Technion
Israel Institute of Technology

Politecnico di Milano

Italian-Israeli Binational Conference

on

Natural Gas

Haifa, June 19, 1996

Proceedings:

Italian-Israeli Binational Conference on Natural Gas

Haifa, June 19, 1996

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Italian-Israeli Binational Conference on Natural Gas

Introduction

In November 1995 an agreement for cooperation between the Technion and the Politechnico di Milano was signed. In addition to agreeing to encourage student and faculty exchanges and joint research, we also agreed to attempt to encourage cooperation between Italian and Israeli industry. The first fruit of this effort was the Binational Conference on Natural Gas held at the Technion on June 19, 1996.

The Conference brought together senior scientists, engineers and administrators from both countries who are involved in the natural gas industry. This subject is of particular interest to both countries as Italy has a well-developed industry with much experience in gas distribution and utilization and Israel is in the process of planning for a nation-wide gas distribution system.

These proceedings are a collection of the papers presented at the Conference. We hope that they will be of interest to people involved in the gas industry. Furthermore we look forward to increased cooperation between our two Mediterranean Countries.

Zehev Tadmor
President
Technion

Adriano De Maio
Rector
Politechnico di Milano

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by
Angelo Incerti
Eni S.p.A.

Organizers: Technion di Haifa-Politecnico di Milano

Thank you mr. chairman, Ladies and Gentlemen

I would like to thank the Technion of Haifa and the Politecnico of Milan, (its Dean prof. De Maio), for the opportunity given to my colleagues of Snam and Italgas, and myself, of joining this meeting.

We are going to deal with the subject of gas as a source in rapid growth in the world, and of its employement starting from our point of view or, if you prefer, from our experience.

My speech will consist of two parts. In the first one I will try to briefly illustrate the problem of the supply of gas to Europe and the beginning of a European Cooperation policy towards the Mediterranean area in the energy sector.

In the second part I will go into a suggetion that we support as ENI about the problem of the gas/ electricity interconnections South-South; I will end with a short presentation of the Group that I represent here.

My colleagues from Snam will explain the Italian experience and the most important uses of gas. My colleagues from Italgas will conclude with referring the experience of a distribution Company.

Up to the beginning of the 90's the discovery of natural gas reserves was considered by oil companies as a shocking event, followed by dispair.

The reason for this unusual reaction was that until then natural gas was usually discovered when exploring for oil, and since no infrastructure was then available gas was either flared or marketed locally. Gas flaring started to decrease at the beginning

of the 50's, in the majority of the producing Countries. Nevertheless there is still an open: issue the realization of an effecient transport system and the organization of the local market.

These difficulties and the high cost of transport are the reasons why untill today the gas market has not turned yet into a global market. Based on past esperience natural gas development requires large proven gas resources, accessible markets, gas transmission infrastructures (high capacity pipelines, liquefaction plants, LNG tankers, and regassification terminals). All these elements are required to ensure that projects can be financed.

Given that we still have other critical points to be solved in order to implement gas project: large finance requirements, transit, national legal framework, common regional pricing policies.

Notwithstanding this difficulties since 1970 there has been a substantial growth of gas network and consumption with the mutual advantage of both producers and consumers. For example in Europe and in the Former Soviet Union where the total lenght of the pipeline has increased respectively from 48.000 km and 37.000 km in 1965, to 175.000 and 220.000 in 1990. At the same time sales passed from 40 and 114 BCMY to 200 and 600 in 1990.

The rapid expansion of natuaral gas is posing the following question: why is gas becoming increasingly important? There are a number of different reasons, to account for that.

First of all there is an environmental reason due to the very nature of natural gas as a very clean energy source,that emits less pollutants than other fossil fuels:

In the second place a further boost comes from technology, that has increased the efficiency level that can be achieved by natural gas in combined cycles from 55% to as high as 60%. In comparison if we consider that electricity that can be produced with steam turbines has a maximum efficiency of 40%, the advantages are obvious.

The use of natural gas as an industrial fuel brings with it a simpler and cheaper technological process of utilization, does not induce corrosion to the equipment, guarantees life time period of the installations

Competitive pricing tied with stability and security of supply complete the picture.

In a word, natural gas seems the ideal fuel to use due to its properties and to environmental premium.

Natural Gas Expansion in Europe

In Europe the level of natural gas consumption is the result of a continuous improvement from 1960 to 1993.

European gas producers and marketers followed a price policy which allowed the gas to enlarge its share market first to replace the mainufactured gas, then to take a large part of the new energy demand, then to substitute petroleum middle distillates and finally to produce electricity in the power plants, in gas fired combined cycle and co-generation facilities.

European countries adopted from the very start a co-operative attitude, which allowed both the rationale use of internal resources and their integration with the imported ones.

The potential demand for gas prompted the building of a very extensive gas pipe network, which gives and will give rise in the near future to a really Trans European Network in even when the market is criss-crossed by national boundaries.

The European transmission grid was gradually built to comply with the sales contracts. Firms take commitments which were made over long terms, making it possible for extremely large investments to be made, requiring the development of new technologies to lay pipeline down more than 600 metres of water (Sicily Channel) and cross mountains range up to 2,500 metres of altitude (Alps).

The interconnections (import lines, connections lines between the producing field and the markets or between differents consumption centres) were built on the basis of long term agreements, overcoming inter-states technical problems (for example the Standards) Long term agreements are essential conditions for the development of natural gas fields, which require large capital expenditure because new production fields are in very difficult areas (deep seas, permafrost) and are far from the consuming areas.

The European gas transport system is 235,000 km long (excluding the CIS) with diameters ranging from 300 to 1220 mm.

(Tables report the international gas pipes in Europe: the system now extends from Italy to Norway and from Russia to Turkey, to France, Spain and in the near future Portugal and Greece).

