

# *An Overview of the Energy Market in Japan: with a view of Gas Development Projects on the Sakhalin Shelf*

(Summary)

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## 1. Introduction

In the summer of 1999, the "Sakhalin-2" project started to ship crude oil. The "Sakhalin-1" project also plans to begin commercial production soon. Commercial gas production is expected in the near future. These developments call on project operators to adopt more active and practical considerations in the marketing of the extracted oil and gas. The operators are conducting feasibility studies into some options for gas pipeline and LNG (Liquefied Natural Gas) projects for the transportation of Sakhalin gas. Given their geographical location, it may be said that Japan is among the most important markets for the Sakhalin projects.

With consideration of a gas pipeline to Japan among the proposed options, this paper focuses on the electric power industry and gas utilities as major users of natural gas in Japan. In 1997, almost all imported LNG and domestic natural gas<sup>1</sup> was consumed as a resource by the electric power industry (67.1%) and the gas utility industry (30.7%). Also, some information on and consideration of district heating industries and diversified energy systems is provided, because they seem to affect local energy demands considerably.

This paper targets three economic-administrative areas of Japan: Hokkaido, Tohoku and Kanto (Fig. 1). This region, eastern Japan, is the first target area of the Sakhalin gas pipeline project, because it is geographically comparatively close to Sakhalin.

## 2. Eastern Japan: General information

Eastern Japan covers 200,000 km<sup>2</sup>, or 53% of the total territory of Japan (Table 1). Actually, eastern Japan is comprised of three categories of area; the metropolitan area, a few regional-center cities and the less-developed rural areas. The capital city, Tokyo, is surrounded by one of the most developed metropolitan areas in the world. Tokyo's metropolitan area has some 30 million people. Hokkaido is characterized by the lowest residential population density in Japan. To the north of Tokyo (outside the Tokyo metropolitan area), there are only two cities with a population of more than one million; Sapporo (1.8 million) and Sendai (1.0 million).

Some economic indicators show more clearly the differences between the Tokyo metropolitan area and the rest of eastern Japan. Industrial output and service sales in the Hokkaido and Tohoku areas consist of a much smaller share than that of population.

## 3. The Electric power industry

### (1) The electric power industry in Japan

There are 10<sup>2</sup> general electric power companies<sup>2</sup> in Japan

(EPC) with their own service areas. In the fiscal year 1998, these companies produced 780.8TWh<sup>2</sup> or 74.6% of the total electricity produced in Japan (1,046TWh). The rest was generated by 'whole-sale electric companies'; which sell electricity to the 10 EPCs, and 'self-generation facilities'; which are installed by consumers for their own use.

After the oil crisis, Japanese electric companies made efforts to diversify their energy sources for power generation, thereby reducing oil consumption. In 1998, 36% of commercial electric power was generated in nuclear plants. However, tough negotiations with local populations and social concerns provoked by a series of recent accidents in Japanese nuclear facilities have apparently slowed some nuclear power station construction projects. EPCs revised their long-term investment plan by the end of March 2000. According to the plans, the companies will start to operate 13 new nuclear plants by year 2010, the targeted number reduced by 7 compared with the former plans of a year before.

### (2) Effects of the liberalization of the large consumer market

EPCs have enjoyed the exclusive supply rights to their service areas, while they have been obliged to supply a steady stream of electricity to all the residents and companies within them. In March 2000, the electricity market for large-scale consumers purchasing high power (2MW and over) in high voltages (20 kV and over) was liberalized. The liberalized market occupies approximately 30% of the total electricity consumption of Japan. Reduction of electric rates is expected through market competition. A review of the consequences of the liberalization is scheduled in 2003, and specialists foresee an extension of the liberalization target.

From the viewpoint of natural gas developers, these actions could bring favorable results, because they give advantages to the gas-firing-combined-generation system, with high thermal efficiency and relatively low costs. On the other hand, natural gas developers might face difficulties in marketing, because buyers, i.e. electric companies, will prefer shorter term gas purchasing contracts to the existing 20 or 25 year contracts, as they can hardly forecast their own electric supply volume for such a long period in the competitive market. In this scenario, gas developers would lose steady consumers and be required to manage the risk of fluctuations in demand.

