

Natural Gas Utilization in the Republic of Korea

Jong-Sool Kim

RECENT TRENDS IN ENERGY CONSUMPTION

Over the last three decades, the energy market of the Republic of Korea has expanded rapidly, because high economic growth during the period has been led by developments of capital- and energy-intensive industries. During the period 1980–97, domestic energy consumption tripled from 43.9 million tonnes of oil equivalent (mtoe) to 180.6 mtoe, although domestic energy production increased by merely 93.5% from 12.4 mtoe to 24.0 mtoe over the same period. Imports and exports of energy also increased greatly from 33.0 mtoe and 8 thousand toe, respectively, to 199.0 mtoe and 33.0 thousand toe (*Korea Energy Review Monthly 1999*).

However, the recent economic difficulties caused by a shortage of foreign currency at the end of 1997 not only depressed the South Korean economy, but also decreased domestic energy consumption. As shown in Table 1, total energy consumption increased by 9.3% from 165.2 mtoe in 1996 to 180.6 mtoe in 1997.

Table 1. Primary energy consumption in the Republic of Korea by energy source, 1996–99 (million tonnes of oil equivalent)

Source	1996			1997			1998			1999
	1/2	2/2	Total	1/2	2/2	Total	1/2	2/2	Total	1/2
Coal	32.2	18.3	16.5	34.8	18.2	17.8	36.0	18.6		
Oil	99.9	55.5	53.6	109.1	44.7	45.9	90.6	48.3		
LNG	12.2	6.8	8	14.8	6.7	7.1	13.8	8.4		
Hydro	1.3	0.8	0.6	1.4	0.8	0.7	1.5	0.7		
Nuclear	18.5	10.6	8.7	19.3	10.3	12.1	22.4	11.9		
Others	1.2	0.7	0.6	1.3	0.7	0.7	1.5	0.8		
Total	165.2	92.7	87.9	180.6	81.5	84.4	165.9	88.7		

Sources: *Korea Energy Review Monthly*, various issues, 1997 and 1999.

Note: 1/2 = first half of the year; 2/2 = second half of the year.

During the same period, consumption of all forms of energy likewise increased: the lowest level of increase was 4.3% (for nuclear power), and the highest level was 21.3% (for LNG). In 1998, however, total energy consumption dropped by 8.9%, to 165.9 mtoe, compared with the 1997 level of 180.6 mtoe.

The decline in petroleum consumption was particularly significant. In contrast to imported energy, the consumption of domestically produced energy was higher than the previous year's level.

To overcome the recent economic difficulties and strengthen the competitiveness of the economy, the government of the Republic of Korea has been conducting a thorough economic restructuring according to the principles of a free market system. Some positive signs have already been observed. According to reports issued by the Bank of Korea, the foreign exchange rates of the won relative to other currencies have been stable since April 1998. The trade balance in July 1998 registered a surplus of more than US\$20 billion. GDP is also projected to increase by more than 8% in 1999 and by about 6% in 2000.

This fast recovery of the economy consequently shifted domestic energy consumption upward. In the first half of 1999, total energy consumption increased to 88.7 mtoe from the previous level of 81.5 mtoe. Among the various forms of energy shown in Table 1, LNG consumption showed the highest growth rate of 25.4%, while hydro energy consumption decreased by 12.5%.

NATURAL GAS SUPPLY

Natural gas was brought in as an alternative source of energy to strengthen the nation's energy security and stability, a few years after the two oil crises hit the world economy in the 1970s. For this reason, the crucial issue for the South Korean gas industry is to secure a stable supply of natural gas at a reasonable price.

Diversification of LNG Supply Sources

Natural gas development projects involve vast capital investments and high risks. To reduce the risks of gas projects, LNG contracts are made in advance, based on a long-term contract with a rigid take-or-pay clause. This innate rigidity has been at the core of arguments between people involved in the LNG business, but no solutions have been found yet. The biggest issue with the rigidity is that it obstructs the stable supply of natural gas by leaving no room for flexibility. The best and easiest way to alleviate the rigidity, from the viewpoint of buyers, would be to increase the number of LNG supply sources.

In the very beginning stage, the South Korean gas industry imported LNG only from Indonesia, based on a twenty-two-year contract for a volume of 2 million tons per year (mty) as shown in Table 2. In 1993, Korea signed another long-term contract with Malaysia to import 2 mty from 1995 to 2015, as LNG demand increased rapidly. In 1997, Brunei was added in the list of LNG exporters to South Korea.

