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LIQUEFIED NATURAL GAS : RENEWED INTEREST AND PROBLEMS

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ABSTRACT

Gaseous methane is a predominant component in natural gas. When its temperature and pressure are at 163°C below the freezing point of water and atmospheric pressure respectively, it becomes liquid phase and its volume is approximately reduced to 1/600 th of the gas phase volume. The liquid phase of natural gas is called liquefied natural gas (LNG). Shipping (bullet tanks) is needed to transport the LNG to other countries (buyers) where pipeline construction is exceptional and the cost to construct the pipeline is so expensive. Both exporter and importer must have a completed receiving LNG terminal. The LNG chain operation demands advanced technology from the stage of liquefaction plant till the regasification process.

INTRODUCTION

The increase in demand and importance of natural gas and specifically in LNG as a primary energy has existed during the late 1980s and early 1990s. This is because of LNG has a several advantages in comparison to other primary energy sources and non-fossil energy options. The reasons of the renewed interest in natural gas world and LNG can be specified as follows.

RENEWED INTEREST OF GAS WORLD AND LNG

There are several reasons for the renewed interest in natural gas and LNG in worldwide applications of the primary enery such in industrial, commercial and domestic sectors.

WORLD GAS RESOURCES

As the second highest proven reserves to production ratio after coal (Table 1), natural gas has the availability of long term supply. It can be found either as associated or non-associated gas. The world ratio of the proven reserves to current production is about 56 years, as compared with 45 years for oil, and widely distribured in many regional areas.

These ratios are likely to change when new gas discoveries are found parallel with technology development.

The oil crises in early 1970s gave some lessons about the supply stability.to many countries in which oil is used as the primary energy sources for industrialization After the crises, these countries need what is called energy security, to diversify the energy sources and to reduce an individual country's reliance on oil. Again natural gas can make the concept of energy security especially for long term period, and confidence in natural gas started from the last decade.

Table 1 : Regional shares of the proven reserves to production ratio of fossil fuels until end 1989.

Regional	Oil	Natural Gas	Coal
North Amerika	10.4	12.6	278
Latin Amerika	50.9	75.0	482
Western Europe	12.6	31.3	175
USSR & East Europe	13.0	50.7	216
Middle East	*	*	}
Africa	27.5	*	}336
Asia & Australasia	20.2	55.3	210
World	**44.4**	**56.3**	**230**

Note : * over 100 years

ENVIRONMENTAL ISSUE

Greenhouse effect and acid rain are the two subjects in continuing debate as the environmental impact, especially in the developed countries. The greenhouse effect issue promises the most significant for the next decade because it has given a global change on the earth's climate and caused the sea level to rise by the global warming.

The main reason for the change in the climate is the increasing emissions of carbon dioxide to the atmosphere due to man-activities such as power generation (coal as burning fuel), other industrialization (coal and oil), transportation (oil) and others. The burning process of the fossil fuels has contributed the gaseous atmosphere. More recently, carbon dioxide (CO_2) produced by burning fossil fuels has been said as the most serious long term pollutant.

It is important to achieve better solutions to minimize the carbon dioxide contribution into atmosphere in order to reduce the global effect. Example of a solution, the existing coal-fired power plant can be converted using natural gas as the burning fuel.

Under the EEC Legislation the sulphur dioxide (SO_2) concentration level must be reduced by 40 per cent by 1998 and 60 per cent by 2005. NO_x emissions can only be reduced by modifying the way in which the fuel is burned. The existing power generation itself contributes about 11 per cent of the 55 per cent CO_2 as the total greenhouse gases. A 20 per cent reduction in CO_2 emissions may be achieved by simply switching from coal to oil firing. However oil can be a much more expensive fuel than coal, thus a less attractive solution from an aconomic view point.

A new concept of combined cycle power plant and combined heat and power are being introduced for the next decade in which natural gas is used as the primary energy. The main idea of introducing natural gas into the existing coal and the new concept of the combined cycle is to increase the efficiency of burning fuel. Table 2 shows the relative CO_2 emissions per unit of heat released.

Table 2 : Relative CO_2 emissions per unit of heat released.

	%
Coal	100
Oil	82
Natural gas	56

It is claimed that by using the gas turbines combined cycle power plant, CO_2 emissions may be reduced by about 55 per cent compared to a similar size coal-fired power plant. Another major point in favour of the combined cycle power plant is the reduction in thermal discharge to river and coastal waters. As long as natural gas is available the combined cycle power plant will have good output of :-

- high efficiency
- speed of contruction
- low capital cost
- low pollutant levels.

In term of payback period, for the same size of power production natural gas technology will give a faster payback period compared to coal technology.

