Chapter 4

Elements of LNG Value chain process

4. 1 LNG Value chain process

A typical LNG value chain consists of following stages explained in figure 4.1 below

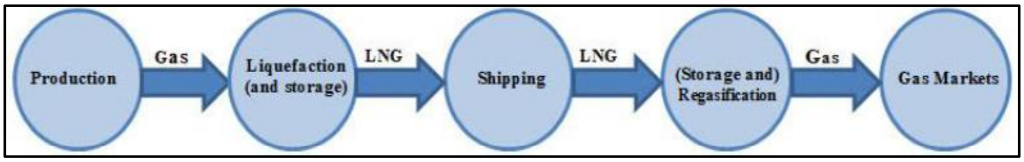

Figure: 4.1 A typical LNG value chain process

Source: Author's own creative diagram

Among the various stages mentioned above, the typical LNG business would commence from Production followed by Liquefaction, Regasification and at end selling in the markets at an agreed price. Hence in this chapter we shall be discussing in this the following

1. Production
2. Liquefaction Plants
3. LNG Shipping tankers
4. Regasification terminals
5. LNG pricing in the markets

4.2 Natural Gas Production and Consumption

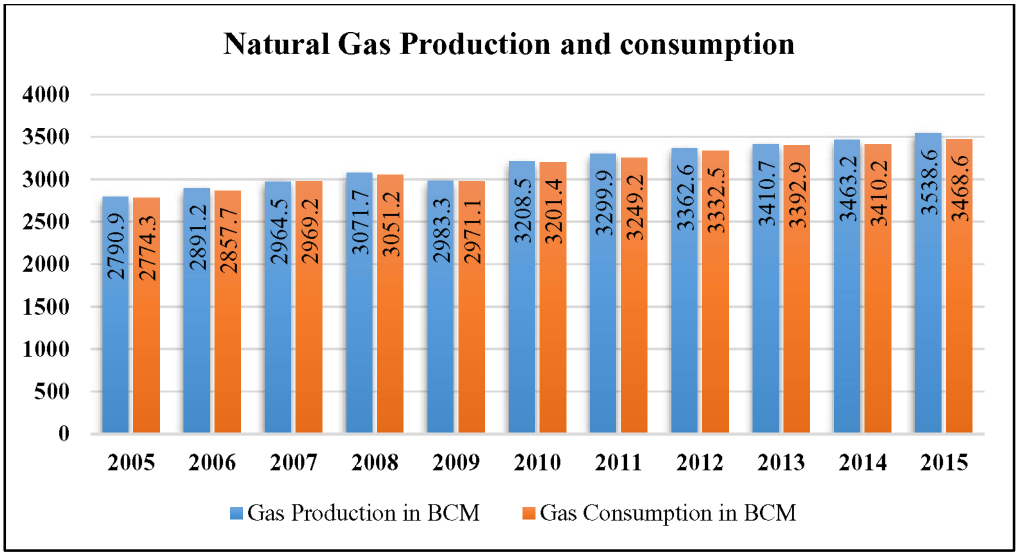

Figure 4.2 Natural Gas Production and Consumption in BCM

Source: (British Petroleum, 2016b)

From (British Petroleum, 2016a) it is evident that Natural gas is second most abundant fuel next to crude oil. The growth rate of natural Gas has been at 1.8% per annum and its share in the primary energy has been steadily increasing. Shale Oil and Gas are projected to have greater potential fuels for the future. Based on consumption patterns, Natural gas looks to be the fastest growing fuel supported by environmental policies, LNG support and abundant supplies. Power generation has been major need for energy where Natural gas is gaining its share by replacing coal. Even though, Transport fuel is primarily dependent on crude oil but natural gas is the fastest growing fuel with annual growth rate of 6.3%. Most this demand for natural gas is coming from China, India which account for 30% and middle east for 20%. The major factors future growth could be accounted to faster shifting to lower carbon fuels and greater potential of Shale gas production.

4.3 Liquefaction Plants

Liquefaction Plants are typical giant refrigerators which are the largest investment element in the chain. They perform the task where the gas is treated to remove the impurities and then liquefying it by cooling to around -163 degrees centigrade of temperature where this gas turns into liquid at atmospheric pressure. Liquefaction process equipment consists of heat exchangers, compressors driven by gas turbines or steam. In this process, heat coming from the incoming gas is transferred to refrigerant gas like ethylene, propane etc. which in turn transfer heat to an outside coolant. The plant is located generally nearer to a jetty or any loading facility that can have good access to LNG tankers.

