Effects of Suspension of Nuclear Power Generation in Japan on International Energy Markets

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Introduction

The publication of reports concerning a case of false statement of nuclear power plant inspection records by Tokyo Electric Power Company (TEPCO) at the end of August 2002 and similar problems in Chubu Electric Power and Tohoku Electric Power in September 2002 coincided with several other factors that could heighten the volatility of the international oil markets, such as the uncertain situation in Iraq. For this reason, these problems attracted considerable attention among market players regarding how they would affect the energy market, in particular the level of additional oil demands.

TEPCO supplies electric power to areas with large electric power demands, such as the Tokyo metropolitan area. In April 2003, the operation of all of the 17 nuclear power plants owned by the company was suspended simultaneously for various reasons, such as advancement of regular inspection schedules. This led to a situation where no electric power was supplied by nuclear power plants at all, and fears of serious supply shortages arose as the summer period, during which the electric power demand is at it's highest, drew nearer. In order to address this situation, TEPCO ran a power saving campaign, while at the same time making every possible effort to secure additional electricity supply through cooperation with other electric power companies and bringing suspended thermal power plants back into operation. As a result, the demand for fuel oil for thermal power generation exploded, which had various impacts on the international oil and gas markets as well. The shortage of the electric power supply itself did not occur, however, because in addition to the aforementioned efforts the summer of 2003 was unusually cool, and agreements with local governments were reached and 6 nuclear power plants resumed operation by the end of August 2003.

This report attempts to analyze how the Japanese situation, with the suspension of nuclear power generation, affected the international oil and natural gas markets. The analysis focuses on TEPCO, which was heavily affected by the suspension of nuclear power generation, and primarily uses data covering the period from the fourth quarter of 2002 to the first quarter of 2003 (the latter half of fiscal year 2002). It then examines how the Japanese nuclear power generation industry has become an entity that can exert an influence, not only on the domestic energy supply in Japan, but also on the

international energy markets.

1. International Oil Market Trends

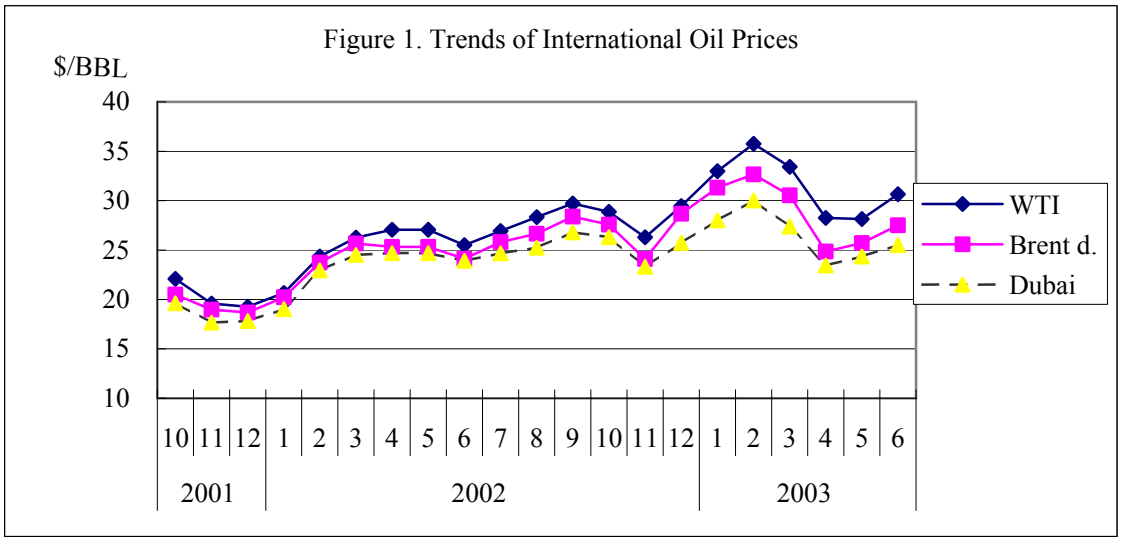
First of all, the trends of the international oil markets are summarized for the period from the fourth quarter of 2002 to the first quarter of 2003 when the concern for electric power supply shortage due to the suspension of nuclear power generation arose in Japan.

(1) Price Trends

Figure 1 shows the development of the crude oil prices, which will be used as an index in this study, on the three major international oil markets in Western Hemisphere, Europe and Asia.

In the latter half of the fourth quarter of 2001, the crude oil price of West Texas Intermediate (WTI) dropped to just over $19/BBL due to the stagnation of the global economy caused by the effects of the September 11 terrorist attacks in the US in 2001. After the end of 2002 to the beginning of 2003, the crude oil prices rose sharply to over $30/BBL, however, due to market psychology directed at the situation in the Middle East, where the Israel/Palestine problem and the possibility of an attack on Iraq came into focus. Thereafter, the crude oil price trends have remained strong in each market.

Figure 1. Trends of International Oil Prices



Source: Oil Market Report (IEA)

(2) Oil Demand Trends

The main factors that led to destabilization of the oil prices in the international oil markets are listed below as background material for the oil price trends shown in Figure 1.

[Factors affecting the supply side]

(1) The export of crude oil from Iraq came to a complete halt on March 18, 2003 as the situation in the Middle East grew increasingly tense. The situation eventually ended up in war breaking out against Iraq.

(2) In December 2002, a general strike with the aim of forcing prime minister Chavez to resign had an impact on the oil sector in Venezuela; the amount of crude oil production dropped sharply, through March 2003.

(3) In Nigeria, prolonged political uncertainty due to escalation of ethnic conflicts caused the crude oil production operated by the major oil companies to decrease.

[Factors affecting the demand side]

(1) After the September 11 terrorist attacks in the US in 2001, China, South Korea and Southeast Asia were caught up in the general decline of the global economic growth. After 2002, however, their economies have begun to show steady recovery and their oil imports have also increased. Moreover, initiatives to increase stocks were intensified in several oil consuming countries in Asia out of concerns that the oil supply from the Middle East might be disrupted in case of breaking out in Iraq.

(2) The oil demand for heating oil increased due to a cold wave that hit the Northern Hemisphere.

Thus, in the period leading to the suspension of nuclear power generation in Japan, there were several multi-tiered factors that seeme to have had an influence on how the demand fundamentals would turn out and increase the price volatility on both the demand and supply sides in the international oil markets.

2. Consumption/Purchase Trends of Fuel for Thermal Power Generation

The overall Japanese electric power demand[1] in fiscal year 2002 showed a growth of 2.1% compared to the previous year, in particular due to an increase in consumption of light and power, with demand increasing by 2.3% for TEPCO, 1.8% for Chubu Electric Power and 2.4% for Tohoku Electric Power, respectively.

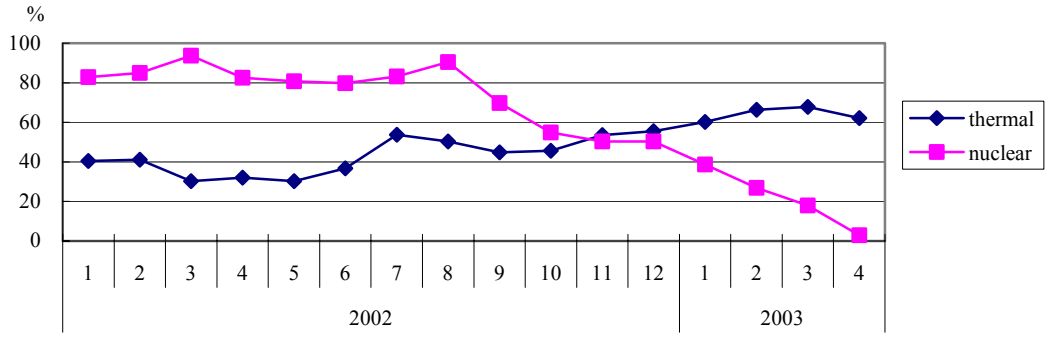
TEPCO's nuclear power plants, accounted for 28.7% of the power produced[2] at the end of March

[1] See the home page of the Federation of Electric Power Companies of Japan ("Electricity Demand Results in 2002" published on April 30, 2003).

