THE REASONS AND PROBLEMS FOR THE RENEWED INTEREST IN NATURAL GAS AND LIQUEFIED NATURAL GAS (LNG) WORLD WIDE DURING THE LATE 1980s AND EARLY 1990s

by

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Abstract

Increase in world's energy demand, energy security and environmental concern has given rise to a new perception of natural gas and LNG as a valuable source and future resource of energy for the world. Although these factors has renewed the interest of natural gas as a fuel there are a number of problems to be overcome in order to put the projects (especially LNG) on stream. This paper will discuss the reasons and problems for the renewed interest in natural gas and LNG world wide during the late 1980s and early 1990s.

1. Introduction

The last few decades specifically in the late 1980s and early 1990s have seen enormous changes in the global interest of natural gas and LNG world wide. From being a predominantly local fuel, accounting for only around one percent of the world's primary energy consumption in the 1950 (most of which was used in the USA)[14], it has been transformed into an international traded fuel with an ever-increasing number of natural gas producing and consuming countries. This change of interest has, not surprisingly, been accompanied by an increase in natural gas's share of the world energy market, to the extent that it now accounts for almost 20 percent of the world's primary energy consumption.

However, although the changes in the last few decades specifically in the late 1980s and early 1990s are undoubtedly significant, there are some who argue that they seem relatively unimportant compare to the changes in the role of gas that might take place from the present until well end of the twenty-first century. As an example, one reputable international forecasting house has suggested, under assumptions that allow for considerable technological improvement, that natural gas could take a share of global primary energy consumption of 60 percent by the year 2030[14]. While such a high long-term forecast may well prove to be more realistic, it does underline the fact that many now consider natural gas to be a long term resource, and illustrate that very major shifts in energy consumption can take place as they have in the past.

2. Reasons for the renewed interest

There are a series of reasons or factors which either directly or indirectly bring the renewed interest in natural especially LNG world wide. The most important ones are increase world energy demand, availability of gas, energy security and environmental concerns. These reasons are supported by the technological changes, growth in international gas trade and political considerations – three major natural gas developments – backing the dramatic increase in interest mentioned before.

The global reason for renewed interest in natural gas/LNG in due to increasing need of world's energy. To sustain steady economic growth and rising living standards the world need ever increasing supplies of fuel and power. And, despite the drive by the government and others for efficiency in the use of fuel, the growth rate of world demand for energy, in various forms, has lately been accelerating. Total world requirement of commercial energy are estimated to have risen from 8058 millions tonnes oil equivalent (mtoe) in 1988; compares to 7774 mtoe in 1987 (Table 1)[1]. The fastest growth in energy requirement in 1988 was in Japan (6.2%) while the second fastest was in North America (4.5%)[10] Australasia. scored again of 3.6%[10], but Europe lagged with rise of only 1%[3]

	1979	1986	1987	%Short 1988	%Change 1989	1982 Over 89	Over 90
By Type							
Oil	3142	2905	2948	3038	38	+3.1	−3.3
Coal	1968	2263	2342	2428	30	+4.7	+23.4
Nat. gas	1283	1487	1552	1625	20	+3.7	+26.7
Hydro	424	517	525	528	7	+0.5	+24.5
Nuclear	156	377	406	439	5	+8.0	+181.4
Total	6972	7548	7774	8058	100	−3.7	+15.6
By Area							
N. America	2136	2040	2099	2192	27.2	+4.5	−2.6
W. Europe	1294	1280	1289	1302	16.3	+1.0	+1.4
Japan	370	372	377	400	5.0	+6.2	+8.1
Australasia	83	97	103	107	1.3	+3.6	+28.9
Total OECD	3883	3789	3868	4001	49.8	+3.4	+3.0
Rest of free world	874	1175	1240	1312	16.2	+5.8	+50.1
Total free world	4757	4964	5108	5313	66.0	+4.1	+11.7
Communist bloc	2215	2581	2666	2745	34.0	+3.0	+23.9
WORLD TOTAL	6972	7548	7774	8058	100.0]	+3.7	+15.6

(a) Commercially traded fucis only
Source: British Petroleum Co.

