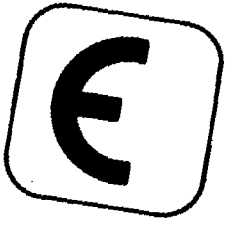
Commission of the European Communities

# NATURAL GAS SUPPLIES AND PROSPECTS IN THE COMMUNITY

Manuscript finished in May 1980



This publication is also available in:

DA ISBN 92-825-2266-0
DE ISBN 92-825-2267-9
FR ISBN 92-825-2269-5
IT ISBN 92-825-2270-9
NL ISBN 92-825-2271-7
ES ISBN 92-825-2272-5

A bibliographical slip can be found at the end of this volume.

Luxembourg: Office for Official Publications
of the European Communities, 1981

ISBN 92-825-2268-7

Catalogue number: CB-30-80-237-EN-C



*Printed in Belgium*

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## 1. Introduction

Following the discovery of fields of regional or national importance, in particular the enormous Groningen field, natural gas supplies have soared in the Community since its inception. Consumption of natural gas has increased from about 7 x $10^9 m^3$ in 1958 to 212 x $10^9 m^3$ (1) in 1978 : a thirty-fold increase in twenty years. The share of natural gas in total primary energy consumption has risen from barely 2 % to more than 17 % over the same period. An impressive performance, which was hardly thought possible when the Community was established, by a branch of the energy industry for which many at the end of the fifties were prophesying an early demise.

This boom occurred in a period of virtually constant economic growth (and hence also energy growth) encouraged by general optimism about the economic future.

However, the 1973/74 oil crisis and the stagnation in economic activity which followed and is still with us today made a nonsense of many optimistic forecasts of energy consumption. Total energy consumption stopped rising, and even fell temporarily, and in general it was realised that :

- energy resources are limited; and
- growing dependence on imports, particularly of oil, is dangerous; and therefore
- there is an urgent requirement to use energy economically and rationally; and
- to develop alternative energy sources.

The natural gas industry has come through the difficult period since the oil crisis comparatively unscathed and although growth rates have fallen considerably, at least some growth has been achieved. Supplies of natural gas were largely unaffected by problems concerning stocks, bottlenecks in supplies, wild jumps in prices, social problems and the like.

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(1) Unless otherwise specified, the gas volumes indicated in this report are calculated on the basis of a calorific value of 35 162 Kjoules = 8 400 Kcal/$m^3$ (high calorific value) (1 tep = 1300 $m^3$)

Indeed, the abrupt increases in the price of fuel oil as a result of the quadrupling of crude oil prices allowed considerable price rises in natural gas, with the result that, despite rising costs, the revenue and profits from gas have gone up considerably, particularly for the producer. Investments which had hitherto been impossible could now be made. Import contracts which had hitherto been thwarted because the costs were too high could now be concluded. In other words, the room for manoeuvre as regards supplies of natural gas widened considerably with the new level of energy prices.

This apparently rosy picture of the natural gas industry could lead to the conclusion that natural gas is the appropriate energy form to help bring about an effective solution to the energy supply problems, at least until the end of the century.

The new supply crisis touched off ort the beginning of 1979 by events in Iran, coinciding with a particularly hard winter, has given rise not only to shortages but also to a considerable escalation of crude oil and petroleum product prices, which is likely to continue for an unpredictable length of time. The fact - already almost submerged in most people's minds - that the securing of energy supplies, particularly oil supplies, will continue to be one of the most urgent international problems has been wrenched back to the surface.

The Community's gas industry has so far coped with this crisis, as with others. However, the limits of the industries capabilities have become very apparent. The almost boom-like rise in the demand for natural gas - which appeared to be a more reliable alternative to heating oil - was substantially partly reinforced by the considerable difference between the price of natural gas and that of heating oil.

The price advantage enjoyed by natural gas as a result of contract and tariff arrangements cannot last. At the same time, the gas industry is faced with the question of how long it can keep up with this surge in demand, particularly since some of the natural gas imports which were planned for the eighties and which seemed to be guaranteed contractually, must now be regarded as questionable.

This study sets out to show what the real possibilities are for natural gas, where its limitations lie and what problems are emerging as regards its future development.

## 2. Summary and conclusions

The rapid expansion of natural gas supplies over two decades, at times with extremely high rates of growth, arose chiefly from the extensive natural gas deposits in the Netherlands and the North Sea. Once full capacity was reached by the major natural gas fields, supply entered a phase of consolidation at a high level.

In the years to come the rise in Community natural gas production, as estimated by the Member States, will increase only slightly to about $185 \cdot 10^9 m^3$. More optimistic estimates expect output to level out at $200 \times 10^9 m^3$/year. For the second half of the 1980s, the national programmes predict a gradual decline in production.

Even if optimistic estimates of possible recoverable reserves were extensively confirmed, this would hardly result in an increase in annual production, although the decline in production might be postponed. Optimistic estimates of the trend in natural gas recovery expect only $160 \times 10^9 m^3$ at most in the year 2000. However, this would require considerable exploration efforts, which would be impossible without a sustained favourable economic climate. The steep increase in the overall energy price level is likely to arouse interest in natural gas fields - known or yet to be discovered - particularly in offshore areas which, for economic reasons, have so far had to be ignored.

Demand will continue to rise and will increasingly be met by imports of natural gas from non-Community countries. The share of this in the total supply will rise rapidly, reaching more than one third as early as 1985 and about 50 % in 1990. Should Community production of natural gas decline seriously by the end of the century owing to diminishing reserves, it is to be expected that imports of natural gas from non-member countries will climb to 80 % of total supply. The future requirement in foreign exchange will be substantial. In 1990 a figure of about $20 \times 10^9$ ECU per year can be expected.

At the present time the following countries export natural gas to the Community :
Norway, the Soviet Union, Algeria and Libya.
Deliveries from Iran will not begin at the end of 1981, as scheduled in the agreements with that country, in fact it is impossible to say at present when or whether these agreements will be honoured. Nor can we be sure that the latest supplies which Algeria contracted to provide will be as

planned, i.e. as LNG. The Algerian Government has for some time been reviewing its investment policy and has let it be known that - because of the high cost of investing in liquefaction plants, ports and tankers - it is no longer interested in expanding its LNG exports and would like to export only by pipeline in future. A final decision on the building of the planned liquefaction plant needed to fulfil the terms of the agreements already concluded has not yet been made and is not to be expected before the spring of 1980.

This turn of events could result in serious gas supply problems in the eighties, for, even where it is a matter of receiving supplies later than was planned, it would be very difficult to replace such supplies in a hurry by increasing internal production or by importing natural gas from other sources, particularly if the demand for new natural gas connections touched off by the Iranian crisis should continue for any length of time.

Nigeria, Cameroon and Canada are possible new sources of natural gas and talks are already being held with them. Mexico is another possibility. Among the Gulf states, not only Saudi Arabia but also Qatar and Abu Dhabi are countries where major new natural gas fields have been found. The conclusion of natural gas agreements with these countries could expand the hitherto extremely modest diversification of imports. Above and beyond that, the new large scale discoveries in the Norwegian sector of the North Sea could - if initial estimates are confirmed - make a far greater contribution to the Community's natural gas supplies than was previously expected.

As far as quantity is concerned, the world's proven reserves of gas are sufficient to cover demand into the next century. If possible recoverable reserves are included, even a world average annual increase in consumption of 5% - 6 % could, in purely quantitative terms, be met into the next century. However, such a purely quantitive view does not take account of two other important factors, i.e. whether it is economic to transport gas over long distances and whether the countries with natural gas fields are prepared to produce and sell at a price which - because of the high cost of transport - must needs be lower than that of oil.

Intensified efforts to perfect known methods and develop new processes for producing SNG from coal therefore appear necessary and logical. True, the contribution of SNG to natural gas supplies will probably not be important up to the turn of the century; yet, with increasing natural gas prices

and with the use of low-cost grades of coal, the breakthrough to economic viability might be achieved. A combination of coal gasification and nuclear process heat might help to solve the cost problems. Underground (in situ) gasification calls for special attention. If the technological problems of this process can be solved economically, considerable energy reserves could be opened up in the Community which would otherwise be lost to us.

LPG - (propane and butane) has so far a fairly modest part to play in the total energy supply scene. Since most of it inevitably arises as a by-product of oil refining, it is available only in limited quantities and at relatively high prices. If the substantial quantities of LPG arising in the course of oil and natural gas production in the North Sea and, more especially, in the oil-producing countries of the Middle East, can successfully be brought to Europe at competitive prices, there could be a considerable increase in sales of LPG. The supply potential for Western Europe in the mid-eighties can be estimated at some 20 million tonnes. In peripheral areas of piped gas supply zones, this LPG could provide fresh competition for natural gas, yet the possibility is greater for LPG to be used to meet peak gas requirements and for mixing with natural gases of low calorific value or with other lean gases.

The pattern of natural gas consumption in 1977 varied greatly between Member States. For the Community as a whole consumption by households at 39 % was just ahead of industrial consumption of natural gas at 38 % with electricity generation in third place with 19 %. The pattern of consumption is changing, however, with strong growth in the domestic sector, and a relative decline in the industrial sector. This shift towards the household and small-users sector (i.e. the premium market)may seem at first sight to be what is wanted, but the fall in industry's share is due in no small measure to short term economic factors. The high rate of natural gas consumption in power stations, particularly base-load plant, is not satisfactory, however, from the viewpoint of energy policy, despite a slight decline in 1977 as against 1976.

The continuing change in the pattern of consumption is not without its problems, however. The drive by exporters towards increasingly uniform offtake of natural gas, combined with the fact that consumption by households is increasingly seasonal, places the gas industry in a growing dilemma which can be resolved only by expensive storage facilities, peak-shaving plant and interruptible supplies at low prices.

Transport and distribution facilities, including storages and LNG terminals, have been greatly expanded during recent years and this will continue in the years to come, with particular emphasis on storage and LNG terminals.

The interconnection of national gas grids has had a more mixed development. Integration has been most marked in the north of the Community due to the importance of the Netherlands as the main gas supplier for the continental Member States. Further south the degree of integration diminishes rapidly. Britain and Ireland still remain isolated. Denmark will probably be connected to the network from 1982/83.

The expected change in the structure of supply requires a fundamental analysis of the existing transport system with regard to required improvements and the scope for optimization - especially from the angle of security of supplies. The Commission has charged an independent expert with such a study, to be carried out in close cooperation with the Member States.

Capital investment by the gas industry in the period 1976-90 is forecast to be approximately 50 000 million EUA. Most of this will consist of market infrastructure, i.e. transport and distribution pipes, storage facilities and - to an increasing extent - LNG installations (liquefaction, storage and regasification facilities).

From this it is possible to detect that a favourable view of natural gas supply possibilities is taken by the industry, although events in Iran and Algeria's new plans have caused a degree of uncertainty. A point that must not be neglected is a fall in investment expectations after 1985. This may well arise in part from the increasing uncertainty of investment estimates with increasing remoteness in time; but it might also point to incipient expectations of a decline in the supply of gas about the turn of the century.

In general, the gas industry is in a position to finance investment in the normal way from its own resources and from the capital markets, although considerable differences between the revenue situations of the Member States' gas supply corporations cannot be disregarded. For the execution of some projects on a continental scale, however, the introduction of new Community financing instruments appears desirable.

The Commission has created such an instrument in the "Ortoli Facility",(1) and further such instruments - intended specially for the energy sector - are at present under consideration. Cooperation between undertakings from several Community countries might also increasingly be a necessary precondition if a project is to go ahead.

Natural gas prices followed the sharp increase in oil prices in autumn 1973, but with a time lag. Hardly had they been brought into line with the new situation when events in Iran produced a new escalation of a similar order of magnitude in the price of oil. Once again natural gas prices have lagged far behind those of heating oil. The gas industry can maintain this situation only for a limited period of time, unless the authorities are prepared to use administrative measures to deal with the sustained boom in demand touched off by the advantageous price of natural gas.

(1) Council Decision of the 16th October 1978 enabling the Commission to make loans to promote investment within the Community. (78/870 CE) O.J. n° L 298 of 25th October 1978

This lagging behind of natural gas prices was due partly to the nature of the contracts in question, with their clauses of varying strictness providing for price adjustments at certain intervals and their inflexible tariffs, but also in some countries to governments' social and anti-inflation policies, where governments could exert strong pressure on the undertakings' pricing policy.

The price increases not uncommonly increased the gas industry's room for manoeuvre since costs did not in all cases rise to the same extent immediately. In the future this room for manoeuvre could well shrink since the costs of procuring natural gas will almost certainly rise faster than the prices that can be charged to the final consumer, which is largely determined by the prices of competing forms of energy, chiefly heating oil.

Hitherto the security of natural gas supply has been regarded as particularly great, mainly due to the fact that the resources of supply are located predominantly within the Community's territory. However, imports from non-member countries will increase very rapidly and are likely to exceed 50 % after 1990. For some member countries this will happen sooner. Long interruptions of supply particularly for political reasons can therefore no longer be precluded. There is no panacea for this security problem. All conceivable possibilities have to be analysed with regard to their technical and economic suitability in close collaboration with industry and the governments of the Member States. The Commission has already had two studies carried out by independent experts entitled the"feasibility of maintaining strategic reserves of natural gas within the European Community,"and"a cost analysis for LNG and SNG plants and storage". A third study "the improvement of the security of supply of natural gas to the Community : coordination of transport systems" is now under way. With the completion of this study the Commission will prepare a consolidated report on the problem of the security of natural gas supply. The Commission believes that apart from certain national measures, common action on a Community basis could be the best method for solving the problems.

With regard to natural gas supplies, the accession of Greece, Spain and Portugal to the Community will not raise any critical problems. Indeed, the accession of Spain, which already has a limited supply of natural gas, could increase the potential for supplying the Community with Algerian natural gas and therefore improve the security of supply. The most recent natural gas discoveries to the south of the Pyrenees and in the Gulf of Cadiz could enable Spain to attain a fairly high level of self-sufficiency. Greece, which is to join the Community on 1st January 1981, has also discovered natural gas in offshore areas which it intends to exploit. In addition, the possibilities of linking up to the Algerian-Italian Mediterranean pipeline are being examined at present.

## 3. Natural gas resources, reserves and production in the Community

The foundation for the impressive boom in natural gas supplies in the Community was laid by the natural gas fields in the Community itself. Some twenty years ago the total recoverable reserves in the Community, including the countries which joined later, amounted to barely 250 x $10^9 m^3$. As production was still on a very small scale, the ratio of reserves to annual production (r/p ratio) was about 36.

In 1959 the enormous Groningen field was discovered in the Netherlands, and the exploitation of this field rapidly changed this situation. In a report published in 1965 on problems and prospects for natural gas in the EEC (1) recoverable natural gas reserves at the end of 1963 were put at just under 1500 x $10^9 m^3$, with more than two-thirds in the Netherlands. Even though production had doubled, the reserves to production ratio had risen to 94.

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(1) Economics and Finance Series, N° 3, 1965

The Groningen field was bigger than originally assumed and this was an important factor in the extension of exploration activities to the North Sea. Significant discoveries, initially of gas (and later of oil), considerably increased the Community's recoverable natural gas reserves. The report "Medium-term Forecasts and Guidelines in the Community Gas Sector" (1) published by the Community in 1972, put certain and probable reserves at 4 200 x $10^9 m^3$ at the end of 1971 (including the UK and Denmark).

Meanwhile production had got into full swing, with the result that the r/p ratio fell to just under 40, which although low compared with the ratios for the United States for example was nevertheless still very good and in no way hindered further expansion. The only imports of natural gas from outside the Community were to the United Kingdom and France, and these were not very significant.

By mid-1979, however, there had been considerable changes in the natural gas supply situation. Despite a number of small to medium-sized discoveries, the recoverable reserves had dropped to about 3 200, x $10^9 m^3$ (2) partly as a result of the considerable increase in production, but also as a result of revised estimates. With natural gas production totalling 175 x $10^9 m^3$ (1978), the r/p ratio had dropped to about 18. Against this background expansion of production hardly seems possible and the 5% fall in production in 1978 compared with 1977 seems to confirm that the peak has already been reached, if not passed.

However it should be borne in mind that the above figure of 3 200 x $10^9 m^3$ is a lower limit, i.e. the proven reserves regarded by the firms as technically and economically recoverable in present conditions. Consequently, it is not directly comparable with the above mentioned figure of 4 200 x $10^9 m^3$. In addition there are natural gas fields, particularly in the North Sea, which have been discovered but whose economic exploitation is not yet certain. Adding a conservative estimate of these quantities to the above mentioned lower limit, the figure obtained for the Community is about 4 200 x $10^9 m^3$.

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(1) Published by the Office for Official Publications of the European Communities, Brussels, 1972, N° 8413

(2) Oil and Gas Journal of 25 December 1978. Converting these quantities to Groningen equivalent gives a rather higher figure, say 3350x$10^9 m^3$.

This figure is more or less the middle of the range of certain and probable reserves (4 000 x $10^9 m^3$ to 4 500 x $10^9 m^3$) estimated by the industry. It is virtually the same as the above figure. This means that output could be matched by exploiting new discoveries. However, as production has risen considerably over the same period, the r/p ratio has dropped from 40 to around 24. Nevertheless, there would be some possibility of increasing production slightly to about 200 x $10^9 m^3$. By the mid-80s, however, a gradual decline would have to be expected. The upper estimates of the Member States are somewhat lower, they expect production to total 183 x $10^9 m^3$ in 1980, 185 x $10^9 m^3$ in 1985 and 178 x $10^9 m^3$ in 1990.

However, the above review is not sufficiently complete to give an overall picture of future development possibilities. There can hardly be any doubt that new natural gas fields will be found and developed in the Community.

The estimates of these "possible" natural gas reserves differ widely, and they are, of course, rather speculative. There are major differences in the estimating and calculation methods and the definition of "possible reserves". In the United Kingdom, for example, the term "possible reserves" only covers fields which have already been discovered but whose size and chances of being economically exploited are still uncertain. In the Federal Republic of Germany, however, reserves which have been estimated geologically but have not yet been discovered are termed "possible".

A conservative combination of the estimates made by the competent department in the Member States gives a figure of 4755 x $10^9 m^3$ (1) for total possible recoverable reserves. There are, however, other

(1) See Doc. XVII/360/76 "Report on the search for and exploitation of liquid and gaseous hydrocarbons in the mainlands and offshore areas under the jurisdiction of Member States of the EC". The quantities indicated in that report in mtoe have been converted into $m^3$ of Groningen equivalent.

estimates which put the figure much higher. The industry estimates that about 1500 x $10^9 m^3$ of reserves recoverable under the present economic conditions will be discovered by the year 2000. The BGR (Bundesanstalt für Geowissenschaften und Rohstoffe) (1) goes as fas as to put the total recoverable reserves in the Community at 7 800 x $10^9 m^3$, including 4 750 proven - virtually the same as the figure mentioned above - and 3 055 possible, but without specifying a period within which these quantities might be available.

Table 1 summarizes the estimates of natural gas reserves in the Community. Conservative estimates of reserves recoverable by the year 2000 of 5000 to 6000 x $10^9 m^3$ produce an r/p ratio of 28 to 34 falling to about 25 to 27 assuming an annual level of production of 200-220 x $10^9 m^3$. By 1985 it would already have dropped to 15 to 17 by 1990 to 13 to 15 and by 1995 dropped below 10. This means that even if these reserves are developed and exploited to the full, a fall in production would have to be expected from the end of the eighties. For the end of the century the industry considers production levels of 100 x $10^9 m^3$ to be certain and a further 60 x $10^9 m^3$ to be likely.

(1) "Das Angebot von Energie-Rohstoffen" (The supply of energy raw materials), March 1976 (Section III of a report on the future development of energy demand and coverage - prospects until the year 2000 - for the Government of the Federal Republic of Germany)

The growth in natural gas production has slowed down considerably in recent years, and since 1976 has virtually come to a standstill; there was even a fall in production in 1978 (table 2). Even assuming that this is partly due to the general slowdown or stagnation in economic growth, and even with future successful exploration, it is unlikely that there will be any substantial increase in natural gas production within the Community. A gradual increase in production to about 200 x $10^9 m^3$ per annum, maintenance of this level until the second half of the next decade and a subsequent falling-off in production to about 100-150 x $10^9 m^3$ in the year 2000 would be an optimistic estimate.



(2)

Table 1

Natural gas reserves in the Community ($10^9 m^3$)

| Country | Proven reserves certainly recoverable in present conditions (1) | Proven reserves certainly or probably recoverable (2) | Proven reserves certainly, probably or possibly recoverable (3) | Reserves recoverable by the year 2000 (4) | Total possible recoverable reserves (5) |
|---|---|---|---|---|---|
| Germany | 178 | 296 | 496 | - | 615 |
| France | 184 (*) | 133 | 133 | - | 420 |
| Italy | 227 | 207 | 207 | - | 495 |
| Netherlands | 1756 | 2300 | 2397 | - | 2935 |
| Belgium | - | - | - | - | - |
| Luxembourg | - | - | - | - | - |
| United Kingdom | 765 | 1081 | 1443 | - | 2360 |
| Ireland | 28 | 32 | 32 | - | 130 |
| Denmark | 71 | 110 | 47 | - | 850(**) |
| Community | 3209 | 4159 | 4755 | 5500-6000 | 7805 |

(*) untreated gas

(**) including Greenland

(1) Oil and Gas Journal of 25 December 1978
(2) Various sources
(3) Report on the search for and exploitation of liquid and gaseous hydrocarbons in the mainlands and offshore areas under the jurisdictionof Member States of the EC (Doc. XVII/360/76)
(4) Figures provided by Shell International
(5) "Das Angebot von Energie-Rohstoffen"
(The supply of energy raw materials), Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, March 1976
(Section III of a report for the Federal Government).

Table 2

Trend and forecasts of natural gas production in the Community up to 1990 ($10^6 m^3$ (35 162 kJ)

| Year | D | F | I | NL | B | L | UK | DK | Irl. | Community |
|---|---|---|---|---|---|---|---|---|---|---|
| 1965 | 3202 | 5449 | 8452 | 1780 | 82 | - | 200 | | | 19165 |
| 1966 | 3862 | 5472 | 9550 | 3441 | 63 | - | 193 | | | 22581 |
| 1967 | 4738 | 5867 | 10176 | 7087 | 65 | - | 691 | | | 28624 |
| 1968 | 6857 | 5850 | 11336 | 14171 | 65 | - | 2432 | | | 40711 |
| 1969 | 9189 | 7229 | 12994 | 22001 | 68 | - | 5810 | | | 57291 |
| 1970 | 13062 | 7699 | 14311 | 31710 | 54 | - | 12456 | | | 79292 |
| 1971 | 15716 | 8017 | 14581 | 43836 | 51 | - | 20704 | | | 102905 |
| 1972 | 18227 | 8316 | 15454 | 58480 | 51 | - | 29875 | | | 130403 |
| 1973 | 19876 | 8361 | 16691 | 71116 | 54 | - | 32338 | | | 148436 |
| 1974 | 20567 | 8427 | 16660 | 84348 | 60 | - | 39010 | | | 169072 |
| 1975 | 19054 | 8205 | 15881 | 90852 | 51 | - | 40538 | | | 174581 |
| 1976 | 19222 | 7920 | 17061 | 97303 | 34 | - | 43135 | | | 184675 |
| 1977 | 19137 | 8501 | 14962 | 96906 | 37 | - | 45071 | | | 184614 |
| 1978 | 20622 | 8785 | 14780 | 88718 | 42 | - | 42293 | | | 175240 |
| 1980 *) | 21000 | 8000 | 13700 | 94000 | - | - | 45488 | | 1170 | 183358 |
| 1985 *) | 19000 | 7200 | 13000 | 82500 | - | - | 45488/58484 | 3509 | 1430 | 172127/185123 |
| 1990 *) | 18000 | 4600 | 13000 | 71250 | - | - | 45488/64982 | 4549 | 1430 | 158317/177811 |

*) Member States' forecasts

However, to make possible such a favourable outcome, i.e. the discovery and exploitation of the total estimated possible recoverable reserves, the current level of exploration in the Community would have to be maintained or even increased, particularly in the offshore areas. On the other hand, it must be expected that there will be a rapid increase in natural gas exploration, production and transport costs following the steep increase in the capital and operating expenditure entailed . Such an optimistic prospect is unlikely to materialize without a steady improvement in the general economic climate and without at least a stable, if not a gradually rising, level of energy prices in real terms.

The following is a brief survey of some of the many objectives and prospects concerning natural gas, which have been formulated and published in recent years :

- The energy policy objectives of the Council of Ministers : these objectives, set on 12 December 1974, aimed at natural gas production in the Community of 175 mtoe (228 x $10^9 m^3$), as part of the objective of reducing dependence on imported energy to 50%. However, a review of these objectives on the basis of national programmes (1) shows that, in view of the continuing worldwide economic difficulties, the Member States are expecting only 138-148 mtoe of natural gas production, i.e. 180-192 x $10^9 m^3$, 15-23 % below the original objectives for 1985. For 1990 the Member States are already expecting a decline in production to 115-130 mtoe or 150-170 x $10^9 m^3$. Details for the Community as a whole and individual Member States on the basis of the national programmes are given on pages 43-58.

