Accelerating Changes in the LNG Chain

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Introduction

The liquefied natural gas (LNG) industry started in 1964, 40 years ago, with the first commercial transaction to export LNG from Algeria to the U.K. Since then, as natural gas has expanded its presence among primary energy sources, the LNG industry has grown into an industry that plays an important role in supplying natural gas. Meanwhile, it should also be noted that the environment affecting the LNG industry has entered a phase of restructuring amid significant changes due to the impact of the introduction of competition in the energy market. In the past, the LNG industry was regarded as a closed industry where, due to the need for huge investments, only a limited number of players shared the roles in each segment of the LNG chain and the role sharing was fixed. However, along with the progress in deregulation of gas/power markets in energy consuming countries, and in particular from the beginning of the latter half of the 1990s, the players in the LNG chain have diversified while the mobility among them has increased significantly. Thus, the internal structure of the LNG chain has been changing rapidly.

In this report, the trends in natural gas supply and demand and LNG trade will be overviewed in the three major natural gas consuming markets, Europe, the Asia-Pacific region, and North America. Subsequently, the recent changes in the LNG chain will be outlined, focusing on new movements of traditional players in LNG projects, and factors for various internal changes will be analyzed. Finally, implications will be offered as to how Japan should be involved in the upstream and midstream sectors in the changing LNG chain, considering that Japan should take appropriate measures to secure stable natural gas supply because, in the long-term primary energy outlook, natural gas demand is expected to achieve higher growth than any other energy sources, up about 37%, from FY2002 until FY2030.

Chapter 1 Trends in Natural Gas Supply and Demand in the Three Major Consuming Markets

(1) Position of natural gas in primary energy demand

Table 1-1-1 shows the data for primary energy demand in 1993, 1998, and 2003 in the three major natural gas consuming markets, Europe, the Asia-Pacific region, and North America, focusing on the trends in natural gas demand during the period from 1993 to 2003.

[European market]

Natural gas demand in the European market increased from 284.7 million tons in 1993 to 360.3 million tons in 1998 (up 26.5% over 1993), with the average annual growth rate at 4.8%, and to 419.9 million tons in 2003 (up 47.5% over 1993), with the average annual growth rate at 3.1%. In each period, the average annual growth rate of natural gas demand was higher than that of primary energy demand, and the share of natural gas consumption that covered primary energy demand expanded from 17.8% in 1993 to 21.1% in 1998 and 23.3% in 2003.

[Asia-Pacific market]

Natural gas demand in the Asia-Pacific market expanded from 170.8 million tons in 1993 to 227.8 million tons (up 33.4% over 1993), with the average annual growth rate at 5.9%, and to 310.9million tons (up 82.0% over 1993), with the average annual growth rate at 6.4%. The average annual growth rate

of natural gas demand in this market was higher than that of primary energy demand, and it was higher than that in the European market and the North American market. The share of natural gas consumption that covered primary energy demand expanded from 8.8% in 1993 to 9.9% in 1998 and 10.7% in 2003.

[North American market]

Natural gas demand in the North American market increased from 610.3 million tons in 1993 to 647.6 million tons in 1998, and 686.3 million tons in 2003 (up 12.5% over 1993), with the average annual growth rate at 1.2% in each period. This growth rate was the lowest among those of hydrocarbon energy sources. The share of natural gas consumption that covered primary energy demand slightly declined from 26.4% in 1993 to 25.7% in 1998 and 25.2% in 2003. During these periods, the average annual growth rate of natural gas demand in this market was lower than that in the European market and the Asia-Pacific market whereas the share of natural gas consumption that covered primary energy demand continued to be larger than that in the other two markets.

Table 1-1-1 Natural gas in primary energy demand (Unit: million ton in oil)

		1993	1998	2003	Average annual growth rate (%)		
					1993~1998	1998~2003	1993~2003
Europe[1]	Oil	679.9	727.5	729.3	1.4	0.04	0.7
	Natural gas	284.7	360.3	419.9	4.8	3.1	4.0
	Coal	375.2	339.1	321.4	-2.0	-1.1	-1.5
	Nuclear Power	219.6	235.7	218.7	1.4	-1.5	-0.04
	Hydraulic power	42.7	46.2	111.4	1.6	19.2	10.1
	Total	1,602.2	1,708.5	1,800.8	1.3	1.1	1.2
Asia-Pacific	Oil	753.8	896.3	1,049.1	3.5	3.2	3.4
	Natural gas	170.8	227.8	310.9	5.9	6.4	6.2
	Coal	878.0	1,013.1	1,306.2	2.9	5.2	4.1
	Nuclear Power	90.7	123.8	104.7	6.4	-3.3	1.4
	Hydraulic power	39.6	46.2	137.5	3.1	24.4	13.3
	Total	1,932.4	2,307.5	2,908.4	3.6	4.7	4.2
North America[2]	Oil	937.7	1,028.7	1,093.2	1.9	1.2	1.5
	Natural gas	610.3	647.6	686.3	1.2	1.2	1.2
	Coal	517.2	577.7	612.7	2.2	1.2	1.7
	Nuclear Power	191.2	203.9	201.1	1.3	-0.3	0.5

[1] The figures are sum totals of the 22 European countries: Austria, Belgium, Luxembourg, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, and the United Kingdom.

	Hydraulic power	53.3	57.3	133.9	1.5	18.5	9.6
	Total	2,309.8	2,515.2	2,727.3	1.7	1.6	1.7
World total	Oil	3,120.6	3,406.6	3,636.6	1.8	1.3	1.5
	Natural gas	1,827.1	2,015.4	2,331.9	2.0	3.0	2.5
	Coal	2,142.9	2,243.2	2,578.4	0.9	2.8	1.9
	Nuclear Power	563.6	626.9	598.8	2.2	-0.9	0.6
	Hydraulic power	201.0	224.8	595.4	2.3	21.5	11.5
	Total	7,854.7	8,516.8	9,741.1	1.6	2.7	2.2

Source: BP Statistical Review of World Energy

(2) Actual natural gas supply and demand[3]

[1] Trends in supply and demand in the three major markets

[European market]

As shown in Table 1-2-1, during the period from 1993 to 2003, natural gas production increased from 218.4 BCM[4] to 290.3 BCM, with the average annual growth rate at 2.9%, whereas the growth rate declined from 3.5% in the first half of the ten-year period (from 1993 to 1998) to 2.3% in the second half (from 1998 to 2003). Among other points, as for the four major natural gas producers in this region, i.e. the U.K., Norway, the Netherlands, and Denmark, the average annual growth rate in this ten-year period was 1.5%, far below the average growth rate for the European market as a whole, and it dropped sharply from 2.7% in the first half to 0.2% in the second half. On the other hand, natural gas consumption increased from 350.4 BCM in 1993 to 498.20 BCM in 2003, with the average annual growth rate at 3.6%, whereas the growth rate declined from 4.0% in the first half to 3.2% in the second half.

As the average annual growth rate of consumption was higher than that of production within the region, the dependence on imports from outside the region (=imports from outside the region/consumption) rose from 38.6% in 1993 to 40.5% in 1998 and 41.4% in 2003. Thus, regarding the balance of natural gas supply and demand in Europe, the declining trend in interregional sufficiency or the increasing trend in external dependence seems to have been established. Viewed by type of supply (transport) from outside the region, PNG[5] supply accounted for a major share during the ten-year period from 1993 to 2003, though the share declined from 85.6% in 1993 to 85.2% in 1998 and 80.6% in 2003. On the other hand, the share of LNG supply increased from 14.4% in 1993 to 14.8% in 1998 and 19.4% in 2003; thus, LNG supply expanded to cover the shortage in PNG supply.

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[2] The United States, Canada, and Mexico.
[3] Stock is not included.
[4] Billion Cubic Meter
[5] In this report, in contrast with liquefied natural gas (LNG), natural gas transported via pipelines is referred to as pipelined natural gas (PNG).

Table 1-2-1 Natural gas supply and demand in the European market[6] (Unit: BCM)

	1993	1998	2003	Average annual growth rate (%)		
				1993~1998	1998~2003	1998~2003
Production	218.40	258.90	290.30	3.5	2.3	2.9
Consumption	350.40	426.2	498.20	4.0	3.2	3.6
Import:						
PNG (within the region)	71.0	87.40	142.41	4.2	10.3	7.2
PNG (from outside the region)	115.80	147.00	166.08	4.9	2.5	3.7
LNG (from outside the region)	19.50	25.60	39.97	5.6	9.3	7.4
Export (to outside the region)	0.00	0.00	0.00	-	-	-

Source: BP Statistical Review of World Energy

[Asia-Pacific market]

As shown in Table 1-2-2, during the period from 1993 to 2003, natural gas production increased from 183.9 BCM to 310.5 BCM, with the average annual growth rate at 5.4%. On the other hand, natural gas consumption increased from 189.3 BCM in 1993 to 345.5 BCM in 2003 (up 82.5% over 1993), with the average annual growth rate at 6.2%.

As the average annual growth rate of consumption was higher than that of production within the region, the dependence on imports from outside the region (=imports from outside the region/consumption) rose from 2.5% in 1993 to 4.6% in 1998 and 10.0% in 2003. Attention should also be paid to the trend of LNG imports; the share of LNG supply from outside the region expanded from 7.8% in 1993 to 13.9% in 1998 and 30.2% in 2003.