The growth of liquefaction capacity in the world has been shown below in figure 4.3

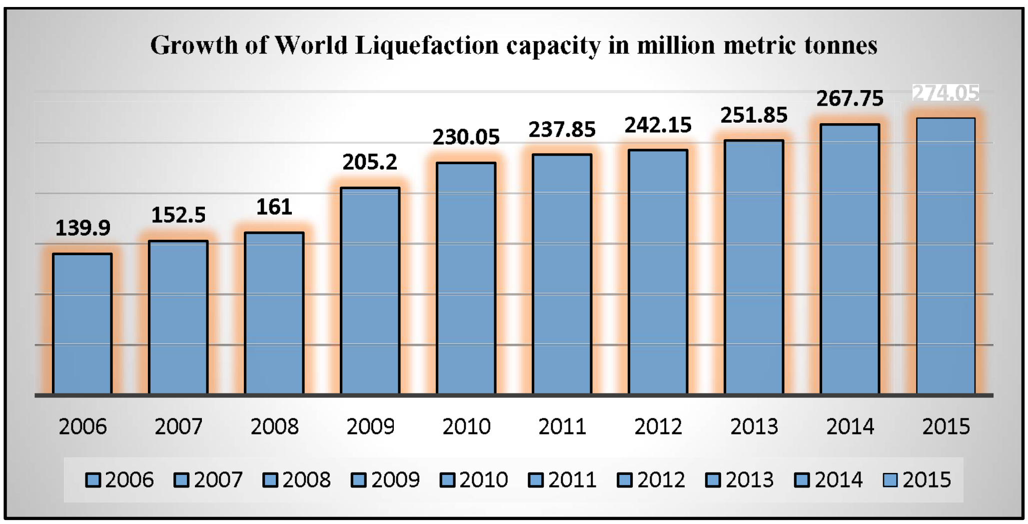

Figure 4.3 The growth of World Liquefaction capacity

Source: IGU World Gas LNG Report, 2016

The pace at which the capacity of liquefaction has increased in 2015 will fast track in the year 2016 as the under-construction projects in Australia and first in USA will commence operations. Based on this 41.5 MTPA of liquefaction capacity would come into operations in USA in 2016. Australia is likely to emerge as leading exporter of LNG with 53 MTPA capacity under construction. But USA may follow soon where 62 MTPA capacity is likely to add up lately which may put USA as the largest exporter across the globe. Other than USA, Canada and Australia, significant liquefaction projects have been proposed in Russia and East Africa. Market oversupply, weaker demand for imports and decreased budgets on weak oil prices have pushed many projects back especially those with higher costs.

Figure 4.4 Liquefaction capacity in MTPA in various countries as on 1st January, 2016

Source: IGU world Gas LNG report, 2016

From the figure 4.4, nineteen countries are into LNG exports across the globe. No new countries have joined in the club in the year 2015 even though Papa Guinea joined the club as latest exporter of LNG. Qatar, Indonesia, Australia, Malaysia and Nigeria are the holders of world's sixty percent of liquefaction capacity, where 25% is held by Qatar. Old aged trains in Algeria have been replaced by new ones to offset the decrease in capacity. The second position is held by Australia in 2015 behind Qatar but over a period of two years, it shall be a major source of incremental supply growth as six liquefaction projects would be online by the year 2018. Though, USA has exported small quantities through Kenal LNG project in Alaska, with five projects of 61 MTPA capacity being added by five projects in the Gulf of Mexico and East Coast. Russia's total liquefaction capacity would be touching 26 MTPA once YAMAL LNG project is completed by year 2019, which has been into trouble due to Artic environment and financing issues.

4.4 Floating Liquefaction Natural Gas

Australia, Cameroon and Malaysia have got four FLNGs under construction with a capacity of 8.7 MTPA as on 1st January 2016. All these four expected to start operations in the year 2018. Apart from this, twenty-four project proposals totalling capacity of 170 MTPA have been proclaimed at the end of the year 2015.

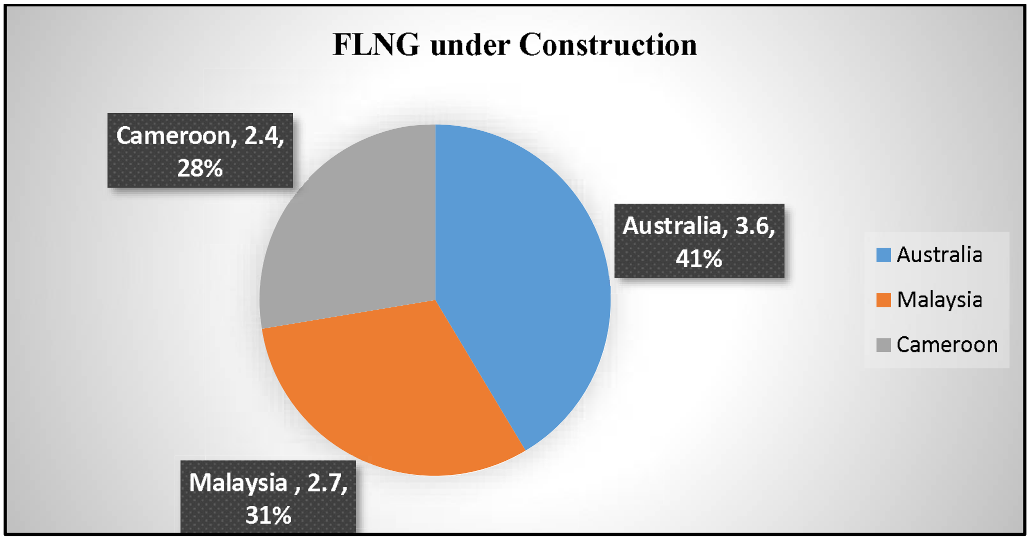

Figure 4.5 proposed FLNG as on 1st January 2016.