- In its study of 1 September 1977 (2) the IEA arrives at lower figures for 1985, i.e. 133.9 to 143.9 mtoe, corresponding to 174-187 x $10^9 m^3$, i.e. about 3-4 % lower than in the Commission's Third Report on the attainment of the objectives for 1985.

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(1) The Energy Programme of the European Communities (COM(79) 527 of 4/10/79)
(2) Natural Gas Prospects, IEA.

- The WAES Study looks ahead to the year 2000. It gives the following figures for natural gas production in Western Europe (1) :

1972 : 133 x $10^9 m^3$
1985 : 233 x $10^9 m^3$
2000 : 128 x $10^9 m^3$

After deducting the production of other West European countries, in particular Norway, the figures for 1985 are between the IEA's estimates and the Member States' objectives.

- The BGR (2) estimates natural gas production in Western Europe as follows :

| | 1980 | 1985 | 1990 | 2000 |
|---|---|---|---|---|
| in $10^9 m^3$ | 230 | 260 | 265 | 265 |
| of which Norway | 40 | 70 | 95 | . |

Here too, there is an assumption that production will fall in the Community countries between 1985 and 1990. Converted into Groningen equivalent the quantities for the Community are as follows :

| | 1980 | 1985 | 1990 | 2000 |
|---|---|---|---|---|
| in $10^9 m^3$ | 208 | 208 | 188 | . |

- A study by the American Gas Association (AGA) presented at the last World Energy Conference, makes the following assessment of natural gas production capacity in Western Europe (3) :

| | 1985 | 2000 | 2020 |
|---|---|---|---|
| Tcf | 7.0 | 7.7-8.0 | 1.5-2.0 |
| in $10^9 m^3$ (4) | 233 | 256-267 | 45- 60 |

(1) Third Technical Report of the Workshop on Alternative Energy Strategies (WAES); Cambridge, Massachussets 1977.

(2) Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, l.c.

(3) "The Future of World Natural Gas Supply", a report prepared for the 10th World Energy Conference in Tokyo on Natural Gas Resources 1985-2020, by the American Gas Association (AGA, September 1977).

(4) Converted into $10^9 m^3$ of Groningen equivalent

The figures for 1985 are exactly the same as the WAES estimates. However, the AGA expects a 10-15 % increase in production between 1985 and 2000. This is an optimistic assessment of the chances of discovery and economic exploitation of the "possible reserves", influenced particularly by the Norwegian potential. The discovery of a large new natural gas field in Block 31/2 would appear to bear out this optimism.

To sum up, the Community's natural gas reserves will allow a further increase in production to around 200 x $10^9 m^3$ per annum, a level which could probably be maintained until the middle of the next decade, followed by a gradual decline. However, assessments of the rate of falling-off in production vary. The Member States already expect a fall in production of 4-8% in 1990 compared with 1985. The lowest figures for the year 2000 are under 100 x $10^9 m^3$ per annum, whilst optimistic estimates would give a production level of 100-160x$10^9 m^3$ at the end of the century. That, however, depends on the discovery and economic exploitation of considerable new reserves, a possibility which presupposes considerable expenditure of technical and financial resources combined with a general economic recovery and a comparatively high energy price level.

4. Trade in natural gas within the Community

To complete the picture of the development of natural gas supplies for the Community as a whole and the individual Member States, it is necessary to take a look at intra-Community trade in natural gas. The importance of this trade for a number of Member States is highlighted by the fact that in 1978 the Netherlands accounted for 50,5 % of total natural gas production in the Community yet only 20.3 % of total consumption.

Supplies from the Netherlands to other Member States rose from 37 million $m^3$ in 1965 to almost 54 x $10^9 m^3$ in 1977, but fell to 47.5 x $10^9 m^3$ in 1978. The first deliveries were to the Federal Republic of Germany, quickly followed by Belgium, France and Luxembourg, and in 1974 Italy.

The percentage shares of Dutch natural gas in the total consumption of these countries is as follows :

| | 1978 | 1980 *) | 1985 *) | 1990*) |
|---|---|---|---|---|
| Belgium | 85.5 | 77.0 | 35.3-38.4 | 24.1-37.9 (**) |
| Germany | 37.1 | 35.5 | 26.8-27.4 | 25.0-26.5 |
| France | 50.5 | 34.7 | 22.9 | 8.0 |
| Luxembourg | 100.0 | 100.0 | 100.0 | 100.0 |
| Italy | 13.6 | 21.0 | 15.0 | 13.3-15.0 |

The steady increase in these supplies came to an end in 1977. A certain levelling-off at around 50 x $10^9 m^3$ is expected up to 1980, but with the exception of Luxembourg and Italy, the relative importance of Dutch natural gas will decline, as the figures for 1980, 1985 and 1990 show. From 1980 onwards deliveries will fall in absolute terms also.

Table 3 summarizes the development of deliveries of Dutch natural gas to other Community countries from the time they began, and the Member States forward estimates for 1980, 1985 and 1990.

Since 1976 Dutch natural gas reserves have been declining slowly as the quantities produced each year are no longer being fully matched by new discoveries. It is thought unlikely that this trend will be fundamentally reversed in the coming years by exceptionally large new discoveries (1). In its 1978 Gas Marketing Plan, NV Nederlandse Gasunie (2) assumes that no new natural gas supply contracts will be made with the gas industries of other Member States, and that existing contracts will not be extended once they expire. This is in line with the Netherlands Government's energy policy.

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*) Calculated from information provided by the Member States.

**) Depending on the development of imports of natural gas from outside the Community.

1) However, there are certain fluctuations in the calculations of recoverable reserves. For example, the Rijksgeologische Dienst raised the estimate of reserves of natural gas still recoverable from the Groningen field from 1650 x $10^9 m^3$ to 1800 x $10^9 m^3$ as at mid-1979.

2) N.V. Nederlandse Gasunie : 1978 Gas Marketing Plan.

However, the figures in Gasunie's marketing plan differ slightly from the information received from the Member States. This is attributable to the fact that, in addition to Gasunie's gas exports, further small quantities are exported outside Gasunie contracts.

Another reason is that Gasunie's supply contracts with customers in neighbouring countries are much more flexible than those with non-Community countries and a certain amount of bringing forward and delaying is possible (1).

According to this plan, the peak for deliveries to other Member States had already been reached in 1976 (approx. 51 x $10^9 m^3$) and exports were to stay at this level until 1979, falling to about 42 x $10^9 m^3$ per annum in 1983 and remaining at that level until 1985. From 1985 deliveries are to fall off more rapidly, down to 30.5 x $10^9 m^3$ in 1990, barely 10 x $10^9 m^3$ in 1995, and drying up completely in 1998. The following graph, taken from Gasunie's report, shows the export outlook until the year 2000. It shows that in the period 1980 to 1997 more than 50 x $10^9 m^3$ per annum will have to be replaced from other sources.

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(1) NV Nederlandse Gasunie : Plan van Gasafzet 1979, pages 5 and 6

Gasunie's natural gas export plan (in $10^9 m^3$)

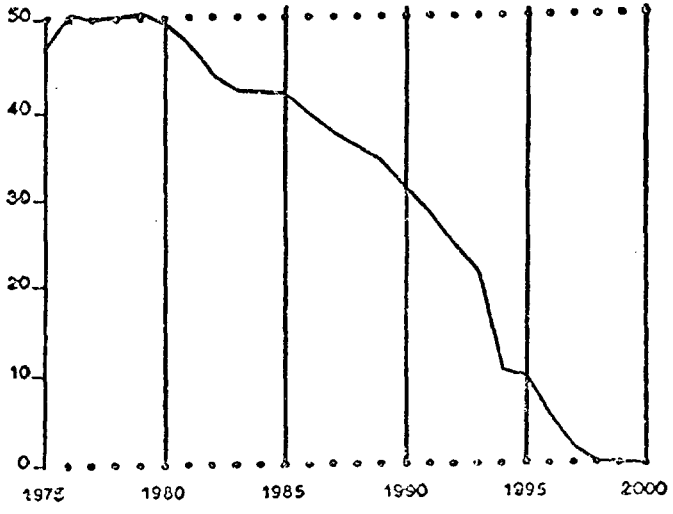


Table 3

Deliveries of Dutch natural gas to other Member States (in $10^6 m^3$) (35162 KJ)

| Year | D | F | I | B | L | Community |
|---|---|---|---|---|---|---|
| 1965 | 37 | - | - | - | - | 37 |
| 1966 | 46 | - | - | 88 | - | 134 |
| 1967 | 341 | 270 | - | 503 | - | 1114 |
| 1968 | 1539 | 1487 | - | 1334 | - | 4360 |
| 1969 | 2665 | 2085 | - | 2810 | 3 | 7563 |
| 1970 | 3745 | 3091 | 0 | 4480 | 14 | 11330 |
| 1971 | 6521 | 4687 | 0 | 6234 | 20 | 17462 |
| 1972 | 10517 | 6348 | 0 | 7755 | 151 | 24771 |
| 1973 | 15616 | 8159 | 0 | 9442 | 290 | 33507 |
| 1974 | 20550 | 9613 | 1769 | 11011 | 387 | 47330 |
| 1975 | 23505 | 9584 | 4536 | 10810 | 455 | 48890 |
| 1976 | 24483 | 11933 | 5025 | 11501 | 521 | 53463 |
| 1977 | 25141 | 12969 | 3965 | 11048 | 549 | 53672 |
| 1978 | 20369 | 12852 | 3944 | 9695 | 600 | 47460 |
| 1980 | 22300 | 10700 | 6500 | 10700 | 715 | 50915 |
| 1985 | 22300 | 10200 | 6500 | 5459-6238 | 775 | 45234-46013 |
| 1990 | 22000 | 4500 | 6500 | 4229-6108 *) | 900 **) | 38189-40008 |

*) Depending on the development of imports of natural gas from outside the Community

**) Via Belgium and France (about half each)

Deliveries of Dutch natural gas to other Member States account for the overwhelming proportion of intra-Community trade in natural gas. However, a number of other contracts require a mention to clarify the overall picture :

- Gasunie has transferred 0.4 x $10^9 m^3$ per annum of its imports of Norwegian natural gas to Gaz de France.
- Ruhrgas is to supply about 1 x $10^9 m^3$ of its gas to Gaz de France each year from 1980 to 1982 and 0.5 x $10^9 m^3$ in 1983.
- Pending completion of the MEGAL transport system, Gaz de France is transferring Soviet gas to SNAM in Italy in exchange for Dutch gas. This exchange should end on 15.2.1980.
- Dutch gas destined for Luxembourg is delivered by Gaz de France and the Belgian Distrigaz company.
- From 1983 to 1985 Ruhrgas will probably deliver 0.35-0.55 x $10^9 m^3$ of natural gas to the Dansk Olie & Naturgas A/S, with the option of a matching quantity of Danish North Sea gas being delivered to Ruhrgas at a later date.
- Distrigaz has made an agreement with Gaz de France to make use of the terminal at Montoir from October 1982. According to this agreement, Distrigaz will cede 5 x $10^9 m^3$ per year of Algerian gas to Gaz de France for four years and Distrigaz will take an equivalent quantity of Norwegian gas from the pipeline which crosses Belgium. It should be noted that the means for delivering Algerian gas to Belgium exists and in the event of an interruption to the Norwegian gas, Distrigaz can receive Algerian gas from Gaz de France.

5. Imports of natural gas - foreseeable development up to 1985/90

Despite the decline in production growth rates since the oil crisis - with even a slight fall since 1977 - there has been a constant rise in natural gas consumption, although at lower rates of increase; in 1978 consumption amounted to more than 212 x $10^9 m^3$, so the share of natural gas in meeting the Community's primary energy requirements reached 17.3 % (1).

This constant rise in consumption was made possible by imports of natural gas from outside the Community. The first long-term import contracts were concluded back in 1962 with Algeria, when the extent of the Groningen

(1) See the Statistical Office's 1978 energy balance ("Statistical aspects of the Energy Economy in 1978" of the 12.6.1979).

field and the potential of the North Sea were not fully known. The first deliveries to the United Kingdom began in 1964, those in France in 1965. After a pause of six years, characterized by a glut of natural gas supplies in Europe, it gradually became apparent that new import contracts were needed in the longer term in order to increase supplies or at least maintain them at the same level. Accordingly, since the end of 1969, not a year passed without one or more new natural gas import contracts being concluded.

The total volumes of gas covered by contracts already concluded amounts to 97 mtoe (126 x $10^9 m^3$ of Groningen equivalent), a figure which will be reached in the late eighties (1). This is slightly above the minimum objective of 95 mtoe laid down by the Council of Ministers. Table 4 summarizes the long-term natural gas import contracts concluded so far. The first Algerian contract concluded with the United Kingdom expires as early as 1980, and hence is not included in the balances for 1985 and 1990. Figure 1 shows the development of natural gas imports broken down by exporting country.

(1) As it has not been officially terminated, the contract with Iran is included even though its future is still uncertain at present.

Table 4

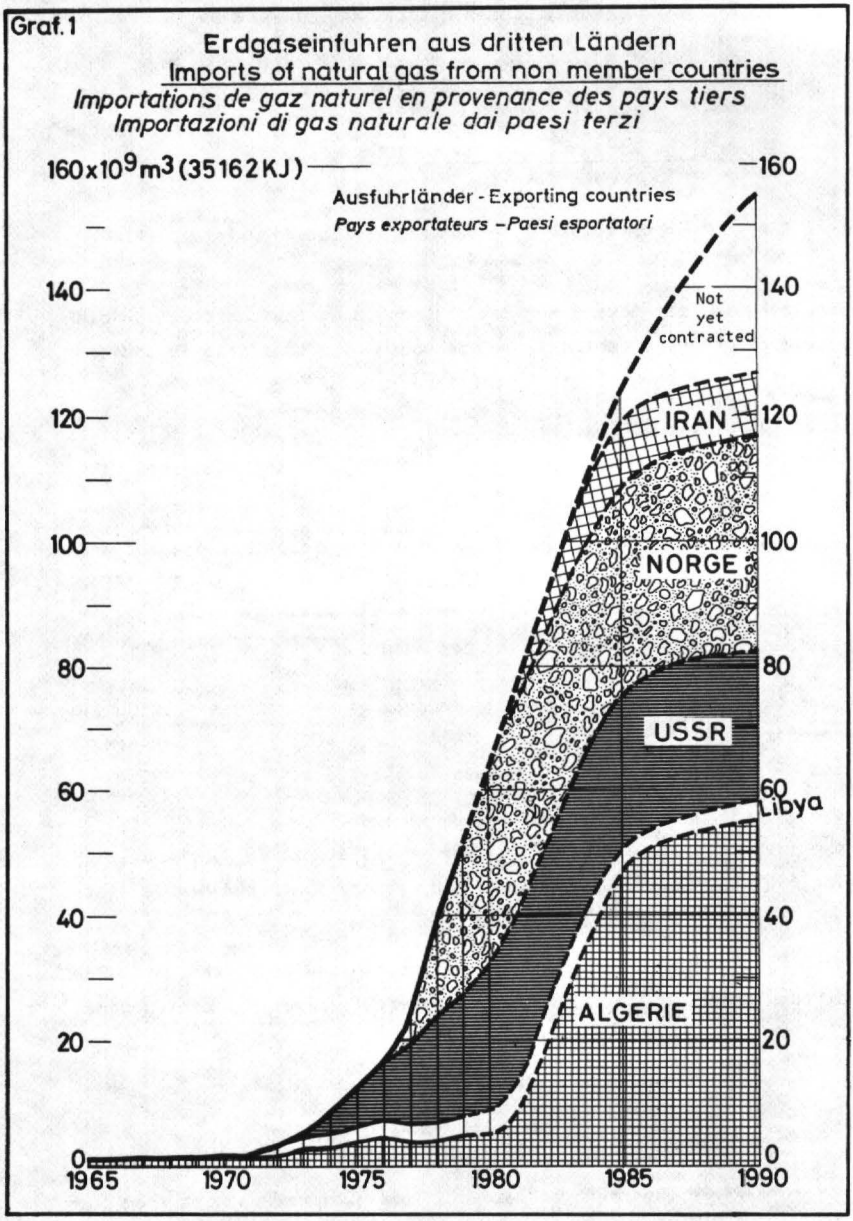
Firm natural gas import contracts with non-member countries

a) $10^9 m^3$ contractual quantities
b) $10^6$ toe
c) end of contract
d) total amount in $10^9 m^3$ - 35162 KJ (Groningen)

| Export. country / Importing | ALGERIA a) | ALGERIA b) | ALGERIA c) | USSR a) | USSR b) | USSR c) | NORWAY a) | NORWAY b) | NORWAY c) | IRAN a) | IRAN b) | IRAN c) | LIBYA a) | LIBYA b) | LIBYA c) | TOTAL a) | TOTAL b) | TOTAL d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quantity / End of contr. | $10^9 m^3$ | $10^6$ toe | End | $10^9 m^3$ | $10^6$ toe | End | $10^9 m^3$ | $10^6$ toe | End | $10^9 m^3$ | $10^6$ toe | End | $10^9 m^3$ | $10^6$ toe | End | $10^9 m^3$ | $10^6$ toe | $10^9 m^3$ |
| D | 4,0 | 3,9 | 2004 | 3,7 | 3,1 | 2000 | 3,1 | 2,8 | 1997 | 5,5 | 4,6 | 2004 | | | | | | |
| | 5,5 | 5,4 | 2004 | 4,5 | 3,8 | 2000 | 4,9 | 4,5 | 1997 | | | | | | | | | |
| | 4,5 | 4,4 | 2004 | 2,5 | 2,1 | 2000 | 1,7 | 1,6 | 1998 | | | | | | | | | |
| total | 14,0 | 13,7 | | 10,7 | 9,0 | | 9,7 | 8,9 | | 5,5 | 4,6 | | | | | 39,9 | 36,2 | 47,2 |
| F | 0,5 | 0,5 | 1990 | 2,5 | 2,1 | 2000 | 2,03* | 1,9 | 1997 | 3,66 | 3,1 | 2004 | | | | | | |
| | 3,5 | 3,4 | 1998 | 1,5 | 1,3 | 2000 | 1,05 | 1,0 | 1997 | | | | | | | | | |
| | 5,15 | 5,1 | 2000 | | | | 0,17 | 0,2 | 1998 | | | | | | | | | |
| total | 9,15 | 9,0 | | 4,0 | 3,4 | | 3,25 | 3,1 | | 3,66 | 3,1 | | | | | 20,06 | 18,5 | 24,0 |
| I | 12,2 | 10,6 | 2006 | 6,0 | 5,0 | 2000 | | | | | | | 3,0 | 2,5 | 1992 | | | |
| | | | | 1,0 | 0,8 | 2000 | | | | | | | | | | | | |
| total | 12,2 | 10,6 | | 7,0 | 5,8 | | | | | | | | 3,0 | 2,5 | | 22,2 | 18,9 | 24,6 |
| NL | 5,5 | 5,4 | 2004 | | | | 1,23 | 1,0 | 1997 | | | | | | | | | |
| | | | | | | | 1,05 | 1,0 | 1997 | | | | | | | | | |
| | | | | | | | 0,17 | 0,2 | 1998 | | | | | | | | | |
| total | 5,5 | 5,4 | | | | | 2,45 | 2,2 | | | | | | | | 7,95 | 7,6 | 9,9 |
| B/L | 5,0 | 4,9 | 2002 | | | | 1,63 | 1,4 | 1997 | | | | | | | | | |
| | | | | | | | 1,05 | 1,0 | 1997 | | | | | | | | | |
| | | | | | | | 0,17 | 0,2 | 1998 | | | | | | | | | |
| total | 5,0 | 4,9 | | | | | 2,85 | 2,6 | | | | | | | | 7,85 | 7,5 | 9,5 |
| UK | 1,0 | 1,0 | 1980 | | | | 9,5 | 8,3 | 1997 | | | | | | | | | |
| total | 1,0 | 1,0 | | | | | 9,5 | 8,3 | | | | | | | | 10,5 | 9,3 | 12,1 |
| COM | | | $10^9 m^3$ | | | $10^9 m^3$ | | | $10^9 m^3$ | | | $10^9 m^3$ | | | $10^9 m^3$ | | | |
| | 46,85 | 44,6 | 57,2 (d) | 21,7 | 18,2 | 23,6 (d) | 27,75 | 25,0 | 32,5 (d) | 9,16 | 7,7 | 10,0 (d) | 3,0 | 2,5 | 3,2 (d) | 108,5** | 98,0 | 127,3 |
| | | | | | | | | | | | | | | | | 107,5 | 97,0 | 126,1 |

*) of which 0.4 is ceded by the Netherlands

**) the low figures do not contain the $1 \times 10^9 m^3$ for the UK-Algeria contract which expires in 1980


Graf. 1
Erdgaseinfuhren aus dritten Ländern
Imports of natural gas from non member countries
Importations de gaz naturel en provenance des pays tiers
Importazioni di gas naturale dai paesi terzi
160x10⁹m³ (35162 KJ)
Ausfuhrländer - Exporting countries
Pays exportateurs – Paesi esportatori
Not yet contracted
IRAN
NORGE
USSR
Libya
ALGERIE
160
140
120
100
80
60
40
20
0
1965
1970
1975
1980
1985
1990

Under the contracts concluded, probable total imports are as follows :

| | | | |
|---|---|---|---|
| Algeria | 43.6 x $10^6$ toe | = 45.0 % | (excluding UK contract) |
| Norway | 25.0 x " " | = 25.8 % | |
| Soviet Union | 18.2 x " " | = 18.7 % | |
| Iran | 7.7 x " " | = 7.9 % | |
| Libya | 2.5 x " " | = 2.6 % | |
| | 97.0 x $10^6$ toe | = 100 % | |

About 48 % of the imports was to be carried in liquefied form by LNG tanker.

However, the Algerian Government has cast doubt on the construction of new liquefaction installations. This could lead to a drastic and serious shift in the Community's import structure.

As comparison of the contractual quantities with the national objectives for 1985 shows, the Member States are expecting that the contracts will not quite have been exhausted by 1985.

For 1990, on the other hand, the Member States' national programmes are expecting imports from outside the Community of 110-120 mtoe (142-155 x $10^9 m^3$). This assumes new contracts or the extension of the existing contracts amounting to 26-30 x $10^9 m^3$ per annum.

There has been a considerable rise in imports of natural gas from outside the Community. They increased from 1 x $10^9 m^3$ to 40.3 x $10^9 m^3$ between 1965 and 1978 and will quickly increase to 142-156 x $10^9 m^3$ by 1990.

Dependence on imports is increasing at a similar rate. In 1970 it was an almost negligible 2 %. In 1978 it was almost 19 %, the prediction for 1980 is 26%, 40-42 % in 1985 and, according to the Member States' available estimates, 46-47 % in 1990.

Even when natural gas imports from the Norwegian sector of the North Sea are not considered, there is still a considerable rise in import dependence, as the following figures illustrate :

| | |
|---|---|
| 1978 | 11% |
| 1980 | 13% |
| 1985 | 29-31% |
| 1990 | 36-40% |

Table 5 summarizes the trend to date in imports of natural gas from outside the Community and the development expected up to 1990.

Figure 2 shows the development of natural gas imports, by member countries.