Natural Gas Demand and Supply in Europe up to the year 2020

In the last 20 years Europe has given preference to natural gas due to the political pressures and constraints on other energy sources: coal and fuel oil for their pollution or anti-pollution costs; nuclear for public acceptance and competitiveness; hydro-geo for the rarefaction of favourable sites.

Europe excluding the CIS - with a population of over 400 million located largely in densely populated urban towns - is an area where a very high volume of natural gas is consumed, produced and imported: it accounts for 18 % of the world consumption, 12 % of production and 37 % of imports.

Today natural gas accounts for 19 % of the total energy consumed in Europe (oil 42 %, coal 24 %, others 15 %), while in the year 1973 it accounted for 12 % (oil 48 %, coal 32 %, others 8 %). In these 22 years its consumption has increased (4%) to detriment of oil and coal which presented yearly trends (respectively of minus 0.4 % and 0.8 %).

Natural gas demand is expected (Eurogas forecast) to grow very rapidly in the future, from 310 billion cubic metres (bcm) consumed in 1994 to 460/470 bcm in the year 2010 , increasing its share from 19% in the year 1994, to 25 % in the year 2010.Other forecasts have also be made about European natural gas demand which are more optimistic. The Eurogas forecasts I reported appear to be set whitin a more realistic global framework.

France, Germany, Italy, the Netherlands and the UK accounts for almost 90 % of the total European natural gas demand; in the future demand is expected to increase rapidly in the countries that have traditionally used little or no natural gas: Spain, Portugal, Greece and Ireland.

Consumption in the residential, commercial and industrial sector, will have an annual growth average of around 1%, compared to the 5-6% achieved over the last twenty years. More than half of the incremental demand of natural gas should be in power generation. The most direct reason for this are: the relatively low level (8%) of natural gas today in power generation, far away from the 33% share of the nuclear energy and the 30% supplied by coal; the introduction of turbogas technolgies and the lower environmental impact. The use of gas in power generation will be analysed in detail by Mr. Visigalli.

Within the framework of the transition process to market oriented economies the restructuring of the natural gas industry is a crucial passage for Eastern European Countries (PECO). Thus the gas industry today needs and is looking for diversification of gas supplies, improvement and rehabilitation of infrastructures, technological upgrading, appropriate legal and regulatory measures, a cost or market-value pricing system and the restructuring of enterprises, including privatisation on a broad scale.

Gas supply. At the beginning of 1994 natural gas proved reserves in Europe were 6,980 bcm, with a reserves to production ratio of 25 years.

Production of natural gas in the EU in 1994 was just over 190 bcm, including gas exported to the other EU counties by Holland: this met about 63% of total energy demand in the area. Eurogas estimates that internal production will peak at about 210 bcm around 2000, meeting 53% of forecast demand. Imports from outside the EU of

around 190 bcm are already contracted. At the turn of the century and for the next few years, supplies to meet forecast demand are already available. Estimates for 2010 indicate a slight drop in internal production, while imports already contracted by this date should ammount to around 200 bcm. The gap to be filled by new imports yet to be agreed is about 65 bcm per year.

Even more marked is going to be the gap after 2010 when internal production will fall further while agreed supplies from outside the EU cover about 40% of the total. Such gap will undoubtedly create problems. Although gas reserves are huge it is also true that in the next few years it will be necessary to produce gas in areas which are increasingly far away whilst maintaining the same levels of safety we have today. Different possibilities exist in regard to future gas import from new and old production areas.

Russia has the greatest potential in terms of gas reserves. It controls about a third of the the world total. In 1994 it exported about 100 bcm, of which 60 was to EU countries. Between 2010 and 2020 exports to EU already contracted for amount to over 75 bcm a year.

Turkmenistan holds substantial gas reserves, is active internationally promoting export projects destined to Western Europe involving a gasline crossing Turkey and the Balkans.

The North Sea still has a reasonable margin of productive capacity, both in the Norwegian sector and in the British one. Further increases in gas production from this sector could be entirely destined to the continental European market.

Mediterranean Africa and Middle Eastern countries has reserves wich vary from country to country and we will see the something more late.

International Natural Gas Transportation Projects

During the last thirty years, European gas companies have progressively built an international gas transmission network adapted to their needs and have, by and large, completed the interlinking of their internal gas networks, with the missing links either under construction or being planned:

- extension of the Norwegian gas pipeline system into continental Europe (Zeepipe, Europipe);
- links between UK and Ireland and the Continent (Interconnector);
- gas pipelines interconnections between east-west Germany and France-Spain.

Planned international pipelines will add new lines, allowing exports from Algeria with two new trans-Mediterranean lines:

- doubling of the TransMed Algeria-Tunisia-Italy: total capacity will be expanded to 24 bcm/y;
- Algeria-Morocco-Spain gas pipeline crossing the Mediterranean Sea near Gibraltar, with extension to other European countries. Initial annual capacity is estimated at 8 bcm/y;
- Yamal Europe gas line.

- ***EU Policy in the Mediterranean area***

In this context concerning the gas market, as to be underlined the broder and more recent action of the EU which is address to the political aspect of the cooperation in the energy field between the EU and Mediterranean Countries.

The European Union current Mediterranean policy is a fundamental stage of the new European approach to cooperation with the Mediterranean countries, which, promoted in 1990 with the approval of the Renewed Mediterranean Policy, has been from time to time confirmed by the Lisbon meeting of the Council of Europe (1992), then by the Corfu meeting (1994) and the one in Cannes (1995), finally being sealed by the Declaration of Barcellona at the Euro-Mediterranean Intergovernmental conference (27-28 November 1995).

Among the more significant stages towards the building of the Euro-mediterranean Partnership we remember:

The **Athens Workshop** (6-7 July 1995) which defined the objectives, the priorities and the organization of the future Euro-Mediterranean energy partnership. The aim of the meeting was to go ahead with finalizing an Action Plan and to identify specific projects, especially in the form of joint ventures.

