WHY NATIONS BUY LNG

LNG technical: Gas purified to strict specifications for cryogenic applications – energy input for low temperature production and transportation – heat input for evaporation – transportation in pipeline to customers

The energy density (energy per unit volume) of LNG is 2.4 times that of CNG and 60% more than diesel

Fuel	Mass Density Lb/gal (US)	Energy Density Btu/gal (US)	Energy Density Btu/lb	Energy Content compared to Gasoline gallon or liter (volumetric)
LNG	3.5 [1]			
CNG	1.07 [2]			
LPG (Propane)	4.1 [3]			
Diesel	6.5 – 7.3			
Gasoline	5.8 – 6.5			
Ethanol (E-100)	6.6			

Comparison: Weight of water is 8.34 lb/gallon (US) or 3.78 kg/gallon (US). A US gallon (3.8 liter) of water is about 16.6% lighter than the imperial gallon (4.2 liter). There are four quarts in a gallon, two pints in a quart and 16 fluid ounces in a US pint, which makes a US gallon equal to 128 fl. oz.

LNG Business: Mostly between nations – Transportation through open sees – no buyer's control over cargo – spot vs long term contract; The Big 3 international players in LNG business are ExxonMobil, Shell and BP.

LNG Geopolitics: Asia and Europe do not need LNG – Iran's supplies can maneuver LNG business – Russia and China is an example

It started in June 1964 from Algeria with the Methane Princess carrying Algerian gas from Arzew to the UK LNG regasification terminal at Canvey Island in June, 1964 for British Gas. The capacity of Methane Princess was 34,500 cubic meter of LNG (1 cu m of LNG equals 584 cu m of natural gas at 101.325 kpa and 15 degree C) thus carrying approx. 710 million standard cubic foot (MMSCF) of natural gas and it was powered by steam propulsion. In 1978 bigger LNG carriers came in to service, most notably the French Jules Verne with capacity around 131,000 cubic meters of LNG which equals 2.7 BCF of natural gas. Today the world's largest LNGC is Q-Max Mozah with a capacity of 266,000 cu m of LNG is serving the industry since 2008. Having a capacity to carry over 5 BCF of natural gas Q-Max has surely dwarfed the Methane Princess. At the moment there are more than 400 LNGCs in service worldwide mostly in the range of 120,000 – 150,000 cu m and the number is expanding at a rate of around 40 vessels per year. The time-charter rate of these LNGCs currently varies between USD 40,000 to USD 45,000 per day.

Originally, like Methane Princess, the nature of LNG shipping existed where there were projects, with ships built specifically for employment within the projects. The projects were self-contained based on huge joint ventures between cargo buyers, cargo sellers and shippers, all in themselves large companies prepared to do long term business together. This co-operative nature of LNG's beginnings has led to several operational features unique to the ships. In particular there is the acceptance that LNG carriers burn LNG cargo as a propulsive fuel, which is commonly stated in terms of **boil-off per day** under set ambient conditions of sea and air temperatures. They also retain cargo onboard after discharge (the '**heel**') as an aid to keeping the ship cooled down and ready to load on arrival at the load port. Thus matters that would be anathema to normal international trades are accepted as normal practice for LNG.

In line with other shipping vessels, LNG carriers also operate under a Charter Party. A charter party is the contract between the owner of a vessel and the charterer for the use of a vessel. The charterer takes over the vessel for either a certain amount of time (a time charter) or for a certain point-to-point voyage (a voyage charter), giving rise to these two main types of charter agreement. Baltic and International Maritime Council (BIMCO) in collaboration with the International Group of Liquefied Natural Gas Importers (GIIGNL) is developing an LNGVOY (LNG Voyage Charter party) which may replace the existing long-term time charters. LNGVOY is an LNG carrier voyage charter party whereby the owner of a ship agrees to transport point-to-point a full shipload of LNG cargo owned or furnished by another person with the ship's crew and master in control of the navigation.

At present, the Middle East, Australia, Russia and few African countries produce most of the world's liquefied natural gas. The prime import markets are Europe and Asian countries, such as Japan, South Korea, China, Taiwan, Malaysia, India and Pakistan. The next tranche of new production will occur in Australia 2014-2016, followed by US and Russia in 2016-2018, plus Canada and East Africa by 2020. The US will soon become one of the major LNG exporters within next 10 years because of abundance of Shale gas.

