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The Global Liquefied Natural Gas Market: Status & Outlook

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AL ZUBARAH
L N G

Preface

Liquefied natural gas (LNG) is expected to play an increasingly important role in the natural gas industry and global energy markets in the next several years. The combination of higher natural gas prices, lower LNG costs, rising gas import demand, and the desire of gas producers to monetize their gas reserves is setting the stage for increased global LNG trade. *The Global Liquefied Natural Gas Market: Status & Outlook* was undertaken to characterize the global LNG market and to examine recent trends and future prospects in the LNG market.

A variety of information and data was used in the compilation of this report. Sources included U.S. government sources (EIA and the U.S. Department of Energy Office of Fossil Energy); intergovernmental sources (the International Energy Agency); private sources (Petrostrategies, LNG Shipping Solutions, the Oil and Gas Journal, the International Institute of Energy Economics, BP, the LNG Express, the Groupe International des Importateurs de Gaz Natural Liquefie, and Cedigaz); and industry trade reports. The global nature of the LNG market is such that no single information source provides a complete and thorough characterization. Information sources are listed throughout the report.

Contents

Overview

The global liquefied natural gas (LNG) market is small but growing rapidly…

- The combination of higher natural gas prices, lower LNG production costs, rising gas import demand, especially in North America, and the desire of gas producers to monetize their gas reserves is setting the stage for increased LNG trade in the years ahead.
- In 2002, 12 countries shipped 5.4 trillion cubic feet (Tcf) of natural gas, which is equivalent to 113 million metric tons of LNG – up from 9 exporting countries shipping less than 4 Tcf (84 million metric tons) in 1997.
- Global LNG liquefaction capacity is expected to increase from 6.6 Tcf (139 million metric tons) per year in 2003 to 9.4 Tcf (197 million metric tons) per year in 2007, based on facilities currently under construction.
- The continental United States imported approximately 229 billion cubic feet (Bcf) (4.8 million metric tons) of LNG in 2002, accounting for 4 percent of world LNG trade. U.S. LNG imports in 2003 are expected to more than double, to about 540 Bcf (11 million metric tons), about 2 percent of U.S. natural gas consumption.
- According to Energy Information Administration forecasts, U.S. LNG imports are projected to increase to more than 2.2 Tcf (46 million metric tons), 8 percent of U.S. natural gas consumption, in 2010.
- As of late 2003, there were 151 LNG tankers in the world LNG fleet with 55 tankers under construction. The addition of new ships to the fleet will raise total fleet capacity 44 percent from 17.4 million cubic meters of liquid (equivalent to 366 Bcf of natural gas) in October 2003 to 25.1 million cubic meters of liquid (equivalent to 527 Bcf of natural gas) in 2006.

New producers and consumers are making LNG markets more diverse…

- In 1990, Japan received 66 percent of world LNG imports; however, Japan's share declined to 48 percent in 2002, reflecting the global expansion of the LNG market. At the same time, shipments received in the Atlantic Basin rose 120 percent, increasing its share of the global market to 32 percent in 2002.
- In addition to expansions by current LNG exporters, three countries – Egypt, Norway, and Russia – are poised to become LNG exporting countries, as they are currently constructing their first LNG liquefaction plants.

- At least seven additional countries – Angola, Bolivia, Equatorial Guinea, Iran, Peru, Venezuela, and Yemen – are in the planning stages for their first LNG liquefaction plants.
- In addition to expansions by existing importers, three countries – China, India, and the United Kingdom – are poised to become LNG importing countries, as they are currently constructing new regasification terminals.
- At least seven countries – the Bahamas, Jamaica, Indonesia, Mexico, the Netherlands, New Zealand, and the Philippines – are in the planning stages for their first regasification terminals.

Changes in the LNG market are promoting growth…

- The LNG market is driven by long-term contracts, but these contracts have been growing increasingly flexible in recent years.
- Some newer long-term contracts are designed to provide only a base supply of LNG, which can be supplemented by short-term contracts during periods of high demand.
- Short-term trading has grown from 1 percent of the LNG market in 1992 to 8 percent (400 Bcf or 8.4 million metric tons) in 2002. Short-term trading will continue to grow, especially in the Atlantic Basin, and could reach 15 to 20 percent of the LNG market over the next decade.
- Costs of liquefying, transporting, and regasifying LNG have fallen significantly over the past 20 years.

What is Liquefied Natural Gas?

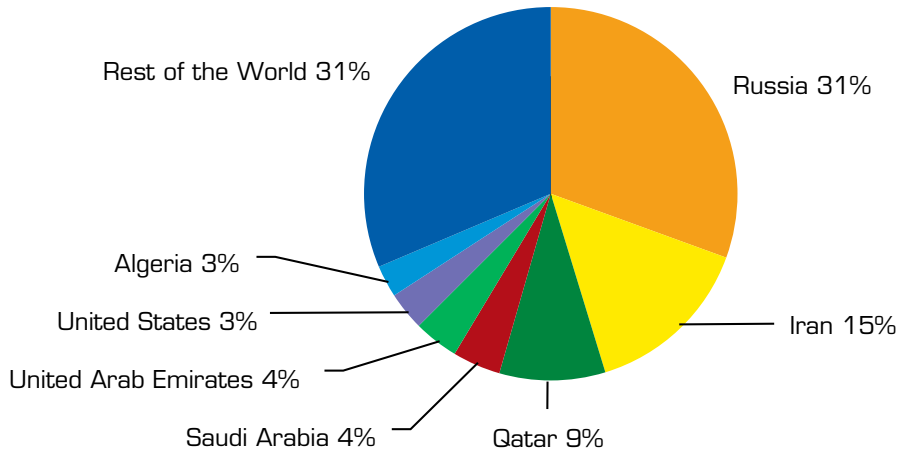
- Liquefied natural gas (LNG) is natural gas that is stored and transported in liquid form at atmospheric pressure at a temperature of –260° F. Like the natural gas that is delivered by pipeline into homes and businesses, it mainly consists of methane (CH_4).
- Liquefying natural gas provides a means of moving it long distances when pipeline transport is not feasible.
- Natural gas is turned into a liquid using a refrigeration process in a liquefaction plant. The unit where LNG is produced is called a train. Liquefying natural gas reduces its volume by a factor of 610. The reduction in volume makes the gas practical to transport and store.
- Generally, LNG is measured in metric tons when it is a liquid, and in cubic feet when it is in its gaseous state.[1]
- In international trade, LNG is transported in specially built tanks in double-hulled ships to a receiving terminal where it is stored in heavily insulated tanks. The LNG is then sent to regasifiers which turn the liquid back into a gas that enters the pipeline system for distribution to customers as part of their natural gas supply.
- On a smaller scale, LNG may also be produced by liquefying gas taken from a pipeline, storing it, and then regasifying it for pipeline distribution to customers when demand is high, such as on cold winter days. These small regasification plants are often called "peakshaving plants." Alternatively, the LNG may be transported in special tanker trucks to small facilities where it is stored and regasified as needed. Such facilities are called "satellite plants." The United States has about 100 LNG satellite and peakshaving plants throughout the country.
- As a part of safety engineering, all LNG facilities are designed to prevent fires and contain the LNG in the event of a spill. In the United States, these facilities must conform to standards set by the United States Department of Transportation, the United States Coast Guard, the Federal Energy Regulatory Commission, the National Fire Protection Association, State utility commissions, port authorities, and other local agencies.

[1] Throughout this document, measurements will be given in cubic feet of natural gas and metric tons of LNG. Usage of the word 'ton' for the remainder of this document denotes metric ton.

Abundant World Natural Gas Reserves and LNG Potential

- World natural gas reserves are abundant, estimated at about 5,500 trillion cubic feet (Tcf), or 60 times the volume of natural gas used in 2003. Much of this gas is considered "stranded" because it is located in regions distant from consuming markets.
- Russia, Iran, and Qatar combined hold natural gas reserves representing more than 50 percent of the world total.
- The 12 countries that currently export LNG have approximately 28 percent of world natural gas reserves.
- Three countries with 33 percent of the world's reserves are currently building their first liquefaction facilities.
- At least seven additional countries, with 19 percent of the world's reserves, are potential LNG exporters.
- According to an industry LNG consultant,[2] the economic crossover — the point at which transporting LNG via tanker is cheaper than transporting natural gas via pipelines — occurs at a distance of around 2,000 kilometers (1,250 miles) for offshore pipelines and around 3,800 kilometers (2,375 miles) for onshore pipelines.

Proved World Natural Gas Reserves, January 1, 2003



Source: *Oil & Gas Journal,* December 23, 2002

[2] Andy Flower, President, Andy Flower LNG Associates

Natural Gas Reserves by Country

Country	Proved Reserves End 1/1/2003 (Tcf)	Percent of World Reserves
TOTAL WORLD	**5501.4**	**100.0%**
Select Countries	**5097.4**	**92.7%**
Russia	1680.0	30.5%
Iran	812.3	14.8%
Qatar	508.5	9.2%
Saudi Arabia	224.7	4.1%
United Arab Emirates	212.1	3.9%
United States	183.5	3.3%
Algeria	159.7	2.9%
Venezuela	148.0	2.7%
Nigeria	124.0	2.3%
Iraq	109.8	2.0%
Indonesia	92.5	1.7%
Australia	90.0	1.6%
Norway	77.3	1.4%
Malaysia	75.0	1.4%
Turkmenistan	71.0	1.3%
Uzbekistan	66.2	1.2%
Kazakhstan	65.0	1.2%
Netherlands	62.0	1.1%
Canada	60.1	1.1%
Egypt	58.5	1.1%
China	53.3	1.0%
Libya	46.4	0.8%
Oman	29.3	0.5%
Bolivia	24.0	0.4%
Tinidad/Tobago	23.5	0.4%
Yemen	16.9	0.3%
Brunei	13.8	0.3%
Peru	8.7	0.2%
Equitorial Guinea	1.3	0.0%
Angola	0.0	0.0%
Rest of World	**404.1**	**7.3%**

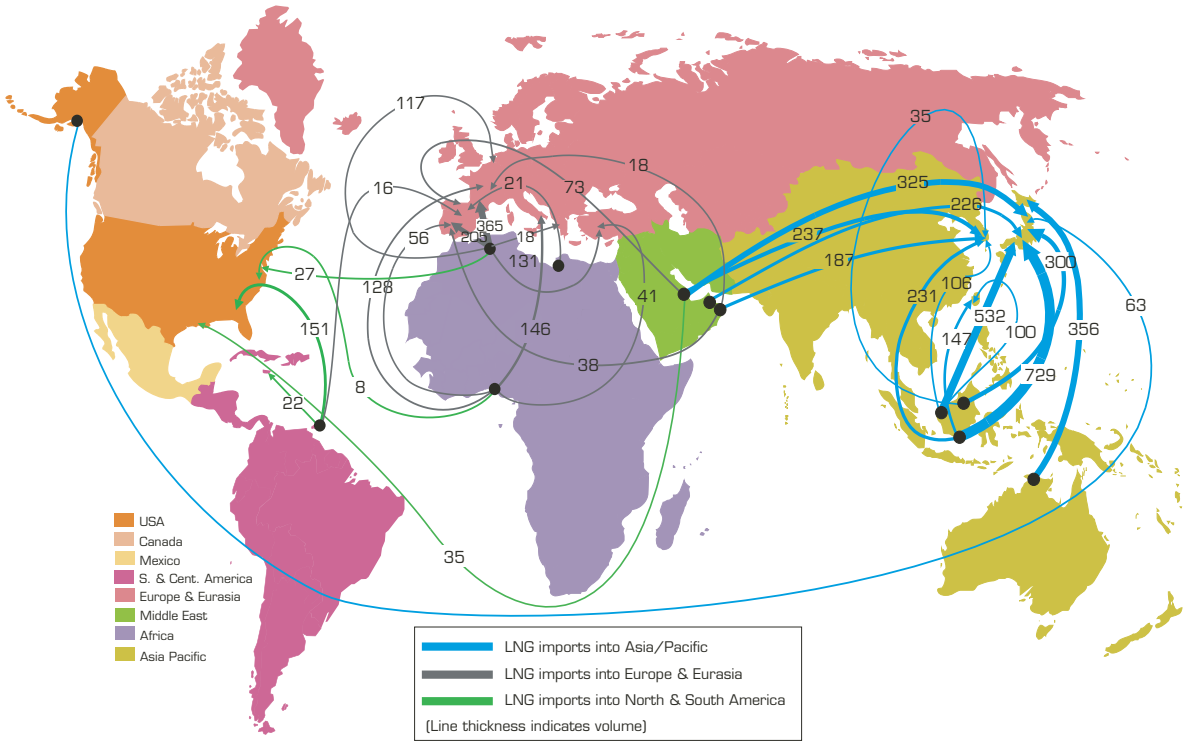
Countries in green are current LNG Exporters. Countries in blue are potential future LNG Exporters.

Source: *Oil & Gas Journal*, December 23, 2002

Growing World LNG Trade

- In 2002, 12 countries shipped 5.4 Tcf of natural gas (113 million tons of LNG) to 12 LNG-importing countries – up from less than 4 Tcf (84 million tons) shipped in 1997.
- Growth of world LNG trade is driven by increasing demand and declining domestic natural gas resources in gas-consuming countries, and by the desire of gas-producing countries to commercialize their resources.

Major LNG Trade Movements, 2002 *(Billion cubic feet)*



Note: The map includes flows greater than 5 Bcf for imports into the United States, and flows greater than 15 Bcf for imports into all other Countries.

Source: **Imports to the United States and Imports to Japan and Mexico from the United States:** Energy Information Administration, *Natural Gas Monthly* (May 2003). **All Other Countries:** Organization for Economic Cooperation and Development, International Energy Agency, Natural Gas Information 2003 (with 2002 data).

- LNG trade accounted for about 6 percent of world natural gas consumption and about 26 percent of total international natural gas trade in 2002.
- In 2002, 8 percent of LNG trade (400 Bcf or 8.4 million tons) was through short-term[3] sales driven by high demand in Europe and South Korea.
- Despite an increase in short-term agreements, the vast majority of LNG is still traded through long-term contracts.
- LNG's share of each importing country's gas supply ranges from 2 percent in the United States to nearly 100 percent in Japan.

[3] In this report, "short-term" refers to a period of less than 12 months.

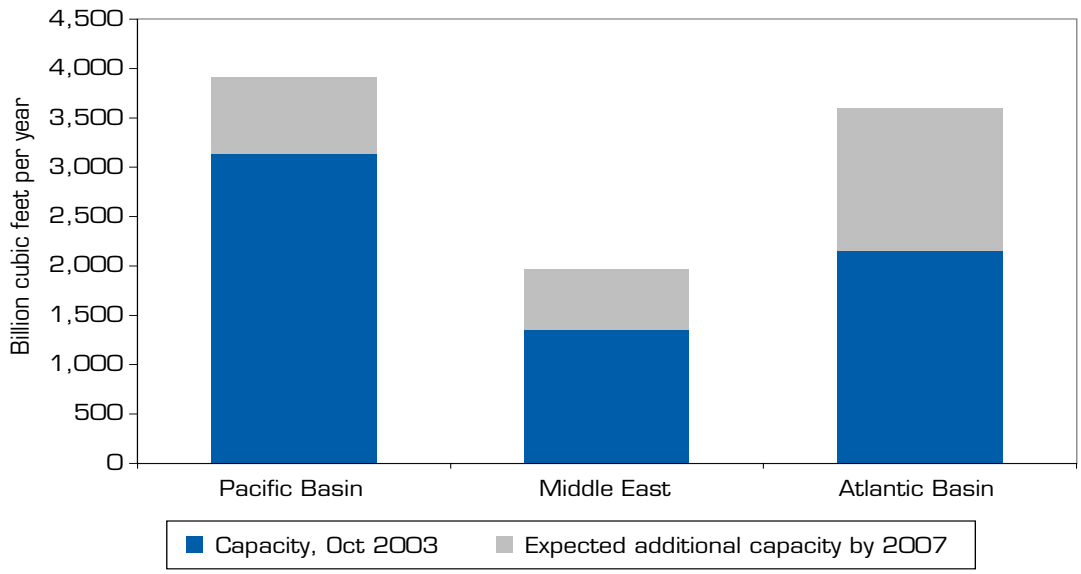
LNG Exporters

- In 2002, 12 countries exported 5.4 Tcf (113 million tons) of natural gas as LNG, up from 9 countries and almost 4 Tcf (84 million tons) in 1997.
- Indonesia is the world's largest LNG producer, exporting about one-fifth of the world's total volume in 2002.
- The Pacific Basin[4] is the largest LNG-producing region in the world, supplying nearly half (49%) of all global exports in 2002. Indonesia alone supplied 21 percent. Countries in the Middle East, led by Qatar, exported 23 percent, while countries in the Atlantic Basin, led by Algeria, exported about 29 percent that year.
- In the first nine months of 2003, two new LNG trains began operating in Trinidad and Tobago and in Malaysia, increasing world annual liquefaction capacity[5] by around 6 percent to 6.6 Tcf (135 million tons).
- New projects under construction in Australia, Russia, Norway, and Egypt, together with expansions of existing facilities throughout the world, will increase annual liquefaction capacity by 2.8 Tcf (58 million tons) by 2007, increasing global capacity to 9.4 Tcf (197 million tons) per year, which represents 10 percent of 2002 global natural gas consumption.
- Potential new exporters such as Iran, Yemen, Equatorial Guinea, Angola, Venezuela, Bolivia (via Peru or Chile), and Peru are looking to LNG exports as a way of monetizing their natural gas resources.

[4] Throughout this report the term "Pacific Basin" will be used to describe LNG activity along the Pacific Rim (including Alaska) and in South Asia (including India). The term "Atlantic Basin" will include all activity in Europe, Africa (including North and West Africa), and the Western Hemisphere (not including the Alaskan terminal on the Pacific Ocean).

[5] See Appendix B for a discussion of measuring liquefaction capacity.

Global LNG Liquefaction Capacity, October 2003



Data from IEA 2003 *Natural Gas Information,* and updated based on trade press reports as assembled by the Gas Technology Institute.

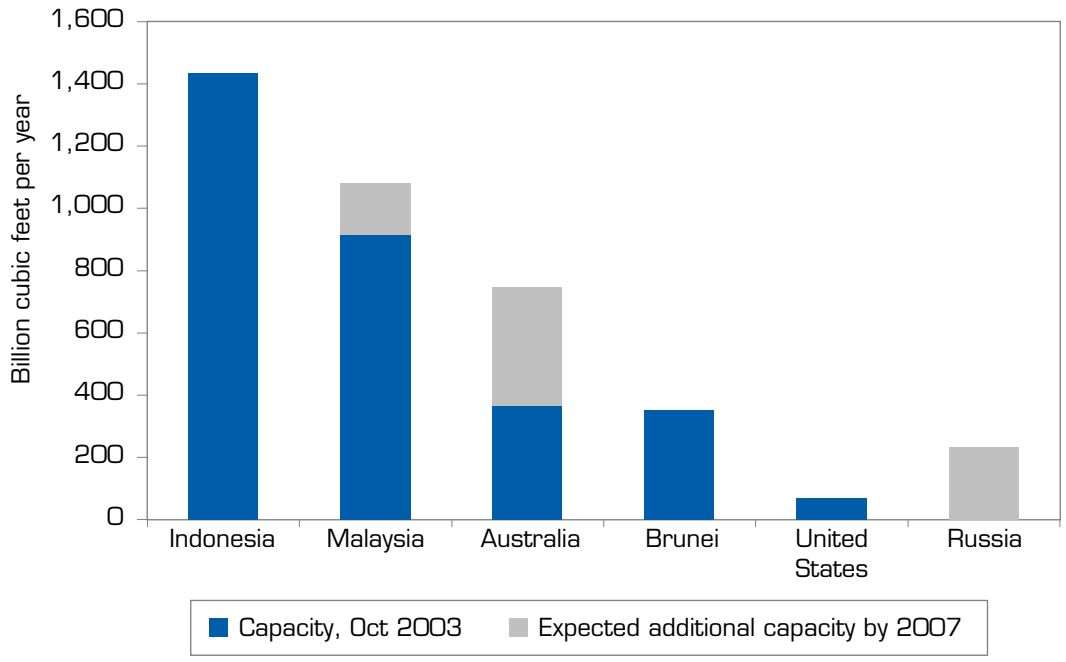
Pacific Basin Exporters

Pacific Basin LNG exporters produced 2.6 Tcf (55 million tons) in 2002, about 49 percent of total world LNG production. As of late 2003, five Pacific Basin exporters had 3.1 Tcf (63 million tons) of annual liquefaction capacity. Liquefaction capacity in the Pacific Basin is expected to increase by 780 billion cubic feet (Bcf) or 16 million tons of annual capacity over the next few years to more than 3.8 Tcf (80 million tons) per year by 2007.