The **Cairo Conference** (2-3 October 1995), in which as many as 22 countries dealt exclusively with financing energy projects, including not only their estimates (USD 250 billion for the period 1996-2010, of which 57% for electricity production-transmission-distribution and 43% for oil and gas), but also the sectors for priority action (supply, transmission, distribution, rehabilitation of plants, energy saving).

The **Euro-Mediterranean Conference in Barcellona** (27-28 November 1995) which marked the start of a new partnership to establish an area of peace and stability, economic freedom and closer economic and financial cooperation.
The pivotal role played by the energy sector was acknowledged and it was therefore decided to strenghten the cooperation and intensify the dialogue in the field of energy policies and to help to create the appropriate framework conditions for investments and the activities of energy companies.

The more recent **Trieste Conference on Euro-mediterranean cooperation** in the field of energy (7-9 June 1996) which allowed an in-depth discussion and approved some fundamental items such as:

- the accession to the Energy Charter Treaty of the Third Mediterranean countries;

- the definition of a set of reference principles to guide the restructuring of the Mediterranean partners' energy sector, in line with the principles of the Barcellona Declaration;

- the definition of a programme of gas and electricity interconnections to facilitate international trade in energy and regional integration among the Mediterranean partners;

- the creation of an investment guarantee system for energy projects in order to effectively mitigate non-commercial risk.

- ***Gas in the Mediterranean Area***

Natural gas in the Middle East accounts for 32 % of the world proven reserves and for only 6 % of the world marketed production.
Mediterranean Africa has reserves which vary, as I say, from country to country. Algeria has proven reserves of more than 3700 bcm, Libya more then 1300 bcm and Egypt over 600 bcm. In the first decade of 2000 Algeria is already contracted to export about 55 bcm annually to EU countries

Over the next few decades North Africa's gas reserves could find new outlets in European markets, via undersea gaslines or by LNG chain. This applies not only to Algeria, but also the other two countries just mentioned.

The Middle Eastern countries around the Gulf, have reserves of around 45 trillion cm of natural gas, about 30% of world gas reserves. As we all know , this area currently exports about 4 bcm to Japan annually in form of LNG. Projects are being studied for new exports; partly by pipeline and partly by sea (LNG). But while the LNG project, destined for Far Eastern markets, is close to the construction phase, the pipeline projects, towards both Europe and local countries, face considerable difficulties. This stems primarily from the today's low cost of energy plus the lack of infrastructures and problemes connected to the crossing of other countries.

In effect some of the MENA countries are between the major producers and exporters of oil and gas and key suppliers to the rest of the Mediterranean. However, hydrocarbons wealth is very unevenly distributed in the region: while it is essentially the sole economic resource for some countries, it is just an important complement for others, and totally absent from a third group.

The reasons for this relative lack of attention are: the low cost of energy, the preference to export a more flexible and bankable product like oil, and at last the fact that any gas transportation project over long distances to be economically viable requires a reasonably large market . Long distance gas transportation infrastructure is characterized by very significant economies of scale. The cost of transporting small quantities of gas over long distances is simply prohibitive

All proposals that have been put forward to serve the potential Near East, or North African gas markets, implicitly or explicitly envisage at least such minimum quantities, but the market for gas is at present much smaller and cannot be enlarged or created unless gas is available to serve the initial customers.

LNG projects may offer a degree of greater flexibility, expecially if they are conceived as an extension or marginal utilization of existing liquefaction facilities as they exist in Qatar. However the cost of shipping LNG around the Arabian peninsula and into the Mediterranean is certainly much higher than the potential cost of pipeline transportation in reasonably large quantities.

Other than with the exception of "spot" shipment, LNG at the moment cannot be exported economically from the Gulf to the European markets. This is either because the price of gas delivered into Europe is presently too low to cover the cost of LNG liquefaction, transport and regasification, or because the Far East market is ready to pay a considerably higher price. As long as these two conditions are not changed it is unlikely that significant LNG volumes will travel westward.

The proximity of very large reserves indicates that the Near East is bound to eventually become a region of relatively low priced gas. The Eastern Mediterranean shore is

likely become a location for LNG plants and consequentely the origin of LNG flows, rather than the destination and a regasification area.

In conclusion some of the largest gas reserves lay all around the Middle East and North Africa, but, political and infrastructural obstacles have prevented the development of gas industry in the region. Except for Egypt, gas is practically not used in the region.

Peace Pipeline

Starting from these point and from our involvement in exploration and production in some producing countries of the area, the ENI Group has tried to break this vicious circle. At the first stage we studied the possibility to export gas from Egypt to Israel, subsequently we reached the conclusion that it was necessary to aim at interconnecting the domestic market.

Thanks to the strong acceleration of the exploration that took place in Egypt after the 80's, gas export is now considered a very sound economic opportunity. The turning point in the increase of Egyptian gas reserves were the new discoveries in the Nile delta, between Alexandria and Port Said.In order to exploit the new Baltim, Temsah, Wakar and Port Said fields, it was thought to transport the gas via pipeline, immediately called "peace pipeline"The pipeline will depart from west Port Said , will cross the Suez Canal and, through the Sinai peninsula will reach the Egypt Israel border.

Several studies, have already been carried out. Recently the Egyptian Trans Gas Company has been established. The company objective is the ownership of gas transmission system and the transportation and trading activities. The company is a

joint stock company with shareholders Egipt gas (34%), Agip (33%), and Amoco (33%). More specifically, in the negotiations already started to export gas volumes to the nearby eastern countries, ETGC will act as trader.

Levante Gas

Now is the time to move one step further: in the meetings held in Jerusalem and Amman, last november 1995, we have proposed an expansion of the concept of the peace pipeline conceiving a pipe network to serve the entire Near East. We called this project "Levante gas".

This is a visionary , yet realistic concept, the objective of which is the realization of a transmission system connecting the middle eastern mediterranean countries, which is capable of both receiving and delivering gas at various points along its route.

