What is Liquified Natural Gas (LNG)?

Liquefied Natural Gas (LNG) is natural gas that has been converted from gaseous to a liquid state under pressure and low temperature of approximately -163°C. During the process, the natural gas is filtered and purified, and colourless and odourless fuel is obtained. Through this so called "liquefaction" technique, gas volume is reduced 600-fold, i.e. 600 cubic meters (cm) of natural gas is reduced to 1 cm of LNG. Such reduction in volume enables easier storage and transportation. Upon delivery to a destination place, LNG is subjected to the process of "regasification", i.e. restoration of its gaseous form through heating the raw material in the liquid state. The obtained gas is then transported to consumers in the same manner as natural gas

To measure LNG both volume (cubic meters or cubic feet) and mass units (usually tons or million tons, MT) measures are used. The former units are mainly used to describe produced gas, the latter are used for the actual LNG. Once the LNG has been regasified it is sold by energy units (e.g. in millions of British thermal units, MMBtu).

A Short History of LNG

LNG technology is not new. It was first explored in the 19th century by the British chemist and physicist Michael Faraday. The first liquefaction technologies were patented in 1896 by a German scientist Carl von Linde, who in 1873 constructed the first cooling equipment in Europe, forming a basis for the modern technology of refrigeration.

The first liquefaction plant was built in Western Virginia in 1917, and the first commercial operation began in 1941 in Cleveland, Ohio. The first large-scale LNG plant was built in Arzew, Algeria, in 1964 and went online in 1965.

The first transport of LNG took place in 1959, when a World War II cargo ship was converted into a special tanker called "The Methane Pioneer" to export LNG from Lake Charles in Louisiana, USA to a terminal in Canvey Island, UK.

Following the successful LNG import by the UK from the US, and later from Venezuela and Algeria, several other countries invested in this new supply technology. Although LNG supplies to the UK have eventually lost the competition to the new North Sea oil and gas discoveries, the LNG became the main way of gas supply in some Asian countries, specifically in Japan and South Korea. In fact, until the 1990s, the trade in LNG was largely limited to this region. However, in the last two decades, the scale of LNG trade has expanded and a number of countries trading LNG has increased. Significantly, Qatar has become a major new exporter, overcoming the hitherto biggest players like Indonesia and Algeria.

Advantages of LNG

LNG offers several advantages over traditional pipeline transport, namely:

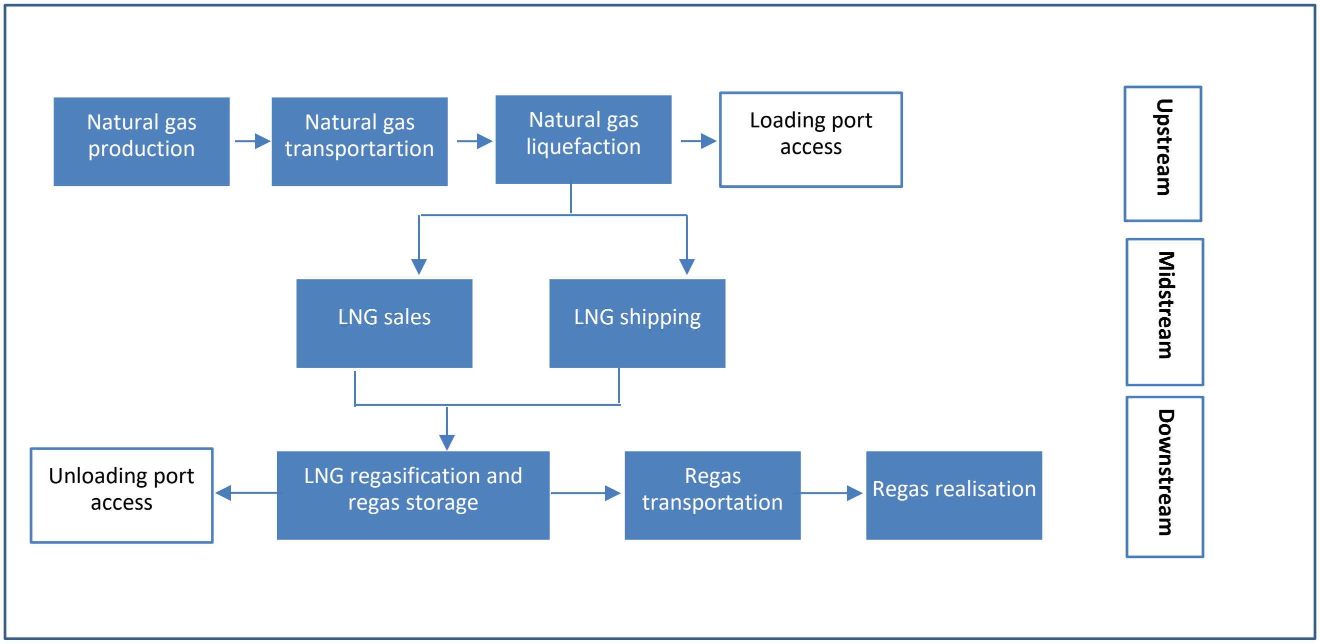
- Flexibility and security of supplies - both in terms of diversifying sources of supply and for responding to the demand for gas in places with difficulties to connect with gas importers via pipelines. Furthermore, LNG enables gas producers to monetise 'stranded' gas reserves.
- Quality - as natural gas' cleaner-than-coal advantages are further strengthened by purification of natural gas from carbon dioxide and other toxic properties during the liquefaction process.
- Safety and environmental impact - in a case of a potential LNG leak, it quickly evaporates and dissipates in the atmosphere. Hence, it presents significantly lower environmental risk than piped gas. However, as LNG terminals require the laying of new pipelines to transport natural gas from the deposits, environmental risks arising from piped gas also arise when the LNG project is seen as a whole.