[2] The total power generation capacity of TEPCO as of the end of March 2002 was 6037.5 billion KW. The breakdown of the power source composition was as follows: 28.7% for nuclear (1730.8 billion KW), 57.2% for thermal (3454.5 billion KW) and 14.1% for hydroelectric (851.9 billion KW) power generation. Note that the total power generation capacity of TEPCO accounts for 30.6% of the entire Japanese power generation capacity.

2002 and supplied 44% of the total electricity generated (results of fiscal year 2001[3]). TEPCO was further obliged to lower the electric power supply output due to gradual suspension of operation as shown in Figure 2. In this section, the trends of fuel consumption and purchase are examined, focusing on oil-based and liquefied natural gas (LNG)-based thermal power generation. Power plants of these types are considered to have played the central role in covering the shortage of supply caused by the suspension of nuclear power generation at TEPCO[4].

Figure 2. Utilization Rate of Power Plant



Source: Electricity survey statistic monthly report

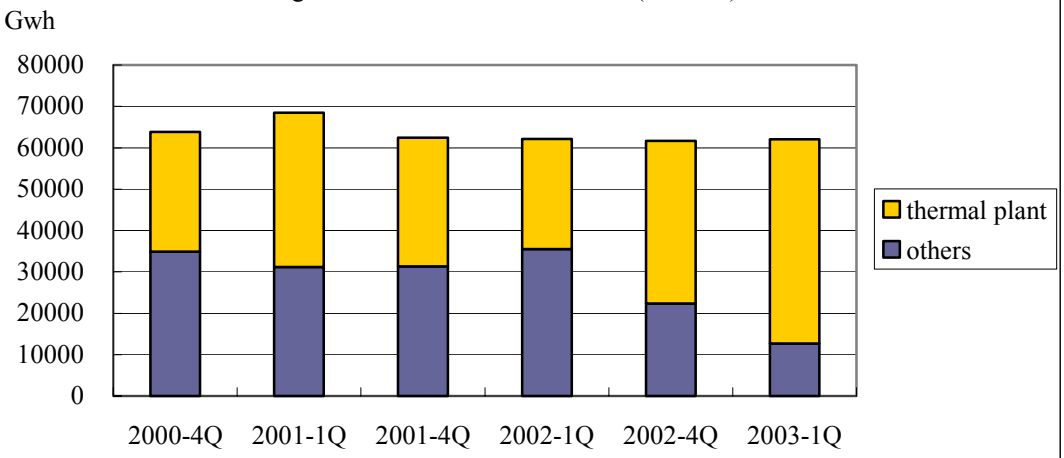
(1) Power Supply from Thermal Power Generation out of Total Power Generation

Figure 3 shows the power supply percentage produced using thermal power generation (oil, LNG and coal) out of the total power supply delivered by TEPCO in the latter half of each fiscal year from 2000 to 2002[5].

The share of thermal power generation in the latter half of fiscal year 2002 was 71.7%, which was significantly larger than the 46.3% of the same period of the previous year. Looking at the quarterly supply, the share increased to 63.7% in the fourth quarter of 2002, which was a significant increase compared to the same period of the previous year, and further to 79.6% in the first quarter of 2003[6].

[3] TEPCO homepage
[4] The examination in this section is based on data for thermal power generation based on oil, LNG and coal.
[5] Note that the latter half of a fiscal year, for example, 2002 refers to the fourth quarter (October to December) of 2002 and the first quarter (January to March) of 2003.
[6] In April 2003, the utilization rate of nuclear power facilities dropped to 2.9% while the share of electric power generated by thermal power generation reached 90.4%. Note that the nuclear power plants resumed operation in stages after May 2003; as of the end of August, 6 plants among the 17 suspended plants had returned to normal operation. In addition to this, TEPCO supplied 36.4% of the total oil-fired power generated by 10 power supply companies in the latter half of fiscal year 2002. This is well over the 29.1% and 31.3% supplied by TEPCO in the same period of fiscal years 2001 and 2000, respectively. Incidentally, out of the total power generated by 10 power supply companies, the thermal power generation share accounted for 53.7%, 52.4% and 62.9% in the latter half of fiscal year 2000, 2001 and 2002, respectively.

Figure 3. Total Power Generation (TEPCO)



Source: Electricity survey statistic monthly report

(2) Consumption and Purchase of Fuel for Thermal Power Generation

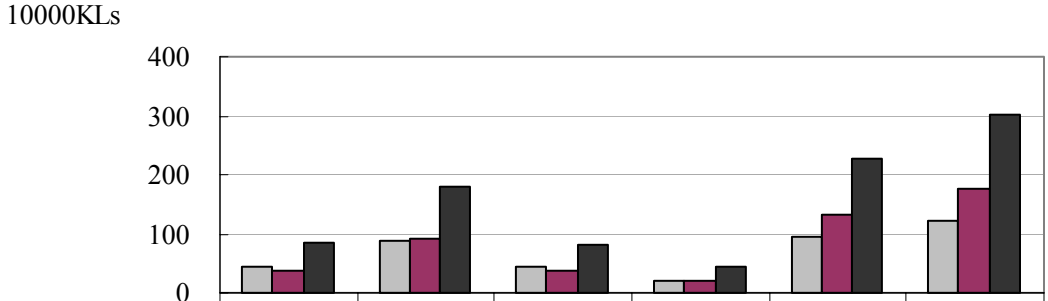
(2)-1 Oil Consumption

Figure 4 shows the development of oil consumed as fuel for thermal power generation in the latter half of each fiscal year from 2000 to 2002.

The oil consumption was 0.61 million KLs in September 2002 when the nuclear power plants started to ramp down operation. After that point, the consumption of oil, the main alternative fuel, began to show an upward trend as the facility utilization rate of the nuclear power plants decreased. As shown in Figure 2, the oil consumption fluctuated within the range of around 0.6 to 0.8 million KLs/month in the fourth quarter of 2002 when the utilization rate of the nuclear power facilities dropped from 69.7% in September 2002 to 50.4% in December of the same year. The oil consumption in the first quarter of 2003 increased to around 0.9 to 1.1 million KLs/month as the utilization rate of the nuclear power facilities dropped further from 38.7% in January 2003 to 18% in March of the same year. The oil consumption in the latter half of fiscal year 2003 was thus 2.18 million KLs crude oil and 3.1 million KLs fuel oil, 5.28 million KLs in total. The consumption of crude oil and fuel oil increased by 232% and 427%, respectively, compared to the same period of the previous year; the total consumption showed a drastic increase of 324% (incremental increase of 4.03 million KLs)[7].

[7] TEPCO's share of the total amount of oil consumed by public power supply companies as a whole for oil-fired power generation (10.48 million KLs) in the latter half of fiscal year 2002 was 50.4% (crude oil 47.2%, fuel oil 52.9%), which is significantly higher than the share in the same period of the previous year, 29.0% (crude oil 37.3%, fuel oil 23.2%).

