Natural Gas and LNG Supply and Demand Trends in Asia Pacific and Atlantic Markets* (2005)

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Introduction

This paper summarizes a study undertaken by the Institute of Energy Economics, Japan (IEEJ) on commission from the Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry under the project title of "FY2005 Investigative Research for Promotion of Natural Gas Development and Utilization (Study of Natural Gas Supply and Demand Trends in Asia Pacific and Atlantic Markets)".

The sharp price increases in oil and natural gas that became prominent since around 2003 are significantly affecting the LNG market. In Japan, for instance, LNG demand is rapidly expanding due to LNG's price advantage over petroleum products, which is enabled by the structure of LNG price formula particularly effective in a market with inflated crude oil prices, and also due to increased consumption of LNG by power utilities. On the other hand, in countries such as India and China which started importing LNG in 2004 and 2006 respectively, the soaring prices are adversely affecting an expansion of LNG demand due to a widening price gap with coal, which is their main fuel that LNG has to compete. Meanwhile, in the U.S.A. or the UK, there appears to be increasing needs for LNG as driven by stagnant or declining domestic production and the sharp rise in gas prices.

Along with the above-mentioned trends, supply security of LNG has been also attracting considerable attention in recent years. Indonesia continues to cut LNG export in 2006 and some liquefaction plant troubles have happened. Elsewhere, state oil or gas companies are strengthening their influence on new gas projects. Moreover, there appear to be cases where inflated cost of materials for constructing liquefaction plants or LNG tankers as well as shortages in skilled workers are causing cost overruns or delays in some of the LNG projects.

The ongoing trends of expansion of the global LNG market and the emergence of new exporters and importers are accelerating with the pace of energy demand increases accompanied

* This paper is an excerpt from a research commissioned by the Ministry of Economy, Trade and Industry in FY2005, and has been released under the permission of the Ministry. We thank the related parties in the Ministry for their understanding and cooperation. We are also grateful and indebted to the Working Group members for their contribution to this research.

by economic growths, policies taken by importing nations to diversify energy sources, and a need for LNG as an environmental protection measure. The world LNG demand could triple towards 2020, with countries such as Russia, Norway, Equatorial Guinea and Yemen being expected to start exporting, while Mexico, Canada, the Netherlands and Germany are expected to begin importing. Among the existing suppliers, a number of large scale expansion projects are on-going in Qatar. Already being the second largest LNG producer in the world, the country is expected to replace Indonesia as the world's largest LNG exporter before long. Since the most of LNG produced from the expansion projects in Qatar will be shipped to Europe and the U.S.A., it will create a new LNG flow of a substantial size that could lead to globalization of the LNG market.

In preparing this paper, we collected and examined information mainly from websites of governments, companies, institutes and other reference materials. An overview of the world natural gas situation and the supply and demand trends for LNG will be presented in the following sections.

1. Natural gas supply and demand

The world natural gas reserves at the beginning of 2005 stood at 180.0 Tcm[1], with the Middle East and the former Soviet Union respectively accounting for 40.7% and 31.9% of the total. Meanwhile, the reserves in Asia and Oceania were 14.3 Tcm, representing a mere 8% of the world total. Natural gas production in 2004 was 2.78 Tcm worldwide, with North America and the former Soviet Union each making up 25.8% and 28.7%, respectively, while Asia and Oceania accounted for 12.8% of the total. In terms of demand, large volumes are notable in North America and the former Soviet Union, each having huge production capacities, and Europe with active intra-region trading supported by well-developed pipeline networks and also by a large amount of natural gas imports from Africa and the former Soviet Union. Natural gas demand in Asia and Oceania was 375.7 Bcm[2], accounting for 13.5% of the world total (see Table 1 and Figure 1).

[1] Trillion cubic meters
[2] Billion cubic meters

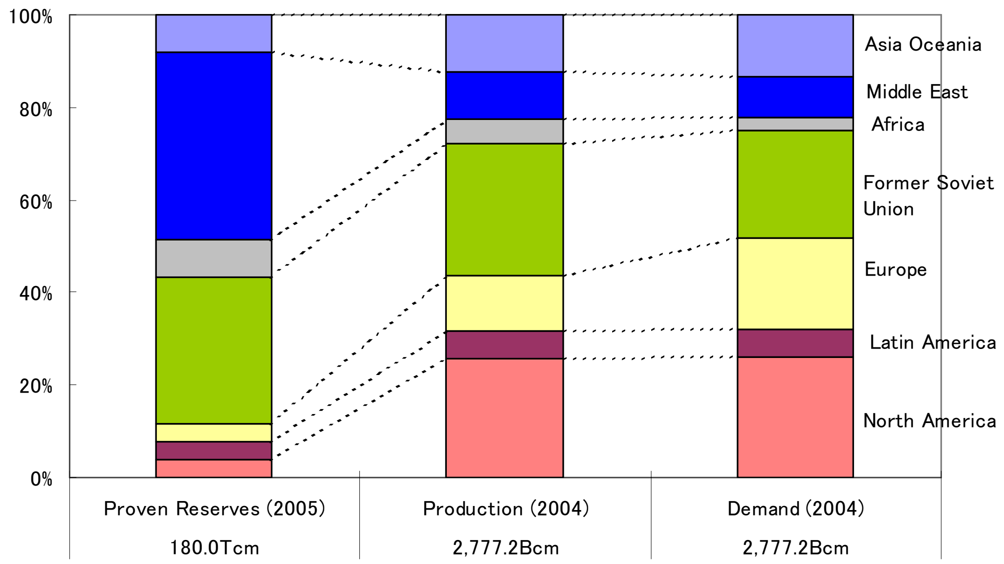
[Table 1] World Natural Gas Reserves, Production and Consumption

	Proven Reserves (2005)		Production (2004)		Demand (2004)	
	(Tcm)	Share (%)	(Bcm)	Share (%)	(Bcm)	Share (%)
North America	6.9	3.9%	716.8	25.8	723.4	26.0
Latin America	7.3	4.1%	165.9	6.0	163.0	5.9
Europe	6.6	3.7%	325.4	11.7	554.1	20.0
Former Soviet Union	57.4	31.9%	796.9	28.7	641.9	23.1
Africa	14.1	7.8%	149.6	5.4	74.2	2.7
Middle East	73.3	40.7%	282.6	10.2	244.9	8.8
Asia Oceania	14.3	8.0%	339.9	12.2	375.7	13.5
Total	180.0	100.0%	2,777.2	100.0	2,777.2	100.0

(Note) Concerning the reserves and production data for the Asia/Oceania region, the figure shown represents the total for 17 countries including Afghanistan, Australia, Bangladesh, Brunei, China, India, Indonesia, Japan, Malaysia, Myanmar, New Zealand, Pakistan, Papua New Guinea, the Philippines, Taiwan, Thailand, and Vietnam, and for consumption, the figure represents the total of 19 countries including the above 17 countries plus Singapore and South Korea.

(Source) *Natural Gas in the World*, Cedigaz

[Figure 1] World Natural Gas Reserves, Production and Consumption by Region



(Source) *Natural Gas in the World*, Cedigaz

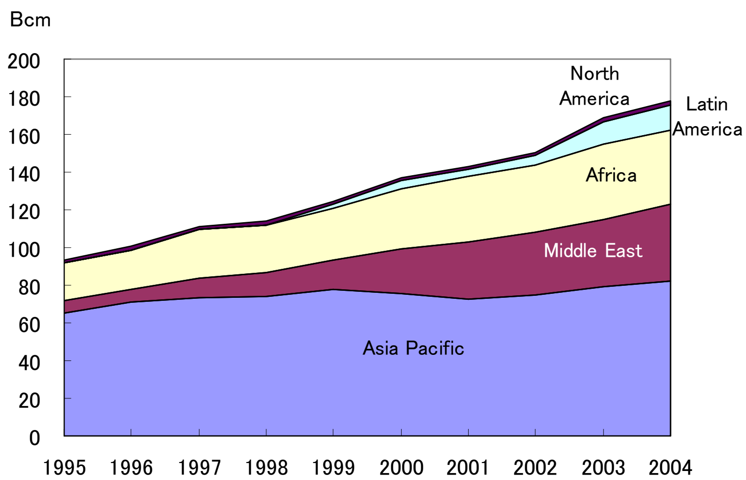
2. LNG trades

2.1. LNG imports and exports

The trading volume of natural gas in 2004 was 691.71 Bcm worldwide, of which 177.50 Bcm or about 129.6 MT (million tons) representing 26% of the total was traded in the form of LNG. The world LNG trading has expanded by an average growth rate of 7.7% per year between 1995 and 2004.

As for export sources by region, in 2004, Asia Pacific accounted for 46% of the world total, while 23% was sourced from the Middle East, 22% from Africa, 8% from Latin America, and 1% from North America. The share for the Middle East has significantly increased due to the new entries of Qatar and Oman into the market (see Figure 2).

[Figure 2] LNG Exports by Region



(Source) *Natural Gas in the World*, Cedigaz

Concerning imports by region, LNG demand in the Asia Pacific market[3] in 2004 was 118.20 Bcm while the Atlantic market[4] had a demand of 59.3 Bcm. Over the period from 1995 to 2004 the average annual growth rate for the Asia Pacific market was 5.7%, whereas the Atlantic market grew by an annual rate as high as 12.5% for the same period (see Figure 3). A sharp increase in imports by the U.S.A. significantly contributed to such a remarkable growth.

