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Review Paper

LNG Projects Financing Structure Review

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Abstract

High investment level, various partners and the volume of gas consuming by the LNG projects, makes them very complicated. All the different parts of the LNG supply chain are linking together and if they cannot connect the sections properly, production and supply of LNG will have problems. A successful LNG project involves the bringing together of a chain of activities to link the gas production to the gas user. The distribution of LNG sale's profit to the final consumers must be in a way that all the chain parts could get benefiting from the supply chain. Otherwise connection will be weaker and problems will occur. The most important connection in LNG supply chain is the link between upstream of gas production and liquefaction. Because upstream will provide the gas needed for producing LNG.The connection between upstream and liquefaction depends on the contracts for developing upstream. The LNG market is predominantly based on long term sales contracts between buyers and sellers. LNG investment construction of the project depends on the strategy of the investor companies. LNG trends show that the buyers are cooperating more in upstream level and the sellers are tend to put more investment in downstream.

Keywords: LNG, supply chain, integrated structure, non-integrated.

Introduction

Liquefied natural gas or LNG is natural gas that has been converted to liquid form for ease of storage or transport. The main component of liquid natural gas is Methane (CH_4), and this perspicuous and transparent liquid has no color and smell. The liquefaction process involves removal of certain components (such as dust, helium) and then condensed into a liquid at close to atmospheric pressure (Maximum Transport Pressure set around 25 kilopascals"kPa" (3.6psi) by cooling it to approximately -163 degrees Celsius. LNG is transported in specially designed cryogenic sea vessels or cryogenic road tankers; and stored in specially designed tanks. LNG is about 1/614th the volume of natural gas at standard temperature and pressure (STP), making it much more cost-efficient to transport over long distances where pipelines do not exist. Where moving natural gas by pipelines is not possible or economical, it can be transported by LNG vessels. The most common tank types are membrance (prismatic), Moss Rosenberg (spheres) or Self-Supporting Prismatic Type[1].

These days the most usual and economical way for transferring natural gas is converting that to LNG. Latest improvements in LNG industry have incredible effects in the world gas industry and specially security of gas supply. On the other hand, the decrease in LNG vessels prices in the last decade makes the LNG transportation more economical[2].

Most of the undeveloped gas fields are located far from the consumer centers and that's why LNG will play the main role in the world energy market. The importance of the gas export in host countries and also pipeline limitations and problems, have encouraged these countries to use LNG plans.

Factors such as higher price of natural gas, decreasing LNG producing costs, Increasing in LNG import demand and producing from faraway gas field sentiment will increase natural gas trade in form of LNG.

Analysts believe that in next decade, LNG supply will growth at about 10 percent a year and the number of exporting country will exceed than importing once. This growth will need huge investment in LNG producing chain and increase the opportunities and threats of LNG industry[3].

Developing the LNG markets and decreasing LNG chain costs specially in developing process (and also the new projects such as Trinidad and Tobago) will make LNG projects successful and economic. This report will explain the LNG supply chain and then it will study the developing trends in LNG investment projects.

The LNG Supply Chain: A successful LNG project involves bringing together of a chain of activities in order to link the gas production to the gas user. The main links in the LNG supply chain are: upstream (gas production), liquefaction, shipping, and there gasification of the LNG for distribution to end users. Each link in the chain depends on the others since a failure in one link

may halt or impair the delivery of the LNG until the problem is overcome[4].
Most of the LNG suppliers use the production sharing contracts in their upstream (developing gas field). In this regards developing the gas field, gas productivity and diverting it to LNG are known as an integrated activity between the cooperators. However nonintegrated project may be seen, too. In nonintegrated project, liquefaction part cooperators buying the gas from supplier without interfering in the developing process. All of the LNG supply chain links will be describe in continuance[5].

Upstream: Upstream covers the exploration, development and production of gas before liquefaction. The gas reserves required for an LNG project have to satisfy a number of important physical and economic necessities: LNG projects typically require large gas reserves (in excess of 10 Tcf or 280 Bcm), able to produce gas at a plateau level for at least 20 years[6]. The quality of the gas is also a key factor in determining whether LNG projects are economic. Associated liquids (liquefied petroleum gases "LPG") provide additional revenues for the project. LPG divided from the main component of the feed gas, can either be sold separately or re-injected in to the LNG.

Some projects are supplied by a single large field (e.g. RasGas in Qatar), while others may supply by a number of small and medium-sized fields (e.g. Atlantic LNG in Trinidad and Brunei LNG) and they may be located off-shore (e.g. Australia's North West Shelf project) or on-shore (as in Algeria).The costs of the delivering gas in to the liquefaction plant including production, transportation, and pre-liquefaction treatment, must be low if the project is to be commercially viable. Credits from the sales of liquids extract from rich gas can make an important contribution to the reduction of the into-plant cost of gas[7].

