NORTHEAST ASIAN ENERGY DEVELOPMENT IN A GLOBAL PERSPECTIVE

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This paper is firstly about Northeast Asia as an economic region, as a market for fuels and energy, and as a source of fuels and energy. It is secondly about Russia, specifically East Siberia and the Russian Far East, as a potential source of fuels and energy and even more specifically, as a source of natural gas for the region.

The energy industries of the United States are already aware of the big oil and gas development projects involving Exxon, Shell, and other international companies on Sakhalin Island just north of Hokkaido. These ventures have also provoked notice in the general press, and large trade missions from Alaska and the Pacific Northwest to Sakhalin.

However, a potentially bigger and strategically more important project to serve East Asian load centers with Russian gas has hardly been noticed in the United States, and thus far it inspires little credibility and little interest from the few Western oil and gas companies who know something about it. This venture would connect gas reserves in several basins of Eastern Russia through a hub near Irkutsk by a large-diameter (56-inch) pipeline across Mongolia to a downstream hub near Beijing. From this point, spur pipelines would branch throughout north China, toward Shanghai, and into Manchuria, Korea and Japan.

The concept is not new. For almost ten years, our Japanese colleagues have been studying the feasibility of route and design variants on a Northeast Asian pipeline grid. For about five years, moreover, a multinational consortium initiated by South Korean industry has been focusing on ways of moving gas from the Sakha Republic (Yakutia) overland through fuel-deficient areas of the Russian Far East, to Korea and Japan. It is only in the last year that these ideas have gained sufficient coherence, momentum and visibility to be regarded as proposals, rather than mere hypotheses.

In the United States, however, neither the Irkutsk corridor nor any other trunkline proposal for Northeast Asia has yet to surface in the general media, or even in the oil and gas trade press.

On the other hand, a swelling chorus of press notices from Asian and Russian sources have appeared recently that have marked the coming of age of a movement to bring Eastern Russian gas into East Asia. The following citations, with added emphasis given to specific sponsors or advocates, date from August 5 through last week:

Nikkei, August 5:

> Tottori Gas Co. has proposed an international joint venture to lay a pipeline from gas fields in Russia's Irkutsk to Japan.
>
> The pipeline would run 5,000 km from Irkutsk, through Mongolia, China and Korea, to Japan. Capacity would be 65 billion cubic meters per year, which is forecast to bring some 4 billion dollars in revenue. The gas would be sold to the utility companies of the participating countries.
>
> The 10-billion dollar project would be jointly funded by Japan, Russia, China, Mongolia and the two Koreas in the form of a joint-stock company, to be capitalized at 2.5 billion dollars. A group of Japanese oil and gas companies headed by the Japan National Oil Corp. are drawing up plans for participating.

Itar-Tass, Tokyo, August 20:

> Japan is posed to take a most active part in the project designed to develop the Kovytkinskoye natural gas field in the Irkutsk region in southern Siberia, and to lay a pipeline to carry the gas to China, South Korea and Japan.
>
> A pool of 10 Japanese-based private firms plan to set up a joint-financed company, which is to become Japan's main participant in the project. The company, which is likely to be founded before the end of this year, incorporates such firms as the Tokyo Gas gas industry enterprise, the Shinnihon Seitetsu steel plant, the Sumitomo Shoji trading firm, the Sekiyu Shigen oil industrial company, and the Sekiyu Kodan oil industrial corporation partially owned by the state.
>
> The bulk of the funds will go to build a 3,500kilometer pipeline via Mongolia to Beijing, which is to become one of the gas consumers. A 1, 200kilometer line via South Korea to Japan will be laid at the sea bottom. Japanese experts put the proved reserves of the Kovytkinskoye gas field at 850 billion cubic meters, 10 times as much as Japan consumes annually.

Nikkei wire service, August 21, a similar story with the following added detail.

> The Japanese participants are Tokyo Gas Co., Osaka Gas Co., Nippon Steel Corp., Sumitomo Corp., Itochu Corp., Marubeni Corp., Nissho Iwai Corp., Japan Petroleum Exploration Co., Teikoku Oil Co., and Indonesia Petroleum Ltd. Mitsui & Co. may join the project. British Petroleum Co., Marathon Oil Co. and Exxon Corp. are also expected to participate."

Hart's Asian Petroleum News, August 25.

> In preparation for an upcoming meeting in Moscow, Japan's Ministry of Trade and Industry (MITI) and Japanese National Oil Co. (JNOC) have stepped up further preparations on the proposed natural gas developments from Irkutsk fields and the pipeline which would transport the gas to Japan.
>
> All this is related to the exchange of letters of intent between President Yeltsin and President Jiang Zemin of China to feed gas by pipeline into the PRC.

