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South Korea's thirst for gas

South Korea, along with Japan and China, has a very strong incentive to push for piped gas supplies from the Russian Far East and Siberia. Lack of domestic resources and a staggering demand growth - tempered by the economic crisis - mean gas is vital for South Korea's industrial development. Nuclear's future, however, looks increasingly bleak

Of the three Northeast Asian countries that are actively contemplating pipeline links to natural gas supply basins in the Russian Far East, it is South Korea for whom the project is most crucial, and whose interest in the venture has been the best focused and the most sustained. The planners of South Korea's state-owned energy sectors showed an earlier public awareness than their counterparts in either China and Japan of the overwhelming cost and environmental advantages of natural gas as an electrical generation, space heating and industrial fuel. They have also shown a greater, and earlier, appreciation of the long-term cost and security advantages of developing access to overland gas sources in the Russian Far East and Siberia.

Beginning in the early 1990s, a consortium of Korean companies initiated a joint feasibility study on the development of gas resources in the Vilyusk Basin of the Sakha Republic (Yakutia), and construction of a pipeline to markets in Northeast Asia. Participants in this study included Russia's Sakhaneftegaz and Gazprom, the Japan National Oil Corp (JNOC), as well as the Korean sponsors. At first, the great interest was in a pipeline from Yakutsk and southward along Russia's eastern margin past Vladivostok, crossing North Korea to markets in South Korea and Japan. An alternative route from Yakutsk would have bypassed the Korean peninsula entirely, crossing instead from the mainland to Sakhalin, then following the length of that island to an undersea pipeline crossing into Hokkaido, Japan's most northern output.

Other studies during the mid-1990s favoured developing east Siberian gas reserves in Irkutsk, with a pipeline running to Vladivostok along the Trans-Siberian Railroad, then crossing both North and South Korea to Japan. However, the most widely accepted routing proposal is now an Irkutsk-to-Beijing-to-Korea trunkline as described in the October 1997 *FTEE*. In current versions, any gas from the Sakha Republic would first travel to the west of Lake Baikal before joining East Siberian gas at a hub near Irkutsk (such as Angarsk or Ulan Ude).