Liquefaction: Natural gas liquefaction by cooling dates back to the 1940 and after 1960 economies of scale of the liquefactions and shipping have been concerned. In 1964 the first LNG was shipped to UK.

After some initial processing at well-head, the gas is delivered to the liquefaction plant. It's first treated to remove any remaining water, condensates and contaminants such as carbon dioxide, mercury and hydrogen sulphide[8].

Liquefaction involves the processing and cooling of gas to –161°C.the liquefied gas is stored in tanks until it can be loaded onto an LNG ship for export. Liquefaction units are referred to as LNG trains, with most LNG plants operating between 2 and 8 independent trains[9].

There are two most common processes for liquefying natural gas, the Multi-Component Refrigerant process and the Phillips Cascade process. The main differences of all the technologies use in liquefaction are as below: Using different refrigerant, Using different heat exchanger system in size, pressure, costs, Different in the number of compressors they use

Liquefaction plant capital costs may make up over 80% of total liquefaction costs; however, in recent years these have been significantly reduced through improved technology and economies of scale. Each liquefaction cycle has got its own productivity conditions that are known by special factors in project. That means each LNG project has got special process that can be compared by noticing the side factors such as situation and place.

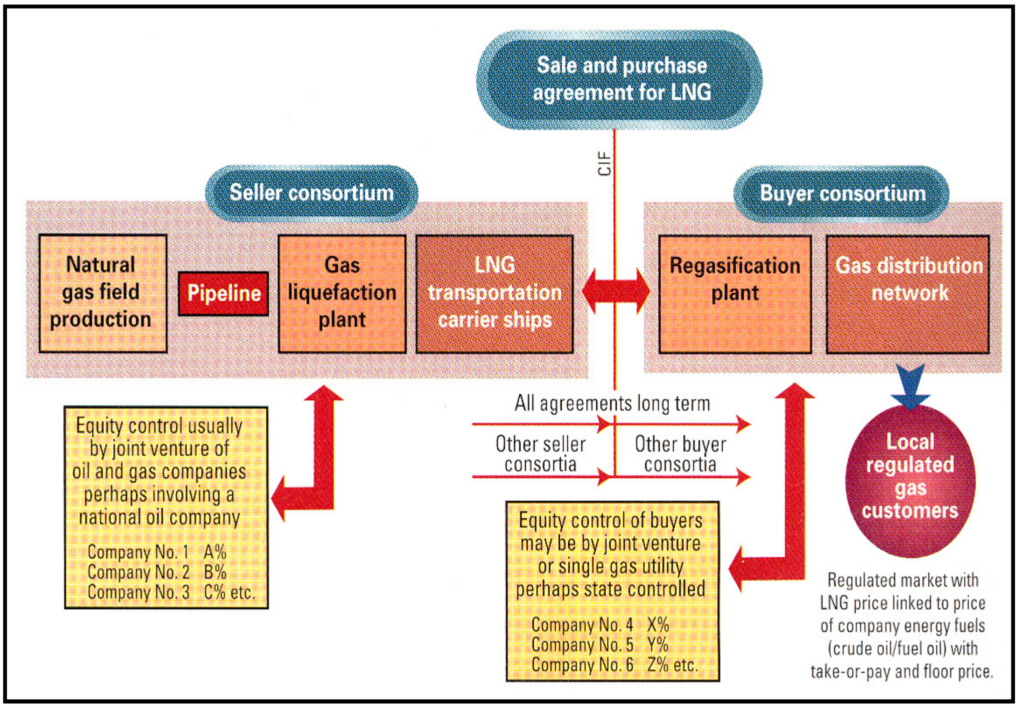
Shipping: The LNG ships are a key part of the LNG chain, providing the link between LNG plant and the market. They are specially designed to carry LNG. It's kept cold by insulation around the tanks, which are not pressurized. Approximately 1-15 percent of the cargo boils off each day, and the process helps to keep the remaining cargo at -161 C. There are currently two main basic designs of LNG ships in operation and under construction: i. Membrane: They are mostly in square shape and cannot tolerate high pressure. These tankers depend on the size of the ship are at about 4-5 in each ship. ii. 2- Moss-Rosenberg: Circle tankers that can tolerate more pressure and are more expensive than the other one. These tankers depend on the size of the ship are also at about 4-5 in each ship. iii. The prices of each LNG ship have varied considerably over time, driven by competition among the shipyards. In the late 1980s and early 1990s, the cost of a 135,000m3 ship reached over $250m. Costs fell steadily during the 1990s and by 2003 the cost of a 145,000 m3 ship was between $150m - $160m. However it rose again in the first half of 2004, reached around $175m. While most of the LNG contracts are Free On Board(FOB)[1], so the buyers are the owner of LNG ships.