Source: IGU world Gas LNG Report, 2016

4.5 LNG Shipping

The LNG is transported by specially designed and built ships with insulated cargo tanks. The LNG ships are traditionally custom built dedicated and for specific project which deliver cargo on regular basis between one LNG supplier and many buyers. The size of LNG ships is built up to maximum size of 26,000CBM capacity. Initially LNG ships used steam turbine for propulsion but with improvement of technology and with changes relative price of oil and gas newer ships are employing slow speed diesel oil. Two different Moss Rosenberg and membrane- tank system using thin flexible membranes were at first developed. In 1971 the Moss Rosenberg system was developed and was well known for its independent spherical tanks which are generally half exposed at the top. There are many designs in the membrane type from different companies, however, the most familiar is designed by Gaztransport and Technograz. By the end of the year 2015, the membrane-type containment system is used by 76% of the LNG fleet.

4.5.1 LNG fleet

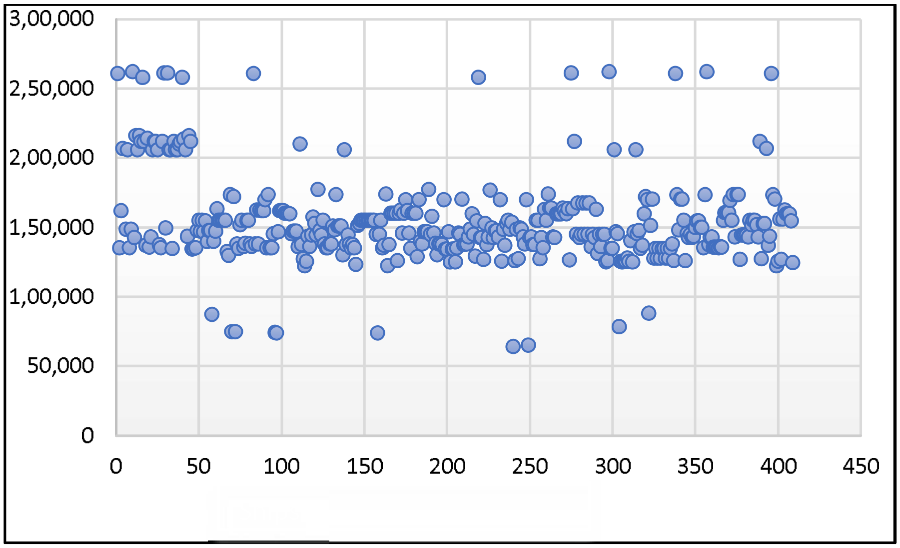

Figure 4.6 LNG fleet composition by size in cubic meter.