Table 1
WORLD PRIMARY ENERGY CONSUMPTION[a]
Million tonnes oil equivalent[1]

In the race to satisfy consumer's requirement, oil has fail to keep pace with the front runners; and in view of shrinking oil reserve (a main source) which is estimated to last till year 2000 something and increased energy requirement, it seem prudent to look for its replacement and that was natural gas because of its availability. Today residual natural gas reserve are larger than those of oil (Figure 1, 2 and 3)[1] Remember gas has hardly ever been the main focus of exploration activity. It seems likely that the current reserve of gas could easily double if exploration business perceived accessible and attractive markets for the increase production that would results. In addition to the increased resources base of undiscovered gas, in many part of the world, particularly in the US, there exists considerable reserves of 'nonconventional' natural gas, including sources such as tight gas sands, coal seam methane, shale gas, ultra deep gas, gas hydrate and abiogenic gas. We also must take note of the wider availability of gas. At present some 80% of proven reserve are found in only ten countries. Furthermore, nearly 40% of world proven reserve are found in just one country, USSR, around half of which in three super giantfields. A further 30% of world proven

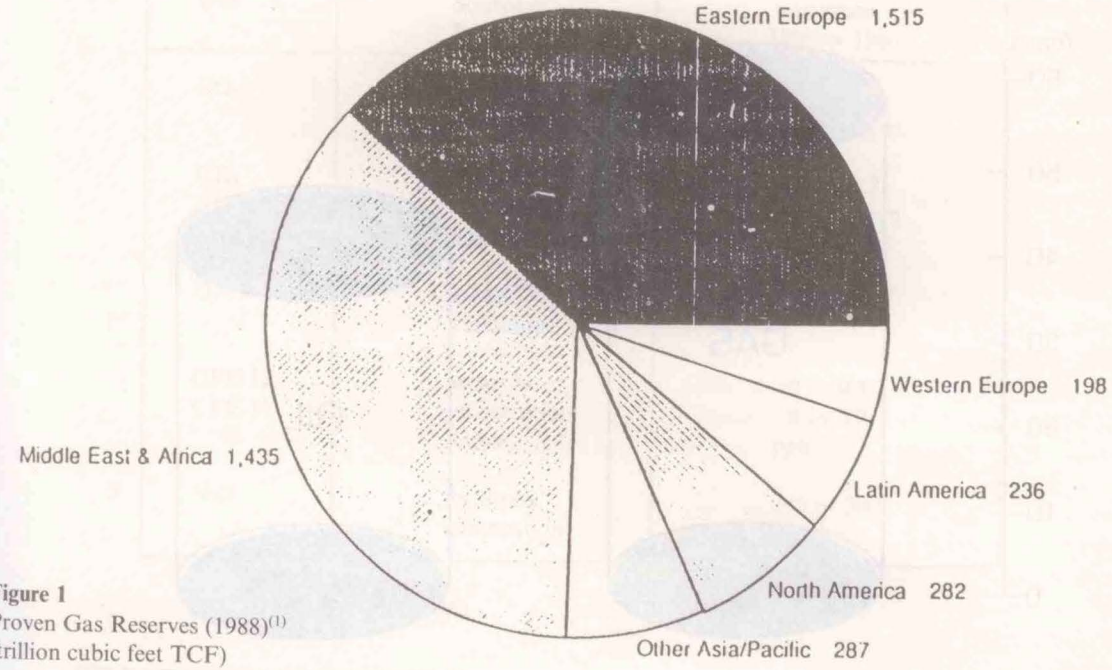

Figure 1
Proven Gas Reserves (1988)[1]
(trillion cubic feet TCF)