Table 1-2-2 Natural gas supply and demand in the Asia-Pacific market (Unit: BCM)

	1993	1998	2003	Average annual growth rate (%)		
				1993~1998	1998~2003	1998~2003
Production	183.90	241.40	310.50	5.6	5.2	5.4
Consumption	189.30	255.40	345.50	6.2	6.2	6.2
Import:						
PNG (within the region)	1.50	1.50	12.19	0.0	52.0	23.3
PNG (from outside the region)	56.70	73.30	79.08	5.3	1.5	3.4
LNG (from outside the region)	4.80	11.80	34.40	19.7	23.9	21.8
Export (to outside the region)	-	0.20	0.16	—	—	—

Source: BP Statistical Review of World Energy

[North American market]

As shown in Table 1-2-3, during the period from 1993 to 2003, natural gas production increased from 684.8 BCM to 766.3 BCM, with the average annual growth rate at 1.1%, whereas the growth rate declined significantly from 2.0% in the first half of the ten-year period (from 1993 to 1998) to 0.3% in the second half (from 1998 to 2003). In any of the countries in this region (Canada, the U.S., and Mexico), the

[6] "Production" is the sum of production in Denmark, Germany, Italy, the Netherlands, Norway, Poland, Rumania, and the United Kingdom. "Consumption" is the sum of consumption in Austria, Belgium, Luxemburg, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Lithuania, the Netherlands, Norway, Poland, Portugal, Rumania, Slovakia, Spain, Sweden, the Switzerland, Turkey, and the United Kingdom.

average annual growth rate of production dropped sharply from the first half to the second half; from 4.3% to 1.1% in Canada, from 1.1% to 0.01% in the U.S., and from 6.2% to 1.2% in Mexico. On the other hand, during this ten-year period, natural gas consumption increased from 701.2 BCM in 1993 to 718.9BCM in 1998, and to 762.2 BCM in 2003with the average annual growth rate at 1.2%.

Viewed by type of supply (transport) from outside the region, the share of PNG supply increased from 96.5% in 1993 to 97.5% in 1998 but then decreased to 88.2% in 2003. On the other hand, the share of LNG supply slightly decreased from 3.5% in 1993 to 2.5 % in 1998 but then increased sharply to 11.8% in 2003.

Table 1-2-3 Natural gas supply and demand in the North American market (Unit: BCM)

	1993	1998	2003	Average annual growth rate (%)		
				1993~1998	1998~2003	1998~2003
Production	684.80	754.80	766.30	2.0	0.3	1.1
Consumption	701.20	718.9	762.60	0.5	1.2	0.8
Import:						
PNG (within the region)	63.40	90.50	115.42	7.4	12.7	6.2
LNG (from outside the region)	2.30	2.30	15.39	0.0	46.3	20.9
Export (to outside the region)	1.40	1.80	1.64	—	—	—

Source: BP Statistical Review of World Energy

Chapter 2 Trends in LNG

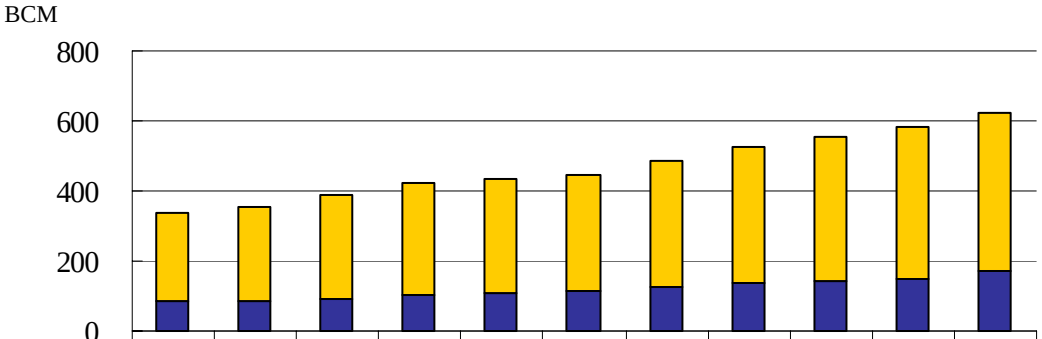
In Chapter 1, the trends in natural gas supply and demand in the three major consuming markets were overviewed, targeting the ten-year period from 1993 to 2003. In Chapter 2, the position of LNG in natural gas consumption will be focused.

(1) Trends in LNG trade

[1] Actual volume of LNG and PNG trade

As shown in Figure 2-1-1, during the ten-year period from 1993 to 2003, the volume of natural gas trade in the international market increased to 762 BCM (up 57.5% over 1993), with the average annual growth rate at 4.6%. By type of supply, the volume of PNG trade increased to 593 BCM (up 48.7% over 1993), with the average annual growth rate at 4.0%, whereas the volume of LNG trade almost doubled to 169 BCM (up 99.0% over 1993), with the average annual growth rate at an extremely high level, 7.1%. The share of LNG in the total trade volume gradually expanded from 17.6% in 1993 to 21.4%in 1998 and 22.2% in 2003. Thus, since its first appearance in the international natural gas market in 1964, LNG has been increasing its importance as an indispensable type of supply to meet natural gas demand.

Figure 2-1-1 World natural gas trade, by type of supply



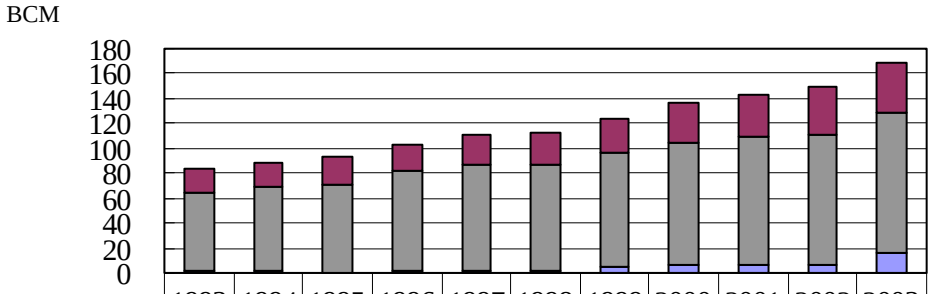
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
PNG	254.00	266.70	295.90	321.80	321.70	333.10	360.51	389.31	411.32	431.35	454.87
LNG	83.30	87.80	92.50	102.40	111.30	113.00	124.20	136.96	142.95	149.99	168.84

Source: BP Statistical Review of World Energy

Figure 2-1-2 shows the trends in the volume of LNG trade in the three major markets during the period from 1993 to 2003. In the European market, the trade volume increased from 19.50 BCM in 1993 to 25.60 BCM in 1998, with the average annual growth rate at 5.6%, and to 39.97 BCM in 2003 (up 105.0% over 1993), with the average annual growth rate at 9.3%. In the Asia-Pacific market, the trade volume also increased from 61.50 BCM in 1993 to 85.10 BCM in 1998, with the average annual growth rate at 6.7%, and to 113.48 BCM in 2003 (up 84.5% over 1993), with the average annual growth rate at 5.9%. In the North American market, the trade volume stayed at 2.30 BCM during the first half of the period but expanded significantly in the second half to 15.39 BCM, increasing 6.7 fold from the volume in 1993, with the average annual growth rate at 46.2%.

Viewed in terms of the share of trade volume in each market in the world's total volume of LNG trade, from 1993 to 2003, the North American market and the European market expanded their share from 2.7% to 9.1% and from 21.9% to 23.7% respectively. On the other hand, the share of the Asia-Pacific market in the world LNG trade volume, which had stayed at more than 70%, fell below 70% in 2002 and to 67.2% in 2003. During this ten-year period, the average annual growth rate of the total LNG trade in the three major markets was 7.1%; by market, the growth rate in the European market was 7.4%, larger than that in the Asia-Pacific market, 6.3%, whereas the growth rate in the North American market was much higher, 20.9%.

Figure 2-1-2 LNG trade in the three major markets



	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Europe	19.50	18.70	21.10	21.00	25.20	25.60	27.48	32.68	33.53	39.08	39.97
Asia-Pacific	61.50	67.60	70.80	80.20	84.10	85.10	92.15	98.04	102.2	103.8	113.4
North America	2.30	1.50	0.60	1.20	2.00	2.30	4.57	6.24	7.22	7.11	15.39

Source: BP Statistical Review of World Energy

Figure 2-1-3 shows the trends in the sources of LNG supply for the three major markets during the ten-year period from 1993 to 2003.

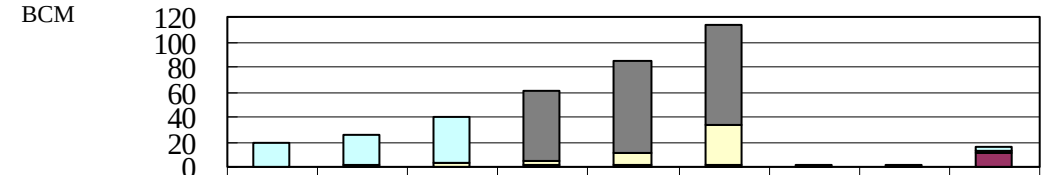
The major supply source for the European market is Africa. However, the share of Africa declined from 100% in 1993 to 93.0% in 1998 due to the emergence of a new supply source, the Middle East, with the share at 7.0%. In 2003, other new supply sources emerged, the Asia-Pacific region and Latin America, holding the share at 0.2% respectively, and the Middle East and Africa lost their shares to 6.1% and 93.5% respectively.

In the Asia-Pacific market, the Middle East expanded its share rapidly as the interregional supply declined. In 1993, the share of interregional supply, supply from North America, and supply from the Middle East was 92.2%, 2.3%, and 5.5% respectively. In 1998, the share of interregional supply and supply from North America declined to 86.1% and 2.1% whereas the share of supply from the Middle East doubled to 11.8%. In 2003, new supply sources emerged, Latin America and Africa, holding the share at 0.1% and 0.2% respectively, and the share of interregional supply, supply from North America, and supply from the Middle East was 69.7%, 1.4%, and 28.6% respectively.

In the North American market, Trinidad and Tobago (Atlantic LNG), which started production in 1999, is gaining the position of the major supply source, replacing Africa. In 1993, Africa held the whole share. In 1998, the share of supply from Africa, the Middle East, and the Asia-Pacific region was 87.0%, 4.3%, and 8.7% respectively. In 2003, the share of supply from Africa, the Middle East, and the Asia-Pacific region was 19.0%, 4.1%, and 0.5%, whereas the share of supply from Latin America was 76.4%.

