gas at 1.9 percent, hydroelectricity at 1.9 percent and nuclear power at 0.4 percent. (SSB 1996, British Petroleum 1996). Altogether, China consumed 17.3 million boe/d (barrels of oil equivalent/day) of primary commercial energy.

China's primary commercial consumption has some unique characteristics compared with the rest of Asia. In terms of the energy production structure, China has a much larger share of coal and lower shares of oil and gas than the world average. Figure 1-2 depicts the structure of primary commercial energy consumption in China and in the rest of Asia, showing that coal dominates China's consumption while oil and gas usage is one-third that of the other countries in the region. Coal and oil account for more than 96 percent of total primary energy production in China. The characteristics of this pattern have a profound impact on the country's energy development strategies and policies.

Both energy production and consumption in China are expected to continue to grow because of the government's efforts to increase domestic energy supply, and the demands of the rapidly growing economy for more energy. We will examine the current situation and future prospects of primary commercial energy for each of the individual energy resources--coal, gas, hydropower, and nuclear power--and the supply options available to China.

Table 1-1 summarizes the growth rates of different kinds of primary energy sources in China. Under our base-case scenario, China's primary energy consumption is forecast to increase from 17 million boe/d in 1995 to 30 million boe/d in 2010 and 42 million b/d in 2020 (Figure 1-3). While coal supplies remain adequate, large-scale oil imports will be needed by 2000 and natural gas imports by 2005. Largely as a result of capital costs, hydroelectricity and nuclear power are expected to remain a small

Table 1-1: Growth of Economy and Primary Commercial Energy Consumption in China

	Period	AAGR
Historical		
GDP	1980-1995	10.2%
Oil	1980-1995	4.9%
Coal	1980-1995	5.4%
Gas	1980-1995	1.4%
Nuclear Power	1993-1995	173.4%
Hydroelectricity	1980-1995	7.9%
Primary Energy Total	1980-1995	5.1%
Forecast: Base Case		
GDP	1995-2020	6.6%
Oil	1995-2020	4.4%
Coal	1995-2020	2.8%
Gas	1995-2020	9.2%
Nuclear Power	1995-2020	14.1%
Hydroelectricity	1995-2020	4.4%
Primary Energy Total	1995-2020	3.6%

Source: East-West Center.

percentage of China's electricity-generating capacity for the foreseeable future.

Coal

China has vast potential coal deposits. According to estimates made by Chinese energy agencies, the coal potential within a depth of 2,000 meters (the broadest definition of coal resources in China) is 4,500 billion tonnes. The recoverable reserves are reported to be 986.3 billion tonnes, about 30 percent of which (295.9 billion tonnes) is considered proved reserves in place (SETC 1994). The BP Review of World Energy, however, placed China's proven coal reserves at the end of 1995 at 115 billion tonnes, still the third largest in the world after Russia and the United States. As mentioned earlier, coal accounts for about three-quarters of primary energy production and consumption in China. During the past 15 years, coal consumption in China has increased at an average annual rate of 5.4 percent a year, faster than the average growth rate of 5.1 percent a year for total primary commercial energy consumption during the same period. In 1995, China produced a total of 1.29 billion tonnes of coal and exported 28.6 million tonnes, imported a small amount (1.6 million tonnes), and consumed 1.27 billion tonnes.

Coal is expected to continue to dominate China's energy picture in the future, although its share in total primary commercial energy consumption is likely to decline. Over the next 25 years, coal consumption in China is forecast to grow at an average annual rate of 2.8 percent under our base-case scenario. Based on this forecasts, coal consumption is expected to increase from 13.3 million boe/d in 1995 to 20.8 million boe/d in 2010 and 26.9 million boe/d in 2020. The share of coal in primary energy consumption is forecast to decline from 77 percent in 1995 to 69 percent in 2010 and 64 percent in 2020.

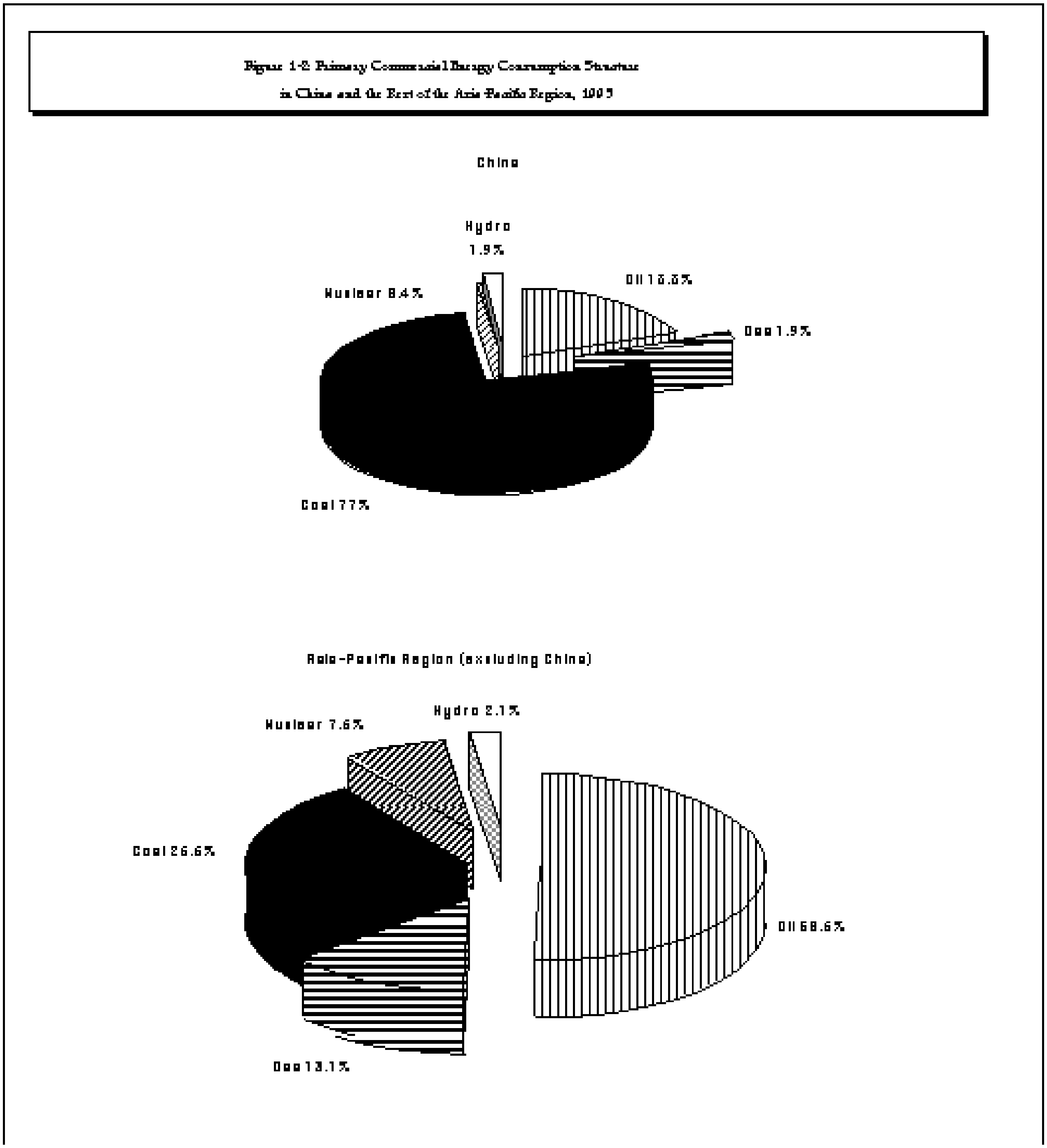
The Chinese government has vowed to produce enough coal to meet its domestic demand and is striving to export as well. Under our base case scenario, it is expected that China will produce 1.5 billion tonnes of in 2000 and will have enough coal for the projected demand by 2010. (Under the Ninth Five Year Plan, the production target for 2000 is 1.4 billion tonnes.) There are many uncertainties beyond 2010 but the country should not be significantly short of coal.

Oil

As with coal, China's claims about its oil reserves are different from the estimates of independent industry sources outside China. The Chinese official estimate refers to so-called oil resources in place, or total overall oil resources, which amounted to 686 billion barrels (bbl) in 1994 (SETC 1994). China does not usually release the figures of proved oil reserves. *BP Statistical Review of World Energy* lists 24 billion barrels as proved reserves for China. At 24 billion barrels, China's oil reserves would represent only 2.4 percent of the world's total.

The development of China's modern oil industry dates from the late 1950s, when the Daqing oil field was discovered in the Songliao basin of northeast China. After more than three decades of development, China has become the sixth largest oil producer in the world. In 1995, China produced 2.98 million barrels per day

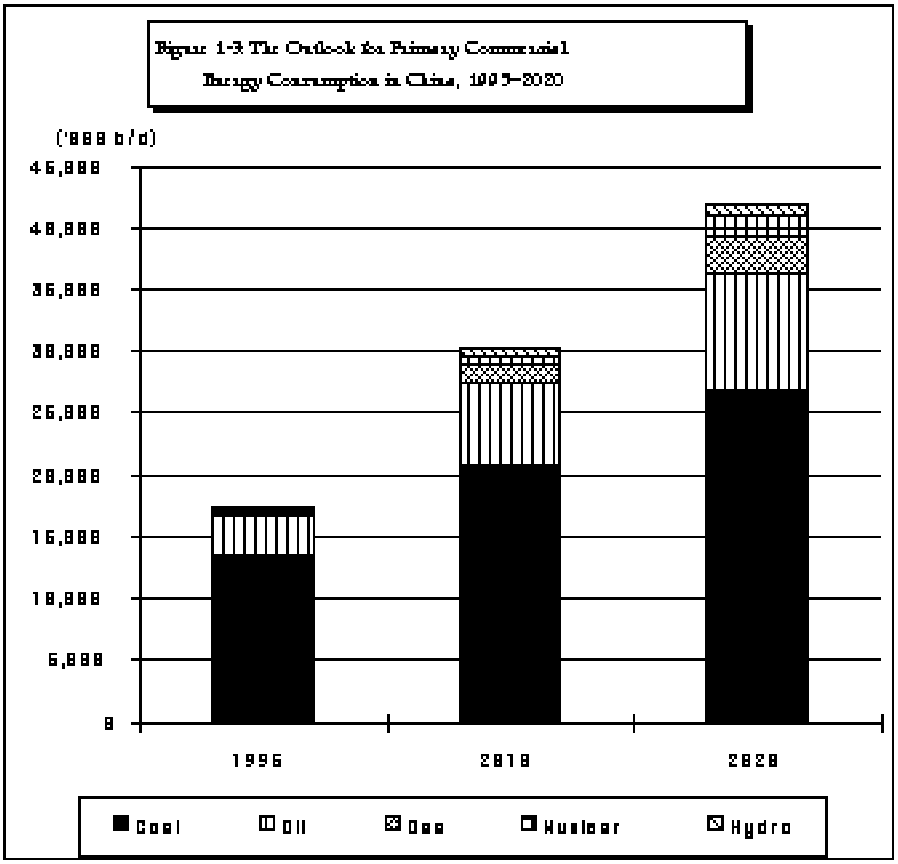
Figure 1-2: Primary Commercial Energy Consumption Structure in China and the Rest of the Asia-Pacific Region, 1995



(b/d) of oil, which accounted for 17.9 percent of the country's total primary energy production. The domestic refining industry underwent a transformation during the decade and half after China opened its doors to the outside world in the late 1970s. As a result of heavy investment in refining, together with the infusion of new foreign technology, China's crude distillation capacity of 4.1 million barrels per day (b/d) is the fifth largest in the world.

China's oil consumption, defined as consumption of petroleum products plus other uses of oil, amounted to 3.3 million b/d in 1995, up from an average of 1.7 million b/d in the 1980s. Although the annual growth rate of petroleum product consumption in China was only 4.9 per-

Figure 1-3: The Outlook for Primary Commercial Energy Consumption in China, 1995-2020



cent during the period 1980-1995, the growth accelerated to 7.3 percent between 1990 and 1995. Over the next 25 years, oil consumption in China is forecast to grow at an average annual rate of 4.4 percent under the base-case scenario. By 2020, China's oil consumption is forecast to be around 9.5 million b/d.

China's crude oil production is expected to increase steadily but at a rate much lower than oil consumption. For the first time in more than two decades, the country became a net oil importer in 1993. In 1995, net oil imports amounted to 230 thousand b/d. It is forecast to increase to 2 million b/d in 2005 and 3.1 million b/d in 2010. By 2020, the import requirements of oil may be very huge. Even if China has a quicker addition of crude producing capacity during the period of 2010-20, the import requirements may still reach 5.5 million b/d or higher under our base-case scenario. This development adds a unique dimension to energy demand in Northeast Asia. During the next century, China, Japan, and South Korea, or perhaps a united Korea, will all be giant oil importers.

Natural Gas

China has huge but largely undeveloped natural gas resources. The overall gas reserves could be as high as 38 trillion cubic meters (m^3). However, at the present time, China's proven natural reserves are estimated to be 1.7 trillion m^3 or 59 trillion cubic feet (tcf), about 4 percent of the world total (British Petroleum 1996). During most of the 1980s and early 1990s, the change in gas production has been closely related to the trend of proven gas reserves, showing that the magnitude of annual gas production in China is affected by the government's efforts to explore for natural gas.

In 1995, China produced and consumed 17.6 billion m^3 of natural gas. The 1995 gas consumption was equivalent to 324 thousand boe/d, up slightly from 261 thousand boe/d in 1980. Over the next 25 years, however, gas consumption is forecast to increase rapidly, thanks to new discoveries and development of gas fields both onshore and offshore China. Gas demand in China is forecast to grow at an average annual rate of 9.2 percent during the period 1995-20, raising total consumption to 1.5 million boe/d in 2010 and 2.9 million boe/d in 2020. Its share in total primary commercial energy consumption is expected to increase from 1.9 percent in 1995 to 7 percent in 2020.

The majority of gas demand is expected to be met by domestic production until 2005. China is confident that it can increase its annual gas production to 25 billion m^3 by 2000 and to as much as 80-100 billion m^3 by 2015. But beyond 2005, imports of liquefied natural gas are likely. Based on our forecasts, China needs 78 billion m^3 of natural gas in 2010 and 154 billion m^3 of gas in 2020.

Hydroelectricity

According to Chinese officials, the hydropower energy potential in China amounts to 676 gigawatts (GW) of power generation capacity. The recoverable potential is about 290 GW. In 1995, China's installed hydroelectric capacity was 52 GW, accounting for 17.9 percent of the recoverable potential. The highest hydroenergy potentials in China are in the Southwest, Northwest and Central South regions. Hydropower construction in Hubei Province (Central China) has been developed rapidly, and the country's largest hydropower plant--the 2.7 GW Gezhouba Hydropower Plant--came on stream in the early 1980s. Hubei Province and neighboring Sichuan Province (in Southwest China) are poised for even greater development of hydropower, since construction of the huge Three Gorges Dam began in 1993. Upon completion, the Three Gorges Dam will be the world's largest hydropower plant--and perhaps the most controversial and expensive power project--with a capacity of about 18.2 GW, consisting of twenty-six 700-megawatt (MW) generators.

In 1995, hydroelectricity consumption in China was about 323 thousand boe/d, which demonstrated the highest average growth rate of 7.9 percent a year among all primary energy sources except for nuclear power. Over the next 25 years, China will continue to invest in the hydropower sector but its consumption growth rate is forecast to slow down to 4.4 percent a year on average during the period 1995-2020. By 2020, hydropower consumption is expected to be 947 thousand boe/d, about 2.3 percent of the total primary commercial energy consumption.

Nuclear Power

Until 1982, China did not elect to build any nuclear power plants, in spite of the country's long development of indigenous nuclear technology. Between 1982 and 1993, nuclear power construction proceeded rather slowly. The country's first nuclear power plant, at Qinshan in Zhejiang Province, with a capacity of 300 MW, came on stream in December 1991. After the completion of two 900-MW nuclear power units at Daya Bay, Guangdong Province, China's current nuclear power capacity stands at 2.1 GW, with ambitious plans to build additional nuclear power plants in Liaoning, Guangdong, and Zhejiang Provinces.

Nuclear power is an expensive option for China, especially with imported equipment and technology. However, it is suitable for provinces such as Guangdong and Zhejiang, where a severe lack of energy sources may impede rapid economic growth. In 1995, China's nuclear power consumption is about 66 thousand boe/d. As new capacity is added, consumption is expected to grow at an average annual rate of 14.2 percent during the period 1995-2020. By 2020, China's installed nuclear power capacity is forecast to reach 58 GW and consumption will be 1.8 million boe/d, accounting for 4.4 percent of the country's total primary energy consumption.

JAPAN

Overview

Japan's energy situation and forecast reflect its unique role as the first of Asia's economic miracles. Energy demand policy and outlook is influenced by a host of factors, but the most important remains a heavy dependence on oil and gas imports. Steps towards deregulation and privatization will increasingly affect energy markets in Japan, while environmental concerns both nationally and globally impact government forecasts, policies regarding fuel choice, and how energy demand is actually met. East-West Center base case forecasts for the next 25 years assume slower economic growth (GDP average annual growth rate of 2.3 percent) and are accompanied by low growth (1.7 percent) in fossil fuel use with natural gas accounting for a growing share of Japan's energy pie.

Historical Context

As shown in Figure 1-4, the share of oil in Japan's primary energy supply grew from 38 percent in 1960 to more than 70 percent in 1970, peaking at 77 percent in 1973. But increased use of natural gas and nuclear power has since reduced reliance on oil imports to 57 percent of primary energy supply. In the 1960s, Japan pioneered Asian trade in liquified natural gas (LNG), using what was then newly established commercial technology to bring natural gas from Alaska. By 1980, the share of natural gas in primary energy supply had grown above 5 percent, further doubling by 1990. Underscoring this increasing reliance on gas, the growth rate of natural gas consumption for the period 1980-95 was 5.9 percent in contrast with that of oil, 0.8 percent (see Table 1-2). Nuclear power, which showed parallel growth in the 1980s, has also accounted for 10 percent of energy supply in the 1990s.

Energy Demand and Policy in Japan Today

Given only incidental indigenous fossil fuel reserves and production, the most notable feature of Japan's energy situation today is its continued reliance on oil imports. Oil accounts for about 55 percent of energy consumption in Japan in contrast to only 40 percent of world consumption and 38 percent in Asia. (the share of oil in Asian consumption rises to 54 percent if one excludes China and India, two giant coal consumers). In the 1990s, 70 to 80 percent of Japan's oil imports came from the Middle East, while only 25 percent of U.S. imports come from the Middle East (a large portion of U.S. imports originates in Venezuela, Canada, Mexico and the North Sea). For the last several years, the United Arab Emirates has been the largest oil supplier to Japan, followed by Saudi Arabia and then Iran and Indonesia.