Source: IGU World LNG report, 2016

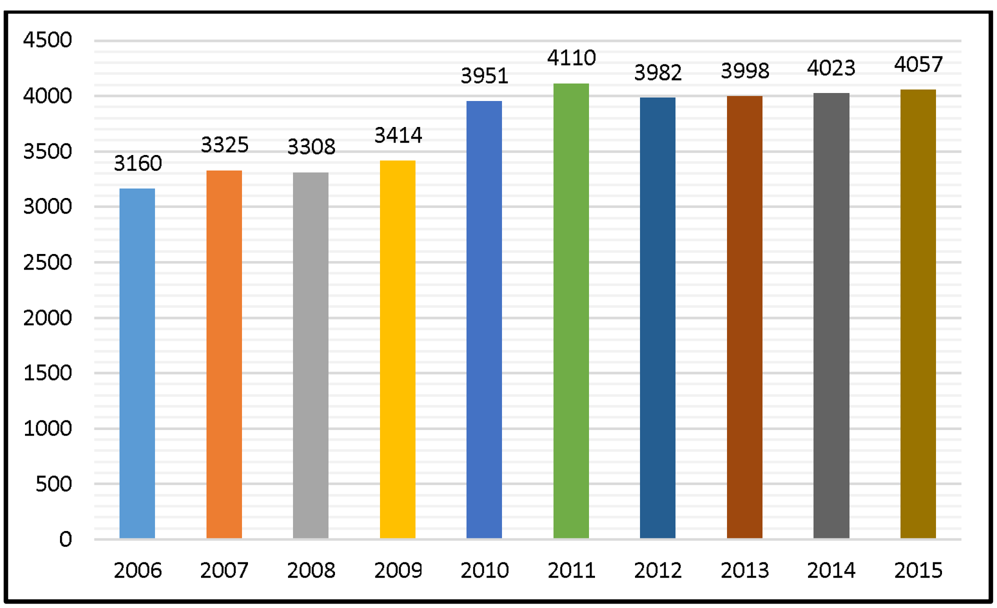

Figure 4.7 Total number of voyages by world LNG ships

Source: The LNG Industry, GIIGNL annual report, 2016

The Traditional LNG fleet vary in size and the recent additions to the capacity demonstrate influence towards larger capacity vessels. Till the year 2008 the standard capacity of LNG vessels was between 1,50,000 cm and 1,25,000 cm. 56% of the active LNG is within this range and this range is the most common. Alternatively, Q class vessels emerged post 2008, with Q-flex size having range of capacity between 2,10,000 - 2,17,000 cm and Q-max having capacity within the range (2,61,000-2,66,000cm) emerged with orders from Qatar. These Qatari Q-Class which are 43 in numbers account for 16% of total LNG tonnage capacity as on 1st January, 2016. However, the cargo capacity is now concentrated around 1,70,000 cm. This is mainly due to expansion of Panama Canal where LNG vessels up to 1,80,000 cm capacity could be accommodated and this new class is defined as New Panamax. As of 1st January 2016, 31% of the global LNG vessels which are active are in the range of 1,50,000 and 1,80,000 cm. With the order book mainly having at an average of 1,70,000 cm, this share is likely to go up substantially. Around twenty-nine new LNG ships were added which in the year 2015 whereas the trade increased by mere 4.7 million tonnes which clearly reflects the oversupply of shipping tonnage added in this period. In total, there four hundred and ten vessels excluding vessels which are less than 60,000 cm capacity which amounts to total capacity of 63 mmcm. The years 2012 and 2013 saw a huge movement of new orders for new build LNG ships driven due to liquefaction projects coming up in Australia and USA rather than due to traditional demand factors. New orders due to speculation and delays in some of the liquefaction projects led to tonnage flooding in the LNG shipping markets. As discussed earlier the New Panama class are dominating the new order with 87% new orders being in this class which can be seen in figure

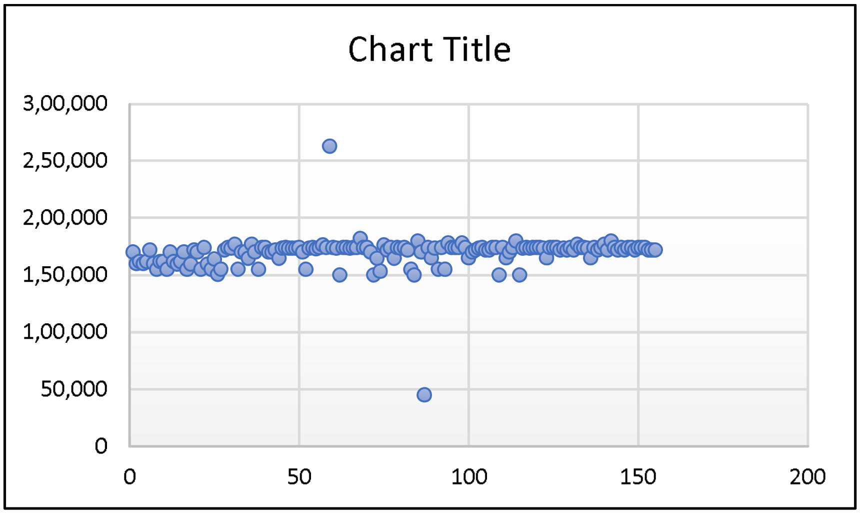

Figure 4.8 LNG order book as per size as on 1st January 2016.

Source: IGU World Gas LNG report, 2016

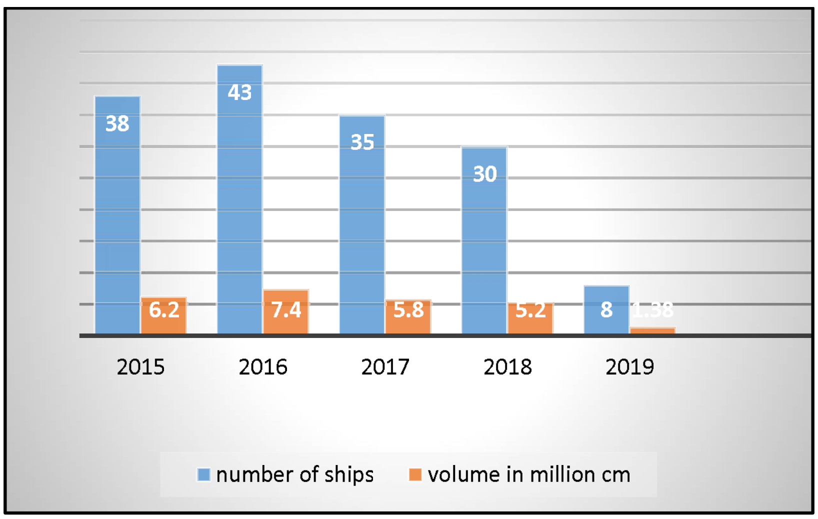

Figure 4.9 LNG order book by volume and number of ships

Source: IGU world Gas LNG report, 2016

These new Panama class would pass through Panama Canal and can as well deliver cargoes in the Asia region. Figure 4.8 above shows the number and volumes as per order book where 75% of these have been chartered for more than a year and rest are yet to be chartered.