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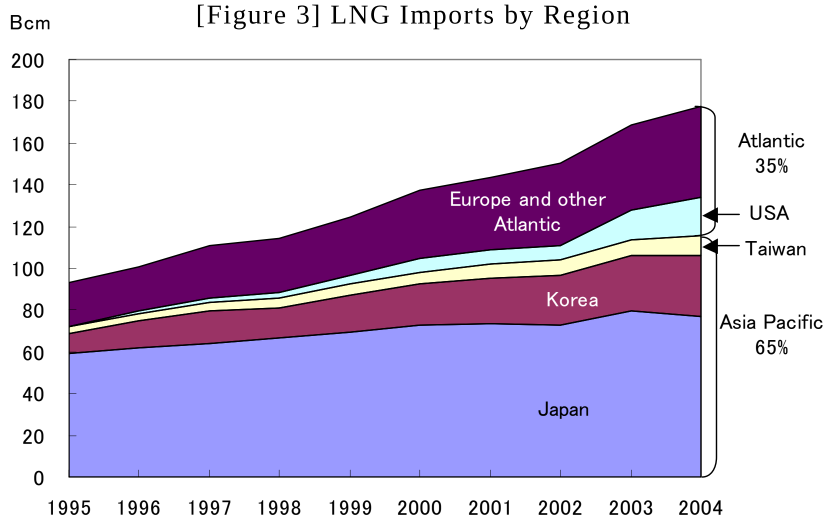
[3] The Asia Pacific market comprises LNG importing and exporting countries east of the Suez Canal. As of 2005, there are 8 exporting countries (Abu Dhabi, Oman, Qatar, Australia, Brunei, Indonesia, Malaysia, and the USA), and 4 importing countries (Japan, South Korea, Taiwan, and India). Since the USA exports LNG from its Alaskan Pacific Coast, its export is included in the Asia Pacific market in this graph.

[4] The Atlantic market comprises LNG importing and exporting countries west of the Suez Canal. As of 2005, there are 5 exporting countries (Algeria, Libya, Nigeria, Egypt, and Trinidad and Tobago), and 10 importing countries (the USA, Dominican Republic, Belgium, France, Spain, Portugal, Italy, Greece, Turkey, and the UK) plus Puerto Rico, a Commonwealth of the USA. Since the USA is receiving imported LNG from its East Coast or the Gulf of Mexico, its import is included in the Atlantic market in this graph.

[Figure 3] LNG Imports by Region

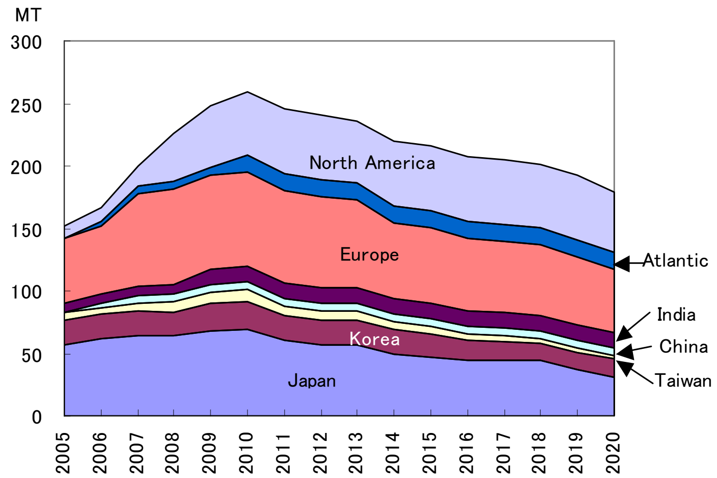


(Source) *Natural Gas in the World*, Cedigaz

2.2. Mid and long term contracts

Most LNG trades are based on long term contracts that extend for twenty years or longer; although mid term contracts for three to ten years have also been concluded in recent years. The total volume of mid to long term LNG contracts at the stage of 2005 has amounted to 152.21 MT. As will be discussed later, a substantial demand increase is anticipated in the European and the U.S. market and is reflected in the contracted volume through 2020 (see Figure 4). A noteworthy fact here is that, in newly concluded contracts for European or the U.S. deliveries, a contractual seller often appoints its own representative as a contractual buyer. Such a contracting practice differs from traditional LNG contracts in a sense that importer is not the user of LNG. As the existing Indonesian as well as Australian contracts for Japan deliveries will expire successively around and after 2010, negotiations are currently under way for renewing or extending these contracts and also for formulating contracts on new projects.

[Figure 4] Mid/Long Term LNG Contract Volumes by Region



Notes:

1. The figures referred to in this graph are the total of volumes provided in Sale and Purchase Agreements (SPAs) and Heads of Agreements (HOAs), and excluding those volumes expressed in Memorandums of Understanding (MOUs) or Letters of Intent (LOIs).
2. In case the contractual volume has a range, the lowest value is used for the projection. In addition, optional volumes are not included in the data.
3. While the graph is based on the total volume on mid and long term contracts, actual supplies may not match the contracted volumes. In particular, volumes supplied at the beginning of a project generally tend to be less than the contracted values. In addition, volumes supplied may fluctuate depending on gas demand trends in the importing country as well as on operating conditions of the liquefaction plant.

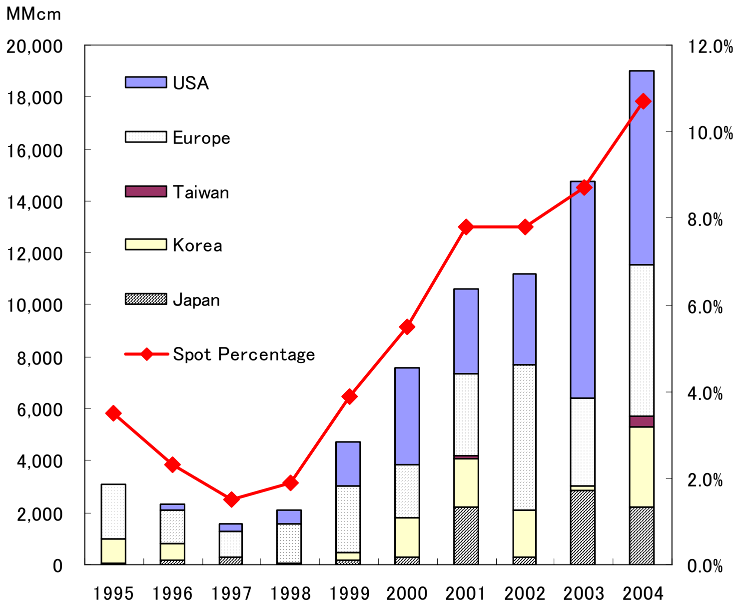
Sources: Press releases by respective project cpmpanies

2.3. Spot trading[5]

The volume of spot LNG trades in 2004 was 19 Bcm (13.87 MT) worldwide, of which 7.4 Bcm (5.4 MT) was for deliveries into the U.S.A., 5.8 Bcm (4.23 MT) into Europe, and 5.7 Bcm (4.16 MT) into the Asian market. While this represents only 10.7% of the total LNG trades, the volume growth since the late 1990s has been significant (see Figure 5). However, this does not necessarily mean an increase in spare LNG production capacity as most of liquefaction plant capacities have been committed under long term contracts; rather, it could be interpreted partly as a reflection of LNG volumes diverted from those under long term contracts for spot transactions.

[5] Transactions made under contracts with terms less than one year.

[Figure 5] Spot LNG Transactions of the World



Note: MMcm = Million Cubic Meters

Sources: Petrostrategies, GIIGNL, Cedigaz

2.4. LNG pricing

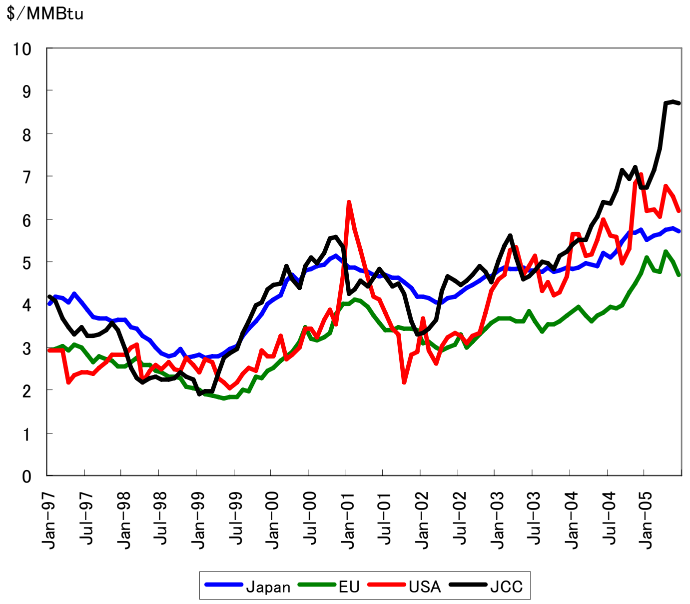
The LNG pricing mechanisms vary from region to region. In Asia, LNG prices are generally linked to the so-called JCC (Japan Crude Cocktail) price, which is an average CIF price of crude oil imported into Japan, whereas in continental Europe they are linked to petroleum products or the Brent crude oil prices. In the U.S.A. or the UK, LNG prices are determined by supply and demand based on natural gas trading points such as Henry Hub in the U.S.A. or National Balancing Point (NBP) in the UK.

