

Can Natural Gas Take the Strain?

Philip Barnes

Oxford Institute for Energy Studies

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The series extends significantly the work presented at a very early stage of the crisis (mid-August) in the Institute's study *The First Oil War*. Many new topics have been researched, and those addressed in *The First Oil War* developed in greater depth.

CONTENTS

1.	INTRODUCTION	1
2.	NATURAL GAS AND THE OIL CRISIS	4
2.1	Poised for Take-off	4
2.2	The Effect on Gas Prices: An Opportunity	7
2.3	Technical Costs and the Impact on Development	9
2.4	Decreasing Lead Times for New Projects	10
3.	THE POTENTIAL FOR OIL SAVING THROUGH ADDITIONAL GAS USE	12
3.1	USA	12
3.2	Japan	14
3.3	Western Europe	16
4.	CAN THE STRAIN BE TAKEN?	20

TABLES

1.	Forecasts of World Natural Gas Consumption	2
2.	Ratios of Proven Reserves over Production	4
3.	Natural Gas. The Contribution of the Main Regions	5
4.	Natural Gas Consumption in Main Markets, 1989	6
5.	Price of Natural Gas Imports	8
6.	Notional Cost of a New Supply of LNG to NW Europe	9
7.	A Potential Supply and Demand Balance for the USA	13
8.	A Potential Supply and Demand Balance for Japan	15
9.	A Potential Supply and Demand Balance for Western Europe	18

CAN NATURAL GAS TAKE THE STRAIN?

1. Introduction

Whenever an oil crisis occurs one can be sure that calls for the replacement of oil by other sources of energy will receive renewed attention. This is, of course, wholly admirable and should not have to wait upon crises. The present situation in the Gulf is already giving rise to equally predictable demands for more money to be spent on various exotic alternatives to oil - generally with the taxpayers being expected to pay the bill. These alternatives, based on wind, tidal, solar power etc., are usually said to be renewable forms of energy, as if that were merit in itself. Popularly, the renewable title is somehow taken to imply that obtaining energy from these sources will involve hardly any cost at all and that their application is wholly beneficial. Both assumptions are rather doubtful. It need only be remembered that these arguments about unlimited, benign and virtually free energy were advanced in favour of nuclear power in its early days.

This is not to denigrate the value of, for example, wind generators and solar heating panels; they have their benefits and a genuine contribution to make. Generally, however, the current state of development of many of the most publicized renewables, high costs and other drawbacks, would not allow them to play a significant role in replacing oil in the near future. Unfortunately, this is the case despite the massive publicity and substantial investment and research efforts initiated after the oil crises of the 1970s.

If we really wish to substitute for oil, during the next decade at least we have little alternative but to utilize sources of energy that, with oil, are already providing almost all our commercial needs.

Of these conventional sources, nuclear power is in a state of limbo, and deeply discredited in many countries. Hydro-electricity, almost a genuine renewable, is a long-term but limited substitute, mainly for fuel oil. Like nuclear, it is highly capital intensive and has increasing difficulty in remaining environmentally acceptable.

Coal is abundant and generally relatively cheap. There is spare production and export capacity at present and a potential for substantial growth in supplies within a few years. However, supply is not the problem; the difficulty lies in the market-place. Although there is potential for some modest switching from oil to coal in the short term, particularly in Western Europe, for the most part this can only be achieved through changing the ranking order of existing power plants. Longer-term substitution through new building and conversion would also be mainly in the power sector and in a few major industries where it is easier to control the environmental and other problems of coal use. It is difficult to envisage coal making substantial inroads into oil consumption by re-entering the residential market or the majority of industrial markets.

This leaves natural gas which appears to have the greatest potential for replacing oil. It is widespread, abundant and a favoured source of energy in all but one of the

major markets in the main OECD oil consuming countries. It is also an established source of energy in several developing countries. In the past, the development of gas has been inhibited by attempts to treat it as a scarce and premium fuel, and these attitudes still linger in some countries. However, natural gas is now more usually regarded as an underutilized source of relatively low-cost energy to be used in a wide range of markets.

The wonder of natural gas is not so much why it has progressed so slowly in the past but why the predictions for its future are so conservative.

Table 1: Forecasts of World Natural Gas Consumption

Million barrels of oil equivalent per day.

	ATG*	EEC*	WEC*	IEA*	OIES*
1970(actual)					19
1975(actual)					23
1980(actual)					26
1985(actual)					30
1989(actual)					34
1990	35	35	na		35
1995	39	42		40	39-44
2000	42	49	36-39		40-50

*ATG: Association technique de l'industrie du gaz en France, 1989

EEC: Energy for a New Century, May 1990

WEC: World Energy Conference, September 1989

IEA: Global Energy Outlook, June 1990

OIES: Oxford Institute for Energy Studies, The OIES Review of Long-term Energy Supplies, September 1990

Table 1 illustrates the less than spectacular increase that has occurred in gas use over the last two decades. This is despite two major oil crises and substantial increases in the price of oil. Natural gas consumption globally, with an annual average increase of 3.2 per cent, has grown slightly faster than coal and its share of total primary energy has increased only from 17 per cent in 1970 to 21 per cent at present. The global data does, of course, hide the major structural changes that have occurred over this period, particularly the decline in relative importance of the USA as a producer and consumer of gas.