Also, to note in 2016 around forty-five new ships including FRSUs are expected to be delivered with only around 10 MTPA capacity of liquefaction likely to be added up. In this scenario of supply surplus of shipping tonnage available and with order book accounting for 40% of existing fleet, the spot LNG charter market would be largely impacted.

4.6 Regasification Terminals for receiving LNG

Regasification terminals also known as receiving terminals are those where LNG cargoes are discharged which are in the customer's or end user's country. These are either owned by the customer or arranged on lease basis from a third party. This regasification terminal consists of single or more berths, supported by asset of unloading arms, LNG storage tanks and vaporization equipment to send regasified LNG through the pipeline system, or loading on to tanker trucks for delivery through roads.

4.6.1 Growth of Regasification terminals

The existing as well as and new LNG importers continue to expand the regasification capacity. The major factor being low prices has led to this growth. Most of these import markets has focused on vessel berthing, storage and growing import volumes. Also, these terminals are also planning to expand for bunkering and reloading facilities. Many onshore regasification projects are up for consideration in countries like Panama, Croatia and Morocco for long term energy supply. FRSUs are being considered by Bangladesh, Ghana, Benin and Uruguay as regasification terminals. The new regasification terminals in 2015 are installed in Jordan, Pakistan and Egypt. UAE has added FSRU with the existing vessel in Dubai LNG. Japan which is the world's largest LNG importer has installed two more regasification terminals in 2015. In total seven new terminals were constructed in year 2015, which included four FRSUs. Chile has brought 1.3 MTPA and Dubai additional 3MTPA capacity online. From the Figure 4.9 it is quite evident that the Asia Pacific and Asia have the largest regasification capacity which has seen the highest growth due to Japan, South Korea, China and India leading the import markets for natural gas. Many new importing countries are likely to add more FRSUs like in middle east and Latin America. Even though traditional European region are part of LNG markets, over past 15 years the number of new countries importing LNG have tripled.

Figure 4.10 Regasification capacity in MTPA in various countries as on 1st January, 2016