The Levante gas project envisages imports from outside the region, such as Saudi Arabia, and eventually from the Gulf, which will become available at appropriate times during the life span of the project.

As a consequence we consider two independent phases: the first phase , is at a regional level, from Egypt to Turkey; for the second phase, the European phase, two options were considered, one based on pipeline transportation, from Turkey to Bratislava, the other one based on an LNG chain from Egypt and/or Turkey to Europe.

The goals of the Levante gas are the creation of such regional gas market and open the door to exports of gas from the Gulf to Europe.

But we have a dream: a huge gas loop in the Mediterranean basin.

Italian-Israeli Bi-National Conference on Natural Gas

The Israeli Natural Gas Project

D. Vardi
Head, Natural Gas Project
Ministry of Energy and Infrastructure

Haifa, June 19, 1996

The Israeli Natural Gas Project

D. Vardi
Ministry of Energy and Infrastructure

Introduction

This paper includes some basic material related to the Israeli Natural Gas Project:

1) A list of principles upon which the project has been based.
2) Forecasts of Natural Gas Consumption from 2000 to 2025.
3) Financial projections from 2000 to 2025.
4) An organizational chart for the project.
5) A list of main tasks for the project.
6) The proposed project time table.
7) The proposed gas network.

Principles

1. The project (all three elements) will be done by the Pivate Sector (ISRAELI and International Companies)

2. The three Elements of the project are :
   - 2.1. Purchase of Gas - will be done by the Major Buyers and Distribution company/ies through the N.G.P.M
   - 2.2. Transportation - common carrier, - will be done through a B.O.O.T tender.
   - 2.3. Distribution - will be done by one or more companies.

3. Cross participation will not be allowed.

4. Participants will be chosen by open tender.

5. Government involvement will be limited to:
   - 5.1. Providing the organization structure (N.G.P.M).
   - 5.2. Providing the legal frame.
   - 5.3. Supervising the implementation.

6. Egypt is considered to be a "natural" supplier.
   - 6.1. Has Gas and has Geographical Advantages.

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FORECAST NATURAL GAS CONSUMPTION IN ISRAEL (BCM/AN)

Yr. Cust.	2000	2005	2010	2015	2020	2025
I.E.C.	2.2	2.8	4.1	5.5	5.4	6.6
Ind. & others	0.3	0.9	1.5	1.8	2.0	2.3
TOTAL	2.5	3.7	5.6	7.3	7.4	8.9

FINANCIAL VOLUME OF THE PROJECT

For the ETGC/ exporters

(at an indicative price of $2.00 per MMBTU)

Year	Volume (BCM)	Turnover (mil$)
2000	2.5	180
2010	5.6	403
2020	7.4	533
2025	8.9	641

In Israel

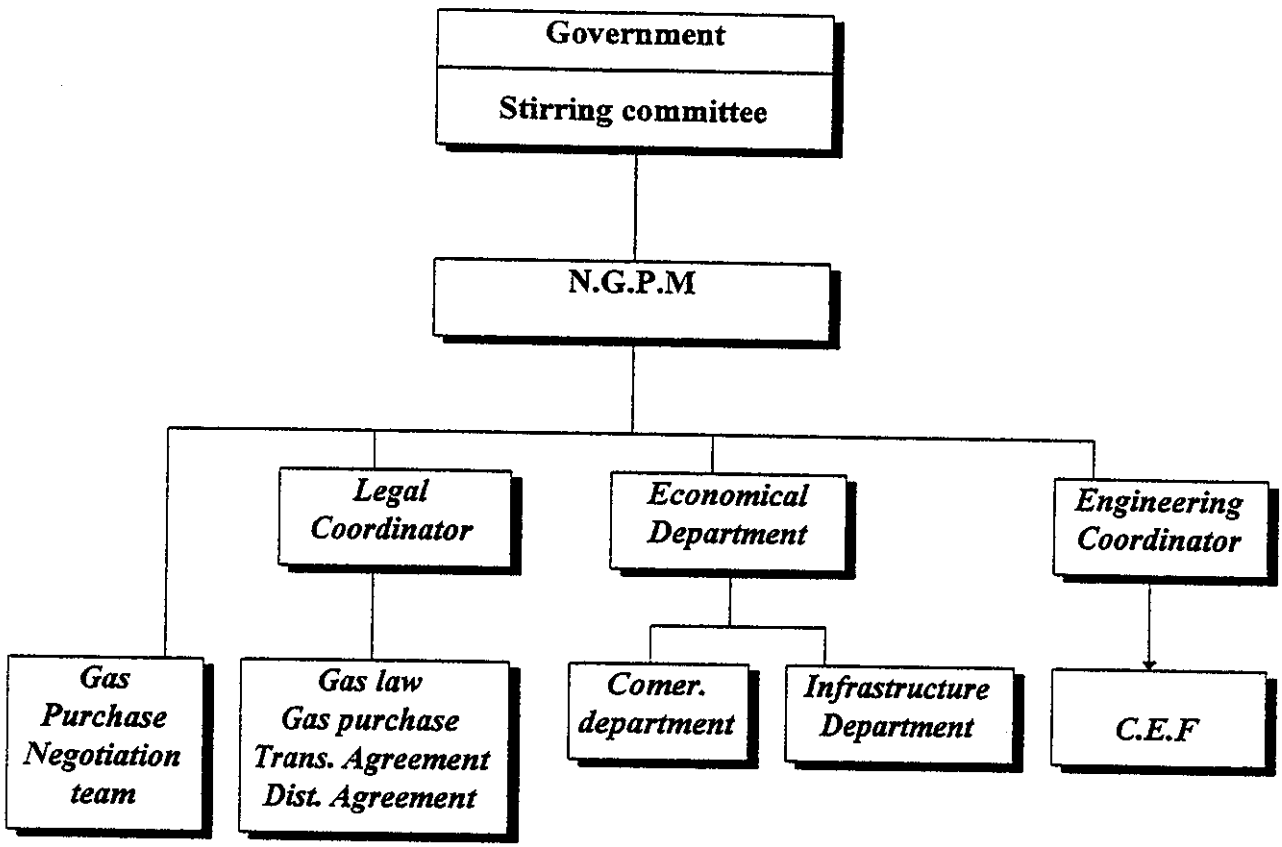
(estimated investment in infrastructure)