Japan's heavy reliance on oil is explained in part by its direct burning of crude for power generation. Use of crude for direct burning ranged from 300 to 450 thousand barrels per day (b/d) in the 1990s or about 8-10 percent of oil imports. Within the power sector, however, Japan has worked to establish a so-called "flexible switching system," enabling a switch from one fuel to another should a serious energy shortage occur. Meanwhile, more than 4 million b/d of crude is processed by Japan's extensive refining system to meet petroleum product demand.

Environmental concerns are a driving force behind energy policy in Japan, influencing not only the choice between fuels, but also how each fuel is utilized. Coal-fired power plants, for example, must have the most advanced flue-gas desulfurization (FGD) equipment, and only crudes of less than 0.1 percent sulfur are burned in power plants. A growing environmental movement is also influential in rural areas, where local protests have blocked development of nuclear power plants already constrained by the increasingly limited number of potential sites. As discussed below, goals for emissions control, especially of carbon dioxide (CO2), continue to

Figure 1-4: Compostition of Primary Energy Supply in Japan

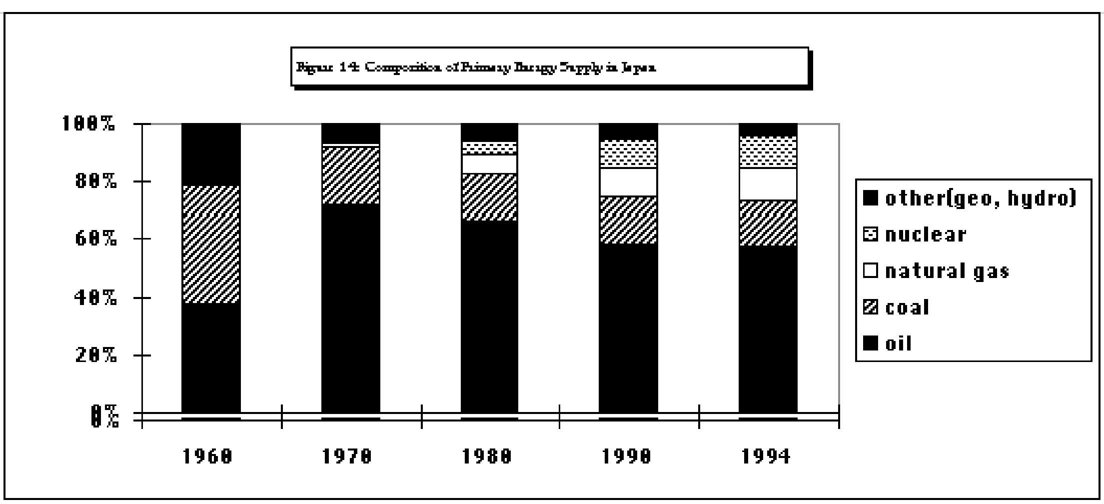


Table 1-2: Growth of Economy and Primary Commercial Energy Consumption in Japan

	Period	AAGR
Historical		
GDP	1980-1995	3.2%
Oil	1980-1995	0.8%
Coal	1980-1995	2.7%
Gas	1980-1995	5.9%
Nuclear Power	1993-1995	7.5%
Hydroelectricity	1980-1995	0.9%
Primary Energy Total	1980-1995	2.2%
Forecast: Base Case		
GDP	1995-2020	2.3%
Oil	1995-2020	0.4%
Coal	1995-2020	2.1%
Gas	1995-2020	4.3%
Nuclear Power	1995-2020	2.4%
Hydroelectricity	1995-2020	4.0%
Primary Energy Total	1995-2020	1.7%

Source: East-West Center.

influence government plans for the future fuel mix resulting in ambitious targets for both LNG and nuclear fuels.

Outlook

The East-West Center base case outlook for energy demand in Japan is based on an assumed average annual GDP growth rate of 2.3 percent through the year 2020. This is shown in Table 1-2 along with forecasted growth rates for various fuels. Figure 1-5 shows what these growth rates imply for shares of fuels in primary energy consumption--the share of oil is likely to decrease while that of natural gas will increase. The future role of nuclear power in Japan remains uncertain. Few believe that official government targets for its nuclear power program will be met because of a lack of suitable sites and opposition from local governments. Increased use of natural gas is likely to substitute for nuclear shortfalls, while also decreasing reliance on oil.

Even with decreased share of electricity being met by oil, oil imports will continue to rise significantly. Paralleled by an increase in oil imports to the Asian region generally, a much greater amount of oil will travel by sea, primarily from the Middle East. Thus, safety of shipping lanes could become a more important issue, along with environmental concerns about shipping of crude oil by tanker and pipeline. Japan is already increasing its double-hulled tanker fleet, but the nature of tanker shipping and the high seas in general will look very different in tomorrow's world. Natural gas imports traveling by LNG tanker will only magnify these issues.

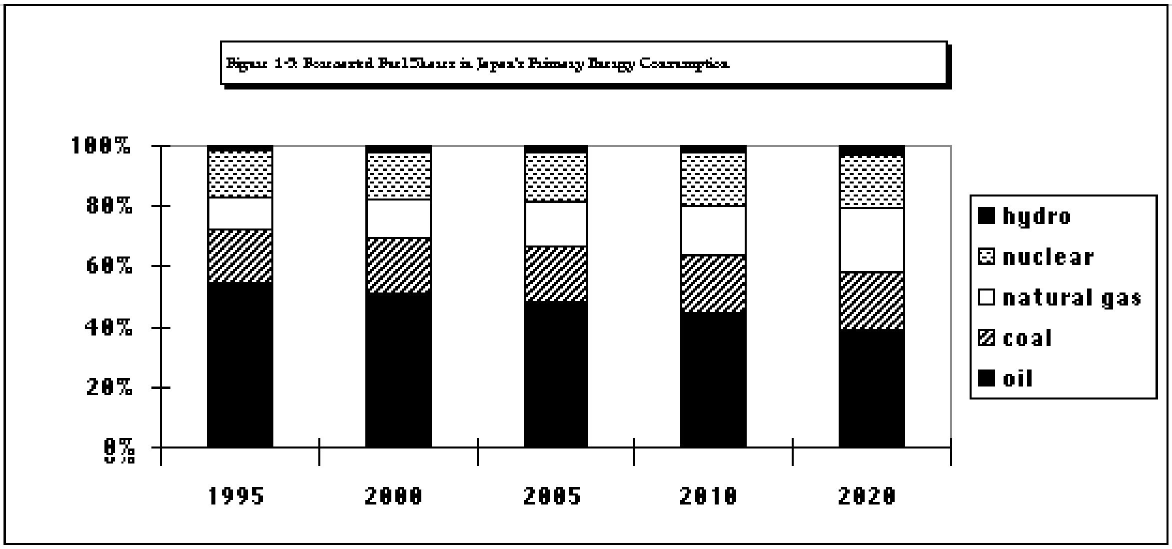
Forecasted natural gas demand, which will rise both quantitatively and in its share of total demand, implies a significant expansion in the development of gas fields and gas exploration. Several large natural gas projects currently on hold, such as the Natuna field in Indonesia and Sakhalin, are almost certain to be developed. Combined with Korean demand and potential demand from other Asian countries, this will represent a notable shift in Northeast Asia's fuel mix.

SOUTH KOREA

Overview

The primary features of Korea's energy sector are similar to Japan in many ways with a few key differences. While Korea's economic boom began about 10 years after Japan's, it remains today one of the strongest developing economies in the world. Korea has no oil or gas reserves, environmental concerns are also important domestic factors, facts that drive energy policy to focus on diversification of types and sources of energy. Korea shows more potential for achieving its nuclear program's goals and also has plans for expansion of natural gas use. Base case forecasts for the next 25 years assume an average annual GDP growth rate of 5.4 percent and average growth in fossil fuel use of 3.4 percent annually.

Figure 1-5: Forecasted Fuel Shares in Japan's Primary Energy Consumption



Historical Context

South Korea's economy experienced an average annual growth rate (GDP) of 9.3 percent in the 1980s and 7 percent for the past five years. Figure 1-6 shows the evolution of Korea's energy diet, in which oil has accounted for a maximum of 63 percent. Nuclear power was first used in 1977 and expanded its share rapidly during the 1980s. LNG imports began in 1986 and comprised the fastest growing fuel demanded for the period 1980-95 (see Table 1-3). Although the share of coal in energy demand did not begin decreasing until after 1990 when domestic anthracite production began falling, imports of bituminous coal have been increasing steadily over the years and now account for the bulk of domestic coal use.

Energy Demand and Policy in Korea Today

Energy consumption in Korea is dominated by oil imports which account for more than 60 percent of primary energy consumption. More than 70 percent of these imports come from the Middle East, 30 percent from Saudi Arabia. Iran, United Arab Emirates and Oman are also main sources of Korea's crude slate, but throughout the 1980s, Korea diversified its crude slate with increasing imports from Indonesia, Ecuador, Malaysia, and Brunei.

The Korean refining system is currently undergoing a major expansion; by the end of 1996, refining capacity grew by one-third over the 1995 level. This will ease some petroleum product imbalances, but naphtha, which fuels a growing petrochemicals industry, will continue to be a major import.

Imports of coal are also significant in South Korea, accounting for more than 15 percent of primary energy consumption. Supply is well diversified with half coming from Australia, Canada and the United States and the other half coming from a variety of other countries. Much of the imported coal is used in the power sector, now accounting for about one-fourth of generation. The share of coal use in the power sector has been growing steadily, and the government plans continued expansion of coal-fired capacity. While current power plant emission standards can be met with available low sulfur coal, the tightening of sulfur dioxide (SO_2) standards in 1999 will necessitate the installation of additional emission control equipment.

First introduced in 1986, LNG imports are also used heavily in the power sector. Currently, LNG accounts for 5 percent of primary energy consumption, but government plans to triple imports by 2010. As in Japan, LNG could become the substitute fuel of choice if ambitious nuclear power plans are not realized. However, unlike Japan, South Korea does not have the same problem siting nuclear power plants, and popular opposition to nuclear power does not thus far appear to be as great an obstacle. Contributing to the relatively greater confidence in South Korea's nuclear power program has been the ability of

Table 1-3: Growth of Economy and Primary Commercial Energy Consumption in South Korea

	Period	AAGR
Historical		
GDP	1980-1995	8.7%
Oil	1980-1995	9.5%
Coal	1980-1995	4.9%
Gas	1980-1995	67.2%
Nuclear Power	1993-1995	22.4%
Hydroelectricity	1980-1995	5.3%
Primary Energy Total	1980-1995	8.5%
Forecast: Base Case		
GDP	1995-2020	5.4%
Oil	1995-2020	2.4%
Coal	1995-2020	2.5%
Gas	1995-2020	7.2%
Nuclear Power	1995-2020	5.8%
Hydroelectricity	1995-2020	0.8%
Primary Energy Total	1995-2020	3.4%

Source: East-West Center.

the Korean utility Kepco to complete nuclear power plants ahead of schedule (Hagen, 1996).

Brief mention must be made of what is known about North Korea's energy situation since it has the potential to greatly impact South Korea and the rest of Northeast Asia. The Democratic People's Republic of Korea (DPRK) has a demand shortfall of all energy resources. It must import all of its oil; it neither imports nor commercially produces natural gas. Two major oil refineries have a total capacity of 42,000 b/d, and a third is planned. The world's 10th largest coal producer, North Korea has mostly anthracite and some lignite deposits, and like South Korea, must import to satisfy most of its bituminous coal needs. More than 50 percent of power is generated by hydro; the remainder is thermal. Three nuclear power plants are under construction.

Outlook

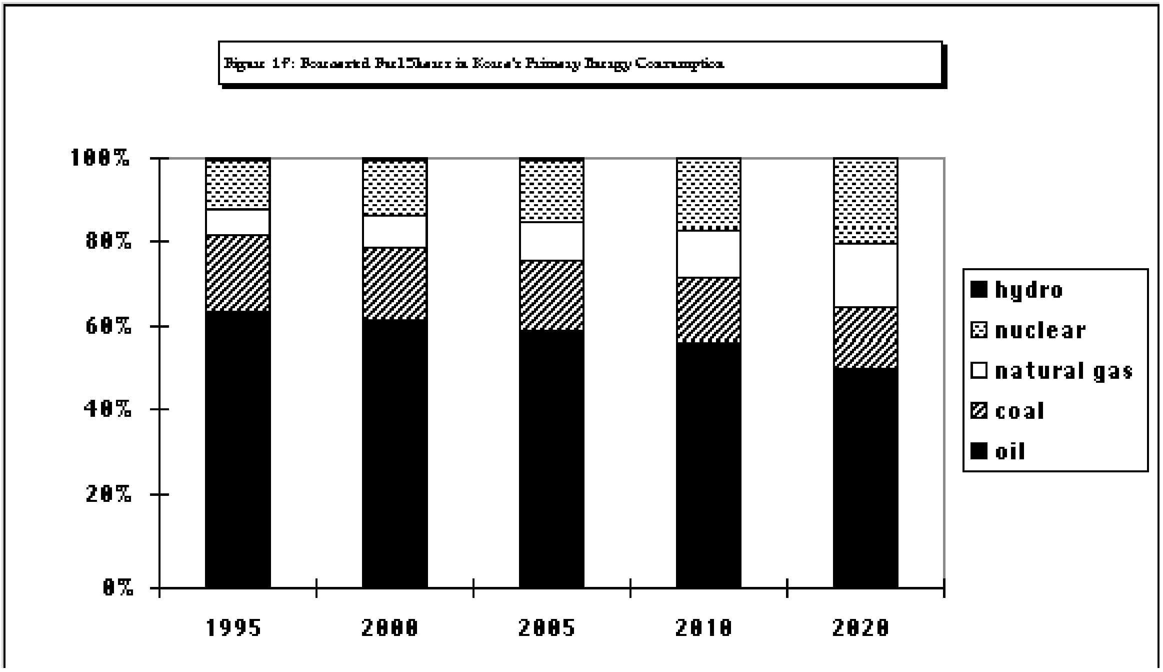
With an assumed average annual growth rate for GDP in South Korea of 5.42 percent through the year 2020, a base case outlook for energy demand is shown in Table 1-3. Like Japan, Korea will find the role of oil in energy demand decreasing, while that of natural gas and nuclear will increase and quantitative consumption of all fuels will rise (Figure 1-7). Realization of its nuclear power program is still uncertain as are many of the issues that were relevant for Japan such as the high volume of Middle East oil imports and how they will be transported.

In addition, the evolution of South Korea's relations with North Korea will impact the energy sector tremendously. South Korea currently helps to provide cargoes of fuel oil to North Korea and has reported plans to build a power station in North Korea as one of the first inter-Korean public works projects. South Korea is also investigating the possibility of supplying electricity to North Korea. Motivation for such plans comes in part from the desire to achieve reunification. Major political changes such as reunification or military conflict obviously would alter all energy outlooks.

Rising Import Dependence for the Asia-Pacific Region

Asian crude oil production already is unable to satisfy existing regional oil demand, and the gap between supply and demand will widen in the future. The result will be a major increase in oil import dependence.[1] In 1995, the net oil import requirements of Asia amounted to 10.4 million b/d, about 59 percent of the regional petroleum product consumption. Based on our forecasts and projections, the region's overall oil import dependence is expected to rise to 66 percent in 2000, 72 percent in 2005, and 77 percent in 2010 (Figure 1-8). Asia has a huge refining capacity. In 1995, distillation capacity in the region was about 16 million b/d, which represents a substantial increase over the 1990 capacity of 12.6 million b/d. Several countries have over 1 million b/d of crude distillation capacity including Japan (4.8 million b/d), China (3.7 million b/d), South Korea (1.7 million b/d), India

Figure 1-7: Forecasted Fuel Shares in Korea's Primary Energy Consumption



(1.1 million b/d), and Singapore (1.1 million b/d). In light of this rising oil demand, many countries in the region have major plans to expand their refining capacity and upgrade infrastructure facilities. For the region as a whole, additions of about 1.8 million b/d by 1997 are firmly planned, with an additional 1.3 million b/d of likely capacity by 2000. During the period 2000-05, a possible 4 million b/d of new capacity could be added to the region, but many uncertainties exist. Associated with current plans are 1.3 million b/d of planned cracking capacities (FCC/RCC, hydrocracking, visbreaking, and coking) by 2000, of which about 60 percent of the additions will be completed by 1997.[2] The huge and expanding refining capacity in Asia implies that crude oil will account for most of the oil import dependence, and dependence on the Middle East to supply the region's crude needs will be inescapable.

Currently, the Middle East accounts for approximately 76 percent of the region's total crude oil imports (including intraregional crude imports).3 Dependence on Middle East crude will go up to 83 percent in 2000 and 90 percent in 2005 (Figure 1-9). By 2010, 93 percent of all crude imports of the region are expected to come from the Middle East, unless alternative sources of petroleum supply can be found. This pattern sharply contrasts with the United States, where Latin America, Canada, and the North Sea will remain key sources for the U.S. market.

Summary and Concluding Remarks

Examining individual countries within Northeast Asia identifies a variety of important trends and unique features related to energy demand and policy. Strong economic growth in the

Figure 1-8: Asia-Pacific Oil Import Dependence, 1995-2010 ('000 b/d)

	1995	1997	2000	2005	2010
Oil Demand	17,545	19,012	21,409	25,397	29,459
Oil Production	7,108	7,121	7,220	6,985	6,687
Net Import Requirements	10,437	11,891	14,189	18,412	22,772
Oil Dependence*	59%	63%	66%	72%	77%

*Defined as share of net oil import requirements in total demand.

Figure 1-9: Oil Balance in the Asia-Pacific Region, 1995-2010

	1995	1997	2000	2005	2010
Crude Production	7,108	7,121	7,220	6,985	6,687
Refinery Throughput + Burning	15,561	17,080	18,871	22,486	26,082
Product Consumption	17,545	19,012	21,409	25,397	29,459
Overall Oil Import Requirements	10,437	11,891	14,189	18,412	22,772
Regional Crude Exports	2,221	1,963	1,589	805	447
To the region itself	1,839	1,835	1,517	781	447
Out of the region	382	128	72	24	0
Crude Import Requirements	10,674	11,922	13,240	16,306	19,842
Share of Asia-Pacific in Crude Imports	17.23%	15.40%	11.46%	4.79%	2.25%
Share of Middle-East in Crude Imports	76.27%	78.40%	82.54%	90.21%	93.00%
MEMO:					
Imports of Middle East	8,141.2	9,347.0	10,927.8	14,709.8	18,452.4
Imports of Other Region	693.8	739.1	794.4	815.3	942.5

region and in each country except North Korea will drive growth in energy demand. How each country attempts to address this demand is influenced by the available domestic resource base, environmental concerns and policies of energy diversification or self-reliance. In addition, rising energy demand will require a tremendous amount of infrastructure and investment, which also influences fuel choices.

All three countries, China, Japan, and South Korea, have identified natural gas as a cleaner and/or underutilized fuel and plan to increase its share of primary energy consumption. All three also have ambitious nuclear power programs to meet electricity demand in areas of concentrated development but are limited by capital and technological resources. Failure to meet nuclear energy goals will affect the shares of oil, coal and gas demand in these countries and throughout the region.