In the European market, the position of LNG in natural gas trade gradually expanded. In the Asia-Pacific market, LNG remained as the core natural gas supply. In the North American market, LNG started to draw attention as a supply source of natural gas. The share of LNG in the total volume of natural gas trade in each market was as follows: in the European market. 9.5% in 1993, 9.8% in 1998, and 11.5% in 2003; in the Asia-Pacific market, 97.6% in 1993, 98.3% in 1998, and 90.3% in 2003; and in the North American market, 3.4% in 1993, 2.5% in 1998, and 11.8% in 2003.

Figure 2-1-3 **Trends in the composition of LNG supply sources in the three major markets**



	1993	1998	2003	1993	1998	2003	1993	1998	2003
	Europe			Asia-Pacific			North America		
Asia-Pacific	0.00	0.00	0.08	56.70	73.30	79.08	0.00	0.20	0.08
Africa	19.50	23.80	37.38	0.00	0.00	0.23	2.30	2.00	2.93
Middle East	0.00	1.80	2.43	3.40	10.00	32.45	0.00	0.10	0.63
Latin America	0.00	0.00	0.08	0.00	0.00	0.08	0.00	0.00	11.75

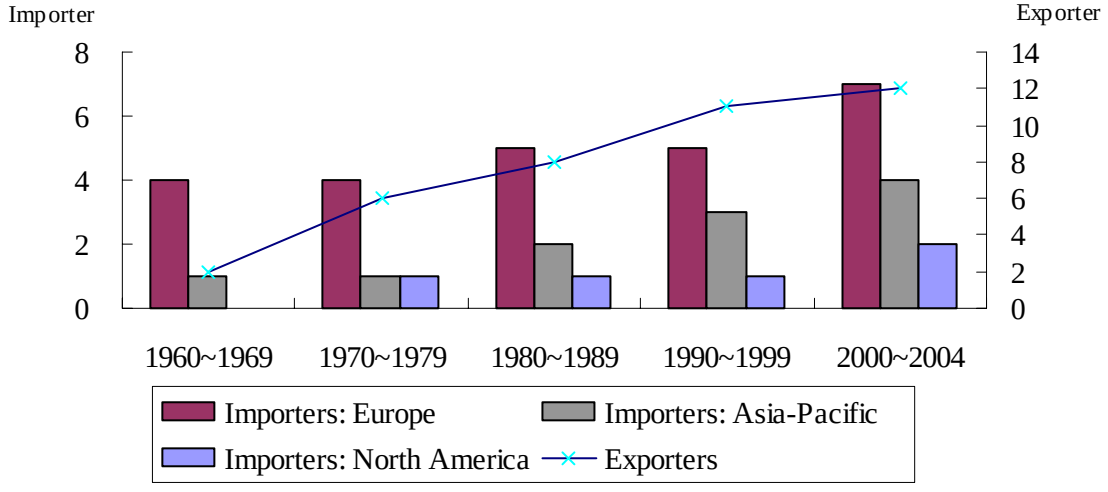
Source: BP Statistical Review of World Energy

(2) LNG trade flows

[1] LNG exporting countries and consuming countries

Figure 2-2-1 shows the expansion of countries involved in the LNG chain as either LNG exporters or consumers.[7] The number of LNG exporting countries expanded from 2 in the 1960s to 6 in the 1970s, 8 in the 1980s, 11 in the 1990s, and 12 in 2000. The number of LNG importing countries also increased from 5 in the 1960s to 6 in the 1970s, 8 in the 1980s, 9 in the 1990s, and 13 in 2004.

Figure 2-2-1 Trends in the number of LNG exporter/importers



Source: BP Statistical Review of World Energy

[7] The flow of LNG trade in this section only refers to the flow of primary trade and does not include re-export of LNG or export of reproduced gas.

The next issue is how the LNG trade flows between regional markets have expanded so far. Table 1-6 shows LNG trade between regional markets under medium or long-term sales contracts, in order of appearance on the scene. The first trade flow between regional markets, "trade from the African market to the European market," appeared in 1964, and along with the increase in the number of countries involved in LNG trade as exporters and consumers, "trade from the North American market to the Asia-Pacific market" appeared in 1969. Subsequently, "trade from the African market to the North American market" and "trade within the Asia-Pacific market" appeared in 1973, "trade from the Middle Eastern market to the Asia-Pacific market" appeared in 1977, and "trade from the Latin American market to the North American market" and "trade from the Latin American Market to the European market" appeared in 1999. Thus, by 2004, a total of 7 trade flows between regional markets have been established.

The gross number of LNG trade flows from producing countries to consuming countries under medium or long-term sales contracts, which have appeared by the end of March 2004, has reached 31, including two trade flows for which sales contracts have subsequently been terminated. The breakdown of the total number is as follows: 12 trade flows make up the gross total in the category of "trade from the African market (Algeria, Libya, and Nigeria) to the European market); 1 trade flow in the category of "trade from the North American (the U.S.) market to the Asia-Pacific market " and the category of "trade from the African market (Algeria) to the North American market" respectively; 9 trade flows from the four exporting countries (Brunei, Indonesia, Malaysia, and Australia) in the category of "trade within the Asia-Pacific market"; 6 trade flows in the category of "trade from the Middle Eastern market (Abu Dhabi, Qatar, and Oman) to the Asia-Pacific market"; and 1 trade flow in the category of "trade from the Latin American market (Trinidad and Tobago) to the North American market" and the category of "trade from the Latin American market (Trinidad and Tobago) to the European market" respectively.

The total number of LNG trade flows in the world including not only those under medium or long-term contracts but also those under short-term contracts increased from 18 in 1993 to 26 in 1998, exceeded 40 in 2000 and reached 42 in 2003.[8] New trade flows between regional markets, "trades from the African and Latin American markets to the Asia-Pacific market" appeared in 2003 due to additional demand for LNG in Japan and the Republic of Korea (ROK), though the trade was made under a short-term contract.

Table 2-2-1 Expansion of LNG markets (under medium or long-term contracts)

	1960〜1969	1970〜1979	1980〜1989	1990〜1999	2000〜2004
Africa → Europe	Algeria → [1] U.K. (1964~1990) [2] France (1965) [3] Italy (1969) [4] Spain(1969)	Libya → [1] Italy (1971~1994) [2] Spain (1971)	Algeria → [6] Belgium (1982)	Algeria → [7] Turkey (1999) Nigeria → [1] Spain (1999) [2] France (1999) [3] Italy (1999) [4] Turkey(1999)	
North America → Asia-Pacific	U.S → [1] Japan (1969)				
Africa → North America		Algeria → [5] U.S. (1973)			
Within Asia-Pacific		Brunei → [1] Japan (1973)	Malaysia → [1] Japan (1985)	Malaysia → [2] Taiwan (1990)	Australia → [2] ROK (2004)

[8] BP Statistical Review of World Energy2004

		Indonesia → [1] Japan (1977)	Indonesia → [2] ROK (1986) Australia → [1] Japan (1989)	[3] ROK (1991) Indonesia → [3] Taiwan (1990)	
Middle East → Asia-Pacific		Abu Dhabi → [1] Japan (1977)		Qatar → [1] Japan (1998) [2] ROK (1999)	Oman → [1] ROK (2001) [2] Japan (2001) Qatar → [3] India (2004)
Latin America → North America				Trinidad and Tobago → [1] U.S. (1999)	
Latin America → Europe				Trinidad and Tobago → [1] Spain (1999)	

Source: "A Review of the Global LNG Shipping Industry," Institute of Gas Technology

(3) Future LNG trends in the three major markets

[1] Outlook for natural gas supply and demand and dependence on imports from outside the region

Table 2-3-1 shows the outlook for the supply and demand balance of natural gas for the three major consuming markets based on the comparison between production and consumption of natural gas during the period from 2001 to 2025.

[European market]

Natural gas production is expected to decrease from 11.1 TCF in 2001 to 10.6 TCF in 2025, with the average annual growth rate at -0.2%, whereas natural gas consumption is expected to increase from 15.4 TCF in 2001 to 24.8 TCF in 2025(up 61.0% over 2001), with the average annual growth rate at 2.0%. The average annual growth rate for production will exceed that for consumption during the period from 2001 to 2010 but the growth rate for consumption will significantly exceed that of production during the period from 2011 to 2025; the gap between supply and demand, in other words, the supply shortage will expand from 4.3 TCF in 2001 to 14.2 TCF in 2025. Due to this large expansion of supply shortage, the dependence on imports from outside the region will rise sharply from 27.9% in 2001 to 42.4% in 2010, 48.7% in 2015, 55.1% in 2020, and 57.3% in 2025.

[Asia-Pacific market]

Natural gas production is expected to increase from 10.3 TCF in 2001 to 18.8 TCF in 2025, with the average annual growth rate at 2.5%, and natural gas consumption is also expected to increase from 11.4 TCF in 2001 to 23.4 TCF in 2025(up 105.3% over 2001), with the average annual growth rate at 3.0%. The average annual growth rate for production will be almost the same as that for consumption during the period from 2001 to 2010 but the growth rate for consumption will significantly exceed that for production during the period from 2011 to 2025; the gap between supply and demand or a supply shortage will expand significantly from 1.1 TCF in 2001 to 4.6 TCF in 2025. Due to this expansion of supply shortage, the dependence on import from outside the region will rise gradually from 9.6% in 2001 to 10.1% in 2010, 13.9% in 2015, 16.0% in 2020, and 19.7% in 2025.

[North American market]

Natural gas production is expected to increase from 27.6 TCF in 2001 to 33.6 TCF in 2025, with the average annual growth rate at 0.8%, and natural gas consumption is also expected to increase from

26.9 TCF in 2001 to 39.8 TCF in 2025 (up 48.0% over 2001), with the average annual growth rate at 1.6%. The average annual growth rate for consumption will exceed that for production during the period from 2001 to 2025; the gap between supply and demand will shift from oversupply in 2001 to a supply shortage of 6.2 TCF in 2025. Due to this, the dependence on imports from outside the region will increase from 2.6% in 2001 to 6.9% in 2010, 11.0% in 2015, 13.0% in 2020, and 15.6% in 2025.