Transportation - Main pipeline - $ 250 - 300 m

Distribution - Distrib. lines - $ 50 - 80 m

If L.N.G. - LNG facilities - $ 400 - 500 m

N.G.P.M


Government
Stirring committee
N.G.P.M
Legal Coordinator
Economical Department
Engineering Coordinator
Gas Purchase Negotiation team
Gas law
Gas purchase
Trans. Agreement
Dist. Agreement
Comer. department
Infrastructure Department
C.E.F

N.G.P.M Main Tasks

1. General

1.1. Recommending to the Government on Gas law and regulation setting up P.U.C.

1.2. Prepare the Gas Master Plane.

1.3. Evaluating possible Gas suppliers.

1.4. Supervising the implementation.

2. Purchase

2.1. Tender to select Main buyers.

2.2. Representing the Main Buyers in the negotiations with Gas suppliers.

3. Transportation

3.1. Tender to select C.E.F.

3.2. Tender for transportation (B.O.O.T).

3.3. Tender for storage.

3.4. Integration between various possible suppliers (N.G / L.N.G etc.)

4. Distribution

4.1. Tender for distribution companies.

4.2. Supervising the implementation.

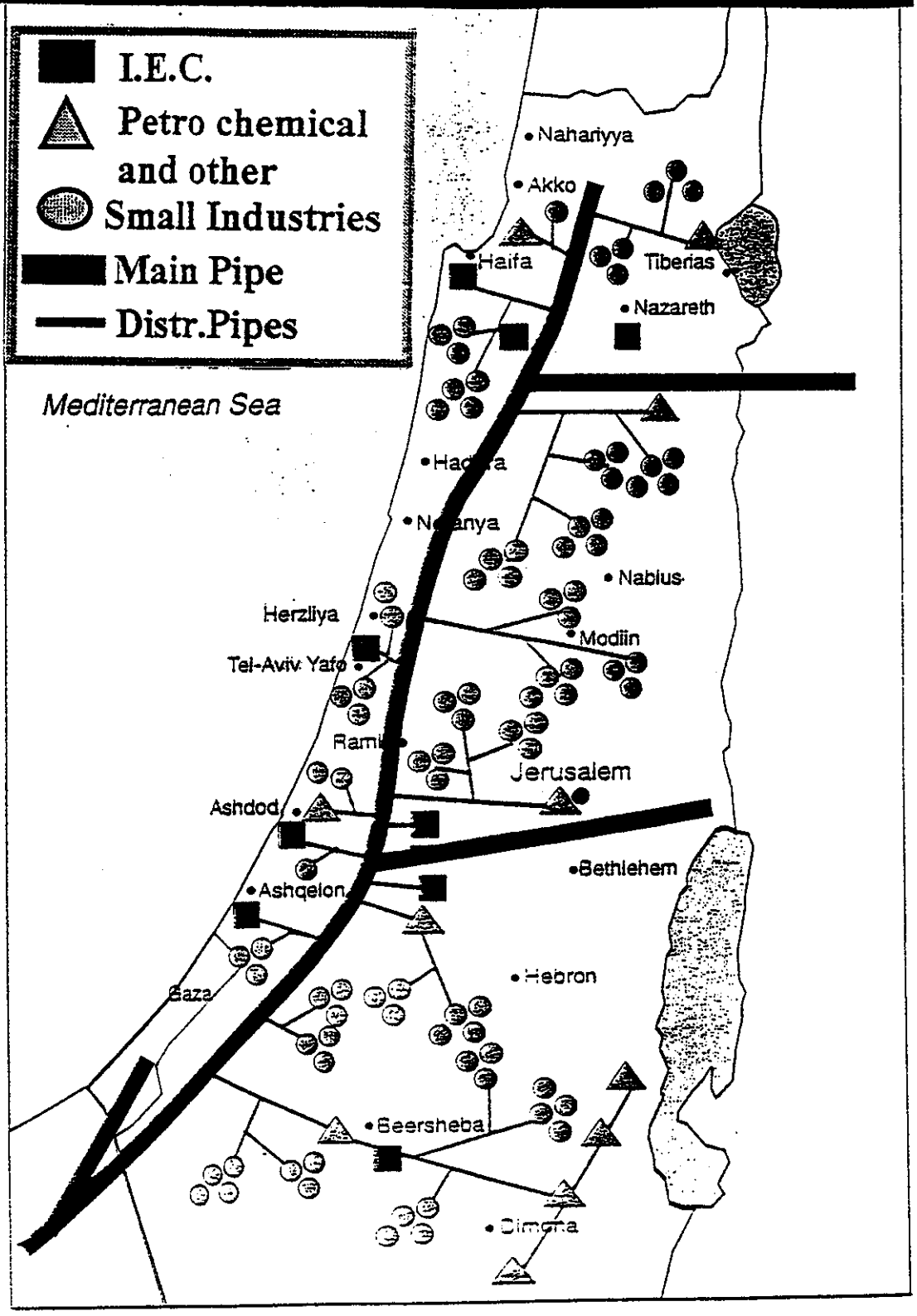
Time Table

96 - 97 - Tendering and negotiation with Gas suppliers.

97 - 99 - Construction of Main and Distribution line.

2000 - Gas flow.