- **Indonesia** is the world's largest LNG producer and exporter. In 2002, Indonesia exported 1.1 Tcf (23 million tons) of LNG or 21 percent of the world's total LNG exports. Most of Indonesia's LNG is imported by Japan with smaller volumes going to Taiwan and South Korea. Indonesia's annual liquefaction capacity is 1.4 Tcf (30 million tons) from the two exporting complexes at Bontang and Arun. An additional train at Bontang is under consideration but has yet to contract for the capacity. BP is leading development of a two-train, 341-Bcf-per-year (7.0-million-tpy) project at Tangguh scheduled to start up in 2007. The Tangguh LNG is destined for China, other Asian markets, and potentially the United States.
- **Malaysia**, the world's third largest LNG exporter after Indonesia and Algeria, exported 741 Bcf (15.6 million tons) in 2002. These exports went primarily to Japan, with smaller volumes to Taiwan and South Korea. Three liquefaction terminals have been developed at the Bintulu LNG complex in Sarawak, Malaysia Satu, Dua, and Malaysia Tiga, the first train of which went on-stream in mid-2003. A second train will come online in November 2003, raising the total capacity of the Bintulu complex to an annual 1.1 Tcf (22.7 million tons).
- **Australia** exported 367 Bcf (7.7 million tons) of LNG from the Northwest Shelf project in 2002, primarily to Japanese utilities. The project owners have started construction on an additional 205-Bcf-per-year (4.2-million-tpy) train scheduled to come online in 2004. An additional train is under consideration. Three new projects are also in various stages of development. ConocoPhillips has begun construction on a 175-Bcf-per-year (3.6-million-tpy) Darwin LNG project, to monetize reserves in the Timor Sea shared by Australia and East Timor. ConocoPhillips is also working with Shell, Osaka Gas, and Woodside Petroleum to develop the 258-Bcf-per-year (5.3-million-tpy) Greater Sunrise project via a floating LNG facility. ChevronTexaco, in partnership with ExxonMobil and Shell, is spearheading a two-train Gorgon project with an annual capacity of 487 Bcf (10.0 million tons) to monetize reserves discovered offshore Northwest Australia.

- **Brunei Darussalam** has a two-train liquefaction terminal at Lumut with an annual capacity of 351 Bcf (7.2 million tons). About 90 percent of its output goes to customers in Japan and the remaining 10 percent to South Korea.
- The **United States** has a 68-Bcf-per-year (1.4-million-tpy) liquefaction terminal at Kenai, Alaska, that has been exporting LNG to Japan for more than 30 years. There are currently no plans to expand this facility.
- **Russia**'s first LNG plant is under construction on Sakhalin Island off Russia's east coast. The two-train facility will have an annual capacity of 466 Bcf (9.6 million tons), with exports of 234 Bcf (4.8 million tons) per year from the first train scheduled to begin in 2007. The partners have already secured sales contracts with three Japanese utilities for 136 Bcf (2.8 million tons) per year over 20 years. There are reports that Russian officials have also expressed interest in exporting LNG from the giant Shtokman field in the Barents Sea to the United States and elsewhere.

Pacific Basin Liquefaction Capacity, October 2003



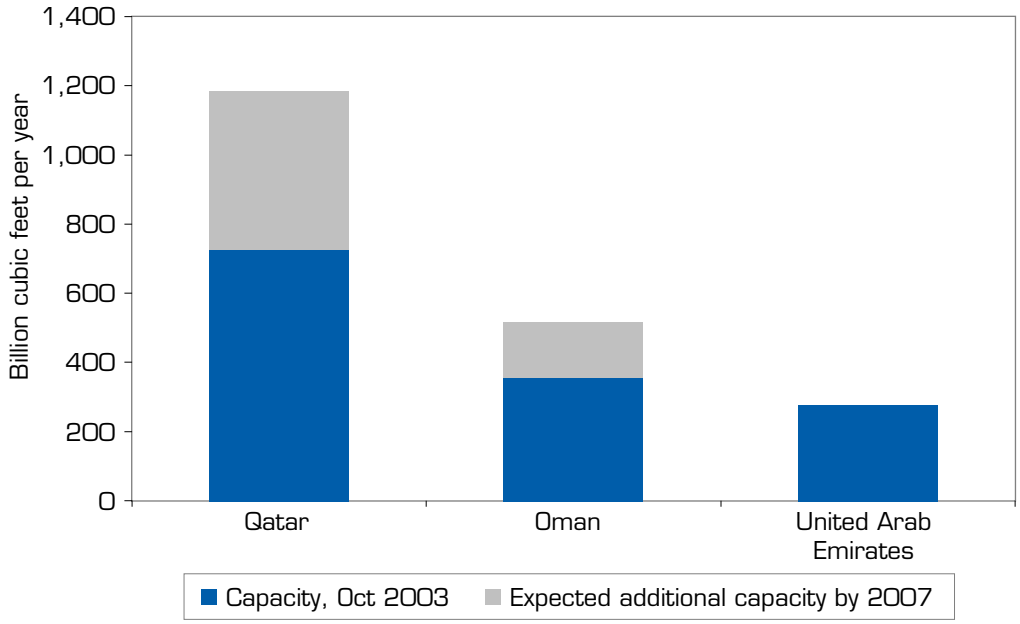
Data from IEA 2003 *Natural Gas Information,* and updated based on trade press reports as assembled by the Gas Technology Institute.

Middle East Exporters

Exporters from the Middle East produced 1.2 Tcf (25 million tons) in 2002, about 23 percent of total world LNG production. As of late 2003, the three Middle Eastern exporters had 1.4 Tcf (29 million tons) of annual capacity. Expansions to facilities in Qatar and Oman will add 619 Bcf (13 million tons) of annual liquefaction capacity, increasing Middle East capacity to 2.0 Tcf (42 million tons) per year by 2007.

- **Qatar** ranks fourth in world LNG exports and has an annual capacity of 726 Bcf (14.9 million tons) from two liquefaction plants owned by the Qatargas and Ras Laffan LNG (RasGas) consortia. The Qatargas plant is being debottlenecked, and two more trains are being added to the RasGas facility, which would add 458 Bcf (9.4 million tons) of annual capacity by 2005. Most of Qatar's exports go to customers in Japan and South Korea, but short-term cargos have also been shipped to the United States and Europe. Its enormous natural gas reserves and low upstream production costs give Qatar the potential to significantly expand its LNG exports to a targeted annual capacity of 2.9 Tcf (60 million tons) by 2015.
- **Oman** has one LNG export terminal, which began operation in 2000 with two liquefaction trains and an annual capacity of 356 Bcf (7.3 million tons). Most of the LNG is sold to South Korea's Kogas. Smaller volumes are shipped to customers in Japan, the United States, and Europe. A planned third train would add 161 Bcf (3.3 million tons) per year in 2006. Further expansion potential for LNG exports from Oman is limited by the modest size of the country's reserves.
- The **United Arab Emirates** (UAE) has the world's fifth largest natural gas reserves and ranks ninth in LNG exports. Abu Dhabi Gas Liquefaction Co. operates the nation's only export facility with a capacity of 278 Bcf (5.7 million tons). Roughly 90 percent of UAE LNG production is exported to Japan. Despite its large reserves, the UAE is unlikely to expand its production of LNG since it uses much of the gas for domestic purposes.

Middle East Liquefaction Capacity, October 2003



Data from IEA 2003 *Natural Gas Information*, and updated based on trade press reports as assembled by the Gas Technology Institute.

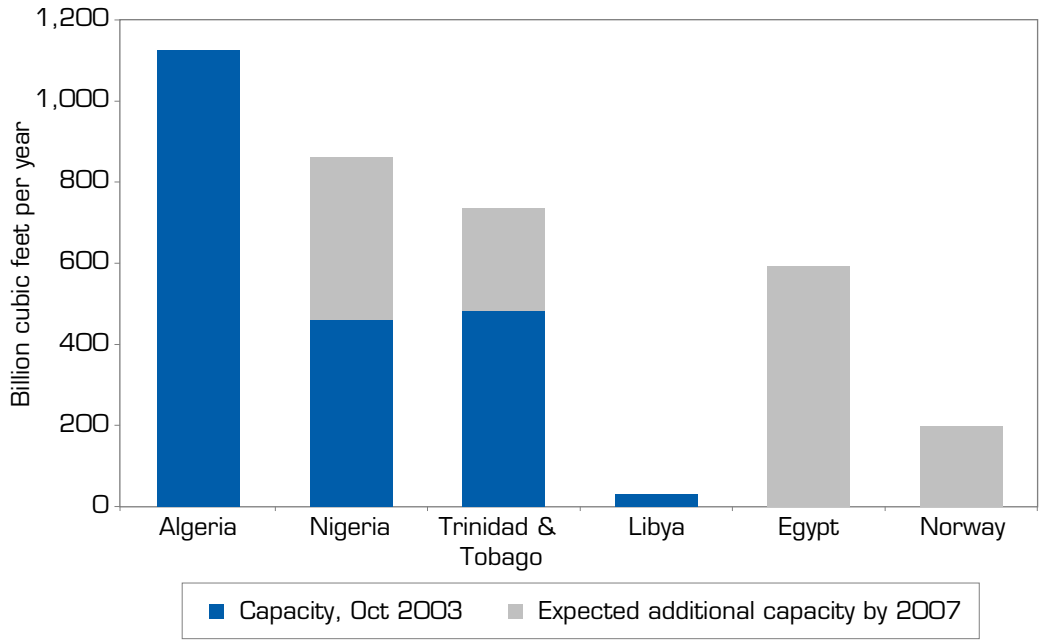
Atlantic Basin Exporters

Atlantic Basin exporters produced 1.5 Tcf (32 million tons) in 2002, about 29 percent of total world LNG production. As of late 2003, Atlantic Basin LNG producers had 2.1 Tcf (43 million tons) of annual capacity. Expansions in Nigeria and Trinidad and Tobago, as well as new facilities in Egypt and Norway, would increase annual Atlantic Basin liquefaction capacity to 3.3 Tcf (73 million tons) by 2007.

- **Algeria** was the second largest LNG exporter in 2002, shipping 935 Bcf (19.6 million tons) mainly to Europe (France, Belgium, Spain, and Turkey) and the United States. A major renovation in 1999 raised the country's LNG production capacity to more than 1.1 Tcf (23.1 million tons) per year. Algeria also exports more than 1.0 Tcf of natural gas per year to Europe by pipeline. The Algerian State-owned oil and gas company Sonatrach owns and operates four liquefaction complexes, the first of which started up in 1964, making Algeria the world's first LNG exporter. Algeria has no new liquefaction capacity planned before 2008 but in the long term is planning to add another train.
- **Nigeria** exported 394 Bcf (8.2 million tons) of LNG in 2002, mainly to Turkey, Italy, France, Portugal, and Spain. Nigeria has also delivered more than 20 cargos under short-term contracts to the United States over the past three years. The total annual capacity of Nigeria's Bonny Island LNG plant is 463 Bcf (9.5 million tons), and Nigeria LNG has begun construction of two additional 200-Bcf-per-year (4.1-million-tpy) trains that are scheduled to begin operation in 2005. Additional trains are under discussion as are three new projects that have been considered in the West Niger Delta (by ExxonMobil, ChevronTexaco, and ConocoPhillips), Brass River (by the Italian company ENI and ConocoPhillips), and a floating offshore project (by Statoil and Total).
- **Trinidad and Tobago** exported 189 Bcf (4.0 million tons) of LNG in 2002. Trinidad and Tobago's LNG facility at Point Fortin has three trains and an annual capacity of 482 Bcf (9.9 million tons). In June 2003, the Government of Trinidad and Tobago approved the construction of a fourth train that could produce an additional 253 Bcf (5.2 million tons) per year. Trinidad and Tobago exports LNG to the continental United States, Puerto Rico, Spain, and the Dominican Republic.

- **Libya** exported 21 Bcf (0.4 million tons) of LNG in 2002. The plant at Marsa El Brega has an annual capacity of about 131 Bcf (2.7 million tons). Only about 25 percent of the total capacity, or 29 Bcf (0.6 million tons) per year, is available for export due to maintenance issues.
- Two LNG export projects are being built in **Egypt**: a one-train liquefaction facility at Damietta, which will start operations in 2004 with an annual capacity of 244 Bcf (5.0 million tons), and a two-train project at Idku with a 2005 startup date and a projected annual capacity of 175 Bcf (3.6 million tons). All of the Idku LNG is contracted to Gaz de France. Commitment to a second 175-Bcf-per-year (3.6-million-tpy) train was announced in September 2003. British Gas (BG) has agreed to buy the entire output for U.S. and Italian markets.
- Beginning in 2006, **Norway** plans to export LNG from a 200-Bcf-per-year (4.1-million-tpy) liquefaction terminal now being built on Melkøye Island in the Norwegian Sea. Exports are targeting markets in Spain, France, and the United States.

Atlantic Basin Liquefaction Capacity, October 2003



Data from IEA 2003 *Natural Gas Information*, and updated based on trade press reports as assembled by the Gas Technology Institute.

Potential New LNG Exporters

At least seven additional countries are exploring their potential as LNG exporters.

Pacific Basin

- A project is proposed for exporting natural gas from **Peru's** Camisea field to a terminal in Mexico.
- Several European and U.S. companies are proposing a project to pipe gas from **Bolivia** to either Peru or Chile on the Pacific Coast where it could be liquefied and shipped to a terminal on the West Coast of North America.

Middle East

- With the world's second largest proved gas reserves, **Iran** has great potential to export gas to markets in Europe, Asia, and India by pipeline and as LNG. The Iranian government is considering at least four projects, each of 390 to 490 Bcf (8 to 10 million tons) per year, to process reserves in the South Pars-North field in partnership with companies in Europe and Asia.
- An LNG project has been proposed in **Yemen** for more than a decade but to date has not made significant progress.

Atlantic Basin

- In **Venezuela**, an LNG project has been discussed since the early 1970s. Shell and Mitsubishi have signed preliminary agreements to develop a 229-Bcf-per-year (4.7-million-tpy) project called Marisal Sucre based on offshore reserves. Discussions have been held with neighboring Trinidad and Tobago to bring Venezuelan gas to their Atlantic LNG plant for processing until a Venezuelan LNG plant can be built.
- In **Angola**, ChevronTexaco, ExxonMobil, BP, Total, and Sonangol are proposing to build a plant based on offshore associated gas for export to North American and European markets. The plant would initially have a single 195-Bcf-per-year (4.0-million-tpy) train with the option for development of additional trains later.
- **Equatorial Guinea** is looking to export LNG from its offshore Alba field. In May 2003, U.S.-based firm Marathon Oil signed a 17-year draft agreement to supply British Gas with 166 Bcf (3.4 million tons) per year of LNG to be delivered to the Lake Charles regasification facility in the United States. The project is currently undergoing advanced engineering feasibility studies, and a final investment decision is due in the first quarter of 2004.

LNG Importers

- In 2002, 12 countries imported 5.4 Tcf (113 million tons) of LNG.[6,7] As of late 2003, LNG-importing countries have a combined annual regasification capacity[8] of 15.1 Tcf (310 million tons).
- Three countries in the Pacific Basin – Japan, South Korea, and Taiwan – accounted for 68 percent of global LNG imports in 2002. Seven European countries received 28 percent of global imports, while the United States imported the remaining 4 percent.
- Japan has long been the world's largest LNG consumer, importing 2.6 Tcf (54.6 million tons) of LNG in 2002. However, the Japanese share of the global LNG trade fell from 66 percent in 1990 to 48 percent in 2002.
- In 2003, two additional countries – the Dominican Republic and Portugal – began operating regasification terminals.[9]
- Most countries with existing import terminals are expanding their import capacity either through construction of new terminals and/or through expansion of existing facilities.
- The United Kingdom, India, and China are currently building their first regasification facilities.
- Other potential LNG importers in the future could include the Bahamas, Indonesia, Jamaica, Mexico, the Netherlands, New Zealand, and the Philippines (countries in which interest in potential sites has been announced).

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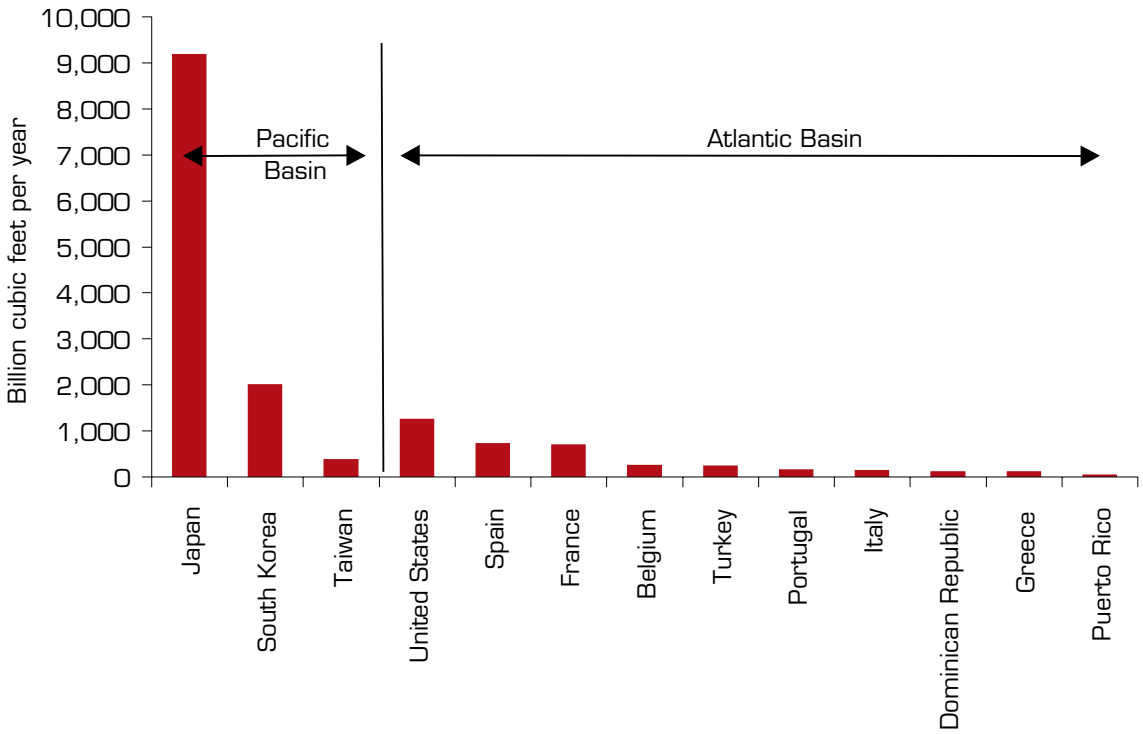
[6] Puerto Rico, a territory of the United States, also imports LNG. In this report Puerto Rico is not counted as an independent country, but is listed separately from the United States because it is not part of the continental United States and does not connect to U.S. natural gas pipelines.

[7] Mexico is considered an LNG-importing country, though it currently has no regasification terminals and receives LNG via truck from the United States.

[8] Regasification capacities listed in this report are peak capacities rather than baseload regasification capacities. Please see Appendix B for a discussion of measuring regasification capacity.

[9] Portugal began operation of its first LNG terminal at Sines in 2003. Prior to the opening of the terminal, Portugal imported LNG from Nigeria via a regasification terminal in Spain.

Global LNG Regasification Capacity, October 2003



Data from IEA 2003 *Natural Gas Information,* and updated based on trade press reports as assembled by the Gas Technology Institute.

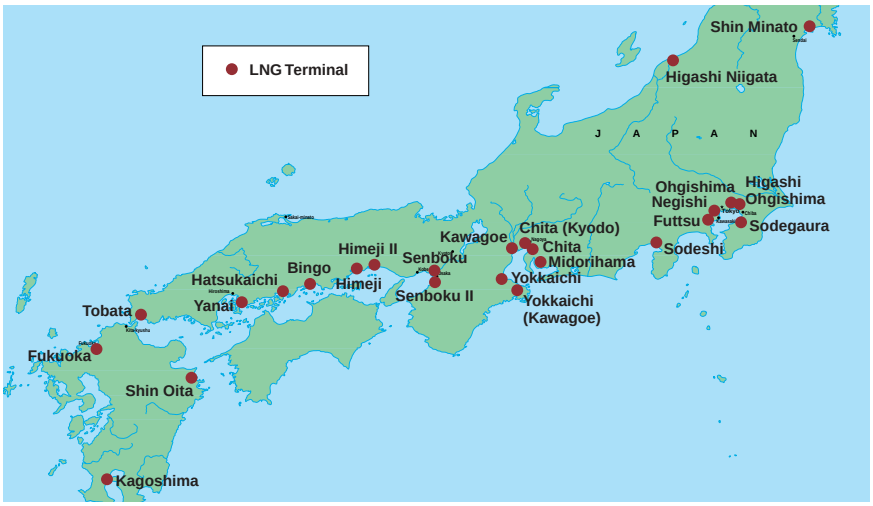
Pacific Basin Importers

Three Pacific Basin importers received 3.6 Tcf (76 million tons) in 2002, 68 percent of total world LNG trade. These countries — Japan, South Korea, and Taiwan — generally depend on LNG for 90 percent or more of their natural gas needs.

