Delivering Clean Energy to People around the World

IHI's liquefied natural gas (LNG) terminals are hubs connecting global supply and demand of clean energy

LNG is a clean energy that plays an important role in city gas supplies and power generation. LNG is delivered from LNG-producing countries to importing countries' LNG terminals, which require specialized technologies to safely handle liquids at cryogenic temperatures. The LNG technologies of the IHI Group support global demands for clean energy.

Gulf LNG Terminal in Mississippi, U.S.

Filled with LNG, Polar Spirit, an IHI SPB LNG tanker, departs for Japan from the LNG liquefying plant in Kenai, Alaska. Upon reaching Tokyo Bay, it steers north off the coast of Sunosaki toward an LNG receiving terminal located in the innermost area of the bay. From the mouth of Tokyo Bay, through the spring morning haze one can see the mountains of the Boso Peninsula to the right and the gentle scenery of the Miura Peninsula in the distance to the left. One can also see ships carrying materials and energy destined for the metropolitan area as well as those departing the bay after having unloaded their cargo.

Behind the Polar Spirit, large LNG tankers, perhaps

Polar Spirit, an IHI SPB LNG tanker

coming from Indonesia or Australia, are sailing in the offing toward the mouth of the bay.

LNG is a clean energy that plays an important role in city gas supplies and power generation. LNG from exporting countries is transported through the mouth of Tokyo Bay to the five LNG terminals located in the innermost area of the bay.

With the distinctive shape of Nokogiri Mountain on the right and the stacks of Yokosuka Thermal Power Station on the left, the tanker proceeds along the center course. After passing Cape Futtsu, the Futtsu LNG Terminal, which is next to the Futtsu Thermal Power Station comes into view on the right. Above ground, only the white roofs of the LNG inground tanks are visible, which were built by IHI and play an important role in constantly supplying fuel to the power station.

Leaving the area off the coast of Futtsu, the Polar Spirit advances toward the innermost area of Tokyo Bay. In view of the Ferris wheel at the Hakkei-jima theme park, the tanker approaches the IHI Yokohama Works. The Negishi LNG Terminal is located on the opposite shore of the canal, and this is where Japan first began importing LNG in 1969. Japan's first aboveground LNG tanks, which were built by IHI, still play their role here. Also, this is the place where the world's first demonstration LNG inground tank was built as a joint development of IHI and one of our customers. This memorable terminal has been expanded into a huge terminal with many large inground tanks, and the terminal now plays an important role in ensuring the energy supply of the metropolitan area.

After passing the Negishi LNG Terminal and the Yokohama Bay Bridge on the left, an LNG unloading jetty several hundred meters offshore can be seen from the tanker. This is the jetty of the Ougishima LNG Terminal. Unloaded LNG is sent from the jetty to the LNG terminal located in the innermost part of the canal through the LNG unloading line in the undersea tunnel. Here, IHI is now working to construct a 250 000 k*l* LNG underground tank to realize the world's largest LNG tank.

The ship advances further toward the innermost area of the bay, and an LNG unloading jetty along the quay of an ironworks can be seen on the left. This is the jetty for the Higashi Ougishima LNG Terminal located 2 km to the north. This receiving terminal has many LNG inground tanks, including some built by IHI.

The tanker passes Higashi Ougishima. As the tanker diverts its course to Chiba Prefecture with the Kawasaki coastal industrial zone on the left, the Sodegaura LNG Terminal comes into view. This is the largest terminal in the metropolitan area and consists of two LNG terminals that supply the city with gas and supply a power station with fuel.

Finally, the LNG tanker reaches the innermost area of the bay. It berths at the jetty of the LNG terminal and is connected to the unloading arms installed on the terminal. After safety inspections are conducted, LNG from the tanker is unloaded to the LNG tanks. Unloading work continues throughout the night and is completed the next morning. Upon completion, the tanker begins making preparations to depart the jetty.

Clean energy LNG

LNG is produced by extracting natural gas from deep underground, removing impurities, and liquefying the gas at a cryogenic temperature (approx. −160°C) in a liquefying plant. Compared to other fossil fuels such as petroleum and coal, LNG emits less CO_2, which causes global warming, and less NO_x, which causes air pollution. In addition, LNG emits no sulfur oxide which causes acid rain.

Liquefying gas reduces its volume and allows it to be transferred in large quantities via tankers from the areas where it is produced to remote areas in which it is consumed. Global demand for LNG for power generation and as a city gas is increasing as LNG is a familiar and practical clean energy.

