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LIQUIFIED NATURAL GAS

by

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Abstract

For many years, natural gas was regarded as useless by-product of crude oil production and flared or vented in vast quantities. Gradually, however, it began to replace town gas, manufactured mainly from coal, as its superior qualities as a clean burning, efficient fuel were realised. Following the growth of the gas industry in North America, natural gas found increasing use in Europe after the discovery of substantial non-associated gas fields close to potential markets.

Many of world's gas fields are, nevertheless, remote from the main consuming markets. Moreover, gas is bulky and relatively costly to transport. Once liquified, though, it is much more compact and can be shipped long distances by specialised tankers. This articles will discuss why market chooses LNG and describes briefly the liquefaction process, LNG business development, the future of LNG and the Malaysian LNG project.

Introduction

Natural gas is a mixture of light hydrocarbons, predominantly methane. Around three-quaters of the world's natural gas is found separate from crude oil ('non-associated'): the rest is found in association with crude oil ('associated gas'). The main applications of natural gas are in the residential, commercial and industrial heating sectors and as a fuel for power generation. It is also used as a feedstock in the petrochemicals industry, in the manufacture of ammonia for fertilisers and in the production of gasoline, methanol and middle distillates.

Natural gas follows oil and coal as the world's third largest source of primary energy. Over the last 15 years world proven gas reserve have grown by around five percent per annum and are now estimated at over 100000 milliard (or billion)(10^9) cubic meters, this is equivalent in energy terms to some 650 billion barrels of oil(3). Since exploration in most parts of the world has traditionally concentrated on the discovery of oil rather than gas, it is likely that there are substantial reserve of gas still to be found.

More than a third of the known reserve are located in the USSR, which is also the world's largest gas producers. The United States, Canada and several countries in Europe (e.g. Netherlands, Norway, the United Kingdom, Germany) are also important gas producers as are Algeria, Brunei, Indonesia and Malaysia(3). Given the huge reserve of the Middle East, there is significant potential for developing these reserves, if they can be brought to market at acceptable prices.

As many gas fields are remote from the main gas markets, transportation is a major component of the gas business. Most gas is transmitted from source to market by pipeline and a network of lines has been constructed across North America, Europe and the USSR. For instance, a number of West and East European countries areas supplied with gas from huge fields in the the Soviet Union, now the world's largest gas exporter (although export account for only some ten percent of its production). The Netherlands, Norway and Algeria are also major international suppliers of gas in West Europe.

Natural gas is extremely bulky by nature and cannot be transmitted in its gaseous form by pipelines across deep oceans: even where long distance transportation is technically feasible, gas suffers from a 'cost of distance' disadvantage compared with oil and coal. Once liquefied, however, natural gas is much more compact, occupying only 1/600th of its gaseous volume. It was this fact, coupled with the need to transport gas over long distances across oceans, that led the growth of the LNG trade.

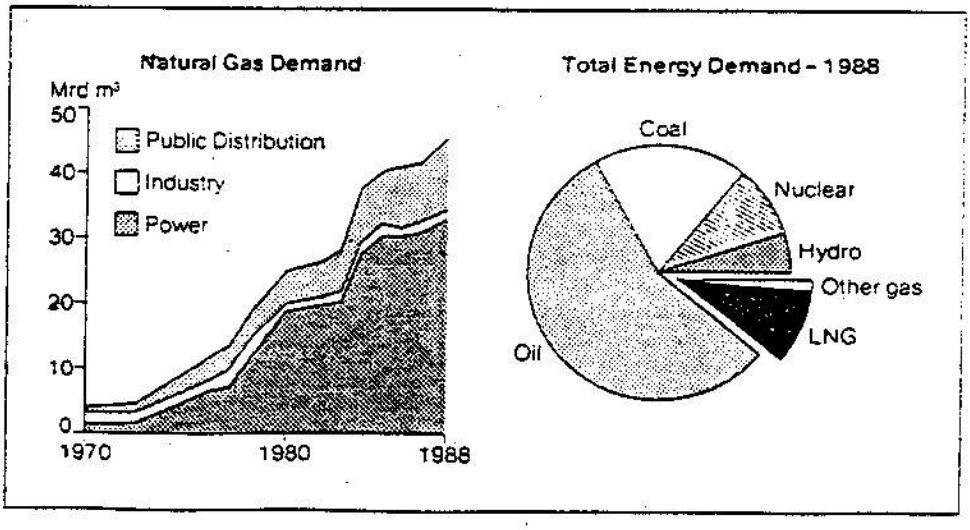
Why LNG ?