Table 2-3-1 Outlook for production and consumption of natural gas in the three major markets

(Unit: TCF[9])

		2001	2010	2015	2020	2025	Average annual growth rate (%)	
							2001~2010	2010~2025
Europe[10]	Production	11.1	9.9	9.8	9.7	10.6	1.3	0.5
	Consumption	15.4 (22.4)	17.2 (24.8)	19.1 (26.7)	21.6 (29.4)	24.8 (31.9)	1.2	2.5
	Gap	-4.3	-7.3	-9.3	-11.9	-14.2		
Asia-Pacific	Production	10.3	12.5	14.2	16.3	18.8	2.2	2.8
	Consumption	11.4 (10.6)	13.9 (10.4)	16.5 (10.8)	19.4 (11.3)	23.4 (12.0)	2.2	3.5
	Gap	-1.1	-1.4	-2.3	-3.1	-4.6		
North America	Production	27.6	29.6	30.6	32.8	33.6	0.8	0.8
	Consumption	26.9 (23.9)	31.8 (24.2)	34.4 (24.4)	37.7 (25.0)	39.8 (24.5)	1.9	1.5
	Gap	0.7	-2.2	-3.8	-4.9	-6.2		
World total	Production	91.1	105.5	118.5	134.5	151.0	1.6	1.5
	Consumption	90.3 (23.1)	105.1 (23.0)	118.1 (23.6)	134.2 (24.4)	151.1 (25.1)	1.7	2.4

Source: EIA-International Energy Outlook 2004 (IEO2004: reference case)
Note: Figures in parenthesis are the percentages of natural gas in the total consumption of primary energy.

In addition to the EIA outlook above, the International Energy Agency (IEA) states, in its report "World Energy, Technology and Climate Policy Outlook (reference cases)" published in 2003, that consumption will continue to exceed production in the future in the three major markets, and therefore the dependence on imports from outside the region will increase from 40.4% in 2000 to 52.0% in 2010 and 70.8% in 2030 in the European market[11], from 2.7% in 2000 to 5.1% in 2010 and 60.3% in 2030 in the Asia-Pacific market, and from 0.5% in 2000 to 3.6% in 2010 and 7.9% in 2030 in the North American market.[12] Such rise in the dependence on imports from outside the region in each consumption market is also supported by the trends in the quantity of identified natural gas reserves in the world (See Chapter 4).

[2] Outlook for LNG supply and demand

As the gap between supply and demand of natural gas is expected to expand in the future, the

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9 Trillion Cubic Feet

10 Turkey is included in Europe according to the categorization in the BP Statistical Review of World Energy whereas it is included in the Middle East in International Energy Outlook 2004; therefore, Turkey is not included in Europe in this table.

11 There are some discrepancies between the report and IEO 2004 due to the difference in the categorization of the "European market."

12 For details, see "*EU no enerugī seisaku to chōki mitōshi ; Dai 5 shō: Sekai ni okeru EU gasu sijō* (EU's energy policy and long-term outlook; Chapter 5: EU gas market in the world) (written by Researcher Tetsuo Morikawa) (October 2003), IEE Website

importance of LNG in the three major markets seems to depend on the geographical environment of each market.

Figure 2-3-3 shows the outlook for LNG demand on a worldwide basis and in the three major markets until 2030, based on the data provided by Cedigaz.[13] LNG demand on a worldwide basis will increase from 111.62 million tons/year in 2002 to 194.7 million tons/year in 2010 (up 74.4% over 2002) and 311.8 million tons/year in 2020 (up 179.3% over 2002) on the basis of the low-demand scenario, or increase to 230.2 million tons/year in 2010 (up 106.2% over 2002) and 379.7 million tons/year in 2020 (up 240.2% over 2002) on the basis of the high-demand scenario. The outlook for demand in the three major markets will be shown respectively.[14]

[European market][15]

According to the low-demand scenario, LNG demand will increase from 29.25 million tons/year in 2002 (actual volume) to 56.9 million tons/year in 2010 (up 94.5% over 2002) and 86.0 million tons/year in 2020 (up 194.0% over 2002), up about 3 fold during this period. On the other hand, according to the high-demand scenario, LNG demand will increase significantly to 70.7 million tons/year in 2010 (up 141.7% over 2002) and 106.2 million tons/year in 2020 (up 263.1% over 2002). The LNG receiving capacity of LNG import terminals in the European market is 45.8 million tons/year as of the end of October 2003. In response to the expected increase in natural gas consumption and expansion of LNG imports, the total capacity of import terminals that are being newly constructed or going through upgrading will be 20.1 million tons/year. The total capacity of import terminals that are in the planning stage will be 43.6 million tons/year.

While natural gas demand is expected to increase due to the movement trending away from the use of nuclear energy, the interregional sufficiency will decline. With such a future outlook, PNG supply from neighboring areas such as Russia and North Africa will be regarded as major supply sources of natural gas. However, the importance of LNG will further increase in Europe because LNG will play a role of physically covering supply shortage in order to achieve energy security through the decentralization of supply sources and enhance the bargaining power of European countries as natural gas importers against PNG exporters, though LNG will also be exposed to competition with PNG.

[Asia-Pacific market]

According to the low-demand scenario, LNG demand will increase from 77.10 million tons/year in 2002 to 101.5 million tons/year in 2010 (up 31.6% over 2002) and 140.5 million tons/year in 2020 (up 82.2% over 2002). On the other hand, according to the high-demand scenario, LNG demand will increase significantly to 113.1 million tons/year in 2010 (up46.7% over 2002) and 164.5 million tons/year in 2020 (up 113.4% over 2002). The LNG receiving capacity of LNG import terminals in the Asia-Pacific market is 236.4 million tons/year as of the end of October 2003. The total capacity of import terminals that are being newly constructed or going through upgrading will be 37.7 million tons/year. The total capacity of import terminals that are in the planning stage will be 5.9 million tons/year.

As of August 2004, there exists no international natural gas pipeline in the Asia-Pacific region, excluding some areas in Southeast Asia.[16] Major pipeline projects in this region as of August 2004 are the

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[13] Published in February 204 (International Gas Report as of May 21, 2004). In the "World Energy Investment Outlook 2003," the IEA states that LNG demand in the world will increase from 100 million tons to 4 million tons in 2020, with the average annual growth rate at 7-8%, and will further expand to be 6 times as large as the current trade volume in 2030.

[14] Figures on the capacity to receive LNG of the three major markets as of October 2003 are based on the report by the U.S. EIA, "The Global Liquefied Natural Gas Market: Status and Outlook" (published in December 2003).

[15] In Cedigaz's outlook, Europe includes Belgium, France, Greece, Italy, Portugal, Spain, Turkey, and the United Kingdom.

[16] Trans ASEAN Gas Pipeline (TAGP) project. At the ASEAN Energy Minister Conference held in June 2004, consensus was

project for the pipeline extending from gas producing countries such as Iran, Turkmenistan, and Myanmar to India, and the Trans ASEAN Gas Pipeline (TAGP) project for the pipeline extending from East Siberia (Kovykta) to China/the ROK, Sakhalin I, and Southeast Asia. As for the former project, people have started to recognize that political tension between the countries in which the pipeline is to pass through, i.e. Pakistan, Bangladesh, and India, has been the obstacle in the development of the national economies of the countries concerned. The possibility of the realization of the pipeline project is emerging, but there will still be twists and turns until the construction of the international pipeline is finally put into action in this area. On the other hand, with respect to PNG supply from East Siberia (Kovykta) to China and the ROK, a feasibility study (FS) has already been completed among the countries concerned in 2003 but agreement has yet to be reached in terms of the trading conditions such as PNG price, and hence the future direction of this project is uncertain.[17] Under such circumstances, for the time being, LNG will continue to be the basic type of natural gas supply in this market as before.

[North American market]

According to the low-demand scenario, LNG demand will increase from 5.27 million tons/year in 2002 to 36.3 million tons/year in 2010 (up about 7 fold over 2002) and 82.3 million tons/year in 2020 (up about 16 fold over 2002). On the other hand, according to the high-demand scenario, LNG demand will increase to 46.4 million tons/year in 2010 (up about 9 fold over 2002) and 102.0 million tons/year in 2020 (up about 20 fold over 2002). The LNG receiving capacity of LNG import terminals in the North American market, where only the United States holds import terminals, is 28.7 million tons/year as of the end of October 2003. The total capacity of import terminals that are in the planning stage will be 69.2 million tons/year.

The report by the United States National Petroleum Council (NPC) titled "Balancing Natural Gas Policy" (published in September 2003) indicates a recognition that the U.S. natural gas market is facing a fundamental change, the increasing dependence on imports from outside the region due to the decline in the self-dependence and reduction in Canada's export capacity. Considering such change, the report mentions that in order to lower the natural gas price and reduce price volatility, it is necessary to develop new supply sources, promote infrastructural improvement, and expand LNG imports with a view to reduce a potential gap between supply and demand.[18] The report also suggests the necessity to simplify the administrative procedures including those required to obtain approval and license for the construction of LNG receiving terminals. Due to local citizens' campaigns against the construction of such terminals, which have become increasingly intense since the beginning of 2003, and the competition over administrative jurisdiction between the US federal government and the state governments that have jurisdiction over the areas where terminals are to be constructed, the project for constructing LNG receiving terminals in the West Coast area is currently being suspended. On the other hand, progress is being made in efforts to expand the LNG receiving capacity of the four existing terminals[19] while approval has been obtained from the Federal Energy Regulatory Commission (FERC) for new projects in constructing three terminals (two offshore terminals and one land terminal) on the coast of the Gulf of

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built to promote the five-year project in the construction of a pipeline from Indonesia through to Malaysia, Thailand, and Singapore. In the Middle East, the development of the Dolphin Project is being carried out between Qatar, Oman and UAE.