It is striking that only two of the projections forecast a larger increase in volumetric terms over the next ten years than has occurred during the last ten years. All were made before the latest crisis although the high of the OIES range was based on an assumption of \$30 oil.

The few international energy companies involved in gas activities appear to be just as conservative in their forecasts as the bodies mentioned above. Certainly, there is often a curious dichotomy in what is said about gas prospects by the management of these companies. In public discussions and speeches they positively bubble over with enthusiasm for gas. But, at the same time, great care is taken to dampen down prospects with talk of very long lead times, enormous costs, contractual problems, demand constraints etc. In a paper given at a symposium earlier in the year two leading figures talked of it being "possible that international trade in gas could more than double over the next twenty years" - as if this were something spectacular. However, it is hardly a very bold view if we take account of the 43 per cent increase that occurred between 1980 and 1989. At the same time, international trade in coal increased by nearly 70 per cent!

The European gas producers, transmitters and purchasers such as Statoil, British Gas, Ruhrgas and Gasunie also seem to make rather heavy weather, at least in public, over the prospects for getting additional gas into new markets. In the past they have appeared to be considerably less enthusiastic than one would expect about the apparently exciting prospects for much greater gas use in Europe. One can understand some of the reasons behind this "steady as we go" attitude and changes are now occurring in tune with the political and economic climate. Presumably the present difficulty over oil will result in an acceleration of these changes.

The American Gas Association, however, can always be relied upon to present the bold view of the future that one would expect from the industry, although in their case it sometimes appears a little too optimistic. In the developing countries the wider use of gas is being actively encouraged by the international lending agencies and may already be poised to play a greater role.

The following sections of this paper consider some possible effects of the Gulf crisis on the problems that inhibit the greater use of natural gas. They also look at the extent to which natural gas could take some of the potential strain out of the current oil crisis and alleviate the impact of the next crisis.

2. NATURAL GAS AND THE OIL CRISIS

2.1 Poised for Take-off

Natural gas competes with oil and, perhaps to a lesser extent, with electricity and coal, and is widely seen as having the long-term potential to substitute for oil on a substantial scale. Whether gas could help in alleviating the need for oil more quickly and significantly than currently envisaged for the 1990s is, however, uncertain. In order to shed some light on this important question, it is worth looking at the present position of gas within the world energy economy.

Gas resources are abundant and in global terms probably represent a larger potential source of energy than oil. Reserves are widely distributed over about eighty countries and at current levels of consumption would last for between fifty-five and sixty years in total. However, the main consuming areas of Western Europe, the USA and Japan, together account for only 9 per cent of reserves compared with 43 per cent of demand. Indeed, Japan has scarcely any indigenous gas resources. In the USA, gas reserves are apparently equivalent to less than ten years of current consumption of gas, although this is a rather dubious and somewhat elastic measure. Eastern Europe is more certainly in a weak situation but elsewhere in the world the reserves position within major regional groupings is one of comparative strength.

The Middle East has some 30 per cent of the world's proven gas reserves but, in stark contrast to oil, only miniscule volumes are exported from the region.

Table 2: Ratios of Proven Reserves over Production. End 1989

	Years remaining	
	Natural gas	Oil
North America	13	10
Western Europe	31	13
Australasia	30	9
USSR	53	13
Eastern Europe	14	10
Central and S.America	75	51
Africa	Over 100	28
Far East etc.	60	21
Middle East	Over 100	Over 100
Total World	56	44

As Table 2 shows, adequate reserves of gas are available outside the Middle East. The contrast between the position of oil and that of gas in the main consuming areas of Western Europe, the USSR and the Far East is particularly striking.

The size of the overall resource base for natural gas is uncertain but likely to be understated and probably represents a bigger potential source of remaining energy than oil. The extent of and speed with which new discoveries are made are not very relevant to availability over the next few years. However, the increased uncertainty of oil supply and the higher prices stemming from the present crisis must, at the very least, serve to increase our knowledge and strengthen our views on the long-term reliability of the gas resource base.

In any case, as the table illustrates, a significant move towards reliance on the Middle East by the rest of the world, is both unlikely and unnecessary under almost any scenario well into the next century, given the current level of proven reserves of gas elsewhere.

Table 3 shows the extent to which gas production is currently dominated by the USSR and the USA. None the less, more than fifty countries produce natural gas and their share is growing.

Table 3: Natural Gas. The Contribution of the Main Regions. Percentage Shares.