Figure 6 shows the historical LNG import prices into Japan, the U.S.A. and the EU. Until around 2000, LNG prices for Japan remained at relatively higher levels in comparison with the U.S.A. or the EU. Japanese price being on the rise in line with the increase in the JCC prices, the rate of increase has been restrained at a lower level than that of the JCC thanks to an alleviating factor built into the pricing formula. While the price for delivery into the EU is lower than that for Japan, there are similarities in their movements since both prices are linked to crude oil or petroleum product prices. Further, it can also be observed that the 2005 prices for the EU appear to follow the U.S. price trends. This may suggest an increased level of mutual relationship between the European and the U.S. markets caused by active spot transactions. With regard to the LNG prices for the U.S.A., they are hovering at high levels reflecting the escalated prices for domestic natural gas, while remaining to be highly volatile as well.

Although it is not shown in Figure 6 for data availability reasons, there was a sharp spike in the prices for the U.S.A. in the latter half of 2005. This was caused by an onslaught of major hurricanes that hit the Gulf Coast regions one after another during August – September 2005, seriously damaging the natural gas production and transport facilities and thereby leading to a sharp rise in the Henry Hub price. The soaring prices in the U.S.A. as the world's largest spot importer of LNG are resulting in escalated prices for spot LNG cargoes destined for Asian markets.

Concerning prices for Japanese deliveries, since the structure of a typical pricing formula is such that it allows LNG a price advantage over competing petroleum products in an inflated crude oil market, the recent crude price hikes are contributing to a considerable increase in LNG demand especially by industrial users. By contrast, countries such as India and China, the soaring prices are discouraging the growth in LNG demand due to a widening price gap with coal as the main competing fuel.

[Figure 6] LNG Import Prices for Japan, EU and the U.S.A.



Source: *Energy Prices & Taxes*, IEA

3. The LNG chain

3.1. Liquefaction plants

The world's annual LNG production capacity currently in operation stands at 163.4 MT as of 2005. On a regional basis, Asia Pacific has the largest capacity at 70.1 MT, followed by Africa and the Middle East at 45.2 MT and 37.4 MT respectively; and North and Central America at 10.7

MT (see Table 2). Supplies of LNG for Asia are mainly sourced from Asia Pacific, North America and the Middle Eastern regions, while LNG shipped to the U.S. and European destinations is primarily supplied from Africa and the Central America regions.

At present, Indonesia has the largest liquefaction capacity in the world with a nameplate capacity reportedly being 28.3 MT per year. However, the actual export volume was much smaller and no more than 24.84 MT as of 2004, which resulted from difficulties such as depletion or production troubles at the gas fields feeding respective liquefaction plants, or the increasing supply to fertilizer plants or other domestic industries. The level of Indonesian LNG production is forecast to remain short of long-term contractual obligations for both 2005 and 2006, with the timing of a full production recovery nowhere in sight.

During 2005, new capacities in the Damietta LNG and the Egyptian LNG projects in Egypt and the RasGas II Train 4 in Qatar were brought on line, altogether raising the worldwide liquefaction capacity by as much as 16.9 MT per year. Among these new projects, the Damietta LNG and the Egyptian LNG have been developed with participation from downstream players such as power and gas utilities of importing countries. These are notable as the cases of downstream players becoming involved in upstream projects.

[Table 2] Existing LNG Production Plants

Region	Country	Project (Train)	Capacity (MT/y)	Start Up	Investors	Main Destination
Africa	Algeria	Arzew GL4Z (Train 1–3)	1.1	1964	Sonatrach	Europe, USA
		Arzew GL1Z (Train 1–6)	7.8	1978		
		Arzew GL2Z (Train 1–6)	8.0	1980		
		Skikda GL1K Ⅰ (Train 1–3)	2.8	1972		
		Skikda GL1K Ⅱ (Train 4–6)	3.0	1980		
	Libya	Marsa el Brega (Train 1–2)	0.7	1970	Sirte Oil	Spain
	Nigeria	Nigeria LNG (Train 1, 2)	6.4	1999	Nigeria LNG (NNPC, Shell, Total, ENI)	Europe
		Nigeria LNG (Train 3)	3.2	2002		
	Egypt	Damietta LNG (Train 1)	5.0	2005	SEGAS (Union Fenosa Gas, EGAS, EGPC)	Spain
		Egyptian LNG (Train 1)	3.6	2005	BG, Petronas, EGAS, EGPC, Gaz de France	France, Spain, USA
		Egyptian LNG (Train 2)	3.6	2005	BG, Petronas, EGAS, EGPC	USA, Italy
	Sub Total		45.2			

[Table 2] Existing LNG Production Plants (continued)

Region	Country	Project (Train)	Capacity (MT/y)	Start Up	Investors	Main Destination
Americas	USA	Kenai (Train 1, 2)	1.1	1969	ConocoPhilips, Marathon	Japan
	Trinidad Tobago	Atlantic LNG (Train 1)	3.0	1999	Atlantic LNG (BP, BG, Repsol-YPF, NGC, Tractebel)	USA, Spain, Puerto Rico
		Atlantic LNG (Train 2)	3.3	2002	Atlantic LNG (BP, BG, Repsol-YPF)	USA, Spain
		Atlantic LNG (Train 3)	3.3	2003	Atlantic LNG (BP, BG, Repsol-YPF)	USA, Sapin
	小　　計		10.7			
Middle East	Abu Dhabi	ADGAS (Train 1, 2)	3.1	1977	ADGAS (ADNOC, Mitsui, BP, Total)	Japan
		ADGAS (Train 3)	2.3	1994		
	Oman	Oman LNG (Train 1, 2)	6.6	2000	Oman LNG (Oman Government, Shell, Total, Mitsubishi, Mitsui, Partex, Itochu, Korea LNG)	Japan, Korea, Spain
	Qatar	Qatargas (Train 1-3)	9.4	1997	Qatargas (Qatar Petroleum, ExxonMobil, Total, Marubeni, Mitsui)	Japan, Spain
	Qatar	RasGas (Train 1, 2)	6.6	1999	Ras Laffan LNG Company Limited (Qatar Petroleum, ExxonMobil, KOGAS, Itochu, LNG Japan)	Korea
		RasGas II (Train 3)	4.7	2004	Ras Laffan LNG Company Limited II (Qatar Petroleum, ExxonMobil)	India
		RasGas II (Train 4)	4.7	2005	Ras Laffan LNG Company Limited II (Qatar Petroleum, ExxonMobil)	Europe
	Sub Total		37.4			
Asia Pacific	Brunei	Brunei LNG (Train 1-5)	7.2	1972 -1974	Brunei LNG (Brunei Government, Shell, Mitsubishi)	Japan, Korea
	Malaysia	Malaysia LNG I (Satu) (Train 1-3)	8.1	1983	Malaysia LNG (Petronas, Sarawak Government, Mitsubishi)	Japan
		Malaysia LNG II (Dua) (Train 4-6)	7.8	1995	Malaysia LNG Dua (Petronas, Shell, Mitsubishi, Sarawak Government)	Japan, Korea, Taiwan
		Malaysia LNG III (Tiga) (Train 7, 8)	6.8	2003	Malaysia LNG Tiga (Petronas, Shell, Nippon Oil, Sarawak Government, Mitsubishi)	Japan, Korea

[Table 2] Existing LNG Production Plants (continued)

Region	Country	Project (Train)	Capacity (MT/y)	Start Up	Investors	Main Destination
Asia Pacific	Indonesia	Bontang I (Train A, B)	5.2	1977	PT Badak NGL (Pertamina, VICO, JILCO, Total)	Japan
		Bontang II (Train C, D)	5.2	1983		Japan
		Bontang III (Train E)	2.8	1989		Taiwan
		Bontang IV (Train F)	2.8	1993		Japan
		Bontang V (Train G)	2.8	1997		Korea
		Bontang VI (Train H)	3.0	1999		Taiwan
		Arun I (Train 1)	1.5	1978	PT Arun NGL (Pertamina,. ExxonMobil, JILCO)	Japan
		Arun II (Train 4, 5)	3.0	1984		Japan
		Arun III (Train 6)	2.0	1986		Korea
	Australia	NWS (Train 1-4)	11.9	1989-2004	Woodside, Shell, Chevron, BHP Billiton, BP, MIMI	Japan
	Sub Total		70.1			
Total			163.4			

Source: Prepared by IEEJ based on various corporate websites, etc.

In addition to existing plants described in the above, there are a number of new projects and expansion programs for existing terminals. The total of LNG production capacities with signed SPAs (Sale and Purchase Agreements) or HOAs (Heads of Agreement) stands at 132.4 MT[6] at the end of 2005, with a general likelihood of their being realized by or around 2010 (see Table 3).

[6] Of the projects listed in the table, the NLNG Trains 4 and 5 in Nigeria, the Qalhat LNG plant in Oman, the Atlantic LNG Train 4 in Trinidad and Tobago, and the Darwin LNG plant in Australia are already in operation as of May 2006.