[17] As the first phase of the project, aiming at starting sales in Irkutsk by the end of 2006, the construction of the intrastate supply pipeline (construction cost at $600 million) started (April 20, 2004, World Market Research Center).

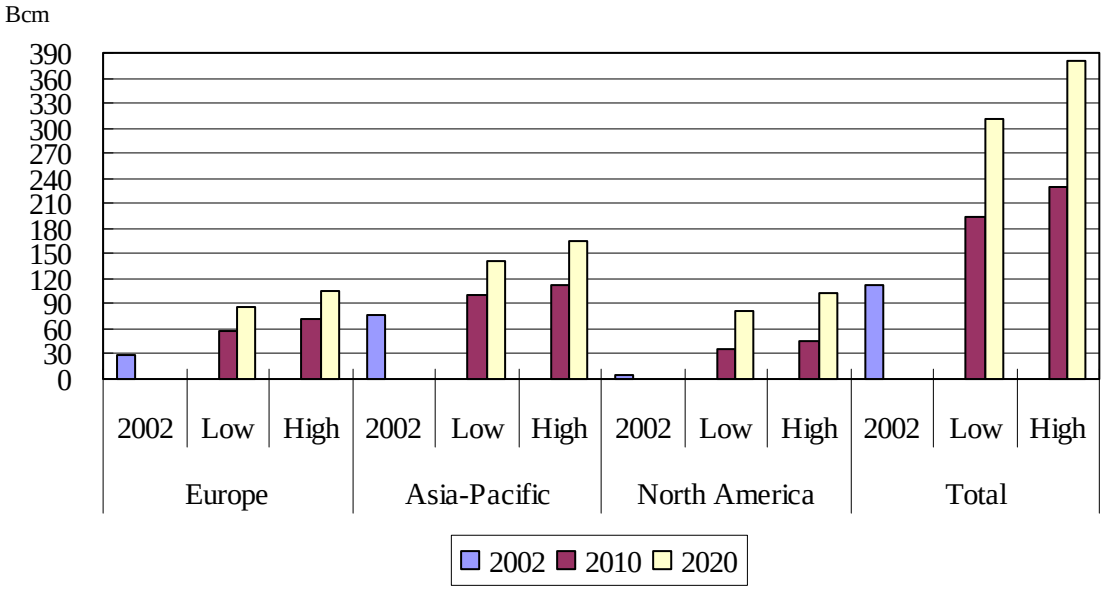
[18] According to the future outlook published by the NPC, the US LNG import in 2010 will be 10 times larger than that in 2002 (228.7 million CF according to the EIA report). According to the US EIA, the US NLG import is expected to increase from 10.5 million tons/year in 2003 to 46.2 million tons/year in 2010.

[19] Lake Charles (Southern Union), Cove Point (Dominion Resources; operation resumed in August 2003), Elba Island (Southern LNG, subsidiary of EL Paso), and Everett (Tractebel). In these four terminals, construction is being carried out to expand the LNG receiving/regasification capacity; the capacity will increase by 6.7 million tons/year around 2006-2008.

Mexico.[20]

In Mexico, while efforts are being made to increase self-sufficiency by shifting the emphasis on the development policy from oil to natural gas, the Comision Reguladora de Energia (CRE) expects that domestic gas demand, mainly for power demand, will exceed domestic production. Considering the necessity to import LNG from a medium and long-term perspective, projects for constructing LNG receiving terminals are being carried out on the coast of the Gulf of Mexico and Baja California.[21] Also in Canada, with a view to achieve self-sufficiency and LNG export to the United States, several projects in constructing LNG receiving terminals are being promoted on the Atlantic coast and the Pacific coast.[22]

Figure 2-3-3 Outlook for LNG demand in the three major markets



Source: Cedigaz

With such demand outlook on the one hand, the LNG production capacity of operating terminals in the world is, on the other hand, 143.1 million tons/year as of the end of 2003, and the production terminals currently under construction will increase the production capacity by 55.8 million tons/year around 2007.[23] When all LNG export projects (107.4 million tons/year) will be in service as scheduled by 2010, the world total production capacity will reach 306.3 million tons/year.[24]

[3] Future LNG trade flows

During the period from now until 2010, on the demand side, the United Kingdom will return to the LNG market in 2005 for imports to the Isle of Grain, and new LNG importers will also appear on the market such as China (Guangdong) in 2006, and Mexico (for imports to Altamira on the coast of the Gulf of Mexico and to Costa Azul on the Pacific coast) and the Philippines[25] in 2007. The current LNG importers

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[20] The FERC stated that a new LNG import terminal would be constructed by 2008 (Platt's dated May 24, 2004).
[21] Weekly Petroleum Argus dated May 3, 2004, and Oil Daily dated May 19, 2004.
[22] In August 2004, Irving Oil obtained approval from the Canadian regulatory authorities for the construction of a LNG receiving terminal (with the capacity of 3.5 million tons/year) in New Brunswick (Platt's Oilgram News dated August 10, 2004).
[23] As of the end of 2003, there were 17 LNG import terminals (69 liquefaction trains). By around 2007, six trains in five new import terminals and seven trains in the existing five terminals will start operation.
[24] Petroleum Economist (May 2004)
[25] Platt's dated April 2, 2004. GNPower obtained approval for the construction of a LNG receiving terminal (with the capacity of 1 million tons/year; scheduled to start operation in 2007) in Mariveles.

are also promoting projects to construct new import terminals or expand the receiving capacity of the existing terminals. Furthermore, Singapore, Thailand, Chile, and Canada have started to consider a feasibility study on LNG reception depending on the energy situation of each country while aiming at achieving energy security. On the supply side, certain achievements have been made in new LNG export projects by concluding MOUs with expected LNG importers, despite some difference in progress of the production projects, and new LNG exporters will appear on the market, including Egypt in 2005, Russia (Sakhalin), Equatorial Guinea, and Norway in 2007, and Iran and Peru in 2008-2010.

In addition to these trends on both the demand and supply sides (LNG projects), there is a movement to achieve further reduction in costs for production and transport by increasing the size of liquefaction plants and LNG tankers, and economic efficiency of long-distance transportation is expected to improve. With respect to the development of LNG transport routes, a feasibility study is being implemented regarding the dredging project for expanding the transit capacity of the Panama Canal, which will connect the Pacific market and the Atlantic market if the project is successfully completed. Considering these trends and movements comprehensively, along with the progress in the change of the internal structure of the LNG chain as mentioned later, trading conditions are becoming more flexible and types of LNG sale contracts are becoming more diversified; under such circumstances, while LNG's inherent advantage, flexibility in transportation, is emphasized, the trade flows between regional markets will further expand, shifting from transactions between points to transactions between areas.

Chapter 3 Change in the LNG Chain

While the LNG trade in the three major consuming markets is expected to further expand along with the diversification of trade flows, a drastic change has already occurred and is accelerating inside the LNG value chain. In the following section, diversified business activities recently conducted by the traditional LNG market players will be analyzed to find the factors that are generating the structural change in the LNG industry.

(1) Recent changes[26]

[1] Traditional players in the upstream sector expanding into the midstream and downstream sectors[27]

Table 3-1-1 shows recent cases in which traditional players in the upstream sector of the natural gas industry made active efforts to expand into the midstream and downstream sectors such as LNG transportation, importation, and marketing, by category (oil majors, state-owned companies, and other players). These cases can be categorized depending on the contents of business.

The first category includes cases in which the players that hold interests in the upstream sector of the natural gas industry order construction of LNG tankers, a means of transport to connect the upstream sector and the downstream sector in the LNG chain, and hold and operate them independently. This measure can be regarded as part of a business strategy for players such as oil majors and BG, aiming at increasing the cost-efficiency of the LNG chain as a whole while securing flexibility by transporting their own assets in the upstream sector, which exist at different locations, with their own fleets for optimal operation. As forms of LNG trade are expected to be further diversified in the future, these players are

[26] Sections (1)[1] and [2] of this chapter only provide recent events involving traditional players that have operated in the upstream, midstream, and downstream sectors of the natural gas (LNG) industry; cases in which players (exclusively) engaging in the downstream sectors launch business overseas and movements of new players that come from outside the industry aiming at becoming "comprehensive energy companies" are not included.

[27] According to the business segmentation for traditional LNG projects, the upstream sector, midstream sector, and downstream sector refer to the gas well development and liquefaction plant operation sector, LNG transportation sector, and LNG reception/regasification and marketing sector, respectively.

working toward achieving centralized control of LNG marketing and LNG tanker operation with a view of establishing a system that will be able to immediately respond to market demand. By connecting this measure with those in the following three categories, which are intended to secure means of transport and direct access to consumer markets, traditional players also participate in creating demand to raise cash from their own upstream assets and strive to maximize profits from the LNG chain as a whole.

The second category includes cases in which traditional players participate in projects for constructing LNG receiving terminals in natural gas consuming countries. Among others, noteworthy cases are the movements toward: global cooperation between oil majors, which have already established their position in the world as interest holders in the natural gas upstream sector, and state-owned oil companies (e.g. ExxonMobil and Qatar Petroleum); cooperation between oil majors for joint business areas (e.g. Shell and Total); and strategic partnership between oil majors and gas companies, which have established their position in the downstream sector (e.g. Shell and Sempra). Changes in the structure and culture of players in the LNG chain suggest that the players have active intention to shift their positions in the direction that is suitable for their own LNG business strategies in each of the three major markets where liberalization is being promoted.

The third category includes cases in which traditional players acquire the right to regularly use LNG storage and regasification capacity of LNG receiving terminals, which is called "capacity trade." This measure is taken by interest holders in the natural gas upstream sector to rent, for a certain period, LNG storage and regasification capacity from companies operating LNG receiving terminals. Particularly in 2000 and thereafter, capacity trade has become popular in wide areas in the European and North American markets where laws and regulations have been improved along with the progress in market liberalization. The success of capacity trade has also promoted infrastructural development and improvement in consuming countries.