	1989	
	Production	Consumption
USA	26	29
Western Europe	9	12
Japan	n	3
Rest of OECD	6	4
USSR	37	33
Eastern Europe	2	4
Developing countries	20	15
	100	100

Although, as mentioned earlier, international trade in gas has been growing, 85 per cent of natural gas is consumed in its country of origin compared with just over 50 per cent of oil. This is largely a reflection of the fuel's inherent characteristics, particularly its low energy intensity. However, other more favourable characteristics have enabled gas, when available and adequately encouraged, to compete successfully with and replace oil in all markets except transport. Even in this market there is some marginal use of gas in road vehicles in a few countries, usually in the form of compressed natural gas or LPG extracted from gas. In New Zealand and soon Malaysia, small volumes of gas are already being converted to liquid motor fuels.

The actual pattern of gas use, as with oil, depends very much on the situation in each individual country regarding availability, inter-fuel competition, climate, pricing and investment policies etc. This is illustrated by the pattern of consumption for some major regions in Table 4.

Table 4: Natural Gas Consumption in Main Markets, 1989. Percentage shares.

	Electricity Generation	Industry	Residential + Services	Others	Total
North America	13	34	38	15	100
Western Europe	11	36	48	5	100
Japan	74	3	n	23	100
Developing Countries	25	49	2	24	100
USSR	35	36	14	15	100
Total World	24	36	24	16	100
(million boe/d)	(8)	(12)	(8)	(6)	(34)

In Western Europe and the USA, the heating and cooling of buildings consumes the major share of gas, followed by industrial uses including chemical feedstocks. Japan is exceptional in the very high proportion of gas used in power plants. This has occurred largely on environmental and efficiency grounds, although it is also a valuable means of diversifying supply sources. Electricity generation is also a major market for gas in the USSR. In Western Europe and the USA, the burning of gas in power plants has been frowned on as a wasteful use of a premium fuel. Fortunately, this rather curious view is now largely discredited and gas-fired power stations are coming in to favour - on environmental and cost grounds.

Natural gas consumption in the developing countries, except in the rare cases where there is an adequate distribution network and a cold climate, is usually spread in widely varying proportions over fertilizer plants, power plants and specific industrial complexes.

The "others" category is very broad and includes gas actually used in gas production, transport and processing as well as pipeline and other "losses".

In only a handful of countries in both the industrialized and developing world does natural gas dominate any specific major market. In a few countries of Western Europe and in parts of the USA, gas use may be close to saturation in the domestic heating market. Elsewhere, however, providing the infrastructure is in place and supplies are competitive, the potential for much greater market penetration is substantial.

Gas use is severely constrained in a few countries, notably Pakistan, because of physical supply problems. In most countries, however, the future development of gas is seen as being largely led by the extent of potential demand from the market place.

The opening up of new markets in some developing countries has been hindered by government policy and the need to invest substantial amounts of effort and capital in the supply and marketing infrastructure against uncertain long-term energy prices. Where the infrastructure is already in place, as in Western Europe or the USA, growth in gas use is more wholly dependent on the usual aspects of competition and growth in consumer needs.

Thus, as well as the economic health of the countries concerned it is the competitive and political climate for gas in relation to other fuels that is the major influence. The position of gas is already changing with deregulation, greater flexibility and new attitudes being adopted by both suppliers and distributors. The overall climate for gas expansion can only be further improved through a combination of higher energy prices and renewed uncertainty on oil supplies.

2.2 The Effect on Gas Prices: An Opportunity

Unlike oil, it does not make sense to quote an international marker price for natural gas. Even for the 15 per cent or so that moves on the world market, prices vary substantially with the age and type of contract.

Particularly since the oil price "shock" of 1986, contractual terms have been changing in the face of growing competition amongst suppliers and falling oil prices. Contract terms for gas have always been closely linked to the official price of oil, often on a crude oil netback basis. Most gas prices are still coupled to those of oil, although increasingly it is the prices of the competing fuels in the final market that are taken into account. Where gas is destined for the power market as, for example, in a recent contract between Statoil and a Dutch electricity company, then gas may also be linked with the price of coal, its main competitor. Most of the main European pipeline contracts are indexed to the market prices of fuel oil and gasoil with price indices of consumer goods also occasionally being used. In the USA, prices for gas are largely independent of oil although in the North East they respond to the price of fuel oil, the main competitor.

Table 5 gives an indication of the prices of gas in international trade, derived from Cedigaz data. It shows that gas prices scarcely increased last year and have stayed well below those in force before the 1986 oil price fall. They are, generally, competitive with oil when quality and other considerations are taken into account. This reflects the much greater realism on pricing that now prevails, particularly on the part of the gas-exporting countries.