The answer is simple. At present, liquefaction is the only wholly-proven technology that enables natural gas reserve to be fed into distant, energy-hungry market overseas for which pipeline transmission would be physically and/or economically impossible. The process involves removing impurities, drying and then progressively cooling natural gas from the well-head into its liquid states at about minus 160°C. At this temperature, methane, the main constituent of natural gas, liquefies and occupies 1/600th of its gaseous volume[2]. This highly concentrated energy product is then transported in specialised ships to the market, where it is regasified before feeding into local transmission systems for delivery to the burner tip.

Why do market choose LNG ?

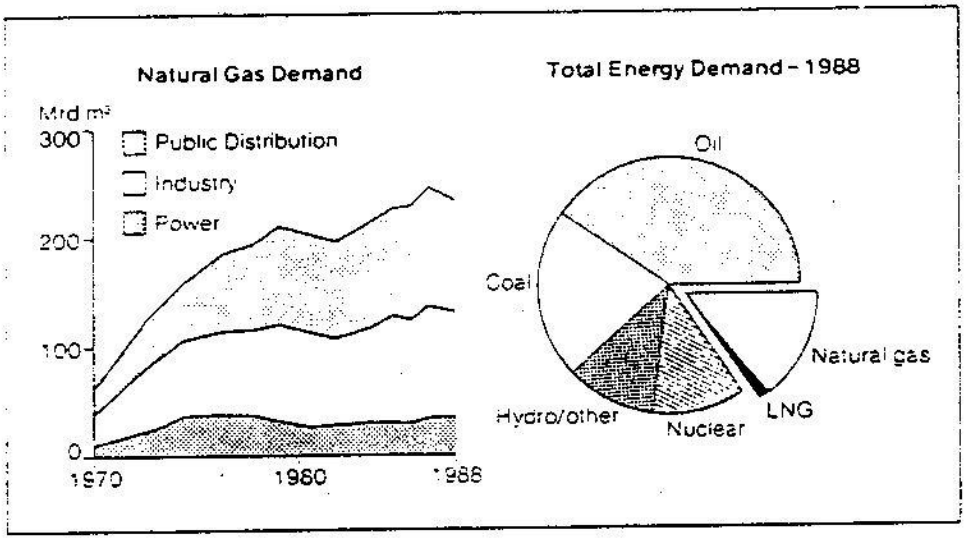
The answer varies from country to country. In Japan, LNG was chosen initially because it was clean fuel for power stations located in or near to major urban areas. Following the first oil shock, the strategic value to Japan in having natural gas as part of a balanced energy supply portfolio was soon realised. Since then, as Figure 1[1,2] shows, the use of regasified LNG has spread to include industrial, commercial and residential outlets, although power generation remains the market for around 75 percent of Japan's LNG imports. At the same time, the number of supply projects has climbed to six-together contributing around 10 percent of Japan's total primary energy requirement. This is an extraordinary achievement in just 20 years[2]. In Japan, LNG has to compete with other fuels used for power generation and increasingly in other end-use sectors. In practice, this has generally resulted in LNG realising a landed price at or just above that of crude oil in terms of thermal parity.