China will continue to develop its fossil fuel reserves while hydroelectric energy will grow more slowly through 2020 due to increasingly limited opportunities. As China joins Japan and South Korea as major oil importers, it will accentuate a dramatic surge of demand in Northeast Asia. This trend will impact the global oil market and raise issues such as the safe and environmentally-sound transportation of ever-larger amounts of oil (and gas). As noted, energy consumption in Japan and South Korea will feature increasing shares of natural gas and nuclear power and decreasing shares of oil (despite quantitative increases). In this way, energy demand together with government policies throughout the region will contribute to a change in global energy markets away from their historically oil-dominated focus.

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Endnotes

1. Import dependence is defined as the share of net oil import requirements (total petroleum product consumption minus regional crude production) in the region's total petroleum product consumption.
2. That is, various refinement processes.
3. If the intraregional imports were excluded, the Middle East accounted for more than 90 percent of Asia's imports of oil (crude and products combined) in 1994.

FOSSIL ENERGY CONSUMPTION AND SUPPLY SECURITY IN NORTHEAST ASIA

by Wu Kang

Summary

Northeast Asia is the home of the world's most populous country, one of the world's most advanced industrial nations, and one of four Asian economic "tigers," along with its northern neighbor. Northeast Asian countries have played leading roles in the Asia-Pacific region's economic growth at various times. Associated with this high growth is a rising energy demand, dominated by fossil fuels. In this paper I discuss fossil fuel energy consumption, supply security, infrastructure requirements, and environmental impacts.

During the fifteen years between 1980 and 1995, fossil energy consumption grew at average annual rates of 9.4 percent in South Korea, 5.2 percent in China, and 2.5 percent in Japan. Demand growth is expected to be strong in China and moderate in both Japan and South Korea over the next fifteen years, raising overall consumption to a much higher level. Supply security for Japan and South Korea has always been important for decades, but in China was largely a domestic issue until the early 1990s, when China started to become a net oil importer. While China will continue to rely on domestic coal for the majority of its energy needs, oil imports on a large scale are expected to become inevitable, which will require construction of new importing facilities and cause supply security concerns for the Chinese leaders. South Korea and Japan will have to compete for Mideast oil with China and other new oil importers in Southeast Asia.

However, needs to secure a stable supply of oil from the Middle East may also provide opportunities for international cooperation. Environmental pollution associated with fossil energy consumption has already become serious in China. China's continuing growth in fossil energy demand, and especially coal, over the coming decades exacerbates concerns about the environmental impacts associated with such growth. China and other countries in the region have to demonstrate a strong common willingness to battle against environmental degradation. While international cooperation is needed in this area, the governments of each country must implement clear policies to stabilize the environment.

Introduction

Spectacular economic growth in Northeast Asia was driven by Japan during the 1950s and 1960s, South Korea during the 1970s and 1980s, and China in the 1980s and 1990s. These three countries are also Asia's largest energy consumers. Thus, the rapid economic growth of Northeast Asian countries resulted in rapid growth in energy demand.

Northeast Asian countries depend heavily on fossil fuels to meet these energy demands, ranging from 98 percent in China and 97 percent in North Korea, to 88 percent in South Korea and 83 percent in Japan. This dependence affects other policy areas outside of energy policy, which in turn impacts regional relations. Fossil fuel consumption requires huge infrastructure facilities for transportation, storage, marketing and cleaning (in the case of coal). Further, depending on the types and qualities of fuels used, and the measures of controlling emissions, fossil fuel consumption can cause adverse impacts on the environment.

Fossil Energy Characteristics

Fossil energy takes all three forms: solids, liquids, and gas. Solids include hard coal, brown coal, peat, and their derivatives. Liquids include crude oil, condensate, natural gas liquids (NGLs), and their derivatives. Finally, gas refers mainly to dry natural gas. One of the common characteristics of fossil fuels is that they are non-renewable or exhaustible sources of energy. Production of fossil energy is relatively cheap compared with many forms of renewable energy, but the limited stock dictates that the cost of using fossil fuels will rise in the long term. Fossil energy consumption also releases various amounts of nitrogen oxides (NO_x), sulfur oxides (SO_x), and carbon dioxide (CO_2), which adversely affect the environment. Use of coal without proper cleaning technologies also results in acid rain.

Oil is the most commonly used fossil fuel in Japan and South Korea. In China, oil consumption has grown rapidly since the late 1980s, but its share has been under 20 percent of total primary commercial energy consumption during the past four decades.[1] China is a large oil producer and has been exporting oil for the past three decades, while Japan and the two Koreas are almost totally dependent on imported oil. Crude oil is used predominantly by refineries to fuel the transportation, manufacturing, and power sectors. Liquefied petroleum gas (LPG) from refineries is mainly used in the residential and commercial sectors. Japan and China are two of the few countries in the world that use crude directly for power generation. At the present time, Japan burns much more crude oil for power generation than China does. Owing mainly to the development of the transportation sector and partly to the continuous growth of demand for electricity, oil will continue to play an important role in Northeast Asia's energy consumption.

The importance of natural gas as an energy fuel has increased in the past decade, principally owing to rising environmental concerns and the desire to use energy resources more efficiently. Natural gas is a relatively clean fuel, and use of natural gas in some applications, such as home heating and cooking or power generation, conserves oil for other purposes such as transportation. Even though oil is the dominant fuel, natural gas can be used in many sectors of an economy: power generation for the residential, commercial, and manufacturing sectors, as well as production of petrochemicals, methanol, and fertilizers. In the form of compressed natural gas (CNG), it can also be used in the transport sector as a fuel for motor vehicles.

China is also the only producer of natural gas in Northeast Asia. Japan and South Korea import liquefied natural gas (LNG) from Indonesia, Malaysia, Australia, and other suppliers to obtain gas. Until the early 1990s, natural gas as an energy resource was largely neglected in China because the Chinese focused their efforts on exploring for oil. The Chinese government strengthened natural gas exploration, development, and production in recent years, and gas has grown in importance. In Japan and South Korea, demand for LNG continues to grow.

Coal differs from other fossil fuels in the severe environmental and health risks that accompany its exploitation and utilization. Coal mining can be dangerous to miners' health, and uncontrolled coal combustion poses environmental risks to plant and animal life in the form of CO_2, SO_x, and NO_x emissions. For all these reasons, coal demand was seriously constrained in industrial countries over the past several decades. In many developing countries, however, coal remains the traditional fuel and, sometimes the dominant primary energy resource. In the 1990s, the worldwide movement to reduce dependence on oil in response to high and volatile oil prices and unstable oil supplies helped make coal and nuclear power promising energy sources. In addition, clean coal technologies--desulfurization, smoke and dust controls, and CO_2 emission controls--provided partial answers to the environmental problem. But the high cost associated with these technologies presents an obstacle to extensive utilization in developing countries. Unless an international law on environmental protection and CO_2 emissions is imposed, developing countries will continue to use coal (mostly without clean technologies) to meet their energy demands as long as oil prices remain higher. In developing countries, growth of coal consumption is expected to increase.

China has huge coal reserves, and its consumption and production of coal are expected to grow steadily in the future. North Korea is also a large coal user because it has significant reserves of coal but no other fossil fuels. Economically exploitable coal reserves are marginal in Japan and South Korea. Both countries currently use coal mainly for power generation and industrial sectors, and this use is expected to continue to grow in the next 15 years.

Fossil Energy Consumption in Northeast Asia

The energy demand structure for the entire Asia-Pacific region is heavily affected by the presence of China. In China, coal plays a dominant role in the country's primary commercial energy consumption, which leads to a much larger share of coal (45 percent) and a lower share of oil (39 percent) in the Asia-Pacific region's total primary commercial energy consumption. If China were excluded from this total, oil would account for 50 percent of the region's primary commercial energy consumption, followed by coal at 27 percent, natural gas at 13 percent, nuclear power at 8 percent, and hydroelectricity at 2 percent (Figure 2-1). The current situation and future prospects of fossil energy consumption in each of the four countries are further discussed below.

China

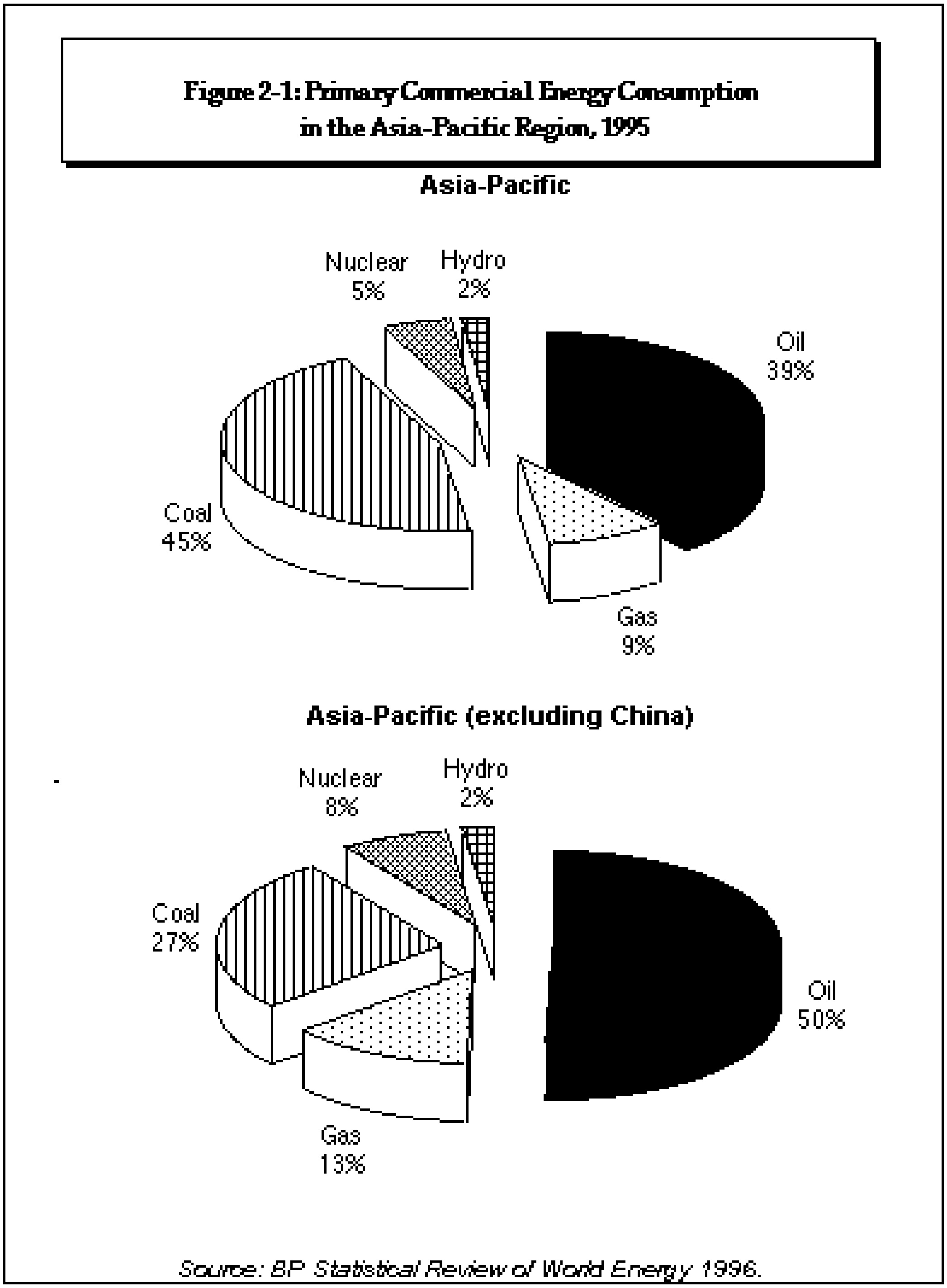
Since 1978, China's economic growth has been spectacular (10.2 percent), but energy demand growth only moderate (5.1 percent). The unique combination of high-speed economic development and relatively low energy consumption growth seen in China for more than a decade was achieved because of structural change of industries and the effects of energy-saving technologies. The low GDP elasticity of energy consumption itself does not indicate that China's energy industry is efficient, but at least it is moving in the right direction. Because of the energy industry's inefficiency before 1970, the effects of using even ordinary energy-saving technologies have been very significant.

China's primary energy consumption was 17.3 million barrels of oil equivalent per day (boe/d) in 1995 (Figure 2-2). Fossil fuels (coal, oil, and gas) form the bulk of the consumption, with coal occupying a dominant position. The share of coal in total primary commercial energy consumption in China has never fallen below 70 percent during the past four decades: the share of coal in China's total primary consumption declined between the 1950s and late 1970s, increased during the 1980, but has declined since 1990. As of 1995, Coal accounts for 77 percent of China's primary commercial energy consumption, with the remaining shares comprising oil (18.8 percent), natural gas (1.9 percent), hydroelectricity (1.9 percent), and nuclear power (0.4 percent). China started to produce electricity from nuclear power stations in 1993, and by 1995, two nuclear power plants accounted for 1.3 percent of China's total electricity generation.

Among fossil fuels, refined products such as gasoline and diesel are used mainly in the transportation and industrial sectors. In 1995, China's petroleum product demand amounted to 3.2 million barrels per day (b/d), of which gas oil (including automobile diesel, industrial diesel, and diesel-range chemical feedstock) accounted for 33 percent, followed by fuel oil (including direct crude burning) at 25 percent, and gasoline at 22 percent. Fuel oil is used for power generation and international shipping as well as in other industrial sectors. China's consumption of liquefied petroleum gas (LPG) has been growing rapidly since the early 1990s, up from 80 thousand b/d in 1990 to 210 thousand b/d in 1995, and is used mainly in the residential sector.

China's use of coal includes power generation, residential use, steel production, and other industrial uses. Residential use of coal increased from 115.7 million metric tons (tonnes) in 1980 to 130.5 million tonnes in 1994, but its share of residential energy consumption declined from 18.5 percent to 10.6 percent (SSB 1995), indicating that more people are utilizing oil and gas for home cooking and heating. In 1995, coal accounted for about 67 percent of all installed electric capacity in China and contributed about 76 percent of the power generated in China.[2] At the end of 1994, China's installed electric capacity reached 200 gigawatts (GW). During 1995, some 15 GW of new generation capacity was

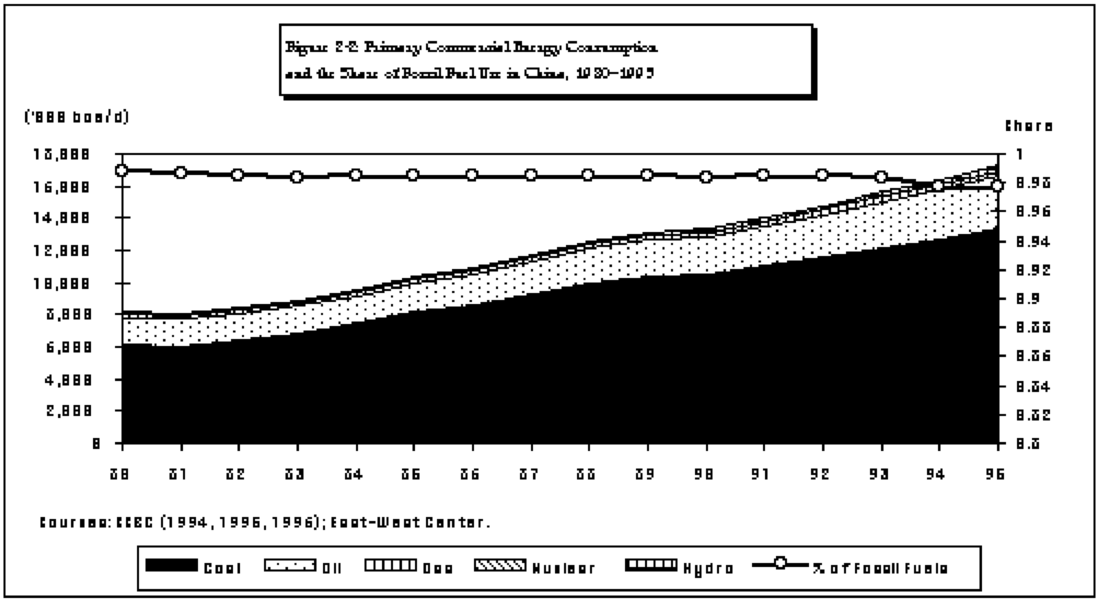
Figure 2-1: Primary Commercial Energy Consumption in the Asia-Pacific Region, 1995



added, and by 2000, China plans to increase its capacity to 300 GW (Matsui 1996). While hydropower generation capacity is being expanded and nuclear power stations are being established, coal-fired power plants will continue to dominate China's electricity production (Wu and Li 1995).

Natural gas consumption accounted for only 1.9 percent of China's total primary commercial energy consumption in 1995, down from 3.2 percent in 1980. Industries are the dominant users of natural gas in China. In 1994, China consumed about 17.3 billion cubic meters (m^3) of

Figure 2-2: Primary Commercial Energy Consumption and the Share of Fossil Fuel Use in China, 1980-1995



Source: SSBC (1994, 1995, 1996); East-West Center

natural gas. The chemical industries (including fertilizers and petrochemicals) constituted 38 percent of total natural gas consumption, gas use by oil and gas fields 21 percent, and residential use of natural gas 11.5 percent in 1994, up from 3 percent in 1985 (see SSB 1995).

Over the next 15 years, fossil energy will continue to play a dominant role in China's overall energy consumption. How fast the consumption grows depends on many factors, especially economic growth (see IGCC Policy Paper 32). Population growth, energy price reform, energy regulations, and interaction between China and the world will also impact energy consumption. Table 2-1 shows our most recent base-case forecasts of the real GDP and fossil energy consumption growth in China by 2010.

On the other hand, coal consumption is forecast to grow continuously but at a much lower rate of 3 percent per annum on average between 1995 and 2010. Altogether, China's fossil energy consumption could reach 29 million b/d, about 70 percent higher than the consumption level in 1995. About 72 percent of the fossil energy consumption will be provided by coal in 2010, down from 79 percent in 1995. The respective shares

Table 2-1: Growth of Economy and Fossil Energy Consumption in China

	Period	AAGR
Historical		
GDP	1980-1995	10.2%
Oil	1980-1995	4.9%
Coal	1980-1995	5.4%
Gas	1980-1995	1.4%
Fossil Energy Total	1980-1995	5.2%
Forecast: Base Case		
GDP	1995-2010	7.3%
Oil	1995-2010	4.9%
Coal	1995-2010	3.0%
Gas	1995-2010	10.7%
Fossil Energy Total	1995-2010	3.7%

AAGR = average annual growth rate
Source: East-West Center.