Table 5: Price of Natural Gas Imports. \$/million Btu, c.i.f.

	mid-1985	mid-1989	end-1989	(\$/boe)
USA (border)	3.3-3.4	1.9	2.0-2.2	(11.6-12.8)
Western Europe	3.4-4.4	2.0-2.6	2.0-2.9	(11.6-16.8)
Japan	4.7-5.2	3.1-3.5	3.0-3.4	(17.4-19.7)

Both the Japanese and the Koreans have been trying to negotiate gas prices away from the influence of oil, using the argument that this would stimulate greater gas use through increased competitiveness. Although it has not been very successful, in most contracts supplying the Pacific Rim there is a lag of approximately three months before higher oil prices start to take effect. In Europe, Netherlands and Algerian gas are the most expensive sources of supply with the latter particularly subject to substantial price increases as crude oil moves up. The full effect of these increases will not be felt until next year as lag times are generally between six and nine months.

Clearly gas prices will go up both in international trade and in the final market-

place; no supplier or marketer could resist the temptation even if the links with oil were not so strong. They will be lagged increases, however, which would be very difficult to sustain if the situation in the Gulf should be resolved in such a way that oil prices return to pre-crisis levels. If the crisis is over by early next year, higher prices may never actually be implemented. In any case, where fuel oil or coal is involved as a competitor, the scope for movement upwards may be very small.

A moderate approach to pricing in the market-place and to the supply of international gas by suppliers and distributors in a situation of high oil prices could well be the opportunity to overcome the demand restraints that have previously held gas growth in check.

2.3 Technical Costs and the Impact on Development

The technical cost of producing from a gas field is usually only a little above that for oil. While exploration and development costs for gas reserves will be affected both directly and indirectly by the increased price of oil, the effect on existing fields is unlikely to be significant. It is the gathering of the gas and its transport to often distant market-places that have created competitive difficulties for gas in the past. With oil prices below \$20 per barrel, the commercial viability of a number of proposed pipeline and liquefied natural gas projects has been very uncertain despite many brave words. The investment needed for the North West Shelf liquefied natural gas (LNG) project was equivalent to around US\$30,000 per barrel of oil equivalent per day (boe/d) of capacity. This compares with the investment needed for a new coal export project of perhaps \$10,000 to \$12,000 per boe/d or that for increasing Saudi Arabian oil producing capacity of around \$5,000 per b/d. To move Alaskan gas to the Lower 48 states of the USA by pipeline is said to require an oil price of at least \$30 per barrel.

As Table 6 illustrates, oil prices of \$30 per barrel or more reflected in those for gas should certainly make many LNG projects look attractive again.

Table 6: Notional Cost of a New Supply of LNG to NW Europe. Commercial Return

	\$ per boe
Gas feed price*	4.5
Liquefaction	10.0
Transport	3.0
Regasification	3.5
Total	21.0

*at \$0.75 per mmBtu

However, a decision to proceed with a new project would only be taken if there were a degree of confidence that prices would not return to below \$20 or so after the present crisis. Given the nature of the international gas business, such reassurance can apparently only be provided by a firm long-term contract with a responsible supplying government or company. However, the increasing flexibility and scope of both supply sources and suppliers seem likely to ease this situation in the future.

Clearly, the longer the crisis continues and the more unlikely a relatively smooth conclusion becomes, so it will become more likely that terms and conditions for natural gas projects will reflect a belief in sustained high oil prices and supply uncertainty.

As well as making new LNG projects more feasible, this perception of continued high prices should also give a boost to the construction of more plants for the conversion of gas to liquid fuels. The commercial cost of producing gasoline from natural gas in the Mobil New Zealand conversion plant is probably around \$30 per barrel of motor fuel produced with the gas feed at just under \$1 per million Btu. It is reported that Statoil could have a commercial plant based on a different process in place by the second half of the 1990s with oil prices little different to those before the present crisis. Shell has quoted a cost of around \$25 per barrel for the next stage of their middle distillate synthesis process in Malaysia.

It is always difficult to determine what is, or is not, included in such quoted costs for new projects of this type and whether they give genuine scope for a commercial return. Certainly, similar costs of alternative energy projects in the past have always seemed to move with perceptions of the future oil price and to remain just that little bit ahead of the oil price. None the less, there may well be a genuine breakthrough involved in the case of gas to oil technology. The present oil crisis, even if only short lived, could lead to an acceleration of some of the existing plans.

Apart from conversion as a route into the one market where gas is scarcely represented, the use of vehicles directly fuelled by gas will receive more encouragement. Perhaps we will even see a revival of the Russian gas-fuelled aeroplane!

2.4 Decreasing Lead Times for New Projects

Most relevant authorities apparently believe that there are not likely to be serious difficulties in meeting the modest growth in gas demand usually predicted for the rest of this decade. Indeed, most of the capacity and infrastructure needed is already in place.

In Section 3 we try to show that in some major regions substantial additional increases could also be met from within present supply patterns, without any huge new investment of capital or manpower.

There is, however, the possibility that a sustained oil crisis, lasting years rather than months, could encourage gas demand to the extent that by the late 1990s existing

capacity would no longer be adequate. The role of price and of economic and political stability is extremely important in encouraging the additional investment that would be needed. However, at the end of the day, it is how long new projects require to be put in place that will determine whether any exceptional growth in demand could be met.

