

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).

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 consultant²⁰ 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.

Shipping Costs

- Most ships are dedicated to particular LNG projects and are owned by LNG importing and exporting companies or shipping

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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:

- 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.

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.

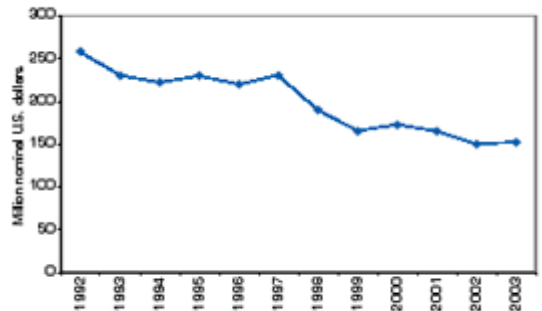
In the United States, the general assumption is that regasification will add US\$0.30 per million Btu to the price of the imported LNG.

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
Oatar	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

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