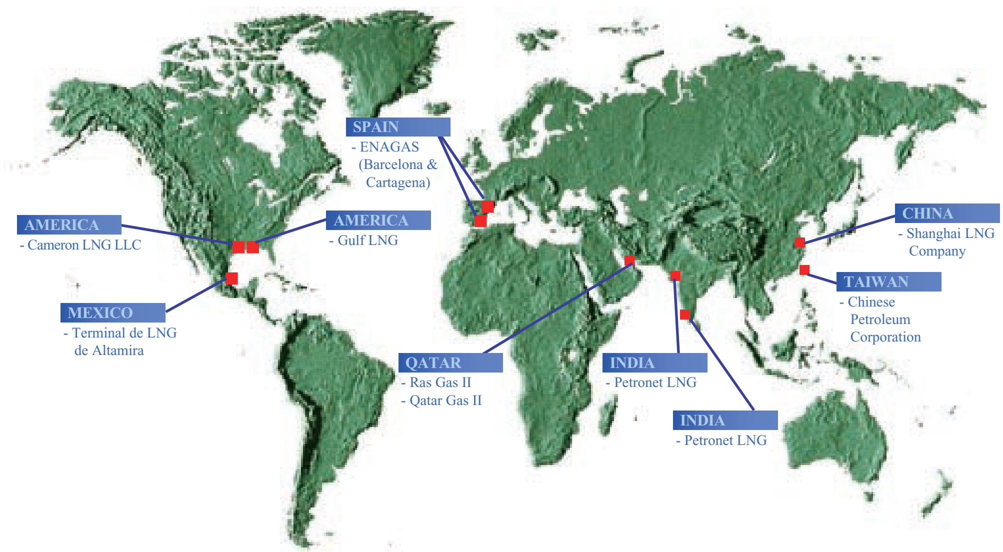
Unloaded LNG is stored in tanks at a cryogenic temperature (approx. −160°C). Various kinds of technologies necessary to ensure safe storage of the cryogenic liquids and unique to LNG facilities are fully utilized for the LNG tank.

An LNG aboveground tank consists of an inner tank, which comes into direct contact with the LNG and is made of 9% Ni steel (ASTM A533 material) to ensure sufficient strength and toughness at LNG temperatures, and a shell plate, the thickness of which decreases as height increases in consideration of the load. The outside of the tank is sufficiently insulated to reduce the inflow of external heat.

A pre-stressed concrete double wall (full containment) tank has a pre-stressed concrete wall around the wall insulation. The pre-stressed concrete wall and outer roof are designed to prevent any LNG from leaking out of the tank even if the inner tank is damaged.

A steel shell liner (with a thickness of approx. 5 mm) is affixed to the inner surface of the pre-stressed concrete wall. Insulation is installed between the inner tank and the pre-stressed concrete wall. The lateral side is filled with granulated pearlite and the bottom is lined with cellular glass or other such material.

LNG continues to vaporize and turn into boil off gas (BOG) inside the tank due to heat entering the tank. Such gas is pressurized in the BOG compressors, liquefied again by the coldness of the discharged LNG in the BOG recondenser, and further pressurized by LNG booster pumps.



Overseas LNG terminals and tanks built by IHI

The pressurized LNG is fed into the LNG vaporizers. Vaporized gas, after its calorific value is adjusted by the addition of an appropriate amount of LPG, is sent to the pipelines for use as city gas, or alternately such gas is sent directly to the pipelines for use as a fuel in power stations. Part of the LNG in liquid state is poured into LNG tank lorries and transported to small-scale LNG satellite terminals built at inland points of demand in remote locations.

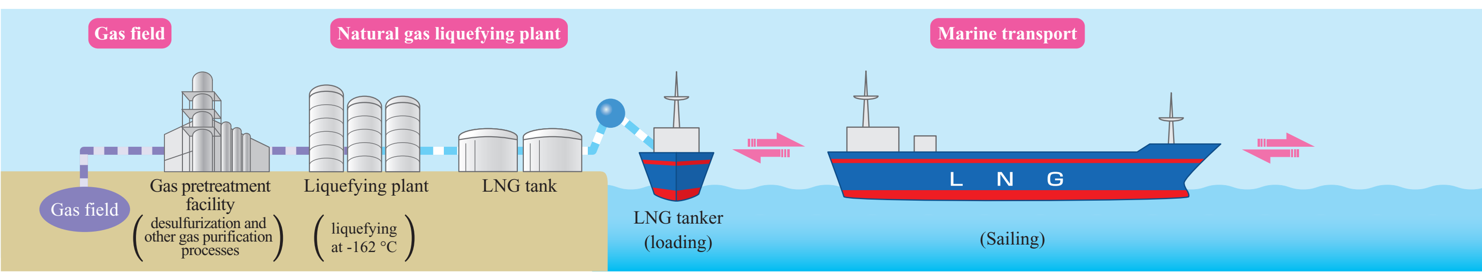
LNG transported by LNG tankers in this manner is used as city gas or converted into electricity, and thereby plays an important role in ensuring energy supply not only in the metropolitan area but also at adjacent points of demand.