Xinhua via Individual Inc.: Beijing , October 12.

> China is planning to build up several major gas pipeline projects. Except the completed Beijing-Sha'anxi project, the country is set to link Sha'anxi, a gas-rich region, with the Ningxia Hui Autonomous Region.
>
> Also on the agenda is to install a circle pipeline between Chengdu, capital of southwest China's Sichuan Province, and its adjacent Chongqing municipality. Moreover, the biggest pipeline project is designed to start from China's neighboring country, pass through Xinjiang and end in Shanghai.
>
> The gas consumption to total energy consumption in China is expected to increase from the current 1.7 percent to 5 percent in the year 2010.

Xinhua via Individual Inc.: Beijing, October 15.

> Russia and China have spent three years studying the physical feasibility of two

pipelines to transport the natural gas of Siberia to China's coastal areas. Victor L. Ott, Russia's vice-minister of fuel and energy, said at a press conference of the 15th World Petroleum Congress today.

Itar-Tass via Individual Inc. : Beijing, October 17

China hopes to meet its growing needs in oil by developing mutually advantageous cooperation with Russia and central Asian countries. This was said by Wang Tao, the chairman of the organizing committee for the holding of the 15th world petroleum congress in Beijing.

Kyodo via Individual Inc.: Tokyo, Oct. 19

Russia has proposed that it and three nearby countries — Japan, China and South Korea — hold a conference to study the feasibility of a natural gas project in East Siberia, government sources said Sunday.

From Japan, several of about 10 private companies interested in the project, including Sumitomo Corp. and Tokyo Gas Co., would also send officials to the conference, the sources said.

Nikkei English News via Individual Inc. : Tokyo, October 23

A group of 24 private Japanese companies has set up a study forum to promote the construction of natural gas pipelines linking Irkutsk, Russia with Japan through Mongolia, China and South Korea. Participants include Toshiba Corp., Itochu Corp., and Tokyo Electric Power Co.

The forum, whose secretariat is located at Mitsubishi Research Institute Inc., will study how to negotiate with related countries and construct such pipelines in permafrost conditions. The group, headed by Toshiba Chairman Fumio Sato, is expected to add more than 10 members in the near future.

Japan National Oil Corp., Sumitomo Corp. and other Japanese companies have already announced their readiness to participate in the large-scale development of natural gas fields in Irkutsk. Japanese Prime Minister Ryutaro Hashimoto is expected to express his support for the project when he meets Russian President Boris Yeltsin in early November.

ENERGY DEMAND GROWTH IN CHINA, JAPAN AND SOUTH KOREA

Engineering studies, international conferences, and press statements do not make projects technically or economically feasible, or politically realistic. To facilitate moving the dialogue along toward a realistic discussion of the opportunities, we would like to provide some background and some basic theses about the outlook for such ventures, without taxing your patience with too much detail or over-sophisticated analyses.

We have not developed all of the themes and theses to any depth, rather we start by listing them for the record. They are sure to recur throughout the conference sessions.

- For the foreseeable future, growing energy demand in China, Japan and Korea will account for two-thirds of the world's total investment in primary energy production and transmission. The region's total capital requirements through 2010 will be on the order of 2-to-3 trillion dollars.
- Natural gas will play a dramatically greater role in the energy budget of Northeast Asia than it has in the past.

- The most promising sources of new energy supply, and particularly of natural gas, for East Asia are in Eastern Russia.
- Russian oil and gas are far from indispensable to the economic security or welfare of China, Japan, or Korea. but the energy markets of Eastern Asia are critical and irreplaceable to the economic future of the Russian Far East and Eastern Siberia.
- The factors that will limit natural-gas development in Eastern Russia are not physical scarcity of resources, or physical difficulty in finding, proving, or transporting it to load centers in Northeast Asia; but instead the limitation will derive from the pace of the cultivation of effective markets, including timely investment in distribution infrastructure.
- A critical limiting factor in development will not be availability of capital to finance investment in production and trunkline transport, but rather organization to develop and coordinate markets to match production and transport capacity, and to mobilize and deploy capital effectively.
- Some parties clearly prefer that Americans (or British, or Canadians) not be deeply involved. Globalization is irreversible, and American participation and money will be both unavoidable and indispensable to the success of natural gas mega-ventures in Northeast Asia.