[Table 3] LNG Production Plants with Signed SPA/HOA

Region	Country	Project (Train)	Capacity (MT/y)	Start Up	Investors	Main Destinations
Africa	Nigeria	NLNG (Train 4, 5)	8.2	2006 Q1	NLNG (NNPC, Shell, Total, ENI)	Spain, Portugal USA, Italy
		NLNG (Train 6)	4.1	2007 Q4	NLNG (NNPC, Shell, Total, ENI)	USA, Mexico, Europe
	Equatorial Guine	Bioko LNG	3.4	2007 Q4	Marathon, GEPetrol, Mitsui, Marubeni	USA
	Sub Total		15.7			
Americas	Trinidad Tobago	Atlantic LNG (Train 4)	5.2	2006 January	Atlantic LNG (BP, BG, Repsol-YPF, NGC)	USA, Europe
	Sub Total		5.2			
Europe	Norway	Snohvit LNG (Train 1)	4.2	2007 December	Petro, Statoil, Total, Gaz de France, Amerada Hess, RWE	USA, Europe
	Sub Total		4.2			
Middle East	Qatar	RasGas II (Train 5)	4.7	2007 Q1	Ras Laffan LNG Company Limited II (Qatar Petroleum, ExxonMobil)	Italy, Belgium
		RasGas 3 (Train 6)	7.8	2008 Q4	Ras Laffan LNG Company Limited 3 (Qatar Petroleum, ExxonMobil)	USA
		RasGas 3 (Train 7)	7.8	2009 Q4	Ras Laffan LNG Company Limited 3 (Qatar Petroleum, ExxonMobil)	USA
		Qatargas II (Train 1, 2)	15.6	2007～2008 Winter	Qatar Petroleum, ExxonMobil, Total	UK, France, USA
		Qatargas 3	7.8	2009～2010 Winter	Qatar Petroleum, ConocoPhillips, Mitsui	USA
		Qatargas 4	7.8	2010	Qatar Petroleum, Shell	USA, Europe
	Oman	Qalhat LNG (Train 3)	3.7	2005 December	Oman Government, Oman LNG, Union Fenosa	USA, Europe, Japan
	Yemen	Yemen LNG (Train 1, 2)	6.7	End 2008	Total, Yemen Gas Corp, Hunt, SK, KOGAS	Korea, USA
	Sub Total		61.9			

[Table 3] LNG Production Plants with Signed SPA/HOA (continued)

Region	Country	Project (Train)	Capacity (MT/y)	Start Up	Investors	Main Destinations
Asia Pacific	Australia	Darwin LNG	3.5	2006 Q1	ConocoPhillips, Eni, Santos, Inpex, Tokyo Electric, Tokyo Gas	Asia
		NWS (Train 5)	4.4	2008 Q4	Woodside, BHP Billiton, BP, Chevron, Shell, MIMI	Asia
		Gorgon (Train 1, 2)	10.0	Beginning 2010	Chevron, Shell, ExxonMobil	Asia, Mexico
		Pluto (Train 1, 2)	7.0	End 2010	Woodside, Tokyo Gas	Asia
	Indonesia	Tangguh (Train 1, 2)	7.6	2008～2009	BP, MI Berau, CNOOC, Nippon Oil, KG Berau Wiriagar, LNG JAPAN	Asia, Mexico
	Malaysia	MLNG I～III De-bottlenecking	3.3	2006	Malaysia LNG, Malaysia LNG Dua, Malaysia LNG Tiga	Asia
	Russia	Sakhalin II (Train 1, 2)	9.6	2008 Summer	Shell, Mitsui, Mitsubishi	Asia, Mexico
	Sub Total		45.4			
Total			132.4			

Source: Prepared by IEEJ based on various corporate websites, etc.

In terms of regional distribution, the Middle East is slated for a total expansion of 61.9 MT, whereas 15.7 MT is planned in Africa, 45.4 MT in Asia Pacific, and 4.2 MT in Europe. It is clear that most of the new projects in the Middle East and Africa have the Atlantic market in mind as their main outlets. Further, countries such as Equatorial Guinea, Yemen, Norway, or Russia are expected to join LNG exporting countries. Among the existing exporters, Qatar's rapid production increase is notable with its LNG capacity expected to jump from the present 25.4 MT to 76.9 MT by 2010.

In seeking further cost reduction, scale of liquefaction plants is also becoming increasingly large. While the Damietta project in Egypt currently boasts the world's largest single train production capacity of 5 MT/year, Qatar's RasGas 3, Qatargas II, Qatargas 3, and Qatargas 4 projects will have a single train capacity of 7.8 MT/year.

Furthermore, there are a number of new projects that are planned for commercialization. As shown in Table 4, the total new LNG production capacity currently under review for commercialization totals to 192.75 MT/year. However, with respect to feasibility of these planned projects, there are significant differences among them depending on factors such as particular LNG demand prospects, political stability at project sites, environmental restrictions, and development strategies taken by respective project owners. Accordingly, there is no guarantee that all of these projects will be implemented, and, even if they are, they may not necessarily start production as currently scheduled.

[Table 4] LNG Production Plants Under Planning

Region	国名	Project (Train)	Capacity (MT/y)	Start Up	Investors	Main Destination
Africa	Egypt	Damietta (Train 2)	5.0	2008	ENI, BP, EGAS	India
		West Damietta	4.0	N.A.	Shell, EGPC	N.A.
	Libya	Marsa el Brega Renovation (Train 1-2)	2.5	N.A.	NOC, Shell	N.A.
	Algeria	Skikda	4.5	2009	Sonatrach	USA, Europe
		Gassi Touil (Arzew)	4.0	2009	Sonatrach	USA, Europe
	Nigeria	West Niger Delta LNG	9.0	N.A.	Chevron, ConocoPhillips, ExxonMobil	N.A.
		NLNG (Train 7)	4.8	2010	ExxonMobil, NNPC	
		Olokola LNG	20.0	2009	Chevron, BG, Shell, NNPC	
		Brass River LNG (Train 1, 2)	10.0	2008-2009	NNPC, ConocoPhillips, Chevron, ENI	USA, Mexico
	Angola	Angola LNG (Train 1)	4.0	2007	Chevron, Sonangol, BP, Total, ExxonMobil, Norsk Hydro	USA, Europe
		Angola LNG (Train 2)	6.0	N.A.	Chevron, Sonangol	USA, Europe
	Sub Total		73.8			
Europe	Russia	Shtokman LNG	14.0	2013	Gazprom	USA
		Baltic LNG	3.0	2009	Gazprom	N.A.
	Norway	Snohvit LNG (Train 2)	4.2	2012	Petro, Statoil, Total, Gaz de France, Amerada Hess, RWE	USA, Europe
	Sub Total		21.2			

[Table 4] LNG Production Plants Under Planning(continued)

Region	Country	Project (Train)	Capacity (MT/y)	Start Up	Investors	Main Destination
Middle East	Iran	LNG 1: Iran LNG (Train 1, 2)	8.0	N.A.	NIOC, Reliance	India, Europe
		LNG 2: Pars LNG (Train 1, 2)	10.0	N.A.	NIOC, Total, Petronas	Asia, Europe
		LNG 3: Persian LNG (Train 1, 2)	14.0	2010	NIOC, Shell, Repsol	Asia, Europe
		LNG 4: NIOC LNG	10.0	N.A.	NIOC	Asia, Europe
	Sub Total		42.0			
Americas	USA	North Slope (Train 1-4)	9.0	N.A.	Yukon Pacific	USA
	Venezuela	Mariscal Sucre (Train 1)	4.7	N.A.	PDVSA, Shell, Mitsubishi	USA
	Peru	Peru LNG	4.4	2008	Hunt Oil, SK, Repsol-YPF	Mexico, USA
	Trinidad Tobago	Atlantic LNG (Train 5)	N.A.	N.A.	N.A.	N.A.
	Sub Total		18.1			
Asia Pacific	Australia	Greater Sunrise	5.3	N.A.	Shell, ConocoPhillips, Osaka Gas, Woodside	Asia Pacific
		Tassie Shoal	2.5	2011	Methanol Australia	Asia Pacific
		Browse	7.0	2011	Woodside, Chevron, BP, BHP Billiton, Shell	Asia Pacific
		Pilbara	6.0	2008	BHP Billiton, ExxonMobil	USA
		Ichthys	3.0	2011	INPEX	Asia Pacific
	Brunei	Brunei LNG Expansion	4.0	N.A.	Brunei LNG (Brunei Government, Shell, Mitsubishi)	Asia Pacific
	Russia	Sakhalin II (Train 3)	N.A.	N.A.	Shell, Mitsui, Mitsubishi	Asia Pacific

[Table 4] LNG Production Plants Under Planning(continued)