Figure 2-3: China Petroleum Product Demand Forecast, 1990-2010

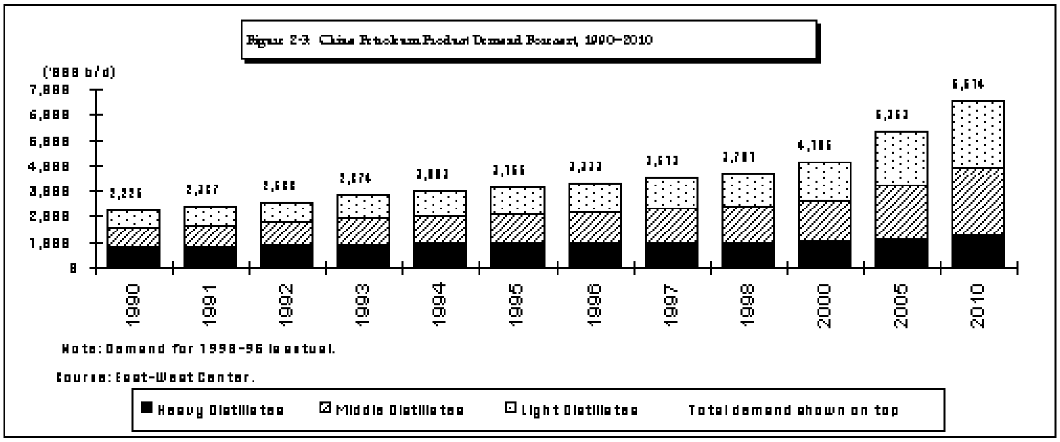
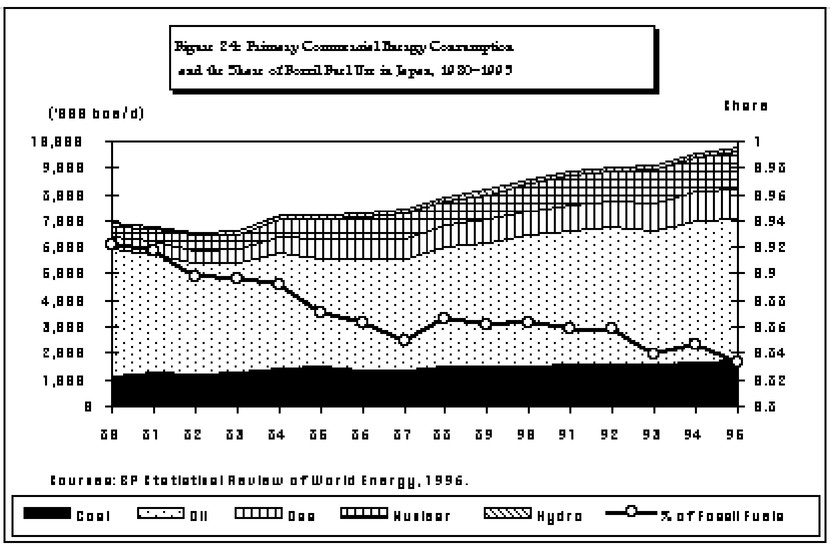


Figure 2-4: Primary Commercial Energy Consumption and the Share of Fossil Fuel Use in Japan, 1980-1995



of gas and oil are forecast to increase from 2 and 19 percent in 1995 to 5 and 23 percent in 2010.

Japan

During the past 15 years, primary commercial energy consumption in Japan increased at an average annual rate of 2.5 percent. The largest increase came from nuclear power, growing at 9.1 percent per year, followed by LNG at 5.9 percent and coal at 2.7 percent. Oil consumption experienced ups and downs and had an overall growth of about 0.8 percent per year during the period 1980-1995. From 1980 to 1995, the overall share of fossil fuels in Japan's total primary commercial energy consumption declined from 92 percent to 83 percent (Figure 2-4).

Over the next 10 to 15 years, the Japanese economy is expected to maintain a moderate growth rate. In 1996, it is expected that the economy will pull out of its stagnation.

The real GDP growth rate is estimated to be 2.7 percent in 1996 and forecast to be 3.1 percent in 1997. Our long-term base-case forecasts of the real GDP growth for Japan average 2.5 percent per annum for the period 1995-2010 (Table 2-2).

Our forecast of Japan's fossil energy consumption is shown in Table 2-2. The overall growth rate of fossil energy demand is expected to average 1.6 percent during the period 1995-

Table 2-2: Growth of Economy and Fossil Energy Consumption in Japan

	Period	AAGR
Historical		
GDP	1980-1995	3.2%
Oil	1980-1995	0.8%
Coal	1980-1995	2.7%
Gas	1980-1995	5.9%
Fossil Energy Total	1980-1995	2.1%
Forecast: Base Case		
GDP	1995-2010	2.5%
Oil	1995-2010	0.5%
Coal	1995-2010	2.5%
Gas	1995-2010	4.5%
Fossil Energy Total	1995-2010	1.6%

AAGR = average annual growth rate
Source: East-West Center.

2010. Under different assumptions, other studies project a lower growth rate of fossil fuel consumption in Japan (Fujime 1996, EIA 1996). Our forecasts are based on the assumption that nuclear power capacity will not be added as quickly over the next 15 years as the government has planned, which will increase the requirements of fossil fuels in power generation, especially coal and LNG. For oil, total petroleum product consumption in Japan is expected to increase at an average annual rate of 0.48 percent during the period 1995-2010. With the exception of fuel oil, all refined products are forecast to increase (Figure 2-5). The gradual liberalization of the Japanese oil market will add to the forces that are pushing up oil demand in the country.

South Korea

South Korea is one of the four "Asian tigers" that led the region in economic growth in the 1970s and 1980s. South Korea's real GDP averaged 9.3 percent during the 1980s. During the period of 1990-95, the economic growth rate in South Korea decreased to 7.4 percent per annum on average (Kim 1996). However, the energy consumption growth has accelerated during the first half of the 1990s. From 1980 to 1990, South Korea's primary commercial energy increased at an average annual rate of 8.9 percent. The growth rate increased to 10.4 percent during the period 1990-1995, largely owing to the high growth rate of oil consumption.

In 1995, South Korea's primary commercial energy consumption amounted to three million boe/d, four times as large as its 1980 consumption level, with an annual growth rate of 9.4 percent during the 15-year period (Figure 2-6). Fossil energy has increased to 88 percent of South Korea's total primary commercial energy consumption, led by surging LNG and oil consump-

Figure 2-5: Japan Petroleum Product Demand Forecast, 1990-2010

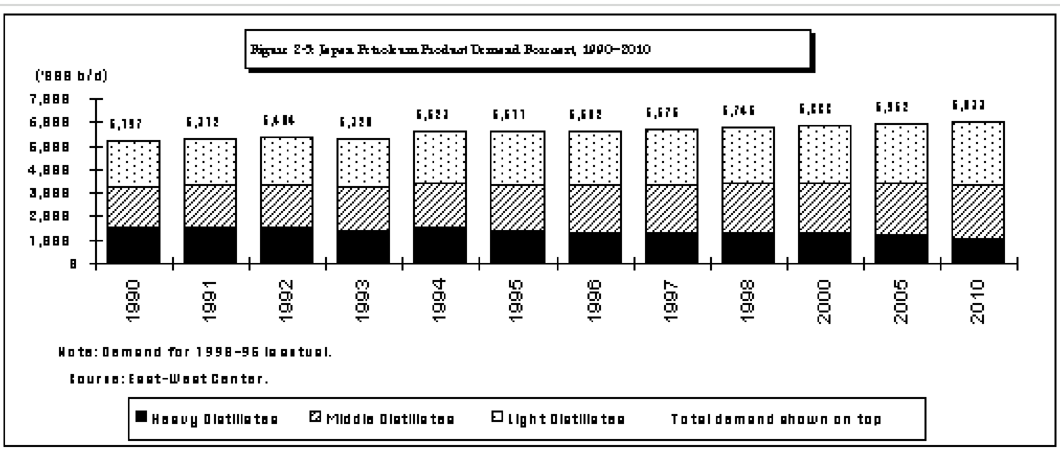
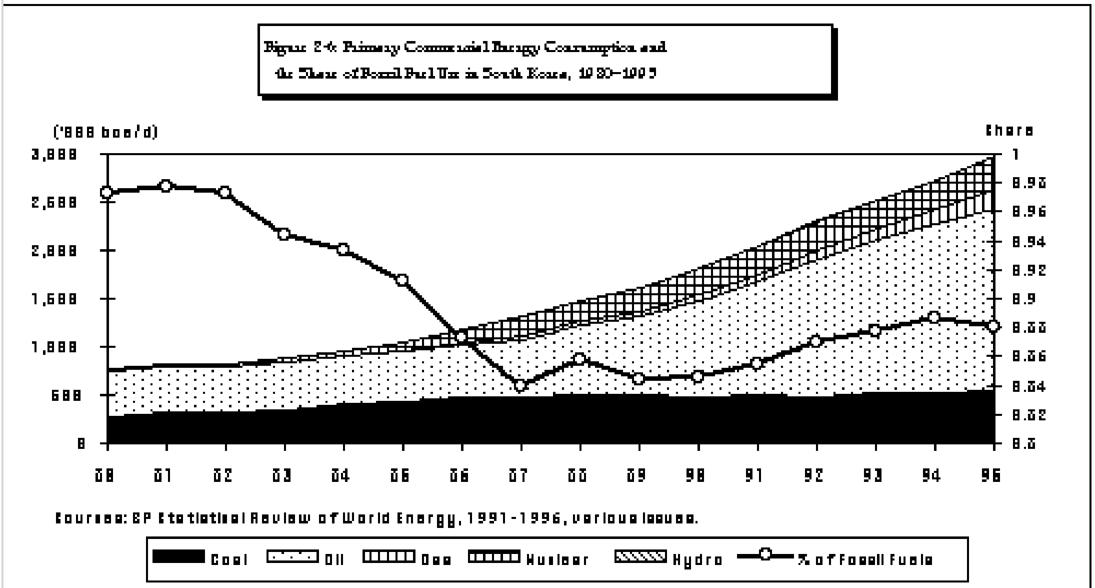


Figure 2-6: Primary Commercial Energy Consumption and the Share of Fossil Fuel Use in South Korea, 1980-1995



tion. During the period of 1987-1995, South Korea's oil consumption increased 16 percent annually, and LNG 20 percent (1987 is the first year that South Korea started to use LNG in significant volumes).

For a number of reasons, fossil energy consumption growth in South Korea is expected to slow over the next 15 years. The South Korean economy will become increasingly mature with growth stabilizing at an annual rate of 5.7 percent. And South Korea's transition from labor-intensive to capital-intensive industries has largely been completed, which may reduce the growth of future energy consumption. Energy conservation policies are expected to be implemented more vigorously in the future, and combined with higher environmental standards and emission controls should further restrain the historically high-growth energy consumption.

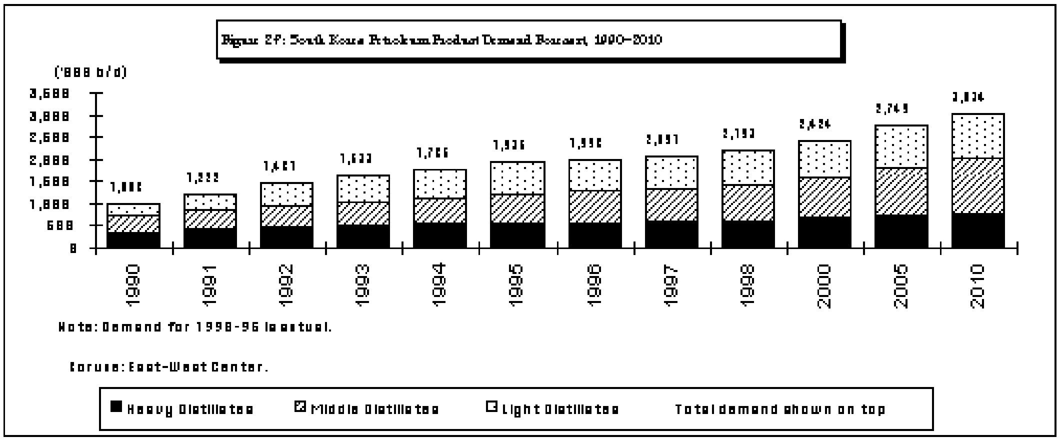
Our forecasts of fossil energy consumption in South Korea during the period 1995-2010 are shown in Table 2-3. Oil, which accounts for nearly half of the country's primary commercial energy consumption at the present time, will exhibit a much slower growth of 3 percent over the next 15 years. Oil consumption growth forecasts by distillate types are shown in Figure 2-7. Coal use in the power sector will continue to grow at an average annual rate of 2.9 percent, reflecting the government's policy of diversify-

Table 2-3: Growth of Economy and Fossil Energy Consumption in South Korea

	Period	AAGR
Historical		
GDP	1980-1995	8.7%
Oil	1980-1995	9.5%
Coal	1980-1995	4.9%
Gas	1980-1995	20.3%
Fossil Energy Total	1980-1995	8.9%
Forecast: Base Case		
GDP	1995-2010	5.7%
Oil	1995-2010	3.0%
Coal	1995-2010	2.9%
Gas	1995-2010	8.0%
Fossil Energy Total	1995-2010	3.5%

AAGR = average annual growth rate
Source: East-West Center.

Figure 2-7: South Korea Petroleum Product Demand Forecast, 1990-2010



ing sources of energy supply for security reasons. LNG consumption growth is expected to remain strong, growing at an average of 8 percent annually between 1995 and 2010. The overall fossil energy consumption growth is forecast to be 3.5 percent per annum, raising the consumption level from 2.6 million boe/d in 1995 to 4.4 million b/d in 2010.

North Korea

Few studies have been carried out to evaluate the energy situation and policies in North Korea. According to the United Nations (UN 1993), primary commercial energy consumption in North Korea is estimated at 1.3 million boe/d, consisting of coal (90 percent), oil (7 percent) and hydropower (3 percent). North Korea imports all the oil it consumes. It also imports a small amount of coal, even though it has fairly large coal deposits. In 1992, North Korea produced 94 million tonnes of coal (74 percent anthracite and 26 percent lignite) and imported 2.5 million tonnes (Table 2-4). The import requirement was met by Chinese supplies. North Korea's 1995 oil consumption was estimated at 76 thousand b/d. All crude oil and some refined products were imported from China, Iran, and other countries. The refinery output of North Korea was around 59 thousand b/d in 1995.

North Korea's future fossil energy consumption is facing tremendous political, social and economic uncertainties (Wu and Fesharaki 1995). We forecast that oil consumption will increase dramatically, but coal consumption will decrease. By 2010, North Korea's petroleum product consumption could reach over 200 thousand b/d; about three-fourths of the incremental demand is expected to be added during the period 2005-2010. Natural gas consumption is also forecast to start and increase rapidly, but the absolute amount will still be insignificant for many years.

Table 2-4: Coal Production, Trade, and Consumption in North Korea, 1991-1992

millions of tonnes

Hard Coal	**1991**	**1992**
Production	69.000	70.000
Imports	2.500	2.500
Exports	.475	.450
Consumption	71.025	72.050
Lignite		
Production	23	24
Consumption	23	24
Total Coal Consumption	94.025	96.050

Source: UN 1994.

Energy Supply Security and Infrastructure Issues in Northeast Asia

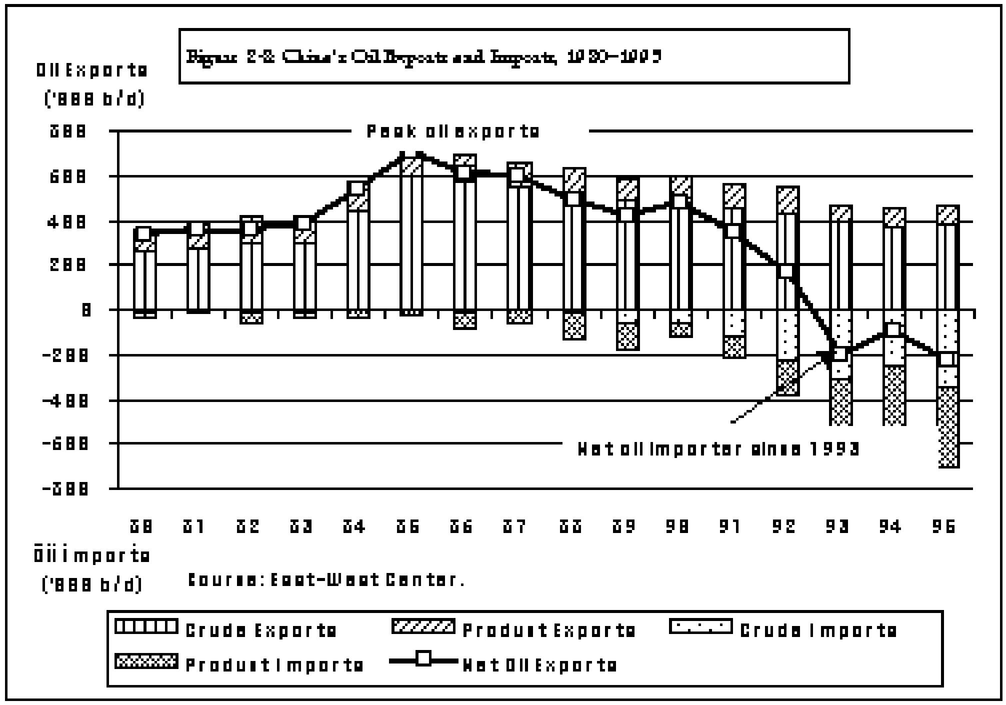
Energy security is a vague and changing concept that has political, military, and economic dimensions. An extensive discussion of the political and military dimensions of energy security is provided by Calder (1996, also see Policy Paper 35). We focus on the economic dimensions of fossil energy supply security in Northeast Asia. Within this region, Japan and South Korea have long depended on imported fossil fuels to meet their energy demand. North Korea has a total dependence on imported oil but relies on domestic coal for most of its energy needs. China is the only significant fossil energy producer in the region. China pursued a self-reliant energy policy in most of the 1960s and 1970s and started to liberalize its energy markets in the 1980s. Under these circumstances, each of the countries may view the concept of supply security in a different way. In addition to sources of fossil energy supply, energy infrastructure can also be an important element of energy security. Lack of importing, stocking, and marketing facilities can greatly limit the consumption of certain fuels and leave the country with even fewer choices of viable energy sources.