Substantial capital investment is necessary for the construction of processing facilities, and for the transport and distribution infrastructure needed to expand existing capacity or build in new areas. The cost on a unit of output basis is, however, less than that needed for new electricity generation or transmission facilities.

Irrespective of the return expected, few investors have sufficient risk funds to make investments of the scale required for significant new gas projects, given the present heightened international uncertainty. Thus joint ventures, often involving mixed private and government participation, will probably continue to be the usual form. The problems involved in setting up a joint venture for a major project, particularly where international movements are involved, have been well publicized by the gas industry itself. In the past they have often led to very long stretches of time between the first conceptual plans for a new gas project and its completion. A project to export LNG from Nigeria has been under consideration in one form or another for over twenty years and construction work has still not started. The North West Shelf project took seventeen years from the first discovery of gas to the first export of LNG. Troll looks likely to take just a year or so less to make its first deliveries by pipeline. More often than not the complexities have led to many potentially useful projects remaining on the shelf.

Collectively, investors are unlikely to react immediately to the first indications of a more favourable investment climate arising from the present crisis. International prices may start to make projects look commercial at last and governments may bend over backwards to encourage their progress, but investors will still feel the need for long-term assurances of stability and contractual guarantees. Thus, we are unlikely to see any dramatic change in the current steady but increasing investment in new gas schemes. The longer the oil crisis continues, however, the more the climate will move in favour of new projects. One would expect to see some speeding up of those currently underway - such as the Malaysian Peninsular pipeline scheme or the Midal pipeline to bring supplies into Eastern Germany from the West European grid.

One should also not be hypnotized by the long lead times of the recent past in to thinking that no major new sources of gas can be developed within this decade. It is always amazing how quickly projects can be undertaken and the skilled workforce found when the conditions are perceived to be right. After all, the gas field that really started the European natural gas business, Groningen, took less than five years from discovery to the first sales.

3. THE POTENTIAL FOR OIL SAVING THROUGH ADDITIONAL GAS USE

This section will consider the extent to which additional use could be made of natural gas to reduce the need for oil over the next few years.

One insoluble problem is to know what natural gas consumption and supply potential would have been over the next few years if there had been no oil crisis or, indeed, if the crisis should pass with little long-term effect. In looking at the main gas consuming regions we have made use of the plethora of published and unpublished views on gas growth in order to give a rough quantitative indication of the future for gas against an oil price of below \$20 per barrel and under "normal" conditions. Against this already uncertain picture, we look at the additional gas penetration that might be feasible and the extent of new supplies that could be made available during the 1990s. This is a one-dimensional approach because, apart from anything else, the pattern and level of overall energy demand will undoubtedly also be affected. However, even if the necessary material were actually available, a more detailed and sophisticated approach, would be unlikely to add anything at this stage.

3.1 USA

The USA is the second largest consumer of natural gas in the world. In 1989, it consumed some 500 bcm of gas, equivalent to approximately 9 million boe/d.

During the early and mid-1980s, US gas consumption fell absolutely in conjunction with increasing oil imports. In recent years falling prices, together with deregulation and a freer market, have resulted in increasing consumption, although the level so far in 1990 seems to be below last year.

The increases over the last two full years were mainly in the industrial and electricity generation markets, which between them absorb around half the total supplies. There is a high level of capability to switch fuels in these markets, with about half the industrial gas users and most of the oil-fired power stations being able to switch from oil to natural gas and vice versa. The American Gas Association claimed in a study two years ago that within a month gas could displace the equivalent of 160 thousand b/d of oil imports. Within a year it could replace some 480 thousand b/d. A substantial switch to gas did occur during the last three years of the 1980s when gas prices were relatively low. Thus, the continuing price advantage of gas over residual fuel probably indicates that most switching has already taken place.

Prices are still below those of the mid-1980s and spot market prices for gas do not yet appear to have strengthened. It seems likely that, with gas prices not tied directly to oil, the competitiveness of gas with gasoil and residual fuel will be enhanced. Any remaining potential to switch should be quickly taken up.

However the present crisis is resolved, gas will certainly be seen as more desirable

and demand will be boosted over the next few years. Unfortunately, to increase gas use in the USA involves a major problem of deliverability, for the system in many areas is already strained at peak times. The two main areas affected are the North East and California which desperately need new long-distance pipelines. There are schemes to build new lines from Texas and Western Canada to the North East and from the Rockies and Canada to California. Given the incentive of higher prices, these lines and the additional infrastructure could probably be in place within one or two years but there will be problems if demand is boosted too soon.

Table 7 gives a broad indication of the possible level of increased demand for natural gas in the USA and the potential for meeting it.