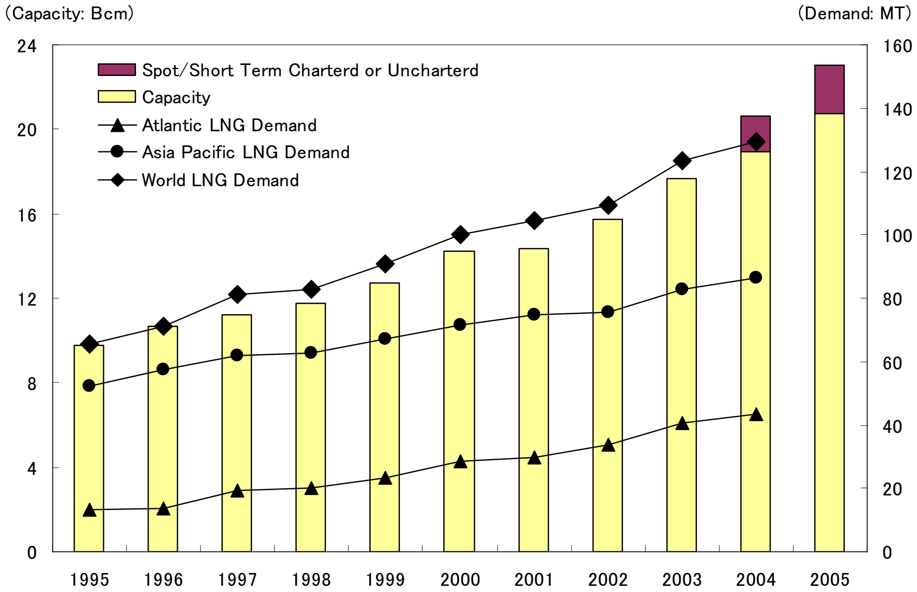
Region	Country	Project (Train)	Capacity (MT/y)	Start Up	Investors	Main Destination
Asia Pacific	Indonesia	Tangguh (Train 3)	N.A.	N.A.	BP, MI Berau, CNOOC, Nippon Oil, KG Berau・KG Wiriagar, LNG JAPAN	Asia Pacific
		Bongtang (Train I)	3.0	N.A.	Pertamina	Asia Pacific
		Bongtang (Train J)	3.0	N.A.	Pertamina	Asia Pacific
		Senoro	0.9	2008	LNG Ltd, Medco	Asia Pacific
		Natuna	N.A.	N.A.	ExxonMobil, Pertamina	Asia Pacific
		Masera	3.0	2015	INPEX	Asia Pacific
	Sub Total		37.7			
Total			192.75			

Source: Prepared by IEEJ based on various corporate websites, etc.

3.2. LNG tankers

As of 2005, the number of the world LNG fleet in operation was 190 with an aggregated loading capacity of 23 Bcm. In the face of strong LNG demand, the number of LNG tankers being built has also been on a steep rise in recent years, and the resultant expansion in the transport capacity has far outpaced the growth in LNG demand. As a result, there recently have been LNG tankers built with only spot or short-term contracts or some of them even without a charter contract. In addition, there are increasing cases where both upstream players such as the majors or trading houses and downstream players such as power and gas utilities to own LNG tankers to enter into the midstream business of LNG shipping.

[Figure 7] LNG Shipping Capacity



Sources: LNG Japan, IEEJ

As with the case of liquefaction plants, the jumboizing trend in newly built LNG tankers is also continuing. While most LNG tankers today have capacities of 135,000 to 145,000m^3 at the maximum, larger vessels having capacities of 200,000 to 250,000 m^3, or so-called Q-Flex or Q-Max vessels, will be built and employed for the new projects in Qatar. However, Q-Flex or Q-Max vessels are designed for a particular range of import terminals in the U.S. or European markets, and there are very few ports that can receive them due to limitations in port infrastructures.

3.3. Receiving terminals

As of 2005, there were 51 LNG receiving terminals throughout the world, with an aggregated annual receiving capacity of 183.27 MT. In terms of regional distribution, Japan has an unparalleled 25 terminals followed by the U.S.A. with 5 terminals, and South Korea and Spain with 4 each (see Table 5).

[Table 5] Existing LNG Receiving Terminals

Region	Country	Name	Investor(s)	Capacity (MT/y)	Storage (1,000kl)	Start-up
Asia	Japan	Sendai	Sendai City Gas	0.15	80	1997
		Higashi Niigata	Nihonkai LNG	4.0	720	1984
		Futtsu	Tokyo Electric	7.0	1,110	1985
		Sodegaura	Tokyo Electric, Tokyo Gas	9.5	2,660	1973
		Higashi Ogishima	Tokyo Electric	6.0	540	1984
		Ogishima	Tokyo Gas	1.5	600	1998
		Negish	Tokyo Electric, Tokyo Gas	3.5	1,180	1969
		Sodeshi	Shimizu LNG	0.3	177	1996
		Chita Kyodo	Chubu Electric, Toho Gas	1.4	300	1977
		Chita	Chita LNG	3.1	640	1983
		Chita Midorihama	Toho Gas	0.8	200	2001
		Yokkaichi LNG Center	Chubu Electric	3.0	320	1987
		Yokkaichi	Toho Gas	0.3	160	1991
		Kawagoe	Chubu Electric	4.0	480	1997
		Senboku 1	Osaka Gas	0.8	180	1972
		Senboku 2	Osaka Gas	7.7	1,585	1977
		Himeji	Osaka Gas	2.6	740	1984
		Himeji LNG	Kansai Electric	2.6	520	1979
		Hatsukaichi	Hiroshima Gas	0.5	170	1996
		Yanai	Chugoku Electric	1.3	480	1990
		Oita	Oita LNG	2.6	460	1990
		Tobata	Kitakyushu LNG	1.3	480	1977
		Fukuoka	Saibu Gas	0.2	70	1993
		Nagasaki	Saibu Gas	0.1	35	2003
		Kagoshima	Nihon Gas	0.08	86	1996
		Japan total		64.44	13,973	
	South Korea	Pyeongtaek	KOGAS	7.2	1,000	1986
		Inchon	KOGAS	7.2	2,480	1996
		Tongyoung	KOGAS	3.0	980	2002
		Gwangyang	POSCO	1.7	200	2005
		South Korea Total		19.10	4,660	
	Taiwan	Yungan	CPC	7.44	690	1990
	India	Dahej	Petronet	5.0	320	2004
		Hazira	Shell, Total	2.5	320	2005
	Subtotal			98.48	19,963	
Americas	U.S.A.	Everett	Tractebel LNG	7.93	155	1971
		Lake Charles	Trunkline LNG	9.20	285	1982
		Cove Point	Dominion	7.67	380	1978
		Elba Island	Southern LNG (El Paso)	9.36	191	1978
		West Cameron, (Off-shore), Gulf of Mexico	Excelerate Energy	3.83	N.A.	2005
	Puerto Rico	Penuelas	EcoElectrica	1.30	160	2000
	Dominica	Andres	AES	0.60	160	2003
	Subtotal			39.89	1,331	

[Table 5] Existing LNG Receiving Terminals (continued)

Region	Country	Name	Investor(s)	Capacity (MT/y)	Storage (1,000kl)	Start-up
Europe	Belgium	Zeebrugge	Fluxys	3.30	261	1987
	France	Fos-sur-Mer	Gaz de France	5.80	150	1972
		Montoir-de-Bretagne	Gaz de France	8.20	360	1980
	Italy	Panigaglia	Snam	2.60	100	1971
	Spain	Barcelona	Enagas	6.20	240	1969
		Cartagena	Enagas	0.90	55	1989
		Huelva	Enagas	2.70	165	1988
		Bilbao	BP, Respol, Iberdola, EVE	2.00	160	2003
	Portugal	Sines	Transgas	3.80	120	2003
	U.K.	Isle of Grain	National Grid	3.30	200	2005
	Greece	Revithoussa	DEPA	1.50	130	2000
	Turkey	Marmara Ereglisi	Botas	4.60	255	1994
	Subtotal			44.90	2,196	
Total				183.27	23,490	

Source: Prepared by IEEJ based on various corporate websites, etc.

In addition to existing terminals, a number of new projects are currently being planned for commercialization (see Table 6)[7]. Such projects are especially numerous in North America and China, where demand for LNG is projected to grow rapidly from now on. However, the project feasibility varies significantly among them depending on factors such as project economics, environmental and social constraints, national policies on infrastructure development, and so forth. In a reversal to the cases where some of the liquefaction projects are involving downstream players as mentioned before, there is an increasing number of cases where upstream players become the investors in receiving terminal projects.

[7] Of the projects listed in the table, Sakai and Mizushima in Japan are already in operation as of June 2006.

[Table 6] LNG Receiving Terminals under planning

Region	Country	Name	Investor(s)	Capacity (MT/y)	Start-up
Americas	U.S.A.	Hackberry, LA	Sempra Energy	11.50	2008
		Bahamas	AES Ocean Express	6.44	2006-2007
		Bahamas	FPL Resources, Tractebel, El Paso	6.36	N.A.
		Freeport, TX	Freeport LNG Development	11.50	2007
		Sabine, LA	Cheniere Energy	19.93	2008
		Corpus Christi, TX	Cheniere Energy	19.93	2008
		Corpus Christi, TX	ExxonMobil	7.67	2008-2009
		Fall River, MA	Hess LNG(Amerada Hess, Poten & Partners)	6.13	2007
		Sabine, TX	ExxonMobil	7.67	2008-2009
		Corpus Christi, TX	Occidental Energy	7.67	2008
		Port Pelican, LA	Chevron	12.26	2007
		(Offshore), LA	Shell	7.67	2008-2009
		Long Beach, CA	Sound Energy Solutions (Mitsubishi, ConocoPhillips)	5.37	2009
		Logan Township, NJ	BP	9.20	2009
		Bahamas	El Paso, FPL	3.83	N.A.
		Port Arthur, TX	Sempra Energy	11.50	2009
		Long Island Sound, NY	TransCanada, Shell	7.67	2010
		Pascagoula, MS	Gulf LNG	7.67	2009
		Bradwood, OR	Northern Star	7.67	2010
		Pascagoula, MS	Chevron	9.96	N.A.
		Cameron, LA	Cheniere Energy	25.29	2009
		Port Lavaca, TX	Gulf Coast LNG Partners	7.67	2009-2010
		Pleasant Point, ME	Quoddy Bay	3.83	N.A.
		Robbinston, ME	Kestrel Energy, Dean Girdis	3.83	N.A.
		(Offshore), CA	BHP Billiton	11.50	2008
		(Offshore), CA	Crystal Energy, Woodside	3.83	2009
		(Offshore), LA	McMoran	7.67	2008
		Gulf of Mexico(Offshore)	Compass Port - ConocoPhillips	7.67	2010
		Gulf of Mexico(Offshore)	Beacon Port - ConocoPhillips	11.50	2010
		Boston(Offshore), MA	Tractebel	3.07	2009
		Boston(Offshore), MA	Excelerate Energy	6.13	2007
		Coos Bay, OR	Energy Projects Development	1.00	2009
		(Off-shore), CA	Chevron	5.75	N.A.
		(Off-shore), CA	Woodside	5.75	N.A.
		St. Helens, OR	Port Westward LNG	5.37	2009
		Galveston, TX	BP	9.20	2009
		Philladelphia, PA	PGW	4.60	N.A.
		Astoria, OR	Calpine	7.67	2010
		Boston, MA	AES Battery Rock LLC(AES Co.)	6.13	N.A.
		Calais, ME	BP Consulting LLC	N.A.	N.A.
		Baltimore, MD	AES Sparrows Point(AES Co.)	11.50	N.A.
		(Offshore), NY	Safe Harbor Energy - ASIC	15.33	N.A.