Table 2. Diversification of LNG sources for the Republic of Korea, 1986–2010

Beginning	Suppliers	
	Country (mty = million tonnes per year)	Region
1986	Indonesia (2 mty)	Southeast Asia
1995	Indonesia Malaysia (2 mty)	Southeast Asia
1997	Indonesia Malaysia Brunei (0.7 mty)	Southeast Asia
1999	Indonesia Malaysia Brunei Qatar (2.4 mty)	Southeast Asia Middle East
2000	Indonesia Malaysia Brunei Qatar Oman (4 mty)	Southeast Asia Middle East
2010	Indonesia Malaysia Brunei Qatar Oman Russia (7 mty pipeline gas)	Southeast Asia Middle East Russia

As a result of this diversification, the heavy reliance of the South Korean gas industry on any one LNG-exporting country has been considerably reduced. In addition, more competition between LNG exporting countries could lead to lower LNG prices. To secure LNG supply further, South Korea not only diversified LNG sources to include Mid-East countries, but also invested in upstream operations itself in the mid-1990s. More precisely, South Korea participated in the Qatar and Oman projects, importing 4.8 million tons (mt) from the Qatar project and 4.06 mt from the Oman project. Deliveries from the Qatar project began in 1999, and deliveries from the Oman project will begin in 2000.

As South Korea added the two Mid-East countries to the existing three Southeast Asian countries in its list of LNG sources, South Korea also became a shareholder in upstream projects, enhancing the stability and security of its LNG

supply considerably. Furthermore, Korea has been investigating the possibility of importing gas from eastern Siberia through pipelines around 2010. Details of the pipeline natural gas projects in eastern Siberia are discussed in the next section.

Diversification of Types of Natural Gas

Up to the mid-1990s, South Korea made efforts to increase the number of countries supplying its natural gas, to alleviate heavy reliance on any one country. Since then, South Korea has turned its attention to different types of natural gas, particularly piped natural gas. This implies that the gas procurement strategy becomes two-pronged, with the addition of piped natural gas. The change in the import strategy was made possible as the new natural gas market in Northeast Asia emerged in the mid-1990s.

Before the 1990s, the huge natural gas resources of eastern Siberia had not attracted much attention from the western oil and gas majors, because these sources not only are remote from western markets, but also are not easily accessible. Recently, however, the abundant gas resources in eastern Siberia have captured the spotlight, as the Former Soviet Union collapsed and a free market system began to prevail in the region. In addition, rapid increases in gas demand in China, South Korea, Japan, and Taiwan made the gas resources in the region more attractive.

At present, three pipeline gas projects—Irkutsk, Sakha, and Sakhalin—seem to be attracting the interest of western investors. South Korea recently conducted prefeasibility studies for the projects and found the Irkutsk project to be the most economically viable. Kim Dae-jung, President of the Republic of Korea, visited Russia in 1999 and signed a memorandum of understanding for the development of the Irkutsk project. The project participants are expected to conduct a feasibility study in 2000.

South Korea hopes to bring in piped natural gas from eastern Siberia around 2010 and thereby strengthen the security of energy supplies. The most crucial factor in determining whether the project should be implemented is mainly the economics. In other words, if natural gas from eastern Siberia is not competitive with the price of LNG, the project will not be carried out, although several obstacles could be resolved through multilateral cooperation among project participants.

In short, South Korea's strategy for securing a stable supply of natural gas is three-pronged. The first and simplest approach is to diversify the sources of LNG imports among several countries. The second approach is to diversify the type of imports from LNG alone to LNG plus pipeline natural gas. The third strategy is to meet 85–90% of the domestic gas demand through long-term contracts and to purchase the remaining 10–15% on the spot or short-term markets. This mixed

strategy for LNG procurement has been effective thus far to meet fluctuations in gas demand.

NATURAL GAS DEMAND IN SOUTH KOREA

The natural gas market in South Korea was created by the government in 1986 to supplement other, existing energy markets. Since then, it has expanded rapidly, particularly in areas that need clean energy. Recently, the role of natural gas in the energy market has been reevaluated, as natural gas has found its own markets in areas such as cogeneration, cooling, and natural-gas vehicles (NGVs).