(3)

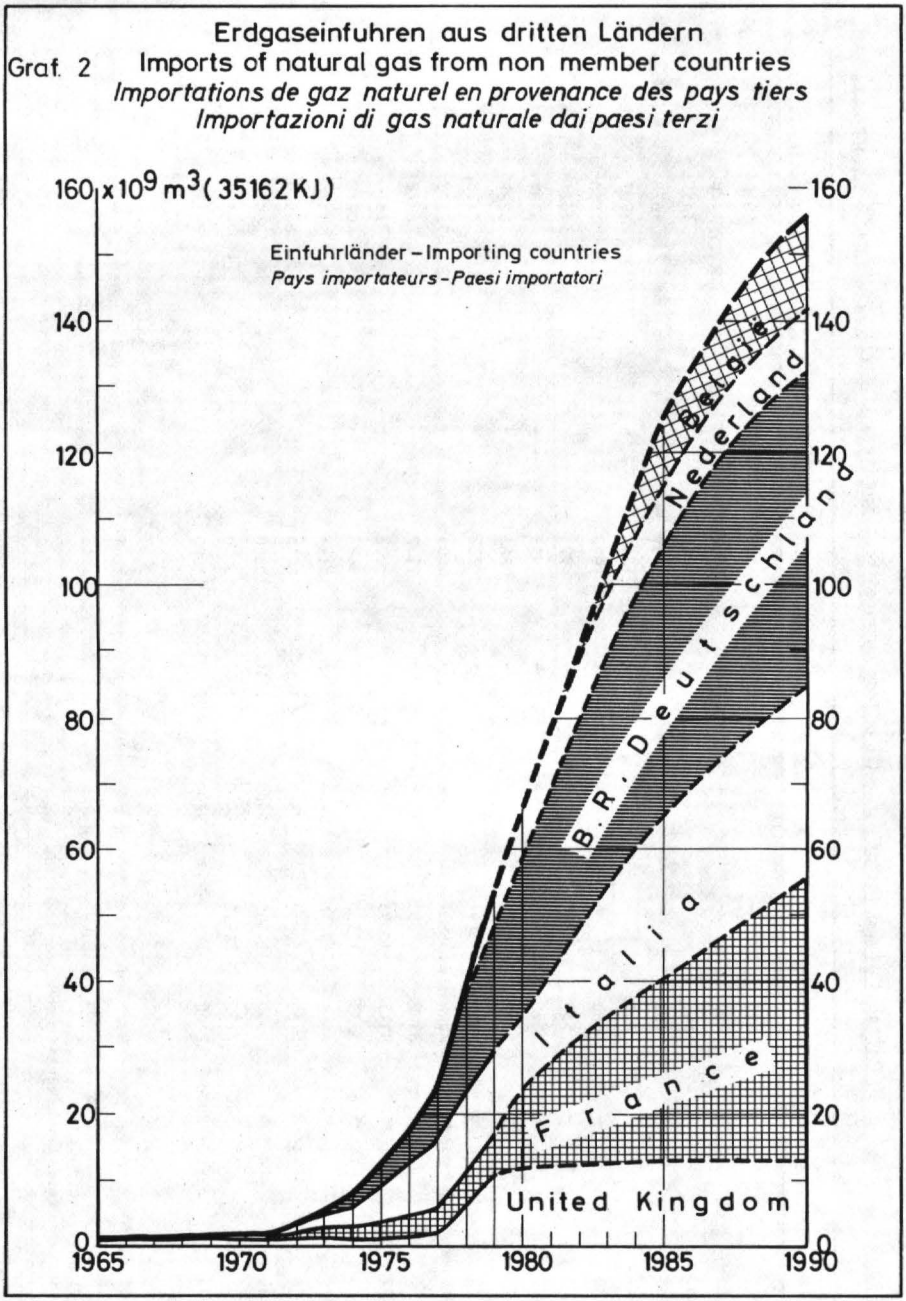
Table 5

The trend of imports of natural gas from outside the Community until 1990 (in $10^6 m^3$ - 35.162 kJ)

| Year | D | F | I | NL | B | UK | DK | Community |
|---|---|---|---|---|---|---|---|---|
| 1965 | - | 233 | - | - | - | 777 | - | 1010 |
| 1966 | - | 458 | - | - | - | 762 | - | 1220 |
| 1967 | - | 543 | - | - | - | 916 | - | 1459 |
| 1968 | - | 489 | - | - | - | 1189 | - | 1678 |
| 1969 | - | 654 | - | - | - | 1249 | - | 1903 |
| 1970 | - | 660 | 0 | - | - | 998 | - | 1658 |
| 1971 | - | 589 | 37 | - | - | 995 | - | 1621 |
| 1972 | - | 896 | 1573 | - | - | 918 | - | 3387 |
| 1973 | 387 | 1843 | 2176 | - | - | 881 | - | 5287 |
| 1974 | 2338 | 2306 | 2747 | - | - | 732 | - | 8123 |
| 1975 | 3390 | 2844 | 4937 | - | - | 1004 | - | 12175 |
| 1976 | 4354 | 3509 | 7863 | - | - | 1152 | - | 16878 |
| 1977 | 6621 | 3515 | 10093 | 290 | 293 | 2002 | - | 22814 |
| 1978 | 14425 | 5273 | 11580 | 1760 | 1562 | 5688 | - | 40288 |
| 1979 | 18005 | 6458 | 12664 | 2500 | 2050 | 10153 | - | 51830 |
| 1980 (2) | 23300 | 12100 | 10800 | 3500 | 3206 | 11700 | - | 64606 |
| 1985 (1) | 46500 | 24000 | 24600 | 9900 | 10200 | 10800 | - | 126000 |
| 1985 (2) | 40000-42000 | 27100 | 24600 | 8400 | 10007 | 13000 | - | 123107-125107 |
| 1990 (2) | 42900-48000 | 42100 | 24600-29200 | 9200 | 10007-13516 | 13000 | 650 | 142457-155666 |

1) Import contracts.
2) Member States' estimates.

Graf. 2


Erdgaseinfuhren aus dritten Ländern
Imports of natural gas from non member countries
Importations de gaz naturel en provenance des pays tiers
Importazioni di gas naturale dai paesi terzi
160 x 10⁹ m³ ( 35162 KJ )
Einfuhrländer – Importing countries
Pays importateurs - Paesi importatori
Belgique
Nederland
B.R. Deutschland
Italia
France
United Kingdom
160
140
120
100
80
60
40
20
0
1965
1970
1975
1980
1985
1990

Pursuant to Council Regulation n° 1055/72 the Commission presents to the Council each year a report (1) on the development of imports of natural gas together with an Annex summarizing contracts concluded, from which further particulars can be obtained.

6. Imports of natural gas - possibilities of expansion after 1985/90

In general, a period of several years elapses between the beginning of negotiations to conclude a natural gas import contract and the actual beginning of deliveries. Apart from the generally complex problems concerning the conclusion of such extensive, long-term, and often multilateral contracts, the chief reason is the substantial amount of investment involved in carrying them out, both in the producing and importing countries. Consequently, it would be fair to assume that new import contracts, which will certainly be concluded in the coming years,will have hardly any appreciable effect before 1985 on the total amount of natural gas available in the Community.

Natural gas is a particularly clean fuel. The long-term nature of contracts resulting from the heavy investment in durable items required from sellers and buyers alike assures a comparatively high degree of security of supply. Natural gas can make a limited contribution towards the diversification of energy sources, even if many of the potential natural gas exporters are at the same time important suppliers of crude oil. It therefore seems desirable from the energy policy view point that natural gas should maintain and, if possible, expand its share of total energy supplies.

If it is assumed accordingly that after 1985 consumption of natural gas will increase at about the same rate as total energy consumption

(1) Doc. XVII/438/79 of 3 December 1979

a rather more rapid increase in imports and dependence on them emerges - even assuming maintenance of Community production of about 200 x $10^9 m^3$; with a lower level of indigenous production it is correspondingly higher.

As forecasts of the development of total energy consumption and the development of individual energy sources are uncertain, a range of projections are given in Table 6 for the total consumption of natural gas until the year 2000. A level of 300 x $10^9 m^3$ (231 mtoe), more or less the mean figure from the national programmes, is taken as the base figure for 1985.

Table 6

Projections of natural gas consumption 1985-2000 (in $10^9 m^3$, annual rate of increase 1-6%)

| | + 1%/yr | + 2%/yr | + 3%/yr | + 4%/yr | + 5%/yr | + 6%/yr |
|---|---|---|---|---|---|---|
| 1985 | 300 | 300 | 300 | 300 | 300 | 300 |
| 86 | 303 | 306 | 309 | 312 | 315 | 318 |
| 87 | 306 | 312 | 318 | 324 | 331 | 337 |
| 88 | 309 | 318 | 328 | 337 | 347 | 357 |
| 89 | 312 | 325 | 338 | 351 | 365 | 379 |
| 1990 | 315 | 331 | 348 | 365 | 383 | 401 |
| 91 | 318 | 338 | 358 | 380 | 402 | 426 |
| 92 | 322 | 345 | 369 | 395 | 422 | 451 |
| 93 | 325 | 351 | 380 | 411 | 443 | 478 |
| 94 | 328 | 359 | 391 | 427 | 465 | 507 |
| 1995 | 331 | 366 | 403 | 444 | 489 | 537 |
| 96 | 335 | 373 | 415 | 462 | 513 | 569 |
| 97 | 338 | 380 | 428 | 480 | 539 | 604 |
| 98 | 341 | 388 | 441 | 500 | 566 | 640 |
| 99 | 345 | 396 | 454 | 520 | 594 | 678 |
| 2000 | 348 | 404 | 467 | 540 | 624 | 719 |

Share of primary energy consumption

| | | | | | | |
|---|---|---|---|---|---|---|
| H1 (x) | 13.9 | 16.1 | 18.7 | 21.6 | 24.9 | 28.7 |
| Hi 2 | 16.2 | 18.8 | 21.8 | 25.2 | 29.1 | 33.5 |
| Li 1 | 17.3 | 20.0 | 23.2 | 26.8 | 31.0 | 35.7 |
| Lt 2 | 19.8 | 23.0 | 26.7 | 30.8 | 35.6 | 41.0 |

(x) Percentage shares of total energy consumption for each of the four "scenarios 2000" (Doc. XVII/448/78).

H = higher hypothesis
L = lower hypothesis
i = assuming far-reaching change in industrial structures
t = assuming a rapid increase in public transport

The average annual growth rates range from 1 % to 6 %; the lower figures are thus below, and the higher figures above, the probable increase in total energy consumption.

The results of such a projection show that, assuming an average increase in consumption of only 1 % from 1985, total consumption in the year 2000 will be some 65 % higher than in 1978. If the growth rate is assumed to be 6 %, as in the four years of crisis after 1973, consumption would increase almost three and a half times.

If, more realistically, it is assumed that growth rates will drop continually from 3 % in 1985 to 1 % in the year 2000, total consumption will almost double to some 410 x $10^9 m^3$ by the end of the century.

The national programmes show an average annual increase of 4.3 % - 4.9 % up to 1985, whilst the subsequent rate of increase, from 1985 to 1990, reaches an average of no more than 0.9 - 1.3 %. This is a relatively moderate figure, which is probably attributable to the continuingly difficult overall economic situation and the uncertainty in forecasting the development of domestic production of natural gas and the possibilities for concluding new import contracts.

The above mentioned assumption of an average annual growth rate of 2 % from 1985 to 2000, coupled with the very optimistic assumption that domestic production can be kept at 200 x $10^9 m^3$ a year would result in import requirements of more than 200 x $10^9 m^3$ a year in the year 2000. The dependence on imports would be above 50 %. It would increase correspondingly more quickly if overall production was lower.

Assuming the other extreme - a drop in domestic production to less than 100 x $10^9 m^3$ a year, with growth rates continuing at the level of the last four years, i.e. 6 % - imports of more than 600 x $10^9 m^3$ will be required in the year 2000, resulting in a dependence on imports of almost 90 %.

This extreme case is not very likely. What is interesting is whether world gas reserves would be adequate in this extreme case, given the increasing requirements of the other consuming regions, and excluding those reserves which cannot be considered as a source for Community supplies because of geographical or other considerations.

7. Natural gas reserves outside the Community

Table 7 shows world natural gas resources. (1). These figures are minimum reserves - except in the case of the USSR - i.e. proven reserves recoverable with present day technology and at the present level of prices. The figure for the USSR covers "explored reserves", i.e. certain, probable and also some possible resources.

The total figure of 71 x $10^{12} m^3$ is just under two-thirds of exploitable world crude oil reserves and represents a remarkable reservoir compared with world natural gas production of around 1.75 x $10^{12} m^3$ in 1978, about one third of it in the USA. The r/p ratio of 41 suggests that natural gas production in the decades to come need not be restricted as a result of a shortage of resources.

Estimates of total possible recoverable reserves vary considerably. One reason for this is that prospecting activities in the hydrocarbons sector usually concentrate exclusively on oil. Natural gas often used to be a by-product of exploration and was often not wanted. Calculations and estimates of the gas deposits were therefore not so interesting and not conducted with the same effort.

The estimates of total possible recoverable reserves published in the last twenty years vary between 120 and 420 x $10^{12} m^3$. Unfortunately, there has been no tendency for the estimates to converge over this long period. Subtracting past production of around 23 x $10^{12} m^3$ there remains an estimated 100-400 x $10^{12} m^3$. The mean of several other available estimates of reserves was found to be 220 x $10^{12} m^3$, i.e. somewhat below the middle of the above range. After the quantities so far produced have been subtracted from the mean of the other available estimates, the remainder is around 200 x $10^{12} m^3$.

An average obtained in this way can have no claim to scientific accuracy. The result is more or less arbitrary. However, as we lack the facilities for making a scientific calculation or estimate of reserves there is no alternative. It is reassuring to know that the result : 200 x $10^{12} m^3$

(1) Oil and Gas Journal, December 1978

of possible exploitable total reserves - differs only slightly from the estimate contained in the BGR report (1), i.e. 215 x $10^{12}m^3$ possible recoverable reserves of natural gas.

At the last world oil conference in Bucharest in 1979,A.A. Meyerhoff (USA) estimated the world natural gas reserves still recoverable on 1st January 1978 at 200 x $10^{12}m^3$.

(1) loc.cit.

Table 7

The world's proven recoverable reserves of natural gas

($10^9 m^3$) *)

| | | | |
|---|---|---|---|
| Denmark | 71 | Abu Dhabi | 566 |
| France | 184**) | Bahrein | 198 |
| Germany (Federal Republic) | 178 | Dubai | 45 |
| Ireland | 28 | Iran | 14160 |
| Italy | 227 | Iraq | 787 |
| Netherlands | 1756 | Kuwait | 886 |
| United Kingdom | 765 | Neutral Zone | 142 |
| Community | 3209 | Oman | 57 |
| Greece | 113 | Qatar | 1133 |
| Austria | 12 | Saudi Arabia | 2659 |
| Spain | 6 | Middle East ex. | |
| Norway | 680 | Mediterranean countries | 20633 |
| Western Europe | 811 | Argentina | 340 |
| USSR | 25772 | Bolivia | 170 |
| Yugoslavia | 38 | Brazil | 42 |
| other Eastern European countries | 283 | Chile | 71 |
| Total Eastern Europe (1) | 26093 | Colombia | 136 |
| Algeria | 2974 | Ecuador | 113 |
| Egypt | 85 | Mexico | 906 |
| Israel | 1 | Peru | 33 |
| Libya | 685 | Trinidad + Tobago | 227 |
| Morocco | 1 | Venezuela | 1161 |
| Syria | 42 | USA | 5806 |
| Tunisia | 170 | Canada | 1671 |
| Turkey | 14 | America | 10676 |
| Non-European | | Afghanistan | 74***) |
| Mediterranean countries | 3972 | Australia | 878 |
| Angola | 34 | Bangladesh | 227 |
| Gaboon | 68 | Brunei | 227 |
| Nigeria | 1189 | Burma | 4 |
| Sudan | 3 | China | 708 |
| Tanzania + | | Taiwan | 20 |
| Zaire and Congo | 67 | India | 99 |
| Africa excluding (2) | | Indonesia | 680 |
| Mediterranean countries | 1361 | Japan | 14 |
| | | Malaysia | 481 |
| | | New Zealand | 170 |
| | | Pakistan | 453 |
| | | Thailand | 142 |
| | | Asia-Australia | 4177 |
| | | Total World | 70932 |

*) Oil and Gas Journal, 25 December 1978 (no definition of calorific value)
**) Crude gas
***) 1977 figures
(1) Including some "probable" and "possible" reserves.
(2) For the Cameroun which is not included in the list above, reserves are estimated at 150-200 $10^9 m^3$.

The value of the estimates mentioned is diminished because no information is given about the period in which the assumed reserves could be exploited. As this study takes as its time horizon the year 2000, the mean figure of 200 x $10^{12}m^3$ for possible recoverable reserves will probably have to be reduced because of the time factor.

If the present annual world production is compared with estimated possible recoverable reserves, we arrive at an r/p ratio of 114, i.e. a statistical lifetime of some 114 years for natural gas reserves.

A calculation of this kind, of course, tells us little about the real lifetime of the world's natural gas reserves, since it postulates a constant rate of production. But even if we assume a growth rate of 5% up to the year 2000, there could still be recoverable reserves of some 125 x $10^{12}m^3$ in that year, which - on the basis of the projected production of some 5.3 x $10^{12}m^3$ in the year 2000 - would mean an r/p ratio or a statistical lifetime of some 24 years.

However, a constant growth rate of 5 % up to the year 2000 must be regarded as unrealistic, particularly in view of the United States' huge share in the consumption of natural gas. A more realistic calculation would be 3 %, a rate which would mean reserves in the year 2000 of around 140 x $10^{12}m^3$ or an r/p ratio of 45 on the basis of a production level of some 3 x $10^{12}m^3$.

Even if the possible reserves recoverable by the year 2000 are put at only 50%, the conclusion, as far as quantities alone are considered, is that no supply problems are to be expected.

An analysis of Table 7 shows that only relatively few of the countries listed there have surplus gas available for export and are suitably located to supply the Community with additional quantities of natural gas. However, these countries account for about three-quarters of proven recoverable reserves.

Table 8 lists them together with the minimum reserves (1) and the total possible recoverable reserves (2).

---

(1) Oil and Gas Journal
(2) BGR l.c.

Table 8

Total certain and possible recoverable reserves of those countries in a position to export natural gas to Europe ($10^9 m^3$)

| Country | Certain | Possible |
|---|---|---|
| Norway | 680 | 3300 |
| Soviet Union | 25772 *) | 68000 |
| Algeria | 2974 | 22600 |
| Libya | 685 | 1350 |
| Nigeria | 1189 | 3500 |
| Iran | 14160 | 24340 |
| Saudi Arabia | 2659 | 7160 |
| Iraq | 787 | 3780 |
| Qatar and U.A.E. | 1741 | 9230 |
| Kuwait | 886 | 2400 |
| Canada | 1671 | 15460 |
| Mexico | 906 | 3230 |

*) The figures for the Soviet Union are not so certain as the other figures in this column (see the note to Table 7).

At first glance, Canada and Mexico appear out of place in this table, but both these countries are considering the possibilities for diversifying their natural gas exports towards Europe.

Total Community requirements of imported natural gas between 1978 and 2000 are estimated to be around $5.5 \times 10^{12} m^3$ on the basis of the maximum figures assumed above (continuing increase in consumption of 6 % per year and a decrease in domestic production from $200 \times 10^9 m^3$ in 1985 to 80 to $100 \times 10^9 m^3$ in 2000). If we compare this figure with Table 8, it can be seen that there will be no difficulty in covering an overall requirement of this magnitude, especially if we remember that a large proportion of available reserves will still be unexplored by the year 2000. This still holds true even if we accept that the domestic requirements of the countries above will increase at a faster rate and that the USA and Japan will also be meeting their own increasing requirements predominantly from these sources. This conclusion is even more valid with the more moderate assumption of a lower and gradually diminishing rate

of increase in consumption. In this case the Community's total import requirements up to the year 2000 would be some 3 x $10^{12} m^3$ if internal production grows satisfactorily and some 4 x $10^{12} m^3$ if the development is unfavourable (drop of production to less than 100 x $10^9 m^3$ a year). As far as quantities are concerned, there appears to be no difficulty in covering these requirements in view of the figures in Table 8.

The existence of adequate world reserves is a necessary but not, of course, a sufficient condition for increasing natural gas imports. A number of other conditions must also be met if the quantities available are to be used. The most important are as follows :

- A sufficiently high proportion of the possible total reserves must be discovered and developed within the next ten years if they are to be used by the end of the century.
- The cost of transporting the gas (which increases sharply with distance) and all related charges can be borne only if the total operation, from source to final consumer, is economically viable.
- The existence of large natural gas reserves does not necessarily mean that the country possessing them also intends to export them. Even if the reserves far exceed possible future domestic requirements - at maximum utilization - the interest of some countries in the capital intensive export of natural gas could fade, especially if constantly increasing revenue from the sale of oil diminishes the attraction of further exports. These obstacles could be overcome by means of appropriate forms of technological and economic cooperation.

8. Exports of natural gas to non-member countries

Exports of natural gas to countries outside the Community are only of subordinate importance but must be mentioned here in order to complete the picture.

Since the completion of the TENP-pipeline to Italy, the Netherlands have also been supplying Switzerland with the natural gas which the Italian SNAM ceded to the Swiss gas industry under its contracts with Gasunie ($0.5 \times 10^9 m^3$ per year). The contract between SNAM and SWISS-GAS is for 15 years and will expire in 1994.

Ruhrgas AG will supply Switzerland annually with $240 \times 10^6 m^3$ of gas from the Norwegian sector of the North Sea. A second contract, for a term of 15 years, is for $350 \times 10^6 m^3$ of gas from Iran a year. Because of the situation in Iran it is not known when deliveries will begin.

These quantities may appear rather small compared with the total consumption of the Community. However, they play an important part in Swiss energy supplies, especially from the environmental point of view. In 1975, natural gas accounted for only about 3.4 % of all primary energy consumption in Switzerland but is expected to reach about 8.4 % by 1985 and at least 8.9% in the year 2000. In another scenario which obtained the support of the majority of the Swiss Commission on a "total energy concept" in its report published in late 1978, it could even reach 13.3%.

A contract which Ruhrgas has signed with the Swedish firm Svedgas for the supply of $1.2 \times 10^9 m^3$ a year will, however, probably fail to materialise as the political supervisory bodies in Sweden have not given their approval.

Ruhrgas will, however, make stop-gap deliveries of $400 \times 10^6 m^3$ a year to the Austrian concern ÖMV in 1980 and 1981.

9. The natural gas supply picture up to the year 2000

Table 9 shows the past development of natural gas consumption in the Community and prospects for 1980, 1985 and 1990.

Table 9

Gross natural gas consumption trends in the Community until 1990 (in $10^6 m^3$ - 35 162 kJ)

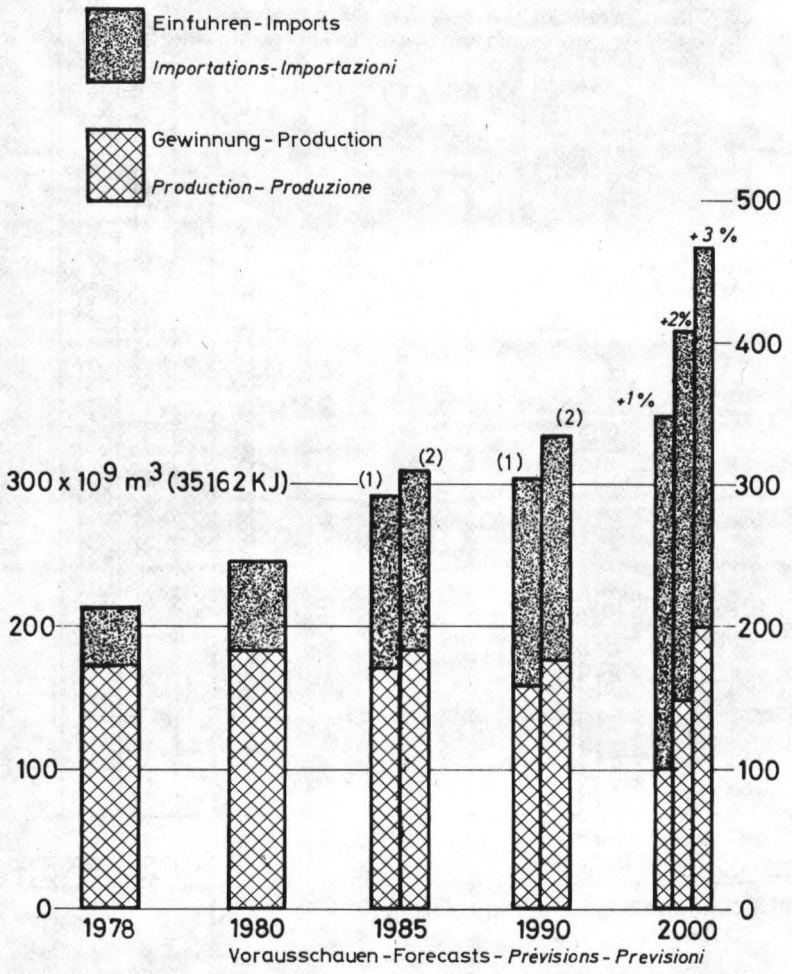
| Year | D | F | I | NL | B | L | UK | DK | Ir. | Community |
|---|---|---|---|---|---|---|---|---|---|---|
| 1965 | 3236 | 5455 | 8387 | 1745 | 82. | - | 978 | | | 19883 |
| 1966 | 3910 | 5708 | 9157 | 3308 | 151 | - | 953 | | | 23187 |
| 1967 | 5079 | 6504 | 10002 | 5972 | 574 | | 1607 | | | 29738 |
| 1968 | 8392 | 7827 | 11691 | 9849 | 1399 | | 3623 | | | 42781 |
| 1969 | 11834 | 9536 | 12917 | 14476 | 2878 | 3 | 7061 | | | 58705 |
| 1970 | 16759 | 10870 | 14032 | 20408 | 4522 | 14 | 13458 | | | 80063 |
| 1971 | 22200 | 12892 | 14353 | 26403 | 6234 | 20 | 21702 | | | 103804 |
| 1972 | 28656 | 15266 | 16654 | 34161 | 7861 | 151 | 30791 | | | 133540 |
| 1973 | 35663 | 17900 | 18821 | 37705 | 9510 | 287 | 33220 | | | 153106 |
| 1974 | 43179 | 18679 | 21122 | 40478 | 11074 | 387 | 39741 | | | 174660 |
| 1975 | 45483 | 20840 | 24154 | 41544 | 10784 | 455 | 41545 | | | 184805 |
| 1976 | 47659 | 22396 | 29221 | 43421 | 11512 | 520 | 44286 | | | 199015 |
| 1977 | 50722 | 24984 | 29020 | 42870 | 11379 | 549 | 47074 | | | 206598 |
| 1978 | 54963 | 25445 | 29094 | 43095 | 11279 | 600 | 47981 | | | 212457 |
| 1980 * | 66600 | 30800 | 31000 | 43600 | 13906 | 715 | 57188 | - | 1170 | 244979 |
| 1985 * | 81300/83300 | 44500 | 43300 | 44400 | 15466/16245 | 775 | 58488/71484 | 3509 | 1430 | 293168/308943 |
| 1990 * | 82900/88000 | 51200 | 43300/48700 | 45000 | 16115/17805 | 900 | 58488/77982 | 5199 | 1430 | 304532/336216 |