The fourth category includes cases in which interest holders in the natural gas upstream sector establish or acquire subsidiaries and affiliated companies that engage in LNG purchase and sale or the power/gas industry, thereby launching and stabilizing LNG export projects in which they are involved. This measure also seems to actively contribute to demonstrating such players' supply capacity in the market, and in particular, it is obviously regarded as part of the movement toward vertical integration in the LNG chain led by oil majors. Recently, a Japanese trading firm has also started efforts to integrate LNG into its own system through this measure.

Table 3-1-1 Cases in which players in the upstream sector expand into the midstream and downstream sectors

		Details
Oil majors	Shell	[1] Ordered construction of LNG tankers with the aim of organizing a fleet under its own control.
		[2] Obtained the right to use the capacity of the Cove Point receiving terminal (Maryland, U.S.; 250 million CFD).
		[3] Started constructing a LNG receiving terminal (to be in service in 2007; 700 million tons/year) in Costa Azul (Baja California, Mexico), in the joint project with Sempra.
		[4] Started constructing a LNG receiving terminal in Altamira (on the Gulf coast of Mexico, Mexico).
	Total	[1] Shell acquired 25% and 26% of interests in ongoing projects for LNG reception in Altamira (Mexico) and Hazira (India) respectively.

		[2] Acquired 26.7% of interests in GDF's Fos Cavaou LNG receiving terminal (Southern France; to be in service in 2007).
		[3] Acquired the right to use the capacity of the Bilbao (Spain) LNG receiving terminal (2BCM at present and 1 BCM in 2006 and thereafter).
	BP	[1] Organized a fleet of LNG tankers under its own control.
		[2] Acquired the right to use the capacity of the Cove Point receiving terminal.
		[3] Acquired 30% of interests in the company holding the Guangdong LNG receiving terminal (to be in service in 2006).
		[4] Acquired 29% of interests in the LNG reception project in Kirishna Putnam (India) (former Kakinada project), which is promoted by IOC (March 2004).
		[5] Acquired 35% of interest in SK Power (ROK) that was constructing a gas-fired power plant (1,074 MW; to be in service in 2006) in Gwangyang (ROK).
		[6] Acquired, jointly with Sonatrach (Algeria), 100% of the right to use the capacity of the Grain LNG receiving terminal (UK; the first phase to be in service in January 2005; 3.3 million tons/year) owned by National Grid Transco (UK).
	ExxonMobil	[1] Started constructing, jointly with QP, the South Hook LNG receiving terminal (to be in service in 2008) in the U.K. (Milford Haven).
		[2] Acquired, jointly with Qatar Petroleum (QP), the right to use the capacity of the Zeebrugge LNG receiving terminal owned by Fluxy (Belgium; 3.4 million tons/year for 20 years from 2007).
		[3] Acquired, jointly with QP at the same rate, 45% in interests in the North Adriatic LNG import project (regasification capacity of 40 BCM/year), which is promoted by Edison Gas (Italy).
	ChevronTexaco	[1] Acquired approval for constructing the Port Perican offshore LNG receiving terminal (U.S.; on the Gulf coast of Mexico; to be in service in 2007; 5.5 million tons/year)[28].

[28] The Energy Bridge system developed by El Paso (for on-board regasification and land transportation via pipelines) is likely to be adopted for the project. Two ships that adopt this system are under construction in the ROK (Daewoo Shipbuilding), both of which are to be owned and operated by Exmar (Belgium). The first ship will be delivered in November 2004 and the second ship will be delivered in April 2005 for the project in Cameron (on the Gulf coast of Mexico), which is promoted by Excelerate Energy.

State-owned oil companies	Petronas	[1] Acquired, from Edison, 35% of interests in the sixth train in the ELNG import project (April 2003).
		[2] Acquired 20% of interests in the South Pars LNG terminal (Iran; aimed to be in service in 2009).
		[3] Acquired 30% of interests in the Dragon LNG receiving terminal in Milford Haven (UK; to be in service in 2007) and 50% in the right to use the capacity of the terminal.
		[4] Acquired 29% of interests in the LNG reception project in Kirishna Putnam (India) (former Kakinada project), which is promoted by IOC (March 2004).
	QP	[1] See the column for ExxonMobil above.
		[2] Acquired interests in Petronet LNG (India) that started LNG supply in January 2004.
	Trinidad & Tobago	[1] Concluded a MOU to acquire interests in MacMoRan Exploration that is planning the project for constructing an offshore LNG receiving terminal in the Gulf of Mexico.
	StatOil	[1] Acquired the right to use the capacity of the Cove Point receiving terminal (US; 10BCM/year for 20 years from 2008; October 2002). (Currently, BP and Shell also have the right to use).
Others	BG	[1] Acquired the right to use the capacity of the Elba receiving terminal in the U.S. in 2003.
		[2] Acquired 81% (until September 2005) and 100% (from October 2005 to 2024) of interests in the right to use the capacity of the Lake Charles receiving terminal in the U.S.
		[3] Organized a fleet under its own control in the course of promoting the LNG business strategy mainly targeting the Atlantic market while making use of its interests in the upstream sector.
		[4] Started constructing the Brindisi LNG receiving terminal (Italy; to be in service in 2007).
	ConocoPhillips	[1] Acquired 60% of interests in Freeport LNG, the constructor of the LNG receiving terminal in the U.S (on the Gulf coast of Mexico; to be in service in 2008) (December 2003).
	Marathon	[1] Acquired the right to use the capacity of the Elba LNG receiving terminal (U.S.; 58 BCF for 22 years).
	BHP	[1] Planning to construct a FRSU[29] receiving/ regasification terminal (capacity of 800 mm CFD; to be in service in 2008) off the coast of California, U.S.
	Mitsubishi Corporation	[1] MC's subsidiary, Sound Energy Solutions, is planning to construct a LNG receiving terminal in the U.S. (Long Beach, California) jointly with ConocoPhillips.
		[2] Concluded a LNG purchase contract with Qalhut-LNG (Oman) for LNG supply of 800,000 tons/year for 15 years from 2006.

[29] Floating Storage and Regasification Unit; three spherical tanks (total storage capacity of 125,000 tons) and eight gasification devices (maximum capacity of 1.5 BCF/day) are installed on the ship, and reproduced gas is transported via pipeline to land.

[2] Traditional players in the downstream sector expanding into the upstream and midstream sectors

Table 3-1-2 shows recent cases in which traditional players in the downstream sector of the natural gas industry made active efforts to expand into the upstream and midstream sectors such as production, transportation and importation, by category (gas/power companies and state-owned companies of LNG importing countries).

The first category includes cases in which the players participate and acquire interests in the gas field development and liquefaction plant operation sectors of LNG export projects. In cases of this category, measures are being taken in line with national policy in addition to the projects led by private businesses, such as formation of corporate consortiums led by state-owned companies. It is needless to say that the participation of the downstream players in the upstream and midstream sectors is based on a recognition that such participation will help them not only expand business opportunities but also achieve security for natural gas supply.

The second category includes cases in which the players construct and hold their own tankers. This measure is not intended only to reduce transportation cost by securing the FOB option in LNG import contracts. Rather, the players seem to take this measure with the objective of securing opportunities to actively adjust themselves to the changes in the market environment, not only acting solely as LNG importers but also shifting their position to act as LNG sellers as appropriate.

Table 3-1-2 Cases in which players in the downstream sector expand into the upstream and midstream sectors

Gas/power companies	Union Fenosa	[1] Acquired interests in SEGAS that managed the ELNG Damietta LNG export terminal (Egypt; to be in service in 2005), and 60% of the right to use the liquefaction capacity of the terminal (4.8 million tons/year) for 20 years.
		[2] Holding 8% of interests in Qalhat LNG (Oman; to be in service in 2006).
	Gas Natural	[1] Published the four-year investment plan (7 million Euro) targeting projects for constructing LNG receiving terminals in the U.S. (upstream sector), via a joint venture established with Repsol (April 2004).
	Tractebel	[1] Holding 10% of interests in the first train of Atlantic LNG (Trinidad and Tobago).
	Osaka Gas	[1] Constructing and holding its own ships (ordered one ship as of April 2004).[30]
		[2] Acquired 10% each in Greater Sunrise gas field and Evans Shoal gas field in July 2000.
	Tokyo Gas	[1] Constructing and holding its own ships (ordered two ships as of April 2004)
		[2] Acquired 3.36% of interests in the Bayu-Undang gas field in the Darwin LNG export project (Australia).
	Tokyo Electric Power	[1] Constructing and holding its own ships (ordered two ships as of April 2004)
		[2]Acquired 6.72% of interests in the Bayu-Undang gas field in the Darwin LNG export project (Australia).

[30] Petrostrategies dated April 26, 2004.

State-owned oil/gas companies	KOGAS	[1] Acquired 5% of interests in RasGas and Oman-LNG respectively through the formation of the ROK LNG consortium (Korea LNG).
		[2] Holding 10% of interests in Block-A1 gas field in Myanmar.
		[3] Negotiating to acquire 4.9% of interests in Malampaya gas field (the Philippines) through the formation of the ROK LNG consortium (Korea LNG).
		[4] Considering participating in the joint project with Shell and Sempra for constructing a LNG import terminal in Baja California, Mexico.
	GDF	[1] Holding 5% of interests in ELNG [2] Holding 12% of interests in the Snohvit LNG export project (Norway; to be in service in 2007). [3] Holding three ships of its own (as of the end of 2003); to receive one ship in 2004 and 2005 respectively.
	CPC	[1] Ordered four LNG tankers for transporting RasGas LNG (Qatar) to the Taizhong LNG receiving terminal (Taiwan; to be in service in 2008).

[3] Other notable movements

This final subsection presents notable movements of gas producing and exporting countries in the Middle East and Asia that are taking active efforts to expand from the Asia-Pacific market to other markets, and state-owned companies of new LNG importing countries that have not been traditional players in the LNG chain in the Asia-Pacific market, though these movements are not always seen inside the LNG chain.

Firstly, Qatar Petroleum (QP) and Petronas, which are both state-owned oil companies and traditional players in the upstream sectors, have been actively launching business on a global scale.