Trends in Gas Demand

Natural gas demand in South Korea has experienced enormous expansion, due largely to users' preferences and stricter environmental regulations. Over the last decade, the average annual growth rate of gas demand was around 25%, although natural gas demand in 1998 declined a bit during the recent economic difficulties. The high growth in gas demand is attributed mainly to the sharp increase in the use of town gas, particularly in the residential and commercial sectors.

In the very beginning stage of the South Korean gas market, power generation consumed much more gas than other sectors, as shown in Table 3. By 1996, however, the two major gas markets accounted for nearly equal shares of consumption: 49.7% for town gas and 50.3% for power generation. Since then, the share of town gas has exceeded that of power generation. The respective shares in 1998 were 59.8% and 40.2%, and the gap is likely to widen further.

The high growth rate of gas demand was interrupted in 1998 by the foreign currency crisis that occurred at the end of 1997. A number of companies became bankrupt, and more than 1.5 million people became unemployed. As a result, economic activities and thus energy consumption dropped considerably. Natural gas consumption declined by 6.5% in 1998, compared with the 1997 level of 11.1 million tons—the first decline in demand since natural gas was introduced to South Korea in 1986.

Recently, however, the South Korean economy has begun to recover at a faster pace than anyone expected. Gas consumption through June 1999 increased by 25.6%, compared with the same period in 1998 and was even 3.6% higher than the same period in 1997. It is now quite evident that the gas demand is recovering to the previous level.

Table 3. Natural gas consumption in the Republic of Korea, 1987–98

Consumer	1987	1990	1993	1996	1997	1998
	<i>thousand tonnes</i>					
Town gas						
Residential	37	245	1,162	3,068	3,768	3,864
Commercial	11	227	452	835	959	975
Industrial	27	104	233	658	1,043	1,394
Subtotal	75	576	1,847	4,561	5,770	6,233
Power generation	1,537	1,741	2,518	4,622	5,377	4,188
Total gas consumption	1,612	2,317	4,366	9,183	11,147	10,421
	<i>share as % of total consumption</i>					
Town gas	4.7	24.9	42.3	49.7	51.8	59.8
Power generation	95.3	75.1	57.7	50.3	48.2	40.2

Uses of Natural Gas

In the very early stage of the gas industry in South Korea, most gas was used for power generation. Gas has penetrated steadily into the domestic energy market, and gas has increasingly been consumed as town gas, which refers to residential, commercial, and industrial consumption. As shown in Table 3, the demand for town gas increased by around 8% even during the economic decline of 1998.

Among the three uses of town gas, residential use accounts for the highest share and commercial use for the lowest. This indicates that steady increases in the demand for town gas are likely to continue in the next century, since more gas is forecast to be consumed in the areas of cogeneration, gas cooling and natural gas vehicles. In fact, in countries where gas demand is reaching the saturation point, these are the areas in which R&D investments are promoted, to increase domestic gas demand.

Table 4 shows the amount of natural gas consumed for cogeneration and cooling during the period, 1995–98. Cogeneration consumed 108.8 thousand tonnes of gas in 1995, increasing to 182.7 thousand tonnes in 1998. This increase in recent years has been encouraged by efforts to increase the efficiency of gas usage as well as to reduce pollution. Gas consumption for cooling has also increased sharply from 49.4 thousand tonnes in 1995 to 119.5 thousand tonnes in 1998. This rapid increase in gas demand for cooling has been driven by incentives such as financial support and price-breaks offered by the government and the gas industry.

Table 4. Three uses of town gas in the Republic of Korea, 1995–98 (thousand tonnes)

Uses	1995	1996	1997	1998
Cogeneration	108.8	140.7	190.1	182.7
Gas cooling	49.4	70.9	117.9	119.5
Natural-gas vehicles (NVGs)	–	–	–	pilot run began

The use of natural-gas vehicles in South Korea is currently in a very primitive stage. Recently, the government announced a long-term plan to replace diesel-fueled buses and switch to natural gas. As a first stage of the plan, nine pilot automobiles were operated from January to December 1998. The one-year pilot operation of gas-fueled automobiles turned out to be successful. Encouraged by the pilot run, the first three gas-fueled buses began operation on their regular routes, one in Ansan from July 1998 and two in Incheon from September 1998.