Table 7: A Potential Supply and Demand Balance for the USA

	1989	1990	1995	2000
Demand in million boe/d				
pre-crisis (say)	9.0	9.0	9.3	9.6
post-crisis	9.0	9.1	10.0	11.0
in bcm	505	510	562	618
Supply in bcm				
Total	505	510	548-603	541-660
Production	467	476	470-520	450-565
Imports ex Canada	37	37	57-62	57-62
ex Algeria	1	2	8	7
Additional imports			13	26

Many of the material obstacles to increasing gas imports, such as the lack of shipping and pipelines, could be eased or completely disposed of with adequate price incentives and a swift end to regulatory confusion. Opposition on environmental grounds

to the installation of existing LNG terminals or the expansion of new ones may not prove so easy to deal with. The additional imports indicated in the table consist largely of projects for which plans are already advanced, such as LNG from Nigeria, from Norway and Venezuela for which new receiving terminals will be needed. The doubling of the existing unused pipeline from Mexico is also assumed. There is little reason to doubt that Canadian resources are adequate to supply the amounts of gas indicated.

It is probable that the "gas bubble" has ended but the extent of future US gas production potential is as uncertain and confusing as ever. Nevertheless, even with higher wellhead prices, some relaxation of environmental controls and the opening up of offshore areas, it seems unlikely that conventional production can be prevented from declining in the 1990s. To bring Alaskan North Slope production to the Lower 48 states would be costly compared with most other options and seems unlikely this century.

Table 7 is, of course, speculative but the volumes indicated are feasible with only modest changes in the business climate to encourage or accelerate existing plans. The supply volumes do not involve projects such as those for bringing in gas from the Mackenzie Delta project in the Canadian Arctic which current oil prices may now make economic. Thus, supply potential is, if anything, understated and the main restraint to greater gas use probably lies in the ability of the market to absorb it.

If the potential demand for substitution in the market place is as we have indicated, then gas supplies should be able by the mid-1990s to support the saving of at least 1 mb/d of oil that would otherwise need to have been imported. By the end of the century, additional supplies could achieve possible oil import savings of at least 2 mb/d.

3.2 Japan

Japanese gas consumers have always been prepared to pay for security and diversity of supply and prices of gas are consequently higher than in the USA or Western Europe (Table 5).

The growth in demand already projected for the 1990s can be readily met by the extension of existing long-term contracts, as Table 8 shows. There is currently some spare capacity, perhaps 5 bcm, amongst the South East Asian suppliers and supplies of Australian gas from the North West Shelf are already building up to a peak. Competition to supply Japanese utilities, particularly from Indonesia and Malaysia, is unlikely to decrease with higher crude oil prices. Firm plans for expansion in these two countries alone could produce an additional 20 to 25 bcm by the mid-1990s. By the latter years of the decade, new projects from Australia, Alaska, New Zealand, Sakhalin and elsewhere could also be in place. Table 8 does not include any of these projects although they would be commercially viable with oil prices at \$30 per barrel.

Table 8: A Potential Supply and Demand Balance for Japan

	1989	1990	1995	2000
Demand in million boe/d				
pre-crisis(say)	0.8	0.9	1.0	1.1
post-crisis		0.9	1.3	1.6
in bcm	45	51	73	90
Supply in bcm				
Total	45	51	72-77	86-96
Production	2	2	2	1
Imports from				
existing contracts	43	48	24	15
extension + expansion		1	46-51	65-70
new projects				5-10

The potential for immediate switching from oil to gas is virtually non-existent, but by increasing throughput in gas-fired power plants 50-70,000 b/d of fuel oil or crude oil might perhaps be saved.

The use of gas in Japan is already growing faster than expected, particularly for combined heat and power production. The Japanese utilities and government are highly concerned with security of supply and will surely need no more encouragement than the events of the last few months to seek to increase the use of natural gas and reduce oil imports still further. Again, it is the extent to which additional gas penetration can be fostered that is the key, rather than any real difficulties with additional supplies.

The amount of oil that can be saved over the next few years through increased gas use without recourse to any extraordinary measures is useful, although small when seen against a demand for oil of over 4.5 million b/d.

3.3 Western Europe

Although the oil crises of the 1970s helped to stimulate gas use in Europe, it is arguable whether market penetration would, ultimately, have been any less without these events. During the 1980s, the use of natural gas in Western Europe grew slowly and somewhat erratically within a modest overall growth in energy demand and in the face of price competition and changes in market structure. Consumption of gas has increased at an average rate of 1.6 per cent per annum since 1980, compared with an absolute decline in the growth of oil. None the less, natural gas's share of 16 per cent of primary energy consumption is still well below that of coal.

The gas market in Western Europe is also still highly concentrated, with nearly 90 per cent of demand in five countries - the UK, West Germany, Italy, the Netherlands and France. These countries will continue to dominate the industry during the 1990s although gas use is generally increasing elsewhere in Europe at a faster pace.

Nearly 50 per cent of European gas demand is for direct premium applications in the residential and services markets. Industrial and other uses take around 40 per cent and electricity generation just over 10 per cent - a reflection of past attitudes by governments and the gas industry itself towards this market.