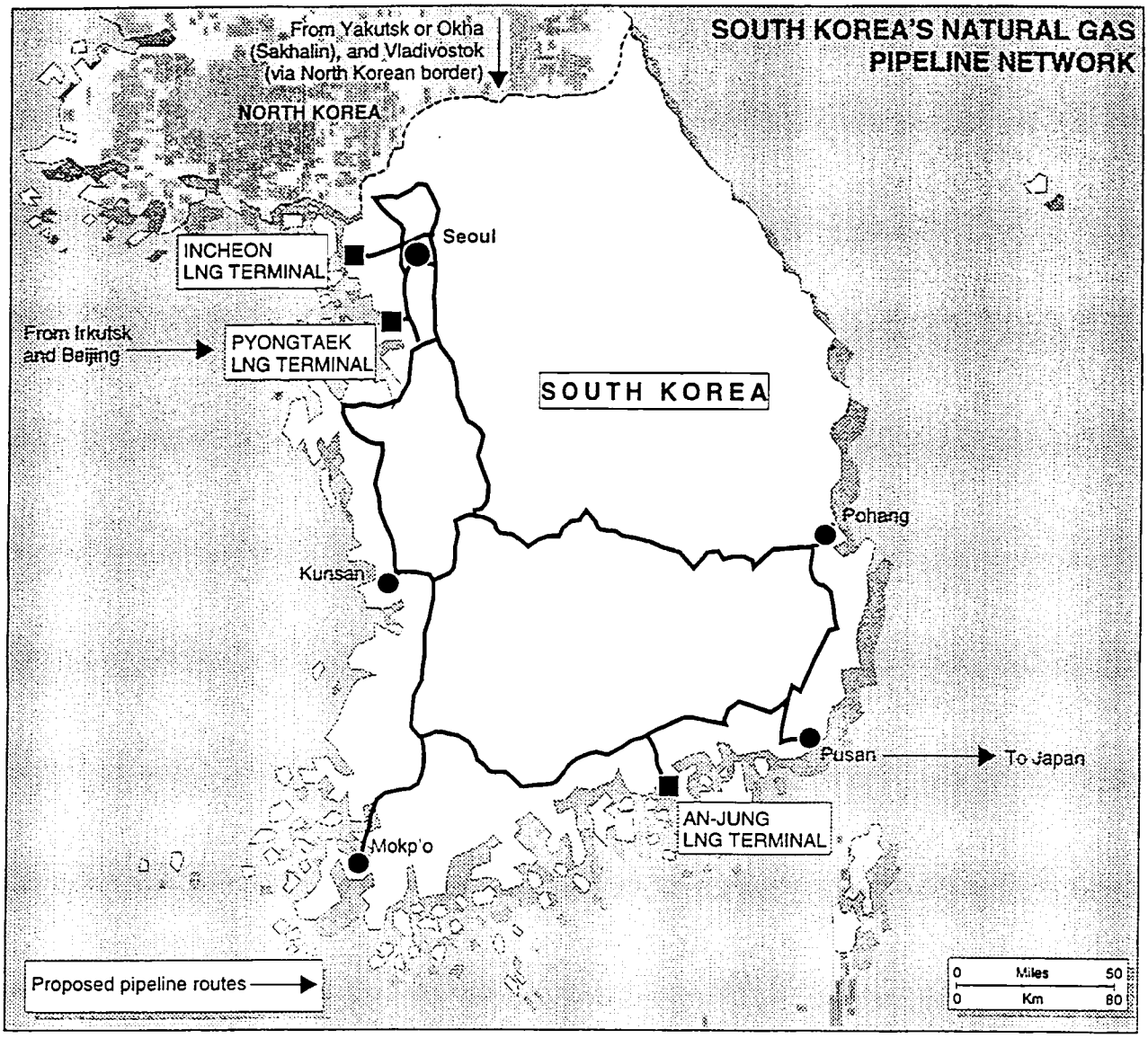
In particular contrast to Japan, whose domestic gas-transmission and distribution network is still only a designer's pipe dream *(see FTEE 196/9)*, South Korea is well on the way to creating the physical infrastructure necessary to accept and distribute new gas supplies throughout the country, whether they become available by pipeline from Russia, or arrive as LNG from North America, Southeast Asia, or the Middle East.

Global comparison: Absolute growth of energy consumption Korea and other Northeast Asia by rank

(million tonnes oil equivalent, 1986-96)

Rank	Country	Absolute growth 1986-1996, mtoe
1	USA	386.9
2	China	288.0
3	Japan	137.2
4	India	108.1
5	South Korea	105.3
6	France	42.4
7	Indonesia	40.7
8	Thailand	40.2
9	Iran	35.9
10	Canada	33.6

Source: BP Statistical Review of World Energy, 1997



When completed in the year 2000, this gas pipeline system will consist mainly of a pair of loops inscribed within the perimeter of the Korean peninsula and several north- and south-pointing spokes *(see map above)*.

Expanding grid system

In the North-west corner, the upper loop connects with a grid system surrounding Seoul and two existing LNG terminals at Incheon and Pyongtaek near Inchon. Also in the Inchon area, the pipeline would ultimately be joined by an undersea extension of the contemplated Northeast Asian gas trunkline from Bejing, Irkutsk, and eastern Siberia. An alternative, or complementary, pipeline from North Sakhalin – where oil and gas production is due to start next year – and possibly from the Sakha Republic (Yakutia) could ultimately carry gas past Nakhodka and Vladivostok, and across North Korea, to connect with the South Korean loop pipeline in the vicinity of Seoul.

In South eastern Korea the pipeline loop connects with another existing LNG terminal at An-Jung near Pusan. A further undersea extension would leave the Korean coast in the Pusan area to deliver Russian gas into the new Japanese domestic gas system near Shimonoseki or Kitakyushu, at Japan's south western tip.