### (3) Electric energy in Eastern Japan

Three eastern electric power companies; Tokyo, Tohoku and Hokkaido EPCs cover eastern Japan and

<sup>1</sup> domestic natural gas, if not otherwise specified.

<sup>2</sup> 1TWh = 10<sup>9</sup> kWh

generated 353 TWh in 1998. Total output in eastern Japan, including the whole-sale companies and self-generation facilities, was 465 TWh, or 44.4% of the total generated electricity in Japan (Figure 2).

The three companies show different energy resource compositions. The Tokyo EPC leads in the introduction of LNG-based thermal plants in Japan. At the end of March 1999, it had 15 thermal power stations with LNG firing boilers or turbines, the total number of which reached 47 units. Almost all facilities are located in the Tokyo Bay area. In contrast, the Tohoku EPC operates only 3 stations, with 9 LNG firing generation units, and the Hokkaido EPC works without LNG. The dominant position of the Tokyo EPC is clear in terms imports of LNG (Figure 3).

Compared with other EPCs, the Tokyo EPC is highly dependent on nuclear power plants (Figure 4). Tohoku EPC had an ambitious plan to triple its nuclear generation capacity by 2010. However, as mentioned before, it revised its nuclear development plan in 2000 and postponed some projects.

Even the revised nuclear plant construction plans seem to be unrealistic. The whole capacity of the planned nuclear plants of the three eastern EPCs accounts for 9,467 MW, which could generate 66.3TWh a year at an assumed utilization rate of 80%. If they give up all the projects and substitute the losses with LNG generation, 2 or 3 large-scale LNG power stations would be needed. The volume of additional LNG demands in this scenario could reach 7.67 million tons per year.

#### **4. The Gas industry**

##### *(1) The Gas industry in Japan*

At the end of March 1998, 243 gas utilities were licensed in Japan and supplied gas to 24.6 million customers for residential, commercial and industrial use. Most gas utilities are small and medium scale enterprises. Only 22 utilities serve more than 100,000 customers, including the Tokyo Gas Company, which covers one third of the total customers. The share of the top 4 companies exceeds 80% of the domestic market.

Because of the small production volumes of domestic natural gas, Japanese gas utilities mainly depend on imported LNG. Other sources are coal, petroleum products and domestic natural gas. They also purchase gas products from other industries such as the oil-refining, petrochemical and steel industries. As LNG projects require a substantial volume of investment, smaller gas utilities are unable to join in consortiums and tend to work on the other resources. Consequently, the major 4 utilities purchase almost all LNG for the gas industry.

As mentioned in the introduction, the gas industry is the second largest consumer of LNG in Japan. However, it is not a final user. The residential sector is the largest user of gas utilities and consumed 40% of the total supply in 1997, followed by industrial users, which purchased 36 %.

##### *(2) The Gas industry in Eastern Japan*

There were 165 utilities in eastern Japan at the end of

March 1998. High density in this area is due to the location of domestic natural gas sites, which encourages small enterprises to start-up without a large amount of initial investment, because there is no need to install huge production and/or transportation facilities, except for pipelines from the nearest gas sites. Niigata prefecture accounts for 34 of the gas supply companies, which is the largest number among the 47 prefectures. Many of them are small-scale public utilities and supply their towns or villages with local natural gas through pipelines. This suggests that a trunk gas pipeline could open possibilities for local municipalities or companies to develop small-medium gas supply networks.

The Tokyo Gas Company, which sold 81.5 trillion kcal (36.5% of the national total) in 1998, is much larger than other local utilities. For example, the supply volume of the Keiyo, Hokuriku and Hokkaido Gas Companies, which follow behind Tokyo Gas, accounted for 5.2, 2.6 and 2.4 trillion kcal respectively. The Tokyo Gas Company has successfully shifted resources from petroleum products to LNG and the share of LNG in its resources reached 91% in 1997. Therefore the future increase of LNG demand will be bound to the dynamics of demand set by the final consumers.