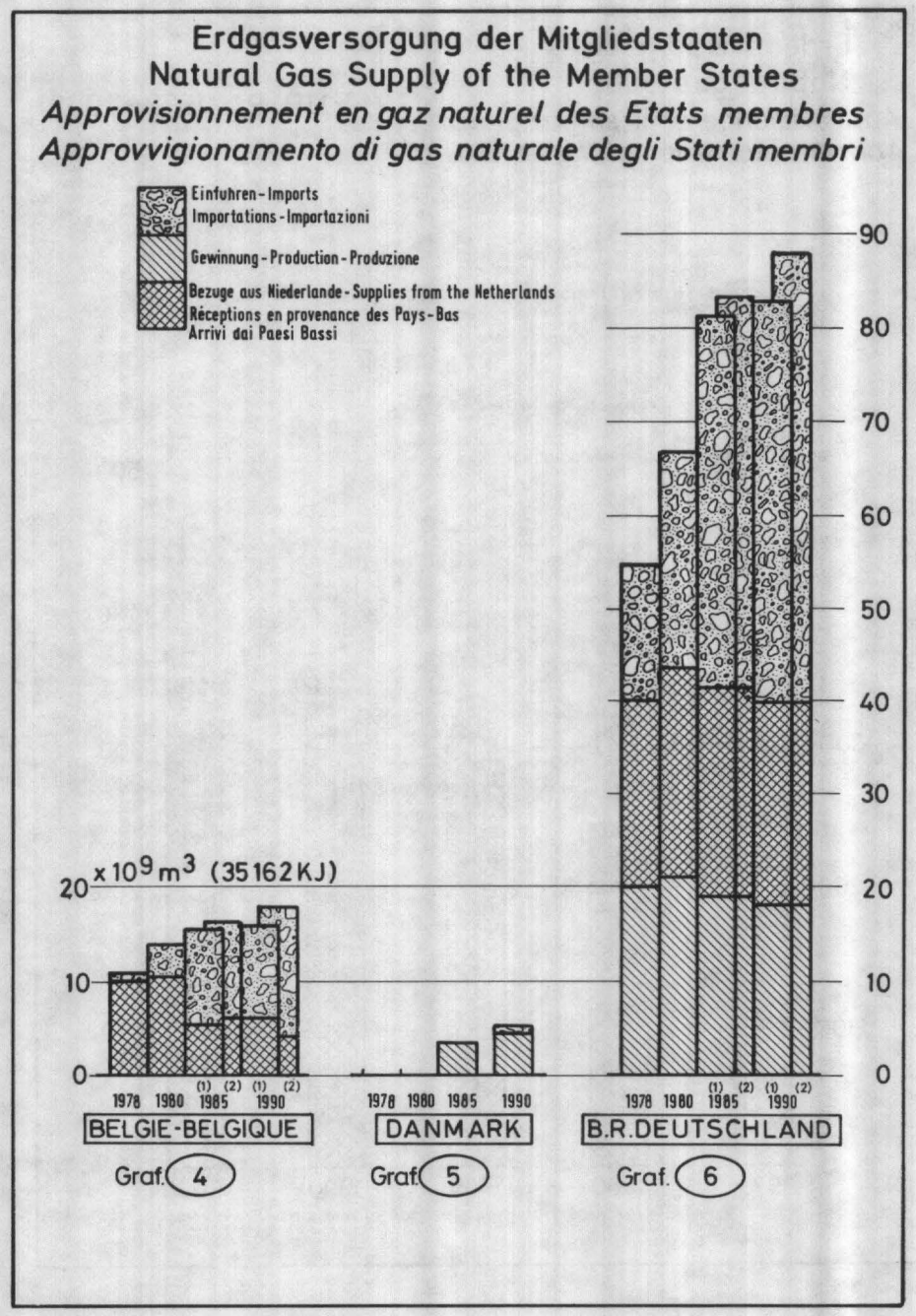
*) As estimated by Member States

Graf. 3

Erdgasversorgung
Natural gas supply
*Approvisionnement en gaz naturel*
*Approvvigionamento di gas naturale*

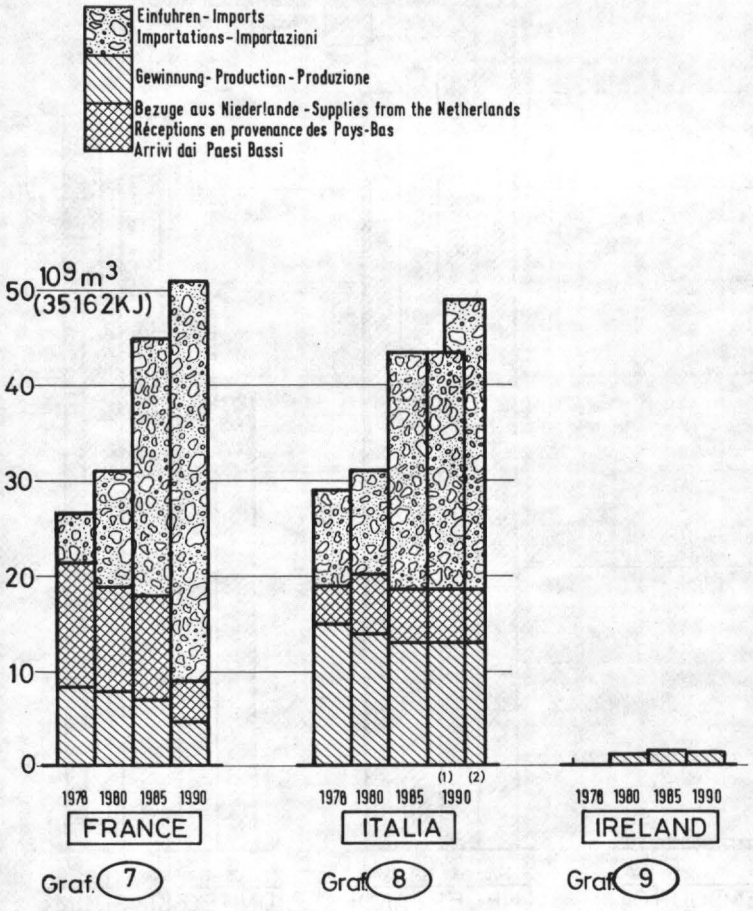
EUR 9 (1978→2000)






Graf. 4 Graf. 5 Graf. 6

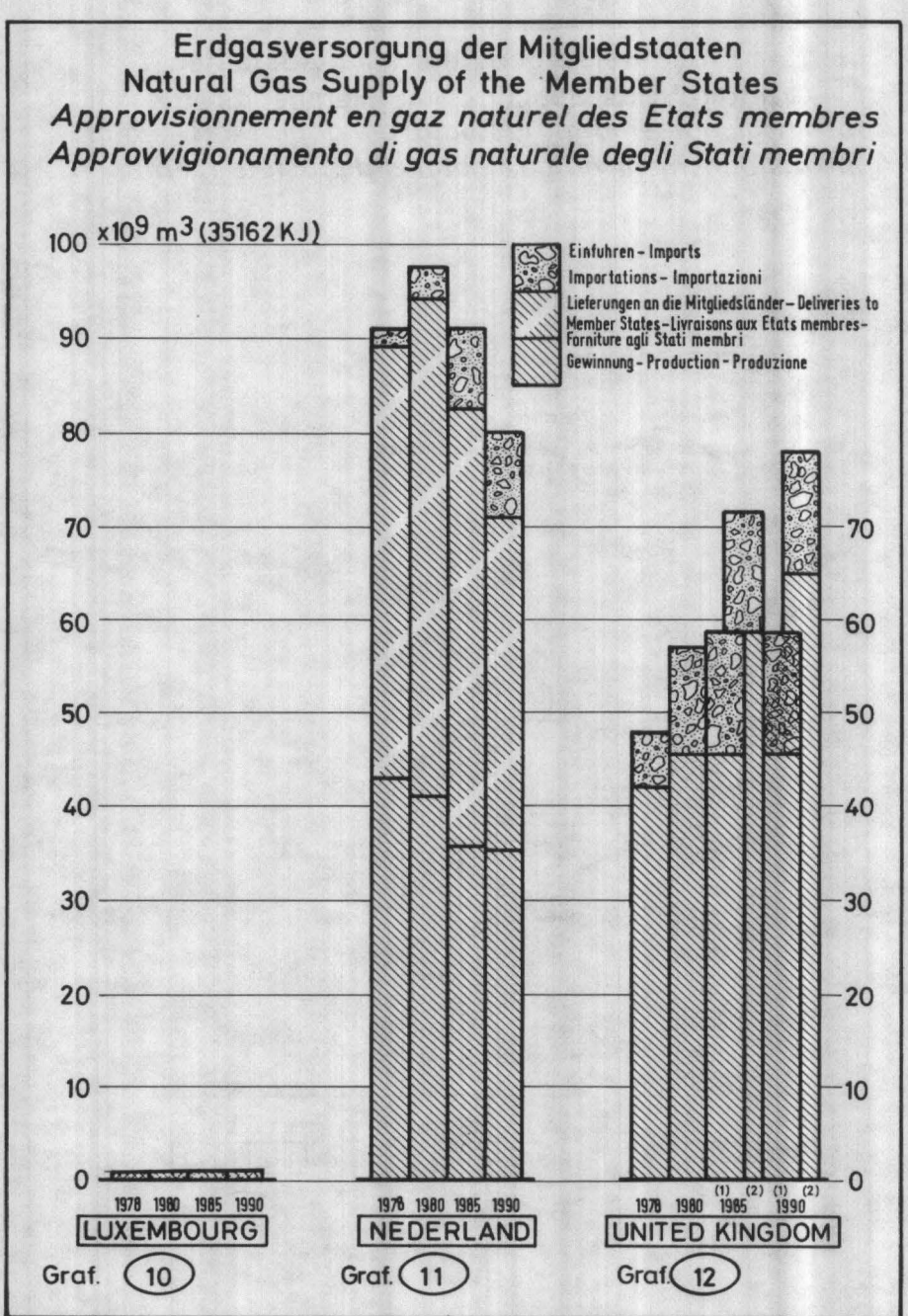
# Erdgasversorgung der Mitgliedstaaten
# Natural Gas Supply of the Member States
## *Approvvigionamento di gas naturale degli Stati membri*
## *Approvisionnement en gaz naturel des Etats membres*




Graf. 7 Graf. 8 Graf. 9



(4)


Erdgasversorgung der Mitgliedstaaten
Natural Gas Supply of the Member States
Approvisionnement en gaz naturel des Etats membres
Approvvigionamento di gas naturale degli Stati membri
100 x10⁹ m³ (35162 KJ)
90
80
70
60
50
40
30
20
10
0
Einfuhren - Imports
Importations - Importazioni
Lieferungen an die Mitgliedsländer - Deliveries to Member States - Livraisons aux Etats membres - Forniture agli Stati membri
Gewinnung - Production - Produzione
1978 1980 1985 1990
LUXEMBOURG
Graf. 10
1978 1980 1985 1990
NEDERLAND
Graf. 11
1978 1980 1985 (1) (2) 1990 (1) (2)
UNITED KINGDOM
Graf. 12

On the basis of national programmes we have computed natural gas supply balances for 1978, 1980, 1985 and 1990, which are presented in the graphs. In Figure 3, which shows the balances for the Community as a whole, three sets of projections for the year 2000 have been included as well, namely based on growth rates in total consumption of 1%, 2% and 3% and, likewise, three assumptions for natural gas production in the year 2000 : 100, 150 and 200 x $10^9 m^3$ per year.

Figures 4 to 12 show the development expected by each country, as set out in the Member States' national programmes. The following comments apply to the graphs for each country and that country's natural gas supply policy :

BELGIUM (Figure 4) does not expect to have any indigenous natural gas production by 1990. The quantities of hydrocarbons so far found in Belgium are not an adequate basis for a more optimistic prognosis. Belgium will therefore continue to rely exclusively on the Netherlands and non-Community countries for its supply of natural gas.

Imports of natural gas from the Netherlands amounted to some 11.0 x $10^9 m^3$ in 1977 falling to 9.7 x $10^9 m^3$ in 1978 but rising to around 11.0 x $10^9 m^3$ again by 1980. A figure of 5.5 to 6.2 $10^9 m^3$ is in the Belgian national programme for 1985 and in 1990 Belgium expects to import between 4.3 x $10^9 m^3$ and 6.1 x $10^9 m^3$ of natural gas from the Netherlands, depending on how imports from non-Community countries develop in the meantime. The contracts between Belgium's Distrigaz and Gasunie of the Netherlands expire in 1995.

The first imports of natural gas from non-Community countries - Norwegian Ekofisk gas - began in 1977. They are to rise rapidly, to 3.4 x $10^9 m^3$ in 1980. As from 1982, liquefied natural gas is expected to be imported from Algeria.

Total imports of natural gas from non-Community countries will thus amount to 10 x $10^9 m^3$ by 1985 and possibly 13.5 x $10^9 m^3$ by 1990. However, the Belgian Government does not regard this further increase by 1990 as certain, which explains the relatively wide margin of possible imports of Dutch natural gas cited above.

Belgium's dependence on natural gas imported from non-Community countries, which was only 13.8% in 1978, will increase rapidly :

| | | | |
|---|---|---|---|
| | 1980 | : | 23 % |
| | 1985 | : | 62-65 % |
| | 1990 | : | 62-76 % |
| after | 1995 | : | 100 % |

Belgium's gross natural gas consumption will increase from some 11.3 x $10^9 m^3$ in 1978 to 13.9 x $10^9 m^3$ in 1980, in other words by an average of 11 % per year. Between 1980 and 1985 a further increase by an average of some 2.1 % to 3.2 % per year to 15.5 to 16.3 x $10^9 m^3$ is expected, while growth rates of between 0.8 and 2.9 % per year - a gross consumption of between 16.1 and 17.8 x $10^9 m^3$ - have been computed for the period 1985-90.

DENMARK (Figure 5) has no natural gas supply so far. However, a number of towns have distribution networks for town gas produced from oil products. The quantities of natural gas discovered in the Danish sector of the North Sea were at first assessed as being insufficient to provide the basis for a Danish natural gas supply.

However, new assessments of the recoverable reserves, carried out for the Danish Government by an independent consulting firm , have come up with considerably higher estimates.

On the basis of this assessment the Danish authorities estimated that if the required supplementary drilling is carried out successfully, total recoverable natural gas, including condensates, will be somewhere between 110 and 120 x $10^9 m^3$. The Danish Government therefore expects to produce 3.5 x $10^9 m^3$ in 1985 and 4.5 x $10^9 m^3$ in 1990.

Two important contracts have since been concluded for the development of a natural gas supply system in Denmark.

DONG (Dansk Olie og Naturgas A/S) has concluded a 25-year contract with DUC (Dansk Undergrounds Consortium) for the supply of a total of 55 x $10^9 m^3$ of Danish North Sea gas which was approved by the Danish Government in June 1979. Deliveries will begin in the autumn of 1984. An annual supply of 3x $10^9 m^3$ is expected after an initial build-up period. DONG has also been given a natural gas supply monopoly (for import,transport,

storage and sales). A contract for the supply of a total of 350 to 550 x $10^6 m^3$ of natural gas between 1983 and 1985 has been concluded between DONG and Ruhrgas AG of the Federal Republic of Germany. A Danish natural gas transport system will therefore be in place at the beginning of 1983. Ruhrgas has also undertaken to provide additional supplies if there are any difficulties in the supply of natural gas from DUC to DONG. Under the terms of the contract, Ruhrgas may be supplied with Danish North Sea gas in the future in exchange for the quantities of gas it has supplied to DONG. The contract has yet to be approved by the Danish Government.

The FEDERAL REPUBLIC OF GERMANY (Figure 6) expects to maintain its present output level until 1985, after which it will slowly decline. The latest forecast for 1990 is 18 x $10^9 m^3$. However, the decline in output is expected to be a relatively slow one, so that even in the year 2000 output will be far from negligible.

Furthermore, domestic output will cover a steadily decreasing proportion of overall consumption. Starting from 37.5 % in 1978, this proportion will decline to 32% in 1980, to 23% in 1985 and to 20 to 22 % in 1990. In the final decade of the century this decline is likely to continue.

The same applies to natural gas imports from the Netherlands : in 1978, they amounted to some 20.4 x $10^9 m^3$, or 37 % of overall consumption. They are expected to cover 34 % in 1980, 27 % in 1985 and 25 to 26 % in 1990. All supply contracts expire in 1995.

Imports of natural gas from non-Community countries, on the other hand, are increasing rapidly in both relative and absolute terms. In 1978 they reached 14.4 x $10^9 m^3$ accounting for 26.2 % of consumption (compared with 13 % in 1977). In 1980, 23.3 x $10^9 m^3$ are expected - a dependence of 35 %. For 1985 imports from non-Community countries are forecast at 40 to 42 x $10^9 m^2$, or approximately 50 % of gross consumption and, for 1990, 42 to 48 x $10^9 m^3$ or 52 to 55 % of overall consumption. In the final decade of the century, this proportion is likely to increase even more because of the termination of deliveries from the Netherlands, and also because of the expected decline in domestic output and could reach 80 % or more by the year 2000.

The rise in overall consumption between 1978 and1980 will be from 55 x $10^9m^3$ to 66.6 x $10^9m^3$, an average annual increase of 10 %. After that growth will slacken rapidly. An overall consumption of 81.3 x $10^9m^3$ to 83.3 x $10^9m^3$ is expected in 1985 - an average annual growth of 4.1 % to 4.6 % - and, for 1990, 82 x $10^9m^3$ to 88 x $10^9m^3$. After that the growth rate will be only 0.4 % to 1.1 %. Persistence of so small a growth rate up to the year 2000 would presumably mean a decline in the proportion of natural gas in the overall energy consumption figure. The Federal Government estimates this proportion at 18 % in 1985. Some economic institutes predict a decline to about 16 % by the year 2000.

FRANCE (Figure 7) expects only a relatively small decline in its domestic output up to 1980 (from 8.78 x $10^9m^3$ to 8.0 x $10^9m^3$). After that, however, the decline in output will speed up, so that for 1985 only 7.2 x $10^9m^3$ and for 1990 4.6 x $10^9$ $m^3$ are aimed at. The contribution made by domestic output to covering overall consumption will thus decline from 34.5 % in 1978 to 26 % in 1980, 16 % in 1985 and just under 9 % in 1990.

Imports of natural gas from the Netherlands in 1980 are expected to be rather below those in 1978 (10.7 x $10^9m^3$ as against 12.9 x $10^9m^3$), but their further decline - to 10.2 x $10^9m^3$ in 1985 - will be a slow one. Their share of overall consumption will thus decline at a relatively slow rate up to 1985 - from 50.6 % to 35 % to 23 %. By 1990, however, there will be a sharp decline to 4.5 x $10^9m^3$ or just under 9 % of overall consumption.

Imports from non-Community countries into France are also rising rapidly. In 1978, they amounted to 5.3 x $10^9m^3$ or 20.7 % of consumption. By 1980, they will already reach 12.1 x $10^9m^3$, in 1985 27.7 x $10^9m^3$ and, in 1990 42.1 x $10^9m^3$. Dependence on imports from non-Community countries will thus rise from 39 % in 1980 to 61 % in 1985 and 82 % in 1990. Because Dutch natural gas deliveries will cease in the nineties, and with the anticipated rapid continued decline of France's natural gas output, dependence on importes must be expected to increase to more than 90% by the year 2000.

As regards overall consumption,the following trend is expected :

| | | | |
|---|---|---|---|
| 1978 | : 25.5 x $10^9 m^3$) | + 10.0 % | average annual growth rate |
| 1980 | : 30.8 x $10^9 m^3$) | | |
| 1985 | : 44.5 x $10^9 m^3$) | + 7.6 % | |
| 1990 | : 51.2 x $10^9 m^3$) | + 2.9 % | |

ITALY (Figure 8) expects its natural gas output to decrease from 14.8 x $10^9 m^3$ in 1978 to 13.7 x $10^9 m^3$ in 1980. By 1985, output will have gradually declined to 13.0 x $10^9 m^3$, and will stay at this level until 1990.

The expected output will cover the following proportions of overall consumption :

| | | |
|---|---|---|
| 1978 | : | 50.1 % |
| 1980 | : | 44.2 % |
| 1985 | : | 30 % |
| 1990 | : | 27 % to 30 % |

Deliveries of Dutch natural gas to Italy, which did not start until 1974, amounted to 4.0 x $10^9 m^3$ in 1978 and covered 13.6 % of overall consumption. In 1980, 6.5 x $10^9 m^3$ - 21 % of consumption is expected. They will also be at this level in 1985 and 1990, accounting for 15 % of overall consumption in 1985 and possibly only 13 % in 1990 (more imports from non-Community countries).

Italy, too, is becoming increasingly dependent on natural gas imported from non-Community countries. In 1978, natural gas imports accounted for 11.6 x $10^9 m^3$ or 39.8 % of total consumption. A slight decline (10.8 x $10^9 m^3$ or 35 %) is expected between now and 1980 but when Algeria begins exporting natural gas via the Mediterranean pipeline now under construction, Italian imports will increase rapidly. For 1985, 24.6 x $10^9 m^3$ or 57 % of the total consumption and, for 1990, 24.6 x $10^9 m^3$ to 29.2 x $10^9 m^3$ or 57 % to 60 % of gross consumption are expected.

Gross consumption will rise from 29.1 x $10^9 m^3$ in 1978 to 31.0 x $10^9 m^3$ in 1980, an average growth rate of 2.2 % per year. The further increase to 43.3 x $10^9 m^3$ expected in 1985, and to a maximum of 48.7 x $10^9 m^3$ in 1990, represents growth rates of 7 % and 2.4 % respectively.

IRELAND (Figure 9) is in a situation similar to that of Denmark. There is as yet no natural gas supply system, though some towns are supplied with town gas produced from oil products. The natural gas deposits found off Ireland's southern coast (Kinsale field) are relatively modest and, in the view of the Irish Gas Board, do not justify constructing a supply system. Production there, which started in October 1978, is being used, initially, to supply a petrochemical plant and a power station near Cork. Output will reach 1.2 x $10^9 m^3$ in 1980 and 1.4 x $10^9 m^3$ in 1985 and will remain at this level. The contract between the Irish Gas Board and the Electricity Board provides that natural gas deliveries to the Electricity Board may be terminated should sufficient reserves become available to set up a public natural gas supply network. Unlike Denmark however, Ireland would initially remain isolated, as far as its natural gas supply is concerned. This would change, if Northern Ireland were to be linked with Britain's natural gas system. Linking up the Irish Republic's natural gas supply system with that of Northern Ireland could also be of considerable advantage for the whole island, particularly from the security point of view.

LUXEMBOURG (Figure 10), the smallest country in the Community but one with a large industrial energy requirement, also imports natural gas from the Netherlands via Belgium and France, on the basis of agreements with Gaz de France and Belgium's Distrigaz. To broaden its supply base, Luxembourg is interested in obtaining natural gas from the Federal Republic via the Saarland at some future date.

In 1978, deliveries of Dutch natural gas were 600 x $10^6 m^3$. In 1980, 715 x $10^6 m^3$, in 1985, 775 x $10^6 m^3$ and in 1990, 990 x $10^6 m^3$ are envisaged.

As Luxembourg has no natural gas production of its own and exports no natural gas, these figures reflect the country's gross consumption.

Growth rates up to 1990 are forecast to be :

1978-1980 + 9.2 % per year
1980-1985 + 1.6 % per year
1985-1990 + 3.1 % per year

The NETHERLANDS (Figure 11) continues to be the Community country with the highest natural gas output. In the last few years it has made considerable contributions to the natural gas supplies of its neighbours and will continue to do so in the years to come (see also Table 3). In 1978, overall output was 88.7 x $10^9 m^3$ (50.6 % of the Community's total output), though this was 8.5 % less than the previous year. This decrease was probably related to the economic situation. Maximum output appeared, however, to have been reached in 1976 (97.3 x $10^9 m^3$). Output predictions are for 94.0 x $10^9 m^3$ in 1980 (51.6 % of total Community output). However, a rapid decrease is expected after 1980 : 82.5 x $10^9 m^3$ in 1985 and 71 x $10^9 m^3$ in1990. After that the Netherlands will account for between 40 % and 45 % of the Community's overall natural gas output.