China is endowed with abundant and varied energy resources, although it possesses less than the world average on a per capita basis. China is the world's largest coal producer and consumer. Raw coal production amounted to 1.29 billion tonnes in 1995 and consumption was 1.27 billion tonnes of coal. With vast coal resources, the Chinese government vows to produce enough coal over the next 15 years to meet the projected energy demand and to export coal between 25 and 40 million tonnes per year. The key bottleneck to China's coal production and consumption is transportation. While coal producing fields are relatively diversified in China, large deficits still exist in East China, South China, and Northeast China. China's provinces and autonomous region of Shaanxi, Shanxi, and Ningxia produce nearly one-third of the country's coal output, and their production is often constrained by their ability to ship the coal to other parts of China. The government continues to allocate a large amount of state funding to improve the infrastructure and facilitate coal transportation, a daunting task, as we forecast that up to 2 billion tonnes of coal will be produced in 2010.[3]

One of the most dramatic changes in the Northeast Asia energy scene is that China became a net oil importer in 1993. China's diminishing surplus of oil is largely caused by its sluggish growth of domestic crude production and increasing demand. Figure 2-8 shows China's trade situation for crude oil and refined products during the period 1980-1995. Oil exports peaked in 1985 at around 726 thousand b/d but declined to 469 thousand b/d in 1995. During the same period, oil imports increased from 18 thousand b/d in 1985 to 700 thousand b/d in 1995. Over the next 10 to 15 years, China's domestic crude production will increase at an average rate of 1 percent a year, while the growth rate of oil consumption will be 4.9 percent a year, with net oil imports expected to increase from 230 thousand b/d in 1995 to 3.1 million b/d in 2010. At that level, China will join Japan and South Korea as one of the largest oil importers in Asia, with an increasingly large portion of the oil import requirements being filled by the Middle East. In 1995, the Middle East accounted for 45 percent of China's crude oil imports, but is expected to increase to 86 percent by 2005 (Wu and Fesharaki 1996). For most of the 1990s, China's handling capacity for importing crude may be adequate, as the country can use some of the crude export facilities to handle crude imports. But during the period of 2000-10, China must build additional terminals and pipelines to secure a smooth flow of crude oil. Fortunately, the country started early and has actively sought foreign capital in joint venture investments in ports, terminals, and storage facilities.

China's gas industry appears to have a much brighter future than the oil industry. Chinese geologists believe that China's potential gas reserves could be as high as 13 percent of the world's total. The industry has been boosted recently, following the completion of the gas field at Yacheng 13-1 off Hainan Island, and the development of the giant Shan-Gan-Ning gas field in northern China and the Pinghu gas field off Shanghai. According to Chinese officials, gas production in China will increase rapidly from 18 billion m^3 in 1995 to 25 billion m^3 in 2000 and 80-100 billion m^3 during the following 15 years (Zhang 1996). So far, no international trade in gas has taken place. The country will remain self-sufficient in gas until perhaps the middle of next decade, when LNG will be imported to South China or the Lower Yangtze region. Based on our forecast, China's gas consumption will increase 10.7 percent annually during the period 1995-2010. By 2010, both imported LNG and

Figure 2-8: China's Oil Exports and Imports, 1980-1995



Source: East-West Center

gas from the Tarim Basin in Western China will be called upon to meet the growing demand. With China's gas market still fragmented, substantial investment is needed to link the producing fields and the market. The government has already started to build gas lines in North China around the Shan-Gan-Ning field and in East China offshore. In South China, Yacheng 13-1 gas field, jointly developed by the China National Offshore Oil Corporation (CNOOC) and the U.S. company ARCO, will supply a portion of its gas to Hainan Island. However, additional pipelines are still needed if the Tarim Basin is to become one of the major gas supplying bases.

To meet its growing demand for fossil energy, China will continue to rely on coal for the next 15 years. However, China's additional dependence on oil exposes the country to international oil markets, especially the Middle East. Like Japan, South Korea, the United States, and many European countries, China will become increasingly concerned with the stability of oil supply from the Persian Gulf. The positive effects of the dependence is that China may cooperate with other countries in securing stable flows of oil from the Middle East to the rest of the world. On the other hand, China's increasing imports contribute substantially to the oil deficit in the Asia-Pacific region. For the first time in history, every nation in Northeast Asia is now a net oil importer, including the Russian Far East. Japan has an overall energy import dependence of 97 percent if nuclear power is considered an imported energy because of fuel imports. Among fossil fuels, the import dependence is 99 percent for oil, 94 percent for coal, and 100 percent for LNG.

Energy security is hardly a new concept for Japan. Since the Middle East oil crises in 1973 and 1979, the Japanese government promoted programs to diversify energy resources away from oil and toward coal and nuclear power. In 1980, oil accounted for 69 percent of Japan's primary commercial energy consumption, but by 1995, it had declined to 55 percent, whereas coal's share had increased to 18 percent, nuclear power's to 15 percent, and LNG's to 11 percent.

Over the next 15 years, Japan will continue to import nearly all of its fossil fuels to meet its energy demand. The government is promoting nuclear power to meet the demand for electricity, hoping to double nuclear power capacity and output over the next 15 years. However, the government's plan may be too ambitious. If nuclear power expansion fails to materialize, it is likely that more coal and gas will be consumed.

Given the existing facilities handling oil imports, transportation, and marketing, infrastructure will remain largely adequate for future oil consumption. However, as the country liberalizes its oil market, some additional ports and terminals to handle large product tankers need to be built. If Japan opts for gas as one of the major sources for power generation and residential use, the country should consider building a long-distance pipeline to ship gas from gas-rich Central Asia. In the meantime, more LNG receiving terminals need to be constructed to accommodate the demand for LNG transported by ships.

South Korea also has a limited energy resource base. Apart from a modest hydropower potential of approximately 3.1 GW, anthracite coal is the only major indigenous energy source. Like Japan, South Korea's nuclear power plants have to import all of their uranium from outside the country. South Korea is fully dependent upon imported oil and LNG, and 92 percent dependent upon imported coal. The main objectives of the energy policy in South Korea can be best summarized as the following (Lucas et al. 1987): (a) conservation of energy; (b) ensuring a stable supply of energy at low cost; (c) optimal diversification of energy resources; (d) domestic and overseas resources development; and (e) the development of new and renewable sources of energy.

In response to the oil crises, the government set out to secure access to low-cost supplies of crude, to expand "self-developed" crude oil supplies through the operations of the Korean Petroleum Development Corporation (PEDCO), and to develop increased flexibility in domestic fuel use. To promote energy conservation, the energy authority has levied various forms of taxes and duties on crude oil and oil products. Oil's share in total primary commercial energy consumption was 64 percent in 1995. Declining crude oil prices since 1986 contributed to the booming of oil consumption in South Korea in the late 1980s and the first half of the 1990s. South Korea started to import LNG in 1986, reaching 6 percent of energy consumption in 1995. Like Japan, South Korea will continue to rely on imported fossil fuel in the future to meet its growing energy demand.

South Korea's refineries are still in the process of expanding their capacities. As fossil energy demand growth continues in the region and refining capability enlarges, South Korea will need more receiving terminals for LNG as well as oil.

North Korea has long pursued a self-sufficient policy. In order to maintain a high level of self-sufficiency in energy except for oil, North Korea has given high priority to the expansion of hydropower capacity and the development of nuclear power. The latter, however, remains controversial, as the two Koreas are still hostile to each other and there remains the possibility of diverting nuclear fuel to military purposes. Before 1992, North Korea had a fairly secure supply of oil from both the former Soviet Union and China. Since 1992, while North Korea continued to rely on Russia and China for oil supply, the country had to trade oil increasingly in the international market. The North Korean government attaches a great deal of importance to imports of oil, which continues to be a prime strategic and security issue.

Environmental Implications of Fossil Energy Use in Northeast Asia

Environmental protection is a broad concept that deals with problems related not only to greenhouse gas emissions but also to air, water, and land pollution. It is widely believed that in developing countries, air and water pollution caused by chemicals, fertilizers, cement, and other manufactured products are far more serious than originally expected, attracting more government attention than the greenhouse effect.

Environmental concerns traditionally have not played a major role in the formulation and implementation of energy policy. The domestic availability of particular energy resources, the relative prices of various fuels, and the trade balance of a country were usually the major factors determining the mix of energy sources (Asian Development Bank 1991, ESCAP 1991). The rapid pace of industrialization in developing countries during the 1960s and early 1970s raised concern about the environment, as pollution in some countries reached levels that endangered the health of the population. Following the lead of some industrialized countries, environmental agencies and ministries were set up in several Asia-Pacific developing countries during the 1970s and 1980s. While air and water pollution are more immediate concerns of the developing countries' governments, preventing global warming and limiting the greenhouse effect, believed to be caused by CO_2 and other greenhouse gas emissions, are of concern to all mankind in both industrial and developing countries. As a result of the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil, in June 1992, not only industrialized countries and the United States in particular, but also developing countries are now under pressure to assume a larger responsibility in controlling CO_2 emissions.

The greenhouse effect hypothesis rests on two premises: first, that the unabated growth of greenhouse gas emissions might increase global mean temperatures, raise sea levels, and significantly alter weather patterns in the next century; and second, that CO2 constitutes the bulk of greenhouse gas emissions, caused mainly by energy consumption, especially fossil fuel combustion. This hypothesis is believed by a large number of scientists. Others have taken a cautious and even skeptical approach toward the greenhouse gas emission issue and its relationship to climate change (forward linkage) and energy consumption (backward linkage). They suggest that the relationship between global warming and CO2 emissions requires further scientific research and that the "popular view" that regards CO2 emissions as the main cause of the greenhouse effect is without solid scientific foundation. Differences also exist among the same group of scientists with regard to the rate and magnitude of climate change caused by the greenhouse gas emissions. Others focus upon the possibly burdensome costs of controlling greenhouse gas emissions and the effectiveness of carrying out expensive CO2 abatement programs by certain countries, therefore encouraging a cautious approach to the issue. However, financial considerations in controlling greenhouse gas emissions should be regarded as a separate issue (Fesharaki and Wu 1992).

In Northeast Asia, China is the largest source of pollutant emissions but has the lowest per-capita energy consumption and the lowest per-capita pollutant emissions. A great danger associated with China's low per-capita energy consumption and emissions is China's potential to dramatically increase its pollutant emissions in the long-term. China is currently facing serious problems with pollution and emissions of SOx, NOx, particulates, and CO2 because of its nearly uncontrolled consumption of coal and, to a lesser extent, some poor-quality refined products. A recent study conducted by Smil (1996) reported that China is experiencing every imaginable environmental problem, yet its capacity to deal with these challenges is limited. For instance, of the world's 10 worst polluted cities, three are in China. In the late 1980s, chronic lung disease aggravated by air pollution accounted for about one-fourth of China's deaths (Smil 1996). Environmental pollution takes many forms in China, including air pollution, land pollution, and water pollution. For instance, acid rain is a very serious issue in many parts of China. While most of the pollution is associated with coal consumption, use of some poor quality refined products, including leaded gasoline, also causes environmental hazards. As China prepares to import high-sulfur Mideast oil in the coming years, high-sulfur fuel oil will likely be produced by the refineries and cause additional environmental problems.

Emissions of CO2 are common for all fossil energy consumption. According to EIA (1996), China's carbon emissions in 1993 were 729 million tons of carbon equivalent; 81 percent came from coal consumption, 18 percent from oil consumption, and 1 percent from natural gas. The emissions are projected to increase to 988 million tons of carbon equivalent in 2000 and 1.46 billion tons of carbon equivalent in 2010. By 2010, coal will still account for 78 percent of the carbon emissions in China, followed by oil at 19 percent and natural gas at 3 percent.

The fast economic growth projected for China and high-energy demand associated with it imply that there is no quick cure to the problem. However, the Chinese government has vowed to fight it. The government started to introduce desulfurization technologies to its coal and oil sectors, has tightened the environmental standards, and has provided incentives to attract foreign investors in environmental-related projects and joint ventures. The government also appealed to developed countries for more funding to combat environmental problems in developing countries, including China. However, in many areas, the denial of the severity of the environmental problems is still widespread in China. China, in conjunction with the entire Northeast Asian region, needs to do more to curtail environmental pollution. (See also Rich, IGCC Policy Paper 30 and Carson, IGCC Policy Paper 32).

Japan has tough environmental laws for emissions from thermal power plants and stringent standards for petroleum products. Its original Air Pollution Control Law was enacted in 1968, based on the Basic Law for Environmental Pollution Control of 1967. During the past three decades, numerous new rules and revision of the laws have been passed and implemented. The current Basic Environmental Law, promulgated in November 1993, sets long-term standards for Japan's electric power sector.

The standards for the control of SOx, NOx, and particulate emissions have been in place for many years, owing to the mounting concerns over air pollution problems in the 1960s and 1970s. Since the late 1980s, the Japanese government also started to focus on global environmental problems and address the issue of CO2 emissions. In 1990, the government announced the Action Program to prevent global warming. To fulfill its commitment to maintain per capita CO2 emissions from 2000 at Japan's 1990 levels, MITI prepared a long-term energy plan to meet these targets. However, the plan has changed every year, since some of the targets have proven too difficult to meet in time.

Japan has the highest standards in Asia for refined product consumption. All gasoline consumed in Japan is now unleaded. The country has strict sulfur content control for uses of fuel oil, diesel, and kerosene. In the power sector, to achieve an ideal weighted average of sulfur content for fuel input, Japan has been using low-sulfur crude oil for several decades for electric power generation. Japan is one of the few countries in the world that use a significant amount of crude oil for power generation. At the present time, only those crudes with a sulfur content of less than 0.1 percent can be burned in power plants. Almost all of these crudes are from the Asia-Pacific region.

To control the emission of SOx and NOx, many power plants are fitted with flue gas desulfurization units and denitrification facilities. Other methods of controlling emissions include two stage combustion, exhaust gas circulation, and low NOx burners. The control of particulate emissions is mainly for coal-fired power plants. Electrostatic precipitators are widely used in Japan's coal-fired plants to control particulate emissions.

In the early periods of post-World War II economic growth, Japan encountered a series of air, land, and water pollution problems, as its manufacturing base developed rapidly. Japan still has the highest per-capita CO2 emissions in Asia because of its huge industrial complex. However, the growth rate of CO2 emissions over the next 15 years is expected to slow. In 1993, Japan's carbon emissions from energy consumption were 319 million tons. The emissions are forecast to increase to 375 million tons in 2000 and 417 million tons in 2010, at an average annual rate of 1.6 percent (EIA 1996).

In South Korea, while primary commercial energy consumption is still dominated by oil, the share of oil-fired power plants declined drastically from 73 percent of capacity in 1980 to 21 percent in 1995, while the share of coal-fired power plants increased from 0.8 percent in 1980 to 25 percent in 1995. South Korea has ever-tightening standards for emissions from power plants. For instance, emissions of SO2 from power generation are currently limited to 500 ppm, and will be further tightened to 270 ppm as of January 1999. South Korea also has stringent standards for oil consumption. The country uses 100 percent unleaded gasoline, low-sulfur diesel for transportation, and low-sulfur fuel oil for power generation. Over the next 15 years, the rapid growth of natural gas use the government's most promising solution to the issues of energy diversification and energy pollution. But South Korea has not yet set any standards for CO2 emissions.

North Korea's energy industry is believed to be very inefficient and pollution-prone and coal is widely used in every sector of the economy. The country's per capita coal consumption is much higher than that of South Korea, leading surprisingly to a higher overall energy consumption per capita than South Korea's.

While fossil-energy related environmental threats exist everywhere in Northeast Asia, each country is facing unique challenges arising from the pattern of its energy consumption. China has several environmental problems because it is a huge developing economy with a large energy base. China has drawn enormous international attention in recent years because of the extent and future potential of environmental pollution in China and their impact on neighboring countries. The future development of China's economy and energy industry will be increasingly subject to international scrutiny out of environmental concerns. China itself should make maximum efforts to accommodate the needs to curtail environmental pollution while developing its economy.

Japan's tougher environmental targets may prove to be very challenging. South Korea may take some time for its government to have a clear long-term plan for environmental protection like those in developed countries. And North Korea is still missing from international discussions of environmental pollution. Judging by its huge coal consumption, pollution will be a critical issue for the country and its neighbors.

Conclusion

Northeast Asia encompasses three of the largest fossil energy consumers in the Asia-Pacific region. In each of the four countries discussed, fossil energy plays a leading role in their energy consumption picture. While oil dominates fossil energy consumption in Japan and South Korea, the consumption of natural gas in the form of LNG is on the rapid rise. Oil is important to the Chinese economy and vital to North Korea's survival, but both countries rely on coal to meet the majority of their energy needs. For decades, energy security has topped the agenda for both Japan and South Korea, which are completely dependent on imported fuels. China and North Korea both pursued self-reliant policies for decades, but the two countries differ in almost every other area. China possesses all varieties of energy resources, but the country recently became a large oil importer. The emergence of China in the international oil market further complicates the urgency of Japan and South Korea to secure energy supplies. However, this common situation could lead to international cooperation in stabilizing Middle East oil supply sources and shipping routes. The energy situation facing North Korea is precarious, as the country could never achieve self-sufficiency in oil. With the former Soviet Union gone, North Korea has to break out of its isolation to secure an adequate supply of oil. Although North Korea imports only a small amount of coal, the imports are necessary to develop the country's steel industry. In addition, energy infrastructure is needed by every country in the region, especially by China, whose consumption of oil and coal are forecast to reach unprecedented levels 15 years from now.

Fossil energy will continue to be the major source of energy for every Northeast Asian country in the foreseeable future. Related issues of supply security and infrastructure must be dealt with seriously for sustainable economic growth to continue.

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Endnotes

1. Throughout this paper, primary commercial energy is defined as including coal, oil, gas, nuclear power, and hydroelectricity. While biomass consumption is still significant in China and North Korea, and other non-renewable energy consumption is on the rise in both Japan and South Korea, these energy sources are not included in our discussion.
2. Program on Resources at the East-West Center.
3. Coal Project at the East-West Center.

MULTILATERAL COOPERATION IN NORTHEAST ASIA'S ENERGY SECTOR: POSSIBILITIES AND PROBLEMS

by Mark J. Valencia and James P. Dorian

Summary

The increasingly positive political climate in Northeast Asia provides an opportunity to think boldly and creatively about regional regime building. Japan, South Korea and Taiwan have the markets, the capital and the technology to develop energy resources and both Russia and Central Asia have enormous untapped natural gas deposits. A multilateral functional approach to developing and delivering natural gas could build confidence, dampen frontier tensions, and improve relations in this region so critical to world peace and prosperity. However, there is considerable competition among consumers for secure supply, and among potential suppliers regarding the exact routing of a pipeline. Competing and overlapping proposals for a multinational gas pipeline link include The Asia-Pacific Energy Community, The Vostok Plan, The Energy Silk Route Project, The Irkutsk Gas Project and The Trans-Asian Gas Pipeline Network. However, these proposals all face formidable political, economic, technical and environmental obstacles that must be overcome if any are to be implemented. A Northeast Asia Energy Forum could foster discussions aimed at resolving or overcoming some of these obstacles and contradictions.

The Positive Political Context

In recent years, unprecedented political and economic changes have occurred within and between nations in Northeast Asia, including the opening of economies once completely closed to foreign investment. Governments in the region are increasingly interested in closer economic ties as well as bilateral and even multilateral cooperation in such fields as energy, telecommunications, and agriculture. Despite these positive trends, however, the region remains characterized by insufficient mechanisms for cooperation as well as those to facilitate trade, technology transfers and investment.