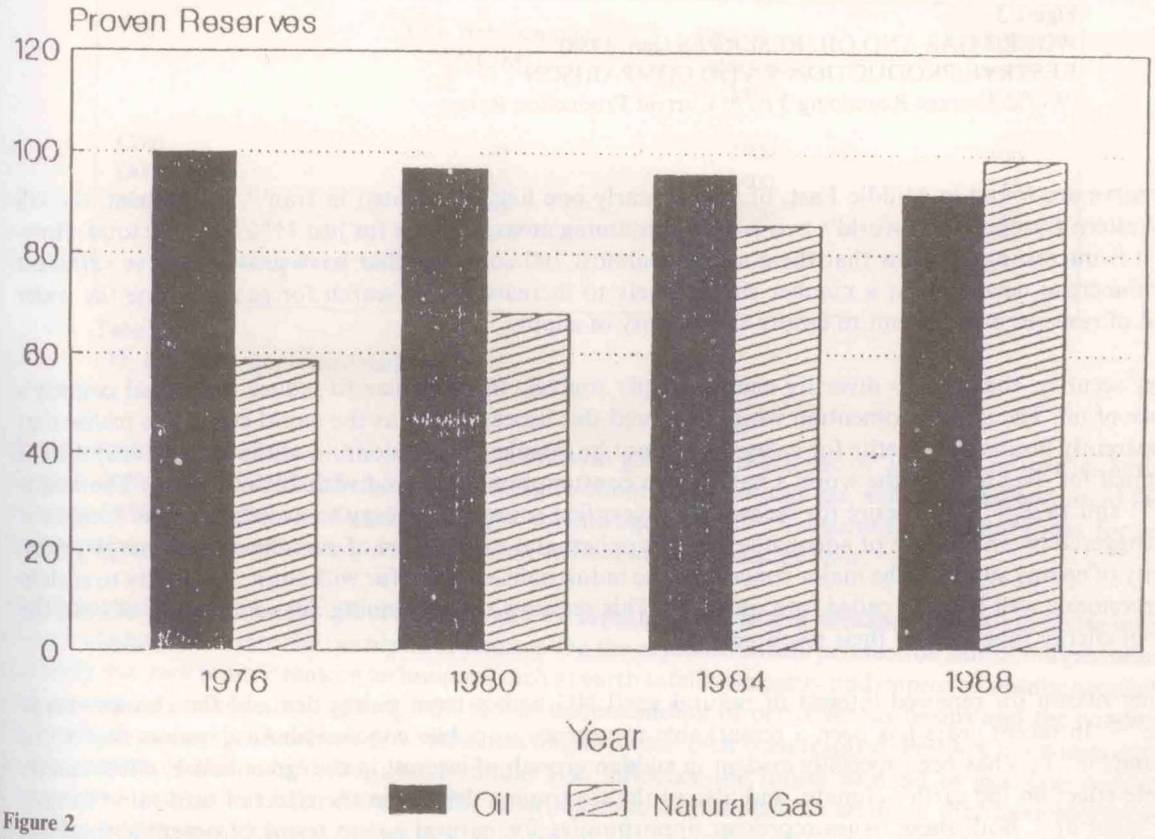

Figure 2
World Natural Gas and Oil Reserves[1]
Billion tons of oil equivalent

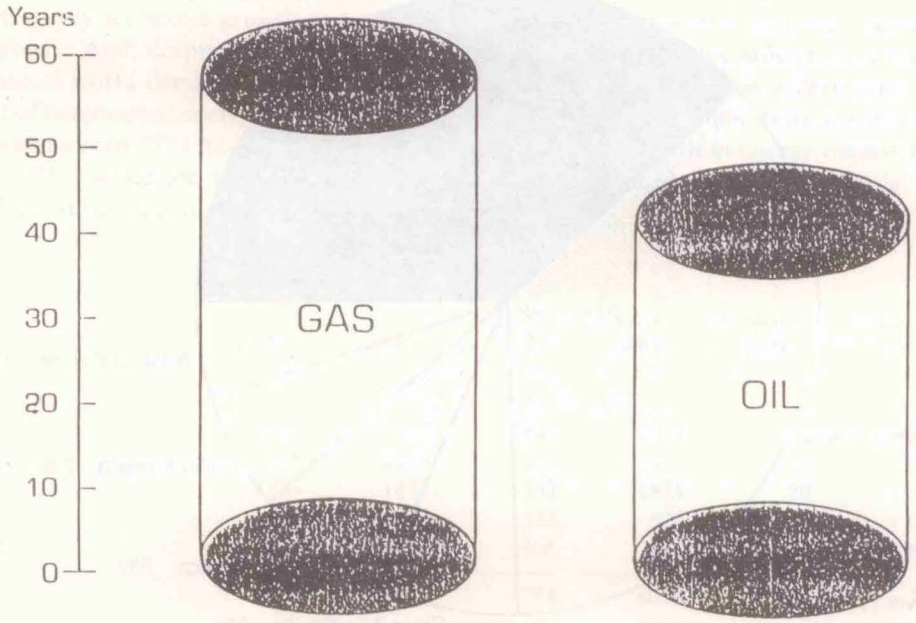

Figure 3
WORLD GAS AND OIL RESERVES (Jan. 1988)[1]
RESERVE/PRODUCTION RATIO COMPARISON
(World Average Remaining Yrs. at Current Production Rates)

gas reserve are found in Middle East, of which nearly one half are located in Iran[1]. In contrast, the US and Western Europe – the world's two largest consuming areas, account for just 11%[10] of the total. However, it is interesting to know that there are now almost 100 countries that have proven reserve sufficient for commercial development a number that is likely to increase as the search for gas goes one the wider spread of reserves is important to ensure the security of supply.