The LNG Supply Value Chain

The LNG supply chain compromises 5 key elements, i.e. different operations that are interdependent upon each other:

- the production and transportation of natural gas
- liquefaction of natural gas at the gas liquefaction facilities
- the transportation of the resultant LNG from the liquefaction facility to where it is needed. The LNG is transported via special tankers of a capacity ranging from several dozen thousand to approx. 250 thousand cm of liquefied gas. The tankers are double-hulled and specifically designed to handle the low temperature of LNG. As of January 2017, there were 439 ships including conventional vessels and ships acting as floating storage regasification units (FSRUs).
- regasification of the LNG and storage. Upon arrival of the LNG in a regasification facility, the liquid fuel is transmitted to special cryogenic tankers where it is kept at a temperature of -163°C prior to regasification. During the regasification stage, gas returns to its gaseous state by either gradual heating of the liquefied raw material to a temperature over 0°C or by burning some of the gas to provide heat.
- the supply of the regasified LNG to the end users for consumption or further processing.

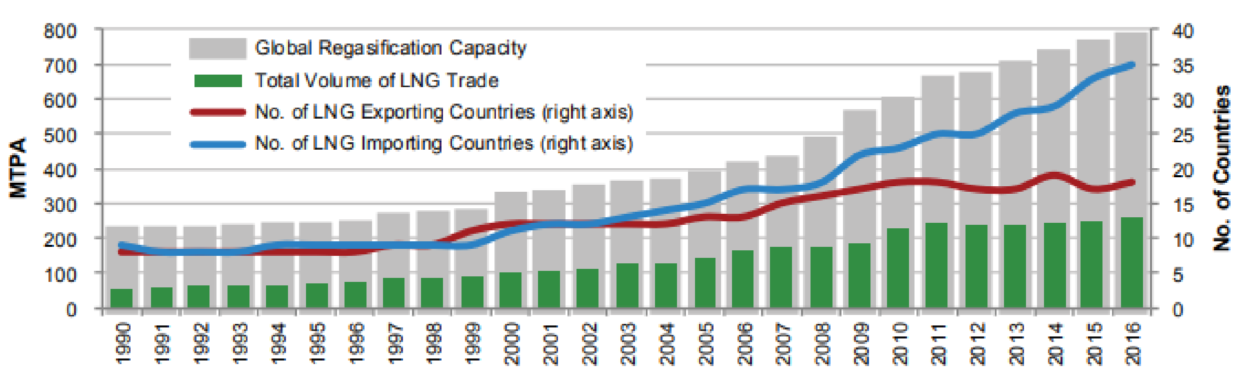
The exemplary supply chain structure is presented in the graph below:



Source: Liquified Natural Gas: The Law and Business of LNG, ed. Paul Griffin, London, 2012