In terms of population, economic activity, and actual and prospective energy demand, East Asia is comprised mostly of China, Japan and South Korea. Here we shall call them the Big Three consumers of energy, to distinguish them from some other Northeast Asian entities, notably the Russian Far East, Mongolia, North Korea, and Alaska, each of which has a very different strategic role to play in the region's development.[2]

- China is, of course, the world's most populous country and has the world's fastest growing economy. However, it consumes less than half as much natural gas today as does the Netherlands.
- Japan has Asia's most powerful and the world's second most powerful economy. It has neither significant domestic gas production or imports by pipeline, but it is the world's largest importer of liquefied natural gas (LNG) by tanker, which it uses chiefly to generate electricity.
- South Korea, although the smallest of the three, is an extraordinarily dynamic entity with perhaps the world's highest sustained rate of energy consumption growth.

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[2] North Korea and the Russian Far East are both chronically and critically deficient in available fuel supply, and thus, over time, will account for an appropriate share of the regional increase in effective energy demand. For now, however, North Korea and Far Eastern Russia have neither the purchasing power nor the institutional arrangements needed to mobilize local capital or to recruit outside investment to fill these deficiencies. We have addressed the potential kinship between Alaska and Eastern Russia (of which it was once a part), in Arlon R. Tussing, *Alaska's Petroleum-Based Economy as a Development Model for the Russian Arctic and Far East*, Russian-American Conference On Arctic Oil And Gas Development, Anchorage, USA, 10 April 1995.

- As a potential source of fuels and energy, on the other hand, Northeast Asia is mostly Russia, which is the world's largest natural-gas producer and consumer, and accounts for nearly half the world's known or indicated reserves. However, the huge gas resources of Eastern Siberia and the Russian Far East are virtually undeveloped.

The increase in primary energy consumption[3] in Northeast Asia during the recent past is the simplest and most trustworthy guide to the likely growth of demand in the near future, and associated capital needs. "Capital need" is, of course, almost the same thing as "investment opportunity." We start today with simple extrapolations from experience of the last 14 years.[4] This is a more useful exercise than you might think, as the published energy statistics for this period have been reasonably credible in magnitude and reasonably comparable, both among countries and between years. In each country, moreover, both the structure and the rate of the increase in energy use have been remarkably stable over the 14-year interval.

Table 1: Primary Energy Consumption Average annual increase, 1983-96	
Japan	3.29%
China	4.93%
South Korea	10.95%
Total East Asia	5.11%

The rate at which consumption has been growing differs widely among the Northeast Asian Big Three, from 3.3 percent annually in Japan and 4.9 percent in China, where it lagged substantially behind GDP, to a remarkable 11.0 percent in South Korea.

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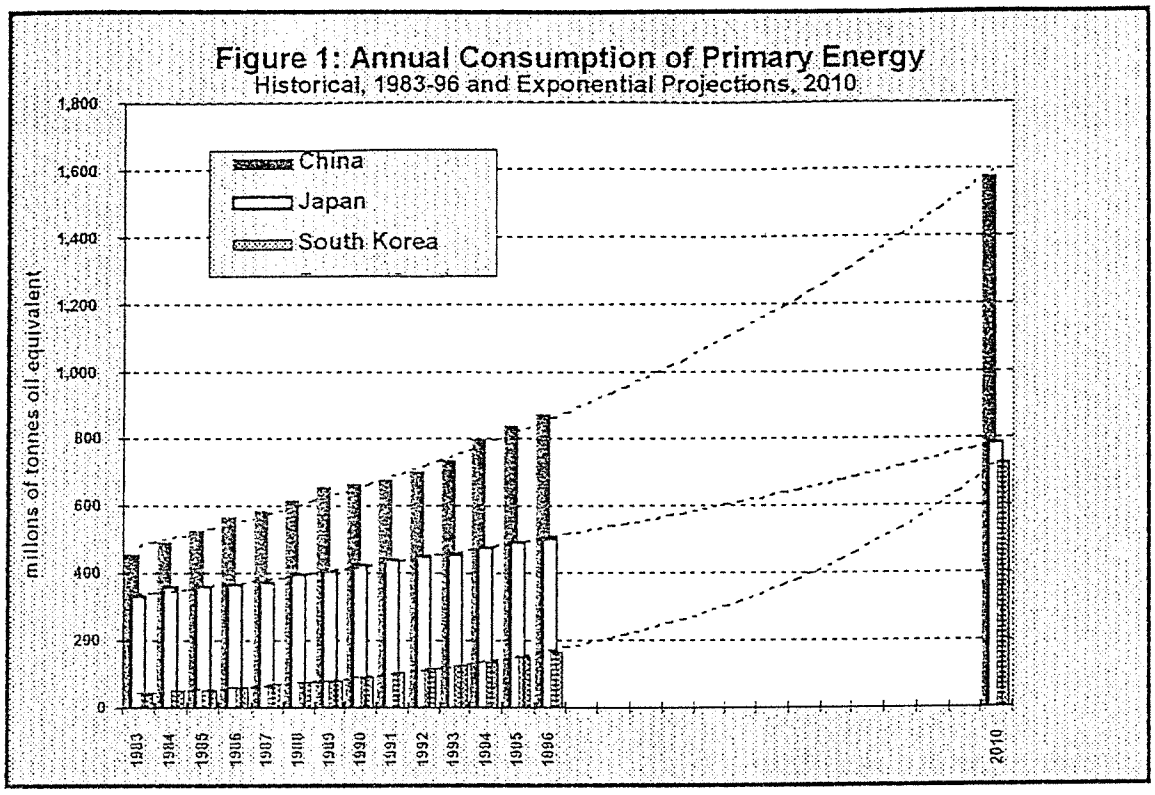
3 "Primary energy" is a measure of the physical form in which fuels and energy are first transported and/or sold. It includes the net heating value of coal, crude oil, or natural gas used to generate electricity, for example, but not the electricity so generated. Nuclear and hyropower, however, measured at the generating station bus bar, are counted as primary energy.