Active LNG terminals around the world

In 2004, IHI finished construction of the Dahej LNG Terminal, India's second terminal. Since then, we have built LNG terminals in Mexico, Spain, Taiwan, the United States, and China. In 2009, IHI completed expansion work for the Dahej Terminal, and we are now building two LNG tanks for the Kochi LNG Terminal in southern India. In addition, we will soon complete the Gulf LNG Terminal on the coast of the Gulf of Mexico in Mississippi, our second terminal to be built in the United States.

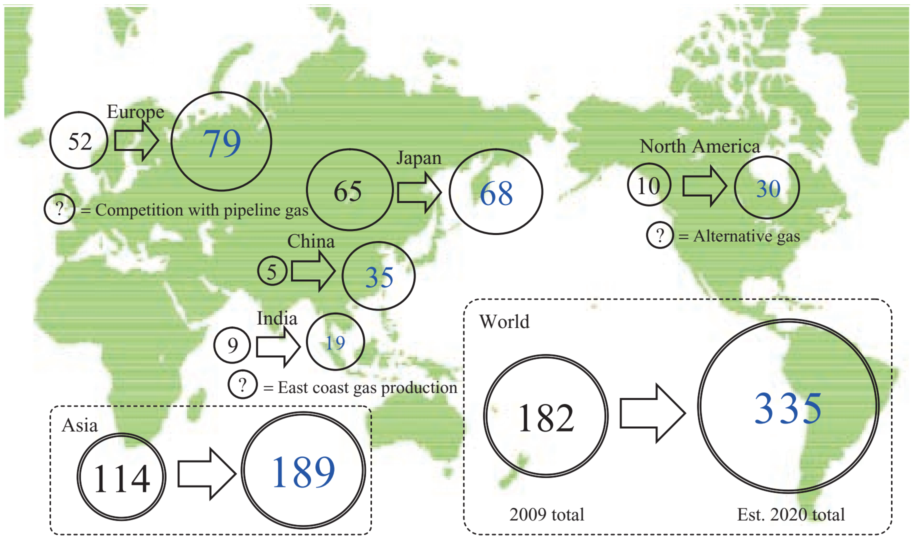
Also, in LNG exporting countries, IHI built two LNG tanks for LNG liquefying plants in 2005 and five in 2009 in Qatar. Qatar surpassed Indonesia to become the world's largest LNG exporting country in 2006 and has increased exports 150% over the past five years. The fourth largest LNG exporting country, Australia, has a number of plans to build LNG plants to further expand its LNG exports. We are actively pursuing sales in Australia as well as other countries to keep pace with the growth in the global LNG market.

From the tank foundation work to the start of commissioning works, it takes about three years to build an overseas LNG terminal. Requirements vary from project to project and are affected by various elements, including site location, ground conditions, climate, laws and regulations, the local labor situation, and work practices. A series of large-scale works, including civil construction works, mechanical works, and welding, are necessary to build LNG tanks. To ensure that the required materials are delivered to the site when needed and that the many interrelated jobs are able to be advanced without delay, comprehensive project management is indispensable in addition to high technical capabilities and extensive



experience.

In most cases, we build overseas LNG terminals by forming a consortium (for sharing work among companies) or a joint venture (for collaborative work between companies) with local companies well-versed in the local situation. To succeed in large-scale projects, it is essential to establish trusting relationships between partners who can communicate well with each other over differences in culture and customs as well as differences in corporate business procedure.



LNG demand estimate (2009 vs. 2020) (million tons/year)
Source: The Institute of Energy Economics, Japan

LNG supports energy demand

As the world's largest LNG importing country, Japan imports 66 million tons per year, which accounts for approximately 35% of the global total. Including those under construction, Japan has about 30 LNG receiving terminals in locations from Hokkaido to Okinawa. This quantity is nearly unheard of elsewhere in the world.

Countries around the world are planning to introduce and expand their use of LNG in consideration of the above-mentioned environmental issues as well as to ensure stable energy supplies and diversify risk in order to avoid reliance on particular geographical locations and energy sources. Like Japan, both Europe and North America have been using LNG for more than 40 years and have built LNG terminals one after another since 2000. They are also increasing the number of terminal construction plans. Korea and Taiwan are increasing LNG imports as they have few resources and must depend on imports to ensure their energy supplies. China and India are achieving remarkable economic growth and attracting close attention as new markets because the total populations of the two countries account for more than 30% of the global total. Both countries have built LNG receiving terminals one after another since the beginning of the twenty-first century and are planning to build many more terminals.

LNG terminals in the Tokyo Bay area support a large part of the energy demand in Tokyo and the surrounding metropolitan area. This will be true for many areas throughout the world in the near future.

IHI built Japan's first LNG aboveground tank, LNG inground tanks, and approximately half of the LNG receiving terminals in Japan. Based on our extensive experience in building these facilities, we will continue to pursue technical developments to ensure the safe and stable supply of LNG while making daily efforts to contribute to society and our customers all over the world.

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