GAS NETWORK


I.E.C.
Petro chemical and other
Small Industries
Main Pipe
Distr.Pipes
Mediterranean Sea
Nahariyya
Akko
Haifa
Tiberias
Nazareth
Nablus
Herzliya
Modiin
Tel-Aviv Yafo
Jerusalem
Ashdod
Bethlehem
Ashqelon
Hebron
Gaza
Beersheba
Dimona

THE ORIGINS AND GROWTH OF A NATURAL GAS MARKET: THE ITALIAN CASE

HAIFA, 19 JUNE 1996

FABIO DUBINI, SNAM S.p.A.

FABIO DUBINI

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He is a MIP MBA, and a graduate of the Polytechnic of Milan in Aerospace Engineering.

THE ORIGINS AND GROWTH OF A NATURAL GAS MARKET: THE ITALIAN CASE

Dear Ladies and Gentlemen,

It is an honour and a great pleasure for me to have been invited to address you today on the particular topic of the origins and growth of the Italian gas market as a case study.

The natural gas industry in Italy started in the 40ies following the discovery of gas fields in the Po valley, in the centre of the most industrialised area of the Country. After an initial pioneering period of rather localised and uncoordinated expansion up to the end of the 50ies, the 60ies witnessed a growth based on the exploitation of domestic gas supplies, destined primarily for the industrial sector.

The advantage of this was that users were highly concentrated geographically and had a relatively uniform pattern of consumption.
These factors helped offset the huge investment needed as well as the system's inability to cope with fluctuating seasonal demand which other sectors would have created.

The price of domestically produced gas was at this time very competitive, providing the Italian industry with an undoubted boost in this crucial period of reconstruction and modernisation.

Given the fact that transportation costs are the single most important element of total costs, it is clear how vital it was to have production wells so close to the main areas of consumption.

During the 60ies the demand for natural gas increased at a rate of 7% a year. Gas sales reached 12.8 Billion cubic meters, representing 10% of the primary energy demand.
Correspondingly the pipeline system increased from 1,460 Km in 1950 to 9,000 Km in 1970.

As the demand for gas rose, the construction of the transmission network went ahead, first linking the north regions and then gradually spreading out into the less developed regions. This was also as a consequence of new gas discoveries scattered around the Country.

The expansion of local distribution networks was nevertheless much slower, due to the lack of necessary finance and because of doubt as to the reliability of gas supplies in the long term.
It was only in the second half of the sixties, with the industrial sector by now largely consolidated, that a new commitment to penetrate the residential and commercial sector began to have its first significant results.

At that time it was realised that, despite new potential discoveries, domestic resources were probably insufficient in relation to the size of the potential market.
In order to sustain demand SNAM began studying the possibility of importing large quantities of gas.
In these years, Holland, the USSR, Algeria and to a lesser extent Libya, all made their appearance on the European gas market. Taking advantage of this opportunity, Italy reached agreements with Holland and the USSR to import gas via pipeline and with Libya to supply LNG.

Import was a difficult choice because it involved long term commitments to make purchases for at least twenty years, huge investments and the use of new transportation technologies.

The annual quantities involved amounted to an ambitious 15 Bcm, exceeding total consumption at the end of the sixties (11÷12 Bcm). However, this choice was dictated by the need to achieve economies of scale in long distance transportation.
The high capital expenditure required for the construction of the facilities was financed on the international capital markets and the increase in gas sales, necessary for marketing the new gas, was exclusively achieved by the competitiveness of gas prices.

The result of the arrival of substantial new supplies and the spread of the high pressure transmission network brought a new prominence to the natural gas sector, further strengthened by the consequence of the oil shock which emphasised the value of having a reliable and diversified energy source able to provide support to the country's industry.

During those years the dependence of the Italian economy on oil products was still shockingly high, oil covered 75.6% of primary energy demand while gas contributing about 15% and the remainder was shared equally between solid fuels and primary electricity.
In this framework the political imperative to change the structure of energy supplies aimed at reducing oil dependence through further diversification of natural gas supplies, led to the realisation of a third major import project, the pipeline across the Mediterranean bringing Algerian gas to Italy.
A pipeline system was given preference over an LNG chain for a number of reasons including: the quantity of natural gas involved, the lower fuel requirements, the easier operation and maintenance of the system and finally the lower environmental impact.

This project involved even greater technological and commercial challenges, such as the laying of pipelines in deep water and the expansion of gas supplies in the southern part of the country, necessary for the commercialisation of the additional quantities.

Besides the increasingly difficult technical problems in bringing projects to completion, another aspect which should not be overlooked was that of the legal and administrative framework to be adopted in crossing several countries.
SNAM's approach was to involve the main gas operators in the countries the distribution network crossed, creating companies in charge of the financing, construction and management of international pipelines.

SNAM has always been a firm believer in the need for co-operation in developing its import infrastructures.
Partnership and stable contractual relationships, together with transfer of know how, greatly contributed both to the success of the initiatives and to the growth of local gas markets but also, and perhaps above all, to consolidating the relations between the countries involved.

As an example new legal and financial solutions were adopted for the Transmediterranean Pipeline where the Algerian seller was involved in an important and risky part of the transportation system, downstream the delivery point.
Also the crossing of Tunisia was developed on the basis of an innovative contractual scheme. In brief, according to a general agreement stipulated between ENI and the Tunisian Government, ENI companies constructed and financed the pipeline system, whose ownership was then transferred to a Tunisian company, wholly controlled by the State, in exchange of the exclusive right to have gas transported through the pipeline.
Furthermore the Tunisian Government in exchange of the full exemption from taxes, royalties, excise, duties and other levies on the companies set up in Tunisia for the purpose of construct and operate the system, received a global fiscal charge based on the volume of gas crossing the Algerian-Tunisian border and transported through the pipeline. This fiscal charge is payable in gas or in cash at discretion of the Tunisian Government.