4 The principal source of these historical data is the *BP Statistical Review of World Energy* for 1997.



Total primary energy use in the three countries, as shown in Table 1, increased at an average annual rate of 5.1 percent. As a standard of comparison, worldwide energy consumption grew at 1.9 percent annually; by coincidence or otherwise, so did consumption in the European Union[5] and North America.[6]

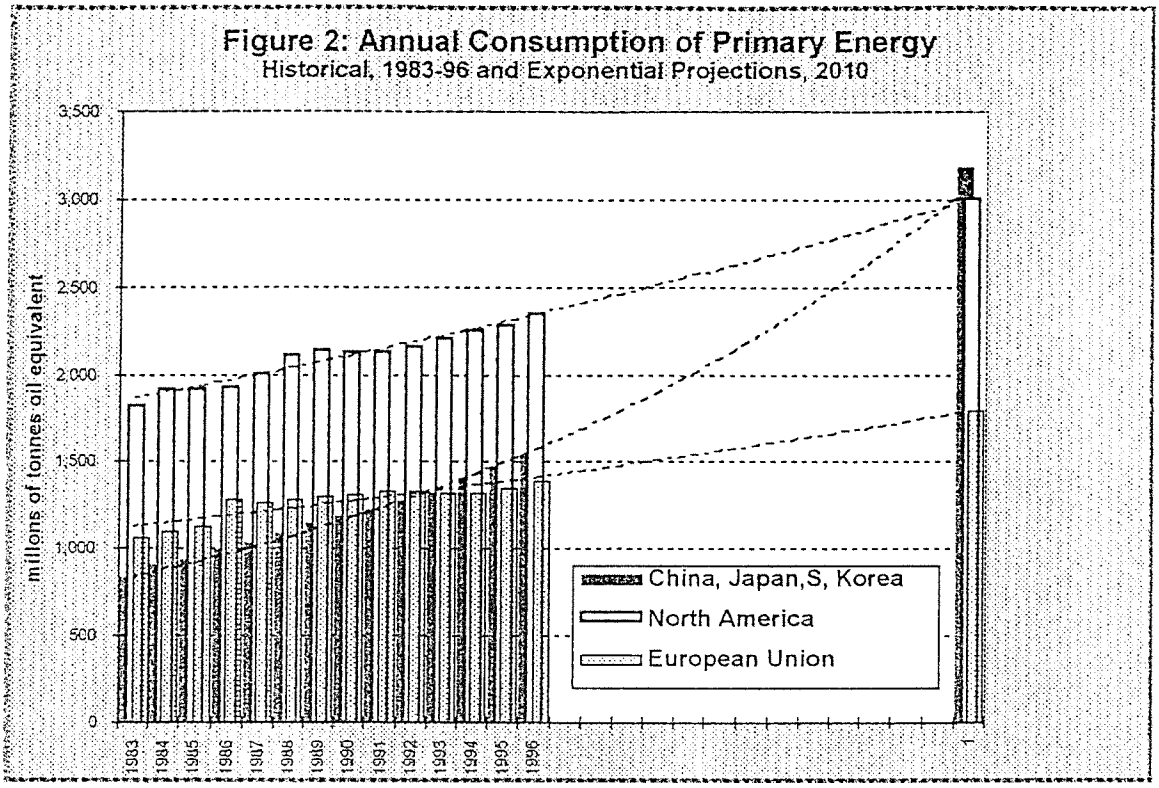
Table 2: Primary Energy Consumption Average annual increase, 1983-96	
East Asia	5.11%
European Union 15	1.94%
US and Canada	1.87%
Total World	1.93%