LNG traded volume and outlook

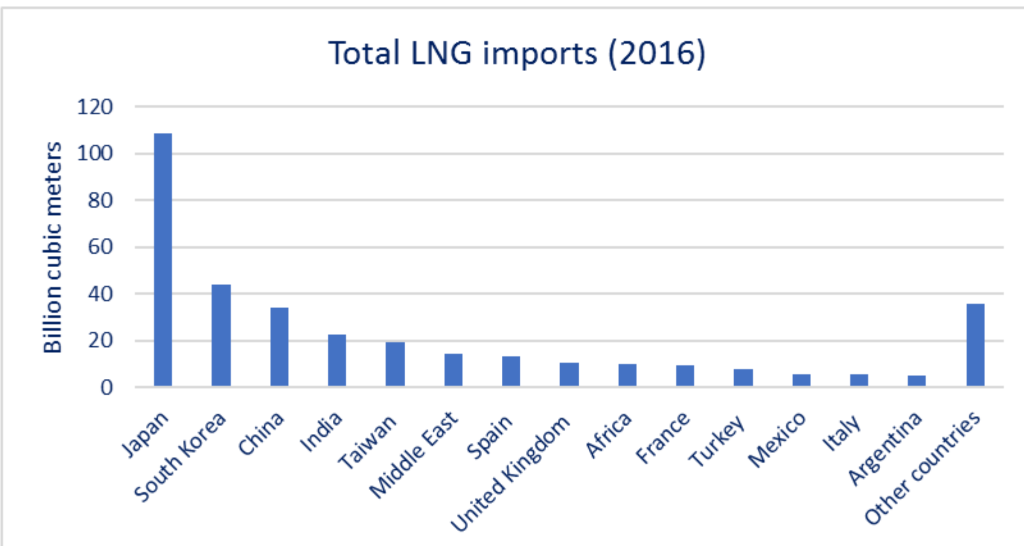
As of 2017, there have been 78 LNG export (liquefaction) terminals of a total capacity of 340 MTPA in 20 countries, 133 regasification onshore and floating terminals of a total capacity of 795 MTPA in 37 countries, and 439 LNG ships which handled 258 MT of LNG in 2017.



Source: IGU World LNG Report — 2017 Edition

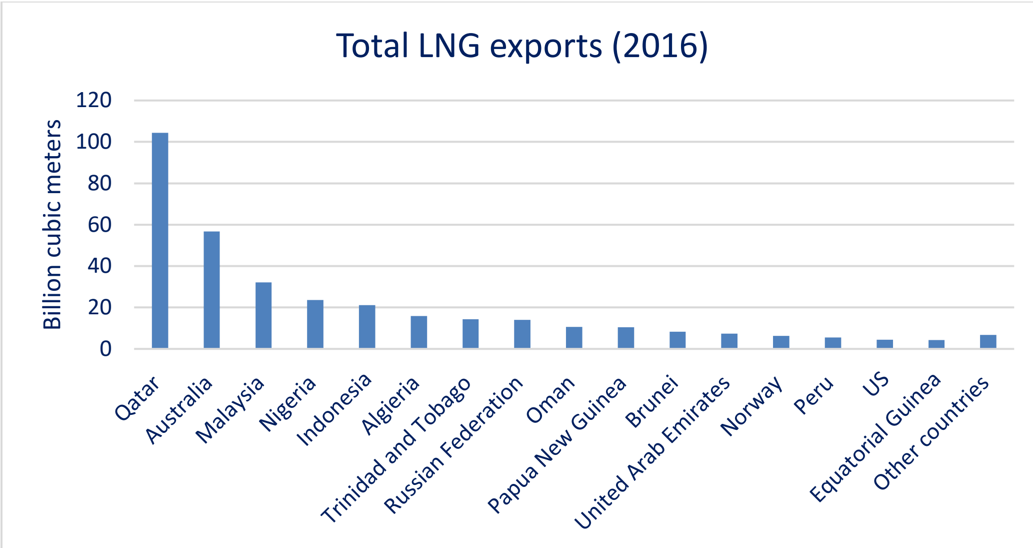
Overall, the trade in LNG has grown at an impressive compound annual growth rate (CAGR) of 4.8% for the last 10 years, although the rate slow downed in the recent years. Despite higher 10y CAGR than other forms or gas trade and consumption, currently the LNG trade constitutes a modest share (10%) of total global gas trade. Yet, its growth rate is significantly higher than both pipeline supplied gas (CAGR of ~ 3%) and consumption of indigenous gas (CAGR of ~ 1.8%).