Energy security, the need to diversify energy supply sources, in particular to reduce individual country's reliance of oil. The initial momentum which triggered this aspect comes as the world started to realise that its apparently insatiable appetite for energy could not be satisfied by oil alone – at that time (1965) the US accounted for over 60% of the world's natural gas consumption compared with 28%[14] today. The events of 1973 and 1978/9[10]; the desire for secure and diversified sources of energy to avoid economic recessions were triggered by an absence of adequate energy supplies; and expectation of ever increasing energy prices. Security of energy supply is the major concern of the industrialised world for without it, the ability to sustain their economic well-being is called into question. This requires the continuing diversitification of both the range of energy supplies and their resource.

Another reason for renewed interest of natural gas/LNG comes from public demand for cleaner energy source[4,6]. In recent years has been a remarkable resurgence in public concern about deterioration of the environment. This has been specially evident in sudden growth of interest in the 'greenhouse' effect and its possible effect on the earth's climate, and also in the continuing debate on the effect of acid rain (Table 2 and Figure 6)[7]. Both these issues represent opportunities for natural gas in terms of potential markets, especially as a fuel in power stations. Natural gas is widely perceived as a clean fuel, with negligible emission of sulphur dioxide and lower emission of nitrogen oxide compared to other fossil fuels (Table 3)[5]. Another feature of the environment debate that could have possible implications in the increasing concern over the

Gas	Source of Increase	Increase 1880 → 1980
CO_2	combustion deforestation	275 → 339 ppm
CH_4	cattle rice paddies mining	1.1 → 1.7 ppm
O_3	urban pollutants	+12.5%
CFC 12 CFC 11	aerosols refrigeration foams	0 → 0.3 0 → 0.2 ppb
N_2O	fertilizers combustion	285 → 300 ppb

Table 2
GREENHOUSE GASES[7]

Fuel	CO_2 emission rate (gC/MJ)	1988 World emssions (MtC)	1988 World energy (EJ)*
Coal	24	2400	100
Oil	19	2400	125
Natural gas	14	950	70

*EJ = exajoule = 10^{18} joule

Table 3
CO_2 emissions from fossil fuels[5]

effects of vehicle emissions within some cities. Natural gas could make use of 'its clean properties here for example, it has been calculated that by switching to compressed natural gas, vehicle emissions could fall as much as 99% for carbon monoxide and 65% for nitrogen oxide[8]. Substitution of natural gas for other hydrocarbon fuels therefore very desirable from environmental point of view.

Technological changes could effect many, if not all aspects of the future demand and also increase interest of gas including LNG into the twenty-first century. On the exploration and production side of the gas industry it is likely that new remote sensing techniques, such as earth satellite imagery and improved seismic acquisition and processing methods, will greatly add to our understanding of petroliferous basins and the conditions under which natural gas has been generated, has migrated and then been trapped. Perhaps more importantly in the context of this subject the above should also influence the future demand of gas. Gas combined cycle power stations has been discussed for environmental advantages. In addition they have shorter construction lead times with lower capital costs and greater thermal efficiency[5]. The use of Compressed Natural Gas (CNG) was mentioned a moment ago as a transport fuel, but natural gas could increase its share of the transport market through natural gas to liquid hydrocarbon conversion technology[13].