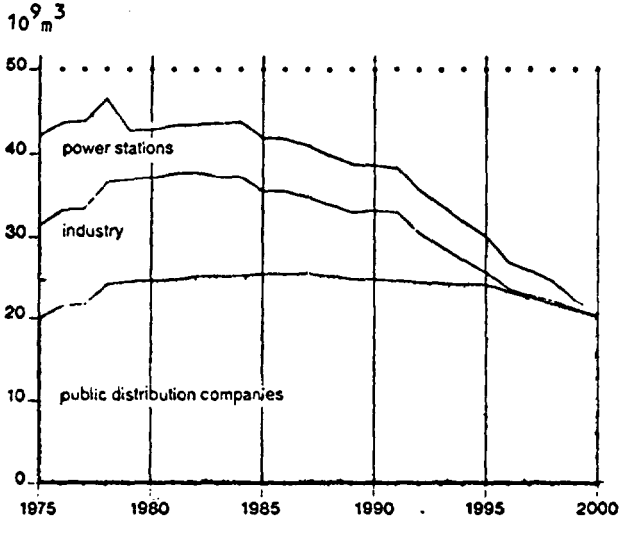
The Netherlands is the leading supplier of the other continental Community countries, as the figures for these countries have shown. In 1977, deliveries to other Community countries amounted to nearly 54 x $10^9 m^3$ - the highest level so far. That was 55.4 % of total Dutch output and 46.7 % of the total natural gas consumption of the countries supplied (B, D, F, I, L). In 1978 it was 47.5 x $10^9 m^3$ or 53.5 % of output. This high level will be more or less maintained up the mid-eighties, when it will gradually decline, its rate of fall increasing after 1990. Natural gas deliveries to the Community amounting to 50.8 x $10^9 m^3$ are envisaged for 1980. In 1985 a volume of 45.2 to 46.0 x $10^9 m^3$ and, in 1990, of 38 to 40 x $10^9 m^3$ is expected. The last supply contracts expire in 1997.

In the Netherlands, the Community's natural gas producer and supplier, the idea of importing gas naturally came to the fore relatively late. However, the need to ensure supplies after the year 2000 finally made it necessary to conclude long-term import agreements. In 1977, the Netherlands imported 350 x $10^6 m^3$ of natural gas (Ekofisk) for the first time, and 1.8 x $10^9 m^3$ in 1978. Imports will increase rapidly in the coming years. In 1980, they are to amount to 3.5 x $10^9 m^3$, to 8.4 x $10^9 m^3$ in 1985 and by 1990 they will have risen to 9.2 x $10^9 m^3$.

However, because of the Netherland's own high natural gas potential, dependence on imports will remain within bounds :

1978 : 8.0 %
1985 : 18.9 %
1990 : 20.4 %

The Netherlands is the only country in the Community which does not expect a further increase in gross consumption in the coming years. On the contrary, the Netherlands is trying to cut down the consumption of natural gas in non-preferential sectors, particularly power stations and large-scale industrial consumers, so as to be able to maintain supplies to public distribution companies fully after the year 2000 The following outline of Gasunie's gas marketing plan makes this clear.




In 1978, total consumption in the Netherlands amounted to 43.1 x $10^9 m^3$. The targets set by the Dutch Government up to 1990 are :

1980 : 43.6 x $10^9 m^3$
1985 : 44.4 x " "
1990 : 45.0 x " "

The proportion of overall energy consumption covered by natural gas will

decrease steadily: from around 50 % in 1978 to some 35 % in 1990.

The steep rise in natural gas consumption began later in the UNITED KINGDOM (Figure 12) than in most of the other Community countries. Although the British gas industry concluded a contract for liquefied natural gas with Algeria at a very early date, the big boom came when the North Sea fields went into production. Output reached 42.3 x $10^9 m^3$ in 1978. It has, however, declined for the first time, by 2.8 x $10^9 m^3$ against the previous year, for which economic factors are responsible.

Future developments depend heavily on whether it proves possible to exploit still untapped natural gas fields in the British sector of the North Sea; figures can therefore be forecast only with a considerable margin of error. The British Government has set a production target for 1980 of 45.5 x $10^9 m^3$. The target for 1985 is given as between 45.5 and 58.4 x $10^9 m^3$ and for 1990 between 45.5 and 65.0 x $10^9 m^3$.

Based on the average for 1985 and 1990 production growth rates will be :

3.7 % for 1978-80
2.7 % for 1980-85
1.2 % for 1985-90

Which of these alternatives materialises depends on the building of a gas gathering system for a number of natural gas deposits and, more particularly, petroleum gas deposits in the North Sea which cannot, on their own, be economically exploited. The prospects for such an outcome are examined in greater detail in section 13 (transport and storage).

Since the UK is not linked to the continental gas grid, it has been unable to share in the exploitation of the Groningen field. On the other hand, the UK has been importing some 1 x $10^9 m^3$ of natural gas annually from Algeria since 1964. It also began receiving Norwegian gas in 1977, when the Frigg pipeline was completed. Imports in 1978 amounted to 5.7 x $10^9 m^3$; they are expected to reach 11.7 x $10^9 m^3$ in 1980. Some 13 x $10^9$ $m^3$ are expected for 1985 and 1990.

Because of the uncertainty as to how production will develop, the overall consumption figures for 1985 and 1990 are given with a margin similar to that applied to production forecasts.

In 1978 overall consumption had reached 48.0 x $10^9 m^3$.

For 1980 57.2 x $10^9 m^3$,
for 1985 58.4 x $10^9 m^3$ to 71.4 x $10^9 m^3$ and
for 1990 58.4 x $10^9 m^3$ to 77.9 x $10^9 m^3$ are expected.

If we take average values again here, the following average annual growth rates for overall consumption emerge :

1978 to 1980 x 9.2 %
1980 to 1985 x 2.6 %
1985 to 1990 x 1.0 %

10. Using substitute natural gas (SNG) to supplement the supply of natural gas

From the purely quantitative point of view, the large reserves of natural gas in the world as a whole, as described in Section 6, would permit a further increase in the consumption of natural gas both worldwide and in the Community. Nevertheless, a question discussed time and again is whether increasing amounts of substitute natural gas should be produced in order that the demand for gaseous fuels and feedstocks may be satisfied in the longer term as well.

The following questions are at the heart of such considerations :

- in the long term, are natural gas resources large enough to permit further expansion or even the maintenance of natural gas supplies?
- Can the rapid rise in the dependence on imports of natural gas be curbed by SNG?
- Can coal reserves, which are considerably larger than crude oil and natural gas reserves, be utilized in a cleaner and technically more appropriate fashion through gasification (and liquefaction)?
- Can the production of SNG from solid fuels create substantial long-term outlets for the Community's coalmining industry?
- Can good economic results be achieved by combining coal gasification with nuclear energy (particularly in the form of high-temperature reactors)?
- Can the considerable coal resources in the Community which are not recoverable by mining methods be utilized through in situ (underground) gasification?

As indicated in Section 6, from the purely quantitative point of view, the answer to the first question is that natural gas resources will certainly be sufficient until the end of the century. They will certainly also be sufficient at the beginning of the next century, but there can be no doubt that in the early decades of the 21st century the limits to the natural gas supply potential will probably become clear fairly rapidly.

Whatever one's optimism about the world's recoverable natural gas reserves, the question is whether countries which are able to export natural gas will also be prepared to do so and whether the cost of importing natural gas from ever more distant areas will not rise so steeply that it will be more economic to produce SNG. One of the main factors on which both questions depend is whether increasing investment requirements can be satisfactorily met.

The problem of rapidly growing dependence on natural gas imports, and hence security of natural gas supply, calls for serious thought over the possibility of using SNG in addition to, or to replace natural gas proper. Balance of payments problems are also involved; since importing 100 x $10^9 m^3$ already requires about 16 to 20 x $10^9$ EUA in foreign exchange and the figure could quickly increase with growing quantities and rising prices.

In theory, any hydrocarbons, including coal and peat, are possible feedstocks for SNG production. In practice, there are three groups of substances under discussion about which a certain amount of experience has already been gained on their use for gas production.

- light hydrocarbons (in particular naphtha and LPG),
- heavy oils (in particular heavy residual oils), and
- coal (most types of hard coal, and lignite)

The first two groups, with the possible exception of LPG (which will be discussed later) can be left out of this review as most of the experts agree that world oil reserves are likely to run out before those of natural gas. Moreover, there would be little point in replacing a perhaps undesirably large dependence on imports of natural gas by an even less desirable increase in dependence on oil imports.

Thus the main question is whether coal gasification can be used on a large scale for SNG production? World (and Community) coal reserves, which are considerably greater than the reserves of crude oil and natural gas, would suggest that it can.

This idea has been taken into consideration by a proposal for a Regulation made by the Commission (1) and adopted by the Council, Article 2 of which explicitly states that the gasification of solid fuels is an appropriate project for financial support.

In September 1977 the Commission made a list of projects which might qualify for financial aid from the Community. A Committee of Experts was also set up to examine the relevant questions and it presented its Report to the Energy Committee in summer 1978 (2).

The Committee came to the conclusion that, barring dramatic changes in energy prices, the large-scale introduction of coal gasification would, of necessity, be a gradual process, because of the costs involved. The first stage according to the Committee, would be the production of producer gases, power gases with a low calorific value, synthesis gas and reduction gas, while SNG production would be unlikely until the second stage. The early introduction of coal gasification on a large scale is therefore not regarded as a possibility, since - quite apart from the considerable lead times involved as a result of planning, approval procedures and the building of the plants required - other problems would also have to be solved, e.g. the improvement and perfection of existing processes with a view to greater efficiency, more flexible areas of application and lower investment and production costs.

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(1) Council Regulation (EEC) n° 1302/78 of 12 June 1978 on the granting of financial support for projects to exploit alternative energy sources (OJ L 158, 16 June 1978).

(2) Report by the Committee on the Gasification and Liquefaction of Coal (COM/ENER/19/78 of 15 August 1978)

Furthermore, fundamental research and development work on new processes would be needed in order to reduce the specific coal requirement and environmental pollution. Providing the quantities of coal and water required could be another problem.

The cost of producing SNG from coal depends on many factors. The price of inputs such as electricity, steam, oxygen and in particular coal, and the proceeds from by-products are important; but so are plant size, interest rates and depreciation, siting, coal quality, environmental protection requirements and other factors. By far the most important factors, however, are coal prices and plant costs.

In its Report the Committee assumes the following costs for SNG production using conventional processes :

| | |
|---|---|
| from lignite | 15 EUA/Gcal |
| from hard coal | 24-26 " " |

These figures are based on prices of 8 EUA/Gcal for hard coal and 2.7 EUA/Gcal for lignite.

The capital cost of an SNG plant with a capacity of $2.4 \times 10^9 m^3$ per annum is put at 1000 m EUA and the corresponding figure for plant using nuclear heat is estimated at 1300 m EUA.

The cost estimates show that even with the present higher price of imported liquefied natural gas, economic operation using Community coal would not yet be possible. However, the new oil crisis and the steadily rising prices of oil and oil products and, consequently natural gas too, have made coal gasification a more flexible large-scale technical proposition.

The outlook is more favourable for lignite, which is cheaper, but the Community's lignite potential is limited. The Committee of Experts estimates it at 125 million t per annum, corresponding to about $30 \times 10^9$ $m^3$ of SNG potential per annum.

However, much of this lignite will undoubtedly be used directly for generating electricity, with the result that the future SNG potential based on lignite will only be limited.

Great hopes are being placed on the belief that the cost problem can be surmounted more easily by combining coal gasification with nuclear process heat from high-temperature reactors.

The underlying idea is to obtain the heat needed for gasification not from the combustion of the coal but from a high temperature reactor. In this way 80 % more gas could be produced with the same amount of coal. If the reactor heat was available fairly cheaply, the costs of SNG production could be considerably reduced. The above mentioned Committee of Experts therefore assesses the costs of SNG from coal gasification using nuclear heat to be considerably lower than the costs of conventional gasification, i.e.

17-19 EUA/Gcal using Community hard coal and
13 EUA/Gcal using lignite

This cost analysis is, however, based on prices for Community hard coal and lignite. The price of imported hard coal, suitable for gasification, ranges between 4.0 and 4.5 EUA/Gcal. Therefore the SNG cost using imported hard coal would be expected to range between the given cost figures although closer to the lignite end of the range.

The last figure is already fairly close to the current price of imported LNG. SNG production using cheap imported coal may thus become feasible more quickly than has been assumed so far, especially if the price of oil continues to rise at its present rate.

To be sure, extensive and lengthy development work will be necessary before a definitive judgment can be made about the possibility of economic operation.

Such considerations led to the setting up of a project for a prototype nuclear process heat plant ("Prototypanlage Nukleare Prozesswärme") in 1975 by a group of German firms. The Project Group is seeking to acquire, by mid-1982, the know-how and information needed for the building and approval of a prototype plant. Consequently, even if the results of the prototype plant are favourable, large amounts of SNG are unlikely to be obtained using nuclear energy and coal before the end of the century. However, for the year 2025 the Project Group is reckoning on a possible building programme for nuclear process heat of the order of 30 plants, each with a 3000 MW nuclear reactor capacity. The amount of coal which would then be needed is estimated at about 100 million t. per year.

Two new conventional, auto-thermic coal gasification pilot plants in the Federal Republic of Germany came into service in the summer of 1979. These are a Lurgi high-pressure gasification plant in Dorsten and a Shell-Koppers plant in Hamburg. Other plants of the same size (100 to 150 tonnes a day) are already operating in Oberhausen (Texaco), Saarbrücken (Rummel-Otto) and there is a Winkler lignite gasification plan in Cologne. Two older Lurgi gasification plants in the United Kingdom (Westfield) are currently being converted.

Coal gasification in Europe in conventional plants or in plants using nuclear energy has two very difficult problems to overcome :

1. High coal prices as result of high working and transport costs.
2. High capital costs as a result of the complexity of the processes.

Both problems might be more manageable if coal could be gasified in situ, i.e., underground. This would provide the energy markets with almost unlimited quantities of gas for a long time.

That is why both the United States and the Soviet Union put considerable effort into solving this problem shortly after World War II. However, the results obtained so far with pilot plants have been unsatisfactory. There are two major drawbacks. First of all, the gas obtained is of poor quality. With increasing gasification the already low calorific value declines rapidly, with the result that the gas produced is no longer combustible. Secondly, if the proportion of ungasifiable coal remaining in the seams is too great the gasification process breaks down irreversibly, comparatively quickly.



(5)

A Belgo-German group with Community backing is now embarking on new attempts to solve this problem at great depths and high pressure. Even if the trials are successful, the gas produced will only have a fairly low calorific value and could not be fed into the public gas supply. However, the cheap production by underground gasification of producer gas, which could be used as power gas for electricity generation or as synthesis gas, would itself be a considerable success.

A French group is planning to carry out underground gasification tests at great depths using oxygen under pressure, in the hope of obtaining gas with a higher calorific value suitable for transformation into gas of natural gas quality.

No indication can be given at present of the feasibility and costs of underground gasification under pressure. We must first await the results of the relevant large scale trials. If they are successful, a wide use could certainly be expected. However, it is open to question whether gas with a calorific value sufficiently high to allow its use in public supplies would be obtained.

Consequently, it is unlikely that coal gasification will make a decisive contribution towards natural gas supplies before the first half of the 1990's. This is no way reduces the great importance of coal gasification in the longer term. However, it cannot hope to become economic unless research and development in this area is continued and intensified.

11. LPG-Propane/Butane

The term liquefied petroleum gas (LPG) applied to propane and butane (and some other gases) stems from the fact that in their normal state (15°C and 1 bar) these hydrocarbons are gaseous in form, but can easily be liquefied by a relatively slight reduction in temperature or increase in pressure. These gases are therefore normally transported and stored in liquefied form.

There are two ways of obtaining these high-grade raw materials and energy sources :

- as a by-product of oil refining, particularly the production of high-octane fuels;
- as a by-product of petroleum and natural gas production. In addition to methane and ethane, petroleum gases in particular (i.e. associated gases) contain considerable quantities of propane and butane.

The proportion of total refinery production accounted for by LPG is relatively slight and depends upon the type of crude oil used, the desired product range and the process selected. The figures for Western Europe, the United States and the Soviet Union are roughly 2.1 %, 1.6 % and 1.3 % respectively.

The figures for "natural" LPG fluctuate much more widely. Although in the United States in 1976 a considerable quantity of LPG was produced along with natural gas production, the corresponding level in Western Europe was only 1.1 %. It is expected that by 1985 this figure will have dropped to 13 % in the United States, while rising to 3 % - 4% in Western Europe.

In absolute terms the US/Western European ratio of "natural" LPG production is about 60 : 1, in other words over 30.5 x $10^6$ tonnes against 0.5 x $10^6$ tonnes.

In 1978 production of LPG outside refineries increased to 0.7 million tonnes, thus covering only about 7 % of the Community's total LPG consumption. This gives a plausible explanation for the enormous difference in the importance of LPG in the USA and in Western Europe. In 1977 total LPG production in Europe was 12.5 x $10^6$ tonnes, almost exclusively from oil refineries and imports were very low. In the United States about two-thirds of the total consumption of 40 x $10^6$ tonnes was covered by natural gas production, 25 % by oil refineries and 10 % by imports. More than one third of the world LPG production expected for 1980 will arise in the course of crude oil production (gas disentrainment by condensation). Just under a third comes from the processing of crude oil in refineries; 20 % is obtained from "wet" natural gas (especially in the USA) and 5 % is separated during the liquefaction of natural gas.

Within the Community LPG has so far played only a relatively modest role in overall energy consumption, especially since a large proportion goes to the chemical industry as a feedstock.

Table 10 summarizes developments in LPG consumption to date.

Table 10

The trend in LPG consumption within the Community (1000 t)

| Country | 1965 | 1970 | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|---|---|
| B | 472 | 464 | 527 | 526 | 520 | 596 |
| DK | 182 | 230 | 181 | 207 | 208 | 207 |
| D | 1577 | 1837 | 1980 | 2119 | 1918 | 1986 |
| F | 1719 | 2326 | 2565 | 2629 | 2693 | 2892 |
| IRL. | 40 | 59 | 104 | 120 | 128 | 121 |
| IT. | 1362 | 1809 | 1998 | 2115 | 2152 | 2040 |
| LUX. | 21 | 26 | 21 | 21 | 22 | 22 |
| N | 284 | 384 | 513 | 722 | 801 | 1204 |
| UK | 1348 | 1233 | 1334 | 1331 | 1307 | 1443 |
| Community | 7005 | 8368 | 9223 | 9790 | 9749 | 10511 |

Table 11 shows the structure of LPG consumption in the Community in 1977. The most important sector is the domestic sector which accounts for half of the total consumption; this is followed by industry, excluding the chemical industry which comes last. Only just over one million tonnes is used for fuelling road vehicles, a negligible quantity in comparison with petrol and diesel consumption.

Table 11

Community LPG consumption by main sector
1977

('000 t)

| Country | Industry (excluding chemicals) | Transport | Domestic and other sectors | Chemical industry | Total final consumption (*) |
|---|---|---|---|---|---|
| D | 451 | - | 667 | 642 | 1760 |
| F | 429 | - | 1948 | 88 | 2465 |
| I | 295 | 744 | 1006 | 97 | 2142 |
| NL | 15 | 324 | 372 | 90 | 801 |
| B | 64 | 37 | 411 | 7 | 519 |
| L | 1 | 13 | 2 | 6 | 22 |
| UK | 1145 | - | 130 | 19 | 1294 |
| IRL | 25 | 3 | 86 | 10 | 124 |
| DK | 77 | 34 | 73 | - | 184 |
| Community | 2502 | 1155 | 4695 | 959 | 9311 |

(*) The differences in the final consumption recorded in Tables 10 and 11 is due to the fact that Table 10 contains the gross consumption including own use, losses and stock changes.

Two factors are likely to increase permanently the importance of LPG in the Community :

- North Sea oil and gas fields contain considerable quantities of LPG which inevitably accompany oil and gas production;
- the oil-producing countries in the Middle East have considerable quantities of LPG available; which in the past was only put to limited use and in the main either reinjected or flared, since transporting such gases to Europe, America or Japan was considered unprofitable during the low price period before the 1973 crisis.

Table 12 summarizes an initial analysis of the world LPG balance for 1977, 1980 and 1985 (1).

Table 12

LPG - Supply and demand (in million of tonnes)

| | 1977 | 1980 | 1985 |
|---|---|---|---|
| Kuwait | 1.2 | 4.5 | 4.5 |
| Saudi Arabia | 4.5 | 7.0 | 15.0 |
| Abu Dhabi | 0.0 | 0.8 | 3.8 |
| Iran | 0.8 | 2.4 | 5.0 |
| Qatar | 0.0 | 0.5 | 0.7 |
| Dubai and others | 0.0 | 0.2 | 2.0 |
| Gulf States | 6.5 | 15.4 | 31.0 |
| Algeria | 0.3 | 2.0 | 5.0 |
| Libya | 0.4 | 0.5 | 1.0 |
| Nigeria | 0.0 | 0.0 | 0.5 |
| Africa | 0.7 | 2.6 | 6.5 |
| Australia | 1.3 | 1.3 | 1.2 |
| Indonesia | 0.2 | 0.4 | 0.6 |
| Canada | 0.2 | 0.2 | 0.2 |
| Far East | 1.7 | 1.9 | 2.0 |
| Venezuela | 1.1 | 1.2 | 2.0- 2.5 |
| Mexico | 0.0 | 0.7 | 1.5 |
| Latin America | 1.1 | 1.9 | 3.5- 4.0 |
| North Sea | 0.0 | 2.3 | 4.4 |
| World production excluding state-trading countries | 10.0 | 24.1 | 47.4-47.9 |
| US imports | 1.3 | 1.0- 7.1 | 13.3-19.3 |
| Japanese imports | 7.2 | 8.0-10.0 | 14.5-22.0 |
| Other imports | 1.5 | 2.0 | 2.0 |
| Total imports | 10.0 | 11.0-19.1 | 29.8-43.3 |
| Surplus | - | 5.0-13.1 | 4.6-17.6 |

(1) Source : MDE Cameron, "Economical Aspects of the Bulk Storage of LPG and Chemical Gases" Speech of the Symposium "Gas Transportation and Storage", Brussels, 3/10/78

The summary shows that a considerable LPG surplus can be expected in the future. An OPEC study forecasts the same total production for 1985 (47.9 million t, but already assumes a production level of 34.9 million for 1980/1982 (1).

More recent studies go even higher than the figures indicated in Table 12 and forecast a surplus which will rise from 6 million in 1980 to 24 million in 1985, slipping back to some 11 million by 1990, with total import requirements continuing at around 55 million t a year.

These export quantities expected originate mainly from the Middle East, Algeria and the North Sea. It is practically impossible to specify quantities and dates as there is no information about the exact date for the entry into service of new facilities being built or planned, in particular for Saudi-Arabia (Master Gas Project - 12 million t a year), Kuwait (Shuaiba NGL Plant - 4 million t a year)and Algeria (10 million t a year, 9 million of which will be from gas processing plants at Arzew). No exact forecasts can yet be made about the use to which LPG from the North Sea will be put. The only certainty is that the LPG from the Norwegian sector will go to the country's petrochemical industry. It is not known whether LPG from the British sector will be used entirely in the United Kingdom or whether some of it will be exported. Three main regions are potential markets for surplus LPG :

Japan, the USA and the Community.

Apart from the North Sea, Algeria and the Middle East are of interest to the Community. However, in the Middle East the Community faces competition from Japan and the USA. The Community's competitive situation is altogether comparable to that of the other two main centres of consumption. The chief problem is the lack, or inadequate development, of an infrastructure for a rapidly expanding LPG market. In particular, the Community possesses hardly any terminals for landing large quantities of LPG. However, the first few projects, such as the LPG terminal planned by Deutsche Shell AG at Emden, are in their preliminary stages. What opportunities are available for marketing relatively large quantities of LPG?

(1) OPEC Review vol.II, N.1, February 1978

First of all, there is the traditional market for bottled gas and LPG in large containers in the domestic and industrial sectors in areas which are not supplied by pipeline and there is still considerable scope for greater penetration in competition with light heating oil. The possibility of substituting LPG for natural gas must also be reckoned with in areas where the transportation costs would be lower.

Another traditional sector for LPG sales is the petrochemical industry which, in Europe, still largely uses naphtha as a feedstock. With the right price trends, the naphtha : LPG ratio could readily shift in favour of the latter.

LPG could also be used for generating electricity in special plants, not so much in large power stations as in Japan, but rather smaller combined heat and power plants or small thermal power stations in densely populated areas with severe environmental protection problems. The use of LPG as a fuel has been much discussed since the Islamic revolution in Iran. Butane can be blended directly with the fuel, but its low boiling point reduces the scope for this use. The direct use of LPG as a motor fuel, however, poses no particular technical problems. Nevertheless, in view of the scant network of LPG filling stations, higher vehicle costs and the current price ratio between petrol and LPG, it will not be possible to expand the LPG motor fuel market quickly unless LPG prices are reduced in relation to petrol prices. That could, of course, be achieved by taxing LPG at a lower rate, i.e. by means of an indirect subsidy.

However the best opportunities for using LPG are in the normal public distribution system. Apart from the direct distribution of LPG as a gas or mixed with air - a method which is sometimes used to introduce a natural gas supply system - the following methods may be considered :

- Utilization in crackers to produce conventional fuel gas for base or peak load. However, the scope for this is limited as considerable investment is required and the energy loss is relatively high. The cost is even higher if natural gas quality is to be produced.