Figure 4. Oil Consumption (TEPCO)



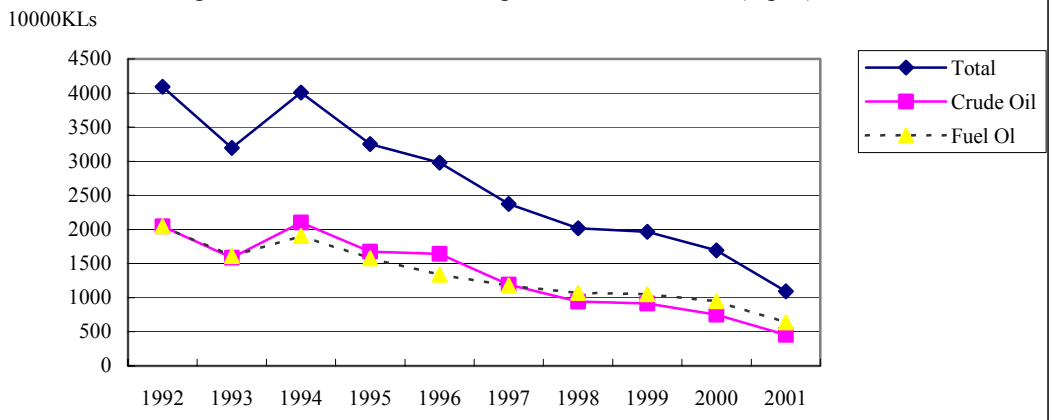
	2000-4Q	2001-1Q	2001-4Q	2002-1Q	2002-4Q	2003-1Q
crude oil	45.0	88.9	44.5	21.4	95.1	123.4
fuel oil	38.4	90.6	37.1	21.7	132.5	177.3
total	83.5	179.5	81.6	43.1	227.5	300.6

Source: Electricity survey statistic monthly report

Figure 5 shows the development of the amount of oil consumed for thermal power generation in the ten-year period starting from 1992. From this consumption trend, it can be seen that the part played by oil-fired power generation in the total power generation declined fairly sharply during this period. Moreover, according to different data[8] during the three-year period from fiscal year1999 to 2001, it is noticed that the share of thermal power generation out of the total electricity generated in Japan as a whole did not change dramatically: 56.7%, 57.3% and 57.4% in 1999, 2000 and 2001, respectively; however, looking at the share of power generated by oil-fired power generation only, it is observed that the share decreased: 11.7%, 10.3% and 7.9%, respectively.

[8] Electric Power Industry Handbook (2000, 2001 and 2002 versions)

Figure 5. Trend of Oil Consumption for Power Plant (Japan)



Source: Electric Power Industry Handbook

(2)-2 LNG Consumption

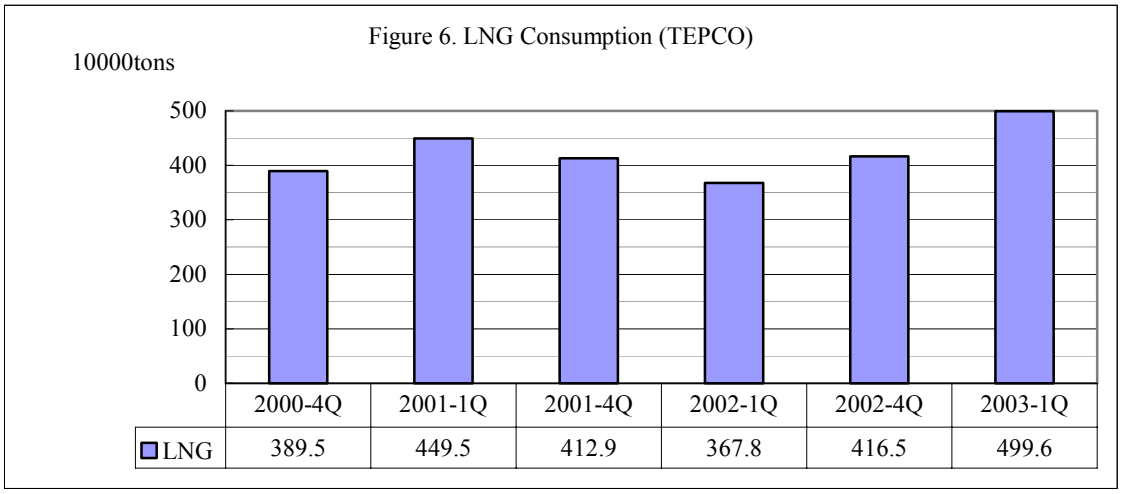
Figure 6 shows the development of the amount of LNG consumed as a fuel for thermal power generation in the latter half of each fiscal year during 2000 to 2002. As can be seen, the development of the LNG consumption shows a different trend to that of oil consumption.

The oil consumption increased from the third to the fourth quarter of 2002 by 0.3 million KLs and 0.56 million KLs for crude oil and fuel oil, respectively while the LNG consumption decreased by 0.39 million tons over the same period.

Looking at data for the latter half of fiscal year 2002, LNG consumption was 1.3 to 1.5 million tons/month in the fourth quarter of 2002, a small increase of 0.9% compared to the same period of the previous year. It was 1.6 to 1.8 million tons/month in the first quarter of 2003, however, an increase of 35.8% compared to the same period of the previous year. The consumption in the latter half of fiscal year 2002 was 9.16 million tons, an increase of 17.3% (incremental increase of 1.35 million tons) compared to the same period of the previous year[9].

[9] The LNG consumption share of TEPCO of the total LNG consumption (19.46 million tons) used for thermal power generation by public power supply companies in the latter half of fiscal year 2002 was 47.1%, which exceeds the 41.9% in the same period of the previous year.

Figure 6. LNG Consumption (TEPCO)



Source: Electricity survey statistic monthly report

(2)-3 Oil Purchase

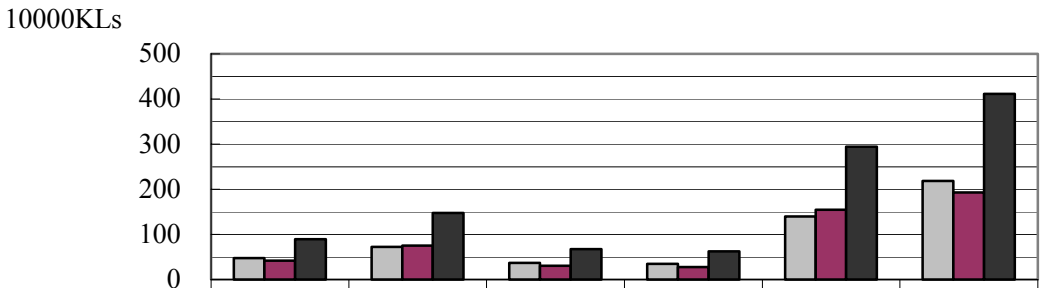
Next, figures 7 and 8 show the development of the amount of fuel received by thermal power plants to meet the increased consumption as mentioned above.

It seems likely that TEPCO increased its procurement of oil from the market while using its in-stock reserves (1.43 million KLs as of the end of August 2002) to get by in September 2002 when some of the nuclear power plants stopped operation. From then on, TEPCO purchased increasing amounts of oil: 0.68 million KLs in September, 0.83 million KLs in October and between 1 million KLs and 1.4 million KLs per month after November 2002. A comparison of the amount of oil purchased in the fourth quarter of 2002 with the previous quarter shows increases of 0.68 million KLs for crude oil and 0.8 million KLs for fuel oil.

The amount of oil purchased in the latter half of fiscal year 2002 was 3.58 million KLs for crude oil and 3.48 million KLs for fuel oil, 7.06 million KLs in total. The purchases of both crude oil and fuel oil showed dramatic increases compared to the same period of the previous year, 397% and 498%, respectively, and 442% in total (incremental increase of 5.76 million KLs)[10].

[10] TEPCO purchased 57.2% (crude oil 59.0% and fuel oil 55.4%) of the total amount of crude and fuel oil for oil-fired power generation purchased by 10 power supply companies (12.34 million KLs) in the latter half of fiscal year 2002, indicating a sharp increase from 30.8% (crude oil 42.9% and fuel oil 22.9%) in the same period of the previous year. Moreover, according to the TEX report dated April 4, 2003, the amount of oil purchased by TEPCO by annual agreements (fiscal year 2002) increased from the initial 3 million KLs to 6 million KLs.