[Table 6] LNG Receiving Terminals under planning (continued)

Region	Country	Name	Investor(s)	Capacity (MT/y)	Start-up
Americas	Canada	St. John, NB	Canaport LNG (Irving Oil, Repsol YPF)	7.67	2008
		Point Tupper, NS	Anadarko	7.67	2008
		Quebec City, QC	Enbridge, Gaz Met, Gaz de France	3.83	2009
		Riviere-du-Loup, QC	TransCanada, PetroCanada	3.83	2009
		Kitimat, BC	Galveston LNG	4.68	2009
		Prince Rupert, BC	WestPac Terminals	2.30	2009
		Goldboro, NS	Keltic Petrochemicals, Petroplus	7.67	2009
	Mexico	Altamira, Tamulipas	Shell, Total, Mitsui	5.37	2006
		Costa Azul, Baja California	Shell, Sempra	7.67	2007
		GNL Mar Adentro, Baja California	Chevron	10.73	2007
		Lazaro Cardenas	Tractebel, Repsol-YPF	3.83	2008
		Puerto Libertad, Sonora	DKRW Energy(Sonora Pacific LNG)	9.96	2008
		Gulf of Mexico(Offshore)	Tidelands	7.67	2008
		Manzanillo	CFE	3.83	2009
		Topolobampo	TransCanada	3.83	N.A.
	Bahama	Bahamas	Tractebel, El Paso	6.44	N.A.
		Bahamas	AES Ocean Express	6.44	2006-2007
	Honduras	Puerto Cortes	AES	1.90	2005
	Brazil	Suape	Shell	1.60	N.A.
	Chile	Quintero Bay	ENAP	2.70	2009
Europe	France	Fos-Cavou	Gaz de France, Total	6.00	2007
		Fos-Cavou	ExxonMobil	N.A.	2009
		Le Havre	N.A.	N.A.	N.A.
	Italy	Isola di Porto Levante	ExxonMobil, Qatar Petroleum, Edison	5.80	2007
		Brindisi	BG	5.80	2008
		Livorno	Endesa, Amga, CrossGas	2.90	2007
		Syracuse	Shell, ERG	5.80	2010
		Rosignano	Edison, Solvay, BP	2.20	N.A.
		Trieste	Gas Natural	5.80	N.A.
		Taranto	Gas Natural	5.80	N.A.
		Monfalcone	Endesa	5.80	N.A.
		Gioia Tauro	CrossGas	N.A.	N.A.
		Taranto	Enel	3.50	N.A.
		Vado Ligure	Enel	3.50	N.A.
		Muggia	Enel	3.50	N.A.
	Spain	Sagunto	Union Fenosa, Iberdrola, Endesa	3.70	2006
		Reganosa	Endesa, Union Fenosa, Sonatrach	2.10	2007
		Gran Canaria	Endessa	N.A.	2008

[Table 6] LNG Receiving Terminals under planning (continued)

Region	Country	Name	Investor(s)	Capacity (MT/y)	Start-up
Europe	U.K.	Milford Haven	Petroplus, BG, Petronas	8.76	2007
		Milford Haven	ExxonMobil, Qatar Petroleum	14.00	2007
		Canvey	Caor Gas, LNG Japan, Centrica、Osaka Gas	4.00	2010
		Teesside	ConocoPhillips	N.A.	N.A.
	Netherlands	Rotterdam	Petroplus	4.40	2009
		Rotterdam	Gasunie/Vopak	4.40	2010
		Eemshaven	ConocoPhillips	N.A.	2010
	Germany	Wilhelmshaven	E.On Ruhrgas	4.40-7.3	2010
	Turkey	Izmir	Colakoglu	4.40	2006
		Ceyhan	N.A.	N.A.	N.A.
	Cyprus	Vasilikos	State Electricity Authority	0.73	2010
	Poland	(Baltic Coast)	PGNiG	2.20-3.7	2010
	Croatia	Krk	E.On Ruhrgas	N.A.	N.A.
	Ukraine	Odessa	Naftogaz Ukrainy	7.00	N.A.
	Latvia	(Baltic Coast)	Itera Latvija	0.37	N.A.
	Litania	N.A.	N.A.	N.A.	N.A.
Asia Oceania	China	Shenzhen, Guangdong	CNOOC, BP etc	3.70-6.7	2006
		Putian, Fujian	CNOOC, Fujian Investment and Development	2.6-5.0	2007
		Qingdao, Shangdong	SINOPEC	3-5	2008
		Shanghai	CNOOC、Shenergy	3-6	2008
		Ningbo, Zhejiang	CNOOC、Zhejiang Energy Group, Ningbo Electric	3-6	2008
		Rudong, Jiangsu	PetroChina	3-4	2008
		Darlian, Liaoning	PetroChina	2-4	2008
		Tiangjing	CNOOC	3.00	2010
		Zhuhai, Guangdong	CNOOC	3.00	2010
		Swatou, Guangdong	CNOOC	2.50	2010
		Guangxi	PetroChina	3.00	2010
		Hong Kong	CLP	3.00	2011
		Yingkou, Liaoning	CNOOC	3.00	N.A.
		Binhai, Jiangsu	CNOOC	3.00	N.A.
	India	Kochi	Petronet	2.50	2009
		Dabhol	Petronet, NTPC, Gail	5.00	2006
		Ennore	IOC, Petronas	5.00	N.A.
		Mangalore	HPCL, Petronet, MRPL	2.50	N.A.
	Pakistan	Karachi	SSGC	2.50	2009
	Japan	Sakai	Sakai LNG	2.70	2006
		Mizushima	Chugoku Electric, Nippon Oil	0.80	2006
		Wakayama	Kansai Electric	N.A.	N.A.
		Joetsu	Chubu Electric, Tohoku Electric	N.A.	N.A.
		Omaezaki	Chubu Gas, Tokai Gas, Suzuyo	N.A.	2010
		Sakaide	Shikoku Electric	0.40	2010
		Yoshinoura	Okinawa Electric	0.70	2010

[Table 6] LNG Receiving Terminals under planning (continued)

Region		Country	Name	Investor(s)	Capacity (MT/y)	Start-up
Oceania	Asia	South Korea	Gunsan	GS Caltex	1.58	2008
		Taiwan	Taichung	CPC	1.68	2007
		Phillipines	Bataan	GN Power	N.A.	N.A.
		Indonesia	Cilegon	PLN	3.00	2007
		Singapore	Singapore	Gas Supply Pte, PowerGas	N.A.	N.A.
		Thailand	Rayong	PTT	5.00	2010
		New Zealand	N.A.	Contact Energy, Genesis Energy	0.90–1.08	2011

Source: Prepared by IEEJ based on various corporate websites, etc.

3.4. Cross participation into the LNG chain

As discussed in the above, there are an increasing number of cases where downstream players such as power and gas utilities are making inroads into liquefaction projects and, at the same time, upstream players such as the majors or trading houses are venturing into receiving terminal projects. In the meantime, many enterprises both in upstream or downstream sectors are building their own LNG tankers.

Upstream players are venturing into downstream businesses with main objectives such as securing market access or quick monetization of their upstream assets. On the other hand, reduction of LNG procurement cost, acquisition of know-how and other information on upstream business, or developing new revenue sources as well as securing supply assurance could be the main motives for the downstream players' foray into upstream businesses.

As for the related efforts by Japanese enterprises, cases of investment into LNG tankers began to appear during 1990s with an escalating trend in recent years. In the area of liquefaction projects, Tokyo Electric and Tokyo Gas are participating in the Darwin LNG project, while Osaka Gas holds an interest in the Greater Sunrise LNG project. Additionally, Tokyo Gas, Osaka Gas, and Chubu Electric are contemplating to invest in the Gorgon LNG project, while Tokyo Gas and Kansai Electric are considering an opportunity in the Pluto LNG project for the future.