Source: IGI World Gas LNG report, 2016

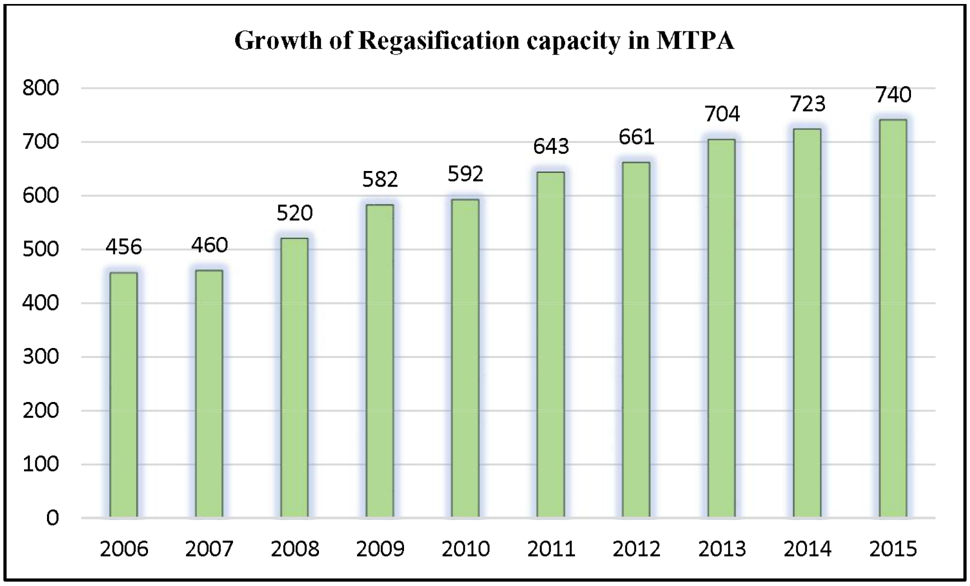

Figure 4.11 Growth of capacity of Regasification as on 1st January 2016

Source: IGU World Gas LNG Report, 2016

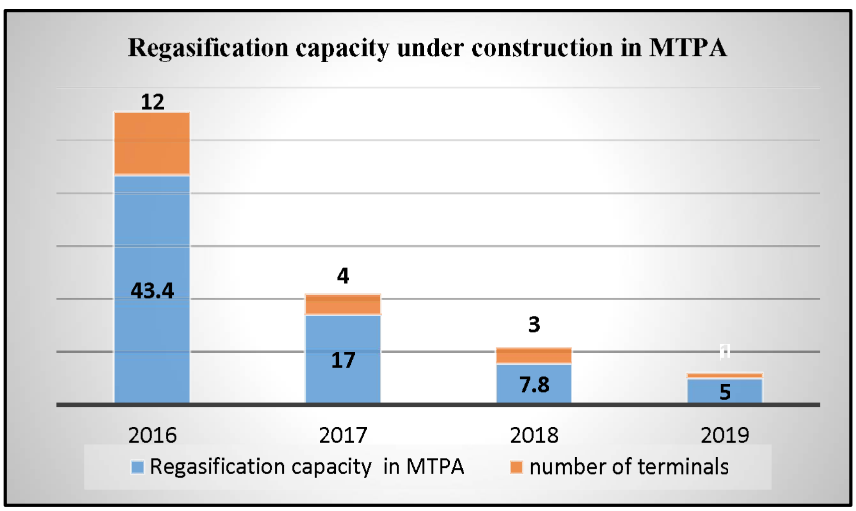

Figure 4.12 Regasification capacity under construction as on 1st January 2016

Source: IGU World Gas LNG Report, 2016

From figure 4.12, 16 new regasification terminals are likely to add up in the year 2016. Out of which 8 would be coming up in China. Philippines and Poland are to start new operations for LNG imports. Two terminals each in India and Japan. Also, to note around 73 MTPA additional capacity in total is likely to be added up over the next four years and 95% of these are in existing LNG markets.

In addition to this Columbia, Puerto Rico, Uruguay, Ghana and Chile are going for new FRSU projects amounting to an additional capacity of about 19MTPA.

4.7 LNG markets and Pricing

4.7.1 Natural Pricing Mechanisms

The Natural Gas Industry has been traditionally following various types of pricing mechanisms. From the survey of (International Gas Union, 2014) the various price formation mechanisms discussed are as per below table 4.1

Oil Price Escalation (OPE)	The price is generally linked to base price of competing fuels like crude oil, gas oil, fuel oil or coal prices with an escalation clause.
Gas-on Gas Competition (GOG)	The price determined by forces of supply and demand gas-on-gas competition. The gas is traded on daily, monthly or yearly periods. The trading is done at notional hubs like NBP in UK or physical hubs like Henry Hub.
Bilateral Monopoly (BIM)	The price negotiated over bilateral agreements and discussions between buyer and seller where the price is fixed for period. Here there could be single dominant buyer or seller at one side of the transaction.
Netback from final product (NET)	Here the price received by the gas supplier is a function of the price received by the buyer for the final product the buyer produces.
Regulation: Cost of Service (RCS)	The regulatory authority like Ministry approves the price where the price level is set to cover the cost of service including recovery of investment and a reasonable rate of return.
Regulation: Social and Political (RSP)	The Ministry sets the price on irregular basis keeping in view political and social factors to cover increasing costs or to increase the revenue.
Regulation: Below Cost (RBC)	The price generally below average price production and transportation costs supported with a subsidy by the government
No Price (NP)	The gas is supplied freely as feedstock to industry and population.
Not Known (NK)	No evidence or data

Table 4.1 Types of Price Mechanisms

Source: (International Gas Union, 2014)

From the survey the above said price mechanisms have been discussed in five different categories

1. Domestic production
2. Pipeline imports
3. LNG imports
4. Total imports – LNG plus pipeline
5. Total Consumption which includes domestic production and total imports.

From the survey, we also find that the LNG imports pricing mechanism composition in 2013 has been shown below

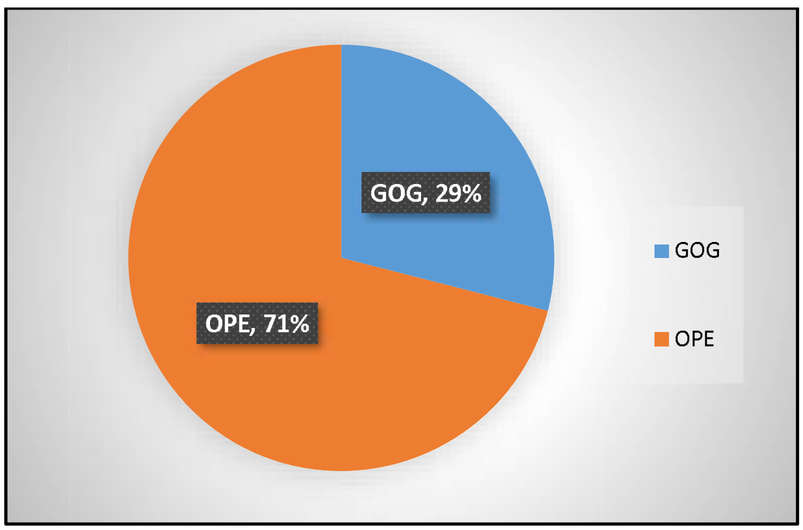

Figure 4.13 LNG imports price mechanism in 2013

Source: (International Gas Union, 2014)

The LNG imports in 2013 were 314 bcm which accounted for 9% of total world consumption. From above OPE pricing mechanism accounted for 224 bcm which mostly in Japan, Korea and Taiwan in Asia Pacific region. GOG pricing mechanism which accounts for 29% sums to 90 cbm of volume. The countries following this mechanism are UK, USA, Canada and Mexico where domestic pricing is GOG.