Northeast Asia[1] has long been a security complex[2] involving Russia, China, Japan and the United States. During the Cold War, international relations there were heavily influenced by the Soviet-United States dynamic and thus were almost indistinguishable from the global system.[3] However, the future central dynamic of this system is likely to depend on relations among the Northeast Asian countries themselves. In the past century these relations have been characterized by revolving patterns of amity and enmity, frequent tension between the strongest powers in the region, and resultant attempts to forge alliances with the lesser powers. Moreover Northeast Asian countries have tended to operate on the basis of "worst-case" scenarios--for the large powers of being isolated by the other powers, and for the lesser powers, having the two strongest join in a hegemonic alliance.[4]

However, we are now witnessing a transformation of the political system in the region. As survival has ceased to be the prime concern of powerful states, their quest for relative gains has become less driven and consistent. Some argue that their behavior can now best be understood in the context of international institutions that both constrain states and make their actions more predictable.[5] Most Northeast Asian governments are now more motivated toward maximizing wealth than territory, and their increasing economic interdependence may make outright conflict too costly. With the development of political multipolarity and the abandonment of Stalinist economic models, economic relationships have begun to develop a more "natural" pattern. [6]

As a result, the trans-Pacific economic axis--so prominent in the Cold War era--is being gradually modified by more multidirectional intra-Asian relationships.[7] Indeed, economic interaction across ideological and political boundaries is creating a "soft" regionalism in Northeast Asia--one which lacks organizational structure but which is accepted and even encouraged by governments.[8] This intraregional multidirectional pattern implies a more diversified set of cooperative and conflictual economic relations in much of the North Pacific, creating a need for rules, codes of conduct, and harmonization of domestic practices affecting international transactions--in short, regional institutions.

Although Northeast Asia is almost unique for its lack of regional institutions[9] present positive political trends provide an unparalleled opportunity to think boldly and to be innovative about regional regime building in Northeast Asia. Indeed, the world and the Asia- Pacific region in particular are witnessing a renewed interest in multilateralism.[10] Some argue that multilateral norms and institutions can make significant contributions toward stabilizing the peaceful transformation of the international system and that they are likely to become increasingly important in the management of change at the regional level.[11] Further, regional arrangements can render great service by contributing to a deeper sense of participation, consensus and democratization in international affairs.[12] Developing states in particular are increasingly attracted to regional arrangements because of their growing political maturity, and because they perceive the potential of regionalism to promote their economic development and to mitigate their disadvantaged position in the international system.[13] Already a thin net of economic, environmental, and, to a lesser degree, political institutions is spreading over the region, but within a broader Asia-Pacific framework.

What is most worrying about potential conflict in Northeast Asia is that it would take place in a region whose diversity and disputes have never been ameliorated by multilateral cooperation and where security has always been defined by military might. Thus the prospects for peace and stability in the region may depend on the success of multilateralism. Indeed, the first step toward the peaceful settlement of international conflicts is the creation of a sense of international community.[14] The creation of such a community presupposes at least the mitigation and minimization of conflict so that the interests and common needs shared by different nations outweigh the interests separating them. Common recognition that even a poor regime is better than none compels nations to collaborate to the extent of developing a minimally satisfying solution. The challenge for the region then is to find a variety of multilateral arrangements that will demonstrate that a habit of dialogue and working together can build common security. Tactical learning--in which the behavior of states towards cooperation is changed--must be replaced by complex learning in which values and beliefs about reaching goals through cooperation are changed.[15]

As one of the world's last frontiers for the development of energy as well as mineral resources, Northeast Asia holds significant potential for multilateral resource cooperation. Vast resources ranging from offshore oil and gas to even alluvial gold are for the first time in decades being made available for investment to foreign companies.

A functional approach, e.g., in the energy sector, could help the growth of positive and constructive common work and of common habits and interests, decreasing the significance of political boundaries by overlaying them with a natural growth of common activities and administrative agencies. Northeast Asia includes both potential energy suppliers--Russia and possibly Mongolia, and major consumers--Japan, China, Taiwan, and South Korea. There are numerous proposals to harness the capital, advanced technology, and human resources of Japan, Taiwan and South Korea to develop energy resources in developing Northeast Asia and thereby link the region in an "energy community." This paper summarizes these proposals and delineates the problems that must be overcome for any of them to be realized.

Energy Geopolitics

Northeast Asia contains several of the world's most energy and minerals-rich nations and regions, notably the Russian Far East, Mongolia, Northeast China, and North Korea. The area produces significant quantities of coal (for example in North Korea and Northeast China) and crude oil (in Northeast China). Indeed, the Daqing oil refinery in Heilongjiang produces around 40 percent of China's annual oil output. And in Russia, there are vast oil and gas fields in Siberia as well as on and offshore Sakhalin island, in the Russian Far East. Much of the region is still relatively lightly explored in geologic terms, indicating that ample reserves of oil and gas as well as minerals may yet be discovered once newer, more advanced geological prospecting techniques are employed.

Japan, South Korea, Taiwan and China are all major consumers of primary energy, using 1.35 billion tonnes of oil equivalent in 1993, 70 percent of oil consumption in the Asia-Pacific and 17.3 percent of the world total.[16] The oil-demand growth rates of the first three for 1983-1993 were 4.3 percent, 11.9 percent and 8.4 percent respectively. However, the Asia-Pacific region's crude oil production is expected to remain about the same at 6.7 to 6.9 million barrels of oil per day (mb/d) to 2010.[17] Thus the region's crude oil production will be unable to satisfy regional demand and the shortfall will increase rather rapidly.

Crude oil imports from outside the region, 87-95 percent from the Middle East, will supply two-thirds of consumption in Northeast Asia. This dependency will make Northeast Asian economies especially vulnerable to sharp oil prices increases,[18] and instability in the Middle East or along the transport route could threaten the very security of their supply. Protection of South China Sea sealanes used for oil transport will become an increasing concern and could result in an even further and more costly forward "defensive" posture of Japan and South Korea.[19] Moreover, growing environmental concerns in Japan and South Korea regarding coal, oil and nuclear power--i.e., air quality, transboundary acid rain, CO_2 buildup and nuclear safety respectively--are forcing a focus on natural gas.[20] Indeed, the forecasts of these governments all project a reduction of oil imports in favor of natural gas and nuclear energy. But the latter is possible only if public resistance can be overcome.[21] In 1994, their imports of LNG were 76 percent of world LNG trade.[22] In 2010, natural gas demand for these countries and Taiwan is expected to be 2.6-2.9 times that of 1994, or 181 billion cubic meters per year (bcm/y). Indeed natural gas is increasingly popular in Northeast Asia, particularly with power generating companies, because of its security of supply, minimal price volatility, and its minimal environmental effects.[23] An added benefit to Japan of China's use of Yakutian gas to power its heavy industrial centers in its northeast would be the reduction of Japan's receipt of transboundary acid rain from China's coal-burning energy plants.

An abundance of natural resources and/or labor in areas like the Russian Far East and China suggest that economic expansion can occur when present political problems subside. Table 3-1 illustrates the point that regional cooperation can take place in Northeast Asia because of complementary conditions among the principal countries and regions--that is, resource-rich and capital-poor areas alongside resource-poor and capital-rich regions.

Superimposed on the resource and physical conditions of the region is the expectation of continued strong economic growth. And as the Northeast Asian economies prosper, consumption of energy will rise to meet growing industrial demand. Oil consumption in the Asia-Pacific region is now projected to grow at an average annual rate of 3.6 percent over the remainder of the decade, 1995-2000. Economic expansion typically increases import demand for energy products, while also increasing capital resources available for investment in the oil and gas sectors. Clearly, the growing demand for energy in Northeast Asia is enhancing prospects for multilateral resource cooperation.

In addition to considering the resources in each country as well as the availability of labor, capital, technology, and managerial expertise, the extent and quality of infrastructure in the different areas is an important component in assessing the prospects for regional cooperation. Throughout Asia and particularly the former Soviet Union, government and industry officials are realizing today that even if ample oil and gas is in place, unless there are means to transport the resources to foreign markets, the international efforts to develop these resources will be minimal.

Both China and Russia have considerable oil and gas reserves and resources, China in its Tarim Basin and the East China Sea, and Russia in the Russian Far East-- off-shore Sakhalin (0.4 trillion cubic meters [tcm]) in just two fields, Piltun-Astokskoye and Lunskoye), Sakha (9.6-13.0 tcm) and Irkutsk (0.6-0.8 tcm in the Kovyktinskoye field alone). But neither country has the capital or requisite technology to develop these reserves in such environmentally harsh frontier areas.[24] Therefore China and Russia are competing for investment to develop these frontier resources. China seems to have an advantage because of its more stable and certain investment climate at the moment, and because of Japan's reluctance to invest in Russia until the Kurile/Northern Territories dispute is resolved. But China's runaway energy consumption will soon make China a net importer of oil and gas, rather than an exporter. Only Russia's huge gas reserves could satisfy regional demand, including that of Northeast China.[25]

Opportunities for regional resource cooperation in Northeast Asia include joint venture projects in oil and gas exploration and development, pipeline construction and other infrastructural development, technology transfers, and financial lending. The potential complementarities have produced a series of overlapping and competing proposals for energy cooperation in Northeast Asia—Japan's Energy Community Plan (figure 3-1), the former Soviet Union's Vostok Plan (figure 3-2), modified by South Korea's proposal (figure 3-3), China's Energy Silk Route Plan (figure 3-4), and the Irkutsk Plan. (figure 3-5).

The Asia-Pacific Energy Community

This is a Japan-centered, multilateral energy "cooperation" plan proposed by 32 Japanese companies. This grand scheme envisions a 42,500 km pipeline grid--easily the largest human-made structure on earth--extending from Yakutsk to Dampier in northwestern Australia, connecting China, Korea, Japan, Taiwan and six ASEAN countries. The grid would be divided into two sections--the Northeast Asia and

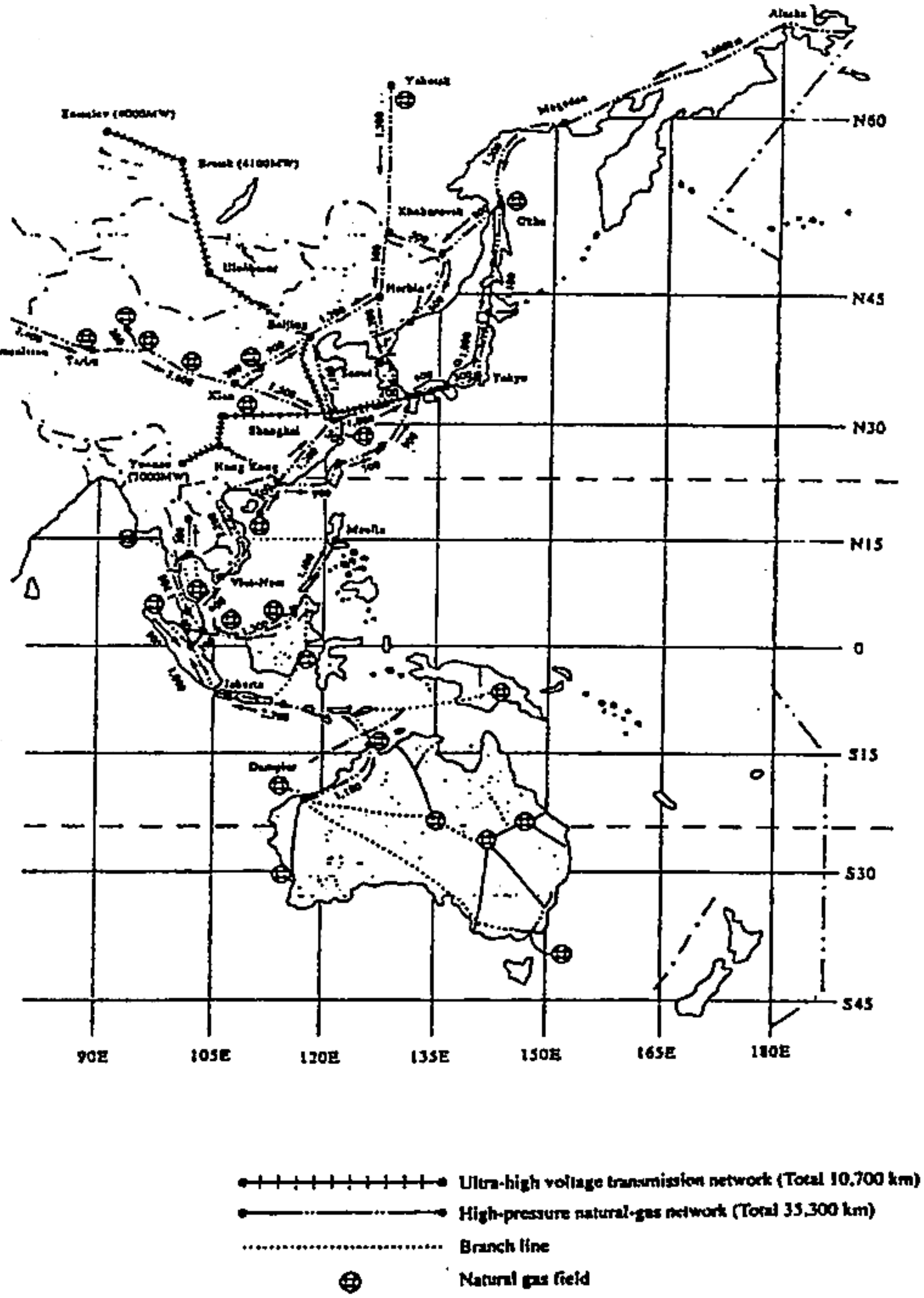
Table 3-1: Qualitative Comparison of Production Characteristics of Northeast Asian Countries

	Oil and Gas	Coal and Minerals	Labor	Capital	Technology	Managerial Expertise
Russia	VR	VR	VP	VP	S	S
China	R	VR	VR	VP	S	S
Taiwan	S	S	S	R	R	R
N. Korea	A	R	R	VP	VP	VP
S. Korea	A	S	S	R	R	R
Japan	VP	S	S	VR	VR	VR

Note: VR = Very Rich; R = Rich; S = Short; VP = Very Poor; A = Absent

Source: Paik, Keun Wook, 1995, *Gas and Oil In Northeast Asia*, Royal Institute of International Affairs, London, 274 p.

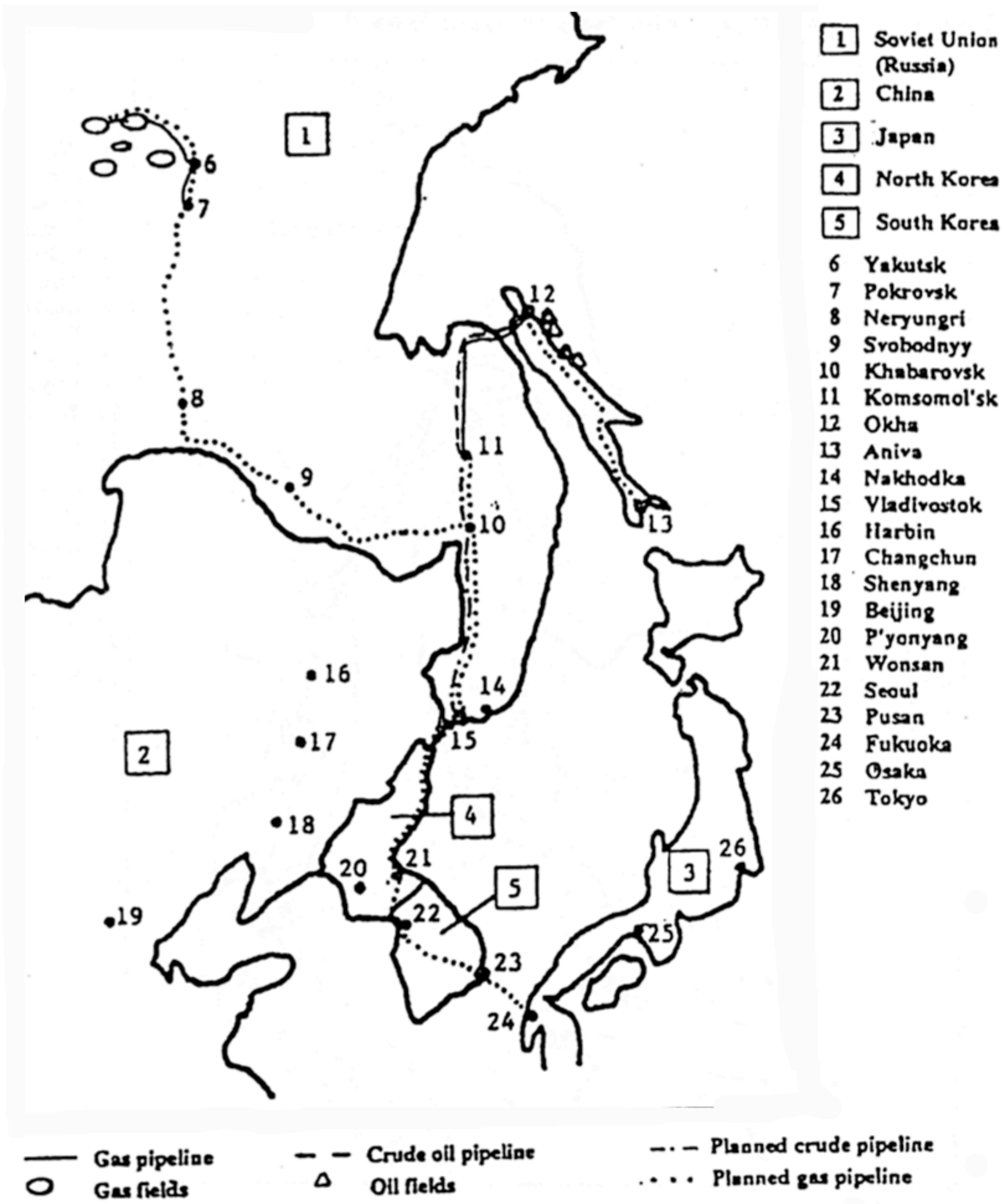
Figure 3-1: The revised Asia-Pacific Energy Community Plan for a natural-gas pipeline grid



Source: Proposal by Masaru Hirata, National Pipeline Research Society of Japan, June 1993; map 6.2 in Paik, supra n. 16, p. 184.

northern Pacific section consisting of Turkmenistan--West China--Korea--Japan; the Yakutsk--China--Korea--Japan grid; and the Alaska--Sakhalin--Japan grid. The second section would connect southern China, Southeast Asia and Australia. This plan obviously overlaps the Vostok project and the $10 billion Trans-ASEAN Gas Pipeline project which would carry natural gas from Indonesia, Malaysia, and Brunei to Singapore, Thailand, and the Philippines.

Figure 3-2: The Vostok plan: Pipeline route



Source: Hyundai Resource Development Company; map 7.5 in Paik, supra n. 16, p. 230.