There are some limited short-term possibilities for switching to gas in the power sector and industry. However, any significant increase in gas use at the expense of oil over the next few years will require a greater penetration of markets in the big five consuming countries.

The conventional longer-term view for the 1990s seems to be that there will be progressive market saturation in the main areas which is unlikely to be offset by expansion in the new gas-consuming countries of Southern Europe and Scandinavia. Thus, overall demand for natural gas in West Europe on this basis should increase at an average annual rate of under 2 per cent to reach around 300 bcm by 2000. Such predictions concerning a highly desirable source of energy with an established supply and distribution network at the centre of a region poised for further growth and expansion seem rather unenterprising.

There are certainly prospects for much greater expansion of gas use for electricity generation. This is partly because of the growing importance of the environmental benefits of burning gas, but also because of a more general change in attitude towards gas use for so-called non-premium purposes. The failure of nuclear power, the privatization of utilities and the availability of competitive supplies of gas are also involved. The old cautious views about gas expansion are still heard from some quarters but a new air of optimism was already developing before the Gulf crisis. This new spirit

has something to do with the opening up of possibilities in Eastern Europe, especially in what was East Germany. Potential for gas penetration may also be greater than expected in Spain, Greece, Sweden and other countries who are at present modest gas users. At present the West European countries outside the big five consumers meet only 6 per cent of their primary energy needs from natural gas. As most of them already have cross border gas connections and a lively domestic gas industry, there seems little reason why their use of gas should not move towards the much higher levels elsewhere.

The European Commission's attempts to enforce greater competition through common access to transmission lines is meeting predictable opposition from the handful of gas utilities that are dominant on the continent of Europe. Whatever the rights or wrongs of common access, the inevitable tendency towards greater freedom in the supply and marketing of gas is helping to create a new climate for growth. The impact of higher oil prices and uncertainty of oil supply on the majority of oil-importing European countries can only improve the likelihood of a substantial expansion in gas demand.

A more buoyant outlook is also encouraged by activity on the supply side. In place of the once common doom and gloom on "supply gaps" there is now an increasing availability of supplies looking for markets in the 1990s.

Western Europe currently meets approximately 70 per cent of its gas demand from indigenous production and there is substantial potential yet to be developed, particularly in Norway. A level of gas demand of around 250 to 300 bcm by the end of the period would appear to be adequately covered with planned production and the flexibility that exists within current long term supply contracts.

The bulk of gas from outside Western Europe comes from the USSR (65 per cent), and crosses borders at highly competitive prices. There is said to be some 20 bcm of spare capacity in the pipeline system from the USSR at present although whether it would actually be available in practice for any length of time is doubtful. A 30 per cent expansion of pipeline capacity is said to be planned for 1993.

The capacity of the overall system is uncertain and unclearly reported but more could probably be done with additional compressors and improved techniques. The USSR will be obtaining better prices for its oil exports as a result of the crisis but this is unlikely to affect their need for hard currency as restructuring of the economy develops. In addition, uncertainty exists over the expansion of supplies in that the USSR is reportedly considering setting aside production capacity to meet their own expected high growth. Additional pressures are being created by the growing assertion of nationalism and local interests that could hamper the expansion of exports. However, it seems unlikely that continuing central control would give up such a substantial source of additional hard currency, representing at present 15 per cent of all such earnings.

The other major supplier of imported gas at present is Algeria which also has spare supply capacity in its LNG system and in the Transmed pipeline to Italy. Revamping and relieving the bottlenecks in the existing facilities, together with the expansion of the Transmed line, could probably double supplies to Europe by the mid-1990s.

Various proposals, some more realistic than others, have been made to expand gas exports to Europe; a pipeline between Libya and Italy, a new pipeline from the Barents Sea to Scandinavia, LNG from Nigeria etc. The construction of additional projects to supply gas from Algeria and Libya were already economic at pre-crisis prices but with oil prices at over \$20 per barrel many other projects come into the picture.

The Netherlands has for many years been the main intra European supplier of natural gas. The stabilization of Dutch exports by the end of the 1990s was at one time said to be planned at a level well below current exports. Substantial potential for expansion remains and the Netherlands seems likely to be a swing producer until the mid-1990s. By then, Norway will be in a strong position to supply much more gas through systems put in place as a result of present contracts. Most of the new capacity will be in Zeepipe, through which gas from Troll and Sleipner will be landed at Zeebruge and in the system to Emden to which Zeepipe will be connected. With extra compression facilities, existing delivery capacity could probably be doubled. Increased sales to Sweden and even LNG to Italy have already been mooted and may now possibly be realized. The abandonment of central sales by the Norwegian Government and new co-operation with British Gas are all part of the more open and dynamic vision for gas.

Table 9 gives an indication of how additional demand resulting from the effects of the Gulf crisis could be met.