Figure 1. Natural gas and energy demand in Japan



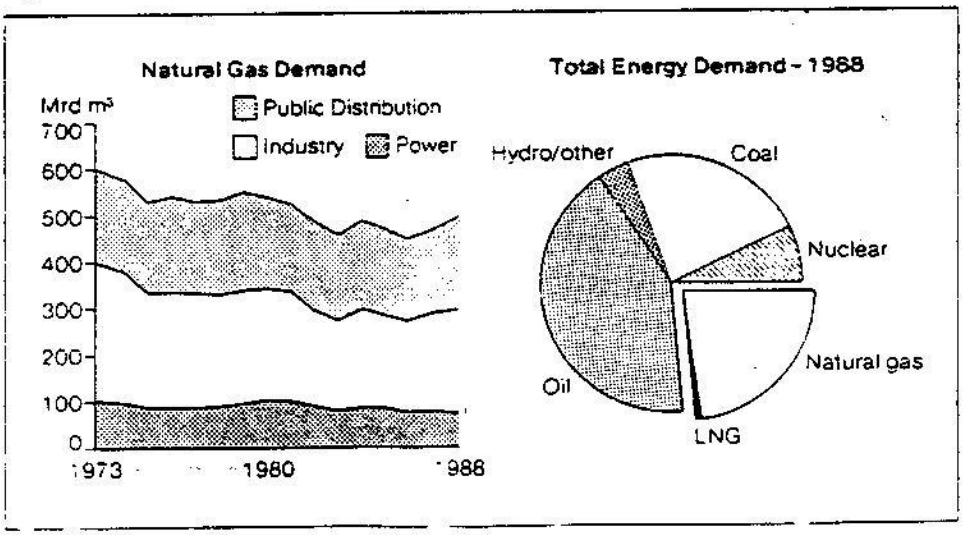
In Europe (Figure 2 (1.2)), LNG faces stiff competition from pipeline gas mainly from relatively near-to-market fields. Again, fuel type and source diversification along with competitive pricing, which in Europe, unlike Japan, reflects oil products rather than crude oil, has led to LNG taking a significant and growing share of Europe's energy market. To date, Algeria and Libya are the only suppliers but LNG deliveries from Nigeria are scheduled to start early in 1995.

Figure 2. Natural gas and energy demand in Europe



The USA (Figure 3(1.2)) is also now seen as an important future LNG market-although the fortunes of LNG to date, to an extent like those in pipeline gas and energy generally, have been somewhat mixed. In the US market, like Europe, LNG competes head-on with oil products and pipelines gas, but here the difference is that much of the pipeline gas is sold under spot terms. The results is that gas prices have tended to be somewhat lower than those of competing oil products.

Figure 3. Natural gas and energy demand in the USA



Making LNG - The Liquefaction Process

There are four main stages involved in processing gaseous natural gas into LNG. Firstly, impurities are removed: these are mainly carbon dioxide and sometimes sulphur compounds. Then water is extracted which would otherwise turn to ice crystal during liquefaction and block the plant. Thirdly, most of the heavier hydrocarbons are removed, leaving mainly methane and ethane. The resultant gas is then progressively cooled, usually by a two-cycle refrigeration process, until it reaches about minus 160 degrees Celsius when it becomes a liquid at atmospheric pressure(4).

The LNG is then stored in specially insulated tanks before being loaded into cryogenic, tankers for shipment. The tankers may have to travel several thousand kilometers to reach their destination. During that time, a small part of the LNG inevitably 'boil off' and is used to fuel the tankers' engines. On arrival at the customer's terminal, the LNG is unloaded and stored until required. Before use, it is regasified: in some instances, part of the vast quantities of cold released during this process finds commercial use, for example as cold for frozen food and air separation.

Business Development

An LNG project requires considerable amount of time, money and effort in its design, economic evaluation, construction and commercial implementation. Ten years may elapse between the conception of the project and receipt of the first revenues, whilst actual construction and start-up time usually around fours years. It is common practice to conclude 20 years supply contacts which means that long term commitment is required from both supplies and customers. This is necessary in order to justify and secure the finance required to construct gas production facilities, a liquefaction plant, storage, a fleet of LNG tankers, a receiving terminal and a regasification plant(2).

Most LNG projects are established on a partnership basis or as joint ventures: they are almost invariably international in nature, both in terms of the supply of equipment and project staff. Success depends therefore not only on technical expertise but also the ability to coordinate projects on an international scale.