Figure 7. Receiving for Oil-fired Power Plant (TEPCO)



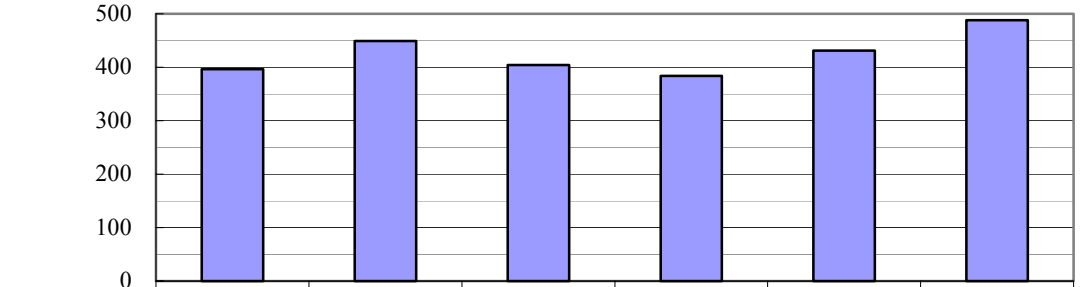
	2000-4Q	2001-1Q	2001-4Q	2002-1Q	2002-4Q	2003-1Q
crude oil	47.5	72.1	37.1	34.9	139.7	218.4
fuel oil	42.1	75.3	30.6	27.6	154.9	193.0
total	89.6	147.4	67.7	62.5	294.6	411.4

Source: Electricity survey statistic monthly report

(2)-4 LNG Purchase

The amount of LNG received by TEPCO's thermal power plants in the latter half of fiscal year 2002 was 9.19 million tons, an increase of 19.2% (1.31 million tons) compared to the same period of the previous year. Looking at the quarterly development, the purchased amount was 4.31 million tons in the fourth quarter of 2002, which is 0.19 million tons less than the third quarter, but it then increased to 4.88 million tons in the first quarter of 2003[11].

Figure 8. Purchase of Fuel for LNG-Fired Power Generation (TEPCO)



	2000-4Q	2001-1Q	2001-4Q	2002-1Q	2002-4Q	2003-1Q
LNG	396.6	448.8	404.3	383.7	431.1	488.0

Source: Electricity survey statistic monthly report

[11] TEPCO's share of the total amount of LNG purchased for thermal power generation by 10 power supply companies (19.48 million tons) in the latter half of fiscal year 2002 was 47.2%, which exceeds the corresponding share of 42.9% in the same period of the previous year.

As the development of fuel consumption and related purchases shows, it seems to have been fairly easy for TEPCO to adjust its power generation operations. It covered the shortage of electric power supply caused by the suspension of nuclear power generation by increasing the operating rate of oil-fired power generation capacity, which is normally used as a power source for peak load supply, and its thermal power generation capacity using LNG, which is a power source for middle load supply, bringing thermal power plants that were suspended according to long-term operation plans back into operation. Further output was gained through extending the operation of new gas-fired power plants, as well as taking other measures such as obtaining electric power from other companies[12].

3. Trends of Procurement of Fuel for Thermal Power Generation

This section examines the actions taken on the procuring side to meet the demands for fuel for thermal power generation as a temporary replacement for the supply loss caused by the suspension of nuclear power generation, focusing on both import into Japan as a whole and domestic production.

(1) Oil Import

Table 1 shows the development of crude oil import into Japan in the latter half of each fiscal year from 2000 to 2002, by supply source. The crude oil import in the latter half of fiscal year 2002 increased by 10.06 million KLs compared to the same period of the previous year. The amount of crude oil imported from the countries that supply crude oil for electric power purposes, namely Southeast Asia and China, increased by 1.29 million KLs in the latter half of 2002, compared to the same period of 2001 and accounted for 12.8% of the increase of the total amount of crude oil import. Furthermore, the Middle East accounts for 6.3% of this increase and Africa for 41.4% due to a sharp increase in imports of low-sulfur crude oil such as Nile Blend[13] etc. suited for electric power purposes (see Figure 9).

[12] The amount of coal consumption was 0.3 million tons in the first quarter of 2003, due to the launch of operation of the Hitachi Naka coal-fired power plant in December 2002.

[13] This refers to crude oil produced in Sudan. The amount of import from Sudan in the latter half of fiscal year 2002 was 181.9 million KLs which accounts for 27.7% of the crude oil import from Africa. Furthermore, the amount of shipment of the crude oil for non-refining was 0.166 million KLs in the latter half of fiscal year 2002, which vastly exceeded the 342 KLs in the same period of the previous year.

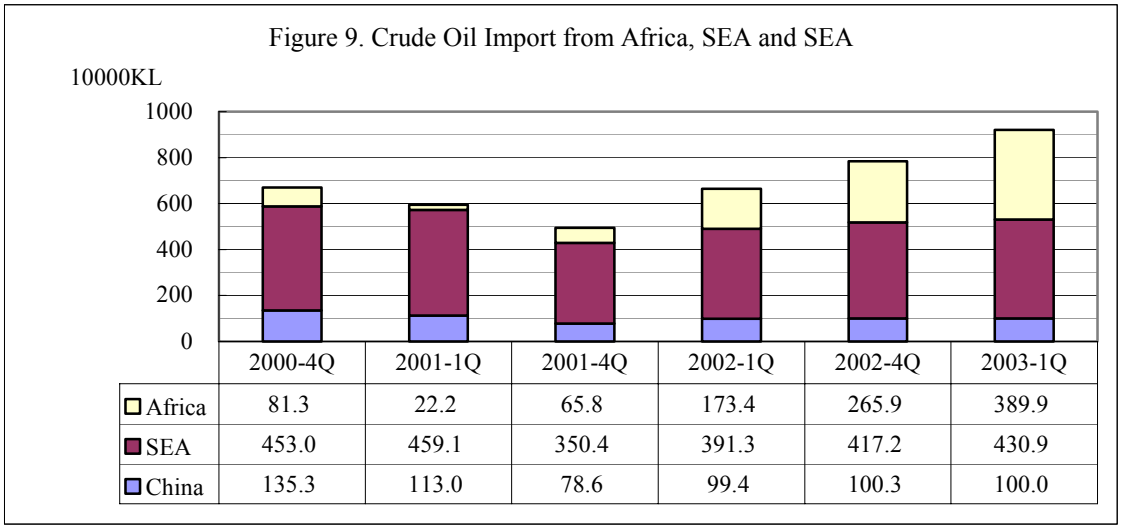
Table 1. Crude Oil Import by Supply Source (Unit: 10,000 kL)

	Total amount of import	Middle East	Africa	Southeast Asia[14]	China	Others
2000-4Q	6500.8	5685.9 (87.4)	81.3 (1.3)	453.0 (7.0)	135.3 (2.1)	145.3 (2.2)
2001-1Q	6950.0	6189.7 (89.1)	22.2 (0.3)	459.1 (6.6)	113.0 (1.6)	166.0 (2.4)
2001-4Q	5994.1	5404.5 (90.2)	65.8 (1.1)	350.4 (5.8)	78.6 (1.3)	94.8 (1.6)
2002-1Q	6218.6	5428.0 (87.3)	173.4 (2.8)	391.3 (6.3)	99.4 (1.6)	126.5 (2.0)
2002-4Q	6374.5	5402.5 (84.8)	265.9 (4.2)	417.2 (6.5)	100.3 (1.6)	188.6 (2.9)
2003-1Q	6844.4	5798.1 (84.7)	389.9 (5.7)	430.9 (6.3)	100.0 (1.5)	125.5 (1.8)

Source: Oil Statistics Monthly Report

Values in ( ) show shares in percent.

Figure 9. Crude Oil Import from Africa, SEA and SEA



Source: Oil Statistics Monthly Report

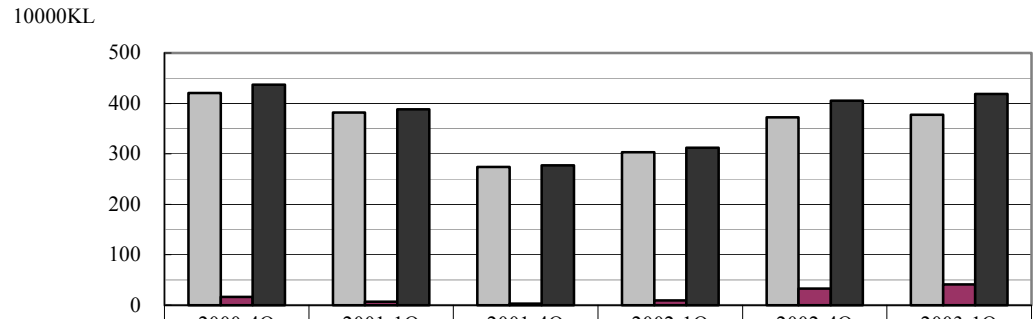
Figure 10 shows the amounts of imported low-sulfur crude oil[15] and low-sulfur fuel oil[16], which are

[14] Minas Topped, which is imported as "raw oil" for the purpose of producing wax and coke, is also included in this figure.