The deep-seated financial distortions associated with over-capitalisation, over-leveraged financing, and over-valuation of assets characterise all sectors of the South Korean economy. The energy sector suffers from additional distortions peculiar to the artificial North-South division of the country. The country's

Global comparison: Rate of energy consumption growth Korea and other leading countries by rank, 1986-1996

Rank	Country	Annual growth rate,1986-1996
1	Thailand	13.3%
2	South Korea	10.7%
3	Malaysia	10.1%
4	United Arab Emirates	7.8%
5	Philippines	7.7%
6	Chile	7.7%
7	Indonesia	7.6%
8	Singapore	7.3%
15	**China**	**4.1%**
25	**Japan**	**3.2%**

Source: BP Statistical Review of World Energy, 1997

hydro and coal resources are mostly in North Korea, while South Korea has larger population centres, most of the industry and a more temperate climate and hospitable geography for agriculture.

Split aggravates energy needs

This split between regions which would otherwise complement each other in terms of energy requirements and resources, together with North Korea's paranoiac commitment to autarky, aggravates import dependency and the seasonality of demand in South Korea. The net result is that South Korea has virtually no domestic energy supply. All oil and gas supplies are imported and its indigenous coal production is less than ten percent of consumption. North Korea produces more coal than South Korea consumes, but has a crude-oil refining capacity (and consumption) of only about 71 thousand barrels per day [b/d]. In contrast, South Korea's refining capacity is 31 times greater, at 2.2 million b/d. A permanent state of political and military crisis further affects all planning and investment decisions.

On the eve of the present economic crisis, South Korea's energy sector had reached a state of maturity in which enhanced domestic competition – with its increased efficiencies – and new external sources of supply were vital if incremental energy was to reach end-users at acceptable costs and prices. The crisis has somewhat alleviated this need; the slump in heavy industrial exports, together with a fall in domestic auto sales and consumer spending generally, has made a material dent in the growth of energy demand. It has also undoubtedly set back some of South Korea's domestic energy investment plans.

Staggering demand growth

Korea's close and early attention to its long term energy procurement strategy and domestic infrastructure requirements reflects the country's recent phenomenal growth in energy demand. The scarcity of domestic fuel resources has turned this demand growth into a near-insatiable need to find or contract for new sources of imported fuel. Although in a global perspective South Korea may not appear to be a top ranking country in terms of population or total GDP, it is a major user and importer of energy, and needs expanded supplies of secure, low-cost energy imports.

In the ten years preceding the current economic crisis South Korea's annual rate of increase in energy consumption was 10.7 percent, number two in the world after Thailand. A remarkable growth in Korea's GDP per head both reflected and drove singular developments in the composition of energy demand. Growth continued in South Korea's energy-intensive heavy industry – a sector that had earlier relinquished its leading economic role in North America, western Europe, and Japan. At the same time, investment in private automobiles, home heating and cooling equipment, and other household appliances was feeding an escalating consumer demand for fuels and electricity. In absolute terms Korea's

energy growth between 1986 and 1996 was fifth globally, after the USA, China, Japan and India. It was equivalent to a staggering three-quarters of the European Union's total consumption growth, and 8.3 percent that of the whole world.

Need for gas

Natural gas is set to capture a large slice of this demand increase. During the last decade refined petroleum products and natural gas gained market share at the expense of coal. Over the last ten years, liquified natural gas (LNG) more than doubled its market share, with the most rapid expansion occurring in sales by local distribution companies (LDCs or "city gas").

As of 1997, natural gas and other gaseous fuels only accounted for 9.5 percent of South Korea's total primary energy supply. But total gas consumption had been growing at 20.7 percent annually, largely driven by growth in the residential sector (an annual 53.6 percent), the commercial sector (42.4 percent), and industry 34.2 percent). This trend is set to continue; according to Dr. Ki-Joong Kim, of the government-sponsored Korean Energy Economics Institute, residential demand for natural gas will triple by 2020.