4. LNG supply and demand balance

4.1. LNG demand forecasts

Table 7 is a summary of world LNG demand forecasts by IEEJ. The global LNG demand is projected to grow from 131.21 MT[8] in 2004 to a range between 197.1 and 233.5 MT in 2010 and between 302.0 and 396.0 MT in 2020. In terms of regional pictures, the Asian demand would expand from 87.99 MT in 2004 to a level between 170.0 and 124.0 MT in 2010 and between 142.0

[8] A slight disagreement with the figure mentioned earlier in Chapter 2.1 is caused due to data sources and conversion factor used.

and 182.0 MT in 2020. For Europe, the forecast indicates ranges between 50.0 and 62.0 MT in 2010 and between 79.0.0 and 98.0 MT in 2020. For the Americas, demands ranging between 40.1 and 47.5 MT in 2010 and 81.0 and 116.0 MT in 2020 are projected reflecting the sharp increase in LNG imports by the U.S.A. From these pictures, it may be suggested that, by 2010, the combined imports by Europe and the Americas could exceed imports by the Asian region. Moreover, the imports by the U.S.A. could overtake those of Japan by 2020 to replace the position of the world's largest LNG importer.

[Table 7] World LNG Demand Forecasts

(MT)

		2004 Demand	2,010		2,020	
			Low	High	Low	High
Asia	Japan	56.84	61.0	71.0	73.0	91.0
	Korea	22.29	23.0	26.0	26.0	37.0
	Taiwan	6.89	10.0	11.0	12.0	14.0
	India	1.97	8.0	9.0	15.0	17.0
	China	−	5.0	7.0	12.0	17.0
	Other	−	−	−	4.0	6.0
	Sub Total	87.99	107.0	124.0	142.0	182.0
Europe	France	7.87	8.0	10.0	10.0	14.0
	Italy	14.90	8.0	10.0	13.0	19.0
	Spain	13.81	19.0	22.0	28.0	30.0
	UK	−	6.0	9.0	15.0	20.0
	Other	6.57	9.0	11.0	13.0	15.0
	Sub Total	29.74	50.0	62.0	79.0	98.0
Americas	US	12.93	37.0	42.0	64.0	91.0
	Canada	−	−	−	6.0	9.0
	Mexico	−	2.5	3.5	8.0	11.0
	Other	0.55	0.6	2.0	3.0	5.0
	Sub Total	13.48	40.1	47.5	81.0	116.0
Total		131.21	197.1	233.5	302.0	396.0

Source: IEEJ

4.2. LNG supply potentials

While Table 2 earlier presented the LNG production capacities as of 2005, for the purpose of an exercise in this section to examine LNG supply potentials, the latest set of available data for demand and production capacity for 2004 is referenced. The world LNG production capacity at the end of 2004 stood at 147.2 MT/year, of which the production capacity in Africa and Latin America for a total of 43.2 MT/year was directed mainly to the Atlantic market. The remaining production capacity in Asia Pacific, North America, and the Middle East for an aggregated total of 104.0 MT/year is directed mainly to the Asian Market, although 5.34 MT was shipped to the

Atlantic market in 2004. Regarding Indonesian export amount as its capacity since Indonesia decreases LNG export significantly, it can be concluded that a production capacity of 91.6 MT was available for the Asian market in 2004 (see Table 8).

Concerning the future outlook, new liquefaction capacities with signed SPAs or HOAs are expected to become operational to bring the production capacity available for the Asian market to a total of 132.51 MT by 2010. The foregoing number, however, excludes production from the Australian Pluto LNG project which already has HOAs concluded but is planned for commissioning only at the end of 2010. For the period after 2011, in addition to the Pluto project, other projects without SPAs or HOAs are anticipated to come on stream. Current assumptions are that, out of such projects 73.65 MT/year would become available for the Asian market. Therefore, the potential supply availability for Asia in 2020 is estimated at 213.16 MT/year.

[Table 8] LNG Supply Availability for Asian Market

		Capacity (MT/y)			Capacity (MT/y)
2004	Asia Pacific	63.34	2008	Asia Pacific	79.29
	North America	1.10		North America	1.10
	Middle East	32.50		Middle East	63.95
	Sub Total	96.94		Sub Total	144.34
	For Europe, North America	5.34		For Europe, North America	39.08
	For Asia	91.60		For Asia	105.26
2005	Asia Pacific	63.92	2009	Asia Pacific	95.99
	North America	1.10		North America	1.10
	Middle East	37.40		Middle East	39.42
	Sub Total	102.42		Sub Total	136.51
	For Europe, North America	7.93		For Europe, North America	50.58
	For Asia	94.49		For Asia	85.93
2006	Asia Pacific	69.60	2010	Asia Pacific	105.99
	North America	1.10		Middle East	92.10
	Middle East	41.70		Sub Total	198.09
	Sub Total	112.40		For Europe, North America	65.58
	For Europe, North America	9.18		For Asia	132.51
	For Asia	103.22	Planning	Asia Pacific	37.65
2007	Asia Pacific	71.10		Middle East	42.00
	North America	1.10		Sub Total	79.65
	Middle East	42.88		For Europe, North America	6.00
	Sub Total	115.08		For Asia	73.65
	For Europe, North America	12.48	Supply Potentical for Asia in 2020 (Existing+SPA・HOA Signed+Planning)		213.16
	For Asia	102.60			

Source: Prepared by IEEJ based on various corporate websites, etc.

From Table 8, it can be seen that a sharp increase is forecast for supplies to the European and the U.S. markets originating from the Asia-Pacific and the Middle Eastern regions which traditionally have shipped most of LNG to the Asian market. While the volume supplied to the

European and the U.S. markets from the Asia-Pacific and the Middle Eastern regions was just 5.34 MT in 2004, assuming the volumes on contract are equal to the volumes to be shipped, such supply is estimated to reach 65.58 MT[9] in 2010. Such a substantial increase means that a new LNG flow from the Asia-Pacific and the Middle Eastern regions into Europe and the U.S.A. will be generated, leading to globalization of the LNG market[10].

4.3. LNG supply demand balance for Asia

Based on the LNG demand forecasts and supply potentials discussed above, supply demand balance for Asia can be overviewed. To reiterate the figures shown in Table 7, the actual Asian import demand in 2004 was 87.99 MT and the forecast demands are between 107 MT and 124 MT for 2010 and between 142 MT and 182 MT for 2020 (see Figure 8).

Meanwhile, LNG production capacity available for Asia, which is estimated at 91.60 MT as of 2004, is projected to increase to 132.51 MT by 2010, which is a sum total of existing projects, projects already under construction, and those having signed SPAs or HOAs and therefore high likelihood of materialization. In the graph shown below, the dotted portion of the bars indicates the capacities coming out of those projects without SPAs or HOAs listed in Table 4. Further, with regard to the production capacity in 2020, a combined annual production of 7.6 MT from Indonesia's Arun project and Alaska's Kenai project is excluded since these sites already show signs of depletion.

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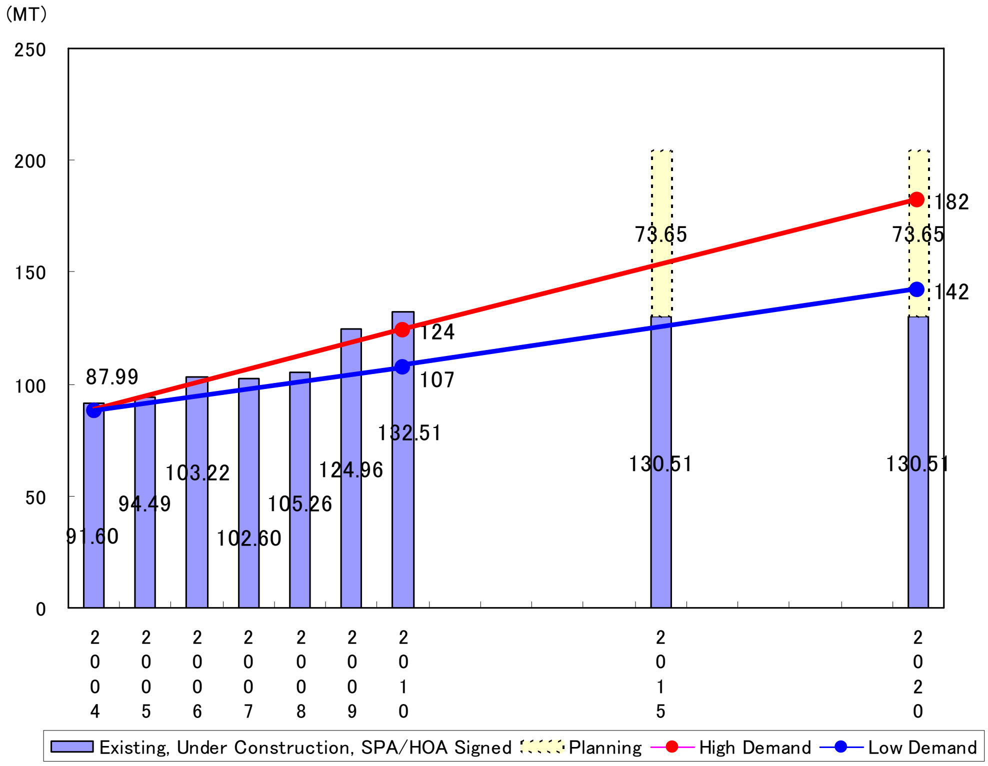
9 Of this, 7.80 MT would be expected from Asia-Pacific, and 57.78 MT from the Middle East.
10 Globalization of LNG market is dealt with later in Chapter 5.