The Vostok Plan

In 1991, the crumbling Soviet Union proposed a plan to develop and utilize Sakha and Sakhalin gas--15.7 million tonnes a year (mt/y) (17.4 bcm) for the RFE and 13.3 mt/y (14.8 bcm) for export,--6.0 mt/y (6.7 bcm) each to South Korea and Japan, and 1.3 mt/y (1.4 bcm) to North Korea. The cost was estimated in 1991 at $13- 15 billion for Sakhalin I, $10-12 billion for Sakhalin II, and $20 billion for the Sakha project. [26]A 3,230 km gas pipeline would be constructed from Sakhalin across Russian territory, through North Korea, on to South Korea, and eventually under the Tsushima Straits to Japan. Another 3,050 km of gas pipeline would run from Yakutsk to Khabarovsk.

However Japan seems more interested in a direct pipeline link between the Sakhalin gasfields and Hokkaido (Figure 3-3). Since the first Sakhalin concessions went to Japan, South Korean interest in the plan evaporated and the 1991 version of the plan stalled.[27] China was also not included in the plan. In 1989 Chung Ju- Yung, Chairman of the Hyundai Group, in essence revised and revived the plan by proposing a pipeline from Yakutsk through Primorskie Krai and North Korea to South Korea, and then under the Tsushima Straits to Japan.[28] It was hoped that this project would both ensure Korea's energy supply and enhance South Korea/ North Korea relations.[29]

Russia has also proposed two internal eastern pipeline routes for Yakutian gas: one route extends from Yakustk to Nakhodka via Boshshoy Never, Khabarovsk and Vladivostok; the other from Yakutsk to Magadan.[30] The first route, though longer, passes through a less harsh environment to Nakhoda port, which is open year- round.

The Energy Silk Route Project

One project that demonstrates the potential enormity of regional cooperation prospects in energy includes the proposed Turkmenistan-China-Japan natural gas pipeline, which is part of the Energy Silk Route concept. This project envisions connecting the rich gas fields of Central Asia with end users in Northeast Asia, including China and Japan. It includes a 6,720 km pipeline from Turkmenistan through Uzbekistan and Kazakhstan to China and a 10 mt/y liquefaction plant on the Yellow Sea, thus reducing the cost of storing and tanker transport of the LNG.

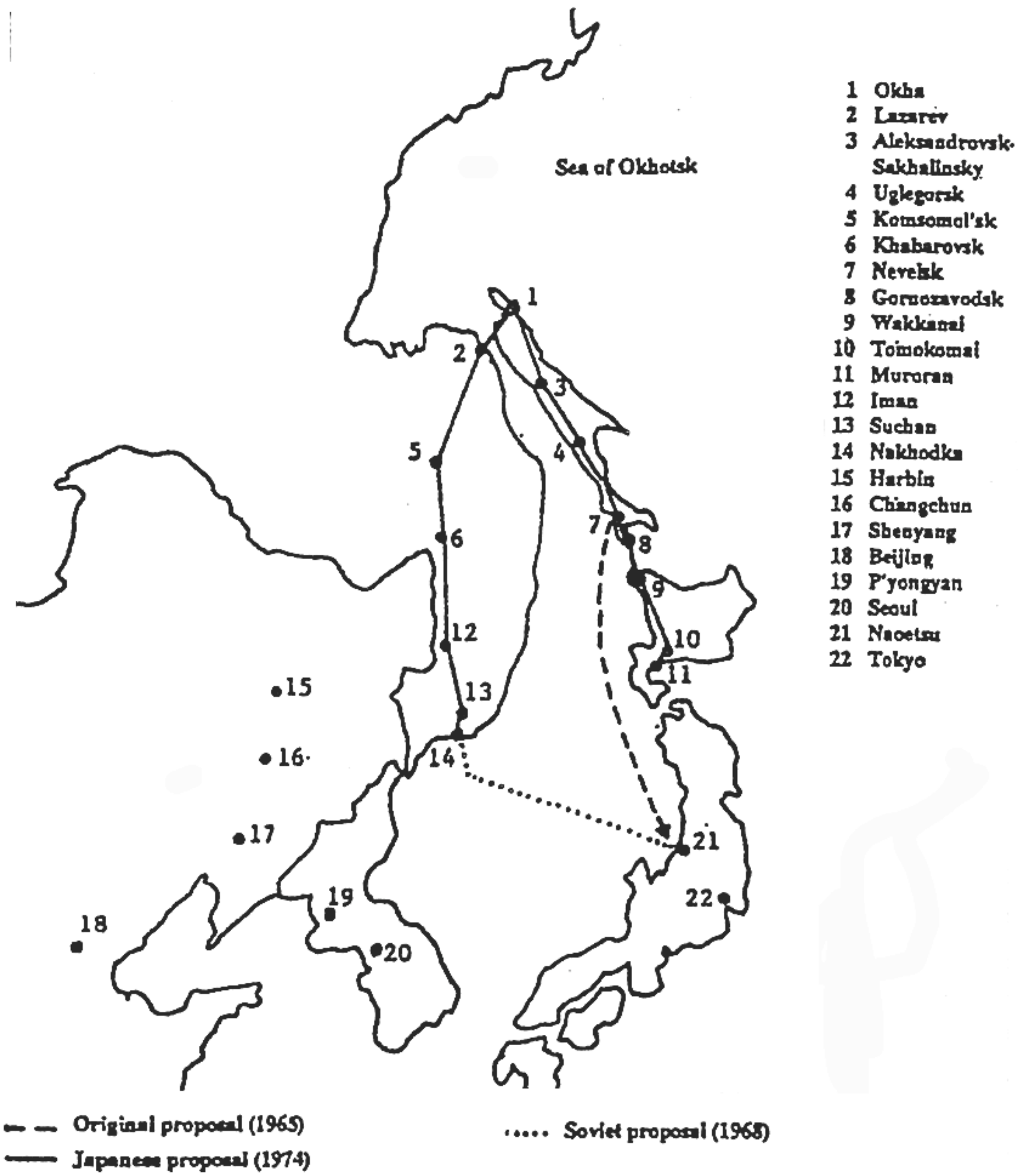
Located in the southwest corner of Central Asia, Turkmenistan is an important gas-and-petroleum producing republic and a manufacturer of chemical raw materials, cotton and animal products. Turkmenistan's energy base includes abundant natural gas. Indeed, the new nation possessed about 6 percent of proven reserves in the former Soviet Union, second only to Russia itself. Western sources place Turkmenistan's proven gas reserves at around 2.9 tcm, while Russian analysts estimate reserves at 10-14 tcm, placing the country third in the world behind Russia and Iran. Most of Turkmenistan's gas and condensate fields are in the eastern part of the country, with half of the gas reserves concentrated in one field along the Iranian border.

Three major pipeline projects are envisaged as alternative routes outside of Russia for the export of Turkmenistan gas. The most ambitious plan being discussed is a close to seven thousand kilometer long natural gas pipeline going east through China, from Turkmenistan to Japan. It would run along the route of an existing pipeline through Kazakhstan, to a completely new line which would have to be laid connecting with China's western Xinjiang autonomous region and the Tarim oil and gas basins there. The line would then move through central China to the eastern port of Lianyungang. At its eastern end, it would pass under the Yellow Sea, across South Korea, and under the Sea of Japan, before terminating in Japan. Some analysts estimate the total cost of the project at $11.8 billion up to Lianyungang, and up to $22.6 billion if the pipe is extended to southern Japan. If ever completed, the pipeline would have the largest gas capacity in the world.

The Irkutsk Region Gas Project

One plan envisions exporting Kovyktinskoye gas via pipeline to China and South Korea through Mongolia.[31] The development and pipeline cost is estimated at $10 billion. The Irkutsk region has much less autonomy than Sakha, which has declared itself autonomous, and thus gas development in Irkutsk is under Moscow's direct control and favored by it. This route is also clearly favored by China. Irkutsk gas export to Northeast Asia could be faster and cheaper than

Figure 3-3: Sakhalin gas-pipeline proposals: 1965–68



Source: Peter Egyed, *Western Participation in the Development of Siberian Energy Reources: Case Studies*, East-West Commercial Relations Series Report 20, Institute of Soviet and East European Studies, May 1983, p. 34; map 7.1 in Paik, supra n. 16, p. 208.

Figure 3-4: Energy silk route: Original plan

Source: National Pipeline Research Society of Japan; map 6.3 in Paik, supra n. 16, p. 187.

that from Yakutia because of its relative proximity to markets and the easier conditions for construction of a pipeline. Sakha, fearing competition, has begun to discuss cooperation with Moscow and Irkutsk in the export of gas.

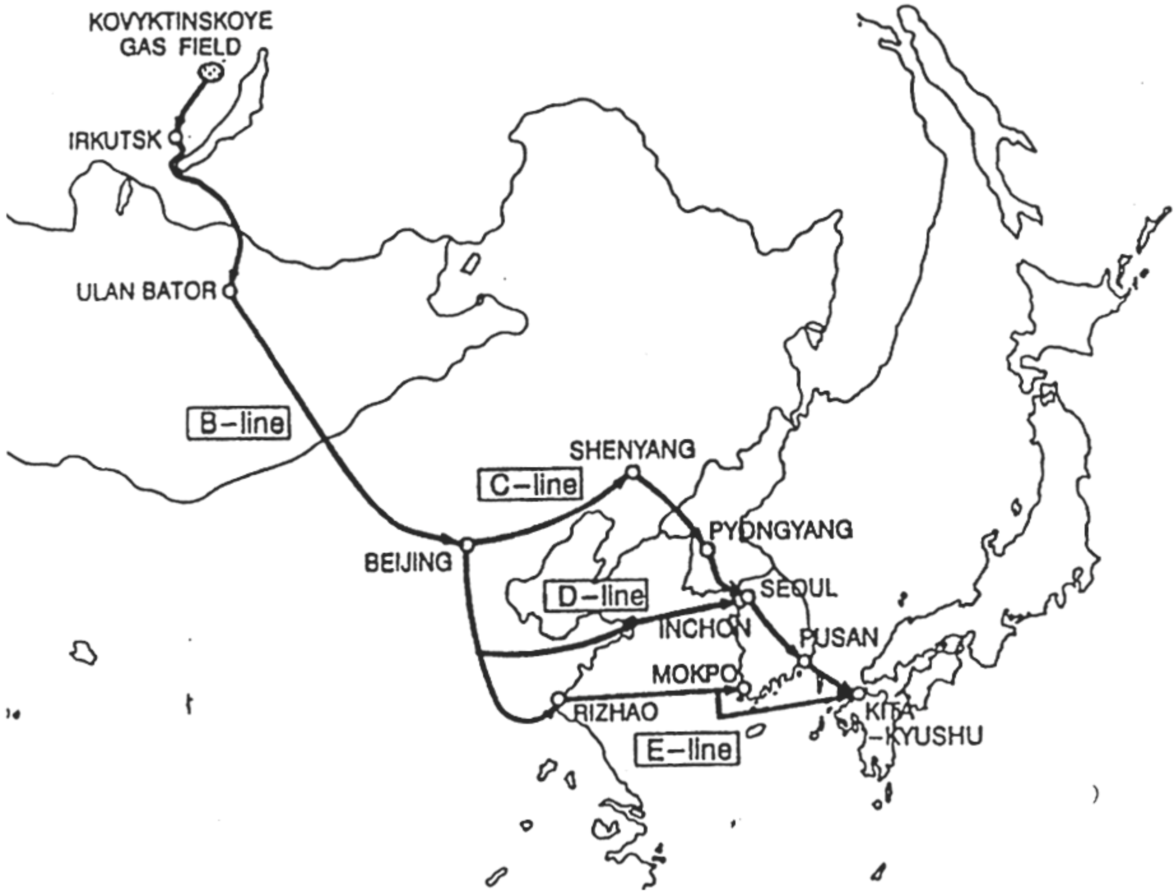
The Trans-Asian Gas Pipeline Network

The core of this proposal is a Trunk Pipeline Project from the West Baikal natural gas fields to Japan.[32] This Trunk Pipeline would be divided into two sections: the Koviktsinskoye gas field to Beijing, and Beijing to Kita-Kyushu, Japan. The first section would pass through Mongolia, and the second through Manchuria. This second section could then run down the Korean Peninsula; under the Yellow Sea to South Korea; or under the East China Sea to both Mokpo (South Korea) and Kita-Kyushu. The volume of gas to be delivered to each country is 10.0 bcm/y for Irkutsk, 8.0 bcm/y for China, 10.0 bcm/y for South Korea and 10.0 bcm/y for Japan. The total minimum construction cost over five years is estimated at $20.3 billion and the gas tariff at Kita-Kyushu would be between 3.21-4.02 $/mmbtu.

First Steps: Internal Sakha Plans

The Sakha Republic envisages the construction of three pipelines by the year 2005 to meet domestic demand.[33] These three domestic gas pipelines are part of the Republic's goal of exporting gas to the Northeast Asian market. The first is a trunk pipeline of 482 km connecting Mirny with Udachny via Chernyshevsk and Aikhal. This is currently under construction and will supply gas to the region's industrial sector, especially the diamond- mining industry. The volume of delivered gas will be 0.38 bcm/y. The second project is a 618.5 km trunk pipeline linking Kysyl-Syr with Mirny, which is now in the design stage. It will run from the Srednevilyuisky gas deposit and create a common gas pipeline grid passing through the central region of the Repub-

Figure 3-5: Irkutsk–Japan Route



Source: Figure 1 in Asakura; supra n. 22.

lic, and could deliver gas from the Vilyuisky deposits to the Aikhal- Udachninsky industrial center. Projected through-put capacity of this pipeline is 1.4 bcm/y. The third line is expected to carry 3.0 bcm/y.

Coming Down to Earth: Problems to be Overcome

Serious interest in these pipeline plans, at least from the perspective of the Japanese government and companies such as Mitsubishi, is indicated by their undertaking of feasibility studies including detailed estimates of the costs of constructing various pipelines. Table 3-2 shows the cost estimates for three separate trans-Eurasian lines, including the Turkmenistan-Japan, or Kita-Kyushu, route. The National Pipeline Research Society of Japan has estimated the cost of constructing an Asia-Pacific natural gas pipeline to be $1.55 million per kilometer.

While many factors favor regional cooperation in Northeast Asia (such as an abundance of natural resources and labor and growing demand for energy and minerals), the potential constraints on multilateral activities are numerous, and include: imbalance of military and economic power; differing political systems; incompatible ideologies; political conflicts; differing pricing systems; competing demands for capital; infrastructural constraints; and incomplete legal regimes. Given these and other problems, relatively smaller projects involving energy and minerals exploitation may be more suitable for regional cooperation activities than the multi-billion dollar mega projects described in this paper. Smaller projects can offer less uncertainty, fewer risks, and a quicker pay off, while providing the experience in international coop-

Figure 3-6: Eurasian international natural gas transmission systems

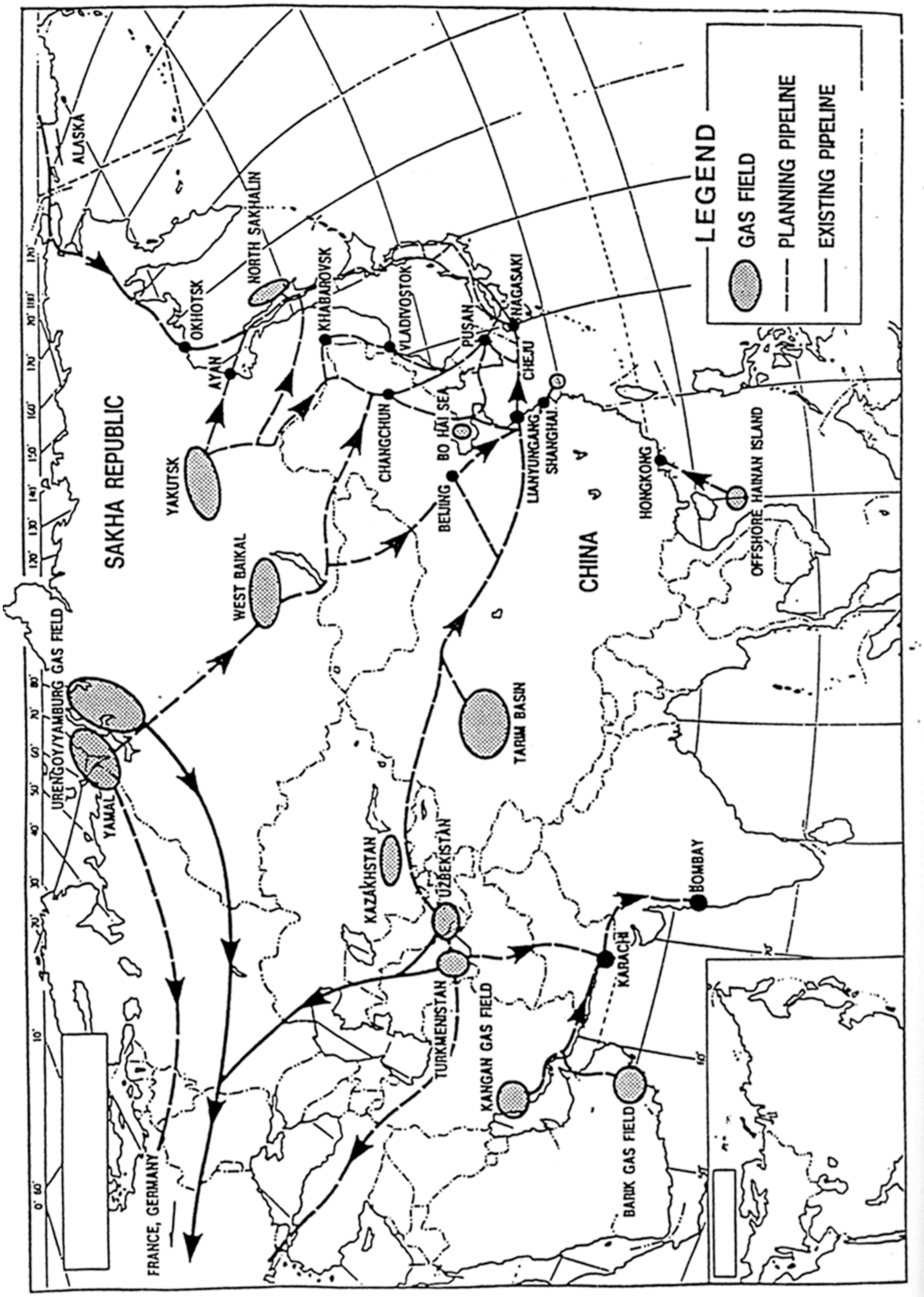
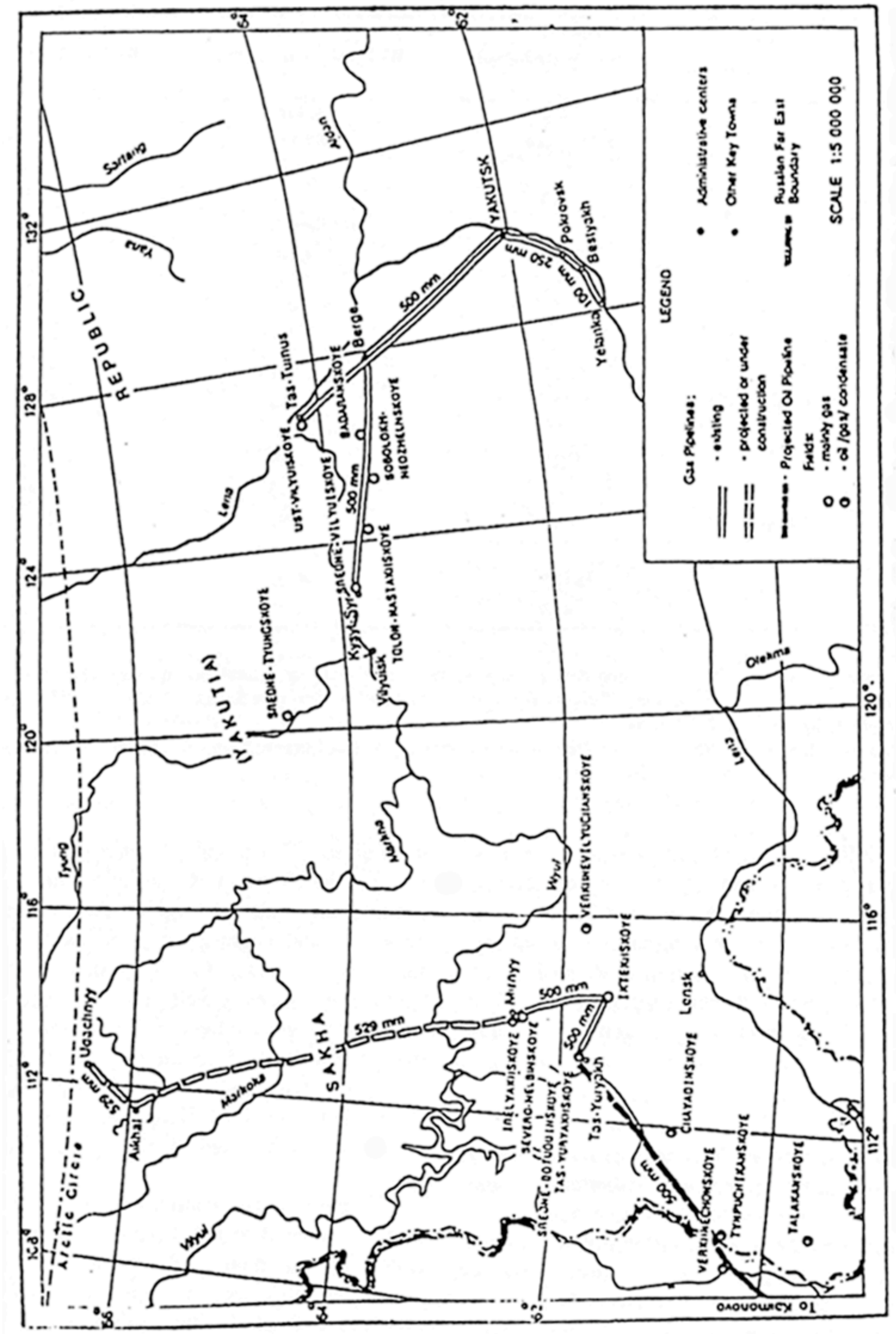