Increasing supplies will bring changes to the structure of the gas market, and also to the structure of the gas business itself. Natural gas now no longer regarded as a fuel suitable only for premium uses. Today gas is able to compete against other fuels in all of the major market sectors (Figure 4)[6,14] without the constraint of being labelled as a very limited resource whose use should be confined to residential and commercial heating and high value industrial applications. Since it is no longer regarded as a scare fuel penetration of non-premium market, electricity generation in particular, will increase. Making this possible will be increased price and volume competition in the industry. Also today natural gas has lessened its dependence on the vagaries of the oil market and increased its status as an independent fuel. In particular, the link between gas prices of competing fuel (Figure 5 and Table 4)[6]. There are many developing countries in the world which have economical gas reserve trying to develop their gas business by using it locally (cheap energy source) and importing all the oil to get a hard currency. If they don't have their own indigenous sources it will reduce dependence on imported oil. By this way it will bring their populations up to standards close to those enjoyed by the developed economies. The call for more energy as a results will be substantial. In addition, population growth in many developing countries will results in higher demand in all applications, but particularly for natural gas used as a feedstock in fertiliser manufacture.

Now, let turn to political considerations. Government has always taken an interest in gas development, and probably always will do. This interest stems from concern over the distribution of what the economist call monopoly rent. about pricing to the consumer and about the national security. In addition, most government seem to think that energy is too important to be left entirely to market forces especially when, as in the case of gas, the amount of money involved in a single contract or project is often of a scale to be national importance (2.7).

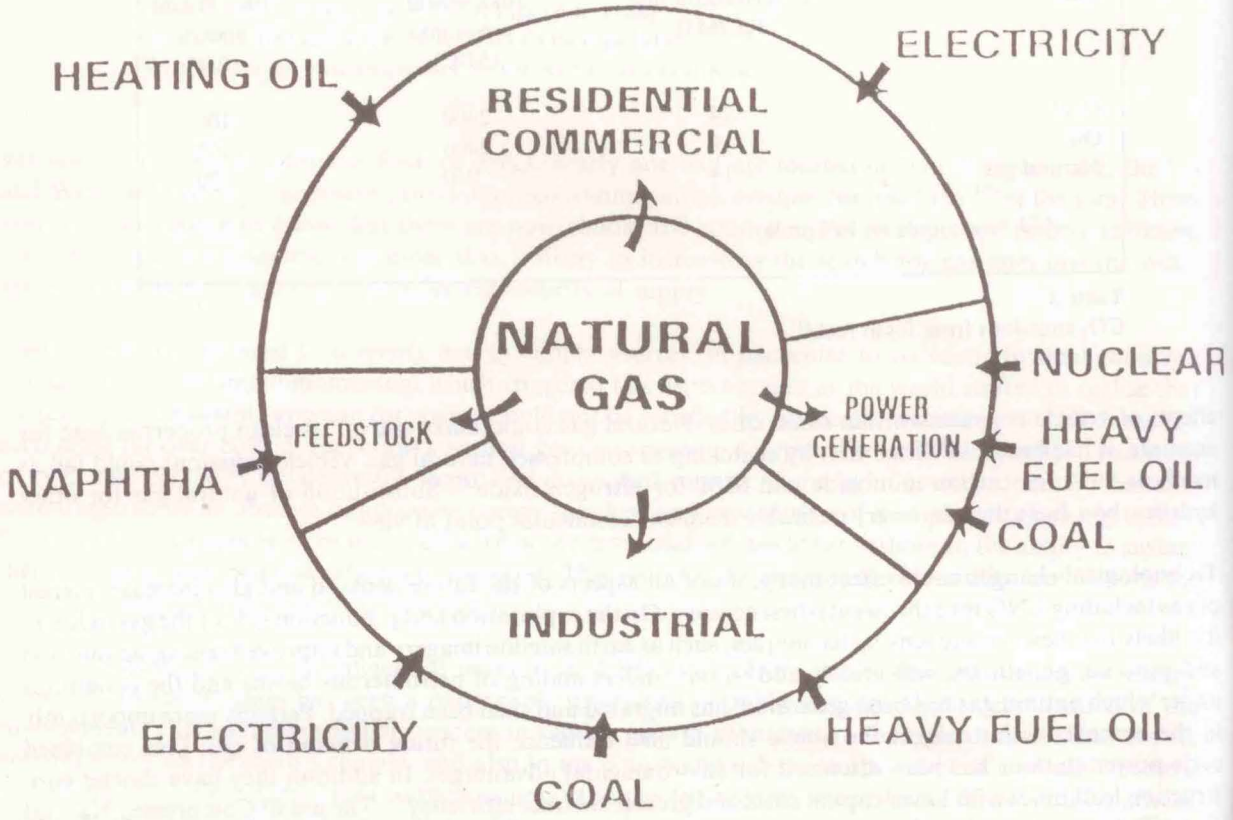

Figure 4
NATURAL GAS FUELS COMPETITION[6]