[15] The seven oil types are Sumatra Light, Cinta, Duri and Widuri produced in Indonesia, Daqing produced in China,

considered to be the typical crude oils used as fuel for thermal power generation, out of the crude oil imported from Southeast Asia and China. The amounts of import of these oil types in the latter half of fiscal year 2002 increased by 1.73 million KLs for crude oil (seven oil types) and by 0.62 million KLs for fuel oil compared to the same period of the previous year, bringing the total to 8.25 million KLs. When each quarter is compared with the same period of the previous year, the total amount of imported crude and fuel oil increased by 46.3% (1.28 million KLs) in the fourth quarter of 2002 and 34.2% (1.07 million KLs) in the first quarter of 2003, each exceeding the value in the same period of the previous year.

Figure 10. Import of Low-sulfur Crude oil and Low-sulfur Fuel Oil



	2000-4Q	2001-1Q	2001-4Q	2002-1Q	2002-4Q	2003-1Q
crude oil	420.5	381.7	274.0	303.0	372.4	377.5
fuel oil	16.4	6.9	3.2	9.3	33.1	41.5
total	436.9	388.6	277.2	312.3	405.5	419.0

Source: Oil Statistics Monthly Report

(2) Domestic Oil Production

Next, the trends of domestic production of oil products for consumption are briefly examined.

Figure 11 shows the development of the amount of processed crude oil and fuel oil production[17] in Japan. The operating rate of the oil refinery capacity was 75% in October 2002, but this rate went up by over 10% in November to meet the increased demand for fuel oil for power generation. Additionally, the operating rate was 89.6%, 93.2% and 91.1% in January, February and March 2003, respectively. Thus, the operating rate in the first quarter of 2003 exceeded the rate observed in the same period of 2002, 87.6%, 88.9% and 83.1% in January, February and March, respectively. Furthermore, the amount of processed crude oil increased by 2.02 million KLs in the fourth quarter of 2002 and 3.66 million KLs in the first quarter of 2003, compared to the latter half of fiscal year

and Bach Ho and Rang Dong produced in Vietnam.

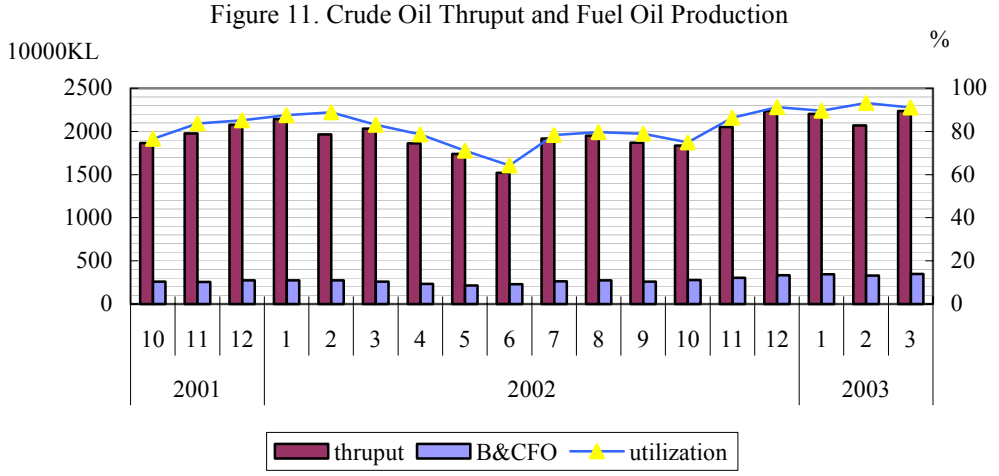
[16] Fuel oil C produced in Indonesia

[17] Total amount of "heavy oil B and C" according to the classification in Oil Statistics Monthly Report

2002.

In the latter half of fiscal year 2002, the amount of processed crude oil increased by 5.676 million KLs (47%) and the amount of fuel oil production increased by 3.404 million KLs (60%) compared to the same period of the previous year. The changes in the thruput ratio of crude oil from the Middle East and southern regions such as Indonesia are not known, but it appears that oil refineries adjusted their operation in order to increase the production of low-sulfur fuel oil for power generation.

Figure 11. Crude Oil Thruput and Fuel Oil Production

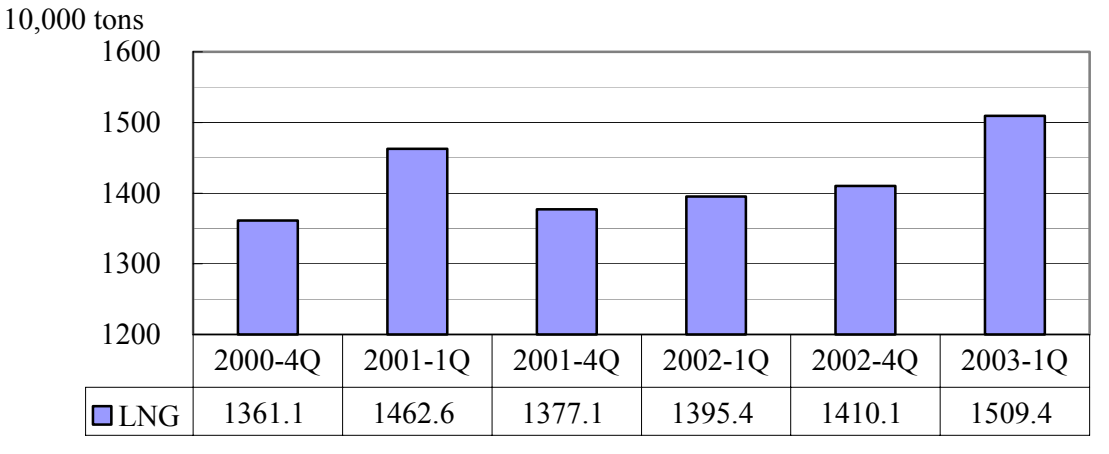


Source: Oil Statistics Monthly Report

(3) LNG Import

Figure 12 shows the amount of LNG import in Japan as a whole in the latter half of each fiscal year from 2000 to 2002. The LNG import in the latter half of fiscal year 2002 was 29.2 million tons, an increase of 5.3% compared to the same period of the previous year. When quarterly LNG import are compared, it can be seen that imports increased by 2.4% (0.33 million tons) in the fourth quarter in 2002 and 8.1% (1.14 million tons) in the first quarter of 2003, respectively, over the same period of the previous year.

Figure 12. Amount of LNG Import (Japan)



	2000-4Q	2001-1Q	2001-4Q	2002-1Q	2002-4Q	2003-1Q
LNG	1361.1	1462.6	1377.1	1395.4	1410.1	1509.4

Source: Oil Statistics Monthly Report

4. Effects on the Energy Market

(1) Influence on International Crude Oil Markets

It is extremely difficult to analyze the degree of influence of the suspension of nuclear power generation in Japan on the international oil markets in a quantative manner. Nonetheless, the development in the nuclear power generation in Japan surely played some role in the increase of oil prices and volatility of the markets throughout the suspended period.

The International Energy Agency (IEA) observed in the Oil Market Report (OMR) published in October 2002 that the nuclear power generation capacity temporarily lost due to the incidents of this time was 11% (five plants - 5.2 GW) of the total nuclear power generation capacity of Japan and, in addition, the suspension period would be extended for some power plants and other facilities planned to be suspended initially. Moreover, the report forecasted that the electric power supply output from these plants would be stopped throughout the fourth quarter of 2002. Based on these observations, IEA projected that the additional demands for oil (and LNG) required to cover the shortfall of electric power would be 85,000 B/D in the fourth quarter of 2002, or more specifically 75,000 B/D in October, 105,000 B/D in November and 80,000 B/D in December.