The Future of LNG

Natural gas is expected to increase its role as one of the world's major primary energy sources. As indigenous sources decline, consuming countries will place emphasis on a flexible and diversified supply base. Prospects for international gas trade are therefore good, and when long distances and ocean crossings are involved LNG is particularly appropriate.

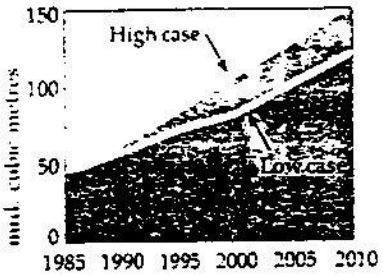
In the USA(3), proven reserves are depleting and future demands will need to be met to an increasing extent by reserve which have yet to be discovered and developed and by imports from other countries. In additions to pipeline gas from Canada, the USA will also need increasing volumes of imported LNG if it is to satisfy its expected demand for gas in the longer term.

Japan is and will remain an important market for LNG(2), despite strong competition from nuclear energy and coal for power generation, the main outlets for LNG in that country. Before the end of this century, South Korea and Taiwan will also be significant LNG importers, thus increasing the already important Pacific Basin market for LNG.

In West Europe, about one half of total demand is already met by internationally traded gas-chiefly by pipeline from USSR, the Netherlands, Norway and, partly by pipeline and partly as LNG, from Algeria. As production from a number of the older European fields inevitably declines, imports will increase. A growing proportion of these imports will likely come from more remote supply sources. New suppliers could include Africa, Latin America and, in the longer term, possibly the Middle East.

Although the international LNG trade is expected to grow, the level of increase depends on s number of different factors. Forecasts for the next 25 years are therefore split into the so-called "Low Case" in which demand is expected to rise to around twice the current levels and a "High Case" in which it could triple. In recent years, although demand has risen, the rate of increase has been closer to the "Low Case" (Figure 4)(2).

World LNG demand



The Malaysian LNG Project

The liquefaction and trading company Malaysia LNG Sendirian Berhad (MNLG) was incorporated in 1978 an initially comprises Petronas (65%), Shell and Mitshubishi (17.5 %) each): in 1985, Petronas ceded five percent of its share holding in MNLG to the Sarawak State Government. MNLG was contract to supply six million tonnes of LNG a year with first deliveries in January 1983. In late 1987, the project reaches its plateau contractual delivery rate. The customers were Tokyo Electric and Tokyo Gas and again the contract was for a period of 20 years. Shell is responsible for supplying the gas under a production-sharing contract with Petronas and for providing technical advice to the liquefaction company. The gas field dedicated are in the central Luconia Basin and located variously some 120 to 180 kilometres off-shore Sarawak in water depths up to 300 feet and are connected to the plant by 36 inch diameter pipeline.

The capacity of the French built LNG carries, catered from Malaysian International Shipping Corporation, at 130 000 cubic meters each. A three-train liquefaction plant was built at Bintulu, Sarawak at a cost of US$1 billion making it the largest single commercial venture ever undertaken in Malaysia. The Bintulu plant was built by contractors from USA and Japan with equipment supplied from many countries. The plant has semi-buried storage tanks, each of 65 000 cubic meters capacity. The project has brought many advantages to the local economy. For example, the Bintulu Development Authorities ensures that the area derives maximum benefit from the new prosperity brought by LNG

Conclusion

Geographic, economic or logistic factors can preclude the use of pipeline for transporting gas. In some cases an alternatives is to ship natural gas in liquefied form (LNG). At minus 160°C, methane, the main constituent of natural gas, liquefies and occupies only 1/600 th of its gaseous volume and can be

transported by specialised ships to the market where it is regasified before feeding into local transmission and distribution systems foe delivery systems to the burner tip.

References

1. The Shell Briefing Services (SBS), number four 1988, and number three 1990.

2. Shell International Gas Limited - Shell Gas and LNG Business.

3. BP Statistical Review of World Energy, June 1990.

4. Lom, WL. Liquefied Natural gas. Applied Science Publishers 1975.