SALES CATEGORY	TYPICAL COMPETITIVE FUEL	TYPICAL GAS TO COMPETITIVE FUEL PRICE RATIO – NHV
RESIDENTIAL/ COMMERCIAL	GAS OIL	1.00
FIRM INDUSTRIAL	LOW SULFUR FUEL OIL	1.05
INTERRUPTIBLE INDUSTRIAL	HIGH SULFUR FUEL OIL	< 1.00
FEEDSTROCK	LOW SULFUR FUEL OIL (REFERENCE FUEL)	< 1.00

Table 4
NATURAL GAS BASE PRICE RELATIONSHIPS[6]

3. The Problems

Although the world has renewed interest in natural gas, there are a number of problems should be born in mind to be overcome in order to put the projects (especially LNG) on stream.

Political and commercial risks pose a major problem. LNG projects are inherently costly. In the case of the North West Shelf LNG projects, total capital investment including off-shore production facilities will amount to around A $12 billion or US $9 billion over the project life[16]. And, remember, much of this has to be spent before a single tonne of LNG is sold. If the gas company is going to invest vast capital sums like that, the company need some form of effective guarantee that the difference between gas purchase price into the LNG plant and gas sale price into the market after regasification, will always be sufficient to cover costs, repay capital and interest and make a profit margin. This security of margin is not only important for the health of the gas company per se but is probably the vital issues in the raising of capital to develop the project in the first place. Banks do not, in general, finance high risk ventures unless the borrowers themselves are of sufficient status to be able to guarantee repayment even if the project for which they borrowed fails completely. Not many gas companies would be in position to give adequate corporate guarantees to cover the cost of a complete LNG project[15].

How can the security problem be overcome? Government could give guarantees to gas companies operating in their countries that they will be free to raise consumer prices to cover cost increases. On its own, however, this is hardly since gas is not likely to find many buyers if it becomes significantly more expensive than available alternate fuels. Thus, to be meaningful, a price guarantee must come, in some form, from the producing country. Companies tend to be wary of all investment in developing countries. Contrary to the first appearances this is not only because of 'political' risk in a narrow sense, that is, a fear of political instability and changes of regime. What companies claim is of great concern to them is the broader of a given government changing its policies, especially its fiscal and taxation policies either erratically, or consistently in unfavourable direction.

Other potential obstacle to LNG is technical difficulties. Moving large volume of gas over long distances is expensive and many cases technically difficult. Despite the existence of several successful LNG schemes, the technology cannot be considered as being fully developed, especially when consideration is given to