Having talked about the LNG Carriers, LNG Shipping, LNG Exporters and LNG Importers let's also look into some details of the commodity – Liquefied Natural Gas.

Liquefied natural gas is a liquid substance, a mixture of light hydrocarbons primarily composed of methane (CH_4), with smaller quantities of ethane (C_2H_6), propane (C_3H_8), higher hydrocarbons (C_{4+}) and nitrogen as an inert component. The composition of LNG depends on the traits of the natural gas source and the treatment of gas at the liquefaction facility, i.e. the liquefaction pre-treatment and the liquefaction process, as provided in Table below:

Classification of LNG by density (Sedlaczek, 2008).			
Composition (%)	**LNG Light**	**LNG Medium**	**LNG Heavy**

Methane	98.00	92.00	87.00
Propane	1.40	6.00	9.50
Propane	0.40	1.00	2.50
Butane	0.1	0.00	0.50
Nitrogen	0.10	1.00	0.50
Density (kg/m3)	427.74	445.69	464.83

Liquefied natural gas is a colourless, odourless, non-corrosive and non-toxic liquid, lighter than water. Typical thermo-physical properties of LNG are presented in Table below:

Thermo-Physical properties of LNG	
Parameter	**Value**
Boiling point	-160°C do -162°C
Molecular weight	16 – 19 g/mol
Density	425 - 485 kg/m3
Specific heat capacity	2,2 – 3,7 kJ/kg/°C
Viscosity	0,11 – 0,18 mPa•s
Higher heat value	38 - 44 MJ/m3

The technical processes of purification of gas from harmful components to obtain gas acceptable for use and liquefaction are performed in the preparation trains. Therefore the following need to be removed prior to liquefaction: components that would freeze at cryogenic process temperatures during liquefaction (carbon dioxide-CO2, water and heavy hydrocarbons), components that must be removed to meet the LNG product specifications (hydrogen Sulfide-H2S), corrosive and erosive components (mercury), inert components (helium and nitrogen) and oil. Typical specifications of gas for liquefaction are less than 1 ppm of water, less than 100 ppm CO2 and less than 4 ppm H2S.

Following the removal of most contaminants and heavy hydrocarbons from the feed gas, the natural gas is subjected to the liquefaction process. Natural gas is converted to its liquefied form by the application of refrigeration technology making it possible to cool the gas down to approximately -162°C when it becomes a liquid.

The produced LNG is stored in cryogenic tanks below the boiling point at the pressure of 0.05-0.2 bar until an LNG tanker arrives to transport the product. Upon the arrival of the tanker, LNG from the storage tank is loaded from the loading plant into the LNG tanker, which will transport the gas to the receiving terminal. For safety reasons, storage tanks at loading and receiving terminals in which liquefied gas is stored usually consist of two tanks designed to be fully loaded. The inside of the container in which liquefied gas is stored is usually made of stainless steel resistant to low temperatures. The outer tank is made of pre-stressed concrete and designed to fully contain LNG in case of spillage and be fully loaded in the event of damage to the inner tank. Apart from safety aspects, LNG tanks are also designed to minimise the ingress of heat into the tanks to prevent the boiling (evaporation) of a fraction of the LNG.

The LNG thus produced is transported to the destination port through LNGC. The receiving terminal (sometimes called a re-gasification facility) receives and unloads the liquefied natural gas from LNG tankers, store, vaporise LNG to convert it into pipeline quality natural gas. The regasified natural gas, thus obtained, is delivered into the distribution network. The receiving terminal is designed to deliver the specified quantity of gas into the distribution pipeline and maintain a reserve quantity of LNG. Therefore, its design must include the following elements: a system for receiving and discharging LNG tankers, storage tanks, a re-gasification plant, a control system to control the LNG boil-off gas, supplying their own consumption (utilities), equipment and facilities support. Since natural gas is odourless, the odourisation (mercaptans used as odourisers) of the re-gasified natural gas is required in many regions and countries before its distribution to consumers.