We have extrapolated these established trends forward for another 13 years, to 2010 — a simple-minded procedure for which we anticipate numerous commonsense and technical objections. The projections for East Asia are presented in Figure 1. Such projections will

5 The fifteen present members.

6 The United States and Mexico ~~Mexico~~ Canada

probably overstate Korea's unconstrained effective demand, for example, and understate China's. However, neither error is fatal to our present purpose, which is to establish a fix on the orders of magnitude for the investment opportunities and the challenges suggested by the East Asian market.



Extension of the last 14 years' trends to consumption in the rest of the world as well as in East Asia, as shown in Figure 2, implies that total primary energy consumption by China, Japan, and South Korea in 2010:

- will be on the order of 3,184 million tonnes oil equivalent [mtoe] — equivalent to 63.9 million barrels per day [mmb/d];
- will account for 30 percent of the world's total, up from 13 percent in 1983 and 18 percent in 1996;
- will exceed the European Union's energy use by 1.392 mtoe (28.0 mmb/d) or 78 percent, and
- will outstrip even North America's total consumption of about 3,005 mtoe (60.3 mmb/d).

These projections imply, further, that over 13 years China, Japan, and South Korea alone:

- will account for about 1,644 mtoe (33.0 mmb/d) of increased consumption, which

- will be greater than the 1997 level of total consumption in the European Union, and
- will account for about two-thirds (68 percent) of the world's total growth in energy use.

CAPITAL NEEDS AND INVESTMENT OPPORTUNITIES

Can you believe two or three trillion dollars? Table 3 presents our calculations of potential capital costs associated with these developments.

Table 3: Sample Scenario
Capital Requirements for Projected Energy Use:
China, Japan and South Korea

	Primary Energy Consumption (mtoe)	Required Replacement and New Capacity (mtoe/year)	Capital Cost (billion $US)
1998	1,705.8	166.0	$144.4
1999	1,791.3	175.1	$152.3
2000	1,882.1	184.8	$160.8
2001	1,978.4	195.3	$169.9
2002	2,080.8	206.4	$179.6
2003	2,189.8	218.4	$190.0
2004	2,305.7	231.2	$201.2
2005	2,429.2	245.0	$213.2
2006	2,561.0	259.8	$226.0
2007	2,701.6	275.7	$239.9
2008	2,851.8	292.8	$254.8
2009	3,012.4	311.3	$270.8
2010	3,184.4	331.2	$288.1
Total	30,674.3	3,093.0	$2,691.0

We have not attempted to forecast either the demand for energy or the capital cost of meeting that demand, but only to locate the vicinity of projections that a range of plausible scenarios would generate. Given quite ordinary assumptions about fuel mix, fossil fuel extraction and bulk transport costs, the following is a typical scenario for facilities costs required to support our extrapolation of energy use through the year 2010. These projections are for the cost of facilities needed to deliver fossil energy in bulk form to the plant gate, refinery gate, city gate in (or on behalf of) China, Japan, and South Korea. However, these projections do not include capital costs for petroleum refining, electricity generation plant, or local distribution of natural gas or electricity to households or small business.[7]

EFFECTIVE DEMAND AS THE LIMITING FACTOR ON NORTHEAST ASIAN ENERGY DEVELOPMENT

Experience suggests that markets (distribution networks aggregating a large customer base) have been more important than resources in developing a region's natural-gas industry. This will clearly be the case for East Asia, but may be a hard reality for resource owners in remote areas such as Alaska or the Russian Far East to grasp. In North America and Western Europe, the emergence of a natural-gas industry took the form of a step-by-step evolution of a pipeline network connecting pre-existing markets to increasingly distant supply basins.

First came synthesis of gas for local distribution from coal and sometimes oil. London had coal-based "gas works" before 1800, and "town gas" distribution systems existed in most major European and American cities by the middle of the 19th Century. Substitution of natural methane, which was non-toxic and had two to three times the energy content of coal gas, occurred first from reserves nearest to established markets, such as Appalachia, Michigan, the Po Valley and the Netherlands. Later, long-distance transmission pipelines reached out from the centers of population and industrial activity to increasingly remote producing basins, in such places as Texas, Alberta, Algeria, and Western Siberia.