Table 9: A Potential Supply and Demand Balance for Western Europe

	1989	1990	1995	2000
Demand in million boe/d				
Pre-crisis(say)	4.6	4.7	5.0	5.6
Post-crisis			5.6	6.9
in bcm	254	263	315	390
Supply in bcm				
Total	254	263	293-349	352-445
Production for national markets				
	111	113	115-120	120-130
Production for cross border sales				
	65	69	82-98	102-125
Imports ex USSR				
ex Algeria	50	50	60-80	80-110
ex Libya	27	30	35-50	40-60
ex Others	1	1	1	5-10

In this table, "additional" demand for natural gas is shown as over 0.5 million boe/d by 1995 and nearly 1.5 million boe/d by the end of the 1990s. The bulk of this "new" demand would be in electricity generation and industry and may well underestimate the speed with which additional gas could be taken up. The table indicates that natural gas supplies would be adequate to support rather higher levels of demand without the need for unusual measures.

Of course, there are many uncertainties involved in any greater expansion of gas use in Europe - for example, UK production potential, the high cost of additional gas from Siberia and the whole complex web of industry and government relations. Also, attention must be given to the difficulties in funding the necessary expansion of the infrastructure in a number of European countries. However, the supply position already has a great deal of upward flexibility since the climate was changing before the Gulf crisis began.

If the use of natural gas gets a boost from the present crisis, then the problems in meeting demand are unlikely to be severe, either in the very short term or through the 1990s. Again the potential for greater gas use hinges more on the possibilities for substitution in the market than on adequate supplies.

4. CAN THE STRAIN BE TAKEN?

The "strain" at present, if any exists, is concerned less with an absolute shortage of crude oil and more with a product and quality mismatch in specific locations. Natural gas can do little to help on this. There may be some modest switching from oil to gas where that is still possible, but the impact globally will be measured in terms of tens of thousands of b/d of oil displaced rather than millions. The challenge to natural gas will come over the next few years as the impact of the crisis and the potential for many more such crises, enter firmly in to the thinking of the decision makers. Before the crisis the use of gas seemed to be gathering momentum once more. It was recognized as a highly desirable source of relatively low-cost energy with a substantial and broad resource base that was underutilized. The growing pressures to do something about the environment and particularly global warming also highlighted the advantages in the comparatively "clean" nature of gas use. New outlets in power generation were opening up in developed as well as developing countries as low capital costs, efficiency and small modules for generating capacity gained favour over massive capital-intensive projects. This was helped by the abandonment of outdated views on the role of gas in "premium" markets. Deregulation in the USA, privatization, restructuring and moves to greater freedom of movement in Europe and elsewhere coupled with more consistent and realistic pricing policies have all helped to create a buoyant climate for gas expansion.

None the less, the potential for additional gas demand in the USA, Japan and Europe is still considered to be rather modest and unlikely to provide the opportunity for dramatic expansion. The expansion and extension of existing supply patterns seem adequate to meet the levels of demand generally projected for the 1990s. Thus, prior to the Gulf crisis one might have expected world gas demand to reach perhaps 2500 bcm by 2000. This represents an increment of some 10 million boe/d that would otherwise have had to be found elsewhere, mainly from oil.

In the earlier sections, we have looked at some of the implications of the Gulf crisis for natural gas. It seems that the impact on prices and the re-emphasis of the dangers of a heavy reliance on Gulf oil can only work to the advantage of natural gas. The problems of financing major projects, their lengthy lead times and the need to ensure contractual confidence will not disappear overnight. Nevertheless, the longer the crisis lasts and the more messy the conclusion, so the more likely it becomes that many of the gas projects currently planned or under construction will be accelerated or expanded. An additional 250 to 300 bcm of gas could be made available for the three main western consuming regions alone, even without the need for "crash programmes". This could supply an additional demand for gas of some 3 to 5 million boe/d and correspondingly reduce the call for Gulf oil. These estimates probably understate what could actually be achieved should perceptions of the reliability of oil and future prices change very dramatically. The extent to which additional gas can be absorbed in to the markets is much more of a limiting factor than supply.

Clearly, it would be easy to make a number of estimates for the main consuming

regions other than those used in the earlier sections. There is little doubt that natural gas could take up a considerable part of any strain that might arise from a need to diversify away from Gulf oil. Investors are unlikely to react immediately to the first indications of a more favourable climate. There will be no sudden and dramatic changes in the development of new gas projects. The longer the crisis continues, however, the more the climate will improve in favour of faster and more substantial expansion of gas use. Even if the crisis is successfully resolved in a few months and prices fall back, uncertainty over Gulf oil supplies will remain. This alone should serve to reinforce changing attitudes and policies on gas and to remove the barriers to greater expansion.

Natural gas has been poised for more rapid expansion for some time. The industry may now have received the necessary boost to make gas the growth fuel both of the decade and the next century.

OXFORD INSTITUTE FOR ENERGY STUDIES
57 WOODSTOCK ROAD, OXFORD OX2 6FA ENGLAND
TELEPHONE (01865) 311377
FAX (01865) 310527
E-mail: publications@oxfordenergy.org
<http://www.oxfordenergy.org>