Re gasification: The process of re gasifying the LNG is technologically much simpler than liquefaction. The LNG is heated in open rack vaporizers, using seawater as a heat source, or in submerged combustion vaporizers. In the latter water is warmed by burning gas and the heat transferred to the LNG. There are currently two main basic ways for converting LNG to natural gas. Most of the terminals are using both of them: Open Rack Type: which use seawater over the gas pipe line, Submerged Combustion Type: which use hot water through the spiral gas pipes.

The capital cost of a terminal varies considerably depending on the location, number of berths and storage capacity. It can be under $200m but can reach over $1bn for a facility with a large storage capacity in a location where construction costs are high.

The structures that are currently used in LNG investment projects are as below: Integrated structure, Nonintegrated structure

Integrated project: In an integrated project the share holders are the same for the upstream developments and the liquefaction plant. There is a common ownership by "production sharing" contracts of the gas reserves, liquefaction plant, and in most cases the LNG ships.



Source: Oil and Journal, 24 Jan 2005

Figure-1
Fully Integrated (Traditional) Model: Sellers, Buyers

An integrated project has the advantages of aligning the partner interests and avoiding negotiation of transfer prices. It's not necessary to agree the price for natural gas supplied to the LNG plant, unless the host government requires a price to assess tax and royalty payments. It can also make expansion a more straight forward process, provided that the original owners have the reserves to support the expansion.

The integrated project can also expand to the liquefaction and shipping levels. On the other hand, an integrated structure may not be possible in many situations because the owners of the gas reserves are differ from the liquefaction plant owners. In these cases, the most common alternative is the transfer pricing arrangement. Partners in each stage agree a transfer price for sale of the gas or LNG into the next stage of the process. Transfer pricing arrangements may lead to conflict, particularly when changing market conditions shift the risk/reward balance between different partners.

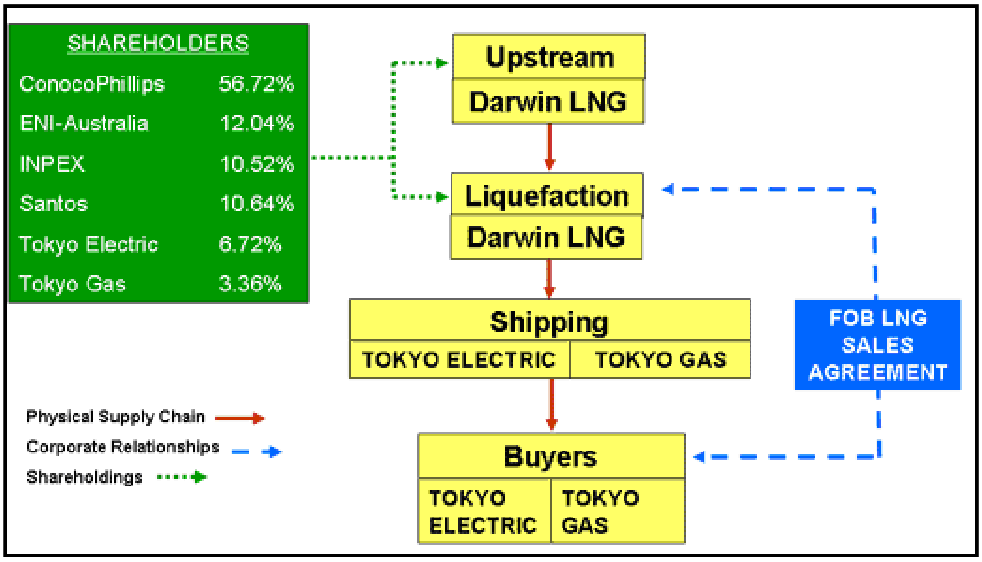
Project Structures-Case Studies: Examples of the integrated projects include Algeria, Alaska, Australia North West Shelf and RasGas in Qatar. In the case of North West Shelf project, the integration extends to the shipping phase as well as the gas production and liquefaction. It has six co-ventures, Woodside, Shell, BP, ChevronTexaco, BHPBillton and MiMi (a joint ventuere of the Japanese trading houses Mitsui and Mitsubishi), who jointly own the gas reserves, the production facilities, the liquefaction plant, and seven of the nine LNG ships used to deliver LNG to the buyers.

RasGas in Qatar: In case of the RasGas project, the LNG from the first two liquefaction trains is sold on an FOB basis. So the integration only extends to the gas production and LNG plant, leaving buyers to make their own shipping arrangements.

The first phase of this project is an integrated project with the shareholders who are having the same interests in the upstream production and liquefaction trains 1 and 2. The LNG is sold to Korea Gas on an FOB basis. A second venture, RasGasII has been formed between Qatar Petroleum (%30) and Exxon Mobil (%70) to expand the project. Train 3 came on stream in February 2004 to supply the Indian market. Future trains are planned to supply Taiwan and the USA.