- The abovementioned blend of LPG and air is well suited for adding to normal natural gas during peak periods. As plants of this type operate relatively cheaply, they can make a considerable contribution towards increasing gas supplies and, in particular, towards solving the growing problem of peak periods.

- LPG could be used in mains supply in relatively large quantities if mixed with natural gases with a relatively low calorific value known as L(ow)-gases. The blending limit is around 5 %. The total amount of L-gas in the Community is now around 80 x $10^9 m^3$ a year, corresponding to a maximum blending quantity of some 8 million t a year or 10 x $10^9 m^3$ a year.

- The limit in the case of H gases is around 2 % - at around 100 x $10^9 m^3$ a year this would be 2.5 million t or 3 x $10^9 m^3$ of natural gas. Overall, this would mean an increase in available natural gas of 13 x $10^9 m^3$ or 6-7 % of total consumption in 1978.

LPG price trends will determine whether and to what extent these possibilities will be applied. The time has gone when the oil-producing states considered LPG as an inconvenient by-product to be flared off, or sold at prices which did little more than cover costs. The fob price quotations have now increased considerably and by mid-1979 more than doubled from their 1977 level of $ 130-150/t.

Because LPG is a premium fuel, the OPEC countries normally set fob prices at above the crude oil price. Time will tell whether these prices can be maintained in the long term in view of the expected LPG surplus and the extra transport costs of about $ 40/t compared with crude oil.

The final price of LPG on the European market will also be largely influenced by whether the OPEC countries carry out their often discussed idea of compulsorily linking the sales of crude oil with that of LPG.

However, large quantities of LPG could only be sold on the heating market where it would be in competition with natural gas and light heating oil.

The movement of LPG prices in 1979 is shown in the table below.

Official selling prices for Kuwaiti LPG

($/t)

| | 1.1. | 1.4. | 1.6. | 15.8. | 1.9. | 1.10. | 1.11. |
|---|---|---|---|---|---|---|---|
| Butane | 125.5 | 127.5 | 185 | 218.33 | 232 | 252 | 277 |
| Propane | 115 | 126.5 | 160 | 185 | 201 | 211 | 266 |

12. The structure of natural gas consumption

In 1977 industry consumed 38 % of the Community total whilst households and small business together consumed 39 %. A further 19 % was used in power stations to generate electricity. Other consumers account for the remainder, just under 4 %. To some extent the picture in the individual Member States differs quite considerably from the average Community pattern. Thus, for instance, in Italy industry comes first with 53 %, while in Britain domestic consumption at 52 % is the leader. The proportion of natural gas used in power stations ranges from 4 % in Britain to 35 % in Luxembourg.

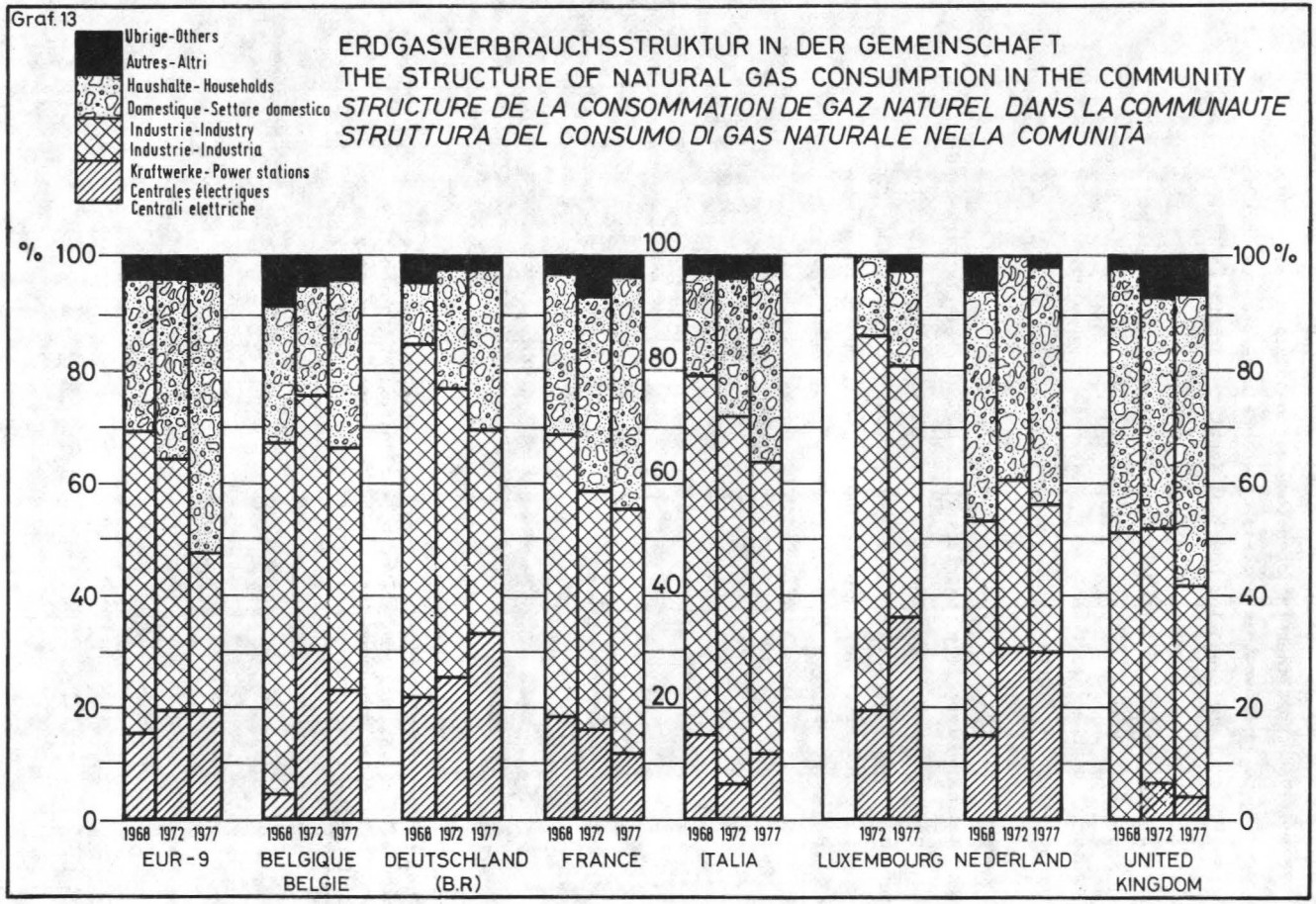
These figures are for 1977. Comparison with the corresponding figures for 1972 and 1968 shows that the structure of consumption has gradually changed. Figure 13 shows this process of change more clearly both for the Community as a whole and for the individual Member States (1).

It is clear from figure 13 that the pattern of natural gas consumption in the individual Member States differs considerably and that the domestic sector (and other small consumers) is generally growing, while the industrial sector is declining.

The abundant availability of indigenous natural gas at the end of the sixties encouraged long term contracts to be made for electricity generation especially in Belgium, the Federal Republic of Germany and the Netherlands. Although the very high 1977 figure for the consumption of natural gas for electricity generation is partly due to these contracts, it must be regarded as unsatisfactory from the energy policy angle.

(1) The problem of where to classify natural gas converted into manufactured gas has been solved by assigning 50 % to industry and 50 % to the household sector. The resulting inaccuracy declines with the progress of conversion to natural gas. By 1977 it had practically ceased to apply.

Graf. 13


Übrige-Others
Autres-Altri
Haushalte-Households
Domestique-Settore domestico
Industrie-Industry
Industrie-Industria
Kraftwerke-Power stations
Centrales électriques
Centrali elettriche
ERDGASVERBRAUCHSSTRUKTUR IN DER GEMEINSCHAFT
THE STRUCTURE OF NATURAL GAS CONSUMPTION IN THE COMMUNITY
STRUCTURE DE LA CONSOMMATION DE GAZ NATUREL DANS LA COMMUNAUTE
STRUTTURA DEL CONSUMO DI GAS NATURALE NELLA COMUNITÀ
% 100
80
60
40
20
0
100
80
60
40
20
1968 1972 1977
EUR-9
BELGIQUE BELGIE
DEUTSCHLAND (B.R)
FRANCE
ITALIA
LUXEMBOURG
NEDERLAND
UNITED KINGDOM

In the next few years the rapidly increasing costs of supplying natural gas will presumably lead to a decline in its use in power stations. Indeed there was already a drop from 21 % to 19 % between 1976 and 1977. This tendency, which will arise out of the market situation, is in accordance with Community policy for this sector, which considers it undesirable for power stations to burn natural gas except in special circumstances.

A proposal from the Commission in 1975 and adopted by the Council, requires Member States to submit new natural gas supply agreements, the extension of existing agreements and the building of new power stations fuelled by natural gas, for prior authorization by the relevant authorities; such authorization only being given if certain condition are met (1).

Estimates for the future trend in natural gas consumption are not available for the different sectors, but it can be assumed that the tendency will continue for domestic and small scale consumption to increase at the expense of large scale industrial consumption, particularly by power stations.

While this tendency coincides with the energy policy objective of supplying natural gas first and foremost to the premium markets in order to achieve the maximum possible utilization of this valuable raw material and energy source, the limits to such a development and the problems arising must be clearly recognised:

- In order to develop the market, Member States with a natural gas supply which is being developed or is about to be developed may be compelled to supply large quantities of natural gas to big industrial consumers as in Denmark and Ireland.
- Maintaining secure, competitive supplies to the premium market i.e. the domestic sector with its highly seasonal demand, presupposes a large base load of large industrial consumers, wherever possible with interruptible supply agreements. The need for such a base load becomes all the more pressing, the larger the share of the total supply imported from non-member countries under very inflexible conditions.

(1) Council Directive 75/404 of 13 February 1975, OJ L 178 of 9.7.1975.

The Community gas industry has the problem of maintaining an adequate base of large industrial consumers with a steady offtake which can be supplied, if possible, on an interruptible basis, but at a price competitive with heavy fuel oil, while at the same time the cost of procuring gas is rising disproportionately. Last year's huge increase in the price of heating oil appears to have mitigated this problem, but the time lag between the rise in gas prices and oil prices only means that the problem has been postponed.

13. Transport and storage of natural gas

The Community's natural gas supply system comprising pipelines, and storage and port facilities for importing liquefied natural gas has further improved over the past few years. Pipeline statistics from the ECE's Committee on Gas (Geneva) show that the total length of gas pipelines has almost doubled in the last ten years and is now approximately 90 000 km (1). Table 13 presents this development in figures whilst the annexed map (figure 14) illustrates the current position geographically. The map clearly shows the concentration of supply pipelines in the northern part of the Community. This is partly due to differing degrees of industrialization and population density (northern Italy also has a relatively dense network of natural gas pipelines), and partly to the fact that by far the largest volume of natural gas reserves are in the Netherlands and the North Sea.

Apart from the natural gas pipelines from the Netherlands and the North Sea to the Member States on the Continent, the links between the various national supply grids are weak. The situation will improve considerably with the completion of the MEGAL pipeline from Czechoslovakia through the Federal Republic to France, supplying natural gas from the Soviet Union and Iran.(2) Denmark will probably be linked to the Federal Republic grid under the Ruhrgas/DONG agreement.

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(1) Town-gas pipelines included, although negligible in 1977.
(2) Part of the gas from the USSR represents gas exchanged for Iranian gas contracted by France and the Federal Republic of Germany in 1975 (European consortium - NIGS - Sojusgas-export).

It is particularly noticeable that there is no link of any sort between northern Italy and southern France. Even the project to build a pipeline from Algeria via Tunisia to Sicily and northern Italy is unlikely to alter this situation for the time being.

If the so called SEGAMO project for a natural gas pipeline from Algeria to Spain and France, with possible extensions to Germany and Belgium - which has been the subject of a feasibility study - ever became a reality, it could, in combination with the Algeria-Italy pipeline, significantly alter the overall supply profile. A dual pipeline link of this type between Europe and North Africa would boost the security of supplies, particularly in the south. However, the discovery of a number of substantial natural gas fields in Northern Spain and the Gulf of Cadiz could influence the attitude of Spain, which is at present negotiating with the Community on accession, to such a project.

Whether the project will be realised thus remains an open question, not only because of the considerable technical and financial problems involved, but also because it is not known whether Algeria is able and willing to sell such large quantities of gas, on top of that already committed by existing agreements, that would allow the pipeline to be operated economically.

For the foreseeable future the islands of Great Britain and Ireland will remain isolated from the Continental pipeline system. Studies carried out by the British Gas Corporation (1) on behalf of the Department of Commerce in Northern Ireland and the Northern Ireland Gas Employers Board(2) on ways of restoring to economic health the municipal gas works of Northern Ireland, which are currently based on naphtha, deal - among several other options - with the building of a pipeline link between Scotland and Ulster. In view of the major changes in energy prices following the events in Iran, the question of whether such a project would now be viable may require reconsideration.

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(1) The Gas Industry in Northern Ireland - BGC - International Consultancy Service 1977

(2) Natural Gas for Northern Ireland - Northern Ireland Gas Employers Board Report August 1977

PRINCIPAL NATURAL GAS PIPE-LINES AND LNG TERMINALS

Figure 14

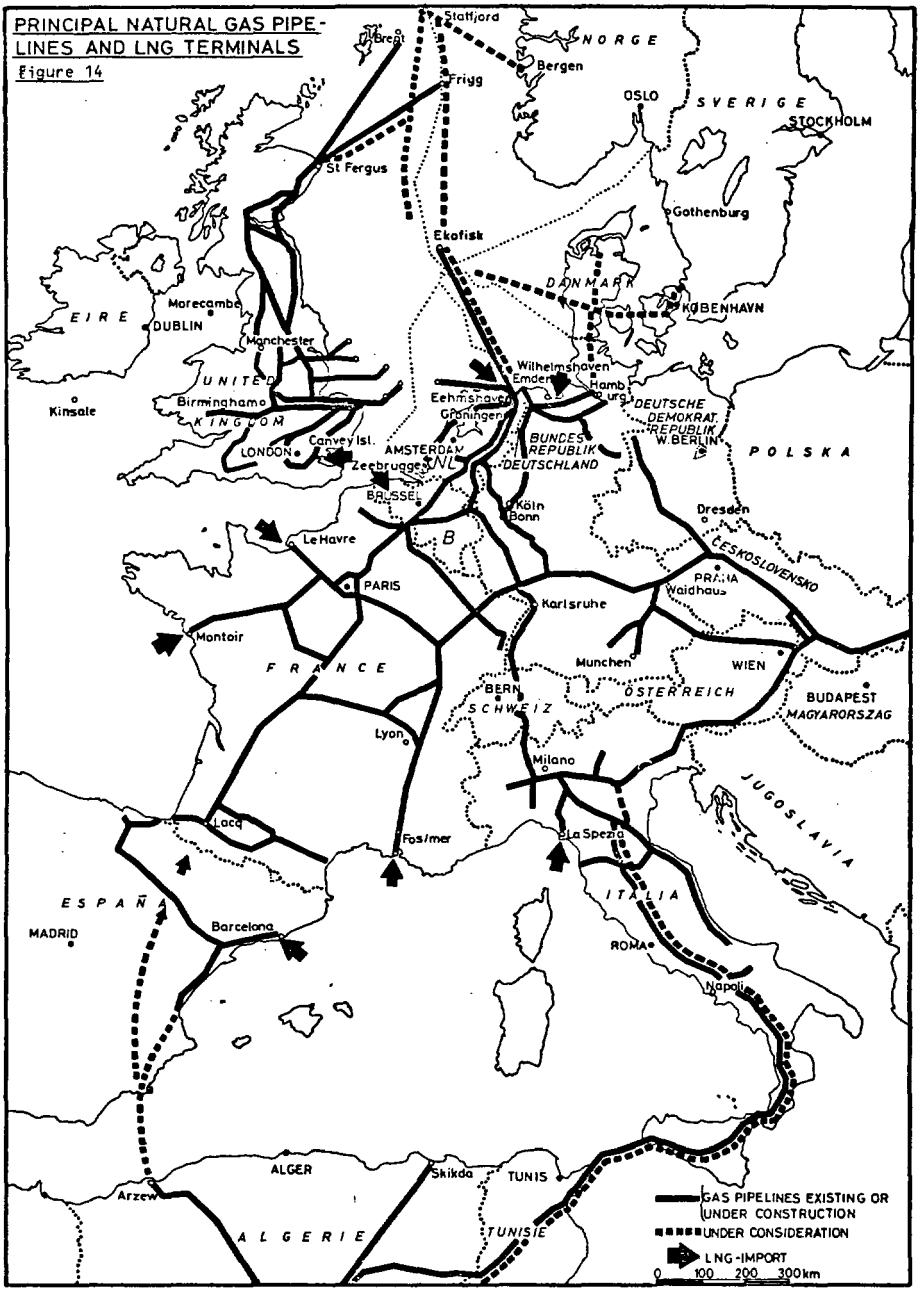

Table 13

Length of gas pipelines in the Community

(in km)

| Year | Community | D | F | I | NL | B | L | UK | DK | IRL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1965 | 40 668 | 14 262 | 13 702 | 5 496 | 5 150 | 1 170 | 16 | 562 | 310 | |
| 1966 | 43 158 | 15 437 | 13 944 | 5 702 | 6 005 | 1 213 | 16 | 663 | 178 | |
| 1967 | 48 136 | 16 936 | 14 541 | 6 490 | 7 214 | 1 630 | 16 | 1 107 | 202 | |
| 1968 | 54 873 | 20 390 | 15 104 | 7 598 | 7 713 | 2 022 | 16 | 1 725 | 305 | |
| 1969 | 58 499 | 21 334 | 15 828 | 8 423 | 7 969 | 2 076 | 47 | 2 519 | 303 | |
| 1970 | 62 051 | 22 286 | 16 439 | 8 970 | 8 921 | 2 143 | 47 | 3 056 | 189 | |
| 1971 | 67 852 | 24 005 | 16 781 | 10 471 | 10 409 | 2 495 | 47 | 3 389 | 255 | |
| 1972 | 71 660 | 25 489 | 17 568 | 11 052 | 11 110 | 2 741 | 47 | 3 464 | 189 | |
| 1973 | 75 013 | 26 756 | 17 974 | 11 641 | 11 921 | 2 868 | 47 (*) | 3 551 | 255 | |
| 1974 | 78 256 | 28 300 | 18 888 | 12 000 | 12 272 | 2 896 | 47 (*) | 3 603 | 250 | |
| 1975 | 83 105 | 30 220 | 19 238 | 13 256 | 12 490 | 3 150 | 47 (*) | 4 454 | 250 (*) | |
| 1976 | 86 545 | 31 776 | 19 862 | 13 913 | 12 939 | 3 116 | 47 (*) | 4 638 | 254 | |
| 1977 | 90 343 | 33 100(*) | 20 383 | 14 270 | 13 825 | 3 139 | 66 | 4 860(*) (16 100)(**) | 200 (*) | |

(*) Estimates

(**) The figures for the UK are not comparable with those for other countries. The figures refer only to the major "pipelines" group. A comparable figure is available only for 1977.

A link-up between the British Isles and the Continent might prove possible if the volume of natural gas in the British sector of the North Sea together with supplies from Norway exceeded British requirements. A major contribution to security of supplies, particularly in the northern regions could be made by turning the natural gas fields in the southern part of the British sector of the North Sea, which will be exhausted in the next decade, into storage and buffer installations and connecting them up to the rest of the European system.

Natural gas from the North Sea will increasingly take over the currently dominant role of Dutch gas. In the United Kingdom, North Sea gas is now almost the sole source of supplies. A number of major pipelines are currently in operation, in particular :

Ekofisk - Emden
Frigg - St. Fergus
Brent - St. Fergus (completed but not yet in operation)
Leman - Bacton

In addition there are several shorter pipelines, particularly from the British fields in the southern part of the North Sea to the east coast of England, and also from Dutch offshore fields to the Dutch and German coast.

However,there are still a fair number of natural and associated gas deposits not connected to the existing pipeline system, particularly in the central and northern parts of the North Sea. This is also true of the Norwegian sector of the North Sea. For this reason, as early as 1975, the British Government appointed the consultants Williams and Merz to investigate whether the construction of a suitable gas gathering system would increase the economically exploitable reserves of natural gas. Because of the relatively encouraging results of this preliminary study, Gas Gathering Pipelines (North Sea) Limited (GGP) was formed by the state enterprises BGC and BNOC together with BP, ICI, Rio Tinto Zinc and Total ELF.

In its recently published report, GGP considers that this type of system would be too costly (estimated capital cost : £ 5 000 million) and takes the view that, as the existing Frigg and Brent pipelines are capable of

handling the quantities of natural gas likely to be available in the next few years, a further pipeline is unnecessary. The report suggests instead that three smaller gathering systems should be laid for piping gas through the Frigg, Brent and Ekofisk pipelines to St. Fergus (1). A system of this type would require an investment of approximately £ 1 000 million. It is estimated that some 200 x $10^9 m^3$ of gas could be recovered in this way. In contrast, the total reserves in the fields not so far connected to the gathering system are estimated at 442 x $10^9 m^3$, with 334 x $10^9 m^3$ economically exploitable. The annexed map (figure 15), taken from the GGP report, illustrates the proposals.

In mid-1979 the UK Secretary for Energy announced that Mobiloil was considering the laying of a pipeline from the Beryl field to Great Britain. At the same time Mobiloil and the British Gas Corporation were together investigating whether gas from the fields in the northern part of the North Sea could also be transported via such a pipeline. Their study covers an area from a line from block 211 through blocks 15 and 16 and possibly as far south as the 56th parallel, with a connection to the Scottish Coast.

The Norwegian Government also considered the idea of building a gas gathering system, in particular with a view to exploiting the gas in the Statfjord field, but until recently took the view that existing isolated natural gas reserves in the Norwegian sector did not justify the construction of a gas gathering pipeline, not even in conjunction with suitable fields in the British sector.

(1) For the Fulmar field a connection to the Ekofisk line is proposed.

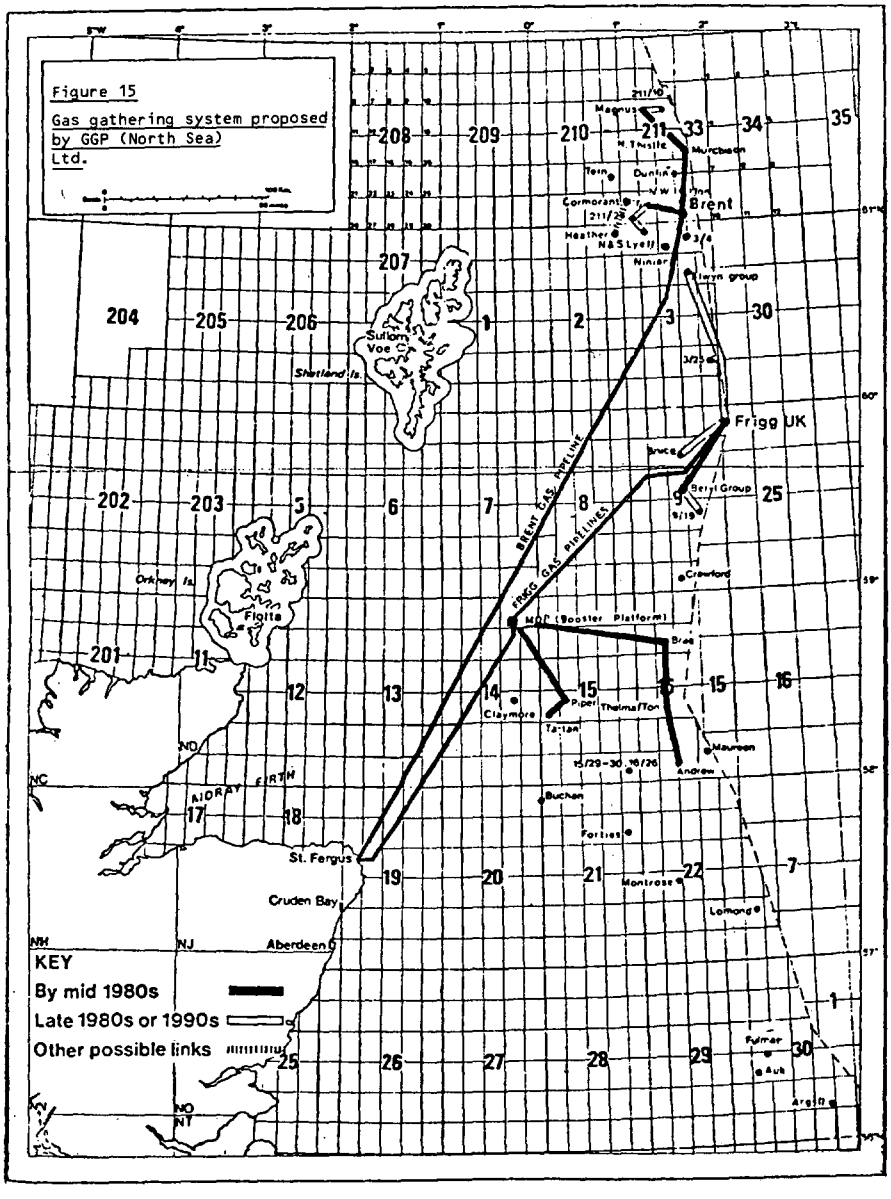
Figure 15
Gas gathering system proposed by GGP (North Sea) Ltd.
KEY
By mid 1980s
Late 1980s or 1990s
Other possible links
Brent
Frigg UK
Magnus
Cormorant
Heather
Ninian
Sullom Voe
Shetland Is.
Orkney Is.
Flotta
Claymore
Piper
Tartan
Thistle
Tern
Dunlin
Murchison
Bruce
Beryl Group
Crawford
Brae
Andrew
Maureen
Buchan
Forties
Montrose
Lomond
Fulmar
Auk
Argyll
St. Fergus
Cruden Bay
Aberdeen
BRENT GAS PIPELINE
FRIGG GAS PIPELINE
MOP (Booster Platform)
MORAY FIRTH

However, a new gas find in block 31/2 in the Norwegian sector means a fundamental change in the situation. Although exact data are not yet available, it is assumed - on the basis of results so far - that this field with a probable size of some 700 $km^2$ contains considerable natural gas reserves, in the order of 1 000 x $10^9 m^3$. In other words there is no longer any question that the construction of a gathering system is justified by the quantities it will be required to handle.