From (International Gas Union, 2014) we can also understand that from 2005 to 2012 there is a rise in GOG from 13% to 32% from 2005 to 2012 which has been due to reduction in OPE pricing mechanism. In BIM Category was also seen to be decreasing as imports from QATAR to India had switched to OPE pricing mechanism.

From the same survey report we can also study the total imports including LNG and pipeline imports as detailed in below table 4.14

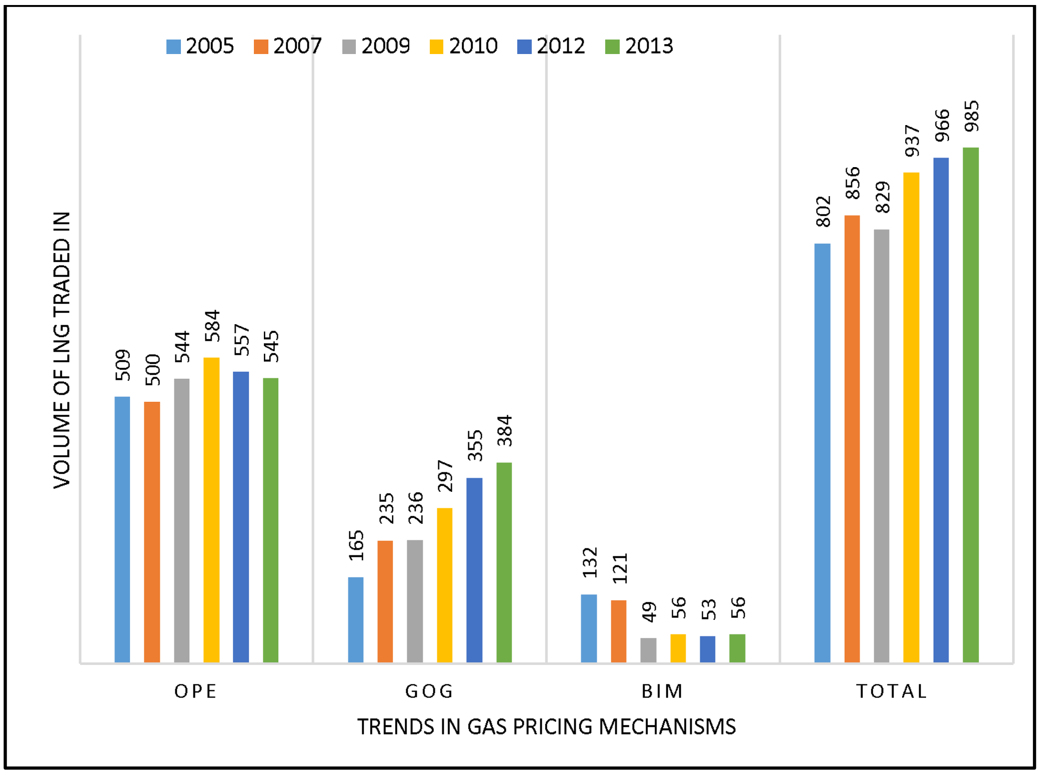

Figure 4.14 World price formation from 2005 till 2013 for Total imports

Source: (International Gas Union, 2014)

The total imports combining pipeline and LNG have comprised of OPE, GOG and BIM pricing mechanism. Since 2005 the OPE has been losing by 10 percentage points and GOG has been gaining a similar share.

We could also look at regional level price survey for total Gas imports from (International Gas Union, 2014)

4.7.2 Asia region

China and India have been dominating the price formation mechanisms. There has been increase in OPE price mechanism from 34% to 41% from 2005 to 2013 at the expense of BIM and regulated categories. The move from BIM pricing mechanism to OPE was largely due to change in pricing of Qatar LNG contract to India between the year 2007 to 2009. There was also a recent rise in OPE which was due to start of pipeline imports into China form Turkmenistan which are oil indexed under the contract. The RSP was down from 48% in 2005 to 10% in 2013 and there was a rise in RCS from 0% to 41 % due to change in price formation in China as regulated prices were increased to economic levels. The decline in RBC from 11 % in 2005 to 4% in 2013 was largely due to change in pricing mechanism in Bangladesh to RCS and declining consumption in Myanmar.

4.6.3 Asia Pacific region

There have been only small changes in price mechanisms since 2005 in Asia Pacific region. There has been a rise in GOG from 11% to 19% while OPE has declined from 60% to 57% and RSP declined from 22% to 16%. There have been rise in GOG due to rise in spot LNG imports mostly in Japan and some quantities in Korea, which reflects rise in Spot LNG. The fall in RSP is majorly due to slow growth in consumption in Indonesia and Malaysia.