Japan

- Japan is the world's largest LNG importer, accounting for 48 percent of world imports in 2002. The country's 23 receiving terminals have a combined sendout capacity of 9.2 Tcf (188.3 million tons) per year. The terminals are owned mainly by electric and gas utilities. Natural gas supplies 12 percent of Japan's energy needs, and more than 95 percent of that natural gas is imported as LNG. Approximately two-thirds of Japan's natural gas consumption is for power generation.
- Although few new facilities have been built in recent years, regasification capacity continues to grow through expansion of existing terminals. Japan's largest suppliers are Indonesia and Malaysia, with substantial volumes from Qatar, the UAE, Australia, Oman, and Brunei Darussalam. The United States also supplies LNG to Japan from the Kenai terminal in Alaska.
- The ongoing liberalization of energy markets in Japan is encouraging significant market changes, and Japanese utilities are spearheading the drive for increased contract flexibility, including lower take-or-pay requirements and a mixture of short-, medium-, and long-term contracts. As existing contracts expire, this trend could become even more pronounced.

Japanese LNG Import Terminals



Source: Energy Information Administration

South Korea

- As the world's second largest LNG importer in 2002, South Korea imports most of its LNG from Indonesia, Qatar, and Oman with smaller volumes from Malaysia, Brunei, the UAE, and Australia. South Korea has three regasification terminals owned and operated by state-owned Korea Gas Corporation (KOGAS) at Pyeongtaek, Incheon, and Tongyeong, with a combined sendout capacity of 2.0 Tcf (40.7 million tons) per year. KOGAS is adding storage capacity at Incheon and Pyeongtaek. A fourth terminal is under construction at Kwangyang by Pohang Iron and Steel Corporation, the country's first independent LNG project.
- South Korea has strong seasonal swings in demand and is a major buyer of volumes on a short-term basis. Korean energy markets are being liberalized, and KOGAS may lose its monopoly position. Thus, like Japanese companies, KOGAS has been seeking greater flexibility in contract terms.

South Korean LNG Import Terminals

Source: Energy Information Administration

- **Taiwan** currently has one LNG regasification terminal at Yung An, with a sendout capacity of about 363 Bcf (7.5 million tons) per year. It receives cargos from Indonesia and Malaysia. A second terminal has been mentioned for the northern part of the island.

Taiwanese LNG Import Terminals

Source: Gas Strategies

- **China** is building its first LNG receiving terminal in Guangdong on the southeast coast. The facility is scheduled for completion in 2006/2007 with an annual capacity of 158 Bcf (3.3 million tons). Partners in the terminal and an associated pipeline are the China National Offshore Oil Corporation (CNOOC), BP, and various local and Hong Kong companies. Initial shipments will come from Australia's North West shelf expansion. A second terminal will be built at Fujian, which will receive LNG from the BP-led Tangguh project in Indonesia starting in 2007.
- **India's** first terminal, at Dabhol, was nearly completed in 2001, but construction stopped when Enron withdrew from the project. Minority shareholders General Electric Co. and Bechtel Corp. are seeking to reactivate the project. The terminal will have an annual capacity of 122 Bcf (2.5 million tons). Construction of a terminal at Dahej on the west coast is nearing completion. Owner Petronet LNG, a consortium of several state-owned companies, will import LNG from Qatar. Shell is building a 122-Bcf-per-year (2.5-million-tpy) terminal at Hazira on the west coast, which is scheduled to go online in 2004. The LNG will initially be delivered under short-term arrangements from Shell projects in Oman, Malaysia, and elsewhere.

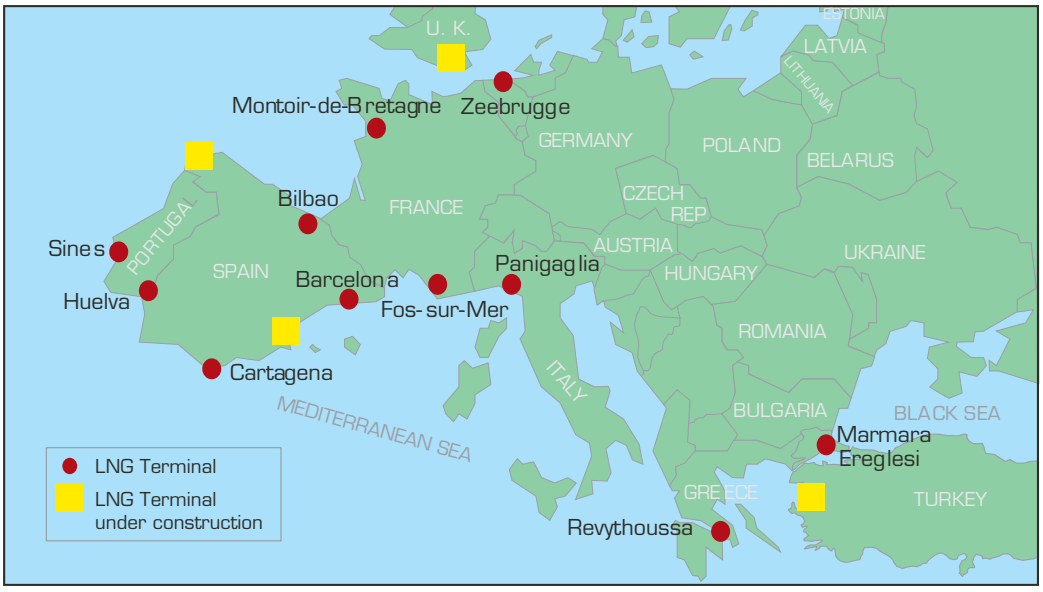
Atlantic Basin Importers

Atlantic Basin importers, including the United States, received 1.7 Tcf (37 million tons) in 2002, 32 percent of total world LNG trade. Regasification capacity continues to grow as most Atlantic Basin importers are planning expansions.

- **France** is Europe's largest LNG importer, with imports of 511 Bcf (10.7 million tons) in 2002. State-owned Gaz de France operates two terminals at Fos-sur-Mer near Marseilles and Montoir-de-Bretagne, near Nantes. ExxonMobil has announced plans to build an additional terminal at Fos-sur-Mer with a startup date in 2006. The terminal would receive LNG from Qatar. Gaz de France has proposed an additional terminal at Fos Cavaou to receive gas from Egypt's Idku project.
- **Spain** has one of the world's most rapidly growing natural gas markets. LNG imports increased by 30 percent in 2002, with nearly half of the volume imported from Algeria. The balance was supplied by Qatar, Oman, the UAE, Libya, Nigeria, Trinidad and Tobago, Australia, and Brunei Darussalam. State-owned Enagás operates regasification terminals at Barcelona, Cartagena, and Huelva, all of which are being expanded. Bilbao, operated by a consortium of BP, Iberdrola, Repsol YPF, and EVE, received its first LNG shipment from the UAE in August 2003. When fully operational, the terminal will have an annual capacity of 131 Bcf (2.7 million tons) and would receive most of its LNG from Trinidad and Tobago. Two more plants are under construction at El Ferrol and Sagunto with estimated startup dates in 2006 and 2007.
- The **United States** imported 229 Bcf (4.8 million tons) of LNG in 2002 with more than half that volume originating in Trinidad and Tobago. The U.S. has four LNG import terminals with a combined total regasification capacity of more than 1,200 Bcf (25.2 million tons) per year. The continental United States is discussed in more detail on page 25.
- In **Italy**, the state-owned gas company SNAM operates a 130-Bcf-per-year (2.6-million-tpy) facility in Panigaglia that receives LNG from Nigeria and Algeria. Several other projects are being explored, including a gravity-based offshore regasification terminal in the northern Adriatic.
- **Turkey** receives natural gas as LNG from Algeria and Nigeria at a 224-Bcf-per-year (4.6-million-tpy) LNG terminal at Marmara Ereglisi, adjacent to a combined-cycle gas turbine power station built and owned by state-owned BOTAS. As of October 2003, a second terminal built by an independent entrepreneur had not yet begun operation. Turkey has abundant pipeline supplies of gas and is not known to have plans to expand its LNG import capacity.
- **Belgium's** sole regasification terminal at Zeebrugge received 124 Bcf (2.7 million tons) of LNG, mostly from Algeria, in 2002. Operator Fluxys is considering increasing capacity at the terminal as early as 2007.

- **Puerto Rico**, a territory of the United States, has one receiving terminal in Guayanilla Bay, which opened in 2000. Gas from the terminal is used to fuel combined-cycle electricity generation that provides 20 percent of the island's electricity. Puerto Rico received 24 Bcf (0.5 million tons) of LNG in 2002, mainly from Trinidad and Tobago, with small volumes from Qatar.
- **Greece** began importing LNG in 2000, under a 21-year contractual agreement with Algeria. Greece's sole LNG terminal at Revithoussa, near Athens, has an annual capacity of 93 Bcf (2.0 million tons).
- **Portugal** began receiving LNG in 2002 under a 20-year contract with Nigeria LNG. The LNG was received through Spanish terminals until October 2003, when the Sines terminal went online. The plant has a capacity of 146 Bcf (3.3 million tons) per year.
- The **Dominican Republic** opened its first regasification terminal at Andres in 2003 to receive LNG from Trinidad and Tobago. The 97-Bcf-per-year (2.0-million-tpy) facility supplies natural gas for electricity generation.
- In 1964, the **United Kingdom** was the first country to import LNG but dismantled its terminal on Canvey Island in 1990 following the arrival of North Sea oil and gas. Now, faced with a prospective gas shortage, the United Kingdom is again looking at LNG imports. National Grid Transco (NGT), operator of the U.K. gas grid, has awarded contracts for the design and construction of a terminal on the Isle of Grain east of London that will start up in early 2005 with a capacity of 161 Bcf (3.3 million tons) per year. Three additional projects, to be located at Milford Haven, have been proposed.

European LNG Import Terminals



Source: Energy Information Administration

Potential New LNG Importers

At least seven additional countries are considering becoming LNG importers.[10]

Pacific Basin

- A 68-Bcf-per-year (1.4-million-tpy) LNG terminal has been discussed for the **Philippines**.
- **New Zealand** is considering importing LNG from Australia.
- **Indonesia** is considering building an LNG-import facility on the island of West Java.

Atlantic Basin

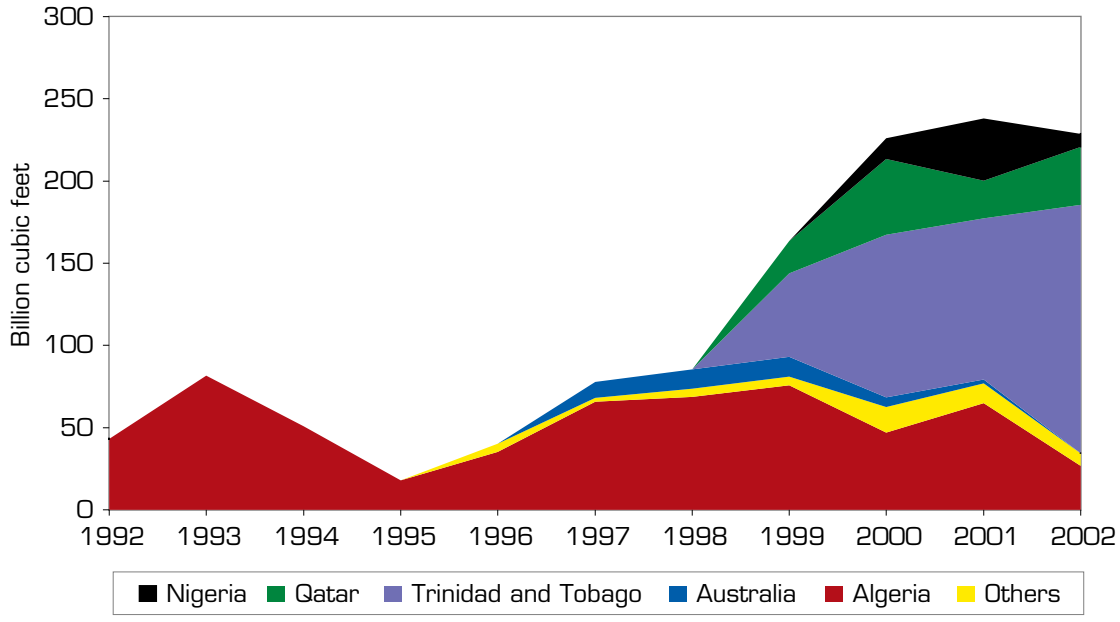
- In **Mexico**, nearly a dozen LNG terminals have been proposed, all but two targeting the Pacific Coast. The Mexican regulatory agency, CRE, has granted permits to four projects, three of them on the Pacific Coast, which would also supply U.S. markets. The fourth terminal, on the Gulf of Mexico, would be built by a team headed by Shell and would be used to supply electricity to Mexico.
- **Jamaica** is exploring the feasibility of importing natural gas from Trinidad and Tobago, either in small LNG carriers or via pipeline.
- Several import facilities are under consideration for the **Bahamas** and are discussed in the U.S. section below, as the gas would be re-exported to the United States via pipeline into Florida.
- **The Netherlands** is also considering building an LNG import terminal at Eemshaven.

[10] Although numerous additional countries could become LNG importers in the future, this list includes countries in which sites have already been identified for proposed LNG facilities.

United States: LNG Activity Expanding

- U.S. LNG imports[11] in 2003 are expected to reach 540 Bcf (11 million tons), up from 229 Bcf (4.8 million tons) in 2002.
- The United States is both an importer and an exporter of LNG. LNG has been produced in and exported from Kenai, Alaska, to Japan for the last 30 years, exporting 63 Bcf (1.3 million tons) in 2002.
- While historically Algeria was the United States' largest supplier of LNG, since 2000 it has been far surpassed by Trinidad and Tobago, which now serves as the source for a full 66 percent of the nation's LNG imports. The United States imported 151 Bcf (3.2 million tons) from Trinidad and Tobago in 2002.
- In addition to Trinidad and Tobago and Algeria, the United States also received LNG cargos from Brunei Darussalam, Malaysia, Nigeria, Oman, and Qatar.

U.S. LNG Imports by Source Country, 1992–2002



Source: Energy Information Administration, *Natural Gas Monthly,* October 2003.

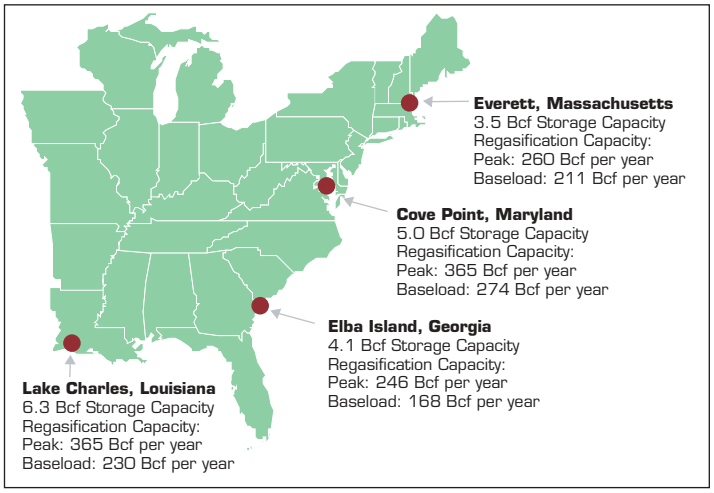
[11] This section refers only to imports into the continental United States.

Current United States LNG Facilities

There are currently four LNG import terminals in the continental United States:

- **Cove Point, MD**: After about two decades of dormancy from international trade, Cove Point received final permission to re-open from the Federal Energy Regulatory Commission in July 2003. Its re-opening adds up to 365 Bcf (7.7 million tons) per year of deliverability. Dominion, the terminal owner, began commercial operations in August and had received 18 Bcf (0.4 million tons) as of the end of September 2003, all from Trinidad and Tobago.
- **Elba Island, GA**: This terminal, the smallest of the continental U.S. import terminals, was reactivated in 2001 and received ten cargos in 2002. Activity was slow at this terminal in the first quarter 2003 but has since picked up due to more LNG production from Atlantic LNG in Trinidad and Tobago. As of the end of September 2003, this terminal had received 41 Bcf (0.9 million tons) from 18 shipments, all originating in Trinidad and Tobago.
- **Everett, MA**: This terminal, owned by Distrigas, received 52 shipments carrying 117 Bcf (2.5 million tons) in 2003 through September, all from Trinidad and Tobago. Distrigas completed an expansion in early 2003 in order to serve a nearby power plant, bringing total deliverability to about 260 Bcf (5.4 million tons) per year.
- **Lake Charles, LA**: This facility, owned by Southern Union, received 186 Bcf (3.9 million tons) from 81 cargos in 2003 through September. This facility has recently been operating above baseload capacity. Shipments this year have come from Trinidad and Tobago, Algeria, Malaysia, Nigeria, Oman, and Qatar.

LNG Regasification Terminals in the United States

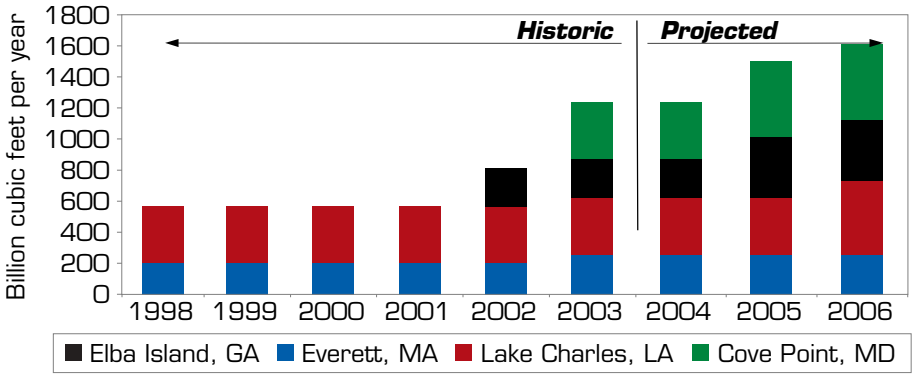


Source: Energy Information Administration

United States LNG Expansion

- The four U.S. LNG import terminals currently have an estimated combined peak capacity of about 1.2 Tcf (26.0 million tons) per year and an estimated baseload capacity of 880 Bcf (18.5 million tons) per year. All four terminals either have recently completed an expansion or plan to expand their regasification capacity by 2006.

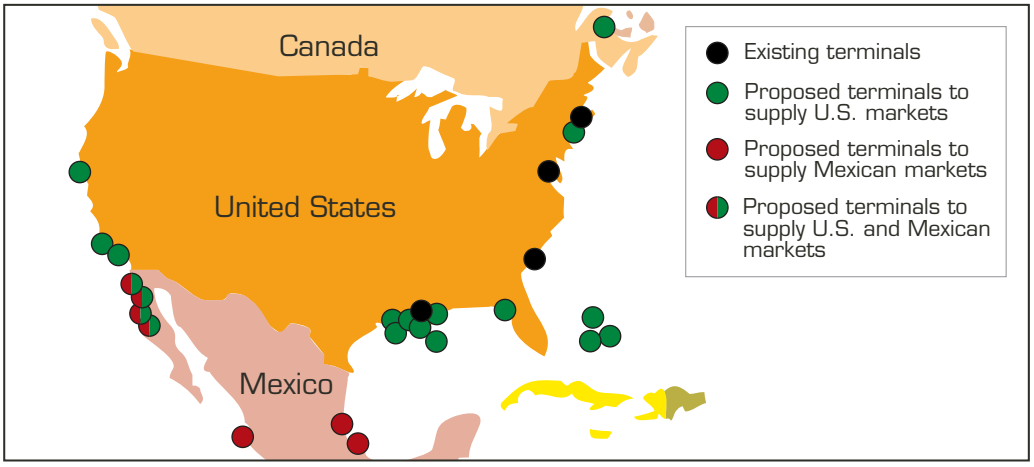
Peak U.S. Import Terminal Capacity



Source: Energy Information Administration

- There are at least two dozen proposals to build new LNG regasification terminals in North America over the next several years. By 2010, projects could be located in the Gulf of Mexico, Bahamas (with pipelines into Florida), offshore the U.S. West Coast, Mexico's West Coast (with supply into the Southwest and/or California), and the U.S. and Canadian East Coasts.