Understandably, all the Community countries, as well as Sweden and Norway itself, are interested in this new field. The outcome of future negotiations on this subject cannot be predicted, particularly since new wells must first provide sound information on the actual size of the field and its characteristics. However, it is possible that the still isolated natural gas and oil gas fields in the North Sea will justify two large-scale pipelines to both the Continent and Britain.

Even if one or more gas-gathering systems is completed, it is likely that there will still be a number of deposits which cannot be economically connected to such a system. The Community has therefore supported a number of technological development projects including the liquefaction of natural gas, its transformation into methanol and the production of electric power all in situ, in order to ensure as far as possible that these resources are available to the Community as part of its energy supplies.

Although within the Community most of the natural gas is piped, over the world as a whole more and more natural gas is being transported in liquefied form (LNG) by tanker. The same applies to natural gas imported into the Community from non-Community countries. More than a third of the quantities contracted for are to be imported in liquid form.

Table 14 gives details of the known LNG projects affecting the Community.

Table 14

Summary of LNG projects affecting the Community

| Route | Commencement | Duration (years) | Participants | Annual volume (1000 mil.$m^3$) | |
|---|---|---|---|---|---|
| Algeria-UK (Arzew-Canvey Island) | 1964 | 15 | Sonatrach/BGC Conch International | 1.1 | current projects |
| Algeria-France (Arzew-Le Havre) | 1965 | 25 | Sonatrach/ Gaz de France | 0.6 | |
| Libya-Italy (Marsa el Brega-La Spezia) | 1969 | 20 | ESSO-Libya SNAM | 2.5 | |
| Algeria-France (Skikda-Fos-sur-Mer) | 1973 | 25 | Sonatrach/ Gaz de France | 3.5 | |
| Algeria-France (Skikda-Fos-sur-Mer) | 1980 | 20 | Sonatrach/ Gaz de France | 5.2 | contracts negotiated, projects in preparation |
| Algeria-Belgium (Arzew-Zeebrugge) | 1982 | 20 | Sonatrach/ Distrigaz | 5.3 | |
| Algeria-Germany (Arzew-Wilhelmshaven) | 1984 | 20 | Sonatrach/ Ruhrgas, Salzgitter Ferngas | 5.5 | |
| Algeria-Netherlands (Arzew-Eemshaven) | 1984 | 20 | Sonatrach/ Gasunie | 5.5 | |
| Algeria-Germany (Skikda-Wilhelmshaven) | 1984 | 20 | Sonatrach/ Thyssengas/BEB | 4.0 | |
| Algeria-Germany (Skikda-Wilhelmshaven) | 1984 | 20 | Sonatrach/ Deutsche BP | 4.5 | |
| Nigeria-West Europe | 1984 | ? | Niger.Government Royal Dutch Shell, BP, Philips Petr. | 7.5 each | possible projects |
| USSR-USA France | mid-80s | 25 | Brown and Root Inc. Teneco Inc. Texas Eastern Gaz de France | (16.5) (USA) 5.5 | |
| Iran-Netherlands | 1985 | ? | Verolme | 11 | |

It is uncertain whether some of the projects cited in Table 14 will be carried out, since the Algerian Government is reconsidering construction of the liquefaction plants III at Arzew and II at Skikda. The investment costs are extremely high and the funds might rather be used for improving the country's infrastructure. This would mean that any new exports of natural gas would be by pipeline only.

A final decision has not yet been made; it is expected early in 1980. If the Arzew liquefaction plant should not be built, this could have a considerable effect on the Community's supply structure. Even if new negotiations on contracts for the delivery of equivalent quantities by pipeline were opened at once, delivery delays would be unavoidable, quite apart from numerous other technical, economic and legal problems. If gas deliveries from Iran were also held up at the same time, the Community could find itself faced with a serious shortfall in its gas supplies in the eighties.

Other LNG projects on which negotiations are largely concluded - such as the Nigeria project - or which are only just appearing on the horizon as possibilities - such as LNG projects on Melville and King Christian Islands in the Canadian Arctic or in Cameroon - will only partly make up for this shortfall, partly because they are too small in scope and partly because they are still too far away from realization.

Liquefaction, transport by tanker, port facilities, storage and reconversion into gas are all expensive and LNG supply chains are therefore extremely costly. A project involving Iran, Belgium and the United States, which was preceded by lengthy discussions and for which a preliminary contract had already been negotiated, finally foundered because of the high costs involved. Given the present state of the art in storage technology, the largest existing LNG tankers - with a payload of 125 000 $m^3$ LNG - are still not sufficiently economic to transport LNG over large distances. The Dutch shipyard, Verolme, has developed a new design for an LNG supertanker with a payload of 300 000 $m^3$ which should reduce transport costs by between 30 % and 50 % (depending on distance). The Community is supporting this project under its financial programme of aid for new technology in the hydrocarbons sector. Indeed the last project listed in Table 14 will presumably be based on its successful development.

There are currently four LNG terminals in operation in the Community - La Spezia (Italy), Canvey Island (UK), and Fos-sur-Mer and Le Havre in France. There are terminals under construction or planned in Zeebrugge (Belgium), Eemshaven (Netherlands), Wilhelmshaven (Germany) and Montoir (France).

The extent and speed of any further building of LNG terminals in the Community depends not only on the solution of safety problems and question of financing but, primarily, on the scope of new LNG agreements still to be concluded - a matter on which no predictions can be made today. The events in Iran and the Algerian Government's second thoughts about its investment policy have caused a relatively optimistic view of future trends to give way to a certain scepticism.

For reasons of security of supply, a larger number of medium-sized facilities would be preferable to a few super-terminals.

The increase in the volume of gas imported from non-member countries on a "take or pay" basis requiring a very regular offtake, and the concurrent change in the pattern of gas consumption, dictate a constant extension of gas storage capacity.

The Community's total natural gas storage capacity has more than doubled from $10.1 \times 10^9 m^3$ in 1970 to $20.3 \times 10^9 m^3$ in 1978. Construction work to extend storage to some $30 \times 10^9 m^3$ is in hand.

In 1970 storage capacity represented 12.5 % of total annual consumption but by 1978 it was down to 9.6 %. Even with the storage facilities currently under construction or being planned, total capacity will hardly cover more than 10 % of consumption in the next few years.

Compared with the United States - whose storage capacity represents over 25 % of annual consumption - this situation cannot be regarded as satisfactory. As far as is technically and economically possible, every effort will have to be made in the next few years to use more exhausted natural gas fields as storage facilities. This would make a dual contribution to security of supply by :

- balancing seasonal fluctuations in demand; and
- providing strategic reserves in the event of supplies being interrupted.

The volume of storage capacity varies greatly from Member State to Member State. Italy is the leader with 9.4 x $10^9 m^3$ (32 % of annual consumption) followed by France with 7.3 x $10^9 m^3$ (29 % of consumption) and the Federal Republic with 3.5 x $10^9 m^3$ (6.3 % of consumption). In the remaining Member States gas storage facilities are, so far, small or insignificant. This may be because a country has large indigenous gas reserves and has less need for any additional storage capacity, particularly if it is small, or because of the lack of suitable geological structures for installing large underground storage facilities - a problem which particularly besets the Belgian gas industry.

For the purpose of quantifying storage capacity, it is important to know not only the total capacity but also the maximum possible daily off-take. For the Community as a whole, the figure for the latter quantity is 204 x $10^6 m^3$ per day, or 35 % of average daily consumption. For France the figure is 67.3 x $10^6 m^3$ per day (97 % of daily consumption), whilst in Germany it is 61.4 x $10^6 m^3$ per day (41 % of daily consumption), in Italy 66.3 x $10^6 m^3$ per day (83 % of daily cons.) and in Belgium 9.4x$10^6 m^3$(30%).

Table 15 is a summary of the Community's storage capacity in use, under construction or planned.

## 14. Investment by the gas industry

According to information from COMECTEC-GAZ (1), investment by the gas industry in the narrower sense (excluding exploration) remained stable when adjusted for inflation in the individual Member States of the Community during 1970-77 (2). From year to year there are indeed certain fluctuations within the individual countries but they more or less cancel each other out. In fact there was a slight upward trend in the total figure up to 1975. When calculated at mid-1975 exchange rates, the total

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(1) Comité d'études économique de l'industrie du gaz - Brussels

(2) COMETEC-GAZ bulletins do not cover Luxembourg and Ireland (including Northern Ireland) and for practical purposes there is no data for Denmark.

volume of investments in the record year of 1975 was almost 2000 million EUA .

Of the total investment more than half (56 %),was accounted for by the United Kingdom and the Federal Republic of Germany in roughly equal amounts. France accounted for about 17 % and the Netherlands with 12 % was followed by Italy and Belgium with approximately equal shares of 7-8%. These percentages admittedly do not give a true picture since the wide fluctuations in exchange rates make certain distortions inevitable.

In 1976 investment fellslightly,towards the 1974 and 1973 levels,but the COMETEC-GAZ forecast up to 1981 calculated at current exchange rates shows an increase of about 40 %, which could still denote a genuine increase when adjusted for inflation. The sharpest increase in investment is expected in France and Italy, but a leap in investment to more than twice the 1976 figure is forecast for Belgium in 1981.

Table 15

Underground gas storage facilities

(End of 1978)

| Region/ Province | Locality | Date entered service | Type of storage facility | Total capacity provided for $10^6 m^3$ | Maximum off-take capacity p.day $10^6 m^3$ |
|---|---|---|---|---|---|
| Installations in operation | Federal Republic of Germany | | | | |
| Hamburg | Reitbrook | | | | |
| | Bergedorf | 1974 | Former oilfield | 230 | 4.0 |
| Lower Saxony | Huntorf Weser-marsch | 1975 | Salt cavern | 90 | 2.7 |
| Bavaria | Wolfersberg | 1973 | Former gas field | 535 | 4.8 |
| " | Bierwang-Grünthal | 1977 | " " " | 1000 | 11.3 |
| Lower Saxony | Engelbostel-Schülemb. | 1973 | Aquifer | 200 | 1.9 |
| Hessen | Hähnlein-Gernsheim | 1969 | Former gas field | 235 | 3.7 |
| Bavaria | Eschenfelden-Königst. | 1974 | Aquifer | 109 | 1.5 |
| Lower Saxony | Upleward-Emden | 1977 | Salt cavern | 251 | 2.7 |
| " " | Epe I Wessum | 1976 | " " | 465 | 22.0 |
| Hessen | Darmstadt | 1973 | Aquifer | 200 | 3.0 |
| Baden Württemb. | Stuttgart | 1971 | Liquefied nat.gas | 17 | 1.5 |
| Schleswig-Holstein | Kiel | 1974 | Salt cavern | 50 | 0.1 |
| Bavaria | Pliening I | 1967 | Aquifer | 56 | 0.2 |
| Nordrhein-Westfalen | Nievenheim | 1976 | Liquefied nat.gas | 14 | 2.0 |
| Total Federal Republic of Germany | | | | 3452 | 61.4 |
| | France | | | | |
| Paris area | Beynes sup. | 1972 | Aquifer | 350 | 4.0 |
| " " | St. Illiers | 1965 | " | 1230 | 15.0 |
| Transport"West" | Chemery | 1968 | " | 2520 | 22.0 |
| " "East" | Velaines s/Amance | 1970 | " | 1190 | 12.0 |
| Paris area | Gournay s/Aronde | 1976 | " | 390 | 3.0 |
| " " | Beynes Profond | 1975 | " | 240 | 1.5 |
| Centre-East | Tersanne | 1970 | Salt dome | 120 | 1.5 |
| Landes | Lussagnet | 1957 | Aquifer | 1300 | 8.3 |
| Total France | | | | 7340 | 67.3 |

| Region/ Province | Locality | Date entered service | Type of storage facility | Total capacity provided for $10^6 m^3$ | Maxim. off-t. capac. p.day $10^6 m^3$ |
|---|---|---|---|---|---|
| | | | Italy | | |
| Lombardy | Brugherio | 1966 | Former nat.gas dep. | 1560 | 11.5 |
| " | Sergnano | 1965 | " " " " | 2700 | 50.0 |
| " | Ripalta | 1967 | " " " " | 1200 | 1.5 |
| Emilia Romagna | Cortemaggiore | 1964 | " " " " | 1560 | 1.3 |
| Basilicata | Ferrandina | 1977 | " " " " | 1900 | 1.0 |
| " | Pisticci | 1977 | " " " " | 460 | 1.0 |
| Total Italy | | | | 9380 | 66.3 |
| | | | Belgium | | |
| Hainaut | Anderlues | 1977 | Former mine | 50 | 1.0 |
| East Flanders | Zeebrugge | 1978 | LNG | 75 | 8.4 |
| Total Belgium | | | | 125 | 9.4 |
| Total installations in operation | | | | 20297 | 204.4 |
| Installations under construction | | | | | |
| | | | Federal Republic of Germany | | |
| Lower Saxony | Hoogstede-Kalle | 1978 | Aquifer | 160 | 1.2 |
| Rheinland-Palatinate | Frankenthal | 1978 | " | 320 | 2.4 |
| Lower Saxony | Hunthorf | 1979 | Salt cavern | 40 | 0,9 |
| " " | Nüttermoor | 1979 | " " | 240 | 3.6 |
| Bavaria | Wolfersberg | 1978 | Former nat.gas dep. | - | 0.3 |
| " | Memmingen | 1979 | " " " " | 300 | 3.0 |
| Total Federal Republic of Germany | | | | 1060 | 11.4 |
| | | | France | | |
| Centre East | Tersanne | 1983 | Salt cavern | 800 | 20 |
| Jura | Etrez | 1980 | " " | 650 | 17 |
| Paris area | Beynes profond | | Aquifer | 570 | 8 |
| " " | Gournay s/Aronde | | " | 1600 | 16 |
| Total France | | | | 3620 | 61.0 |

| Region/ Province | Locality | Date entered service | Type of storage facility | Total capacity provided for $10^6 m^3$ | Maxim. off-t. capac. p.day $10^6 m^3$ |
|---|---|---|---|---|---|
| | | | Italy | | |
| Emilia Romagna | Cortemaggiore | 1981 | Former nat.gas dep | 100 | 1.7 |
| Lombardy | Ripalta | 1984 | " " " " | 740 | 3.0 |
| Emilia Romagna | Minerbio | 1986 | " " " " | 3430 | 30.0 |
| | | | | 4270 | 34.7 |
| | | | Belgium | | |
| Antwerp | Heibaert | 1982 | Aquifer | . | . |
| | | | United Kingdom | | |
| East Yorkshire | Hornsea | 1978 | Salt cavern | 187 | 4.5 |
| | | | Community | | |
| Total installations under construction | | | | . | . |
| Planned installations | | | | | |
| | | | Federal Republic of Germany | | |
| Lower Saxony | Epe II Wessum Graes | . | Salt cavern | 1238 | 22.0 |
| | | | Belgium | | |
| Hainaut | Ressaix | 1980 | Former mine | 200 | 3.0 |
| | | | Community | | |
| Total planned installations | | | | 1438 | 25.0 |

Table 16 shows developments in gas industry investments since 1970 plus forecast up to 1981 calculated in the national currencies according to COMETEC-GAZ information.

This table also analyses investments by three sectors : production (P), transport (T) and distribution (D), where sector (P) does not include natural gas production, but does include liquefaction, regasification and purification. Where natural gas production cost are not shown, this means that this sector is of relatively slight importance for the gas industry in the countries concerned.

Changes in the ratios between investment in transport and in distribution are of interest, for example in 1970 distribution led by a wide margin in most countries owing to the high cost of converting equipment to natural gas.

However its importance had gradually dimished by the mid 70's as conversion work was completed and the construction of extensive pipeline systems moved transport up into first position.

Investments in the distribution sector will probably regain their position by the 1980s since the construction of large storage installations in particular could involve considerable funds.

The governments of the Member States also provide estimates of probable trends in investment in the individual energy sectors up to 1990 in their national programmes. Table 17 summarizes the results converted into EUA. Some missing data had to be estimated in order to provide an overall view of the Community.

This summary yields the following conclusions as regards natural gas :

- The following investment is expected in the exploration sector (oil and gas together):

| | | |
|---|---|---|
| 1976-80 | 1 739.6 | million EUA |
| 1981-85 | 1 865 | " " |
| 1986-90 | 1 865 | " " |

- Investment in the natural gas sector in the narrower sense (production and market infrastructure) is estimated as follows :

Table 16

Investments by the gas industry within the Community (excluding Denmark, Luxembourg, Ireland and Northern Ireland) from 1971 to 1977, and forecasts up to 1982 (in national currencies) (1)

| | | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B mill. Bfr. | Production | - | - | - | 114 | 156 | 319 | 545 | 249 | 70 | 136 | 241 | 223 |
| | Transport | 2041 | 1666 | 869 | 896 | 4050 | 1024 | 723 | 1264 | 2110 | 3154 | 2763 | 2865 |
| | Distribut. | 2869 | 2409 | 1989 | 2432 | 3375 | 3411 | 4148 | 4167 | 4077 | 4172 | 4201 | 4337 |
| | Total | 4910 | 4075 | 2858 | 3442 | 7581 | 4754 | 5416 | 5680 | 6257 | 6257 | 7462 | 7425 |
| D mill. DM | Production | 82 | 96 | 215 | 200 | 253 | 450 | 267 | - | - | - | - | - |
| | Transport | 474 | 537 | 770 | 684 | 607 | 410 | | 695 | 750 | 730 | 1369 | 1481 |
| | Distribut. | 709 | 832 | 828 | 741 | 1031 | 1133 | 1763 | 1235 | 1230 | 1190 | 1321 | 1380 |
| | Total | 1265 | 1465 | 1813 | 1625 | 1891 | 1993 | 2030 | 1930 | 1980 | 1920 | 2690 | 2861 |
| F mill. FF | Production | 22 | 20 | 31 | 56 | 64 | 18 | 10 | 203 | 272 | 195 | 35 | 85 |
| | Transport | 347 | 387 | 360 | 580 | 1184 | 667 | 797 | 1048 | 1186 | 1501 | 1414 | 1564 |
| | Distribut. | 611 | 667 | 829 | 906 | 1011 | 1106 | 1240 | 1284 | 1367 | 1369 | 1451 | 1546 |
| | Total | 980 | 1074 | 1220 | 1542 | 2259 | 1791 | 2047 | 2535 | 2825 | 3065 | 2900 | 3195 |
| I thous. mill. Lit. | Production | 8,0 | 7,5 | 4,3 | 4,5 | 1,6 | 2,7 | 2,5 | 3,7 | 3,0 | 2,8 | 1,8 | 1,8 |
| | Transport | (x) | (x) | 80,0 | 70,0 | 70,0 | 60,0 | 55,0 | 150,0 | 300,0 | 350,0 | 350,0 | 450,0 |
| | Distribut. | 8,5 | 18,5 | 21,9 | 60,0 | 58,2 | 65,0 | 69,1 | 90,0 | 95,0 | 110,0 | 100,0 | 90,0 |
| | Total | (x) | (x) | 106,2 | 134,5 | 129,8 | 127,7 | 126,6 | 243,7 | 398,0 | 462,8 | 451,8 | 541,8 |
| NL mill. Hfl. | Production | - | - | - | - | - | - | - | - | - | - | - | - |
| | Transport | 567 | 508 | 423 | 367 | 508 | 241 | 259 | 540 | (x) | (x) | (x) | (x) |
| | Distribut. | 419 | 519 | 379 | 377 | 359 | 374 | 399 | 400 | (x) | (x) | (x) | (x) |
| | Total | 986 | 1027 | 802 | 744 | 867 | 615 | 658 | 940 | (x) | (x) | (x) | (x) |
| GB mill. UKL | Production | 0,8 | 0,6 | 0,8 | 3,7 | 6,6 | 6,8 | 1,3 | 1,1 | 1,6 | 0,3 | 0,7 | 0,3 |
| | Transport | 49,5 | 30,0 | 36,8 | 112,7 | 218,5 | 138,4 | 92,7 | 86,9 | 117,9 | 156,7 | 119,4 | 146,4 |
| | Distribut. | 99,2 | 88,6 | 98,7 | 118,9 | 97,9 | 98,1 | 115,0 | 137,4 | 140,8 | 143,0 | 145,4 | 135,9 |
| | Total | 149,5 | 119,2 | 136,3 | 235,3 | 323,0 | 243,3 | 209,0 | 225,4 | 260,3 | 300,0 | 265,5 | 282,6 |

(1) Source : COMETEC-GAS
(x) not available

Table 17

Investment in the Energy Sector by the Community 1976-1990 (million EUA)

| | 1976-1980 | 1981-1985 | 1986-1990 | 1976-1990 |
|---|---|---|---|---|
| Solid Fuels | 6.154 | 9.229,3 | 9.457 | 24.840,3 |
| Hydrocarbons Exploration and Development | 1.739,6 | 1.865 | 1.865 | 5.469,6 |
| OIL-Production | 15.138 | 10.180 | 11.326 | 36.644 |
| Market | 12.863 | 9.155 | 8.925 | 30.943 |
| Infrastructure | | | | |
| Total | 28.001 | 19.335 | 20.251 | 67.587 |
| NATURAL GAS-Production | 3.237 | 2.700 | 2.700 | 8.637 |
| Market | 11.050,4 | 14.778 | 13.212 | 39.040,4 |
| Infrastructure | | | | |
| Total | 14.287,4 | 17.478 | 15.912 | 47.677,4 |
| ELECTRICITY-Production | | | | |
| Nuclear | 24.502,5 | 40.106,1 | 37.165 | 101.773,6 |
| Hydro | ( 2.144,8) | (1.623,2) | (2.150) | 5.918 |
| Thermal | ( 8.554,1) | (9.370,5) | (12.055) | 29.979,6 |
| Total conventional | 10.698,9 | 10.993,7 | 14.205 | 35.897,6 |
| Transmission and distr. | 25.232,4 | 29.518,1 | 32.162,5 | 86.913 |
| Total | 60.433,8 | 80.617,9 | 83.532,5 | 224.584,2 |
| Total investment | 110.615,8 | 128.525,2 | 131.017,5 | 370.158,5 |

| | | |
|---|---|---|
| 1976-80 | 14 287.4 million EUA | |
| of which | 3 237 million EUA | for production and |
| | 11 050.4 " " | for market infrastructure |
| 1981-85 | 17 478 million EUA | |
| of which | 2 700 million EUA | for production and |
| | 14 778 " " | for market infrastructure |
| 1986-90 | 15 912 million EUA | |
| of which | 2 700 million EUA | for production and |
| | 13 212 " " | for market infrastructure |

Although investment forecasts naturally become more uncertain the longer the period they cover, the following forecasts can be tentatively made :

- For the period 1976-90 total investment in the natural gas industry is forecast to be

50 thousand million EUA (1)

The majority (77.4 %) will be absorbed by the market infrastructure sector, i.e. primarily the construction of transport and distribution facilities, including compressor and storage installations.

- Compared with the investment in energy supplies as a whole, for which natural gas will account for approximately 18 %, investment in the natural gas sector will be less than proportional at a level of 13.6 %. As regards specific investment, it is therefore closer to the other two fossil sources of energy, coal and oil, than to the second type of line supplied energy - electricity, which owing to very high generating and transport costs, accounts for a share of total investments - 60 % in the energy sector up to 1990 - far higher than its proportional share in energy supplies.

(1) Half of the investments in prospecting and development have been attributed to natural gas.

- Forecast investment in the natural gas sector reflects a healthy assessment of natural gas supplies up to and beyond the end of the century, since investment in natural gas supplies extend predominantly over periods of 20 years or more. Anyone investing in supply line construction in 1985 is counting on the line still being fully utilized in 2005, so that it can be depreciated without a loss.

- The slight dip in the second half of the eighties could point to the expected gradual shrinking of the natural gas markets after the year 2000. Investment forecasts for period at least ten years ahead are, admittedly, subject to so many uncertainties that they can only be assessed with reservations.

Whether it will be possible to finance investment through the normal market economy, i.e. a balanced mix of self financing from profits and earned depreciation together with outside financing from the capital market, depends to a great extent on future natural gas supply costs and revenues. Both are closely linked with development in the general energy price level and in particular the price of the chief competitor of natural gas in both the domestic and industrial sectors: oil.