In 2016, the importing countries were led by Japan (31.2% of the market share), South Korea (12.6%), China (9.8%), India (6.4%) and Taiwan (5.6%). The United Kingdom's share of the global LNG imports was 3%. Significantly, in 2017 China added 50% to its LNG imports and becomes world second largest importer. According to the Bloomberg New Energy Finance Global LNG Outlook 2017, China will drive global LNG demand growth through 2020, but Europe is expected to buoy it from 2026 throughout to 2030.



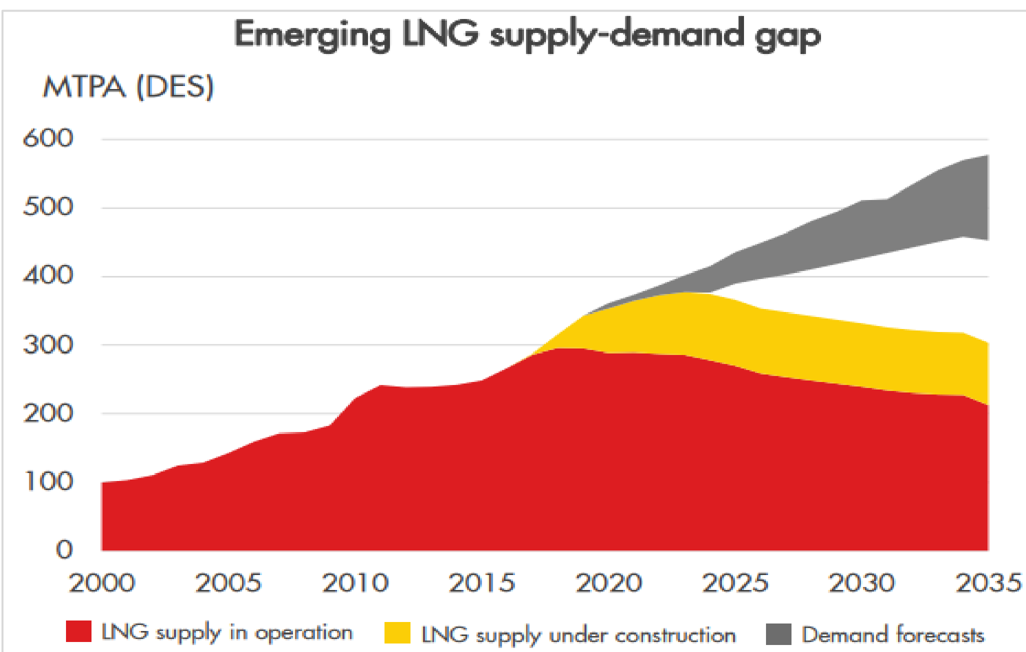
Source: The BP Statistical Review of World Energy 2017

Qatar is the world's largest LNG exporting country (30% of the market share), followed by Australia (16.3%), Malaysia (9.2%), Nigeria (6.8%) and Indonesia (6.1%). However, according to the IEA's World Energy Outlook 2018, the US will become the world's largest exporter by the mid-2020s, given the abundance of U.S. natural gas and changes in its gas export policy, specifically in LNG exports.



Source: The BP Statistical Review of World Energy 2017

The LNG growth is expected to continue and lead to what some industry insiders believe could be named as "another gas revolution", driven by a wave of new LNG supply, particularly from the US where the LNG production has been facilitated by the shale gas revolution. Some analyses indicate that such development will reshape gas markets in the coming years. For example, according to the IEA forecast, global LNG trade will more than double by 2040 (IEA 2017). Other outlooks, e.g. Bloomberg New Energy Finance Global LNG Outlook 2017 or Shell LNG Outlook 2018, expect a potential supply shortage from 2025.