Potential Locations for LNG Regasification Terminals in North America



Source: Energy Information Administration

United States Natural Gas and LNG Outlook to 2010

- EIA's *Annual Energy Outlook 2004* (*AEO2004*)[12] projects that four new LNG regasification terminals will be constructed on the Atlantic and Gulf Coasts from 2007 through 2010 to meet the 58-percent increase in LNG imports that is projected for that timeframe.
- The first new U.S. LNG terminal in more than 20 years is projected to open on the Gulf Coast in 2007. It is projected that additional terminals will be constructed to serve markets in Florida, the south Atlantic states, and the western Gulf Coast. EIA also forecasts that a terminal targeting the Florida market will be constructed in the Bahamas with the gas piped to Florida.
- Almost 60 percent of the increase in LNG imports would be served by expanded capacity at existing terminals.
- By 2010, the new terminals are projected to be collectively importing 812 billion cubic feet annually.

Import by New U.S. LNG Terminals, 2010
(Billion cubic feet per year)

Census Division	Start Year	2010
East South Central (MS, AL Gulf Coast)	2007	313
West South Central (LA, TX Gulf Coast)	2009	261
South Atlantic	2009	123
Florida	2010	116
Total		**812**

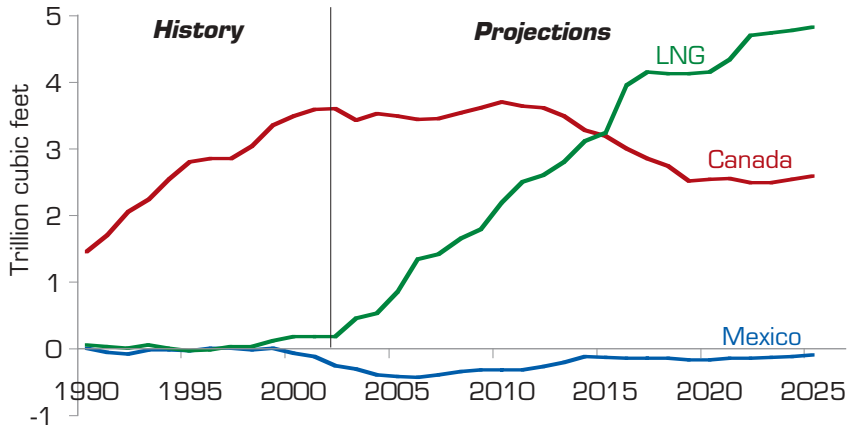
Source: Energy Information Administration, *Annual Energy Outlook 2004*, Reference Case

[12] To be released and posted to *http://www.eia.doe.gov/oiaf/aeo/index.html* by December 16, 2003.

United States Natural Gas and LNG Outlook: Beyond 2010

- Based on EIA long-term forecasts, U.S.[13] natural gas consumption is projected to increase from 22.5 Tcf in 2002 to 26.2 Tcf in 2010 and 31.4 Tcf by 2025. Domestic gas production is expected to increase more slowly than consumption over the forecast period, rising from 19.0 Tcf in 2002 to 20.5 Tcf in 2010 and 24.0 Tcf by 2025. The difference between consumption and production will be made up by imports, which are projected to rise from net imports of 3.5 Tcf in 2002 to 7.2 Tcf by 2025.
- Nearly all the increase in net U.S. natural gas imports from 2002 to 2010 is expected to come from LNG, with an almost 2.0-Tcf (42.0-million-ton) increase expected over 2002 levels. Net U.S. LNG imports are expected to rise from 5 percent of net U.S. natural gas imports in 2002 to 39 percent in 2010.
- Over the forecast period, net pipeline imports from Canada are expected to reach 3.7 Tcf in 2010, and then decline as Canadian fields mature and Canadian demand increases. It is projected that LNG will become the largest source of net U.S. imports by 2015, as Canadian imports decline.
- Mexico, currently a net importer of U.S. natural gas, is expected to remain so throughout the period, mainly to supply industry located on the United States–Mexican border. Exports to Mexico are forecast to decline after 2005 as terminals in Baja California, Mexico come online to supply both the U.S. and the Mexican markets.

Net U.S. Imports of Natural Gas, 1990–2025



Source: Energy Information Administration, *Annual Energy Outlook 2004,* Reference Case

[13] In this section, the United States includes all 50 states, but excludes U.S. territories.

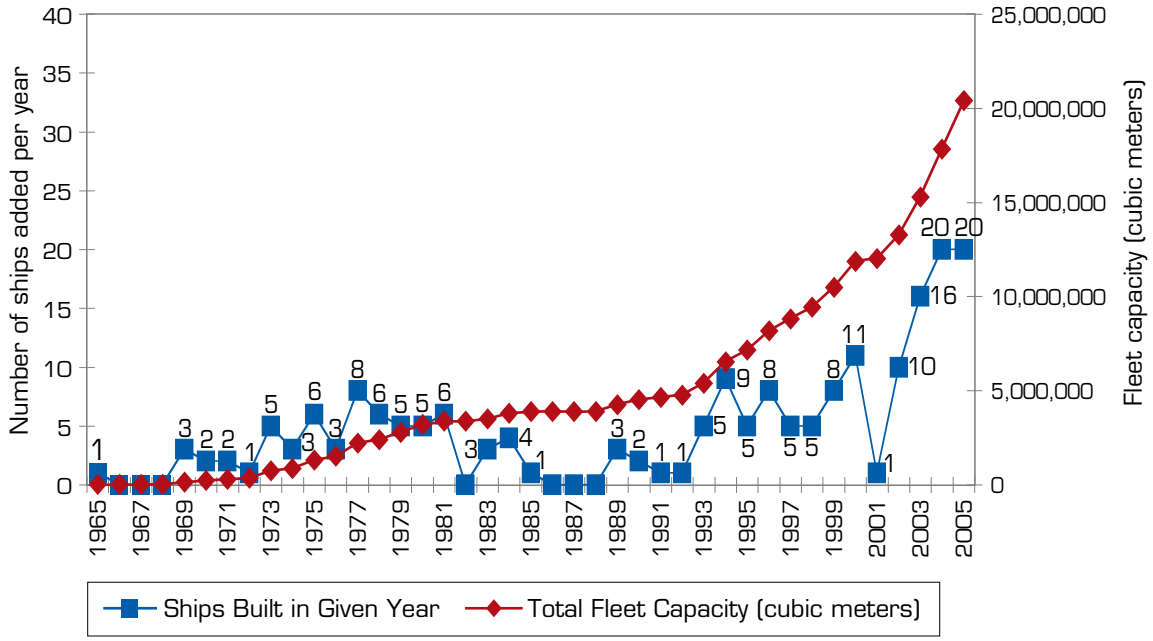
World LNG Shipping Capacity Expanding

- According to LNG Shipping Solutions, 151 LNG tankers were in operation worldwide as of October 2003: 16 ships with a capacity of less than 50,000 cubic meters, 15 in the 50,000 to 120,000 cubic meters range, and 120 larger than 120,000 cubic meters.
- Fifty-five ships are under construction, of which 46 are designed to carry at least 138,000 cubic meters of LNG (equivalent to 2.9 Bcf of natural gas).[14] Much larger ships with 250,000 cubic meters of capacity (equivalent to 5.3 Bcf of natural gas) are under consideration, but may not be compatible with all existing LNG terminals.
- The addition of new ships to the fleet will raise total fleet capacity 44 percent from 17.4 million cubic meters of liquid (equivalent to 366 Bcf of natural gas) in October 2003 to 25.1 million cubic meters of liquid (equivalent to 527 Bcf of natural gas) in 2006.
- Shipping accounts for 10 to 30 percent of the delivered value of LNG (depending on the distance from the reserves to the market), compared with less than 10 percent for oil, because of the relatively high cost of manufacturing LNG tankers. Tankers currently cost $150 to $160 million for a 138,000-cubic-meter ship, more than double the price of a very large crude oil tanker which carries 4 to 5 times as much energy. One reason for this high cost is that LNG ships require expensive, insulated cryogenic containment for the cargo.
- The cost of a 138,000-cubic-meter LNG tanker has declined, however, from a peak of $280 million (in nominal dollars) in 1995.
- In the conventional oil tanker market, most ships are built on speculation. This has not been the case in LNG where ships were used on dedicated routes for specific projects. However, several large companies that import or export LNG, including BP, Shell, and Tokyo Gas, have recently ordered ships that are not dedicated to a project.

[14] It is industry practice to measure LNG shipping capacity in cubic meters of liquid.

- The availability of uncommitted LNG tankers is a key element in the development of the LNG short-term market.
- Only eight shipyards in the world currently build LNG tankers: three in Japan; three in Korea; and two in Europe. However, India, China, and Poland are planning to develop LNG tanker construction capabilities in their shipyards.

LNG Tanker Fleet, 1965–2006



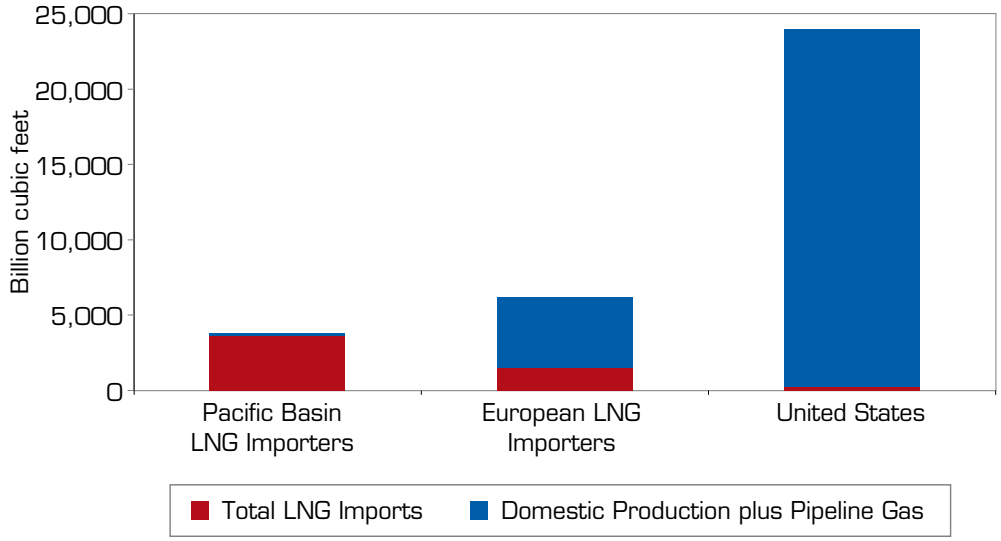
Source: LNG Shipping Solutions

World LNG Market Structure

The structure of the international LNG market influences current and future LNG trade. Key issues include differences in history and pricing mechanisms between the Atlantic and Pacific Basins, recent market changes that increase flexibility in LNG trade, the declining trend of LNG costs throughout the value chain, and the addition of new participants to the market.

- LNG trade evolved differently in the Atlantic and Pacific basins, and this continues to affect import volume, pricing systems, and contract terms. Importing countries in the Pacific Basin are almost totally dependent on LNG while countries in the Atlantic Basin use domestic supplies and pipeline imports as well as LNG to meet natural gas demand.
- Recent changes in the LNG market have trended towards increased flexibility. Contracts have loosened terms on both price and volume, and can be negotiated for shorter periods of time. Additionally, flexibility in LNG shipping has led to an increase in short-term contacts.
- Costs of liquefaction, shipping, and regasification have declined over time, lowering costs to producers. Since the LNG market is primarily driven by long-term contracts with pricing mechanisms pegged to petroleum products, however, lower operating costs do not necessarily translate into lower LNG prices, at least in the short term.
- Buyers and sellers have been taking on new roles. Buyers have been investing in the upstream, including liquefaction plants (e.g., Tokyo Gas and the Tokyo Electric Power Company have both invested in the Darwin liquefaction plant in Australia). Traditional sellers, such as BP and Shell, have leased capacity at terminals and are extending their role into trading. New buyers have been emerging, including independent power producers in Puerto Rico and the Dominican Republic.

LNG Imports and Total Gas Consumption by Region, 2002



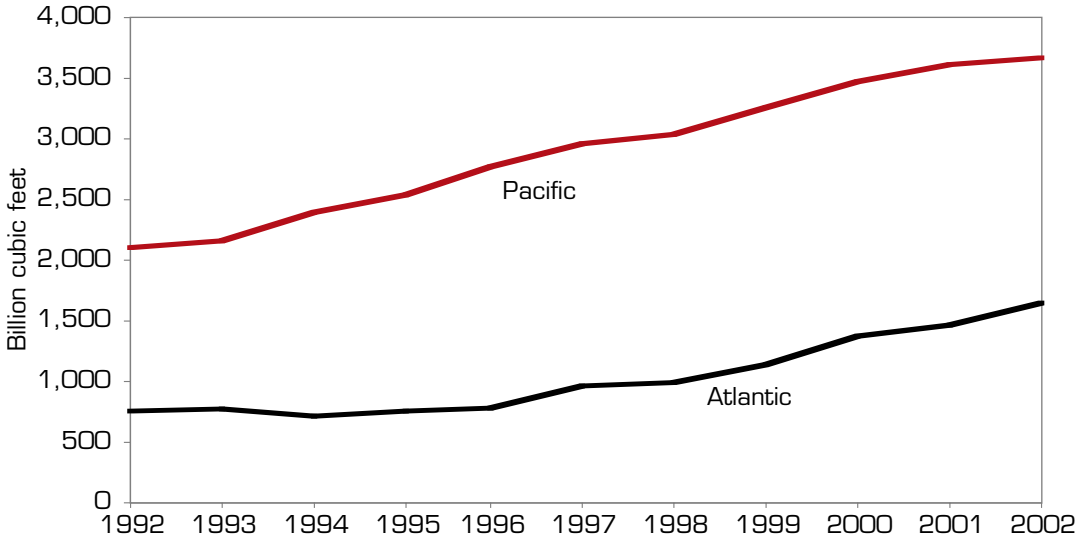
Note: For Cedigaz data, flows are on a contractual basis and may not correspond to physical gas flows in all cases.

Source: **Imports to the United States and Imports to Japan and Mexico from the United States:** Energy Information Administration, *Natural Gas Monthly* (May 2003). **Imports to Belgium from United Arab Emirates, Imports to Spain from Australia and Brunei, Imports to Puerto Rico from Qatar:** Cedigaz Centre International d'Information sur le Gaz Naturel et tous Hydrocarbures Gazeux Natural Gas In the World, Major Trends for the Gas Industry 2002. **All Other Countries:** Organization for Economic Cooperation and Development, International Energy Agency, Natural Gas Information 2003 (with 2002 data).

Atlantic and Pacific Basins Differ

- In the 1980s and early 1990s, indigenous natural gas supplies were abundant for most countries in the Atlantic Basin, and pipeline gas readily available. It was difficult for LNG to compete and, as a result, LNG imports into the Atlantic basin grew very slowly.
- LNG still makes up a small portion of the natural gas market in the United States and Europe, and competes with domestic supplies and pipeline imports.
- In contrast, the LNG importers in the Pacific Basin – Japan, South Korea, and Taiwan – have little or no domestic gas production and no pipeline sources for natural gas imports.
- Because current LNG importers in the Pacific Basin did not have access to domestic or piped imported gas, LNG imports into the region increased rapidly in the 1980s and early 1990s as these countries sought alternatives to oil. Security of supply was a more important consideration in the Pacific Basin than price.

LNG Imports into the Atlantic and Pacific Basins, 1992–2002

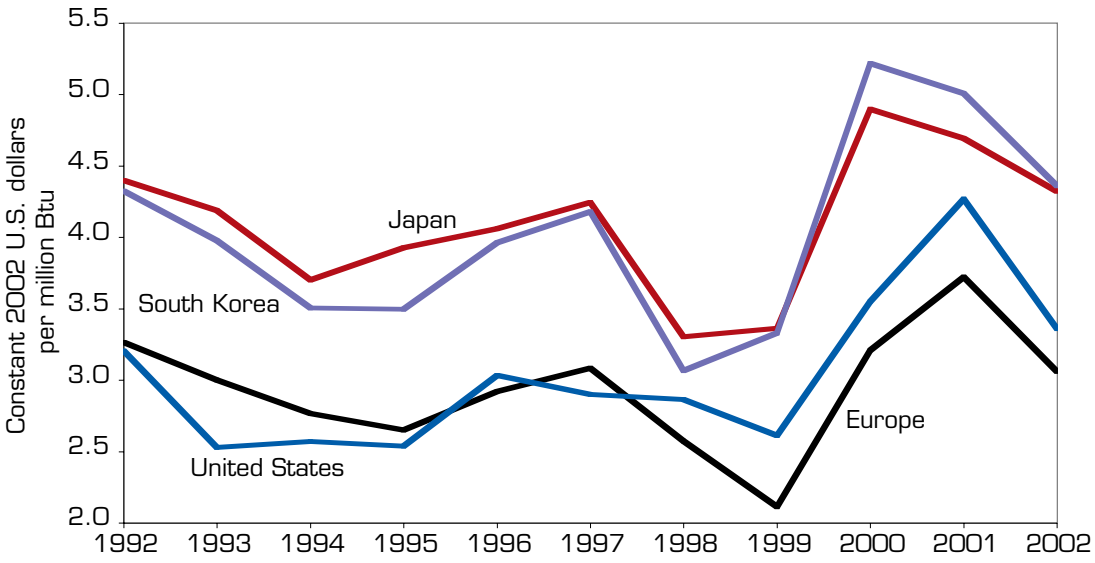


Source: Cedigaz. Based on contractual flows.

LNG Pricing Around the World

- LNG prices are usually expressed in U.S. dollars per million Btu (MMBtu). Prices can be calculated on a free on board (f.o.b.) or delivered ex-ship (d.e.s.) basis. Today most new contracts are f.o.b., since buyers see this as giving them more control over the landed price and allowing them to trade surplus LNG cargos.
- Gas "hubs" involving both LNG and pipeline gas are emerging in the United States, Belgium, and the United Kingdom, presenting opportunities for price arbitrage and eventual convergence of price.
- LNG prices have historically been higher in the Pacific than in the Atlantic Basin, averaging about US$4/MMBtu in the former and US$3/MMBtu in the latter over the past 10 years.
- The rapid growth in Middle East LNG supply may contribute to a convergence of the Atlantic and Pacific prices. So far, the quantity of LNG flowing from the Middle East into the Atlantic Basin has been relatively small, but several projects in the Middle East are aiming to supply European and North American markets. In addition, if LNG import terminals are built on the North American West Coast, Pacific Basin suppliers could gain greater access to the U.S. market.

LNG Import Prices, 1992–2002



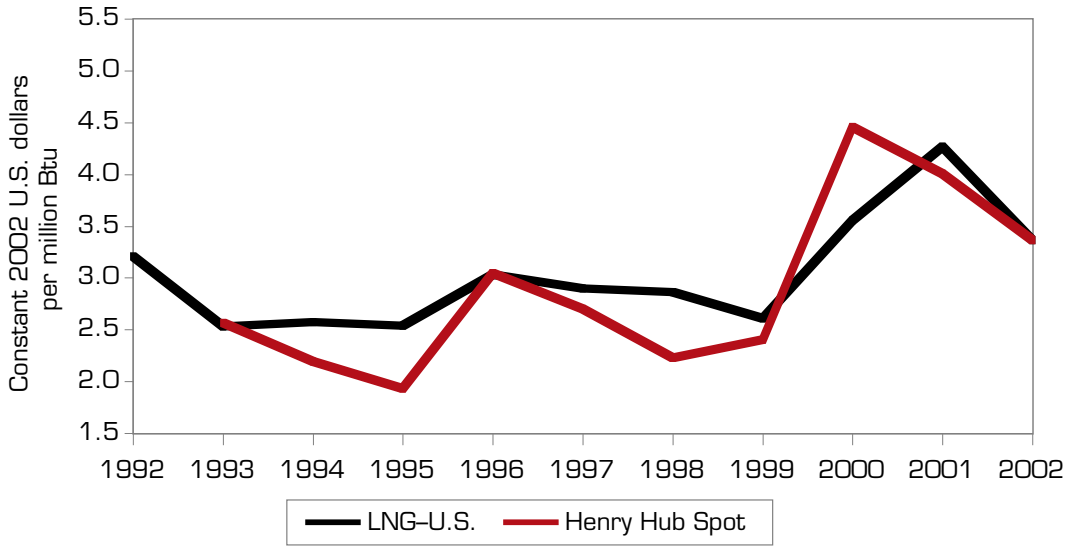
Source: International Energy Agency, Energy Prices and Taxes, third Quarter 2003, online data services.

Atlantic and Pacific Basin LNG Pricing

LNG prices are benchmarked to competing fuels. There have been three distinct and relatively independent markets for LNG, each with its own pricing structure. Price risk is inherent in each pricing structure, although the degree of risk differs among the markets.

- In the United States, the competing fuel is pipeline natural gas, and the benchmark price is either a specified market in long-term contracts or the Henry Hub[15] price for short-term sales. Importers and exporters involved in U.S. LNG transactions are exposed to a significant level of risk given the high degree of price volatility in U.S. natural gas markets.
- In Europe, LNG prices are related to competing fuel prices, such as low-sulfur residual fuel oil. However, LNG is now starting to be linked to natural gas spot and futures market prices.
- In Asia, prices are linked to imported crude oil. The pricing formula typically includes a base price indexed to crude oil prices, a constant, and perhaps a mechanism for the review/adjustment of the formula. Asian prices are generally higher than prices elsewhere in the world.