RasGasII is also organized as an integrated project, and the integration will extend in to the shipping phase since some of the sales will be on an ex-ship basis with a number of ships owned. the integration is also extending in to the re gasification phase for the first time with QatarPetroleum and ExxonMobil taking shares in the Italian terminal that will receive the LNG and also planning to develop terminal capacity in the USA jointly[10].

Darwin LNG: Darwin LNG is an integrated project, and the integration expands to the liquefaction phase. The LNG is sold to Tokyo Electric and Tokyo Gas on an FOB basis.

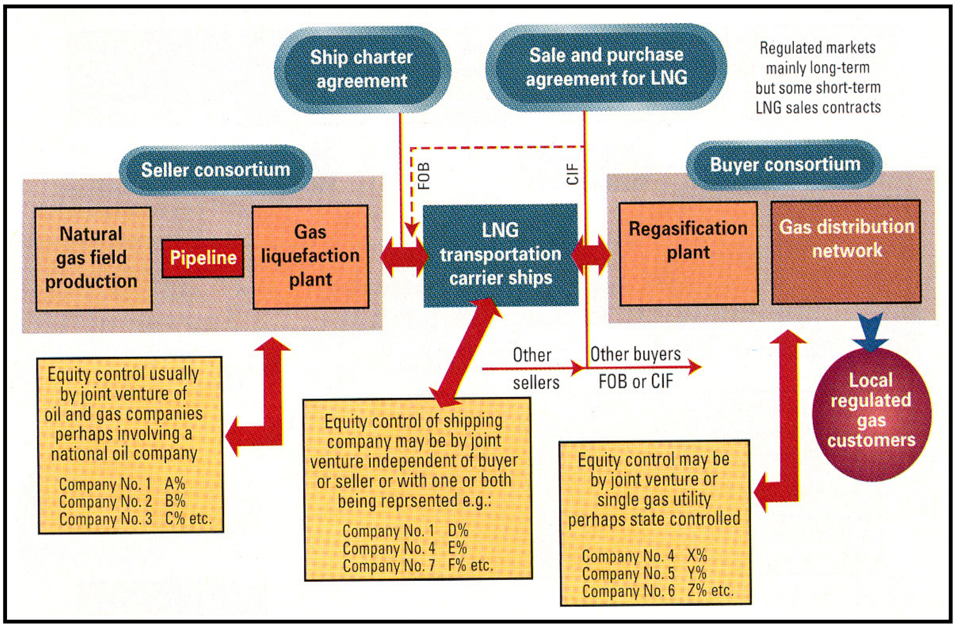


Source:www.globallngonline.com, 2007

Figure-2
Darwin LNG Project

Tangguh and sakhalin LNG: These LNG projects are also known as integrated projects, which the integration will extend in to the liquefaction phase. Tangguh is in Indonesia and Sakhalin in Russia. The LNG of these projects will be sold to buyers on an FOB and CIF basis. In Tangguh LNG, it is sold to CNOOC on FOB and to POSCO, Sempra and K-Power on CIF.

Nonintegrated project: In a nonintegrated project, the share holders are not interfere in developing gas field and just buy gas from the host country or company. In these projects the owners of gas fields are different from the liquefaction shareholders. Also there is not a common ownership in upstream gas production of the host country by "production sharing" contracts such as production sharing contracts in Indonesia, Malaysia, Abozabi and Oman. In these kinds of contracts reserve's ownership is the host government specialty and the government delivers the gas to the company in liquefaction infrastructure.



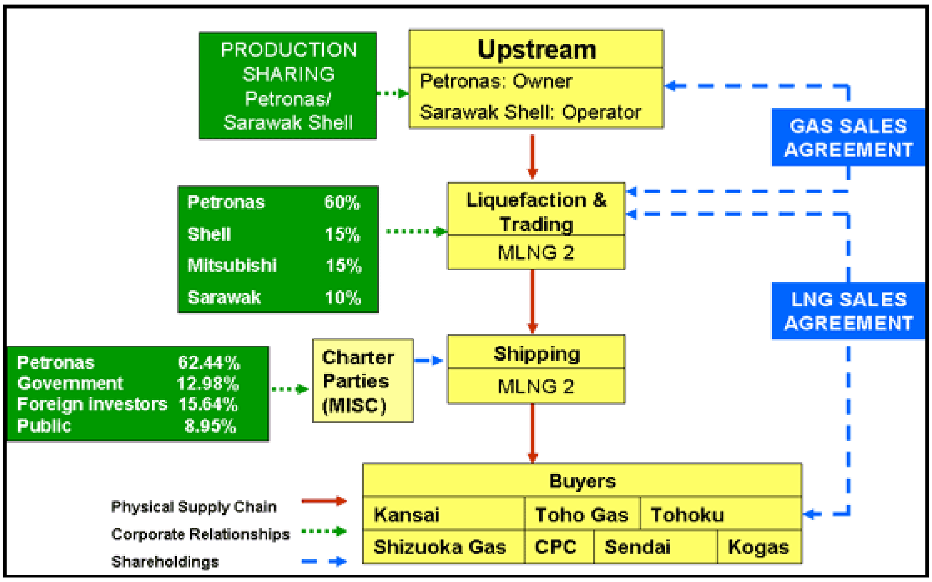
Source: Oil and Journal, 24 Jan 2005

Figure-3
LNG Integrated Projects Structure (to liquefaction phase)