[Figure 8] LNG Supply and Demand Outlook for Asia



Source: IEEJ

For projected demand in 2010, existing projects as well as projects with signed SPAs or HOAs could satisfy. However, as some of the new projects delay, the supply and demand balance through 2010 is expected to remain relatively tight. Thus, some importers may attempt to keep supply and demand in balance by procuring supplementary spot LNG cargoes. For projected demand in 2020, some projects under planning need to be on stream to add capacity of somewhere between 11.49 MT and 51.49 MT.

The supply and demand balance after 2010 would be significantly influenced by the magnitude of demand growths in emerging markets in addition to demand trends within the Asian region. Among LNG contracts for emerging markets, many of those destined for China or India reportedly have a pricing reference linked to the crude oil prces. If the crude oil prices remain at the current high level, the growth in LNG demand in these countries may be significantly restricted due to a widening price gap with coal as the main competing fuel. In that event, the extent of demand increase in the U.S.A. and the UK as the main markets for the new projects in Qatar will have a rather large influence on the supply and demand balance in Asia after 2010.

5. Globalization of LNG market

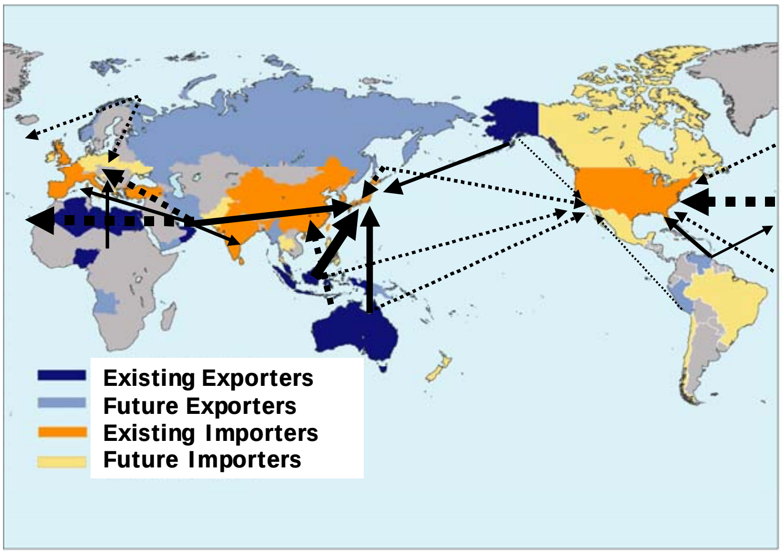
In the present LNG market, the bulk of trades are intra-regional in that they are confined to the inside of either the Asia-Pacific market or the Atlantic market. As discussed before, different pricing mechanisms coexist as well. In this context, the LNG market is not globalized to the same extent as the oil market. However, there are factors strongly suggesting that the globalizing trend in the LNG market may intensify from now on, both in terms of geographical and trading aspects as described below:

(i) Geographical aspect:

As of 2005, there are 13 exporting countries and 14 importing countries for LNG throughout the world. As already discussed, LNG demand has a potential of growing to two to three times the present size by 2020, with a number of countries considering to start either importing or exporting LNG.

Looking at the details of such a growth in the LNG market, it is noted that while the Middle East region is currently supplying LNG mainly to the Asian market, a sizable flow of LNG from the region to North America as well as Europe will emerge by 2010. Since the Middle Eastern suppliers are located in a geographic position allowing them to conveniently allot shipments to Asian, European, or the North American markets, and also as a significant increase in LNG production is projected for the Middle East led by Qatar, the globalizing trend for LNG trades seems to accelerate (see Figure 9).

[Figure 9] Diversifying LNG Flows



Source: IEEJ

(ii) Trading aspect:

LNG flows being globalized, price linkage between the Atlantic market and the Asia-Pacific market is becoming stronger through spot transactions. When consumers in the Asian market procure spot LNG cargoes, the Henry Hub price often seems to provide the reference nowadays. For the Asian market, while the conventional long term contracts covering two-point deals are likely to stay as the main form, non-conventional LNG trades based on spot, swap, or back-haul transactions may also be practiced to some degree.

(iii) Factors to be considered in globalization:

However, the foregoing does not guarantee that globalization of the LNG market will progress without hurdles. In addition to constraints such as the high cost of LNG transportation or destination clauses, there are two major factors to be taken into consideration in LNG market globalization.

First, there is an issue of LNG heat content that varies from project to project. While mainly high heat content LNG is currently being supplied to Asian destinations, since natural gas having low heat content is used in the Atlantic market, the liquefaction plants planned for Europe and U.S.A. are designed to produce LNG of lower heat content. When separate grades of LNG having widely differing heat content are received into an LNG storage tank, there is a potential risk of a phenomenon called rollover[11]. Further, after receiving LNG with varying characteristics, steps must be taken to ensure combustion performance at the end-user appliances or compatibility in the distribution systems. For the Japanese receiving terminals, the calorific adjustment is not a major issue since most of them are equipped with LPG injection system to enrich gases. However, in South Korea or Taiwan, where no LPG injection system available, it becomes necessary to either newly install such systems or deal with the fluctuation in heat content at distribution or consuming stages. Conversely, when high heat content LNG is brought into Europe or in the U.S.A., the receiving terminals may need to take steps such as nitrogen injection or blending with natural gas having low calorific value. Such adjustments would naturally increase cost.

The second point of consideration is the compatibility between LNG tankers and receiving terminals. Today’s standard size LNG tankers having capacities approximately ranging from 130,000 to 150,000m^3 can be received at most import

11 An abnormal generation of boil-off gas that can occur when two separate layers of different densities (due to different LNG compositions) exist in a tank under specific conditions.

terminals of the world. However, the so-called Q-Flex or Q-Max vessels that Qatar is pioneering with capacities of 200,000 to 250,000 m^3 can only be received by a particular range of import terminals in the U.S. or European markets and hardly any other ports can receive them so far. While some Asian importers are considering the possibility of receiving Q-Flex vessels, as far as Japan is concerned, it will require development and expansion of port infrastructures as well as coordination and collaboration with the administrative authorities concerned.

6. LNG supply security for Asia

As is the case with oil, the issue of how supply security should be safeguarded for LNG has also been attracting the attention of Asian consumers in recent years. Ensuring LNG supply security is crucially important for the majority of Asian countries which, unlike their European or American counterparts, are relying most of natural gas supplies on imported LNG. In the backdrop of the above concern is perceived tightness in the short-term LNG supply and demand status created as a result of Indonesia’s cut-backs on the contractual export volume, a high incidence of LNG plant troubles, or delays in new project development. Furthermore, there is a concern that the intensifying resource nationalism may hinder investments into gas field developments or liquefaction plants for the middle to long term future.

Under such circumstances, a variety of measures for ensuring supply security are being considered. In this regard, it is important to keep in mind that supply security not only means to ensure physical supply availability alone but it must also accompany economic sense with it. In other words, even if LNG is physically secured, and if it does not come with adequate economic performance, it will affect competitiveness of the importer and/or the consumer, and eventually hurt the industrial competitiveness of the consuming country.

The LNG chain involves phases such as exploration and development, production and liquefaction, transportation, receiving and regasification, and marketing and distribution. It is therefore essential to recognize that a range of security measures exist at each stage.

For upstream phases of exploration and development, or production and liquefaction, the most fundamental measure for ensuring physical supply security is to diversify supply sources to the furthest extent possible. Such a measure is crucial as a national energy policy and also as a procurement strategy for each business entity. Spurred perhaps by China and India which are vigorously competing for acquiring upstream oil assets abroad, there is a view that acquisition of an upstream interest in gas fields or liquefaction plants is vital from the energy policy grounds. Such a measure could contribute to enhancing physical supply security, in that investment in the upstream sector could provide the driving force for project startup. However, in the event that physical supply availability is interrupted by causes such as war, it is questionable if an upstream interest held by an entity in a consuming country could directly contribute to remedy in such a situation. Furthermore, there is no guarantee that a project developed with an acquired upstream right is always cost competitive. Accordingly, it should be recognized that acquisition of an upstream interest does not necessarily lead to securing physical supply availability with adequate economic performance. In the area of trade arrangements, it goes without saying that securing a long-term supply agreement is far more advantageous than relying on spot deals, not only for physical supply security but also from an economic viewpoint in the present situation.

For the transportation phase of the LNG chain, conceivable measures for improving supply security include cooperation between sellers and buyers or among buyers in areas such as shipping schedule coordination and vessel availability optimization, or efforts toward relaxation of contractual destination clauses. These practices have already been implemented and proved very effective as security measures, although they are by nature the matters to be dealt with among project operators. Also, if it is possible to own or charter an LNG tanker for free disposal, it will lead to acquiring mobility in the LNG procurement such as taking deliveries of spot LNG cargoes at the buyer’s own discretion.

For phases after receiving terminals, development of infrastructure such as pipelines to connect receiving terminals or expansion of storage tanks should be promoted while keeping economics in balance. As a means for the final phase in the LNG chain, an issue to be considered by each entity may be a possibility of devising an interruptible contract system between the importer and the end-user. Furthermore, human resources development focused on engineers and seamen to work in the LNG chain is also required as these workers are at present in short supply. In the area of diversification in the supply arrangements, an international gas pipeline may also have to be considered as a potential avenue. As discussed in the above, measures for safeguarding security are wide-ranging and it is important to assess the conditions under which each means can be effective together with associated costs.

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