The other gas utilities have the potential to increase their LNG purchase, theoretically, by shifting resources and expanding supply networks, along with the possible basic increase as a result of growth in per capita consumption. However, the effect of resource shift might be less, because many small utilities use local natural gas and may not shift to LNG. On the other hand, they have a greater chance to obtain new customers, as the gas consumption in the Hokkaido and Tohoku area is less than the average of Japan.

#### **5. The District-heating industry**

##### *(1) The District-heating in Japan*

Historically, Japanese cities have not developed central heat supply systems that are common in Russia and other European countries. This is partly due to the physical urban structure. In the first stage of urbanization, Japanese cities expanded outwards too fast, which made it difficult to develop urban infrastructures sufficiently. Heating does not have priority compared with such key utilities as water, lighting and sewage, considering the short winter in the Japanese major metropolitan areas. The first heat supply system was established in 1970 in Osaka. The district heating industry is still underdeveloped in spite of steady development in the last 30 years. In June 1999, 82 companies had licenses to supply heat in 137 service areas. However, each area is small, most less than 50 ha, and total heat supply recorded only 4,410 Tcal or 0.5% of the residential and commercial energy consumption in FY 1997.

##### *(2) The District-heating in eastern Japan*

Out of 137 service areas, 95 are located in eastern Japan, which means that the district heating system is utilized more widely in eastern Japan than in other parts of

Japan, partly because the large number of office buildings in the Tokyo metropolitan area creates a huge market on the demand side. On the supply side, major utilities like the Tokyo Electric Power Company and the Tokyo Gas Company play leading roles in the development and introduction of the district heating system, mobilizing their advanced technologies and financial resources. Also, it is not surprising that Hokkaido is the second largest market next to the Tokyo metropolitan area, considering its cold winter.

We can expect market growth in these areas, as Japanese people prefer a more comfortable and safe heating system to the individual kerosene stove that is so popular at the moment. There are enough perspectives in regional-center cities, which have densely inhabited districts. Redevelopment projects in these districts are expected to facilitate the wider-scale introduction of the district heating system. However, the process will be slow, if we consider eastern Japan as a whole, including rural areas.

### **6. Diversified Energy Systems**

In a diversified energy system, fuel is supplied to consumers, and they generate and utilize electricity and heat on their site. It can reduce energy loss in transmission and waste heat, compared with the existing system based on large-scale power stations and long-distance transmission lines.

Such co-generation systems are widespread among large industrial users with huge plants. Some district heating companies also employ co-generation plants. As far as 'micro-co-generation' systems for households are

concerned, companies are developing a variety of prototype products for practical use in households. Systems utilizing a fuel cell or a micro gas turbine are among the most realistic options. Their introduction into residential use could open a new market for gas suppliers, because either can work on gas fuel. However, it is difficult to know how fast the diversified energy systems will become common and how much gas they consume.

### **7. Conclusions**

Natural gas affects the environment modestly and is expected to be more popular in the period before new and more ecological energy resources are developed. The power industry and the gas supply industry, the existing major consumers of natural gas, will increase their natural gas consumption. In addition, new energy systems based on natural gas, including district heating, fuel cell and micro gas turbines, have future prospects.

On the other hand, power companies will hardly continue to contract for long-term natural gas purchases as they have done so far, and there are difficulties in estimating the speed of implementation of new energy supply systems that will become new consumers of natural gas. Therefore, natural gas developers/suppliers, including Sakhalin projects operators, have to develop flexible systems for demand fluctuation, which brings them additional risks in project operation. Nevertheless, simultaneous changes in natural gas demands structure, i.e. long-term demand increase and shortened demand cycle, may be considered as a world trend, and no natural gas developer could not resist adapting to the new market situation.