In the United States, construction of high-pressure, long-distance gas pipelines surged after high-pressure rolled steel pipe became available early in the 20th Century. As late as the 1930s, half of the gas produced in North America was either "flared" at the well or

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7 "Conventional" assumptions included, for example, a laid-in cost of natural gas at Northeast Asian load centers of $4 per million btu ($1 extraction and $3 transmission), a laid-in cost of crude oil at $20 per barrel ($10 plus $10), an average 20-year economic life for all capital goods (including fuel reserves), and a 15 percent cost of capital.

burned nearby to manufacture "carbon black," actually soot, as a raw material for printer's ink. An integrated North American grid that joined the major producing areas with major load centers and with one another was not completed physically until about 1970, and did not actually begin to function as a network until after "unbundling" of gas sales from transportation in the late 1980s.[8]

In Europe, development of a natural-gas transmission grid lagged America's by at least a generation; the oil crises and attendant high prices of the 1970s triggered the most recent surge in European trunkline construction. An undersea pipeline was constructed between Africa and Italy and gas from the North Sea was connected to the main European pipeline system. Most importantly, Russian gas from Western Siberia moved into the European gas network. The added variety of sources created a diversity of competing and complementary pipeline segments, which opened new markets, reduced transmission costs, and enhanced reliability for both buyers and sellers.

TECHNICAL AND ECONOMIC OPPORTUNITIES FOR EASTERN RUSSIAN NATURAL GAS

Effective demand requires both the physical requirement (technical opportunity) for the commodity and the willingness to pay a price for the commodity that will provide sufficient incentive for some entity or entities to deliver it (economic opportunity). An upper bound on the physical requirement for natural gas in the power sector may be evaluated as the volume of natural gas that could be employed to operate all planned future generation capacity, for example. The willingness to pay for natural gas will be linked to the cost of the alternatives with which it will compete. Therefore, the gas cannot be priced too high relative to the alternatives, or it simply will not be sought after.

For the Big Three East Asian countries, Table 4 shows the planned capacity expansion expected to occur through 2010, by the respective governments. The table also provides an estimate of the share of the expansion that is expected to be financed by the private sector in each country. China's planned increase is remarkable, whether viewed as a nearly 80 percent increase over the 1995 level (and over a 60 percent increase from the 1997 estimated installed capacity of 210GW) or in comparison with either Japan's or Korea's

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8 An elaboration of this historical review can be found in Tussing and Tippee, *The Natural Gas Industry: Evolution, Structure and Economics* (Second edition, 1995) Tulsa: PennWell Books, Chapter 2 "Coal Gasification in the 19th Century and the Origins of the Gas-Distribution Business," and Chapter 3, "From Manufactured to Natural Gas and Emergence of the Gas-Transmission Industry."

planned capacity growth. Moreover, when we look at the share of the planned expansion to come from the private sector, China's private sector expansion, 68,000MW, is expected to exceed the total expansion planned in either of the other two.

Table 4: East Asia planned power sector growth to 2010

Country	1995 Capacity (MW)	Planned additions to 2010 (MW)	Expected private participation (%)	Implied private additions (MW)
China	190,100	340,000	20%	68,000
Japan	199,878	64,204	15%	9,631
Korea, South	31,665	67,844	65%	44,099

Source: International Private Power Quarterly, various trade press

Given China's central role in the linking of the Russian Far East and Eastern Siberian natural gas reserves to the Big Three, it will be instructive to examine the effective demand that may arise there.

There are currently 37 independent power producer projects solicited or in various stages of development, though not under construction, in China ranging in capacity from 150MW to 10,800MW. Nearly all of this potential capacity is currently planned to be fired by coal. The total capacity for the 37 is 62,920MW, and it is all expected to be online by 2010.

Table 5 shows the physical requirement (technical opportunity) if all of this capacity were to be fired with natural gas. The requirement will depend on the operating characteristics of the generation facilities, and three cases are shown. The three cases differ only in their thermal efficiencies, i.e., 36 percent, 40 percent and 45 percent. The different efficiencies result in technical opportunities ranging from 9.2 billion cubic feet per day (Bcfd) to about 11.5 Bcfd.

Table 5: Technical "Opportunities" for Eastern Russian natural gas based on China's private power sector				
	MW	GWh/y*	Bcfy**	Bcfd
Case 1	62,920	440,943	4,189	11.5
Case 2	"	"	3,761	10.3
Case 3	"	"	3,345	9.2

Case 1 = 36% thermal efficiency
Case 2 = 40% thermal efficiency
Case 3 = 45% thermal efficiency
* - Assumes 80% capacity factor
** - Assumes 1,000 Btus/cf

To put these technical opportunities into perspective, the total 1996 daily consumption of natural gas in China amounted to 1.9 Bcf, the total 1996 daily consumption of natural gas in Japan was 6.4 Bcf and the daily capacity of the proposed pipelines from Irkutsk and the Russian Far East is about 2 Bcf.