This useful experience has been drawn on for other projects of similar complexity; we are proud to see others taking the same path, for example with the Algeria–Morocco–Spain pipeline and hope that similar initiatives around the Mediterranean will contribute towards reinforcing the natural gas market and in doing so reinforce relations between countries with different cultures and traditions.

The Italian Government and the European Community also contributed to the success of this ambitious project through the decision to support the gas development program in the south of Italy, giving grants and incentives for the construction of transportation and distribution networks.

The size of the market, now at 40 Bcm p.a., accentuated the problems regarding reliability of supplies and the balance between supply and demand. This latter problem was exacerbated by a doubling of the market share in the residential and commercial sector, from 20% to 40%, within the relatively short time of ten years (in Italy the ratio of winter to summer demand is an average of 3:1 and can reach 4:1 at the peak period of the day).

A solution to these problems was found in two main directions:

- firstly, on the commercial side, greater prominence was given to interruptible industrial supplies and to the use of gas for power generation, which did not have a great need for flexibility and could take more gas in the summer; and

- secondly plans were drawn up for a massive expansion of storage capacity through the rehabilitation of depleted or semi–depleted gas fields.

Regarding the latter their location close to premium markets allowed the full exploitation of the transportation system thus reducing the average cost of transmission to the minimum and therefore its incidence on the price to end users.

In addition storage played a strategic role by compensating for any reduction in imported volumes, due to technical or commercial reasons.
The application of the above has led to a maximum storage capacity in winter of 14 Billion cubic meters of working gas, with a maximum withdrawal flow rate at the beginning of the winter period of 260 million cubic meters a day.

Commercial incentives combined with the expansion of sales to the power generation sector were the strategies adopted to offset the fall in demand for energy and maintain the market share of gas after the occurrence of the second oil crisis.
These measures were accomplished by a change in SNAM's organisational structure aimed at facilitating relations with the customer by subdividing the market into four regions with a certain independence regarding technical and commercial issues.

As a result of these measures the average rate of growth for gas in the second half of the 80ies was 6% a year, well above the overall rise in energy consumption in this period. The result was that by the end of the decade the market share of gas had risen from 18.5% to 24% of the total energy market, with the transmission network reaching about 27.000 Km.

In the current decade Italy is witnessing further expansion in the gas sector.
Demand is continuing its upward trend, stimulated by the quality of the product itself, its intrinsic economic and environmental value as well as the quality of the service supplying the gas.
By the turn of the century the market share of natural gas should exceed 33%, compared to today's figure of 25%, with gas sales reaching 75 Billion cubic meters a year.
A significant part of this increase is envisaged for power generation and for cogeneration of heat and power by small and medium size plants.
In the space of a few years we have gone from the principle that a prized fuel such as natural gas should not be used inappropriately in the thermoelectric sector to the exact opposite where, for environmental reasons, such use is highly desirable A

contributing factor to this change of policy, in addition to environmental reasons, has been technological developments in high efficiency gas turbines in combined cycle power stations.
Lower investment costs and simpler operation, in addition to the highest level of efficiency, are pushing demand for natural gas in this segment.

This growth has required the development of new supplies, such as the doubling of the Transmed –pipeline from Algeria and the upgrading of the transportation system for the import of additional volumes of Russian gas and once again, projects costing billions of dollars have been undertaken.

The challenge of conceiving new projects and of sustaining the huge investments necessary for their implementation requires the existence of a relatively stable and predictable environment where everybody operates.
It would have been impossible to take on the risks we took in the past if the market had been subjected to creeping regulations instead of being left open.

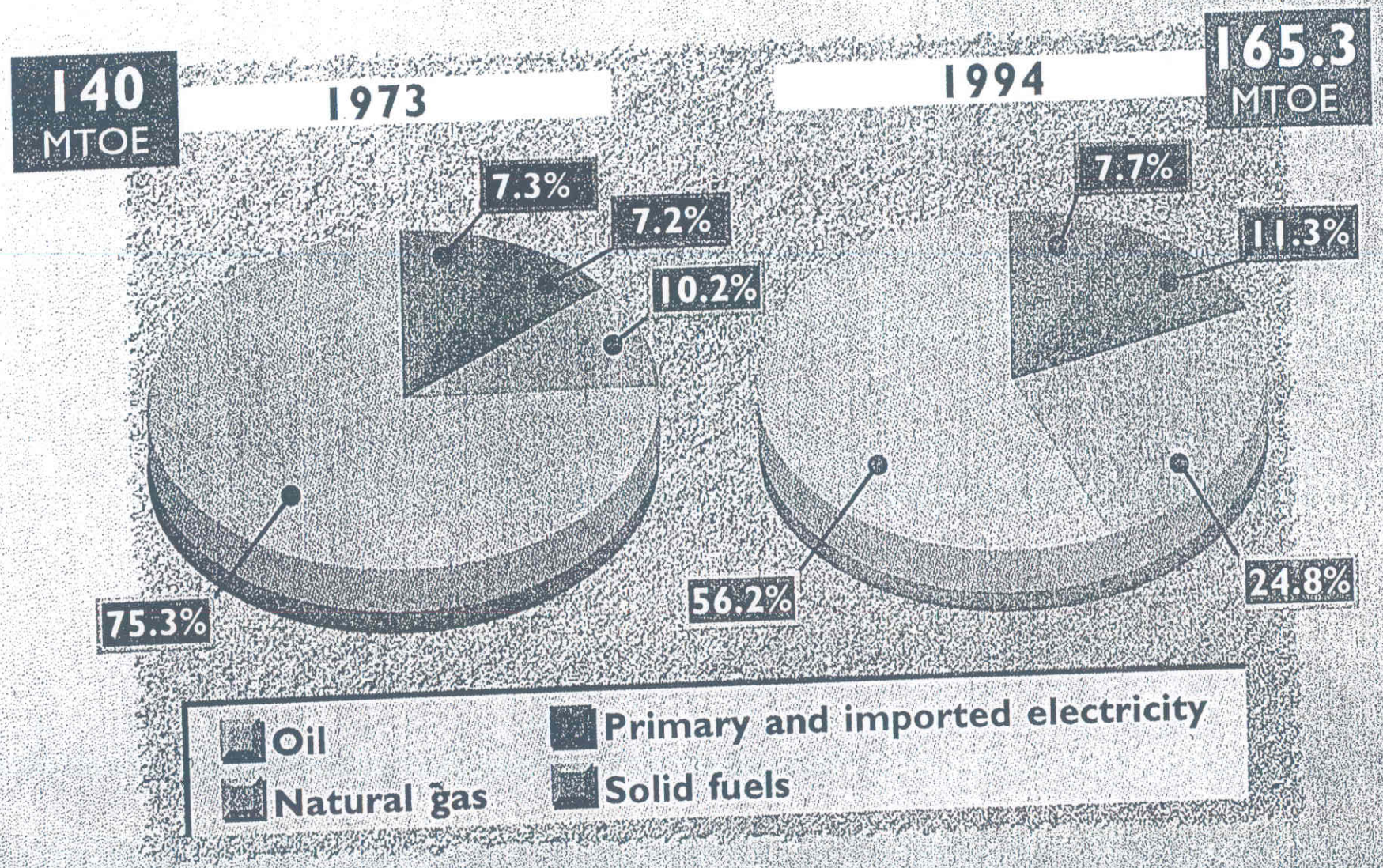
The experience demonstrates infact that third party access and unbundling would certainly not help countries lacking a natural gas system to develop one. Their introduction favours companies in the most privileged position and penalises small consumers and those less fortunately placed.