The growth in gas-fired generation has been less strong, however, with the bulk of South Korea's electricity still generated by nuclear and coal. In 1987 power generation accounted for 95 percent of the gas consumed; in 1996 power generation's share had fallen to 49 percent. Its annual growth rate was much lower at 11.7 percent. But these statistics can be misleading, because they obscure the rapid introduction of combustion turbines (CTs). In 1990 gas-powered turbines accounted for less than 1 TWh of generation. In 1996 they accounted for 27 TWh, mainly used as peaking plant, and rarely achieving a plant factor of more than 35 percent.

Growing peak demand

Peaking demand is also growing in the gas sector. The continued expansion of the gas distribution system and the expected increase in residential use means winter consumption will grow faster than summer, further exaggerating the difference between peak and off-peak demand. This will put pressure on the existing system; LNG systems often find it more difficult to accommodate demand variability than pipeline-based ones. The capital intensity of the LNG liquefaction, transport and regasification cycle is best suited to constant levels of production, since above-ground storage near the destination market tends to be exceedingly costly. Although Korea's pipeline infrastructure is more flexible than Japan's, it is nothing like the intricately balanced and flexible pipeline delivery system of North America or western Europe, where (among other things) air conditioning and space heating cause offsetting peaks.

This growth in peak gas demand is one of the key factors behind South Korea's interest in the development of overland gas pipelines from Russia or China. It is

Global comparison: Primary energy consumption Korea and other Northeast Asia by rank

(million tonnes oil equivalent, 1996)

Rank	Country	Million tonnes oil equivalent 1996
1	USA	2,130.3
2	China	874.0
3	Russian Federation	605.4
4	Japan	501.8
5	Germany	345.0
6	India	246.7
7	France	243.4
8	United Kingdom	230.1
9	Canada	223.1
10	South Korea	164.7

Source: BP Statistical Review of World Energy, 1997

Korean natural gas and total gas consumption by sector, 1986-1996 (million cubic metres, gaseous state)

	Natural gas (LNG) consumption				City gas (including LPG & synthetics)			
Year	Total	Pipeline use	Electrical generation	City gas (LDCs)	Total	Residential	Commercial	Industrial
1986	73	11	62	0				
1987	2,237	12	2,121	104				
1988	2,890	7	2,629	254	323	142	76	105
1989	2,810	11	2,317	482				
1990	3,213	17	2,403	794	963	438	307	223
1991	3,718	21	2,484	1,213				
1992	4,863	59	3,071	1,733	2,114	1,251	504	359
1993	6,076	51	3,475	2,550				
1994	8,087	110	4,594	3,382	3,942	2,532	838	572
1995	9,823	138	4,976	4,709	5,327	3,481	1,024	822
1996	12,994	242	6,378	6,374	6,780	4,390	1,287	1,103
Annual growth 1988-1996	20.7%	56.0%	11.7%	49.6%	46.3%	53.6%	42.4%	34.2%

Source: Korea Energy Economics Institute, Korea Energy Review Monthly; Korea City Gas Association Yearbook of City Gas Business, 1997

also a crucial part of the economics of these pipelines. Greater system flexibility has a genuine economic value, over and above the average cost of delivered natural gas.

Nuclear impact

If pipeline gas ever did arrive in South Korea, it could have a devastating effect on the country's nuclear power programme. With its almost total dependence on imported energy, South Korea opted to develop nuclear, which now accounts for 36 percent of power generation. To date, South Korea has nearly 10,000 megawatts of nuclear generating capacity and has plans to build another 3,200 megawatts by the year 2000, with a further 1,900 megawatts by 2003. These plans were drawn up before the economic collapse and it is likely that at least some construction will be scaled back or delayed.

In recent months, moreover, the long-standing unanimity among energy analysts favouring nuclear generation has begun to crack openly. Jeong-Shik Shin and Sung-Bong Cho of the Korean Energy Economics Institute, for example, have initiated a public campaign to apply "market tests" to incremental nuclear power, which it would clearly fail if natural gas was readily available from Russia. The view of the Institute contrasts pointedly with the reluctance of government and utility officers in Japan to utter any public statement or speculation to this effect, despite their private admissions that published construction schedules will not be implemented because of mounting public opposition and unacceptable costs.