In December 2002, IEA reported in the OMR that the number of nuclear power plants whose operation would be suspended had been increased compared to the previously announced figure, and that the suspension period would also became longer than initially expected; the plants in question would not resume operation until the second quarter of 2003.

Table 2 shows the development of IEA projections of oil demands in Japan for the fourth quarter of 2002 and the first quarter of 2003. IEA revised the demand projection for the fourth quarter of 2002

from 5.52 million B/D in September to 5.64 million B/D in December in 2002, and finally settled at a fixed amount of 5.89 million B/D in February 2003. This figure exceeds the projection made in September in 2002 by 370,000 B/D. These projections show that the additional demands for oil in Japan as a result of the suspension of nuclear power generation became higher as time progressed. On the other hand, it is extremely difficult to project oil demand accurately, and that further "uncertainty" was introduced to the international oil markets during this period.

Table 2. Development in Projections of Oil Demands in Japan (Unit: Million B/D)

	2002.9	2002.10	2002.11	2002.12	2003.1	2003.2	2003.3
2002 - 4Q	5.52	5.59	→	5.64	5.78	5.89 (Fixed)	→
2003 - 1Q	5.78	→	→	5.83	5.97	6.11	6.07

Source: Oil Market Report

As mentioned above, in a situation where several factors destabilizing the market at several levels conspired to make projection of the future development of the international oil markets increasingly difficult, it would be allowed to conclude that the problem of the suspension of nuclear power generation in Japan generated additional demands for oil as an alternative fuel, tightened the supply/demand situation, and, furthermore, that it had a certain effect on the price increase. The scale of the future suspension of nuclear power generation and uncertainty in the amount of additional demands became new factors heightening the volatility of the market, making the prediction of market trends even more difficult. In addition to these factors affecting the fundamentals, the news of the suspension of nuclear power generation in Japanese regions demanding large amounts of electric power had a significant psychological impact on the decisions of the players in the international oil futures markets, including the NYMEX. It could be said that the suspension of nuclear power generation acted as a factor to drive up the international crude oil prices although the impact cannot be easily measured quantitatively.

(2) Influence on Crude Oil Markets in Asian Regions

Next, it was examined what effect the extra procurement of crude oil and fuel oil purchased by Japan for thermal power generation on the Asia oil market.

Figure 13 shows the development of prices (monthly averages) in the spot markets of Minas (Sumatra Light), low-sulfur and light Tapis, low-sulfur fuel oil LSWR[18] (cracked) and Dubai, which are crude oil types typically used for power generation.

[18] Abbreviation of Low Sulfur Waxy Residue. The prices indicated are from the Singaporean market.

Firstly, the crude oil price differentials between the Middle East and Southeast Asia are examined. The price of Dubai was basically on a downward trend, from $26.32/BBL in September to $25.73/BBL in December 2002. On the other hand, the price of Minas was already higher than that of Dubai as of September 2002, and kept increasing, except in November 2002. The price differentials between them widened from $0.96/BBL in September 2002 to $7.03/BBL in December 2002. In the first quarter of 2003, this price gap became smaller, but there was still a gap of $2 to 4/BBL. When the development of the average prices of these crude oils in the third and fourth quarter of 2002 are compared, it is seen that the price of Dubai dropped by 1.8% while the price of Minas increased by 15.0%.

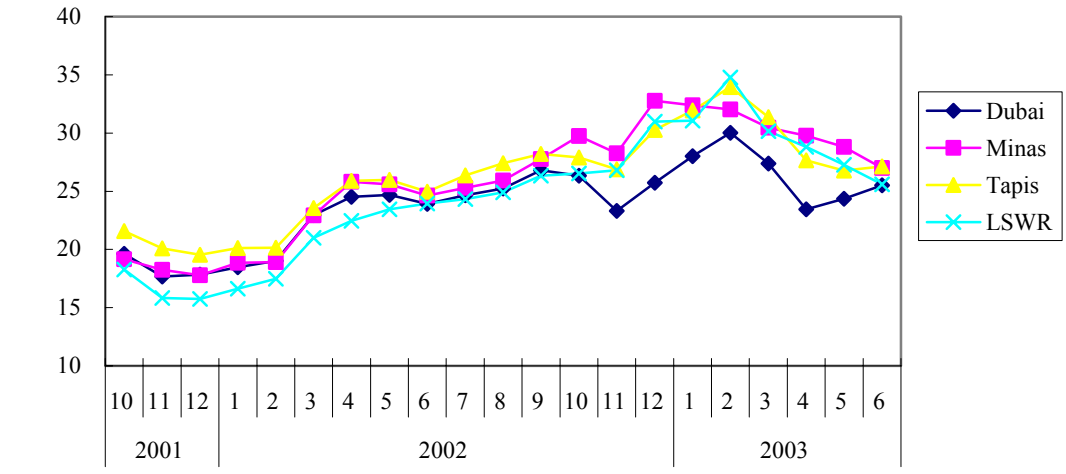
Next, the price differential between Minas and Tapis low-sulfur light crude oil is examined. Under normal circumstances, Tapis is evaluated higher in market transactions than Minas, and reversals of their price levels are observed only rarely. Between October 2002 and January 2003, however, the price of Minas crude oil maintained a higher level than the price of Tapis; the price of Minas was $1.37 to 2.49/BBL higher throughout the fourth quarter of 2002. When the development of the average prices of these crude oil types in the third and fourth quarter of 2002 are compared, it is seen that the price of Minas crude oil increased by 15.0% as mentioned above while the price of Tapis increased by 3.8%. And this relatively long-lasting reversal phenomenon was observed in the official sales prices of these types of crude oil in the fourth quarter of 2002 as well.

Moreover, the price of Minas on the spot market put a premium[19] of $0.92/BBL compared to the official sales price in October to December of 2002.

The price of LSWR (cracked) in the Singapore market was also on a steady upward trend during the period of September 2002 to February 2003, and posted a high price exceeding the spot price of Minas, $34.77/BBL, in February 2003. During the latter half of fiscal year 2002, the price of LSWR was constantly higher than that of Dubai, which was not observed in the same period of the previous year.

[19] The premium of Minas crude oil, compared to ICP (Indonesia crude oil official sales price), peaked in June 2003 at $1.22/BBL.

Figure 13. Development of Prices of Crude Oil and Fuel Oil for Power Generation



Source: Oil Market Report (IEA)

In the latter half of fiscal year 2002, the price differentials between the oil types became more prominent, as shown in Figure 13, and the trends of the prices of Dubai, Minas used for power generation and Tapis moved in different directions than in the latter half of the previous fiscal year. This is considered to be a result of aggressive overseas procurement of alternative fuel due to the suspension of nuclear power generation in Japan, which amplified the price fluctuations of crude and fuel oil used for power generation. The price trends of Minas, which increased steadily as mentioned above, was used as a benchmark in determining the prices of different competing types of low-sulfur crude oil for power generation. For the aforementioned reason, Minas had a direct impact on the prices of Daqing on a long-term trade transaction base and crude oils produced in Vietnam imported by Japan. Moreover, the price development of Minas had effect on the price development of LSWR in the Singapore market as well.