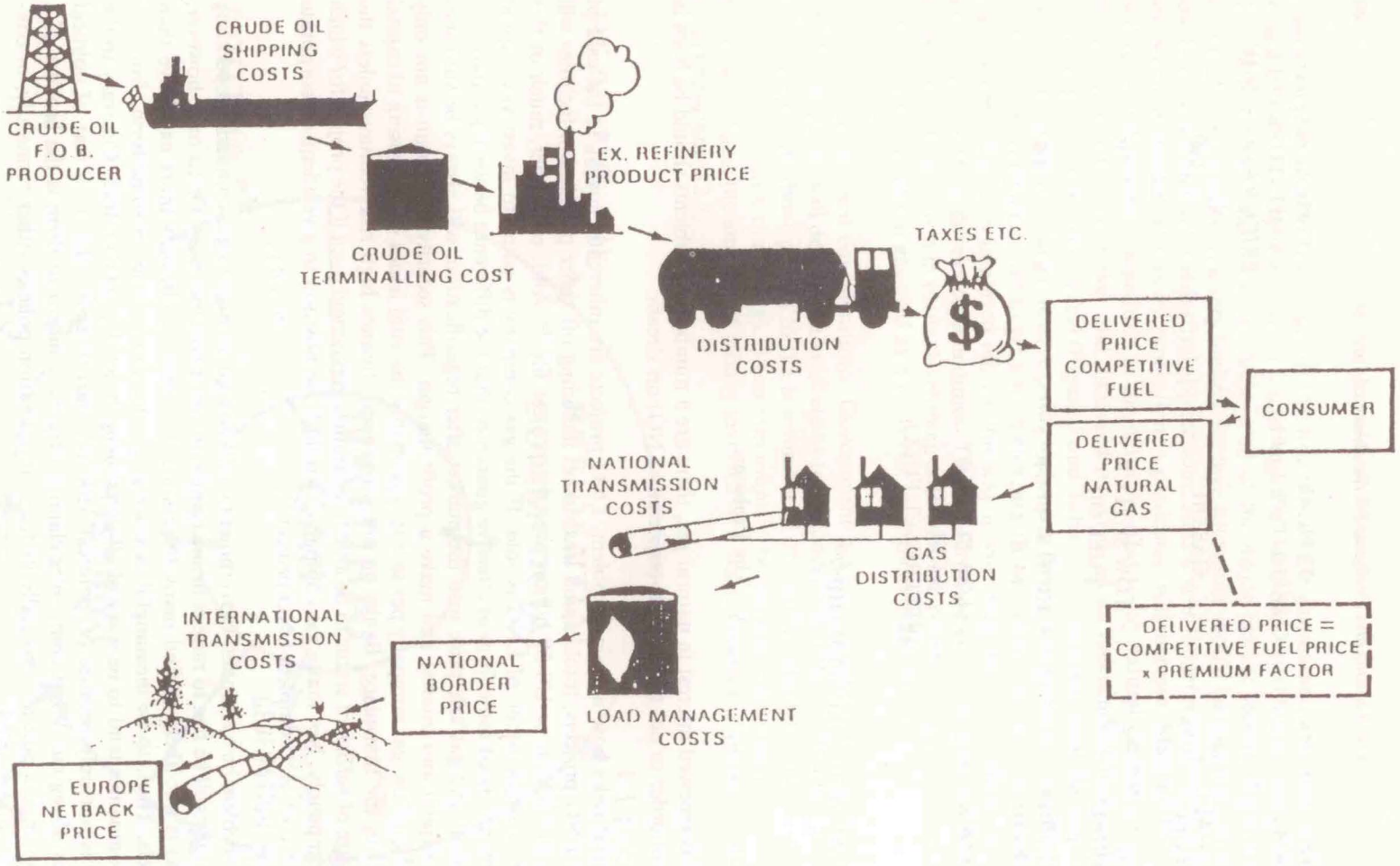

Figure 5
COMPETITIVE PRICING[6]

the limited train capacity currently attainable. One of the main problems is in selection of material to be used in tankers and tanks, and embrittlement, a characteristic change in mechanical properties of most metals at low temperatures. The solution is a careful selection of certain alloys, usually nickel, containing steels, which do not suffer from embrittlement and will also stand up mechanically to temperature changes and the consequent expansion-contraction. While the latter problem can be overcome by mechanical design, eg crinkle membranes, the alternative is to used non-expanding alloys such as INVAR. Both the latter and previously mentioned 5% and 9% Ni-alloys are, clearly, much more expensive than mild steel[5,8] Insulation gaps filled with these porous materials must be dry, and.if leak occurs and LNG penetrates into the insulation, staff must be warned. especially in ships, where the cryogenic liquids even if it has penetrated into the insulating layer must not be allowed to reach the plates of the hull.

A further problem in gas/LNG projects is the environmental impacts of natural gas/LNG technology, facilities and users (especially in power generation sector). There has been increasing concern world-wide over noise and visual impact on the local environment. Noises such as that emanating from compressors stations, gas turbines or valves can be reduced by silencers but again at a price. Visual impact from LNG facilities and power station is more difficult as it tends to be subjective. The world-wide trend in the construction of power stations has been to larger unit size. In the 1950s, 30 and 50 or 60 MW boiler turbine units were the norm. This has increased in number of steps to sizes now of 660 and 750 MW with certain supercritical units and nuclear units of 950 or 1200 MW size[3,7] The incentive to produce larger units has been the economy of scale whereby the incremental capital cost has been reduced by increasing the individual size. However this has led to large structure and increase demand for cooling water. The cooling towers which are generally necessary at most inland sites become very big. Increasingly people are objecting to sitting of these larger power stations, and the carry over from the cooling towers which can cause a number of problems.

As far as the problem of water for steam generation is concerned, the problem is not of quantity but is of quality. The requirement of high quality water in steam cycle is of order of 3 to 4 cum/hr/MW and the make up quantity will be 60 Cu.M/hr maximum[8]. This requirement can be met from a small canal, curry supply or even through tube wells. The main problem is of quality. If the water is very hard the demineralising cost will be very high and also it will require a larger water treatment plant.