A terminology called decommissioning phase is a permanent disturbance of landforms which have been associated with the mining of coal for coal-fired plant and quarrying of limestone for use in fuel gas desulfurization (FGD). These will give an environmental impact especially when the disposal sites are in perpetuity conditions. However, there is a minimal long term disturbance of the landforms for gas pipeline construction during transmission and distribution. This gas pipelines are used to supply gas after LNG is reformed to gas phase by regasification at the receiving terminal or storage facilities to consumers.

MARKET OPPORTUNITIES

There is a substantial scope for the rapid growth of gas consumption especially the prospects in developing countries are brighter than those in developed countries. The developing countries accounted for only 17 per cent of world gas consumption. Natural gas is expected to be the fastest-growing fuel with the total consumption about 10 per cent in 1988 to about 18 per cent by year 2000.

Japan government has a major reason for introducing liquefied natural gas (LNG) to tackle environmental problems. The government was urged from the first and second oil crises, to reduce its reliance on imported oil and to diversify energy sources in order to get the stability of supply and energy security.

Many exporter countries take these opportunities to sell their gas in the form of LN. Japan is the largest importer of LNG and has currently imported LNG about 75 per cent from the total world LNG consumption. This LNG is being imported from Indonesia, Malaysia, Brunei, Alaska, Abu Dhabi and new producer from Australia.

Japan has increased the demand for production of electricity, the leading consumption sector in Japan. In 2000 the LNG demand could attain 38 to 44 Mt as opposed to 29.7 in 1987.

South Korea and Taiwan governments are also producing policies to import LNG for energy consumption in industries and the rising standard of living. In Korea, the introduction of LNG is required because of limited domestic natural resources and the inbalance between demand and supply. These are also applied in Taiwan.

LNG in Europe faces stiff competition from gas by pipeline. There is more market tendency for LNG if the existing contracts are extended and that a new route for Europe is begun, in which then flow could reach 16 to 23 Mt in year 2000.

Therefore the world LNG demand will increase dramatically during the next decade, it could reach 50 - 56 Mt in 1990 and go up to 65 - 80 Mt in 2000, which is nearly double the demand in 1987 (41 Mt). See Table 3.

Table 3 : International LNG trade: Prospects for the year 2000.
(Mtons)

	1987	1990	1995	2000
Japan	29.7	31-35	36-40	38-44
South Korea	0.4	2	2-3	3-5
Taiwan	-	1.3	1.5	1.5
Europe	10.5	14-15	15-16	16-23
USA	-	1-3	5-7	6-10
Total	**40.6**	**49.3-56.3**	**59.5-67.5**	**64.5-83.5**
bcm	54.8	67-76	8 -91	87-11

TECHNICAL ADVANTAGES OF NATURAL GAS

In heat treatment processes by direct firing, heat transfer rates, efficiencies and lower capital costs can be achieved. With cleanliness and purity of natural gas in particular the lack significant sulphur, the advantages in quality of product by the process and metal reheating can be obtained. This also means that other processes such as drying, curing etc., the direct firing can be employed in which the materials being heated can be directly contacted with the combustion gases.

When indirect heating has to be employed especially in boiler equipment, the purity of gas leads to an absence of fouling and low temperature corrosion of heat exchanger surfaces. The same reason can be applied to waste heat recovery devices of high efficiencies which do not deteriorate rapidly in performance due to fouling and corrosions.

The flow of natural gas is easy to control such pressure reduction and controlling systems which can be actuated by electric, pneumatic or hydraulic systems especially a fully automatic system for safety aspect.

SCOPE OF APPLICATIONS

Premium gas has been diversely used in many applications such as industry, commercial and domestic sectors. The premium characteristics provide gas with an advantage over oil in those sectors.

It can be used as a feedstock for production of fertilizer (ammonia and urea) and methanol. The use of gas in the transportation sector also have a strong possibility. In New Zealand, Mobil has developed a process by which gas is converted to motor gasoline via methanol route. Compressed natural gas (CNG) has been used as a vehicle fuel in gaseous and diesel engines. It has been successfully proven especially in USA, Italy and Netherlands.

Natural gas liquid can be removed from wet gas and the natural gasoline, propane and butane fractions are sold separately. Ethane fraction can be separated and processed for ethylene and subsequently polyethylene production.

TRANSPORTATION

It is very expensive to have pipeline systems involving very far distances. The capital cost to construct pipeline under water will normally cost three times higher compared to on shore pipeline construction. To overcome this problem, LNG carrier is designed for the gas is to be changed into liquefied gas and to be sent to customer by shipment, road or railway. In addition, a liquefaction plant, LNG storage, shipping, receiving terminal and regasification systems have to be built. Long-distance gas transportation across oceans by LNG carriers is now accepted as the more economical means. Once gas enters the liquefaction plant, it is cooled to about -161^{o}C at atmosphere pressure to reduce its volume to 1/600 th of the equivalent quantity of gaseous methane.

IMPACTS OTHER NON-FOSSIL FUELS RELATED TO ENVIRONMENT

Another energy options to produce electricity are from nuclear and hydropower sources. However these two sources will have some impacts and problems related to the environment.