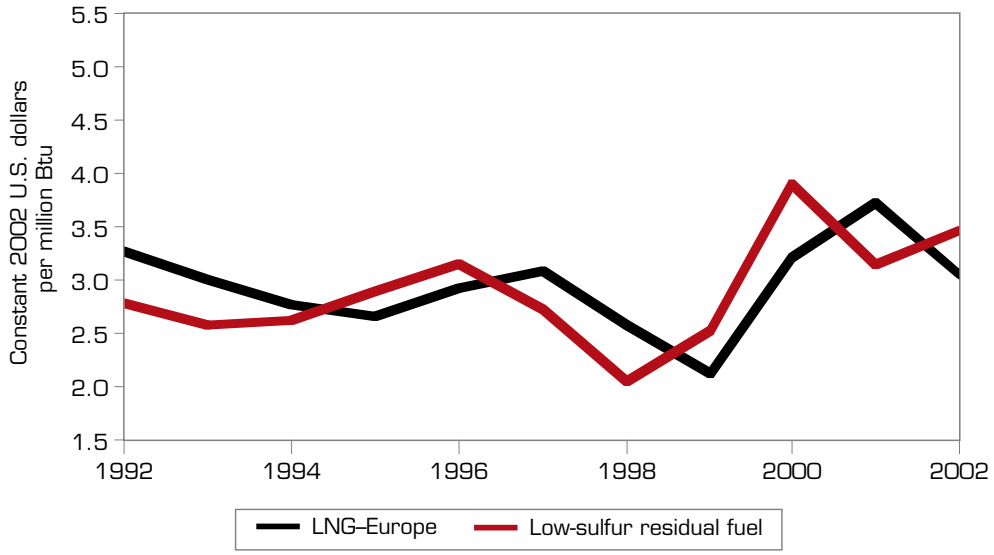
LNG Import Prices and Henry Hub Spot Prices in the United States, 1992–2002



Source: Natural Gas Intelligence; International Energy Agency, Energy Prices and Taxes, third Quarter 2003, online data services.

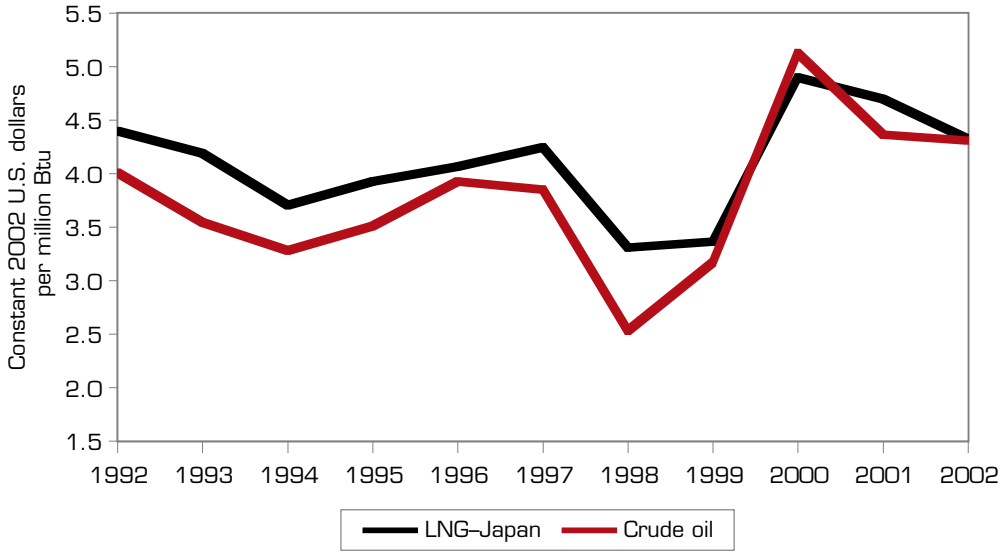
[15] A natural gas pipeline hub on the Louisiana Gulf coast. It is the delivery point for the natural gas futures contract on the New York Mercantile Exchange (NYMEX).

LNG Import Prices and Low-Sulfur Residual Fuel Spot Prices in Europe, 1992–2002



Source: International Energy Agency, Energy Prices and Taxes, third Quarter 2003, online data services.

LNG Import and Crude Oil Prices in Japan, 1992–2002



Source: International Energy Agency, Energy Prices and Taxes, third Quarter 2003, online data services.

Recent Market Changes: Contracts and Pricing

Although long-term LNG contracts are not likely to disappear, importing companies are seeking increased flexibility and better contract terms. According to the Groupe International des Importatuers de Gaz Liquefie (G.I.I.G.N.L.), contracts covering the sale of nearly 30 million tons per year to Asian countries will come up for renewal over the next decade.

- Traditional LNG contracts focused on security of supply for the buyer. Contracts were long-term (often 20–25 years) and rigid. Take-or-pay clauses shifted the volume risk to the buyer. LNG was generally shipped d.e.s., that is, the LNG was transported in designated tankers. Contracts also contained "destination clauses" that prevented buyers from reselling the cargos to third parties.
- Changes to this situation have been underway since the mid-1990s. LNG suppliers offered more favorable terms, including substantially lower prices, to new importers in India and China, which led traditional LNG buyers to seek lower prices when renegotiating their contracts. Some examples:
  - Owners of Australia's Northwest Shelf project agreed to sell LNG to China for a price reported to be around $3 per million Btu when crude oil prices are $20 per barrel (with the actual LNG price varying with the price of crude oil). Existing contracts with Japanese buyers are reported to be about 20 percent higher than the Chinese contract.[16]
  - When Japanese utilities renewed an expiring 20-year, 360-Bcf-per-year (7.4-million-tpy) contract for Malaysian LNG, they reportedly obtained a 5-percent price reduction, a two-tier contract arrangement whereby 58 Bcf (1.2 million tons) per year is sold for 4 years and the rest for 15 years, and an agreement that about one-fourth of the volumes will be sold f.o.b., which will increase shipping flexibility and reduce freight costs for the buyers. The contract also covers short-term purchases.[17]

[16] Koji Morita, "LNG: Falling Prices and Increasing Flexibility of Supply—Risk Redistribution Creates Contract Diversity," International Institute of Energy Economics, Japan, March 2003, page 7.
[17] "Shorter Periods, Partial FOB Transactions Spice Japanese-Malaysian LNG Contracts," LNG Express, July 2003, page 15.

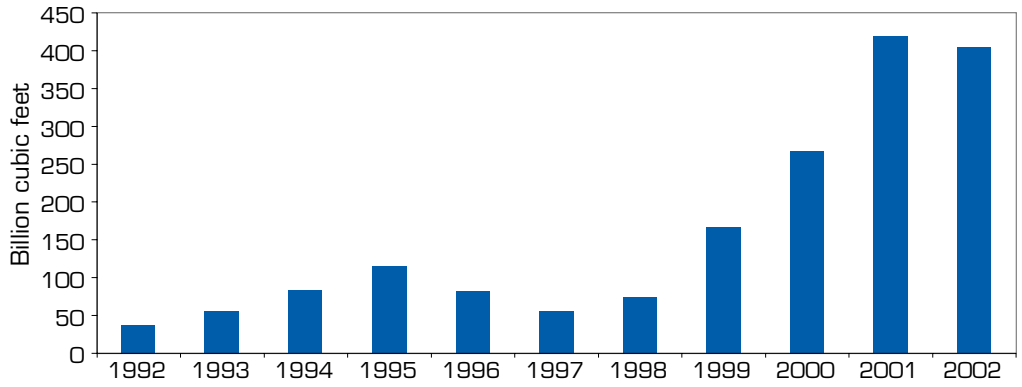
- In the U.S. market, LNG prices are linked to Henry Hub prices, which have been steadily rising. Prices for natural gas in the United States are expected to remain in the $3 to $4 per million Btu range, which would reduce the LNG price differential between the Pacific and Atlantic markets. Meanwhile, the European Union is insisting that LNG sellers remove destination clauses from their contracts.
- The changing market is boosting short-term LNG sales, which accounted for a record-high 8 percent of traded LNG in 2002. The short-term LNG market was virtually nonexistent until a few years ago, and few LNG facilities were built until sales contracts were signed for the entire capacity. Recently, some projects have gone forward with capacity unclaimed. Spare capacity and more flexible contracts should lead to increased short-term sales.

Recent Market Changes: Growth of the Short-Term Market

- One very significant result of this changing environment has been the emergence of a short-term LNG market. All cargos not traded under long-term[18] agreements are here described as short-term sales. This includes cargos traded under 1-year contracts as well as individual cargos of LNG that are bought and sold.
- Several factors continue to drive the short-term market:
  - Uncommitted production capacity, as some new plants are being built (e.g., Malaysia Tiga) without committing the full production volumes.
  - Market demand for more LNG, especially in Spain and the United States, where receiving terminals have excess capacity, and Korea, which needs greater volumes in winter.
  - The availability of ships not committed to projects.
  - Greater contract flexibility.
- The short-term market has grown from virtually zero before 1990, to 1 percent of the LNG market in 1992, and to 8 percent (400 Bcf or 8.4 million tons) in 2002. In 2002, 32 companies traded 218 shipments of LNG either as short-term transactions or as swaps. The leading short-term sellers in 2002 were Algeria, Oman, Qatar, Trinidad and Tobago, and the UAE. Short-term imports were dominated by the United States and Spain, followed by South Korea and France.
- Short-term trading is projected to continue to grow, especially in the Atlantic Basin, and could reach 15 to 20 percent of LNG imports over the next decade. However, whether LNG will ever become a true commodity is still a matter of debate.

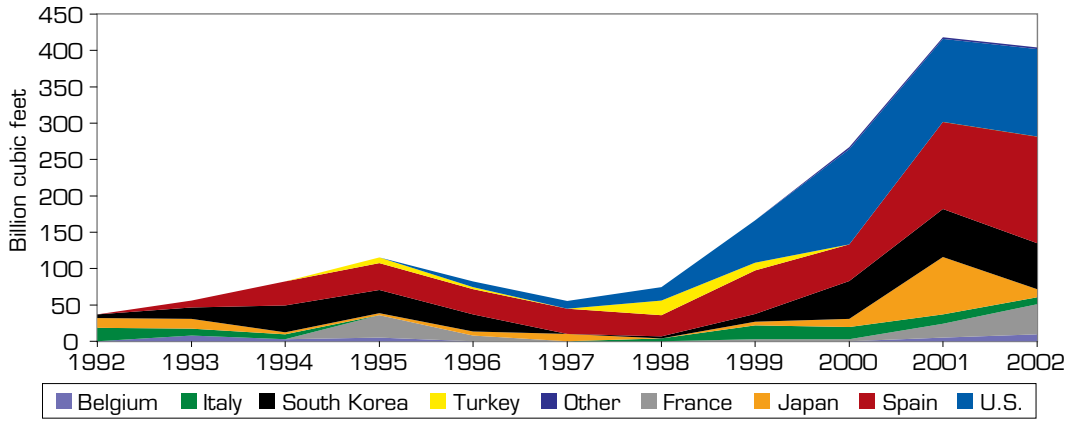
[18] "Long-term" refers to periods greater than or equal to 12 months.

Short-Term LNG Transactions, 1992–2002



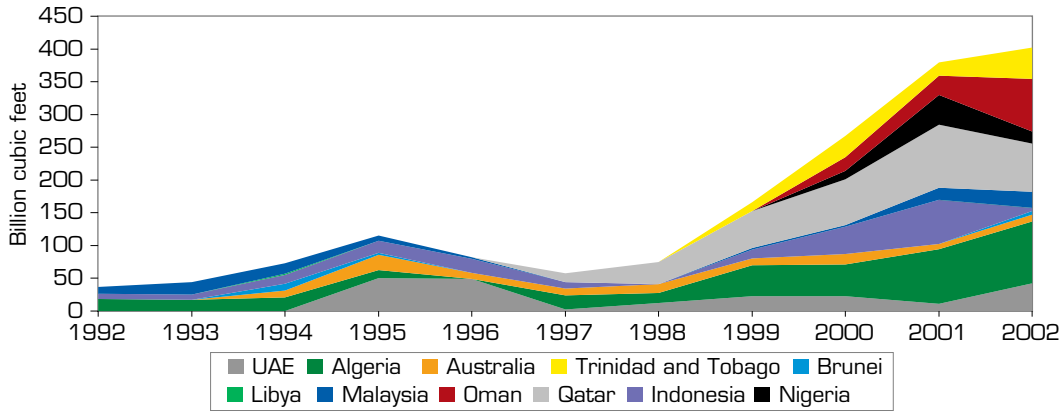
Source: Petrostrategies

Short-Term Contracts by LNG Importing Countries, 1992–2002



Source: Petrostrategies

Short-Term Contracts by LNG Exporting Country, 1992–2002



Source: Petrostrategies

LNG Industry Costs Declining

Costs throughout the value chain have been declining in the LNG industry in recent years. According to the Gas Technology Institute (GTI), liquefaction costs have decreased 35 to 50 percent over the past ten years, with plant capital costs decreasing from more than US$500 per ton of annual liquefaction capacity to less than US$200 for trains at existing plants (in nominal dollars). Building costs for LNG tankers have decreased from about US$280 million (nominal) in the mid-1980s to about US$155 million in late 2003. Regasification terminal costs have also fallen, though costs tend to be site-specific and can range from US$100 million to more than US$2 billion.

- LNG projects are among the most expensive energy projects. Accurate data on LNG plant costs are difficult to pinpoint since costs vary widely depending on location and whether a project is greenfield, i.e., built in a new location, or an expansion of an existing plant.
- According to an independent LNG consultant,[19] there are four main price components of an LNG project, from the gas field to the receiving terminal:
  - Gas production: from the reservoir to the LNG plant, including gas processing and associated pipelines (15 to 20 percent of costs);
  - LNG plant: gas treating, liquefaction, LPG and condensate recovery, LNG loading and storage (30 to 45 percent of costs);
  - LNG shipping (10 to 30 percent of costs); and
  - Receiving terminal: unloading, storage, regasification and distribution (15 to 25 percent of costs).

[19] Andy Flower, President, Andy Flower LNG Associates

Liquefaction Costs

- The largest cost component in the LNG value chain is the liquefaction plant, which consists of one or more trains, or production units. LNG plant costs are typically high relative to comparable energy projects for a number of reasons, including remote locations, strict design and safety standards, large amounts of cryogenic material required, and a historic tendency to overdesign to ensure supply security.
- According to GTI, construction of a liquefaction plant that annually produces 390 Bcf (8.2 million tons) of LNG could cost $1.5 to $2.0 billion. Roughly half of that amount is for construction and related costs, 30 percent is for equipment, and 20 percent is for bulk materials. The liquefaction trains account for approximately half the costs of operating an LNG plant, storage and loading facilities for 24 percent, utilities 16 percent, and other facilities account for the final 11 percent.
- An independent consultant[20] estimates that generic liquefaction costs amount to around US$1.09 per million Btu for a two-train, 8-million-tpy greenfield LNG project and US$0.97 for an expansion train. The cost of adding trains to existing projects (expansion trains) are significantly lower than building a new greenfield plant, since many of the facility components are already in place.
- Major economies of scale have been achieved by increasing the size of liquefaction trains, therefore requiring fewer trains to achieve the same output. In the early days of the industry, trains with annual capacities of 49 Bcf to 97 Bcf (1.0 to 2.0 million tons) were the norm; today, trains with annual capacities of 242 Bcf (5.1 million tons) are under construction, and a 380-Bcf-per-year (7.8-million-tpy) train is planned for Qatar.
- Other factors driving costs downward include:
  - Reduction of over-design margins;
  - Larger and fewer storage tanks;
  - Improved technology, e.g., gas turbines, larger axial compressors, multiple compressors, turbines on a single shaft;
  - Improved engineering techniques; and
  - Competitive lump-sum bidding.

[20] James Jensen, President, Jensen Associates Inc.

Shipping Costs

- Most ships are dedicated to particular LNG projects and are owned by LNG importing and exporting companies or shipping companies. Independent shipping companies own only about a dozen ships in the LNG tanker fleet.
- LNG shipping costs are determined by the daily charter rate, which is a function of the price of the ship, the cost of financing, and operating costs. There is no set market for LNG tanker rates, as there is for crude oil tanker rates. Charter rates vary widely from as low as US$27,000 per day to as high as US$150,000. Today the average rate for long-term charters is between US$55,000 and US$65,000.
- LNG shipping costs expressed in dollars per million Btu are distance- and time-sensitive. Representative shipping rates for the United States include:

Representative LNG Shipping Rates
(Dollars per million Btu)

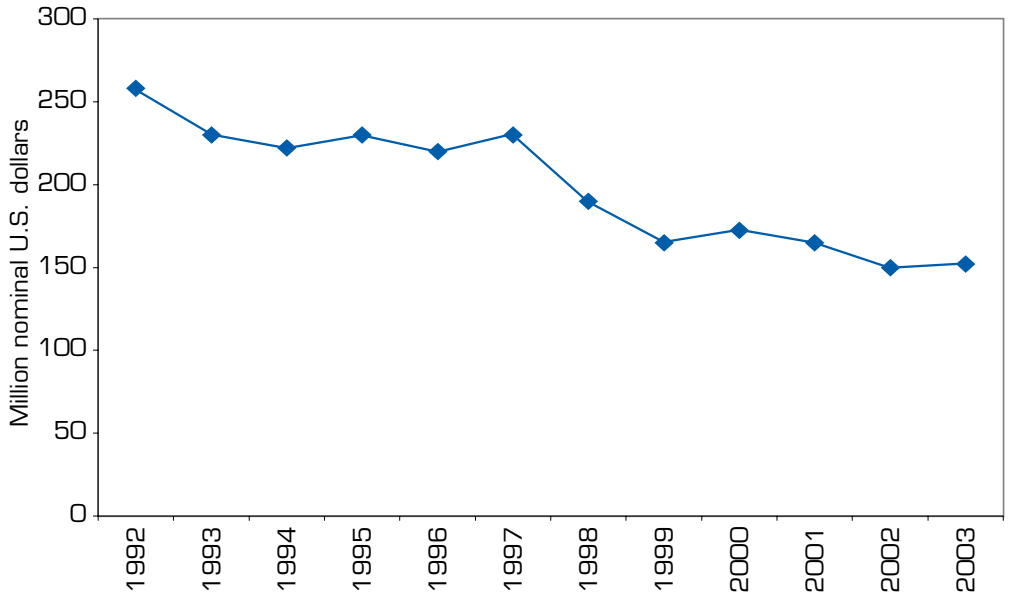
Exporter	Everett	Cove Point	Elba Island	Lake Charles
Algeria	0.52	0.57	0.60	0.72
Nigeria	0.80	0.83	0.84	0.93
Norway	0.56	0.61	0.64	0.77
Venezuela	0.34	0.33	0.30	0.35
Trinidad and Tobago	0.35	0.35	0.32	0.38
Qatar	1.37	1.43	1.46	1.58
Australia	1.76	1.82	1.84	1.84

Note: Prices based on a 138,000-cubic-meter tanker at a charter rate of $65,000 per day.
Source: LNG Shipping Solutions

- Although the average price of purchasing an LNG tanker is difficult to determine, GTI estimates that the average price of a 138,000-cubic-meter-ship (which carries 2.9 Bcf of natural gas) in November 2003 was US$155 million, down from a peak of US$280 million (nominal) in the mid-1980s.
- The main factor driving down prices is an increase in the number of shipyards that can build LNG tankers, which enhances competition. Perhaps the most important savings would come from the emergence of a merchant fleet that could precipitate a more active short-term market with flexible trading. A more fuel-efficient propulsion system could also produce economies in transportation costs.

- According to GTI, the LNG industry is building larger ships, which results in lower per-unit LNG-shipping costs. The largest ships now being built can hold 145,000 cubic meters of LNG, but ships with capacities from 200,000 to 240,000 cubic meters are under study. An increase in ship length and draft, however, could cause compatibility problems with existing terminals that were designed for smaller vessels.

Construction Prices of LNG Tankers, 1992–2003



Note: Price reflects a 125,000-cubic-meter ship from 1992-2000. Price reflects a 138,000-cubic-meter ship from 2001-2003.