Another problem as far as environmental impact of natural gas/LNG technology is concerned is natural gas leakage. Although using natural gas instead of coal reduces carbon dioxide (CO_2) emissions per unit of electricity generate (Figure 6)[7], some have argued that leakage of methane in natural gas pipelines and fuel cycle could give rise to a larger basis, methane in the atmosphere is about 21 times more powerful as an infra-red absorber than CO_2 (IPCC 1990)[2], so this possibility needs careful evaluation.

Finally, as far as social angle are concerned, people tends to reject using gas because its higher price and their misconception that gas appliances is not safe and dificult to use especially for those living in a remote areas in the developing countries. They also want the gas price to be uniform through out the country.

4. Conclusion

There several reasons for sudden surge of interest in natural gas and LNG world-wide during late 1980s and early 1990s. The important one is the increased of world energy demand because of economic and population growth. In view of the shrinking oil reserve it seems prudent for the world to intensify the exploitation of natural gas as a surplus availability of that type of fuel, and its premium in certain markets sector over alternative fuel. Security of energy supply remains the major concern of the industrialised world, for without it there is an ongoing concern about the ability to sustain the economic well being of those countries. This requires the continuing diversification of both the range of energy supplies and their sources. But the developing countries are just as concern, driven by rapidly growing populations and the desire to catch with the developed world.

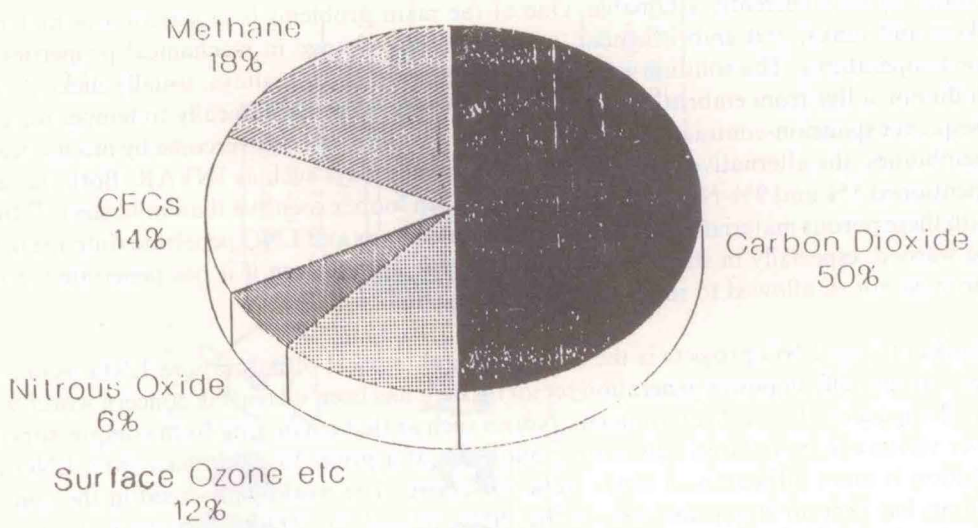

Figure 6
Relative Contribution of Greenhouse Gases[7]

Public demand for cleaner energy has dramatically raised the profile of the environmental issues with extensive coverage in the press and television; and the potential consequences of global warming, climate changes and the acid have alerted politicians of the industrialised countries to the importance of action now as a measure of their 'green ness'. Substitution of natural gas for other hydrocarbon fuels is therefore desirable from environmental point of view.

An LNG project is a complex, capital-intensive venture in which a number of different technical disciplines are combined, including a high level of specialist technical support. It is also highly political since governments hardly gives price guarantees to gas company operating in their countries to raise freely consumer price to cover the increasing cost. Governments tend to give subsidies to fertiliser plants and want uniform price in their countries.

Noise and visual impact of natural gas/LNG technology and power stations always face critics from people siting nearby. However, it can be overcome by silencer and certain colours but at a price. As far as cooling water is concerned, certain quantities and quality of water must be met to keep the power stations running up. Methane, a major component of natural gas and also LNG is the major contributor to the greenhouse effect, when it escapes to the atmosphere from transmission and end uses of the fuel. However, it is reported that only less than I percent gas leakage happens in the transmission lines.

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