Nonintegrated project: In a nonintegrated project, the share holders are not interfere in developing gas field and just buy gas from the host country or company. In these projects the owners of gas fields are different from the liquefaction shareholders. Also there is not a common ownership in upstream gas production of the host country by "production sharing" contracts such as production sharing contracts in Indonesia, Malaysia, Abozabi and Oman. In these kinds of contracts reserve's ownership is the host government specialty and the government delivers the gas to the company in liquefaction infrastructure.

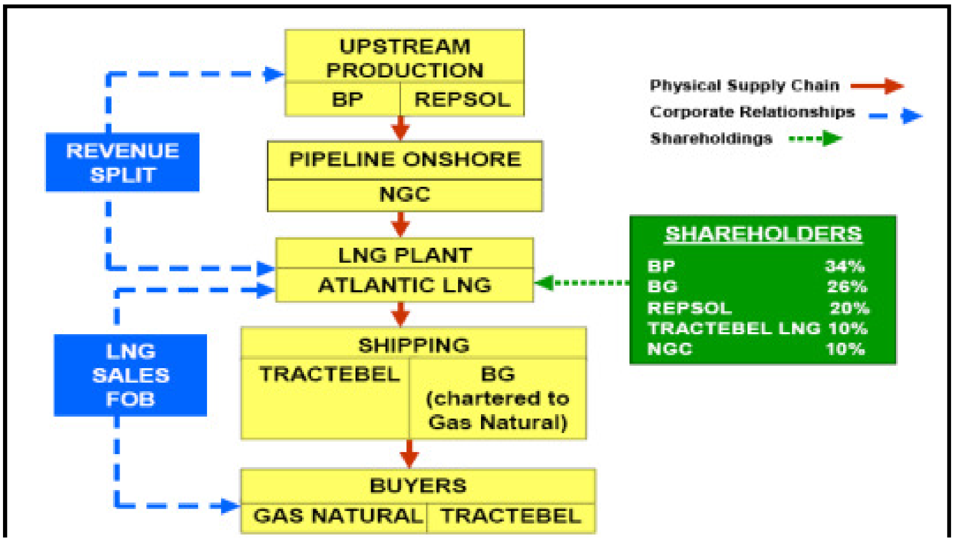
The nonintegrated project has one gas supply contract and the partners must agree the price for natural gas. In these contracts, transportation cost is one of the main factors in defining investment rate of return and the amount of shareholders cooperation depends on their willing and agreements.

Project Structures-Case Studies: MLNG Dua in Malaysia: The MLNG Dua is a nonintegrated project. The upstream producers (Shell, Petronas Carigali) produce gas through a production sharing arrangement and sell it to the plant operator (MLNG Dua), a joint venture between Petronas, Shell, Mitsubishi, and the Sarawak government.



Source: www.globallngonline.com ,2007

Figure-4.
MLNG-Dua Project



Source: www.globallngonline.com ,2007

Figure-5
Atlantic LNG, Train 1 Project

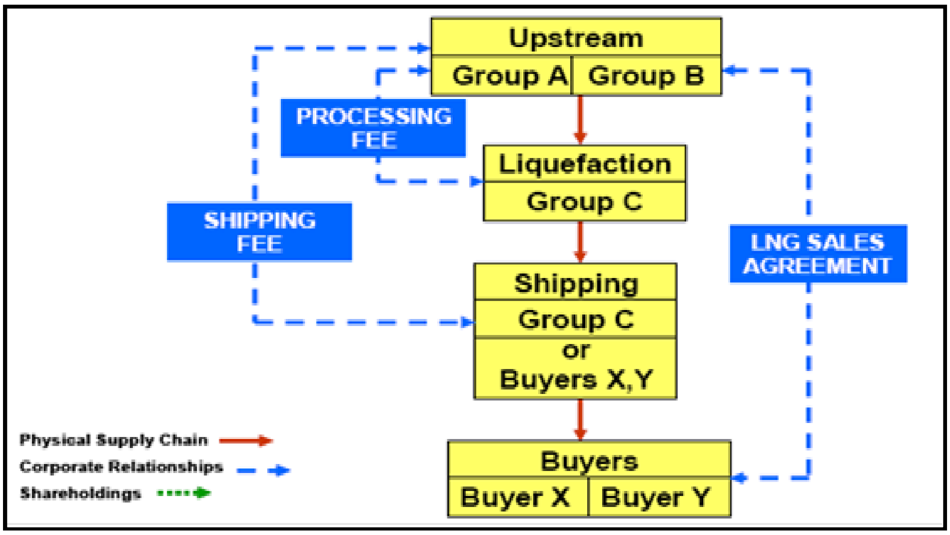
MLNG Dua sells the LNG and arranges shipping through the Malaysian International Shipping Company (MISC). A similar structure was used in the first Malaysian LNG project, MLNG Satu, and in MLNG Tiga, but the upstream and plant shareholdings and the buyers vary between the projects.