Source: LNG Shipping Solutions

Regasification Terminal Costs

- The costs of building regasification or receiving terminals show wide variation and are very site-specific.
- GTI estimates that terminal costs can range from US$100 million for a small terminal to US$2 billion or higher for a state-of-the-art Japanese facility. In the United States, most new terminals are estimated to cost US$200 to US$300 million for a sendout capacity from 183 to 365 Bcf (3.8 to 7.7 million tons) per year of natural gas.
- By far the most expensive items in a terminal are the storage tanks, which can account for one-third to one-half of the entire cost, depending on the kind of tank. The tank type, in turn, is dictated largely by location and local regulatory requirements.
- Marine facilities are another major cost item, especially if significant dredging of the ship channel is needed, which could add as much as US$100 million to the cost of the terminal.
- In the United States, the general assumption is that regasification will add US$0.30 per million Btu to the price of the imported LNG.

Sources

United States Government

Department of Energy, Office of Fossil Energy
(*www.fe.doe.gov*)

Energy Information Administration
(*www.eia.doe.gov*)

Inter-Governmental Organizations

International Energy Agency
(*www.iea.org*)

Consulting Companies/Non-Governmental Organizations

Andy Flower, President, Andy Flower LNG Associates

BP
(*www.bp.com*)

Cedigaz
(*www.cedigaz.org*)

Gas Technology Institute
(*www.gastechnology.org*)

Groupe International des Importateurs de Gaz Natural Liquefie (G.I.I.G.N.L)
(*www.giignl.org*)

International Institute of Energy Economics
(*eneken.ieej.or.jp/en/*)

LNG Express
(*www.lngexpress.com*)

LNG Shipping Solutions
(*www.lngship.net*)

Oil and Gas Journal
(*ogj.pennnet.com/*)

Petrostrategies
(*www.petrostrategies.fr*)

APPENDIX A

Conversion Tables

Frequently Used Conversions

To:	Billion Cubic Meters NG	Billion Cubic Feet NG	Million Tons LNG	Trillion Btu
From:	MULTIPLY BY			
1 Billion Cubic Meters NG	1	35.3	0.73	38.8
1 Billion Cubic Feet NG	0.028	1	0.021	1.1
1 Million Tons LNG	1.38	48.7	1	51.9
1 Trillion Btu	0.028	0.98	0.02	1

One-to-One Conversion Table

To:	Liquid Measures			Vapor Measures		Heat Measure
From:	Metric Ton LNG	Cubic Meter LNG	Cubic Foot LNG	Cubic Meter Natural Gas	Cubic Foot Natural Gas	Btu*
Metric Ton LNG	1.00	2.19	77.47	1,335.90	47,256.70	51,982,370
Cubic Meter LNG	0.46	1.00	35.3	610.00	21,533.00	23,686,300
Cubic Foot LNG	0.012	0.028	1.00	17.08	610.00	671,000
Cubic Meter Natural Gas	0.000749	0.001639	0.058548	1.00	35.30	38,830
Cubic Foot Natural Gas	0.000021	0.000046	0.001639	0.03	1.00	1,100

*Based on Volume Conversion of 610:1 and 1,100 gross dry Btu per cubic feet of vapor.

APPENDIX B

Liquefaction and Regasification Capacity Measurements

Liquefaction Capacity

It is difficult to give precise numbers for the production capacity of liquefaction plants. Figures cited in the press or in company documents can show significant differences depending on whether they refer to the design capacity of the plant or actual output, which itself can vary from year to year depending on operational factors such as the timing of maintenance.

LNG plants are designed to produce the volume of LNG required by the project sponsors; this is often referred to as the 'design' or 'nominal' capacity. Most plants produce significantly more than their design capacity. This was especially true in the early days of the LNG industry, when security of supply was very important and sponsors and contractors wanted to ensure that the plant would not perform below its design capacity. Hence, the facilities were often over-sized and suboptimal operating conditions were assumed.

When these plants came on-stream, they then produced considerably more than their design capacity would have indicated. As experience in designing and operating LNG plants has increased, the degree of over-design has reduced, but plants coming on-stream in recent years still typically operate at 10 percent above their design capacity. After plants come into operation, bottlenecks that constrain production are often identified. 'Debottlenecking' the facility to remove these constraints can provide a low cost option to increase capacity further. As a result, the actual capacity of many LNG plants is over 20 percent higher that the original design capacity.

Regasification Capacity

Many regasification terminals are built to have the ability to send out far more than the average annual requirements of the areas they serve, since they must meet variable seasonality requirements. The nominal capacity of many terminals, especially in Asia, is more than double actual throughput and thus greatly exceeds actual imports. In the United States, total terminal capacity is more than 3 times annual throughput.

APPENDIX C

World LNG Imports by Origin, 2002

(Billion cubic feet)

	Country of Origin												
	Trinidad & Tobago	Algeria	Libya	Nigeria	Qatar	United Arab Emirates	Oman	United States	Australia	Brunei	Indonesia	Malaysia	Total LNG Imports 2002
IMPORTERS													
North America	**151.11**	**26.58**		**8.12**	**35.08**		**3.01**	**0.40**		**2.40**		**2.42**	**229.13**
United States	151.11	26.58		8.12	35.08		3.01			2.40		2.42	228.73
Mexico[1]								0.40					0.40
Central/ South America	**22.18**				**1.77**								**23.94**
Puerto Rico	22.18				1.77								23.94
Western Europe	**15.89**	**908.83**	**21.22**	**385.50**	**76.17**	**17.02**	**56.08**		**2.47**	**2.83**			**1486.02**
Belgium		117.49			3.07	3.53							124.10
France		364.80		128.19			18.40						511.40
Greece		18.01											18.01
Italy		72.47		145.89									218.35
Portugal				14.62									14.62
Spain	15.89	204.65	21.22	55.90	73.10	13.49	37.68		2.47	2.83			427.24
Turkey		131.41		40.89									172.30
Asia/Oceania					**563.06**	**236.96**	**221.04**	**63.44**	**364.63**	**335.95**	**1107.62**	**738.19**	**3630.89**
Japan					325.57	226.02	33.73	63.44	356.54	300.46	728.83	532.09	2566.67
South Korea[2]					237.49	10.95	187.31		8.09	35.49	231.53	106.12	816.98
Taiwan											147.26	99.98	247.24
Apparent Exports	**189.18**	**935.42**	**21.22**	**393.62**	**676.08**	**253.99**	**280.13**	**63.84**	**367.10**	**341.18**	**1107.62**	**740.61**	**5369.99**

[1] Imports to Mexico from the United States are delivered by truck; Imports from Nigeria to Portugal are received in Spain.
[2] Japan re-exported approximately 5.30 billion cubic feet of LNG received from Indonesia to South Korea.
[3] South Korea re-exported approximately 1.77 billion cubic feet of LNG received from Indonesia to Japan.

Source: **Imports to the United States and Imports to Japan and Mexico from the United States**: Energy Information Administration, *Natural Gas Monthly* (May 2003). **Imports to Belgium from United Arab Emirates, Imports to Spain from Australia and Brunei, Imports to Puerto Rico from Qatar:** Cedigaz Centre International d'Information sur le Gaz Naturel et tous Hydrobarbures Gazeux, Natural Gas In the World, Major Trends for the Gas Industry 2002. **All Other Countries:** Organization for Economic Cooperation and Development, International Energy Agency, Natural Gas Information 2003 (with 2002 data).

Note: For Cedigaz data, flows are on a contractual basis and may not correspond to physical gas flows in all cases.

APPENDIX D

Liquefaction Summary Table, October 2003

	Liquefaction Capacity October 2003 (Bcf)	Liquefaction Capacity Under Construction (Bcf)	Proposed New Liquefaction Plants
AFRICA			
Algeria	1,125	-	Yes
Libya	29	-	
Nigeria	463	399	Yes
Egypt	-	594	Yes
Angola	-	-	Yes
Equatorial Guinea	-	-	Yes
TOTAL AFRICA	***1,617***	***993***	
ASIA PACIFIC			
Australia	365	380	Yes
Brunei	351	-	Yes
Indonesia	1,432	-	Yes
Malaysia	916	166	
TOTAL ASIA PACIFIC	***3,063***	***545***	
MIDDLE EAST			
Oman	356	161	
Qatar	726	458	Yes
United Arab Emirates	278	-	
Iran	-	-	Yes
Yemen	-	-	Yes
TOTAL MIDDLE EAST	***278***	***-***	
EUROPE			
Norway	-	200	
Russian Federation (Pacific)	-	234	Yes
TOTAL EUROPE	***-***	***433***	
NORTH AND SOUTH AMERICA			
Trinadad & Tobago	482	253	Yes
United States	68	-	Yes
Bolivia (Peru or Chile)	-	-	Yes
Peru	-	-	Yes
Venezuela	-	-	Yes
TOTAL NORTH AND SOUTH AMERICA	***482***	***253***	
WORLD TOTAL	**5,440**	**2,226**	

APPENDIX E

Regasification Summary Table, October 2003

	Regasification Capacity October 2003 (Bcf)	Regasification Capacity Under Construction (Bcf)	Proposed New Regasification Terminals
ASIA PACIFIC			
Japan	9,168	Expansions	
South Korea	1,982	83	
Taiwan	363	Yes	
China	-	285	
India	-	487	Yes
Indonesia	-	-	Yes
New Zealand	-	-	Yes
Philippines	-	-	Yes
TOTAL ASIA PACIFIC	***11,513***	***855***	
EUROPE			
Belgium	234	-	Yes
France	688	-	Yes
Greece	93	-	
Italy	130	-	Yes
Portugal	146	-	
Spain	716	526	
Turkey	224	146	
United Kingdom	-	161	Yes
Netherlands	-	-	Yes
TOTAL EUROPE	***2,229***	***833***	
NORTH AND SOUTH AMERICA			
Dominican Republic	97	-	
Puerto Rico	34	-	
United States	1,236	-	Yes
Bahamas	-	-	Yes
Jamaica	-	-	Yes
Mexico	-	-	Yes
TOTAL NORTH AND SOUTH AMERICA	***1,367***	-	
WORLD TOTAL	**15,110**	**1,687**	

APPENDIX F

Existing LNG Liquefaction Plants, October 2003

	Plant Capacity					
	Million tons of LNG/year	Billion cubic feet of gas/year	Number of Trains	Lead Plant Operator	Start-Up Date	Comments/ Expansion Plans
AFRICA						
Algeria						
Arzew GL1Z	7.9	385	6	Sonatrach	1978	Revamped 1997
Arzew GL2Z	8.3	404	6	Sonatrach	1981	Revamped 1996
Arzew (Camel) GL4Z	0.9	44	3	Sonatrach	1964	Revamped 1999
Skikda GL1K Phase I and II	6.0	292	6	Sonatrach	1972/1981	Revamped 1999
Total Algeria	**23.1**	**1,125**	**21**			
Libya						
Marsa el Brega	0.6	29	3	NOC (Sirte Oil Company)	1970	Technical limitations only allow the plant to operate at about 1/4 its nominal capacity of 2.5 million tpy.
Nigeria						
Bonny Island	6.6	321	2	Nigerian LNG Ltd (NNPC, Shell Elf, Agip)	1999	Operating at 10 percent above design
Bonny Island Train 3	2.9	141	1	Nigerian LNG ltd.	2002	
Total Nigeria	**9.5**	**463**	**3**			
TOTAL AFRICA	***33.2***	***1,617***	***26***			
ASIA PACIFIC						
Australia						
Withnell Bay	7.5	365	3	NWS joint venture (Woodside, Shell, BHP, BP, Chevron, Mitsubishi/Mitsui)	1989	Debottlenecked 1995
Brunei						
Lumut 1	7.2	351	5	Brunei LNG (Brunei govt., Shell, Mitsubishi)	1972	
Indonesia						
Arun Phase I		–		PT Arun NGL (Pertamina, ExxonMobil, JILCO)	1978	
Arun Phase II		–		PT Arun NGL	1984	
Arun Phase III	6.8	331	4	PT Arun NGL	1986	Two trains decommissioned 2000. Shortage of gas supply means capacity determined by contract volumes rather than liquefaction capacity
Bontang A-H	22.6	1,101	8	PT Badak NGL (Pertamina, VICO Total, JILCO)	1977	A/B:1977; C/D:1986; E:1989; F:1993; G:1998; H:1999
Total Indonesia	**29.4**	**1,432**	**12**			

continued

Existing LNG Liquefaction Plants, October 2003 (continued)

	Plant Capacity					
	Million tons of LNG/year	Billion cubic feet of gas/year	Number of Trains	Lead Plant Operator	Start-Up Date	Comments/ Expansion Plans
Malaysia						
Bintulu MLNG 1	7.6	370	3	MLNG 1 (Petronas, Shell, Mitsubishi	1983	
Bintulu MLNG 2	7.8	380	3	MLNG 2 (Petronas, Shell, Mitsubishi, Sarawak)	1994	
Bintulu MLNG 3	3.4	166	1	MLNG 3 (Petronas, Shell, Nippon Oil, Mitsubishi, Sarawak)	2003	One train commissioned March 2003 but shutdown in Aug because of fire. Train 2 due on stream in Nov 2003. Less than two-thirds of capacity sold.
Total Malaysia	**18.8**	**916**	**7**			
TOTAL ASIA PACIFIC	***62.9***	***3,063***	***27.0***			
MIDDLE EAST						
Total Qatar	**14.9**	**726**	**5**			
Oman						
Qalhat	7.3	356	2	Oman LNG (Oman govt., Shell, Total, Korea LNG, others)	2000	First two trains operating 10 percent above design. Further increases possible through debottlenecking.
Qatar						
Ras Laffan	8.3	404	3	Qatargas (QP, Exxon Mobil, Total, Marubeni, Mitsui)	1996	Currently debottlenecking to raise capacity to 9.5 million tpy. First stage (0.6 million tpy completed Oct 2003)
Ras Laffan	6.6	321	2	Ras Laffan LNG Co. (QP, Exxon Mobil)	1998	
United Arab Emirates (Abu Dhabi)						
Das Island I, II	5.7	278	3	ADGAS (ADNOC, BP, Total, Mitsui)	1977/1994	
TOTAL MIDDLE EAST	***27.9***	***1,359***	***10***			
NORTH AND SOUTH AMERICA						
Trinadad & Tobago						
Point Fortin	9.9	482	3	Train 1: Atlantic LNG Co. (BP, BG, Repsol, Tractebel, NGC); Trains 2&3: BP, BG, Repsol	1999/2003	
United States						
Kenai	1.4	68	2	Marathon/Phillips	1969	
TOTAL NORTH AND SOUTH AMERICA	***11.3***	***550***	***3***			
WORLD TOTAL	**135.3**	**6,589**	**66**			

Data from IEA 2003 *Natural Gas Information*, Gas Technology Institute's *World LNG Source Book 2001*, and updated based on trade press reports as assembled by the Gas Technology Institute.

APPENDIX G

LNG Liquefaction Capacity Under Construction, October 2003 *(online by 2007)*

	Plant Capacity					
	Million tons of LNG/year	Billion cubic feet of gas/year	Number of Trains	Lead Plant Operator	Anticipated Start-Up Date	Comments/ Expansion Plans
AFRICA						
Egypt						
Damietta	5.0	243.5	1	Segas (Union Fenosa, EGPC)	2004	
Idku	3.6	175.3	1	Egyptian LNG (EGPC, EGAS, BG, Gaz de France, Petronas)	2005	Entire output contracted to Gaz de France. Complex can house up to six trains
Idku	3.6	175.3	1	EGPC, EGAS, BG, Petronas	2006	Contracted to BG – intially 100 percent for from 2007 up to 50 percent to Brindisi (Italy)
Total Egypt	**12.2**	**594.1**	**3**			
Nigeria						
Bonny Island	8.2	399.3	2	Nigeria LNG Plus (NNPC, Shell, Total, AGIP)	2005	
TOTAL AFRICA	***20.4***	***993.5***	***5***			
ASIA PACIFIC						
Australia						
Northwest Shelf Train 4	4.2	205	1	Northwest Shelf Venture (Woodside, Shell, BHP, BP, TexacoChevron, Mitsubishi, Mitsui)	2004	Output sold to Japanese buyers. Build-up 2004-2010. Surplus volumes during build-up sold to Shell and Korea Gas
Darwin	3.6	175	1	Darwin LNG (ConocoPhillips, Santos, Impex, Kerr-McGee, AGIP, Tokyo Gas, Tokyo Electric)	2004	Entire output committed to Tokyo Electric/Tokyo Gas
Total Australia	**7.8**	**379.9**	**2**			
Malaysia						
Malaysia LNG Tiga	3.4	165.6	1	Malaysia LNG Tiga (Petronas, Shell, Nippon Oil, Sarawak, Diamond Gas)	2003	Second train
TOTAL ASIA PACIFIC	***16.0***	***545.4***	***3***			

continued

LNG Liquefaction Capacity Under Construction, October 2003 (continued)

	Plant Capacity					
	Million tons of LNG/year	Billion cubic feet of gas/year	Number of Trains	Lead Plant Operator	Anticipated Start-Up Date	Comments/ Expansion Plans
EUROPE						
Norway						
Melkoye	4.1	199.7	1	Snohvit AG (Statoil, Total, Gaz de France, Norsk Hydro, Norwegian govt.)	2006	
Russia						
Sakhalin II	4.8	233.8	2	Shell, Mitsubishi, Mitsui	2007	First train 2007 (4.8 million tpy) second train 2008 (4.8 million tpy).
TOTAL EUROPE	***4.1***	***233.8***	***2***			
MIDDLE EAST						
Oman						
Qalhat	3.3	160.7	1	Qalhat LNG (Oman govt., Union Fenosa, Shell, Japanese and Korean cos.)	2006	
Qatar						
Ras Laffan	9.4	457.8	2	Ras Laffan II (QP, ExxonMobil)	2004	Train 1: Feb 2004 Train 2: Oct 2005
TOTAL MIDDLE EAST	***12.7***	***618.5***	***3***			
NORTH AND SOUTH AMERICA						
Trinidad and Tobago						
Atlantic LNG Train 4	5.2	253.2	1	BP, BG, RepsolYPF, NGC	2005	Gas producers will market own production. US likely to be main market.
TOTAL NORTH AND SOUTH AMERICA	***5.2***	***253.2***	***1***			
WORLD TOTAL	**58.4**	**2,844.1**	**14**			

Data from IEA 2003 *Natural Gas Information*, and updated based on trade press reports as assembled by the Gas Technology Institute.

APPENDIX H

Proposed LNG Liquefaction Capacity, October 2003

	Plant Capacity					
	Million tons of LNG/year	Billion cubic feet of gas/year	Number of Trains	Lead Plant Operator	Anticipated Start-Up Date	Comments/ Expansion Plans
AFRICA						
Algeria						
Arzew (new)	4.0	194.8	1	Gassi Touil Integrated Gas Project	2008+	
Angola						
Soya	8.0	389.6	2	ChevronTexaco, Sonangol, BP, ExxonMobil, Total	2008+	
Egypt						
Damietta	5.0	243.5	1	Segas		Additional proposed train
Idku (Edku)	3.6	175.3	1	Egyptian LNG Train 3	2007+	Further expansion. Will require existing partenrs to bring in gas from other producers
Equatorial Guinea						
Bioko Island	3.4	165.6	1	Marathon	2007	Signed MOU with BG for sale of 3.4 million tpy with flexibility in gas destination
Nigeria						
Nigeria LNG 6	4.1	199.7	1	Nigeria LNG	mid-2006	Additional proposed train
West Niger Delta	5.0	243.5	1	ExxonMobil, ChevronTexaco, ConocoPhillips	2008+	
Brass River LNG	10.0	487.0	1	NNPC, ENI, ConocoPhillips, ChevronTexaco	2007+	Plant to use associated gas currently flared
Floating LNG	5.0	243.5	1	Statoil, Shell	2009+	Initial feasibility study initiated 2002 by Shell and Statoil

continued

Proposed LNG Liquefaction Capacity, October 2003 (continued)

	Plant Capacity					
	Million tons of LNG/year	Billion cubic feet of gas/year	Number of Trains	Lead Plant Operator	Anticipated Start-Up Date	Comments/ Expansion Plans
ASIA PACIFIC						
Australia						
Northwest Shelf 5	4.2	204.5	1	NWS Joint Venture	2007+	Need for train uncertain. Contracts with Japan and China can probably be supplied by existing three trains and train 4 expansion
Gorgon LNG	10.0	487.0	2	ChevronTexaco, ExxonMobil, and Shell	2008	MOU for 5 million tpy to China and 4 mtpa to W. Coast of U.S.
Greater Sunrise	5.3	258.1		Woodside, Osaka Gas, ConocoPhillips, Shell	2009	
Brunei						
Brunei LNG 6	4.0	194.8	1	Brunei LNG	2008+	Depends on proving additional gas reserves
Indonesia						
Donggi	7.0	340.9	2	Pertamina	2008	Potential market W. Coast
Tangguh	7.0	340.9	2	BP, CNOOC, Mitsubishi, Mitsui, Nippon Oil, etc.	2007	Markets Fujian (China), Korea, W. Coast
Bontang Train I	3.5	170.5	1	Total, Unocal	2007+	
EUROPE						
Russia						
Sakhalin II	4.8	233.8	2	Shell, Mitsubishi, Mitsui	2008	Second train 2008 (4.8 million tpy).
Mermansk						Corsortium of Russian companies have agreed to split the costs of a necessary pipeline from gas fields in Siberia to Murmansk.

continued

Proposed LNG Liquefaction Capacity, October 2003 (continued)

	Plant Capacity					
	Million tons of LNG/year	Billion cubic feet of gas/year	Number of Trains	Lead Plant Operator	Anticipated Start-Up Date	Comments/ Expansion Plans
MIDDLE EAST						
Iran						
NIOC LNG (South Pars Phase 11)	8.0	389.6	2	NIOC, BG, Enel, Agip		
Iran LNG Partnership (South Pars Phase 12)	8.0	389.6	2	NIOC, BP, Reliance Petroleum Ltd.		
Pars LNG	10.0	487.0	2	NIOC, Total and Petronas		
Persian LNG	10.0	487.0	2	NIOC, Repsol and Shell		
Qatar						
Ras Laffan 5/6	15.0	730.5	2	Ras Laffan LNG Company		Agreement bteween ExxonMobil/QP for 2 new trains for U.S.
QatarGas II	15.0	730.5	2	Qatargas, ExxonMobil	2007/08	Proposed additional train; LNG targeted at UK
Qatargas III	7.8	379.9	1	Qatargas, ConocoPhillips	2009	Targeting the U.S.
Qatargas IV	5.0	243.5	1	Qatargas, Total		Targeting Europe and the U.S.
Yemen						
Yemen LNG	6.0	292.2	2	Yemen LNG		
NORTH AND SOUTH AMERICA						
Bolivia/Peru or Chile						
Margerita	7.0	340.9	2	Total, Repsol, BG, Sempra		Ships gas from Bolivia either to Peru or Chile for liquefaction at the coast. Export via Chile strongly opposed.
Peru						
Camisea	4.0	194.8	1	Hunt Oil Co., SK Corp.	2007	MOU with Tractebel for supply to Lazaro Cardenas (south-west Mexico).
Trinidad and Tobago						
Atlantic LNG 5/6	10.4	506.5	2	Atlantic LNG		Two additional trains under discussion.
United States						
Liquefaction at Valdez, Alaska	14.0	681.8		Yukon Pacific Corporation		Project has been proposed for more than a decade. Gas from North Slope to be transported 500 miles via pipeline to liquefaction terminal at Valdez.
Venezuela						
Marischal Sucre	4.7	228.9	1	Shell, Mitsubishi	2007	Under discussion since 1970s with limited progress.