QP has been making efforts to implement its strategic plans targeting the LNG consuming markets. While maintaining its position as LNG exporter in the East Asian market, QP has been striving to acquire interests in LNG export projects and LNG receiving terminals in India, a new LNG importer in the Asian market. In the European market (the U.K. and countries in the European Continent), QP has started construction of new LNG receiving terminals and acquired the right to use new LNG receiving terminals in joint projects with ExxonMobil, QP's biggest partner in the upstream sector of the Qatar natural gas industry. Also in the North American market, QP has acquired interests in new LNG receiving terminals that third parties are planning to construct, with the intention of supplying LNG. Thus, the Qatar government, which holds the world's second largest identified reserves (909.6 TCF as of the end of 2003) and sets the LNG production capacity for 2010 at 45 million tons/year, established Qatar Gas Transport in May 2004 for transportation of domestically produced LNG, and has been taking positive measures with a view to build bases for expanding into the three major LNG consuming markets.

Petronas, a Malaysian state-owned company, has also been promoting its LNG business on a global scale according to the twin-track strategy. While firmly maintaining its position in the upstream sector as an established LNG supplier in the East Asian market, Petronas has been aiming to expand into the downstream sector of India, a new LNG importer, and acquire interests in LNG export projects in Iran, a new LNG exporter. On the other hand, in the European market, Petraonas has been carrying out a wide range of business activities in the downstream sector such as marketing LNG, constructing LNG receiving terminals, and acquiring the right to use the capacity of such receiving terminals, while acquiring interests in the upstream sector, based on the experience in acting as a LNG business operator in the Asian market.

Viewing the current circumstances where it is becoming popular to grant the FOB option, as one of contractual flexibility options, to traditional Asian LNG importers, Petronas seems to expect that redundancy will be generated in LNG fleets owned by its subsidiary (Malaysian International Shipping Corporation; MISC). In order to respond to such potential trends, Petronas has also made arrangements to ensure appropriate fleet management and charter-out of such redundant freight space to players that operate business in the European and North American markets, aiming at expanding sources of revenue.[31]

While these two companies have maintained their positions on the supply side, India and China have appeared in the market on the consumption side. These countries have not held their bases in the overseas upstream sectors but are equipped with high potential as new LNG importers. India's Petronet LNG, based on a recognition that imported LNG must be more competitive in price than coal, expects that its LNG receiving capacity will expand to reach 25 million tons/year by 2010-2015 due to the increase in domestic gas demand mainly from the power and fertilizer sectors. On the other hand, China National Offshore Oil Corporation (CNOOC) published a forecast that by 2010, natural gas demand in China would expand to reach 160-250 BCM, 39% of which would be covered by imported LNG, and therefore ten additional LNG receiving terminals would be needed. CNOOC has also been pursuing the opportunity to acquire interests in LNG supply projects upon the conclusion of LNG purchase contracts, and has actually acquired interests in such projects in the upstream sector in Indonesia and Australia. Aiming at narrowing the gap between natural gas supply and demand to cover supply shortage, which is expected to expand in the future, these two countries have been making active efforts to acquire interests in overseas natural gas assets while placing emphasis on the development of domestic resources from the perspective of energy security.

Finally, it should be additionally noted that some traditional players in the midstream sector, such as LNG transport companies, have started to consider participating in projects for constructing offshore LNG receiving terminals such as FRSU, though these movements are currently seen only in very limited cases.

(3) Factors for the change

There seem to be two major factors that have caused the change in the behavior of traditional players in the LNG chain or encouraged them to actively and freely move within the industry beyond the bounds of segments, such as natural gas field development, liquefaction plant operation, LGG transportation, LNG regasification and marketing.

The first factor is an external one, the progress in liberalization through deregulation in the energy market, which seems to be the most important factor for the change.

In the mid-1990s, Japan, the ROK, and Taiwan, the traditional players in the Asia-Pacific market that had held about 75% share of LNG trade in the world, started to make progress in deregulation and introduction of competition in the gas/power market, with some difference in the level of progress. Under such circumstances, the outbreak of the Asia financial crisis in 1997 and 1998 forced gas/power companies, which had been LNG importers, to have a more uncertain outlook for gas demand. However, despite the stagnation in the LNG international market where long-term contracts had been commonly employed, LNG importers, with the aim of "ensuring stable supply at a reasonable price," acquired from exporters various flexibility options, which seemed to contribute to the diversification of LNG trade flows as contractual terms suitable for a liberalized market. More importantly, this situation gave the upstream players, which were forced to adapt to market changes upon concluding LNG supply

[31] International Gas Report dated September 26, 2003.

contracts, the opportunity to review how they should be involved in the LNG industry in the future.

The second factor is an internal one, the improvement in economic efficiency of long-distance transportation through the efforts to reduce costs in LNG production and transportation to compete with PNG.

In the liquefaction plant operation sector, along with the increase in the size of trains in new projects, LNG production costs decreased from $433/ton/year in 1983 (Malaysia) to $396/ton/year in 1996 (QatarGas) and $273/ton/year in 2000 (Oman LNG), down 37% during this period.[32] Further reduction of production costs through expansion of the size of trains will be achieved when Qatar Gas 2 (7.8 million tons/year) is launched (to be in service in 2006-2007). According to the World Energy Investment Outlook 2003, the IEA expects that production cost will decrease to $200/ton/year by 2010 and $150/ton/year by 2030.

The increase in transport capacity through the use of large LNG tankers has also brought about a significant impact to promote cost reduction in the same manner as the increase in capacity of liquefaction trains. The capacity of LNG tankers has continued to expand from 27,400 CM[33] in 1964 when tanker transportation started in the pioneer days of the LNG industry, to 126,000 CM in the mid-1970s, over 130,000 CM in 1978, 138,000 CM in 1999, 145,000 CM in 2003, and 153,000 CM for ships to be delivered in 2004.[34] ExxonMobil, in a strategic alliance with QP, is planning to increase the capacity to 200,000-250,000 CM for tankers to be delivered around 2007.[35] Similarly, the sea speed also increased from 16.50 knots/hour for 71,500 CM tankers constructed in 1969 to 20.80 knots/hour for 138,200 CM tankers delivered in 2000.[36] This means that, for example in the case of a voyage of 6,430 miles from the Middle East (Abu Dhabi) to Japan (Negishi), the number of days for round voyages can be reduced by about seven days, not including the time for LNG loading and costs, which can also be reduced significantly. It should be noted that reduction in transportation cost has also been brought about by other factors such as the reduction in loss during voyages caused by long-distance transportation,[37] life extension of tankers by repair, and adoption of innovative technologies including the Dual Fuel Propulsion System and the Electric Propulsion System.

Cost reduction has also been achieved by expanding the size of LNG storage tanks. Construction cost for a storage tank accounts for one-third or half of the total construction cost for a LNG receiving terminal. Efforts are being made to reduce cost while pursuing economy of scale. The storage capacity of a LNG tank expanded from 40,000 CM in the initial days to 100,000-140,000 CM in the 1990s and 160,000-200,000 CM thereafter. ExxonMobil has obtained a patent for LNG storage tank technology

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[32] Petroleum Economist (November 2003). QatarGas achieved a 13% cost reduction by increasing the capacity of the third LNG train from 3.3 million tons/year to 4.7 million tons/year upon the completion of the train, and further achieved reduction by 7% for the third train '5.5 million tons/year (World Gas Intelligence, dated December 17, 2003). According to Jensen Associates, a LNG consultant, a project for constructing a new liquefaction plant with the LNG production capacity of 8 million tons/year (or two plants with the capacity of 400 million tons/year) will cost $1.09/million BTU. A project for upgrading an existing plant will cost $0.97/million BTU.

[33] Cubic Meter

[34] As of August 20, 2004, the total LNG freight space in the world includes: 165 tankers that are in service (total capacity: 19.460 million CM); 13 new tankers that are to be delivered by the end of 2004 (total capacity: 1.798 million CM); 83 tankers that are in the order book (total capacity: 11.814 million CM); 37 tankers that were ordered in 2004 (total capacity: 5.360 million CM) (LNGOneworld, dated August 20, 2004). In the freight space of tankers in service, 81 tankers have the capacity of less than 130,000 CM.

[35] In the LNG 14 meeting held in May 2004, an index was presented to show the improvement in transport capacity through the expansion of the size of tanker; if a 135,000 CM tanker was 100, a 145,000 CM tanker was 106, and 200,000 CM tanker was 121.

[36] Colton Website, All LNG Carriers in Service or on Order

[37] The rate of loss in natural gas during voyage is 3.6% for voyage between the Middle East and Japan, 4.1% for voyage between the Middle East and the East Coast are of the U.S., 1.1% for voyage between Trinidad and Tobago and the East Coast are of the U.S., and 6.2% for voyage between Western Australia and the East Coast area of the U.S. (EIA report, Natural Gas Monthly, August 1997).

(modular tank) [38]which will enable further significant reduction in construction cost and time. This technology is expected to be introduced in LNG export and import terminals.

Total cost for LNG projects have been reduced significantly by these constant efforts in individual segments of the LNG chain, including the diffusion of combined-cycle gas turbines (CCGT), which have achieved efficiency improvement and cost reduction in the power sector that will lead future natural gas demand. Along with the progress in diversification and decentralization on both supply and demand sides, the geographical distance between the countries that own large natural gas reserves and the countries that consume natural gas is not a big problem any more for the realization of LNG projects.

While these two factors interact with each other, as in the recent cases mentioned above, rapid change is being seen in the business structure based on the traditional LNG chain, which has seemed to be closed by segments so far. As an example case in which an upstream player expands into the downstream sector, Shell has been taking measures to transport its LNG assets from all over the world, using its own fleets, to import terminals which it constructed independently or third parties' terminals for which it has the right to use, and promote the sale of town gas and power generated by CCGT, with the aim of securing final demand. On the other hand, downstream players have been making efforts to promote LNG projects, which have been failing to make progress due to the difficulty in maintaining demand for a long period because of the advancement of deregulation, by retaining the right to acquire interests in the upstream sector in return for offering of demand or by reducing transportation cost by using their own fleets. Thus, as progress is made for liberalization in the energy market and for cost reduction in individual segments of the LNG chain, traditional players making active efforts to gain opportunities for expanding into other sectors have increased.