According to the government's plan, 1,500 buses using compressed natural gas (CNG) as a fuel, will begin operation in 2000 in Seoul and neighboring cities. Thirty natural-gas refueling stations are also going to be built. By the end of 2002, the 15,000 old diesel-fueled buses will be replaced with natural-gas-fueled buses in the seven big cities where pollution is serious. The number of gas-fueled buses will be increased further to 15,000 by the end of 2007. The number of natural-gas refueling stations will be increased to 100 by then.

Thus far, there have been high demand-increases in the three areas of natural gas use mentioned above. However, there are a number of obstacles to overcome to maintain such high demand growth. Whether the South Korean gas industry can prosper in the twenty-first century will depend mainly on the extent to which technological improvements are achieved in the three areas of gas use.

Prospects for the South Korean Gas Industry

South Korea has suffered from serious economic difficulties since the end of 1997. Although some positive signs have been observed lately, it will still take some time to recover to the previous status of the economy. South Korea's gas industry has likewise suffered from the economic crisis, but is recovering at a fast pace. Much effort has been and will be made to restore the gas industry to its previous level and maybe even a higher level. Resumption of capital investment in supply facilities such as storage and gas grids will be a first priority to increase gas demand by spreading it to the regions where it is not yet supplied.

According to a recent forecast by the Department of Commerce, Industry, and Energy, South Korea's natural gas demand will increase at an average annual rate of 4.9% and reach 20.8 million tonnes in 2010. Although this rate is much smaller than the rate that the industry has recorded previously, it is not a low

growth rate for a gas industry that is entering the stage of maturity. In the mid-term and long-term, South Korea's gas industry has a bright and promising future. Several factors support this optimistic view.

First, the government is attempting to restructure the domestic energy market through deregulation and increased competition. Changes in the energy market toward deregulation and competition will lead to marketing of natural gas for new applications. It is now used mainly for heating and cooking, but as competition among fuels makes marketing more aggressive, more gas will be used for cogeneration, gas cooling, natural-gas vehicles, and new industrial applications.

Second, the environmental awareness of the public has recently increased greatly. People now are more concerned with pollutants from emissions and residues associated with the combustion of fossil fuels. In addition, the enforcement of the UN Framework Convention on Climate Change is likely to affect the structure of the energy industry in favor of natural gas. At present, more than 95% of CO₂ emissions come from the energy industry. Thus tighter environmental regulations will boost the expansion of natural gas.

Third, South Korea was previously only a buyer of natural gas. Recently, however, KOGAS has expanded its business boundaries into upstream operations, by acquiring equity in gas development projects in Oman and Qatar. Furthermore, KOGAS is considering the possibility of participating in the Irkutsk pipeline gas project. If the project is implemented, a new era of gas-to-gas competition will be opened. Competition between different types of natural gas is expected to reduce supply costs and service rates considerably, thereby making natural gas more price-competitive in relation to other fossil fuels. If South Korea can deploy low-priced natural gas, as North America and Europe have done, that may increase gas demand at a rate much higher than is projected.

CONCLUSIONS

Natural gas utilization in South Korea was initiated as a part of a centrally planned economic policy. The main objectives of introducing natural gas to the nation were to stabilize the energy supply and promote the use of high quality fuels for the residential sector. Over the past two decades, natural gas demand has experienced unprecedented growth, due to rapid economic growth and stricter environmental regulations.

The recent economic difficulties caused by the shortage of foreign currency reduced the consumption of gas in the power generation considerably. However, the consumption of town gas continued to grow, in spite of the economic crisis. Recently, gas demand for power generation has slowly been recovering to the previous level, as the economy performs better. Whether or not the South Korean

gas industry can prosper in the twenty-first century depends on the extent to which technological improvements are achieved in the three areas of gas use: cogeneration, gas cooling, and natural-gas vehicles.

The South Korean gas industry is now at a threshold of structural change, which other countries with advanced gas industries have experienced. The most crucial changes include the breaking of the LNG import monopoly, the adoption of open access to gas grids, and the subsequent liberalization of the gas business. The currently pursued Qatar and Oman LNG projects and pipeline gas projects in eastern Siberia provide both increased opportunities and challenges for the South Korean gas industry. Diversified gas imports will strengthen national energy security.

Since many of these opportunities are becoming multi-dimensional, the future of the South Korean gas industry is likely to be better off.