Atlantic LNG in Trinidad and Tobago (train1): Train1 of the Atlantic LNG Project in Trinidad and Tobago is a nonintegrated project. Share holders of this project are BP and Repsol and they don't have the ownership of the liquefaction part.

Tolling Structure: Another kind of the nonintegrated project is known as Tolling Structure projects. In this kind of project, producers always pay the tolling fee for using the liquefaction infrastructure to the investors. Tolling cost will be defined in agreement and depends on the investment rate of return.

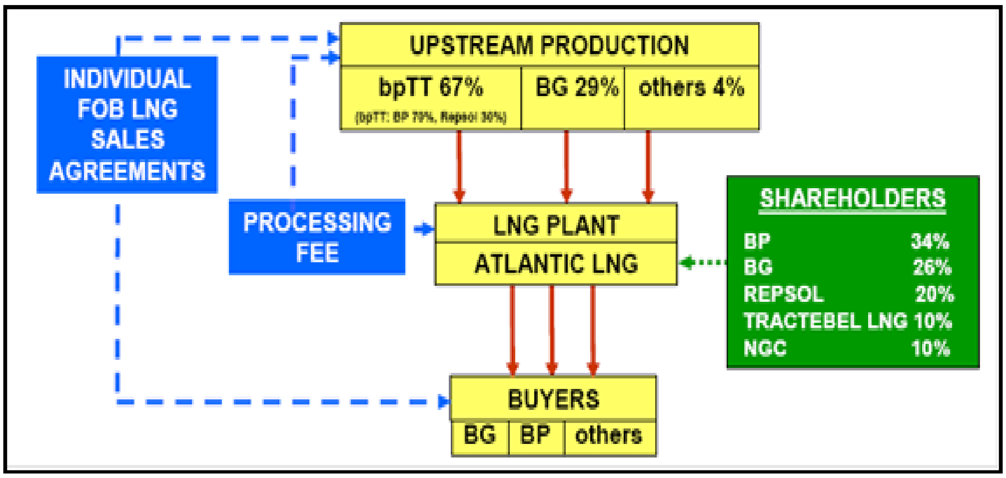
Tolling Structure projects have been more common since the year 2004, because in this way companies can do the LNG marketing themselves, also there are more possibilities to have innovative shareholders for reaching the new resources. Examples of the tolling projects are as below:

Atlantic LNG in Trinidad and Tobago (train4, 2 and 3) : The structure adopted for train 4 at Atlantic LNG in Trinidad, which is scheduled for completion in early 2006, is pure tolling structure. The liquefaction's shareholders in the train 4 are BP(%34), BG(%26), RepsolYPF(%20), Tractebel LNG(%10), NGC(%10) and the upstream shareholders include BP and Repsol (%67) and BG(%29).