(3) Influence on LNG Import Prices

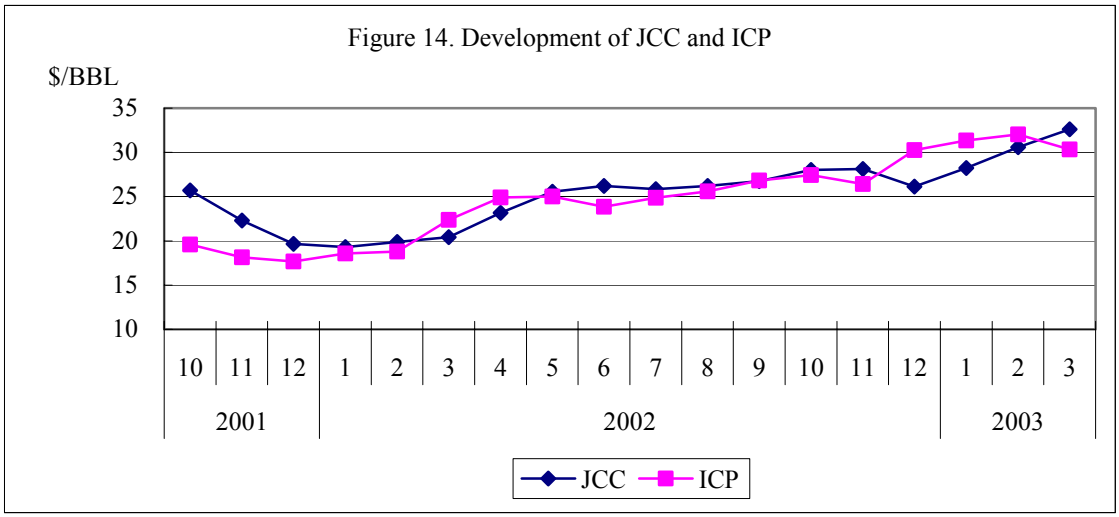
The price increases on the international crude oil markets mentioned above inevitably led to an increase of the JCC (Japanese Crude-oil Cocktail) index adopted as the sales price determination method of LNG; it has had a direct influence on the import prices of LNG. Moreover, the price development of Minas had an impact on the prices of crude oil produced in Indonesia as well. Thus, the monthly reviewed ICP was increased, and consequently the price of LNG produced in Indonesia which takes ICP as a factor to determine the price, also went up.

Figure 14 shows the development of JCC and ICP, which are taken in two types of calculation

models that currently dominate the LNG sales price determination methods for the traditional LNG importing countries in Asia, i.e., Japan, Korea and Taiwan.

The simple average value of ICP[20] in the latter half of fiscal year 2002 was $29.64/BBL (an increase of 54.5% compared to the same period of the previous year), which exceeded the pace of increase of JCC ($28.96/BBL, an increase of 36.5%). The JCC and ICP in the latter half of fiscal year 2002 showed different trends than those observed in the latter half of the previous year. ICP was lower than JCC in October to November of 2002, but exceeded JCC in the period from December 2002 to February 2003.

Figure 14. Development of JCC and ICP



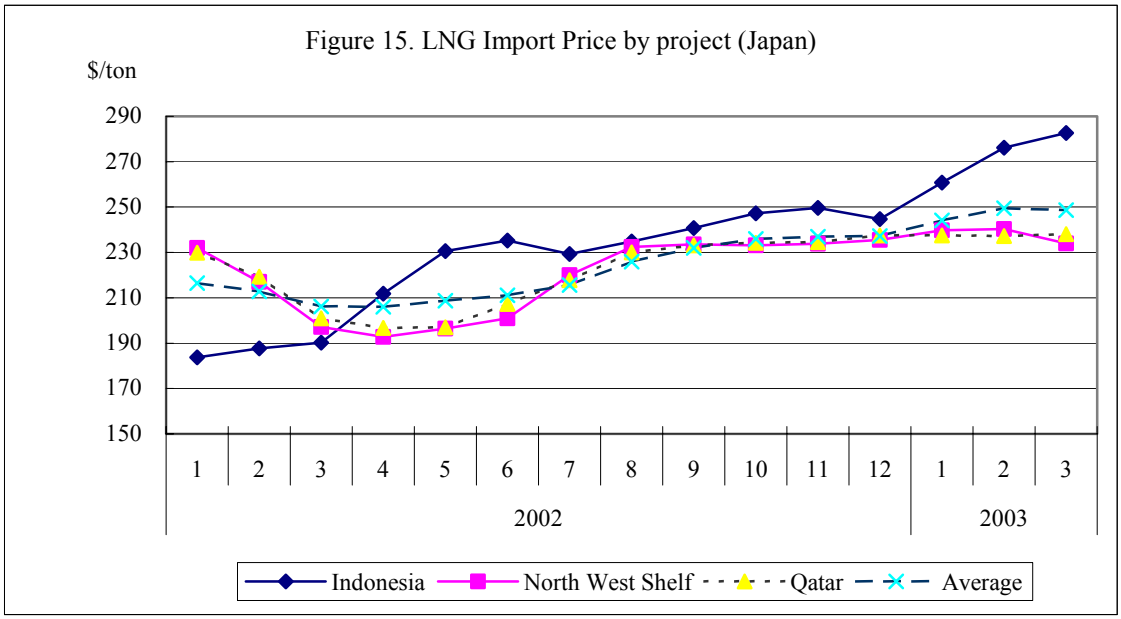
Source: Materials from Petroleum Association of Japan and others

Figure 15 shows LNG import prices in Japan for the main supply sources.

Since the price of LNG produced in Indonesia is linked to the price of crude oil produced in Indonesia, an increase of the price of crude oil produced in Indonesia is directly reflected in the price of LNG. Thus, in the first quarter of 2003 when the Minas price was in the range of $30 to 32.50/BBL, the price of LNG produced in Indonesia was also at a high level composed with other LNG supply sources.

[20] Abbreviation of Indonesia Crude Price, an average price of 41 types of crude oil and gas-condensate produced in Indonesia

Figure 15. LNG Import Price by project (Japan)

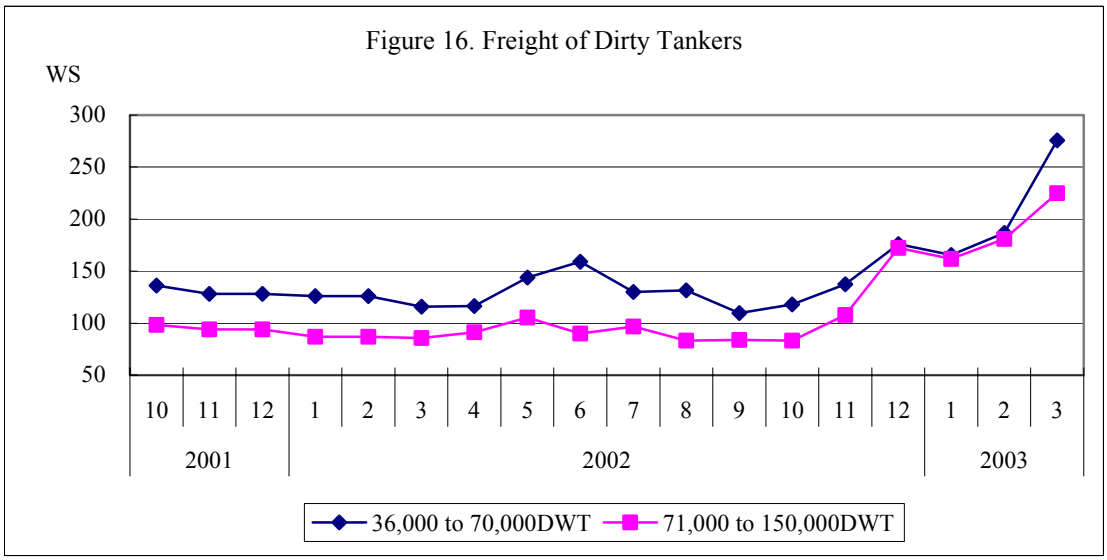


Source: TEX Report

(4) Influence on Tanker Freights

Figure 16 shows the development of freight market of tankers suitable for transporting crude and fuel oil for power generation.

The freight (given as a percentage of the World Scale (WS)) of tanker types with dead weight tonnage (DWT) from 36,000 to 70,000 tons increased by 60.4% in December 2002 compared to September in the same year, and 56.8% in March 2003 compared to December 2002. Similarly, the freight of tanker types with DWT from 71,000 to 150,000 tons also increased by 105.2% and 30.6%, respectively. For both categories of tanker types, the trends shifted upward from October of 2002. The effect of aggressive procurement of crude and fuel oil for power generation by Japan can be implied from the development of these tanker freight market conditions as well.