Data from IEA 2003 *Natural Gas Information*, and updated based on trade press reports as assembled by the Gas Technology Institute.

APPENDIX I

Existing LNG Import Terminals, October 2003

Country	Plant Capacity: Million Metric Tons LNG per year	Plant Capacity: Billion Cubic Feet per year	Storage Capacity Cubic Meters	Lead Plant Operator	Start-Up Date	Comments/ Plans for Expansion
EUROPE						
Belgium						
Zeebrugge	4.8	234	260,000	Fluxys	1987	
France						
Fos-sur-Mer	5.9	285	150,000	Gaz de France	1972	Revamped 1995-2000
Montoir-de-Bretagne	8.3	402	360,000	Gaz de France		
Total France	**14.1**	**688**	**510,000**			
Greece						
Revithoussa	1.9	93	144,000	DEPA	2000	
Italy						
Panigaglia	2.7	130	100,000	SNAM	1971	
Portugal						
Sines	3.0	146	240,000	Gas de Portugal	2003	
Spain						
Barcelona	6.4	311	240,000	Enagas	1968 (latest expansion 1996)	Plans expansion by 2005
Huelva	2.9	141	160,000	Enagas	1988	Plans expansion by 2005
Cartagena	2.7	131	160,000	Enagas	1989	Plans expansion by 2005
Bilbao	2.7	131	320,000	BP, RepsolYPF, Iberdrola, EVE	2003	Facility received commissioning cargo Aug 2003
Total Spain	**14.7**	**716**	**880,000**			
Turkey						
Marmara Ereglisi	4.6	224	255,000	Botas	1994	
United Kingdom						
Canvey Island					1964	Dismantled
TOTAL EUROPE	***45.8***	***2,229***	***2,389,000***			
ASIA PACIFIC						
Japan						
Chita Kyodo	8.0	387	300,000	Toho Gas	1977	
Chita	12.0	584	640,000	Chubu Electric	1983	
Fukuoka	0.6	31	70,000	Fukuaoka Gas	1993	
Futtsu	16.0	779	860,000	Tokyo Electric	1985	
Hatsukaichi	0.4	18	170,000	Hiroshima Gas	1996	
Higashi-Ohgishima	14.7	714	540,000	Tokyo Electric	1984	
Himeji	8.3	402	520,000	Osaka Gas	1979	
Himeji Joint	4.0	195	1,440,000	Osaka Gas/ Kansai Electric	1984	
Kagoshima	0.1	6	36,000	Kagoshima Gas	1996	
Kawagoe	7.7	374	480,000	Chubu Electric	1997	
Negishi	13.6	662	1,250,000	Tokyo Gas	1969	
Niigata	17.1	830	720,000	Tohoku Electric	1984	

continued

Existing LNG Import Terminals, October 2003 (continued)

Country	Plant Capacity: Million Metric Tons LNG per year	Plant Capacity: Billion Cubic Feet per year	Storage Capacity Cubic Meters	Lead Plant Operator	Start-Up Date	Comments/ Plans for Expansion
Ohgishima	5.1	247	600,000	Tokyo Gas	1998	
Senboku I	2.5	119	180,000	Osaka Gas	1972	
Senboku II	13.1	636	1,510,000	Osaka Gas	1977	
Shin-Minato	8.0	389	80,000	Sendai Gas	1997	
Oita	5.1	247	460,000	Kyushu Electric	1990	
Sodegaura	27.7	1350	2,660,000	Tokyo Gas	1973	
Sodeshi	6.4	311	174,300	Shizuoka Gas	1997	
Tobata	6.4	311	480,000	Kyushu Electric	1977	
Yanai	2.4	117	480,000	Chugoku Electric	1990	
Yokkaichi LNG Centre	8.8	428	320,000	Toho Gas	1987	
Yokkaichi Works	0.6	31	160,000	Chubu Electric	1991	
Total Japan	**188.3**	**9,168**	**14,130,300**			
South Korea						
Pyeongtaek	13.3	649	1,000,000	Korea Gas	1986	
Incheon	22.4	1090	1,000,000	Korea Gas	1996	
Tongyeong	5.0	244	300,000	Korea Gas	2002	
Total South Korea	**40.7**	**1,982**	**2,300,000**			
Taiwan						
Yung An	7.5	363	430,000	CPC	1990	Debottlenecked 2001
TOTAL ASIA	***236.4***	***11,513***	***16,860,300***			
NORTH AMERICA						
Dominican Republic						
Andres	2.0	97	160,000	AES Corp	2003	
Puerto Rico						
Guayanilla Bay (Ecoelectrica LP)	0.7	34	160,000	Edison Mission Energy, Gas Natural	2000	
Continental United States						
Everett, MA	5.5	260	155,000	Tractebel	1971	
Lake Charles, LA	7.7	365	286,200	Southern Trunkline–Open access	1980, Reopened 1989	Capacity up to 28 million cf/d
Elba Island, GA	5.2	246	118,000	El Paso–Open access	1978; Reopened 2002	Capacity up to 19 million cf/d
Cove Point, MD	7.7	365	180,000	Dominion Resources–Open Accees	1978; Reopened 2003	
Total Continental United States	**26.0**	**1,236**	**379,000**			
TOTAL NORTH AMERICA	***28.7***	***1,367***	***699,000***			
WORLD TOTAL	**310.8**	**15,110**	**19,948,300**			

Data from IEA 2003 *Natural Gas Information*, Gas Technology Institute's *World LNG Source Book 2001*, and updated based on trade press reports as assembled by the Gas Technology Institute.

APPENDIX J

LNG Import Capacity Under Construction, October 2003

Country	Plant Capacity: Million Metric Tons per year	Plant Capacity: Billion Cubic Feet per year	Storage Capacity Cubic Meters	Lead Plant Operator	Start-Up Date	Comments/ Plans for Expansion
EUROPE						
Spain						
Sagunto	3.7	180.2	300	Union Fenosa, Iberdrola, Endesa	2006/07	
El Ferrol	2.0	97.4	300	Union Fenosa, Sonatrach etc.	2006/07	
Barcelona	1.2	58.4	150	Enagas	2005	Expansion
Huelva	2.9	141.2		Enagas	2005	Expansion
Cartagena	1.0	48.7		Enagas	2005	Expansion
Total Spain	**10.8**	**526.0**				
Turkey						
Aliaga (Izmir)	3.0	146.1	300	Ege-gaz	?	Facility complete but no link to pipeline grid.
UK						
Isle of Grain	3.3	160.7	200	National Grid Transco	2005	Conversion of existing peak-shaving plant to import terminal. Although conversion is not yet underway, contracts for conversion have been awarded. BP/ Sonatrach have contracted for all the capacity.
TOTAL EUROPE	***20.1***	***978.9***				

continued

LNG Import Capacity Under Construction, October 2003 (continued)

Country	Plant Capacity: Million Metric Tons per year	Plant Capacity: Billion Cubic Feet per year	Storage Capacity Cubic Meters	Lead Plant Operator	Start-Up Date	Comments/ Plans for Expansion
ASIA PACIFIC						
China						
Guangdong	3.3	158.3	320	Guangdong LNG	2006/07	Construction was delayed by SARS. Receiving from Australia's NW shelf expansion Feasibility study approved Oct 2003.
Fujian	2.6	126.6		Fujian LNG	2007	Construction was delayed by SARS. Receiving from Indonesia's Tangguh facility.
Total China	**5.9**	**284.9**				
India						
Dahej	5.0	243.5	300	Petronet	2003	Contract for 5 mtpa with RasGas (Qatar). Start-up end 2003.
Hazira	2.5	121.8	300	Shell	2004	Speculative terminal no contracts yet for supply
Dabhol	2.5	121.8			?	Construction delayed when Enron withdrew from the project. Project abandoned 95 percent complete following bankruptcy of Dabhol Power Co.
Total India	**10.0**	**487.0**				
Japan						
Expansions underway at several existing LNG regasification terminals						
South Korea						
Kwangyang	1.7	82.8	300	Pohang Iron and Steel		2005
Taiwan						
Taoyuan				Tung Ting		Project unlikley to proceed since Tung Ting failed to secure Taipower contract.
TOTAL ASIA	***17.6***	***730.5***				
WORLD TOTAL	**37.7**	**1709.4**				

Data from IEA 2003 *Natural Gas Information*, and updated based on trade press reports as assembled by the Gas Technology Institute.

APPENDIX K

Proposed LNG Import Capacity, October 2003

Country	Plant Capacity: Million Metric Tons per year	Plant Capacity: Billion Cubic Feet	Lead Plant Operator	Anticipated Start-Up	Comments
EUROPE					
Belgium					
Zeebrugge	4.8	233.8	Fluxys		Expansion planned
France					
Fos Cavaou	6.0	292.2	Gaz de France	2007/08	
Fos-sur-Mer			ExxonMobil	2009	Proposed to import LNG from Qatar
Italy					
Total of ten projects discussed in Italy, including at Toranto, Muggia, Vado Ligure, Tuscany, 2 in Calabria					
Brindisi	3.0	146.1	BG/ENEL	2007	BG received necessary government authorization
Rosignano Marittimo	3.0	146.1	"Edison SPA, BP"	2007+	Currently seeking authorization
Rovigo Offshore	3.0	146.1	"ExxonMobil, Edison"	2006+	Terminal being planned
Offshore Livorno	2.0	97.4	Cross Energy/ Golar LNG	2005+	
Netherlands					
Eemshaven			NAM		
United Kingdom					
Milford Haven	7.5	365.3	ExxonMobil	2007	Planning permission received Oct 2003
Milford Haven (Expansion)	7.5	365.3	ExxonMobil	2008/09	
Milford Haven	6.8	331.2	Petroplus	2007	

continued

Proposed LNG Import Capacity, October 2003 (continued)

Country	Plant Capacity: Million Metric Tons per year	Plant Capacity: Billion Cubic Feet	Lead Plant Operator	Anticipated Start-Up	Comments
NORTH AND SOUTH AMERICA					
Bahamas					
Hawksbill Creek LNG	7.0	340.9	Tractebel	2007+	
Ocean Breeze	7.0	340.9	AES	2007+	
El Paso				?	Project for sale
Jamaica	1.4	68.2		2007+	Early stages of planning
Jamaica LNG	1.4	68.2		2007+	Early stages of planning
Mexico					
Baja California Regional Energy Project	6.0	292.2	Marathon	2007+	Engineering and construction contract awarded but still needs permit from local authority
Costa Azul Energia	12.0	584.4	Sempra	2007+	All necessary permits in place
Costa Azul	12.0	584.4	Shell	2007+	Needs permit from local authority
Offshore Tijuana	12.0	584.4	ChevronTexaco	2007+	Seeking approvals
Lazaro Cardenas	4.4	214.3	Tractebel	2007+	MOU for LNG from Peru
Altamira (Gulf of Mexico)	6.0	292.2	Shell/Total	2006	Secured contract to supply local power plants
United States and Canada	More than two dozen proposed locations throughout the United States and Canada. Many of the projects listed for Mexico and the Bahamas are also targeting the United States' market.				
ASIA PACIFIC					
India					
Kochi	2.5	121.8	Petronet	2007+	
Indonesia					
West Java	2.0	97.4	BP, Pertamina	2007+	
New Zealand	n/a		Contact Energy, Genesis Power	n/a	Supplies from Australia
Philippines					
Mariveles	1.4	68.2	GN Power	2007+	

Data from IEA 2003 *Natural Gas Information*, and updated based on trade press reports as assembled by the Gas Technology Institute.

APPENDIX L

LNG Tanker Fleet

	Vessel Name	Year Built	Capacity (Cubic meters)	Ship Owner	Project/Trade	Availability
1	Cinderella	1965	25,500	Chemikalien Seetransport	Algeria to Spain	Fixed
2	LNG Palmaria	1969	41,000	SNAM	Algeria to Spain	Fixed
3	Methane Arctic	1969	71,500	BG	Algeria to Spain/ Trinidad to U.S.	Fixed
4	Methane Polar	1969	71,500	BG	Algeria to Spain/ Trinidad to U.S.	Fixed
5	Laieta	1970	40,000	Maritima del Norte	Enagas/Algeria to Spain	Fixed
6	LNG Elba	1970	41,000	SNAM	Algeria to Spain	Fixed
7	Hassi R'Mel	1971	40,850	SNTM-Hyproc	Algeria–Europe	Fixed
8	Descartes	1971	50,000	Messigaz	Algeria to France–Panigaglia	Fixed
9	Bebatik	1972	75,060	Brunei Shell Tankers	Brunei to Japan	Fixed
10	Tellier	1973	40,081	Messigaz	Algeria to France	Fixed
11	Bekalang	1973	75,080	Brunei Shell Tankers	Brunei to Japan	Fixed
12	Bekulan	1973	75,070	Brunei Shell Tankers	Brunei to Japan	Fixed
13	Norman Lady	1973	87,600	Leif Hoegh/MOL	Enagas–Trinidad to Spain/U.S.	Fixed
14	Havfru	1973	29,388	Bergesen D.Y. ASA	Abu Dhabi to Spain	Fixed
15	Belais	1974	75,040	Brunei Shell Tankers	Brunei to Japan	Fixed
16	Hoegh Galleon	1974	87,600	Leif Hoegh	Oman to U.S.	Fixed
17	Century	1974	29,588	Bergesen D.Y. ASA	Algeria to Greece	Fixed
18	Isabella	1975	35,500	Chemikalien Seetransport	Enagas	Fixed
19	Annabella	1975	35,500	Chemikalien Seetransport	Enagas	Fixed
20	Bilis	1975	77,731	Brunei Shell Tankers	Brunei to Japan	Fixed
21	Bubuk	1975	77,670	Brunei Shell Tankers	Brunei to Japan	Fixed
22	Belanak	1975	75,000	Brunei Shell Tankers	Brunei to Japan	Fixed
23	Hilli	1975	126,227	Golar LNG	Kogas–Indonesia to Korea	Fixed
24	Mostefa Ben Boulaid	1976	125,260	SNTM-Hyproc	Algeria	Fixed
25	LNG Lagos	1976	122,000	Bonny Gas Transport (NLNG)	Nigeria to Europe	Fixed
26	Gimi	1976	126,277	Golar LNG	Spot	Fixed
27	Larbi Ben M'Hidi	1977	129,767	SNTM-Hyproc	Algeria to Turkey	Fixed
28	LNG Port Harcourt	1977	122,000	Bonny Gas Transport (NLNG)	Nigeria to Europe	Fixed
29	Edouard LD	1977	129,299	Methane Transport	Algeria to France	Fixed
30	LNG Aquarius	1977	126,300	BGT. Ltd.	Qatar to Japan	Fixed
31	LNG Aries	1977	126,300	BGT. Ltd.	Brunei to Japan/Korea	Fixed
32	Hoegh Gandria	1977	125,820	Leif Hoegh/MOL	Indonesia–Korea	Fixed
33	Golar Freeze	1977	125,858	Golar LNG	Trinidad to U.S.	Fixed
34	Khannur	1977	126,360	Golar LNG	Trinidad to U.S.	Fixed
35	Methania	1978	131,260	Exmar	Algeria to Belgium	Fixed
36	LNG Capricorn	1978	126,300	BGT. Ltd.	Indonesia to Japan	Fixed

continued

LNG Tanker Fleet (continued)

	Vessel Name	Year Built	Capacity (Cubic meters)	Ship Owner	Project/Trade	Availability
37	LNG Leo	1978	126,400	BGT. Ltd.	Indonesia to Japan	Fixed
38	LNG Gemini	1978	126,300	BGT. Ltd.	Indonesia to Japan	Fixed
39	Galeomma	1978	126,540	STASCO	Spot	Fixed
40	LNG Delta	1978	126,540	STASCO	Nigeria to Europe	Fixed
41	Bachir Chihani	1979	129,767	SNTM-Hyproc	Algeria to Turkey	Fixed
42	LNG Virgo	1979	126,400	BGT. Ltd.	Indonesia to Japan	Fixed
43	LNG Taurus	1979	126,300	BGT. Ltd.	Indonesia to Japan	Fixed
44	LNG Libra	1979	126,400	BGT. Ltd.	Indonesia to Japan	Fixed
45	Matthew	1979	126,540	Tractabel	Trinidad to Boston	Fixed
46	Mourad Didouche	1980	126,130	SNTM-Hyproc	Algeria to Belgium	Fixed
47	Tenaga Dua	1980	130,000	MISC	Malaysia to Japan	Fixed
48	Tenaga Satu	1980	130,000	MISC	Malaysia to Japan	Fixed
49	LNG Abuja	1980	126,530	Bonny Gas Transport (NLNG)	Nigeria to Europe	Fixed
50	LNG Edo	1980	126,530	Bonny Gas Transport (NLNG)	Nigeria to Europe	Fixed
51	Tenaga Empat	1981	130,000	MISC	Malaysia to Japan	Fixed
52	Tenaga Lima	1981	130,000	MISC	Malaysia to Japan	Fixed
53	Ramdane Abane	1981	126,130	SNTM-Hyproc	Algeria to France	Fixed
54	Tenaga Tiga	1981	130,000	MISC	Malaysia to Japan	Fixed
55	Golar Spirit	1981	129,000	Golar LNG	Indonesia–Japan (Arun)	Fixed
56	LNG Bonny	1981	133,000	Bonny Gas Transport (NLNG)	Nigeria to Europe	Fixed
57	Bishu Maru	1983	125,000	K Line/NYK/MOL	Indonesia to Japan	Fixed
58	Echigo Maru	1983	125,568	NYK/MOL/K LINE	Indonesia to Taiwan	Fixed
59	Banshu Maru	1983	125,542	K Line/NYK/MOL	Indonesia to Japan	Fixed
60	Kotowaka Maru	1984	125,199	NYK/MOL/K LINE	Indonesia to Japan	Fixed
61	LNG Finima	1984	133,000	Bonny Gas Transport (NLNG)	Nigeria to Europe	Fixed
62	Dewa Maru	1984	125,000	Kline/MOL/NYK	Indonesia to Japan	Fixed
63	Senshu Maru	1984	125,000	NYK/MOL/K LINE	Indonesia to Japan	Fixed
64	Wakaba Maru	1985	125,000	Kline/MOL/NYK	Indonesia to Japan	Fixed
65	Northwest Swift	1989	127,590	MOL/NYK/KL	Australia to Japan	Fixed
66	Northwest Sanderling	1989	127,525	Aust. LNG Ship Optg.	Australia to Japan	Fixed
67	Northwest Swallow	1989	127,708	MOL/NYK/KL	Australia to Japan	Fixed
68	Ekaputra	1990	136,400	P.T. Humpuss/MOL	Indonesia to Taiwan	Fixed
69	Northwest Snipe	1990	127,747	Aust. LNG Ship Optg.	Australia to Japan	Fixed
70	Northwest Shearwater	1991	127,500	Aust. LNG Ship Optg.	Australia to Japan	Fixed
71	Northwest Seaeagle	1992	127,452	Aust. LNG Ship Optg.	Australia to Japan	Fixed
72	Aman Bintulu	1993	18,928	MISC	Malaysia to Japan	Fixed
73	Arctic Sun	1993	89,880	Phillips 66/ Marathon Oil	Alaska to Japan	Fixed
74	Polar Eagle	1993	89,880	Phillips 66/ Marathon Oil	Alaska to Japan	Fixed
75	LNG Flora	1993	127,705	Osaka Gas/ Toho GasNYK/MOL	Indonesia to Japan	Fixed
76	Northwest Sandpiper	1993	127,500	Aust. LNG Ship Optg.	Australia to Japan	Fixed
77	Al Khaznah	1994	135,496	National Gas Shpg.	Abu Dhabi to Japan	Fixed
78	Puteri Delima	1994	130,405	MISC	Malaysia to Taiwan	Fixed
79	Puteri Intan	1994	130,405	MISC	Malaysia to Japan	Fixed

continued

LNG Tanker Fleet (continued)