Source: www.globallngonline.com ,2007

Figure-6
Tolling Arrangement



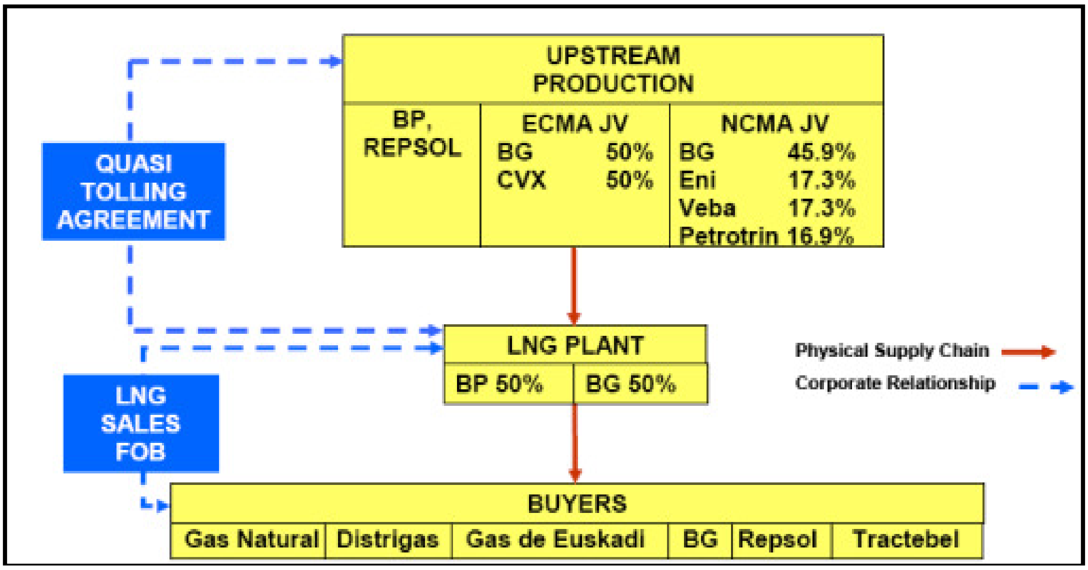
Source: www.globallngonline.com ,2007

Figure-7
Atlantic LNG, Train 4 Project

In these circumstances, shareholders will have the right to supply natural gas in to plant and get the LNG in shareholding percentages. Each shareholder is responsible for the transport and marketing of its own LNG. The tolling fee calculates to catch an agreed rate of return on the investment in the LNG plant.

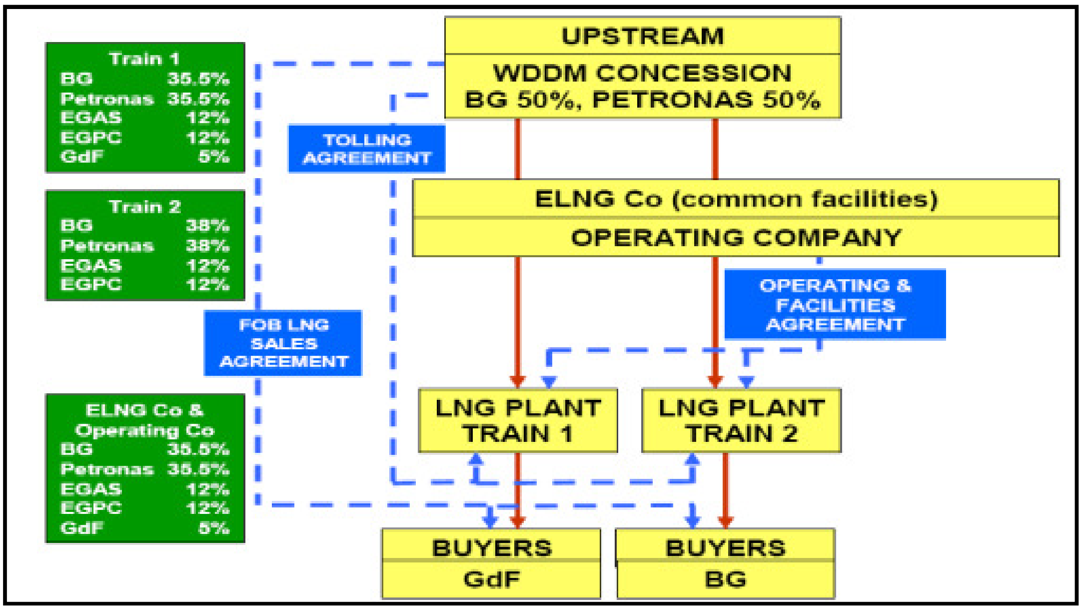
The structure adopted for trains 2and3 at Atlantic LNG has got some of the trolling characteristics, too. BP supplies about %50 of the train 2, upstream gas of this project is from East Coast Trinidad and remain is providing from joint venture of NCMA from North Coast by BG (%50).

In train 3, %75 of the upstream gas is from BP and the other %25 is providing by NCMA and ESMA joint venture. Notice that the LNG Idku Egypt and Segas in Damietta have the same structure, too.