The prospect of natural gas imports could also put paid to nuclear development in North Korea. In 1994, the US agreed to help North Korea to replace its planned graphite-moderated reactors with two 1,000 MW light water reactors, in order to reduce the country's output of weapons-grade plutonium. South Korea, no more keen than the west for its northern neighbour to develop nuclear weapons, agreed to provide financing for the $5.1 billion plants, with the plan that South Korea's state-owned electricity utility would buy the surplus power (the two plants would meet North Korea's incremental demand more than four times over). Construction work on the project duly started in August 197, with completion scheduled for 2004.

But the present financial crisis makes it very unlikely that South Korea can now come up with the money. More than ever – the project was always largely political – the North Korean nuclear plants make no economic sense. There is negligible demand for such costly electricity in North Korea. Moreover, all of the

technology, most of the components and most of the technical and skilled labour have to be imported.

A dependable gas supply, however, could have huge advantages for both North and South Korea. As previously mentioned, North Korea could be an integral part of a gas-pipeline system connecting eastern Russia, the Koreas, Japan and possibly northeastern China. In contrast to the nuclear plants, gas-based development could provide North Korea an affordable energy supply, jobs, and a solid base for economic expansion. A CT or combined cycle (CC) plant scaled to effective demand in North Korea could be included in an international project financing package for the pipeline and thus avoid direct dependence on South Korea government outlays or guarantees.

Pipeline gas from Russia could therefore benefit the whole region. It could supplant the need for the nuclear reactors, reduce pipeline construction costs to South Korea, and help open the Sakhalin gas resources both to the Northeast Asia market and to the desperately fuel-short Vladivostok area. **Arlon Tussing and Samuel Van Vactor**

Company profile: Enron Europe

Prising open the markets

Enron, the famously aggressive US power and gas marketer, has set its cap at the European market. But the going is proving tougher than the company would like ...

Start talking about Enron and sooner or later the word aggressive crops up. The company has earned a fearsome reputation for its no holds barred approach to entering markets. "I prefer entrepreneurial", says Mark Frevert, President and CEO of Enron Europe. "I think in order to lead the charge in some of the forays into competitive markets you have to be somewhat aggressive, but we don't see that as a negative – rather it's one of the things that separates us from a number of our competitors."

This entrepreneurial approach has certainly paid dividends in the US, where Enron has used the deregulation of energy markets to become the country's largest wholesale marketer of gas and electricity. Formed in 1985 by the merger of two medium-sized gas pipeline companies, Houston Natural Gas and InterNorth, the company has grown from one initially worth $2 billion in market value, with a debt to capitalisation ratio of 73 percent, to one worth $11 billion at the end of 1996, with debt down to 38 percent. The city of Houston, where the company has its headquarters, has been so impressed it has even declared March 4 "Kenneth Lay day", after the Enron President and CEO.

At the end of the 1980s, Enron looked across the channel and saw similar opportunities developing in the UK, as the Thatcher government began to privatise the electricity sector. In 1989, Enron started planning one of the first, and certainly the largest, independent power plant (IPP) in the UK, with the construction of the giant 1,875 MW combined cycle gas turbine (CCGT) plant for ICI's works on Teeside.

In 1996, Enron moved into the other area of Europe where power markets were opening up to competition, setting up Enron Nordic Energy in Oslo to trade on the Nord Pool, the Norwegian/Swedish power exchange, since joined by Finland.

These two moves, into the UK and Scandinavia, exemplify the various approaches the company takes to accessing new energy markets. In the UK, Enron used Teeside power to get a foothold in the market at a time when all talk of competition was focussed around IPPs. Teeside, which now generates four percent of the UK's electricity, was a showcase for Enron's ability to bring together all aspects of a large infrastructure contract, negotiating the then-new – for the UK – concept of back-to-back fuel and electricity offtake contracts.

Enron's approach in the Nordic market has been very different. In the past two years it has become the largest trader in the region, and the market maker on