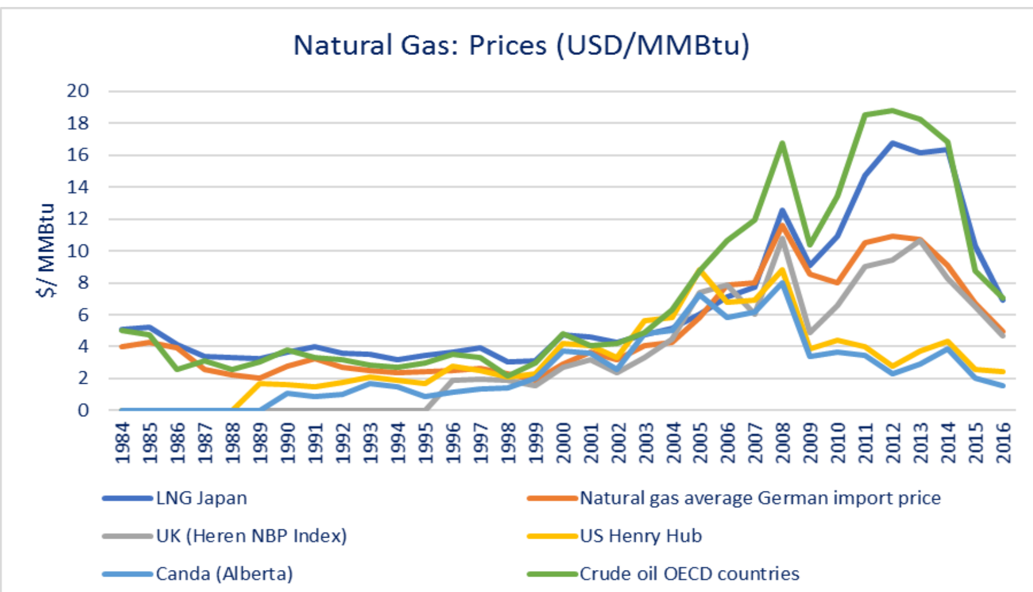


Source: Shell LNG Outlook 2018

LNG Prices and Contracts

Historically, LNG has been structured by long-term contract, as 95% of LNG contracts were for 10 years or more. Such structure has become more complex in the recent years, driven mainly by a surge in US LNG exports and its impact on contractual flexibility in Asia and Europe. Other factors influencing the LNG contractual structure are an increase in the number of exporters and importers, an increase in the number of LNG tankers, relaxation of destination clauses which limit buyers from reselling excess gas or consequences of the 2011 Fukushima nuclear disaster which highlighted needs for greater flexibility in addressing the emergency power generation shortages. As a consequence of these changes, long-term contracts have been complemented by short-term contracts and spot trading, making the market more liquid. The long-term contract share in the LNG market has been reduced from 95% to around 60%.

LNG prices have been falling since 2014, reflecting decline in oil prices but also weakening demand from the main importing countries paired with an increase of supply. Nevertheless, one can observe a large disparity between prices in different geographies, e.g. the soaring spot prices in some Asian markets. According to some analyses, the lack of a consensus on LNG pricing in Asia results in complex and non-viable pricing formation mechanisms.



Source: The BP Statistical Review of World Energy 2017

As per the BNEF LNG Outlook 2017, if oil prices stay close to the current futures, spot LNG prices should stay close to $6/MMBtu until mid -2020s. According to some analyses, prices higher than that are not affordable for many countries and may destroy demand.

Further reading:

International Gas Union World LNG Report – 2017 Edition, https://www.igu.org/sites/default/files/103419-World_IGU_Report_no%20crops.pdf

Shell LNG Outlook 2018, https://www.shell.com/energy-and-innovation/natural-gas/liquefied-natural-gas-lng/lng-outlook/_jcr_content/par/textimage_864093748.stream/1519645795451/d44f97c4d4c4b8542875204a19c0b21297786b22a900ef8c644d07d74a2f6eae/shell-lng-outlook-2018-presentation-slides.pdf

Bloomberg New Energy Finance Global LNG Outlook 2017, https://data.bloomberglp.com/bnef/sites/14/2017/09/BNEF-Global-LNG-Outlook-2017.pdf

Stern, J., (2017) 'Challenges to the Future of Gas: unburnable or unaffordable?', The Oxford Institute for Energy Studies, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/12/Challenges-to-the-Future-of-Gas-unburnable-or-unaffordable-NG-125.pdf

Gas in Focus, http://www.gasinfocus.com/en/focus/the-lng-supply-chain/

'UKs Global Gas Challenge', UKERC, (2014), http://www.ukerc.ac.uk/publications/the-uk-s-global-gas-challenge.html

Griffin, P (ed.) (2012), Liquified Natural Gas: The Law and Business of LNG, London

'Strong policies and technology driving energy market change', the Energy Institute's 2017 Melchett Award Ceremony Speech by Fatih Birol, IEA Executive Director, https://knowledge.energyinst.org/Energy-Matrix/product?product=108407

'Frequently Asked Questions About LNG', California Energy Commission http://www.energy.ca.gov/lng/faq.html