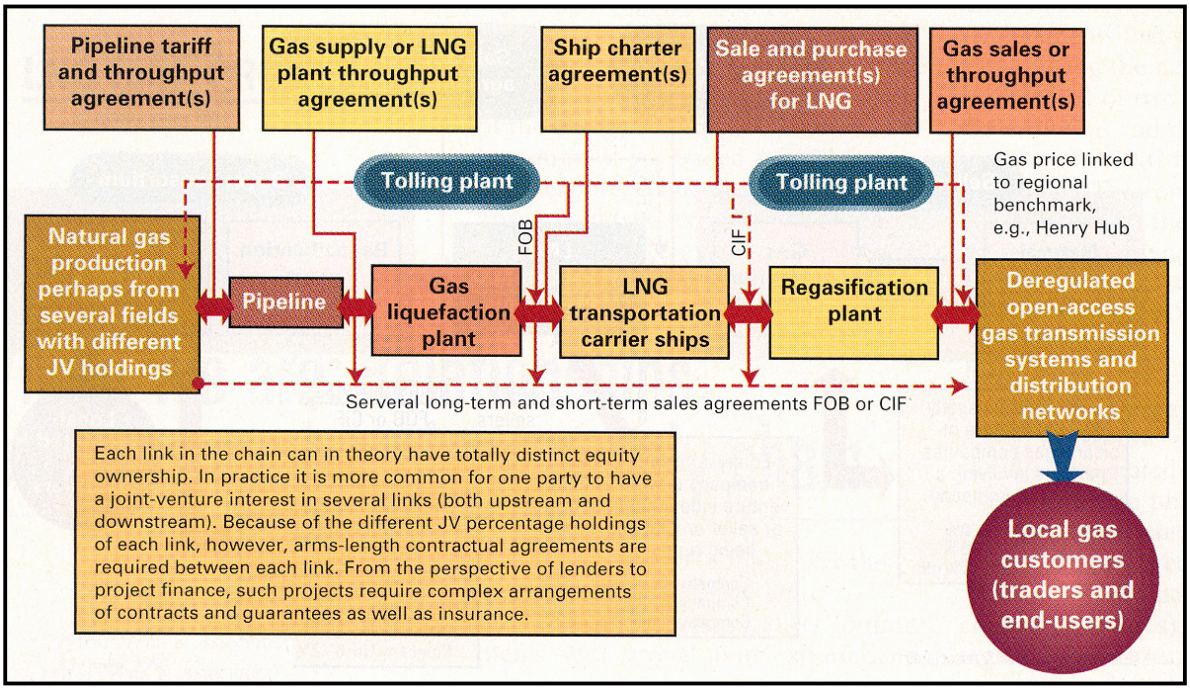
Source: www.globallngonline.com ,2007

Figure-8
Atlantic LNG, Trains 2and3



Source: www.globallngonline.com, 2007

Figure-9
Egypt LNG Project Structure



Source: Oil and Journal, 24 Jan 2005

Figure-10
LNG Nonintegrated Projects Structure

Arun and Buntang in Indonesia: Indonesian LNG projects (Aran and Butang), has got some of the trolling structures and conditions. In these projects, the Pertamina Company has the right to sell the LNG more over having the production sharing contracts (PSCs) in upstream development. Pertamina Company, as a main centre, is the owner of the LNG infrastructure. All of the companies in upstream part will have pure revenue after diminishing liquefaction and shipping costs. Although upstream companies are not responsible for selling LNG but they will cooperate with Pertamina in marketing and sale[3].

After the LNG project has signed and all the upstream and liquefaction structures defined, there is time to decide about the shipping to the consumer markets. One of the usual ways of shipping is FOB that shifts all of the transferring responsibilities to the buyers. In Atlantic LNG, all of the productions will sell through the FOB contracts and shipping process can be designed independent from the other trains of LNG chain.
One of the important factors in LNG shipping is the ownership of the tankers. Having the tanker's ownership or trolling them is a subject that is different in each project depends on the shareholders and downstream structure of the LNG chain.

In some projects such as Australian LNG North West Shelf Coast and Nigeria LNG, most of the LNG tankers are belong to the producers and some are trolling. In 2004, seven out of 9 LNG tankers in Australian LNG North West Shelf Coast belonged to the producer and the remained 2, were rented from Japan. Also Nigeria LNG had 11 tankers that 9 of them were under the producers' ownership and 2 were trolling. One of them has got long term renting contract and the other one short term contract.

In the Qatar Gas Project, all of the 10 tankers are trolling from Japan. Moreover in the Abozabi Adgas and MLNG Dua, all the tankers have rent from ADNOC and MISC in order.

Conclusion

LNG project structure is changing depends on the investor companies' strategies. In the past there was a complete difference between the buyers and sellers. Producers were mostly included the consortium of the investors in liquefaction plants and buyers were the main consumers of gas and power that buy LNG under FOB or CIF and they were investing in LNG terminal themselves.

Companies that in the past were just involved in producing and selling the LNG, have desire to expand their activities now and have more share in other LNG supply chain. In order to get more profit, they even prefer to take part in marketing and trade and also invest in LNG terminals. In this regards, some of the buyers have done the liquefaction and upstream investment. In fact in LNG projects, tolling structures are the reason for restructuring needs in investors companies. This restructuring, lets the upstream producers do the marketing and trade with their own credits. Nowadays companies such as BP and Shell that have long experience in upstream investment and liquefaction are having the LNG tankers and buying LNG.

BP was the first company that designed LNG sells contract without specifying the resources. This contract has been removed the links between upstream, liquefaction and sales sections that was used as an implication for the buyers till now.

As a result, LNG project trend shows that the buyers are mostly willing to have more share in upstream investment and the sellers have the anxiety to have more share in downstream investment.

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