With a view of actively responding to changes in the environment surrounding the LNG industry, not only traditional players in the upstream sector but also players that carried out business activities in limited segments of the LNG chain have made efforts to restructure business portfolios for the future and consider ideal involvement in the future LNG chain. In consequence, as shown in the tables above, such players that are achieving self-reforms while foreseeing possible changes in the environment take proactive measures across the LNG chain.

Chapter 4 Implications for Japan

(1) Outlook for natural gas supply and demand in Japan

As mentioned above, energy organizations in the world generally expect expansion in LNG demand. In June 2004, the Japanese government published its long-term outlook for energy supply and demand in the draft interim report titled "Energy Supply-Demand Outlook in 2030."

Table 4-1-1 shows a reference case for the outlook until 2030.[39] Natural gas supply, which showed the second highest growth rate following nuclear power supply in the decade from FY1990 to FY2000, is expected to achieve a higher growth rate than that for any other energy source, increasing form 79 million kl in oil in FY2000 to 108 million kl in FY2030 with the average annual growth rate at 1.0%, due to the diffusion of distributed power sources.

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[38] Oil Daily dated January 9, 2004.

[39] This report is based on the precondition that four and six new nuclear power plants will start operation in FY2010 and FY2030 respectively. The operation factor is 85% for both FY2010 and FY2030 (82% in 2000).

Table 4-1-1 Long-term outlook for primary energy supply until 2030 (reference case)

Unit: million kl in oil

	FY1990	FY2000	FY2030	Average annual growth rate (%)	
				1990~2000	2000~2030
Oil	271	274	233	0.1	−0.5
	(52.8)	(46.5)	(38.4)		
LPG	19	19	23	0.0	0.6
	(3.6)	(3.2)	(3.7)		
Coal	86	107	106	2.2	−0.03
	(16.8)	(18.1)	(17.4)		
Natural gas	53	79	108	4.1	1.0
	(10.4)	(13.5)	(17.8)		
Nuclear power	49	75	90	4.3	0.6
	(9.6)	(12.7)	(14.8)		
New energy sources	35	35	47	0.0	1.0
	(6.7)	(6.0)	(7.7)		
Total	512	588	607	1.4	0.1

Note: Figures in parenthesis are percentages in the total primary energy supply.

(2) Implications for Japan

[1] Factors that will affect the environment for Japan's natural gas procurement

When reviewing how to be involved in the changing LNG chain with the aim of securing supply to meet domestic natural gas demand, Japan should take the following potential factors into consideration that may have an influence on its position as a LNG importer. The important thing is that these factors are related to and amplified by one another and therefore they will have a significant influence on Japan's future.

The first factor is the outlook for natural gas demand in India and China, which will have an influence on the supply and demand balance in the Asia-Pacific market; it demonstrates the importance of LNG (see Chapter 3(2)).

The second factor is to what extent LNG trade flows to the United States——the West Coast area for a short term and off the coast of the Gulf of Mexico and the East Coast for a long term——will be activated in the future. Attention should be paid to the influence of the increase in supply on the Henry Hub, the U.S. natural gas market price index, although it depends on the terms of price in individual LNG supply contracts. As mentioned above, it is in the course of nature for the players in the LNG chain that are achieving self-reforms to supply LNG to more profitable markets, and as a result, LNG supply is expected to be in short supply in the Asia-Pacific market. When such a market situation constantly exists, competition for LNG supply sources will occur among consuming countries and the current buyer's market could change into a "seller's market."

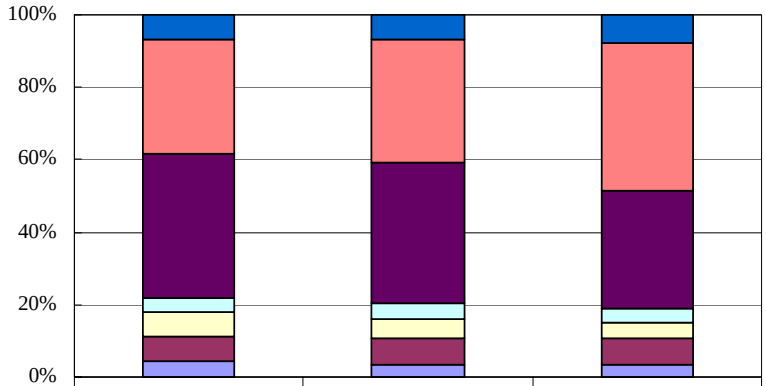
The third factor is the availability of optional supply (import) means via international pipelines for Japan. In India and China, which are new LNG importers in Asia, and in the Republic of Korea, which is a traditional importer, there is a growing possibility that PNG supply will be available via international natural gas pipelines by 2015, though it will take time to overcome various political, technical, and

economic obstacles. In such a situation, if Japan alone continues to depend only on LNG, other LNG importers that will also have access to PNG will strengthen their negotiating power against exporters whereas Japan, with such a limited supply means, will lose its negotiating power (weaken its position in negotiations) upon purchasing LNG.

The fourth factor is the advantageous position of the Middle Eastern countries as LNG exporters. The Middle Eastern countries can access the three major LNG consuming markets more freely and they will be able to choose buyers after closely examining market trends. In consequence, the Middle Eastern countries will exert their influence on the market as LNG exporters with flexibility. Considering that the Middle Eastern countries hold plentiful identified natural gas reserves including large gas wells, their advantage will be further reinforced by low-cost natural gas production.

Figure 4-2-1 shows the trends in the quantity of identified natural gas reserves in the world during the period from 1993 to 2003. As the volume of international natural gas trade expanded along with the intensification of competition among energy sources due to the progress in market liberalization, the quantity of identified natural gas reserves in the world increased through the active efforts in the upstream sector of the gas industry. As shown in this figure, the share of the quantity of identified natural gas reserves in the Middle East, where infrastructure for LNG transport to consuming countries had been established, to the total quantity in the world expanded from 31.5% in 1993 to 40.8% in 2003, with the average annual growth rate at 4.8%, which is far beyond the growth rate in other LNG supply regions (2.5% in Latin America, 0.0% in FSU, and 3.5% in Africa).

Figure 4-2-1 Trends in the quantity of identified natural gas reserves



	1993	1998	2003
Africa	343.5	361.1	486.5
Middle East	1581.0	1749.6	2531.8
FSU	1997.0	2002.6	1997.6
Latin America	197.5	219.0	253.7
North America	330.8	294.6	258.2
Asia-Pacific	354.5	359.5	475.6
Europe	211.9	183.9	201.4

Source: BP Statistical Review of World Energy (unit: Tcf)

[2] Ideal involvement in the LNG chain

a. When considering ideal involvement in the changing LNG chain in response to the factors that will affect the future environment, Japan, as a LNG consuming country, should place emphasis on the perspective of achieving energy security, on which more attention is focused in the LNG consuming markets. To this end, it is necessary to build a relationship of mutual dependence between LNG consuming countries and LNG supplying countries through interactive LNG diplomatic activities, which have been activated since the end of the 1990s. As examples of such diplomatic activities, the Prime Minister of Australia, one of the LNG exporters, visited China where large potential demand existed when China launched the Guangdong LNG reception project with the aim of participating in the LNG chain to secure LNG supply capability in response to the market demand, and the Minister of Oil and Natural Gas of India, a recent potential LNG consuming country, visited Iran where a LNG export project was being promoted.

b. When seeking to participate in the upstream sector that is involved in the stage of launching LNG projects, newcomers will be required to make a certain contribution to the realization of the projects. Before progress was made in deregulation, by offering large and long-term demand or favorable financial terms, Japan, a credible and stable importer, was regarded as having made a certain contribution to the realization of the projects and was allowed to acquire interests in the upstream sector of the LNG chain. However, as asset value of natural gas has increased due to liberalization in the energy market, interest holders in the upstream sector have changed their business strategies. In the case of stable supply projects which are promoted by oil majors and in which there is low risk in the upstream sector and solid financial strength is established, it is unlikely for the oil majors to simply offer a third party, in the middle of the project process, interests in the profitable upstream sector, and in particular, the segment of natural gas development that will bring about valuable management resources. Though the LNG chain is not closed to newcomers, we should recognize that much ingenuity would be required to achieve participation in the chain. One of the ways to participate is shown in the actions taken by the traditional LNG consuming countries in the East Asia region and new importers, India and China, as presented in the example cases of the change in the LNG chain above. Another way would be to remove the risk of the upstream interest holders securing demand by offering assurance for LNG imports, and acquire interests in return for such assurance.

c. The quantity of natural gas reserves in the Asia-Pacific region increased during the period from 1993 to 2003, and the supply and demand balance will continue to be stable in this region for the time being. However, in order to maintain such balance in the future and prevent the rise in dependence on imports from outside the region, it is necessary to make investments intensively in exploration and development of natural gas. Upon such occasion, due consideration should be given to economic efficiency of the project as a whole, as suggested in the Darwin project for the development of the Bayu-Undang gas well in which Japanese utility companies participate. More specifically, in the upstream sector of the project, how much condensate, a byproduct of gas development, will be produced and when the production will start will have a significant impact on the profit structure of the project as a whole. While earnings from the sale of condensate will be able to cover project costs promptly or will be available as development and operation funds, they will also be able to promote reduction of LNG purchase costs indirectly.[40] In this project, Japanese utility companies have successfully acquired interests as newcomers because they could offer a strong bargaining term, long-term and stable demand necessary for the launch of the LNG export project.

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[40] In the Bayu-Undang gas well (reserved quantity: 400 million barrels including LPG), production of condensate started in February 2004, prior to the launch of the LNG project (LNG production will start in 2006).