Figure 3-7: The Sakha Republic pipeline grid



Source: "Oil and Gas in the Russian Far East," a study report prepared by Fesharaki Associates Consulting and Technical Services, Honolulu, Feb. 1994, p. 205; map 7.3 in Paik, supra n. 16.

Table 3-2: Japanese Cost Estimates of Three Trans-Asian Gas Pipelines[a]

Route	A-Line (Turkmenistan-Japan)	B1-Line(Russia-Japan)	B2-Line (Russia-Japan)
Well	Ashkabad	Yakutsk	
Consumer	Kitakyushu	Wakkanai	Kitakyushu
Length (km)	7,475	2,950	4,800
Volume of gas (BCM p.a.)	20	21	21
Construction Cost		(Million $)	
Material	9,480	4,170	6,617
Construction	3,591	1,520	2,314
Scada system	2,364	1,121	1,697
D/E	789	345	541
Interest	6,327	2,791	4,356
Grand Total	22,550	9.948	15,525
Annual Cost		(Million $)	
Capital Cost	3,210	1,416	2,210
Running Cost	515	475	503
Grand Total	3,725	1,891	2,713
Tariff			
($/1000m3)	186.25	90.05	129.19
($MMBTU)	4.69	2.27	3.26

[a]Japanese government and industry officials envision three primary routes for trans-Eurasian natural gas pipelines. They include: (1) A-Line-- Askhabad-Urumqi-Lanzhou-Xian-Lianyungang-Cheju-Kitakyushu; (2) B1-Line--Sakha-Ayan-Sakhalin-Wakkanai; and (3) B2-Line--Sakha- Changchun-Beijing-Qingdao-Seoul-Kitakyushu.

Source: Hirata, Masaru, March 1995, "A Proposal on Trans-Asian Natural Gas Pipeline Network," Intnl. Conference on Northeast Asian Natural Gas Pipeline, Tokyo.

eration necessary to establish large projects in the future. Regardless of the size of the project, however, shortages of capital can impede the development of joint-ventures involving resources.

Political Problems

The Kurile Islands/Northern Territories dispute is likely to prevent any significant Japanese investment in the development of Russian gas for the foreseeable future. Moreover, Russia's very political instability, its provincial/national power struggles,[34] and its insufficient or uncertain legal system also inhibit external investment. Certain to figure in any political risk analysis for these proposals is the possibility of pipeline sabotage due to local unrest. This possibility increases as ethnic minorities and localities in Russia and China demand their political and cultural "rights." At the least, the many provinces and countries crossed by the pipeline will likely exact charges for its passage. And negotiations between provinces as well as between countries for allocation of the gas are likely to be extremely difficult. Further, Japan has no relations with North Korea and passage of the pipeline through North Korea requires *detente* between North Korea and the rest of the region, including South Korea, if not outright Korean unification.

To date, energy relations have been bilateral rather than multilateral and this realist pattern may continue. Competing national goals for energy projects could actually increase tensions rather than enhance cooperation. For example, if the current approach of separate bilateral development for offshore Sakhalin, Sakha and Irkutsk continues, multilateral cooperation may be more difficult. And if Japan focuses only on secure supply for itself, say from Sakhalin, then multilateral energy cooperation will be retarded or bypassed. Meanwhile, Russia is apparently using the prospect of South Korean investment in development of its energy resources and Korea's strategic location for pipeline links to Japan as a counterweight to Japan. China may have opened the East China Sea and the Tarim Basin for investment in part to distract Japanese and South Korean interests from Russian oil and gas.[35] And if the Japanese government supports the implementation of the Energy Silk Route project connecting the gas fields of Central Asia with China, South Korea and Japan, significant development of Sakha gas will be delayed.[36] Although most of the projects are still in the feasibility stage two rival giant Japanese firms, Marubeni (together with the World Bank, UNDP and Mobil) and

Mitsubishi (together with Exxon) are competing to build pipelines tapping Central Asian gas for Northeast Asia. And the China National Petroleum Corporation is hedging its bets by participating in both projects.[37] Clearly, Japan's decision regarding its future energy supply will be a major factor in accelerating or delaying implementation of any of these proposals as well as the prospects for multilateral cooperation.

Economic Problems

To attract such huge amounts of foreign capital, China and especially Russia must successfully undertake complex financial and monetary reforms to establish a reliable and predictable economic environment. The pace of such reforms, particularly in Russia, is unsteady, and its direction uncertain. The current low price of energy is another disincentive, and in this context, the scarcity of investment capital and increased competition for this scarce capital will be a major problem for these multibillion dollar projects.[38] Other proposed projects which are competing for the scarce energy investment capital include the Caspian Sea, Alaska and Natuna. Indeed these projects are also seeking Japanese and South Korean commitments for development and they may well be more attractive to Japanese industry, politically, if not economically. Commitment to any of these projects would probably delay development of Russian gas. In any event, capital importers will clearly face tighter capital supplies, higher interest rates and higher degrees of capital repatriation.

Capital Scarcity

During this decade much of the world has experienced slow economic growth, or recession. As the world's leading economies continue to struggle to improve their own domestic conditions, capital for overseas investment has become increasingly scarce. Yet, considerable funds are needed to reconstruct the former Soviet Union and Eastern Europe, while also restoring the health of the global environment and curbing the rise of pollution. Indeed the capital scarcity and competitiveness have been predominant in the first half of the 1990s. Most capital importers, for example Latin America, Africa, South and Southeast Asia, and China, will face tighter capital supplies in the years ahead, as well as higher interest rates and higher degrees of capital repatriation associated with their direct foreign investment, while the burden of financing internal investment will tend to fall increasingly on their own domestic savings.

The issue of capital scarcity and its potential impact on multilateral energy projects in Northeast Asia raises several important questions, including (1) what will be the sources of capital; (2) what will be the total capital requirements for the energy sector (including maintenance, replacement, and environmental control); (3) what forms of investment will predominate during the remainder of the 1990s; (4) will oil and gas companies be expected to substantially increase capital expenditures on environmental protection; and (5) will the so- called transitional economies of Northeast Asia receive the massive funds they seek to further develop their energy industries. Ultimately the costs and benefits of initiating large multilateral energy projects will be the primary determining factors in their establishment. For the projects to be favorable economically, energy demand, and particularly oil and gas demand, and the price of energy in Northeast Asia must continue to rise.

Much of the hope for developing the Sakhalin oil and gas and Tumen River Basin projects, as well as the other cooperative ventures in energy and minerals, is predicated on substantial inflows of South Korean and particularly Japanese investment over decades. To provide an indication of whether Japan is likely to invest the capital needed for joint resource development in Northeast Asia, Table 3-3 presents figures of Japanese foreign direct investment in Asia for the three decades between 1951 and 1988, disaggregated by category, including resources development. Less than one-quarter (or 22.8 percent) of Japanese direct foreign investment in Asia during the three decades was in resource development projects, amounting to 7.34 billion U.S. dollars. Moreover, most of this investment was directed at the Indonesian energy and metal sectors, notably oil and gas (LPG and LNG) and bauxite and aluminum. While Japanese investment in resource development overseas has increased in nominal terms since the 1950s/1960s, the pace of growth slowed considerably after the second oil shock of 1979/1980. Structural adjustment of the Japanese economy led to less energy consumption, therefore reducing the need to secure stable and diversified sources of supply. Clearly, for these several pipeline proposals to receive the funding they require from Japan, the country will have to shift its emphasis away from investment into manufacturing and commerce, and begin to emphasize resource devel

Table 3-3: Japanese Foreign Direct Investment in Asia (1951-88)

	NIEs				ASEAN				OTHER		
US$ million	**Hong Kong**	**S. Korea**	**Tai-wan**	**Singa-pore**	**Indo-nesia**	**Thai-land**	**Malay-sia**	**Philip-pines**	**China**	**Rest of Asia**	**Total**
Manufacturing	492	1,589	1,473	1,990	2,955	1,456	1,350	510	349	207	12,371
RESOURCES DEVELOP-MENT	33	21	4	5	6,441	38	179	455	48	119	7,343
Commerce and services	5,515	1,506	246	1,744	400	416	294	144	1,575	85	11,925
Others	127	132	68	73	8	82	11	11	64	12	588
Total	6,167	3,248	1,791	3,812	9,804	1,992	1,834	1,120	2,036	423	32,227

Source: The Export-Import Bank of Japan.

opment activities, in contrast to its decisions between 1951 and 1988.

South Korea too, while placing importance on investment in mining and related activities, in actuality provides very little capital to resource development projects. Between 1968-1985, for example, Korea's direct foreign investment in mining totaled just $235.3 million, spread over thirteen projects.

Technical and Environmental Problems

The climate and physical conditions of Sakha and Sakhalin are daunting.[39] Drilling off Sakhalin is limited to three months of the year, and platforms are very expensive; moreover, ice damage to such structures is a concern. Average January temperatures in Yakutsk are-35°C to -40°C, and there is less than six hours of daylight. In addition to human discomfort, transportation equipment must be warmed or kept running, and tires must be specially produced or they crack. Ice fog builds up from human breath and exhaust fumes, hampering transportation, especially at airfields. Winter temperature inversion exacerbates this problem. Permafrost covers most of Yakutiya from 60-250 m, the latter depth being common in the large natural gas basin. In a permafrost environment, any surface heat can cause shallow melting or upheaval; in summer the ground becomes a quagmire because of the inability of snowmelt to be absorbed. Roads must be elevated on protective beams or they break up and collapse. Buildings must be elevated on pilings to prevent foundations from sinking. In this environment, costs inevitably rise and construction schedules are prolonged. To make matters worse, the area across which a Yakutiya gas pipeline must pass is among the more seismically active zones in Russia. Although seismic events in the gas field itself average an intensity of less than 5 on the Richter scale, the area to the south has experienced seismic events ranging from 7 to 8. Permafrost increases the possibility of seismic damage to construction.

These regions lack much of the necessary infrastructure for development of energy resources--roads, railroads and airports. As a result few people live in these areas and labor must be imported, serviced and supplied at high costs.

Concerns over environmental damage must also be addressed. For example, Yakutia is a largely pristine complex of mountains, forests and wildlife. The "Green" movement is growing there as elsewhere in Russia and environmental concerns have already resulted in a cutback of diamond mining there. To obtain loans for infrastructure from international lending institutions, e.g., the World Bank or the Asian Development Bank, they must be satisfied that environmental damage will be kept to a minimum.

A Northeast Asia Energy Forum?

Northeast Asian countries must calculate the cost of basing current development programs on bilateral rather than multilateral relations. Even though a number of major international oil and gas companies are participating in the preliminary stages of these projects, strictly speaking, the Sakhalin-I and II projects and the Tarim Basin project are bilateral, rather than multilateral. Yet because of the scale and geographic breadth of the projects, multilateral cooperation seems necessary if Russia is ever to become an important energy source for Northeast Asia.

The uneven distribution of major production factors among the Northeast Asian countries paradoxically indicates mutual benefits can be derived from energy cooperation among the countries. Russia and China have huge oil and gas reserves but need capital, advanced technology and equipment for their exploration and development. Japan, Taiwan, and South Korea have the necessary capital, technology and equipment and need to lessen their heavy dependence on Middle Eastern oil. The mutual benefits would not only be economic. A gas pipeline from Russia through North Korea to South Korea and Japan could only be undertaken through a pan-Northeast Asian agreement on energy which would clearly contribute to better relations.

A model for Northeast Asian energy cooperation exists--the European Energy Charter. Its goals were to agree on binding investment protection, transit of energy supplies, environmental protection, development of energy security installations, dispute settlement procedures, and increased energy security throughout Western Europe and the new democracies. The real impetus for the treaty lay in the desire to assist in the economic development of Central and Eastern Europe through greater cooperation and foreign investment from Western industrial nations and corporations. However, the European Charter does not finance or put projects together, but rather provides institutional assistance to potential investors in the event of political problems. Of course, the introduction of such institutional arrangements in Northeast Asia, which has no history of multilateral cooperation, would be a major undertaking, and finance and project-development issues would be magnified.[40]

Although it is difficult and dangerous to transfer experience from one region to another, two fundamental ideas adopted by the European Energy Charter might be considered for Northeast Asia. One would be to promote a consensus in all Northeast Asian countries on the central objectives of energy policy, such as energy saving, diversification of supplies, integration of networks, nuclear safety, and environmental conservation. The other would be to create a political, legal, and if necessary, financial instrument to include substantial transfers of capital, management ability, expertise and technology necessary to rational development of the medium and long-term supply and consumption of energy in Northeast Asia.

Such an arrangement might also draw lessons from the ASEAN Council on Petroleum (ASCOPE).[41] ASCOPE was formed in 1975 to promote and extend cooperation among state oil companies/agencies in each ASEAN country. The Council consists of the heads of each national company/agency. Its impetus was the 1973 oil shock and thus an emergency petroleum-sharing scheme was its first priority. Its major thrust was the priority provision of oil by producers to consumers during times of worldwide shortage, and the priority purchase of oil by consumers from producers during a glut. However, data and technology exchanges and joint training programs soon followed, becoming more comprehensive every year. ASCOPE sponsors an annual Technical Conference which has become the nexus of oil and gas discussions in the region. And ASCOPE laid the groundwork for an ASEAN Committee on Energy comprised of the Ministers of Energy of each country which pursues technical and policy cooperation.

There are oil and gas complementarities in Northeast Asia which are similar to those in ASEAN. Data and technology exchange in petroleum exploration, development and utilization, joint training programs, policy discussions and a major annual Conference could be a big boost to cooperation in this sector and lay the foundation for more difficult areas of cooperation such as joint development of petroleum in areas of overlapping maritime claims, as well as broader cooperation in the entire energy sector.

Needed are gradual step-by-step confidence-building efforts in the energy sector with achievements to attract the attention and support of governments. Such confidence-building might initially be primarily bilateral and consist of private level contacts among individuals and institutes. These contacts might be strengthened by data exchange, conferences such as this one, and even joint resource assessment. This web of bilateral government and non-government relations could eventually evolve through a loose multilateral network to a more formal multilateral organization. This evolution could be assisted by the organizing of multilateral non-governmental conferences on issues of mutual concern, e.g., the realistic supply and demand schedules and patterns for a Northeast Asian gas grid; the most logical complementarity of related industry sites and types; and the implications of such a grid for national development plans. There are obviously a plethora of questions that need to be addressed. A Northeast Asia Energy Forum might be formed in this region to discuss and analyze these questions as well as other cooperative aspects of energy resource development and use, including supply and demand agreements.

Conclusions

In summary, the increasingly positive political climate in Northeast Asia certainly provides an opportunity to think boldly and creatively about regional regime building. Japan, South Korea and Taiwan have the markets, the capital and the technology to develop energy resources and both Russia and even Central Asia have enormous untapped natural gas deposits. A multilateral functional approach to developing and delivering natural gas could build confidence, dampen frontier tensions, and improve relations in this region so critical to world peace and prosperity. However, there is considerable competition among consumers for secure supply, and among potential suppliers regarding the exact routing of any pipeline.

Competing and overlapping proposals for a multinational gas pipeline link include The Asia-Pacific Energy Community, The Vostok Plan, The Energy Silk Route Project, The Irkutsk Gas Project and The Trans- Asian Gas Pipeline Network. These proposals all face serious political, economic, technical and environmental obstacles that must be overcome if any are to be implemented. In this context a Northeast Asia Energy Forum could foster discussions aimed at resolving or overcoming some of these obstacles and contradictions. However, unless the economics of these projects are favorable, they will not take place, despite the additional benefits of improving political relations.

Endnotes

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27. *Ibid*., p. 232.
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29. 29 *Ibid*., p. 40.
30. *Ibid*., pp. 233-234.
31. *Ibid*., pp. 234-237; 206.
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