	Vessel Name	Year Built	Capacity (Cubic meters)	Ship Owner	Project/Trade	Availability
80	YK Sovereign	1994	127,125	SK Shipping Co. Ltd.	Indonesia/ Malaysia to Korea	Fixed
81	Hyundai Utopia	1994	125,182	Hyundai Merchant Marine	Indonesia to Korea	Fixed
82	Shahamah	1994	135,496	National Gas Shpg.	Abu Dhabi to Japan	Fixed
83	LNG Vesta	1994	127,547	Tokyo Gas/Toho Gas/ NYK/MOL	Indonesia to Japan	Fixed
84	Dwiputra	1994	127,386	MOL/NYK/LNG Japan	Indonesia to Japan	Fixed
85	Northwest Stormpetrel	1994	127,606	Aust. LNG Ship Optg.	Australia to Japan	Fixed
86	Puteri Nilam	1995	130,405	MISC	Malaysia to Japan	Fixed
87	Hanjin Pyeong Taek	1995	130,600	Hanjin Shpg Co.	Indonesia to Korea	Fixed
88	Mubaraz	1995	137,000	National Gas Shpg.	Abu Dhabi to Japan	Fixed
89	Ish	1995	137,540	National Gas Shpg.	Abu Dhabi to Japan	Fixed
90	Ghasha	1995	137,514	National Gas Shpg.	Abu Dhabi to Japan	Fixed
91	Al Hamra	1996	137,000	National Gas Shpg.	Abu Dhabi to Japan	Fixed
92	Al Khor	1996	137,354	K Line/MOL/NYK/IINO	Ras Laffan to Japan	Fixed
93	Al Zubarah	1996	137,573	K Line/MOL/NYK/IINO	Ras Laffan to Japan	Fixed
94	Puteri Zamrud	1996	130,405	MISC	Malaysia to Japan	Fixed
95	Hyundai Greenpia	1996	125,000	Hyundai Merchant Marine	Indonesia to Korea	Fixed
96	Surya Aki	1996	19,474	MOL/LNG Japan	Indonesia to Japan	Fixed
97	Mraweh	1996	137,000	National Gas Shpg.	Abu Dhabi to Japan	Fixed
98	LNG Portovenere	1996	65,000	SNAM	Algeria to Italy	Fixed
99	Al Rayyan	1997	135,358	K Line/MOL/NYK/IINO	Ras Laffan to Japan	Fixed
100	Aman Sendai	1997	18,928	MISC	Malaysia to Japan	Fixed
101	Al Wajbah	1997	137,354	K Line/MOL/NYK/IINO	Ras Laffan to Japan	Fixed
102	Puteri Firus	1997	130,405	MISC	Malaysia to Japan	Fixed
103	Umm Al Ashtan	1997	137,000	National Gas Shpg.	Abu Dhabi to Japan	Fixed
104	Aman Hakata	1998	18,800	MISC	Malaysia to Japan	Fixed
105	Al Wakrah	1998	135,358	K Line/MOL/NYK/IINO	Ras Laffan to Japan	Fixed
106	Zekreet	1998	135,000	Kline/MOL/NYK	Ras Laffan to Japan	Fixed
107	Broog	1998	137,529	K Line/MOL/NYK/ SHOWA/IINO	Ras Laffan to Japan	Fixed
108	LNG Lerici	1998	65,000	SNAM	Algeria to Italy	Fixed
109	Al Bida	1999	135,000	K Line/MOL/NYK/IINO	Ras Laffan to Japan	Fixed
110	SK Summit	1999	138,000	SK Shipping Co. Ltd.	Qatar to Korea	Fixed
111	K. Acacia	1999	138,000	Korea Line	Oman to Korea	Fixed
112	Hanjin Muscat	1999	138,200	Hanjin Shpg. Co.	Oman to Korea	Fixed
113	Hyundai Oceanpia	1999	135,000	Hyundai Merchant Marine	Indonesia to Korea	Fixed
114	Hyundai Technopia	1999	135,000	Hyundai Merchant Marine	Qatar to Korea	Fixed
115	Doha	1999	137,354	K Line/MOL/NYK/IINO	Ras Laffan to Japan	Fixed
116	Golar Mazo	1999	135,000	Golar LNG	Indonesia to Taiwan	Fixed
117	Al Jasra	2000	137,100	K Line/MOL/NYK/IINO	Ras Laffan to Japan	Fixed
118	K. Freesia	2000	135,000	Korea Line	Qatar to Korea	Fixed
119	Hanjin Ras Laffan	2000	135,000	Hanjin Shpg. Co.	Qatar to Korea	Fixed
120	Hanjin Sur	2000	135,000	Hanjin Shpg. Co.	Oman to Korea	Fixed
121	Hyundai Aquapia	2000	135,000	Hyundai Merchant Marine	Oman to Korea	Fixed
122	Hyundai Cosmopia	2000	135,000	Hyundai Merchant Marine	Qatar to Korea	Fixed

continued

LNG Tanker Fleet (continued)

	Vessel Name	Year Built	Capacity (Cubic meters)	Ship Owner	Project/Trade	Availability
123	LNG Jamal	2000	135,000	Osaka Gas/NYK/MOL	Oman to Jaoan	Fixed
124	Surya Satsuma	2000	22,000	MOL/LNG Japan/ PT Humpuss	Indonesia to Japan	Fixed
125	SK Splendor	2000	135,000	SK Shipping Co. Ltd.	Oman to Korea	Fixed
126	SK Stellar	2000	135,000	SK Shipping Co. Ltd.	Qatar to Korea	Fixed
127	SK Supreme	2000	135,000	SK Shipping Co. Ltd.	Qatar to Korea	Fixed
128	Sohar LNG	2001	135,000	MOL/GOSO	Oman	Fixed
129	Abadi	2002	135,000	Brunei Gas Carriers	Brunei to Japan	Fixed
130	Gallina	2002	136,600	STASCO	Oman to Spain	Fixed
131	Galea	2002	135,000	STASCO	Cove Point/Shell P	Fixed
132	Puteri Intan Satu	2002	137,100	MISC	Malaysia Tiga	Fixed
133	Fernando Tapias	2002	140,500	Naviera F.Tapias	Trinidad/Spain	Fixed
134	Excalibur	2002	138,000	Exmar	Oman	Fixed
135	LNG Rivers	2002	137,500	Bonny Gas Transport (NLNG)	Nigeria–U.S./Europe	Fixed
136	LNG Sokoto	2002	137,500	Bonny Gas Transport (NLNG)	Nigeria–U.S./Europe	Fixed
137	Puteri Delima Satu	2002	137,100	MISC	Malaysia Tiga	Fixed
138	British Trader	2002	138,000	BP SHIPPING	Qatar-Spain-Gas Natural	Fixed
139	Berge Boston	2003	138,000	Bergesen D.Y. ASA		Fixed
140	LNG Bayelesa	2003	137,300	Bonny Gas Transport (NLNG)	Nigeria–U.S./Europe	Fixed
141	British Innovator	2003	138,000	BP SHIPPING	Own Use	Fixed
142	Berge Everett	2003	138,000	Bergesen D.Y. ASA		Fixed
143	British Merchant	2003	138,000	BP SHIPPING	Own Use	Fixed
144	Methane Princess	2003	138,000	Golar LNG		Fixed
145	Excel	2003	138,000	Exmar/MOL		Open Period
146	Inigo Tapias	2003	138,000	Naviera F.Tapias		Fixed
147	Energy Frontier	2003	145,000	Tokyo LNG Tanker Co.		Fixed
148	Pacific Notus	2003	135,000	Tokyo Electiric/NYK/ Mitsubihshi		Fixed
149	N/B Mitsubishi H.I. 2169	2003	137,100	MISC	MLNG	Fixed
150	SK Sunrise	2003	138,000	I.S. Carriers S.A.	Qatar–Korea	Fixed
151	Castillo de Villalba	Oct 03	138,000	Elcano		Fixed
152	Granatina	Nov 03	145,700	STASCO	Own Use	Fixed
153	Disha	Dec 03	138,000	Petronet LNG Ltd.		Fixed
154	N/B Hyundai H.I. 1444	Dec 03	138,000	Golar LNG		Uncommited
155	Puteri Zamrud Satu	Jan 04	137,100	MISC	MLNG	Fixed
156	Fuwairit	Jan 04	138,000	EXMAR/MOL/NYK/ KL/Q-Ship	Ras Laffan to Japan	Fixed
157	N/B Daewoo H.I. 2220	Mar 04	138,000	Golar LNG		Uncommited
158	Bilbao Knutsen	Mar 04	138,000	Knutsen O.A.S. Shpg.	Trinidatd to Spain	Fixed
159	Muscat LNG	Mar 04	145,000	MOL/GOSO/Mitsui&Co	Oman LNG	Fixed
160	Gemmata	Mar 04	135,000	STASCO	Own Use	Fixed
161	N/B Samsung S.B. 1425	Mar 04	138,000	AP Moller	Ras Laffan to Japan	Fixed
162	N/B Daewoo H.I. 2214	Apr 04	138,000	Aust. LNG Ship Optg.		Fixed
163	Kari Elin	May 04	138,000	BG		Fixed
164	Cadiz Kanutsen	Jun 04	138,000	Knutsen O.A.S. Shpg.	Egypt to Spain	Fixed
165	Elvira Tapias	Jul 04	138,000	Naviera F.Tapias		Fixed
166	N/B Daewoo H.I. 2217	Jul 04	138,000	Bergesen D.Y. ASA	Algeria	Fixed
167	N/B Mitsui S.B. 1561	Aug 04	135,000	MOL/NYK/KL/ Q-Ship/Mitsui&Co	Ras Laffan to Japan	Fixed

continued

LNG Tanker Fleet (continued)

	Vessel Name	Year Built	Capacity (Cubic meters)	Ship Owner	Project/Trade	Availability
168	N/B Mitsubishi H.I. 2177	Sep 04	137,100	MISC	MLNG	Fixed
169	N/B Hyundai H.I. 1460	Oct 04	138,000	Golar LNG		Uncommited
170	Gaz de France Energy	Oct 04	74,000	Gaz de France		Fixed
171	N/B Daewoo H.I. 2208	Nov 04	138,000	Exmar/MOL		Uncommited
172	N/B Hyundai H.I. 1469	Nov 04	141,000	Bonny Gas Transport (NLNG)	Nigeria–U.S./Europe	Fixed
173	Indhan	Dec 04	138,000	Petronet LNG Ltd.		Fixed
174	N/B Kawasaki H.I. 1534	Dec 04	145,000	Hyproc/MOL/Itochu	Algeria	Fixed
175	N/B Samsung H.I. 1502	2005	138,000	MISC	MLNG	Fixed
176	N/B Samsung H.I. 1503	2005	138,000	MISC	MLNG	Fixed
177	N/B Mitsui S.B. 1562	Jan 05	137,100	MISC	MLNG	Fixed
178	NB Samsung 1440	Jan 05	145,000	EXMAR/MOL/NYK/ KL/Q-Ship	Ras Laffan to Japan	Fixed
179	N/B Daewoo H.I. 2221	Mar 05	140,500	Bergesen D.Y. ASA	Nigeria–U.S./Europe	Fixed
180	Energy Advance	Mar 05	145,000	Tokyo LNG Tanker Co.		Fixed
181	N/B Daewoo H.I. 2218	Apr 05	138,000	Exmar/MOL		Uncommited
182	N/B Daewoo H.I. 2219	May 05	138,000	Exmar/MOL		Uncommited
183	N/B Izar P. Real 105	Jun 05	138,000	Naviera F.Tapias		Fixed
184	N/B Daewoo H.I. 2222	Jul 05	140,500	Bergesen D.Y. ASA	Nigeria–U.S./Europe	Fixed
185	N/B Hyundai H.I. 1470	Jul 05	141,000	Bonny Gas Transport (NLNG)	Nigeria–U.S./Europe	Fixed
186	N/B Samsung H.I.	Sep 05	145,000	MOL/NYK/KLine/ Q-Ship	Ras Laffan to Japan	
187	N/B Mitsubishi H.I. 2184	Oct 05	138,000	Leif Hoegh/MOL/ Statoil	SNOHVIT LNG	Fixed
188	N/B Daewoo H.I. 2223	Nov 05	140,500	Bergesen D.Y. ASA	Nigeria–U.S./Europe	Fixed
189	N/B Hyundai H.I. 1471	Nov 05	141,000	Bonny Gas Transport (NLNG)	Nigeria–U.S./Europe	Fixed
190	N/B Mitsui S.B. 1564	Nov 05	140,000	K Line/Statoil/Iino	SNOHVIT LNG	Fixed
191	N/B Samsung H.I.	Nov 05	145,000	MOL/NYK/KLine/ Q-Ship	Ras Laffan to Japan	
192	N/B Daewoo H.I.	Nov 05	145,700	Maran		Uncommited
193	N/B De l'Atlantique	Dec 05	153,000	Gaz de France	GDF	Fixed
194	NBK Kawasaki H.I. 1562	Dec 05	145,000	GOSO	Oman-Spain	Fixed
195	N/B Daewoo H.I.	Dec 05	145,700	Maran		Uncommited
196	N/B Mitsubishi H.I. 2185	Jan 06	138,000	Leif Hoegh/MOL	SNOHVIT LNG	Fixed
197	N/B Daewoo H.I.	Jan 06	145,700	Golar LNG		Uncommited
198	N/B Daewoo H.I. 2224	Mar 06	140,500	Bergesen D.Y. ASA	Nigeria–U.S./Europe	Fixed
199	N/B Hyundai H.I. 1472	Mar 06	141,000	Bonny Gas Transport (NLNG)	Nigeria–U.S./Europe	Fixed
200	N/B Mitsubishi H.I. 2187	Mar 06	135,000	Tokyo Electiric/NYK/ Mitsubihshi		Fixed
201	N/B Kawasaki H.I. 1532	Apr 06	140,000	Kline/Mitsui&Co/ Statoil	SNOHVIT LNG	Fixed
202	N/B Kawasaki H.I. 1545	Sep 06	145,000	Osaka Gas/NYK		Fixed
203	NBK Kawasaki H.I. 1540	2006	145,000	MOL	To Japan	Fixed
204	N/B Samsung H.I.	2006	145,000	BG		
205	N/B Samsung H.I.	2006	145,000	BG		
206	N/B Samsung H.I.	2006	145,000	BG		
	TOTAL	**by 2006**	**25,168,616**			

Source: LNG Shipping Solutions

APPENDIX M

Companies Based in the United States

- **ExxonMobil Corporation** has been involved with LNG for more than 30 years through Mobil. It has interests in both the operating phase and planned expansions of the Qatargas and RasGas LNG projects in Qatar. It produces and supplies natural gas for the Arun plant in Indonesia and has a 30-percent share in PT Arun, the company that operates the plant on behalf of its owner, Pertamina. ExxonMobil has also announced plans to build receiving terminals in the United Kingdom, France, and the United States.
- **ConocoPhillips**, **Inc**. operates and owns 70 percent of the only LNG export facility in southern Alaska. ConocoPhillips is involved in a new liquefaction facility near Darwin, Australia, which is currently under construction. The company is also a participant in the planned Brass River LNG project in Nigeria and has recently announced that it has a 30-percent share in the Qatargas 3 project in Qatar.
- **Marathon Oil Corporation** owns 30 percent of the LNG export facility on the Kenai Peninsula in southern Alaska. It also leases capacity at El Paso's receiving terminal at Elba Island, Georgia. The company is planning to develop a plant in Equatorial Guinea and has contracted to sell the LNG to BG for delivery to Lake Charles, Louisiana.
- **ChevronTexaco Corporation** is one of the owners of Australia's Northwest Shelf project and is the main shareholder in the planned Gorgon LNG plant, also in Australia. It also has interests in the planned Brass LNG project in Nigeria and in the Angola LNG project.
- A subsidiary of **El Paso Corporation** owns the LNG regasification terminal at Elba Island, Georgia.
- **Dominion** owns the Cove Point LNG terminal and regasification facility in Lusby, Maryland.
- **Panhandle Energy**, which is owned by **Southern Union Company**, owns and operates the regasification terminal at Lake Charles, Louisiana.
- **Edison Mission Energy** is one of the owners of the EcoElectrica receiving terminal in Puerto Rico.
- **Unocal Corporation** has ownership in Indonesian production ventures supplying natural gas feedstock to the world's largest LNG plant in Bontang, Indonesia.
- **Sempra Energy** proposes building LNG terminals near Hackberry, Louisiana, and Ensenada, Mexico.

APPENDIX N

Selected Private Companies Based Outside the United States

- **Shell** has ownership in liquefaction projects in Australia, Brunei Darussalam, Malaysia, Nigeria, and Oman and in the Sakhalin Island facility under construction in Russia . It is also a participant in the planned Marisal Sucre LNG facility in Venezuela. It controls one-third of the capacity at the Cove Point, Maryland receiving terminal and the entire capacity of the expansion of the Elba Island, Georgia terminal.
- **BP** is an owner of liquefaction plants in Trinidad and Tobago, the UAE and Australia. It also supplies gas and has an interest in the company that operates the Bontang plant in Indonesia. It will be the operator of the planned Tangguh LNG facility in Indonesia and has a share in the planned Angola LNG project. BP also controls one-third of the capacity at the Cove Point, Maryland terminal.
- **Total** participates in operating liquefaction facilities in the UAE, Indonesia, Nigeria, Qatar, and Oman and planned facilities in Yemen and Angola.
- **British Gas (BG)** holds shares in Trinidad and Tobago's Atlantic LNG project and the new Egyptian LNG project at Idku and has access to capacity at the Lake Charles, Louisiana, terminal.
- **Tractebel** is an owner of terminals in Zeebrugge, Belgium, and Everett, Massachusetts, and has an interest in the first train of Trinidad and Tobago's Atlantic LNG plant.
- **Statoil** is involved in the Snohvit project, currently under construction in northern Norway, and controls one-third of the capacity at the Cove Point, Maryland LNG terminal.
- **Mitsubishi**, a large Japanese trading house, holds interests in operating liquefaction plants in Malaysia, Brunei Darussalam, Australia, and Oman, and is a participant in Russia's Sakhalin plant that is under construction. It is also a shareholder in the planned Marisal Sucre LNG project in Venezuela and Indonesia's planned Tangguh project.
- **Mitsui**, another Japanese trading company, is a participant in operating projects in the UAE, Australia, Qatar, and Oman, and in the Sakhalin project in Russia. It has also recently purchased shares in the Tangguh project in Indonesia.

APPENDIX O

State-Owned Companies

- **Sonatrach** is the sole owner of Algeria's liquefaction facilities.
- **Petronas** holds a majority interest in the three Malaysia LNG projects.
- Indonesia's **Pertamina** is the sole owner of the country's LNG plants at Arun and Bontang and has a 55-percent share in the companies that operate these facilities.
- **Nigeria National Petroleum Co**. has 49-percent ownership of Nigerian LNG Ltd.
- The Oman government has a 51-percent share in **Oman LNG**.
- In Qatar, state-owned **Qatar Petroleum** has majority interests in both Qatargas and RasGas projects.
- **Abu Dhabi National Oil Co**. holds 70 percent of the liquefaction facility in the United Arab Emirates.
- The government of Brunei Darussalam has a 50-percent share in the **Brunei LNG** project.
- In Trinidad and Tobago, the state-owned **Natural Gas Corporation** has a 10-percent share in the first train of the Atlantic LNG plant.