Nuclear source has two principles to be concerned. They are safety aspect and the long-term storage of nuclear waste. The nuclear industry has made some mistakes especially the disaster at Chernobyl. Anti-nuclear campaigns has appeared everywhere either in the developed or developing countries.

Large hydroelectric schemes appeared to offer cheap and clean energy. However, the schemes throughout the world are being reconsidered. The main objections to large hydroelectric are :-

- they involve massive and destructive relocation of communities
- they destroy flora and fauna
- the weight of the reservoir can cause geological disturbance
- they can lead to an increase in water borne diseases
- they lower the water table.

LNG with its clean properties to produce electricity has no site discharge problems and the land structure does not give problems geologically.

PROBLEMS

The implementation of LNG projects is not simple as it mentions. They will face some restrictions such as technical, political, social and environmental problems. However all the restrictions have to solved in order to proceed the projects. This paper has explained only a few examples of the restrictions.

TECHNICAL PROBLEMS

The concept of LNG processing is very simple, but very sophisticated technology is required, especially in the main cryogenic heat exchangers, to deliver natural gas as a liquid at minus 160^{o}C.

To build the LNG facilities need a lot of specialized technical support. LNG project has been assured by detailed analysis and design, careful preparation and project control, all supervised by experienced organisations.

The total engineering effort required to prepare the project specifications can exceed 100,000 manhours. Once built, LNG plants do not operate by themselves. They require people with a wide range of skills to handle the very specialised technical, operating and maintenance jobs. Because of the remoteness of most LNG plants, these skills are rarely available locallly. They must be developed - using indigenous peoples as

many as possible. This requires a massive recruiment and training programmes, often includes the production sector as well as parallel to the construction phase in order to have manpower available for start-up.

There will be no room for compromise where safety is concerned.

POLITICAL PROBLEMS

It has a truth that companies have a single objective dominantly to maximize profits, but governments have multiple objectives. Again governments not as homogeneous as companies therefore more likely to make unexpected changes in policies because less knowledgeable about the gas business.

To make a successful gas project will involve three parties that are seller (normally producer), buyer and government. They have to undergo a lot of negotiations until finalization stage is reached and satisfied to all parties whether the gas project is to be proceed or 'killed' by the third party.

Government roles are to ensure that the gas projects are viable, to make policies such as protection of national resources, depletion policy, pricing policy and achievement of social stability. Gas selling needs a long-term contract between twenty to twenty five years. Normally every five years government will have a voting to select a new government. During the campaign period some policies may be changed in order to win the election.

The new government may also change some federal policies especially if the new government consists of mixed parties. This indirectly will affect the invested companies who already have established and signed long term contracts during the previous government.

The capital costs on gas projects or LNG investment are very high, thus government policies and stability have an initial attraction for companies to invest.

SOCIAL PROBLEM

The LNG will be reformed to gas phase by regasification process at receiving terminal or storage system.

An approved gas project involves a lot of network grids, especially distribution parts where new construction and reworking have to take place to correspond to the design specifications. The installations of gas pipeline systems and other facilities have to be built either in existing city (urban area) or rural area. According to a new approach technology especially in urban areas, the existing city gas networks should be expanded and modified. However these constructions have to damage the existing parts such as buildings, roads, railways and bridges.

The rural areas in some countries especially the poor parts, many informations have to be delivered in order to change peoples attitude to accept gas works and applications. These people refuse to contribute their lands for the development of transmission and distribution networks. To proceed with the project the government

must pay the landholders in order to get land for project construction and the re-infrastucture is also to be cared.

The maximum safety aspects must be installed in-house use of gas appliances either fully automatic or manually controlled.

In industrial application such as power generation using gas turbine combined cycle plant, the trend of construction of the thermal power stations have been a larger unit size. This leads to a large structure and increase demand for new cooling water. The cooling tower at most inland sites have become very large. The siting of these large power plants and the carry over from cooling towers can cause a number of social problems.

ENVIRONMENTAL PROBLEMS

Gas exploration and production involve a lot of works either onshore or offshore locations. Impurities from underground during drilling to the gas point discharged to the environment cause water and land quality problems. These activities give some geological risks in the future and creat problems for animals, plants and sea-lifes

CONCLUSION

The energy crises of early 1970s gave some lessons to imported oil countries. After the events, these countries tried to get supply stability and the energy security to diversify the energy sources.

The environmental issue especially greenhouse effect is actively debated in order to reduce the carbon dioxide emissions from the various energy sources. Recently, natural gas with its 'green' properties has been widely used in technology development to reduce the emissions into the atmosphere.

The market opportunities are at good level especially in the developing countries and the Far East for this and the next decades.

However to implement and run a LNG project will require a lot of experience and skills. These will face some of the technical, political, social and environmental problems as mentioned above.

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