The physical requirements represented solely by the potential IPPs in China clearly constitute a significant technical opportunity for the East Siberian and Russian Far East natural gas. Nevertheless, to translate this technical opportunity into an economic opportunity, the gas will have to be delivered into the China market at a price competitive with the coal it would have to replace.

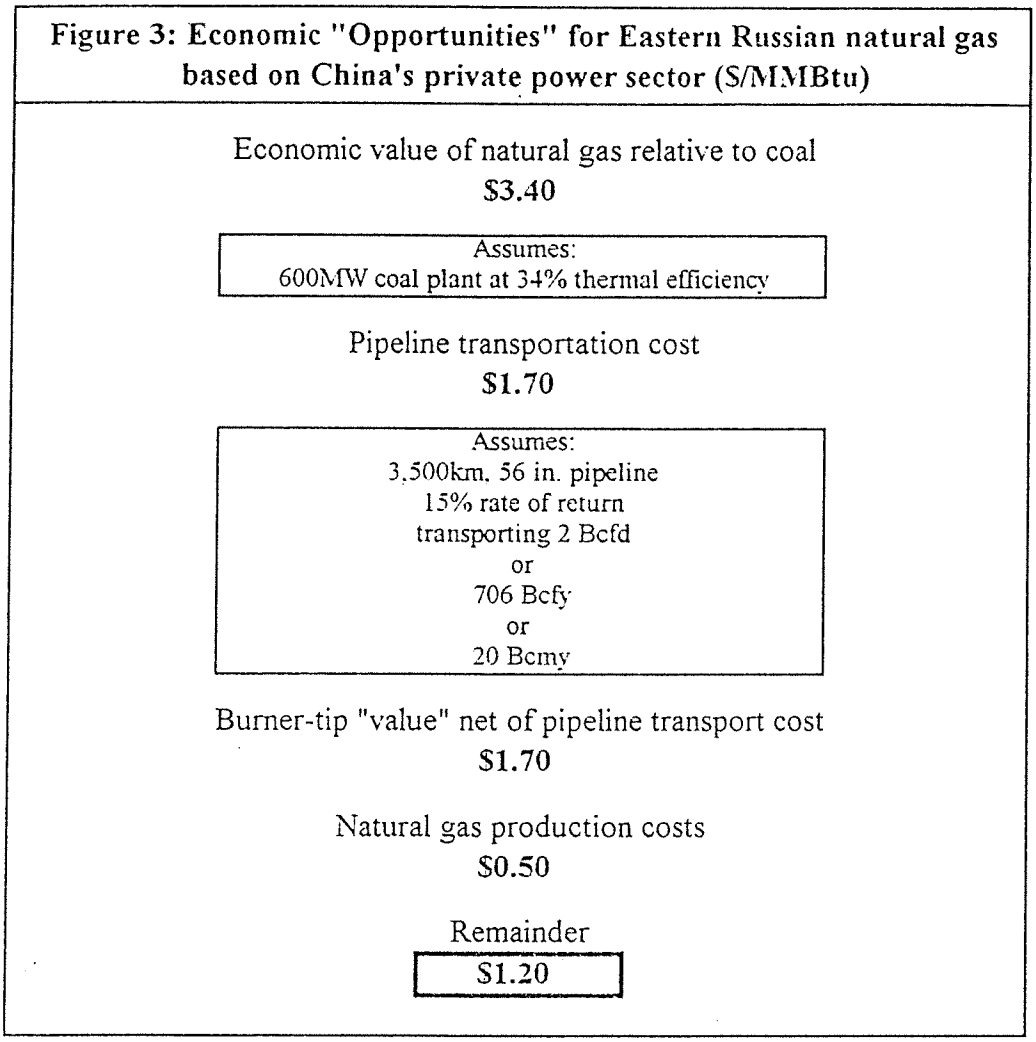
Figure 3 shows an rudimentary analysis of the possible economic viability of moving the Eastern Russian natural gas into China. The coal-based economic value of the natural gas is $3.40 per MMBtu, assuming a 600MW plant for both coal and the natural gas alternative.[9] Against this delivered value we must account for pipeline transportation costs, which amount to approximately $1.70 per MMBtu. The pipeline cost assumes that the gas will be transported through a 3,500 km, 56-inch pipeline, transporting 2 Bcfd and returning 15 percent over 30 years.