The report (IEA, 2014) discusses the why gas prices are linked to oil prices. The mechanism was first adopted in 1960s in Netherlands where oil was the alternative to gas. Over a period, the oil indexation spread to Asia although current mechanism of JCC (Japan Crude Cocktail) was not established. In late 60s Japan started importing LNG at fixed price. But in 1973 the oil prices have increased significantly by which the LNG prices had to be discounted substantially. Today most of the Japanese LNG contracts use the JCC which is the weighted average price of Japanese oil imports. Even though oil indexation was widely spread other indices such coal and electricity prices have been used especially in Europe. But oil indexation has lost its relevance now as oil is less alternative to Natural gas in 1970s. Now Nuclear, Coal and renewables are used as alternatives to reduce oil consumption for power generation. But the share of oil indexing is high in middle-east as they use oil and natural gas for power generation. This the last region which still uses oil indexation as fundamental basis. Also, to note that there are many factors which have disturbed that oil indexation model, which are

1. Emergence of LNG spot cargoes and short term LNG trade
2. The rise of US shale gas exploitation which transformed from would be importer into would be exporter.
3. A large gap between gas prices in Asia and the United States.

From the report (IEA, 2014) we also understand the various reasons for Asia paying a premium for gas supplies

1. The oil linked pricing in long term contracts.
2. The emphasis on security of supply.
3. A low level of demand flexibility.
4. A lack of appropriate regional spot prices reflecting Asian supply and demand balance.

4.7.4 Short Term and Spot LNG markets

Keeping in view some of the above factors saw rise of short term and spot LNG trade volumes. The have been many potential sources of surplus capacity due to which the there is a steady rise in short term and Spot LNG

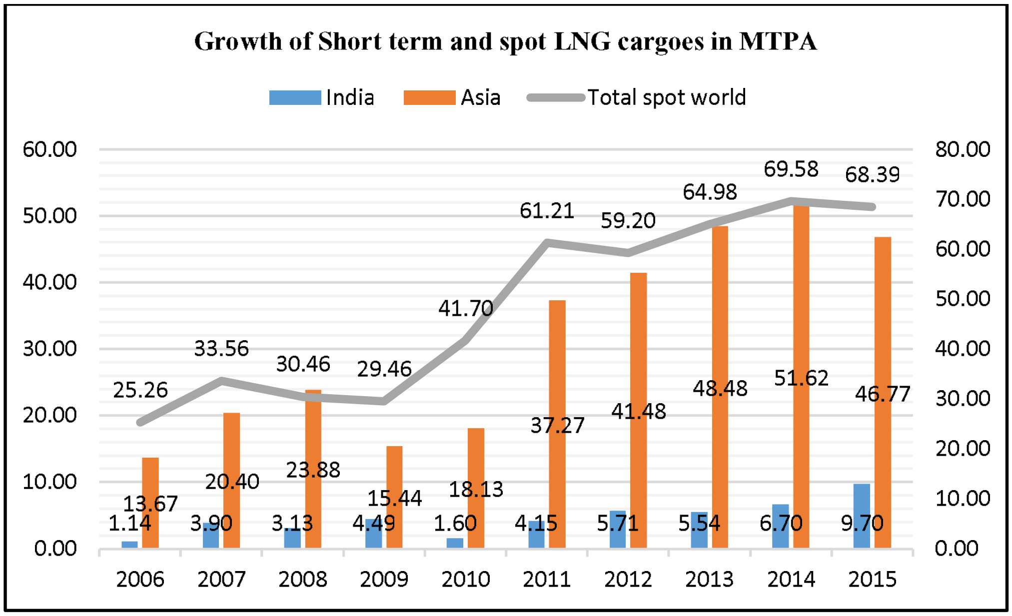

Figure 4.15: Growth of short term and Spot LNG cargoes in the world in million tonnes per annum

Source: The LNG Industry, GIIGNL Annual Report, 2016

The various reasons for the surplus supply and rise of spot LNG has been discussed in (Michael D. Tusiani, 2007) which could be of following reasons

a. Wedge volumes: This is created when there is a new train built at the liquefaction plant and surplus LNG is available for sale before buyers could achieve their long-term contract obligations.
b. Expiration of Long-term contracts: Traditionally after expiry of Long term contracts the buyer and seller would renegotiate but with increase in number of buyers and sellers in the present scenario, regulatory issues, insufficient supply of gas could lead to nonrenewal of these contracts thus giving rise spot trade options.
c. Buyer over commitment: There could be error in projection of long term demand and thus may give rise to situation of over contract for the buyer. This could be due to inadequate storage facilities where the buyer is forced to sell elsewhere which could lead large volumes of spot trades.
d. Contract failure: There could be cases where due to unforeseen circumstances the buyer could fail to take off the project and could lead

to termination of contract. In such circumstances the seller would look for selling the unsold cargo through spot trade.

e. Contract and Operational flexibility: The seller could offer cargoes to seasonal markets where there is a flexibility clause and thus the excess volume available during off season could be sold through spot trades.
f. Conservative liquefaction Plant design: The projects costs could lead to overdesign of liquefaction trains than contracted volume where the excess capacity could be sold through spot trades.

From above discussions in this chapter it could be seen that there is great deal of uncertainty and volatility in LNG market prices and LNG shipping due to various respective factors.