Source: Oil Statistics Monthly Report

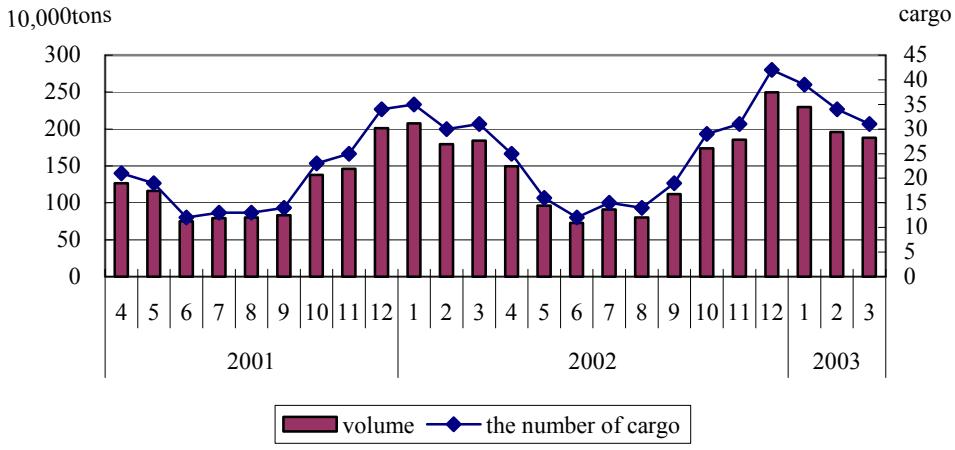
(5) Influence on Fuel Procurement of Korea

The LNG demands in Korea are significantly different in summer and winter[21]. In 2002, a cold wave hit Korea earlier than usual and a severe winter was expected; the increased procurement activities for addressing the additional demand became evident from early fall, not only for LNG but also for low-sulfur fuel oil for power generation[22].

As shown in Figure 17, the large seasonal rise in demand is reflected in the import trends as well. The imported LNG quantity in the latter half of fiscal year 2002 in Korea was 12.232 million tons, an increase of 15.8% (1.665 million tons) compared to the same period of the previous year. While the number of procured spot cargoes in the winter of 2001 was 22, it is reported that Korea procured 41 spot cargoes in order to address the additional demands for the winter of 2002[23].

[21] The demand for heating in winter accounts for a large part of the gas demand in Korea; 70% of the demand goes to city gas, while the rest is used for electric power.
[22] On December 10, 2002, Daily Sekitsu pointed out that the demand for LNG increased in Korea because the startup of the nuclear power plant Uljin No. 3 was delayed due to troubles during regular inspections.
[23] World Gas Intelligence, February 12, 2003

Figure 17. LNG Import (Korea)

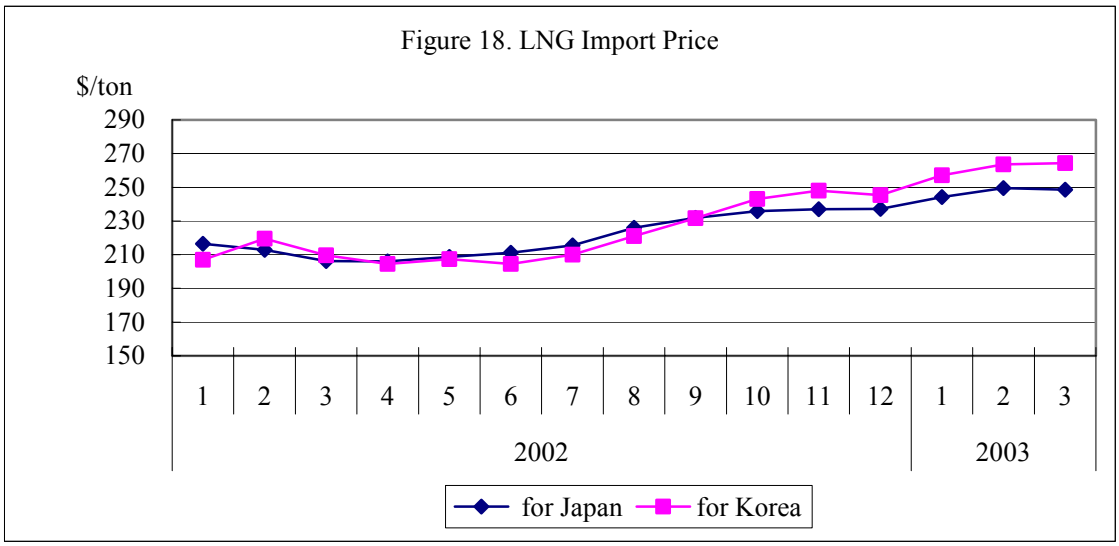


Source: Korea Energy Review (KEEI)

Under these conditions, the Japanese procurement activities to meet the unexpected additional demands of oil and LNG as substitute fuels to make up for the loss of nuclear power can be considered to have affected Korea's procurement of additional LNG and oil as well. In other words, there is a possibility that Japan and Korea got involved in a kind of "competition" in procuring LNG. As a result, the demand for oil, which is used for highly flexible sectors of the overall supply system, increased in both countries, and so forth. Furthermore, the amount of imported low-sulfur fuel oil in Korea in the latter half of fiscal year 2002 increased in the first quarter of 2003; it showed an increase of 9.5% (775,000 BBLs) in the entire period compared to the same period of the previous year.

Figure 18 shows the development of prices of LNG imported to Korea and Japan.

Figure 18. LNG Import Price



Source: TEX Report, Korea Energy Review (KEEI)

5. Conclusion

To summarize the discussion in this report, the main points will be listed below.

- In order to cover a decrease in electric power supply caused by the suspension of nuclear power generation, it was chosen to increase the operating rate of the thermal power generation capacity. As a result, the demand for oil and gas increased significantly.
- Influenced by this as well, the import volumes of low-sulfur crude oil, fuel oil and LNG in Japan increased to 7.5 million KLs (an increase of 30.0% compared to the same period of the previous year), 0.75 KLs (an increase of 497%) and 29.2 million tons (an increase of 5.3%), respectively, in the latter half of fiscal year 2002 (see figures 10 and 12).
- Together with other factors, the additional demand generated in Japan tightened the international oil supply and demand situation and became one of the factors causing a general price increase.
- In particular, the additional demand generated in Japan tightened the supply and demand balance of low-sulfur crude oil and fuel oil significantly, and caused the prices of low-sulfur crude oil and fuel oil produced in Asia, the main market, to increase dramatically.
- The increased demand for oil in Japan caused the oil price to increase and, as a result, also had an impact on the increase of LNG prices. The sharp increase of low-sulfur crude oil prices, in particular, led to a significant increase in the price of LNG produced in Indonesia.
- The additional demand in Japan are likely to have influenced Korea in its procurement of LNG and oil.
- As mentioned, this incident has made it clear that the trends of nuclear power generation and uncertainty of energy supply in Japan influence not only the domestic energy market, but also

the Asian market and international markets, and that there is a direct link between the trends of various types of energy sources, such that the mutual influence among them will cause increases in the prices of all energy sources.

- In order to cover the electric power supply lost by the suspension of nuclear power generation, which is the base load, the supply side procured additional alternative fuel, i.e., oil and LNG, and the demand side promoted various energy conservation activities, such as saving electricity. The fact that Japan managed to handle this situation provided significant experience in its efforts of securing its domestic energy supply. At the same time, it was made clear that it is necessary to take actions from both the demand and supply aspects in order to ensure "energy supply security" and that, if an unexpected situation occurs that disrupts the generation of nuclear power, it will place a large load on the Japanese energy supply system as a whole, which in turn may put a strain on the Asian and international energy markets as a whole.
- Ensuring energy supply security is and will be one of the most important issues in Japan in the future. In this context, it is important to analyze the role and significance of Japanese nuclear power generation from various angles, including the relationship with the international energy markets, when discussing nuclear power generation in the future.

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