The result is a burner-tip *value* net of pipeline transport costs equal to $1.70 per MMBtu. That is, the economic value of the gas used to replace coal in the power sector of China netted back to the field amounts to $1.70 per MMBtu. For an economic opportunity to exist for moving this Eastern Russian natural gas to China, this $1.70 per MMBtu will

9 These assumptions draw upon the World Bank report, "Natural Gas Trade in Asia and the Middle East," IEN Occasional Paper No. 8, September, 1996.

have to cover the costs of field operations, return value to the producers and royalty holders, and cover transit fees, etc.

Figure 3: Economic "Opportunities" for Eastern Russian natural gas based on China's private power sector (S/MMBtu)



To provide a basis for further discussion of the potential economic viability of transporting East Siberian or Russian Far East natural gas to China, and possibly beyond to Korea or Japan, we account for field production costs by assuming them to be $0.50 per MMBtu. This is equivalent to the cost of producing natural gas in the U.S. Rocky Mountains and is comparable to the costs claimed for production associated with Indonesian gas that feeds its LNG operations. While the costs may be higher due the remoteness of the location, the $0.50 will suffice for our purposes of laying a foundation for discussion and further analysis.

The remainder, then, is $1.20 per MMBtu to be divided among the participants. Further analyses may show this amount to be lower or higher. Nevertheless, this preliminary analysis suggests that there is likely to be ample economic value to be shared among potential participants in a trunk pipeline project to ship Eastern Russian natural gas into China, and perhaps beyond.

THE ROLE OF LNG AND GAS-FIRED ELECTRICAL GENERATION

In its modern East Asian variant, LNG has played a role similar to that of coal gasification in the U.S. and Europe as a critical phase in building a market for natural gas. The remarkable increase in thermal efficiency of combustion turbines (CTs) and their widescale availability at reasonable cost have turned the economics of power generation on its head. It used to be thought that CTs were the highest cost form of power generation, to be used only for producing peak power. Typically, new gas-fired CTs or combined-cycle (CC) plants now produce baseload power more cheaply and more reliably than coal or nuclear-fired steam plants. CTs have additional advantages — portability, short installation times, and modest economies of scale, which permit phased and modular installation.

Regions with high economic growth normally have concurrent growth in electricity demand, at even higher rates. Construction of one or two large new generating stations, or repowering an existing coal-fired station, may create sufficient gas demand to justify the construction of a long-distance gas pipeline. More importantly, such facilities provide immediate cash flow to the sponsor on completion of the line. Because gas pipelines have pronounced economies of scale, spare capacity can be added at a modest increase in cost. This allows other markets for the gas to evolve gradually.

Recently, the competitive advantages of gas-fired combustion turbines for generating electricity have accelerated the growth of natural-gas markets. These installations are often of such a scale as to create an instant market for natural gas and thus provide the initial support for pipeline construction. Overall, however, gas market development in Northeast Asia is a century behind that of America.

LNG is not necessarily a competitor to pipeline gas, and in East Asia especially it can serve as an indispensable complement. Seventy percent of the region's people and, doubtless, an even larger proportion of economic activity, are located within 250 kilometers of tidewater. The industrial regions have high population densities, in which pipeline construction will prove time consuming and costly. On the other hand, most of the industrial

areas are close to tidewater, making LNG an attractive option initially as compared to pipeline gas.

However, developing LNG facilities in coastal areas will pioneer and deepen the markets for gas. Once the initial facilities are in place, regional distribution grids can be expanded incrementally to the point where consumption volumes make it economic to consider pipeline gas from Baikal, Sakha, or other remote areas. China has similar options with respect to using coal gasification as a precursor to natural gas, according to its classic historical sequence.

In broadest terms, Asia has abundant potential for pipeline-gas development, but, the first step in that development must be to create and enhance local markets for gas. The most cost-effective option for the near term may be to expand overseas LNG imports, followed by filling out the transmission and distribution infrastructure, as is now contemplated in Japan.

Emergence of a natural-gas industry in East Asia, will be driven by a combination of a traditional urban market-development strategy, the market incubation of coal-gas and overseas LNG, and the demand for new gas-fired power generation. Long-term planning for transmission pipelines from remote inland basins, such as Sakha, Baikal, Tarim or the Central Asian republics is likely to proceed in parallel with the further growth of LNG imports to coastal terminals. A major function of these imports may be to grow the gas markets that will later be served by mainland supplies of pipeline gas. Indeed, it would not be surprising to see LNG terminals at Nakhodka or Tianjin, initially built to import supplies from Sakhalin or North America, later exporting gas originating in the Russian North to (say) Japan or Hawaii. Although there is a tendency to view offshore LNG and mainland pipeline gas as competing alternatives, they will undoubtedly be complements to each other over the long run.