The economic situation of the Community's natural gas supply undertakings is satisfactory, so that normal financing of the investment required can in general be considered possible under present market conditions. Certain very large projects,such as continent-wide pipeline projects or major pipelines under the North Sea and the Mediterranean could, however, come up against problems; not because they would be unprofitable under normal circumstances, but rather because of the magnitude and long-term nature of the required investment coupled with the increased uncertainty in assessing the technical and political risks. Individual companies - even the largest - could soon reach the limits of their capacity. In this context the North Sea gas-gathering projects and the Mediterranean pipeline projects should be borne in mind. But even the total investment for the relatively simple LNG supply line from Algeria to Germany is estimated by Ruhrgas at DM $3.10^9$.

Cooperation agreements, consortium contracts and other arrangements will be indispensable preconditions to realise a certain number of import projects. New financing instruments, in particular on a Community basis, could also be useful. In this context the "Ortoli Facility", instituted on a proposal from the Commission, could figure prominently.

15. Natural gas prices and procurement costs

Consumer prices for natural gas have for many years been following the trend of fuel oil prices, although increases have sometimes been delayed. Natural gas can maintain or expand its market share only if it is able to compete, in the case of large industrial customers , with heavy fuel oil, and in that of smaller consumers, households, small businesses, and to some extent in small manufacturing plants, with light fuel oil.

In some sectors, especially households, electricity is also a competitor, but competition is not so much on price as on real or supposed technical advantages such as safety, controllability, peak availability, convenience, modernity, etc.

However, it is the price of fuel oils which will define clearly the upper limit of competitive natural gas prices in both the domestic sector and in industry, so long as the consumption of fuel oil is not prohibited or restrained by administrative measures. In this way natural gas can exploit certain technical advantages over fuel oil to justify limited surcharges - hardly more than 5-10 % in industry - apart from the few exceptional cases in this sector where an alternative to gas can be provided only with difficulty. Even for central heating, which accounts for the major part of domestic consumption, the customer's costs may not be appreciably greater than they would be with fuel oil. In this comparison of costs, there are of course other cost factors to be considered in addition to the actual price per unit of heat such as storage costs, safety costs, and differences in efficiency.

The same comments do not apply to the lower limit. Under normal market conditions the seller of natural gas will adjust his prices and tariffs to those of his competitors in order to retain maximum profitability, even when his costs may allow him to reduce his prices; yet the market

freedom of the gas utilities in the individual Member States is restricted to varying degrees by public supervisory bodies particularly for supplies to "tariff" customers. That is the reason why natural gas price trends in some Member States differ, on occasion considerably, from those for fuel oil. Such variations, which are mostly attributable to the government's or the regional authorities' social, anti-inflation, industrial, regional or general energy policies, are not entirely desirable in the long term, for they artificially change the structure of total energy consumption, introduce distortions of competition and may hinder the development of a genuine common energy market.

Furthermore, there is a certain cumbersomeness about the way prices are adjusted, the causes of which are to be found in the purchasing contracts and price adjustment clauses of large scale consumers and in the fact that the rates paid by consumers on tariffs have to be publicly announced and, mostly, approved by political bodies.

Thus, for example, gas prices followed the steep rise in the price of fuel oil both after the 1973/74 crisis and after the Iranian crisis only in part and with considerable delay. Although this may, up to a point, have a calming effect on the energy market as a whole, it is bound in the long run to disturb the balance of the market appreciably. The demand for natural gas experienced a positive boom in many cases in 1979, for example, with the result that the gas industry may soon find itself at the limit of its capacity.

The Commission is preparing a study on gas and electricity prices analysing the tariff structures with a view to the general objective of energy saving. The results of this analysis concerning gas prices and tariffs are as follows :

- in all the member countries, percentage price increases during the period 1973-78 were higher in the industrial sector than in the domestic sector (in some cases, three times as high);

- in the domestic sector, some tariffs seem to reflect political rather than specific economic aims,

- in the heating sector, prices show a greater sensitivity due to the stronger competition with alternative fuels,

- the fall in unit price with increasing quantities of gas sold is not so marked as it used to be, reflecting a policy by the gas industry of encouraging a more rational use of energy,

- town gas in countries without natural gas supplies appears to be non-competitive with other fuels, a situation that has been true ever since the advent of natural gas.

The findings of this study and the "boom" like rise in natural gas consumption after the Iranian crisis have caused the Community authorities to consider making recommendations for suitable modifications of gas (and electricity) tariff structures within the Community.

The graphs in Fig. 16 show the evolution of gas prices in the domestic and industrial sectors between 1973 and 1978 in national currencies. They do not reflect the price movements triggered by the Iranian crisis.

The enormous increase in the price of fuel oil after the two crises gave a considerable boost to natural gas sales which was of immense benefit to the producers. However, the public utilities themselves, which are mostly concerned only with transport and distribution, were also in general able to improve their economic situation, with the result that they can now bear increased costs and finance the requisite investment in the normal way.

We should not overlook the considerable benefit which the public authorities of the natural gas producing countries have derived from the unusual increases in the price of natural gas. This advantage, from which the general public benefits in terms of the general budget, is undoubtedly a positive matter; however, we should not lose sight of the considerable financing burdens and risks which will devolve upon the natural gas industry in the next few years as a result of the search for new sources of supply and the switch-over from Community to non-Community suppliers.

It should not be overlooked that the relatively favourable position of the natural gas industry since the oil crisis is an exceptional one which will gradually return to normal. Natural gas procurement costs will increase considerably in the next few years, mainly for the following reasons :

- Exploration and production costs are increasing at a disproportionately high rate as the drilling depth increases, as expensive secondary recovery techniques are applied and as activities are shifted to an ever increasing degree from on-shore sites to the continental shelf of the maritime Member States;

- the cost of transport by undersea pipelines is much higher than by similar land pipelines;

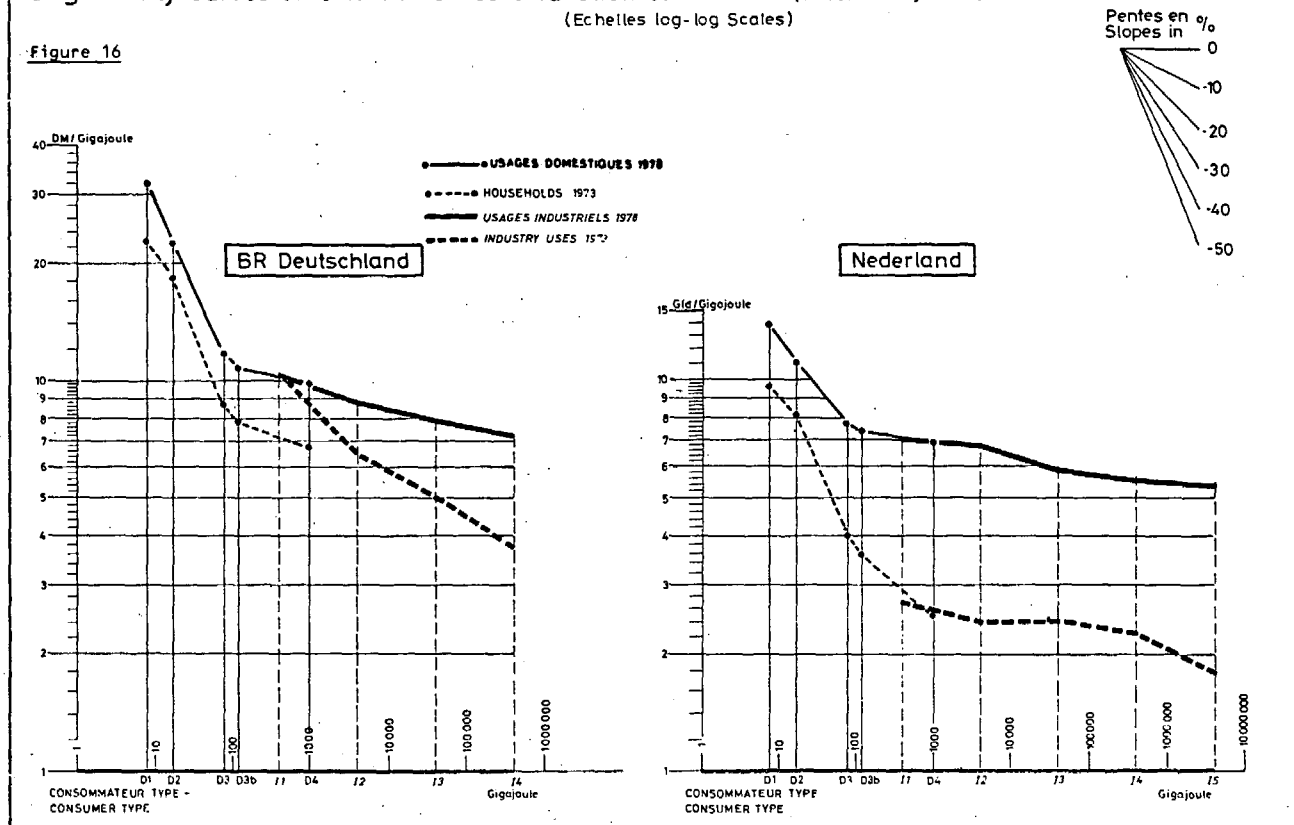
- the increased share of LNG in the total supply which is expected over the next few years will affect costs to a considerable degree;

- distance plays a greater part in determining the cost of transporting natural gas than it does with oil. The proportion of the total supply of natural gas which is transported over long distances will rise steeply in the next few years and as a result,the effect on natural gas procurement costs will be disproportionately high;

- the mismatch between a steady flow of natural gas shipments, especially from non-member countries, and temperature dependent variations in consumption will grow. Countermeasures such as the use of storage, SNG peak-shaving plants and interruptible supply contracts are expensive.

Courbes de dégressivité des prix du gaz en fonction des quantités enlevées (monnaies nationales courantes)
Degressivity Curves of Gas Prices as a function of Volume (current money terms)
(Echelles log-log Scales)

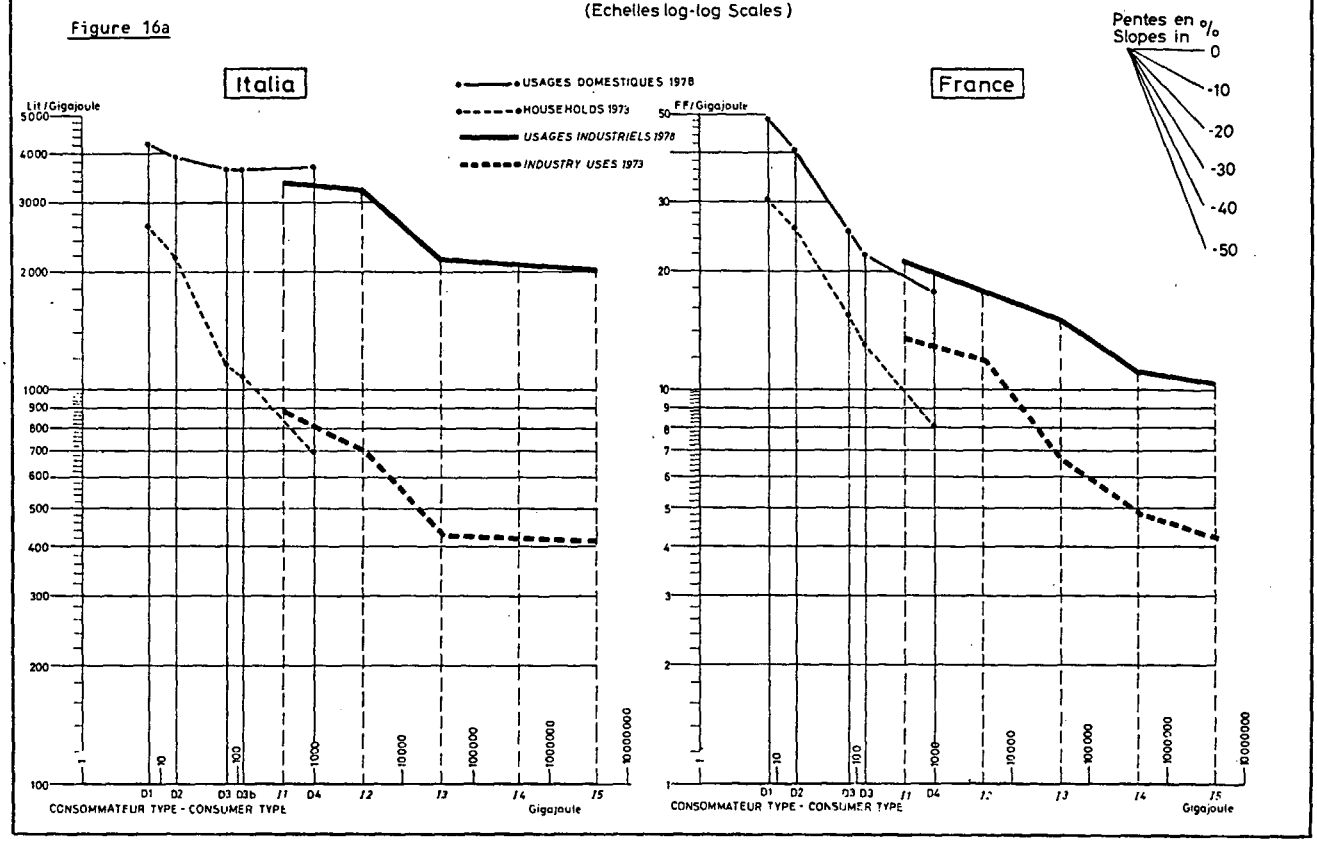
Figure 16



Courbes de dégressivité des prix du gaz en fonction des quantités enlevées (monnaies nationales courantes)
Degressivity Curves of Gas Prices as a function of Volume (current money terms)

(Echelles log-log Scales)

Figure 16a

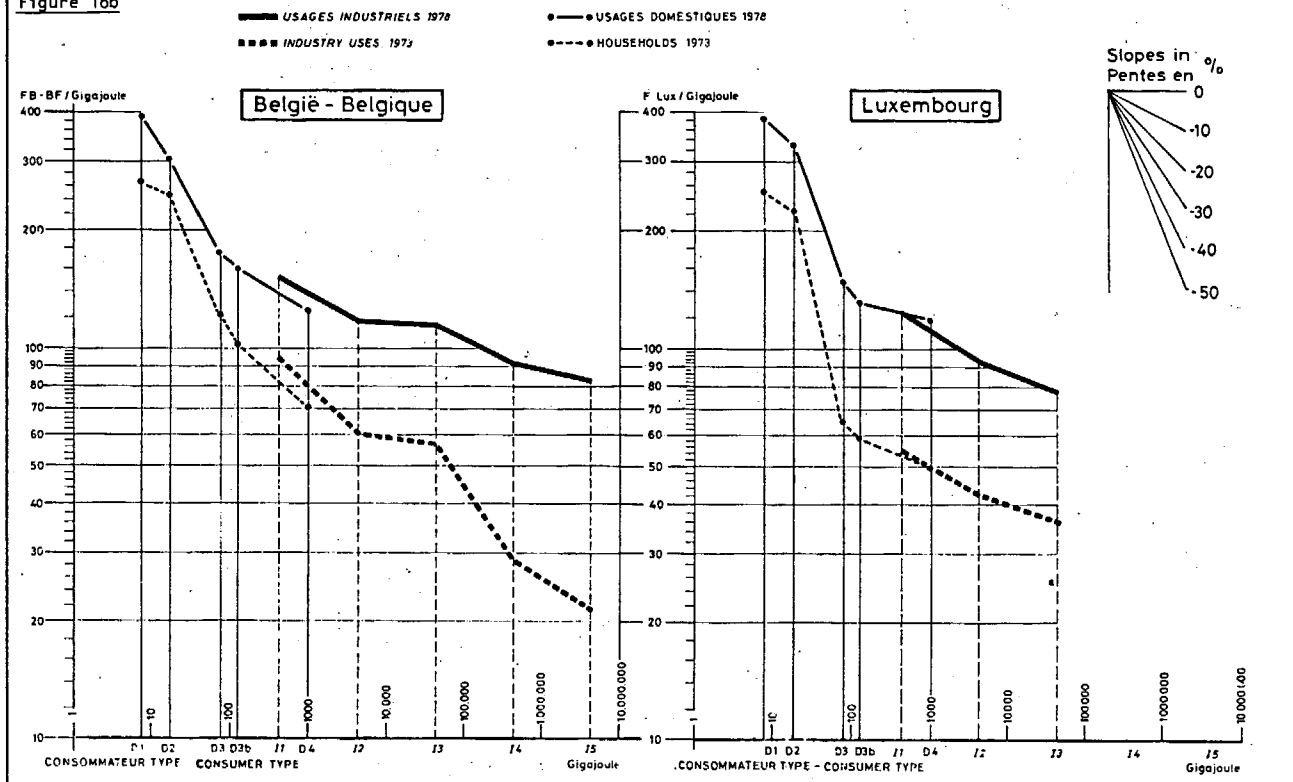


# Degressivity Curves of Gas Prices as a function of Volume (current money terms)

# Courbes de dégressivité des prix du gaz en fonction des quantités enlevées (monnaies nationales courantes)

(Echelles log-log Scales)

Figure 16b

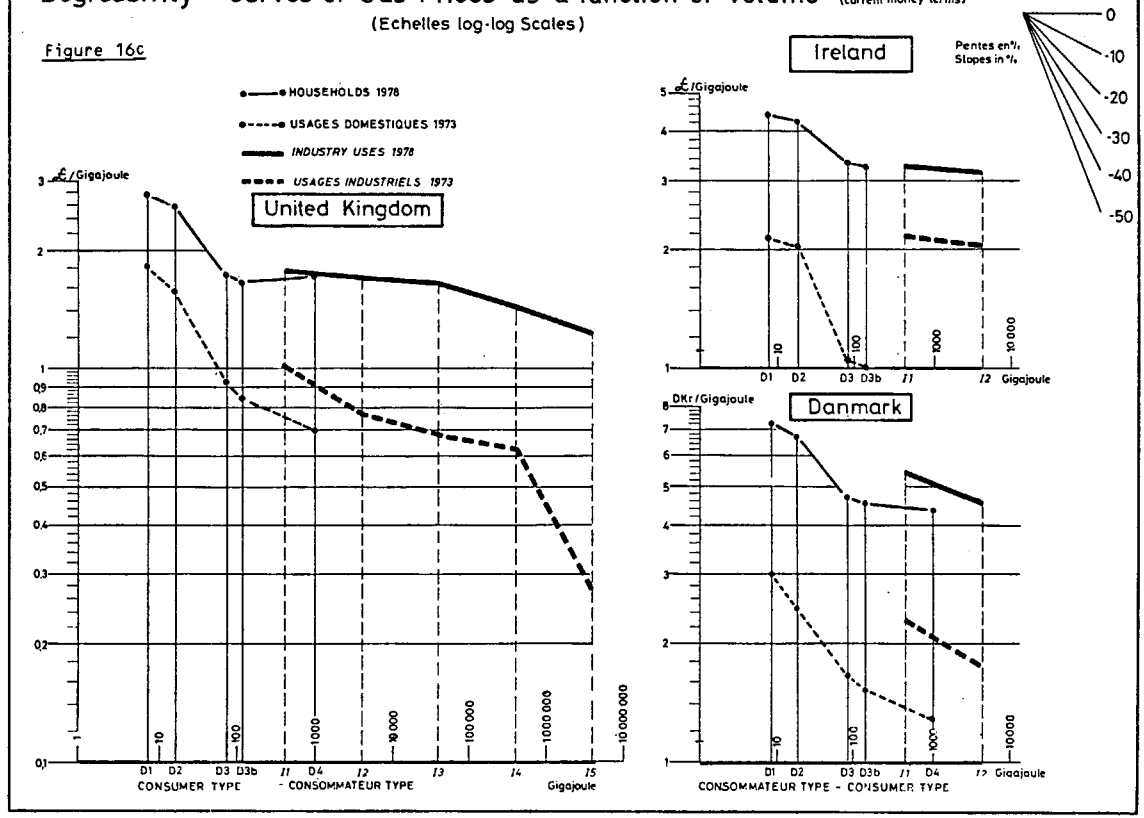


Courbes de dégressivité des prix du gaz en fonction des quantités enlevées (monnaies nationales courantes)

Degressivity Curves of Gas Prices as a function of Volume (current money terms)

(Echelles log-log Scales)

Figure 16c



16. Security of supply

Continuity of supplies at all times is one of several characteristics of natural gas which has undoubtedly greatly promoted its unusually rapid expansion. The consumer, in the household, or industry, needs only open the tap to have the necessary heat available immediatly in the required quantity.

This security of supply results not least from the fact that the sources of supply are located not very far from the consumers within the Community and are largely immune from the effects of political tensions. Technical malfunctions - which are very rare anyway - can be remedied relatively quickly, usually without the consumer noticing at all. Even strikes affect natural gas supplies less than any other form of energy supply; the flow of gas, from well-head to consumer is almost fully automatic.

The attainment of a high degree of security of supply is, of course, in the interest of the natural gas industry itself, which would not readily relinquish an important advertising point. And yet security of supply is also important from the economic and general political angles, for a protracted interruption in the supply of natural gas from one or more sources might have unpredictable economic and political consequences, owing to the crippling of important industries and the loss to substantial portions of the population of their vital supplies of heat for cooking, space heating and hot water.

There are two reasons - fundamentally different - for supply interruptions; technical malfunctions and political events. Moreover, one cannot rule out the possibility that technical malfunctions may be put forward as an excuse for what is actually due to political reasons.

To continue to provide the same degree of security of supply is becoming increasingly difficult, because :

(a) the distances over which gas is transported are constantly increasing;
(b) important supply mains are now entirely or partly outside territory where the supplying undertakings can exert any influence.

(c) the increasing dependence on imports of natural gas from countries whose political stability is in some cases difficult to assess. The extent of the increase in dependence on imports is described in Sections 4 and 5.

Basically, this growing problem can be approached by :

- strategic reserves of natural gas in storages ;
- Spawe production capacity from existing natural gas fields ;
- SNG production from relatively easily stored feedstocks, e.g. naphtha ;
- storage of substitute energy forms at appropriate multifuel major consumer ;
- conclusion of interruptible supply contracts with major consumers ;
- disconnection plans under which, in extreme cases, certain consumers' supplies would be cut off for a period, depending on how essential such supplies are and the reasonableness of such action; and
- public appeals for a voluntary reduction in consumption.

All these steps cost money - to a greater or lesser extent. Naturally, the expenditure must be kept within acceptable bounds and be reasonably proportional to the results achieved.

The gas industry itself has already carried out some of these measures and included them in its supply programmes; others are still in the construction or planning stage.

The Commission believes in addition to these important individual measures, a general solution to the security problem giving an optimization of costs could best be achieved at the Community level, particu-

larly bearing in mind the increasing integration of national supply networks as well as the growing interdependence of gas supplies at an international level.

For this reason the Commission has had the following two studies carried out :

- "Feasibility of maintaining strategic reserves of natural gas within the European Community"

- "Cost analysis for LNG and SNG plants and storage"

A third study entitled "The improvement of the security of supply of natural gas to the Community : coordination of transport systems" is under way.

The Commission attaches great importance to a fundamental study of these problems. Once the results of these three studies are available, the Commission will undertake, in close collaboration with relevant government departments and industries, a consolidated report on problems relating to the security of natural gas supply and possible measure for solving them.

European Communities — Commission

**Natural Gas Supplies and Prospects in the Community**

Luxembourg: Office for Official Publications of the European Communities

1981 — 110 p. — 16,2 x 22,9 cm

DA, DE, FR, IT, NL, ES

ISBN 92-825-2268-7

Catalogue number: CB-30-80-237-EN-C

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|---|---|---|---|---|
| BFR 175 | ECU 4,20 | DKR 33,60 | DM 11 | DRA 260 |
| FF 25 | IRL 3 | LIT 5 200 | HFL 11,80 | UKL 2.20 |
| USD 5.20 | | | | |

The report describes the evolution of the Community's natural gas supply from 1965 and gives forecast data for 1985 and 1990 based on the national energy programmes of the different Member States. It also gives a general view of prospects up the year 2000.

In the past, the Community's gas supply was largely autonomous. However, both the production and consumption of gas have developed at an extraordinary pace, resulting from a growing trade in gas, mainly based on the considerable reserves in the Netherlands and the North Sea. Currently natural gas holds the same share of the overall energy balance for the Community as coal. Production, however, is levelling off; and consumption, which continues to grow, will be met increasingly from imports from third countries.

Indeed long term importation contracts amounting to about 100 mtoe/yr (million tons of oil equivalent) have been concluded, some of which will extend beyond the year 2000.

Other contracts will have to be concluded simply to maintain the gas in share in the overall energy balance and to increase the degree of diversification. In order to guarantee gas supplies in the long term, increasing recourse to synthetic natural gas (SNG) from LPG and coal, will have to be made.

The importance of investment, as well as the development of gas price policy is underlined; the opportunities for expansion in the gas supply system and the difficulties this may present are also reviewed.

The report contains several tables and graphs on gas reserves, production intra-Community trade, imports and consumption, to back the conclusions made.