With hindsight, it would seem that development of the natural gas market in Italy was a simple matter of matching supply to demand. But where was the demand for a product which was hardly known? Where was the supply, capable of meeting a demand which still had to develop, when the supply itself required immediate and large scale commitments?

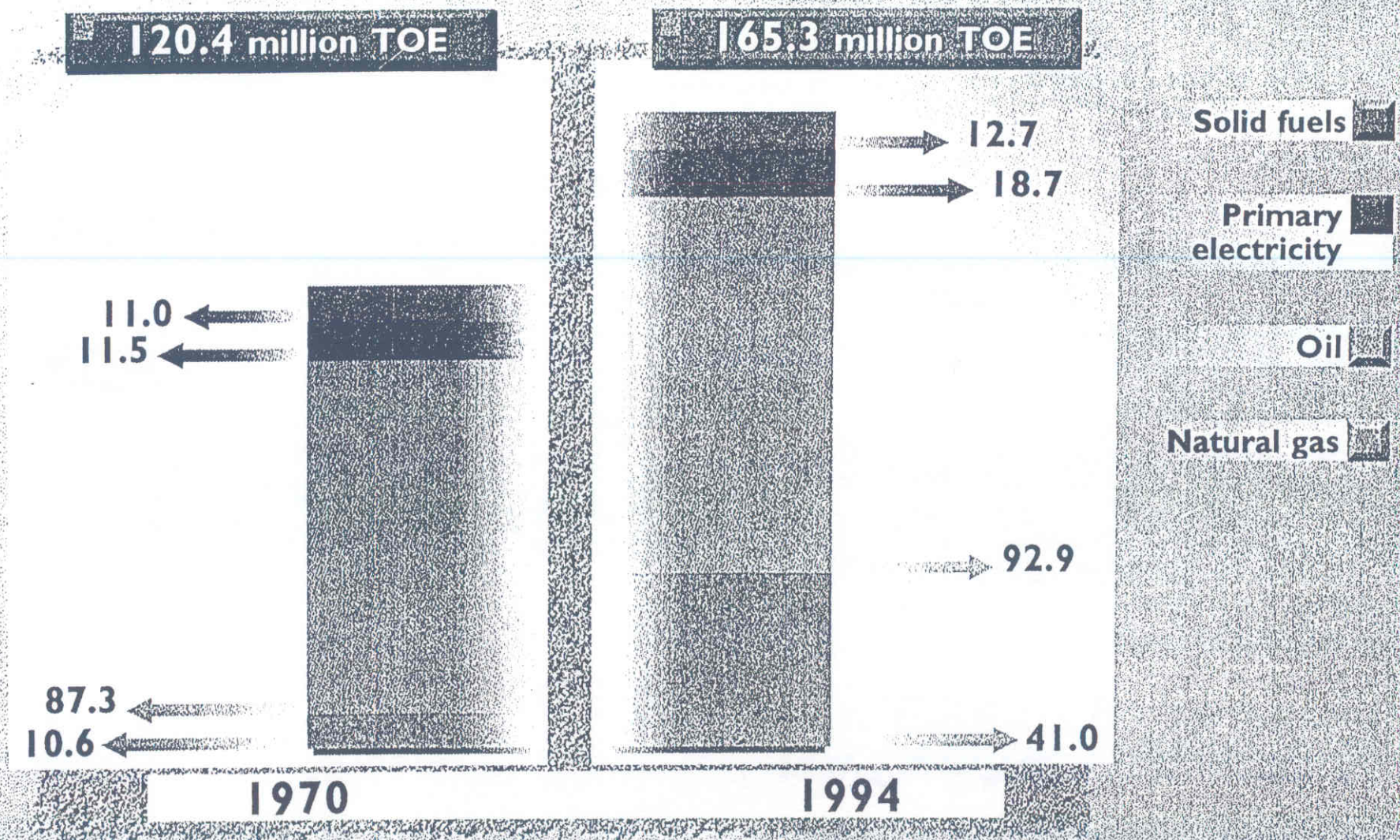
The key to these two questions was found in the continuous effort to achieve a political consensus for the overall strategy whilst at the same time obeying market laws and responding to developments as and when they happened, taking on the risks associated with the pursuit of this strategy.

Thank you for your attention.

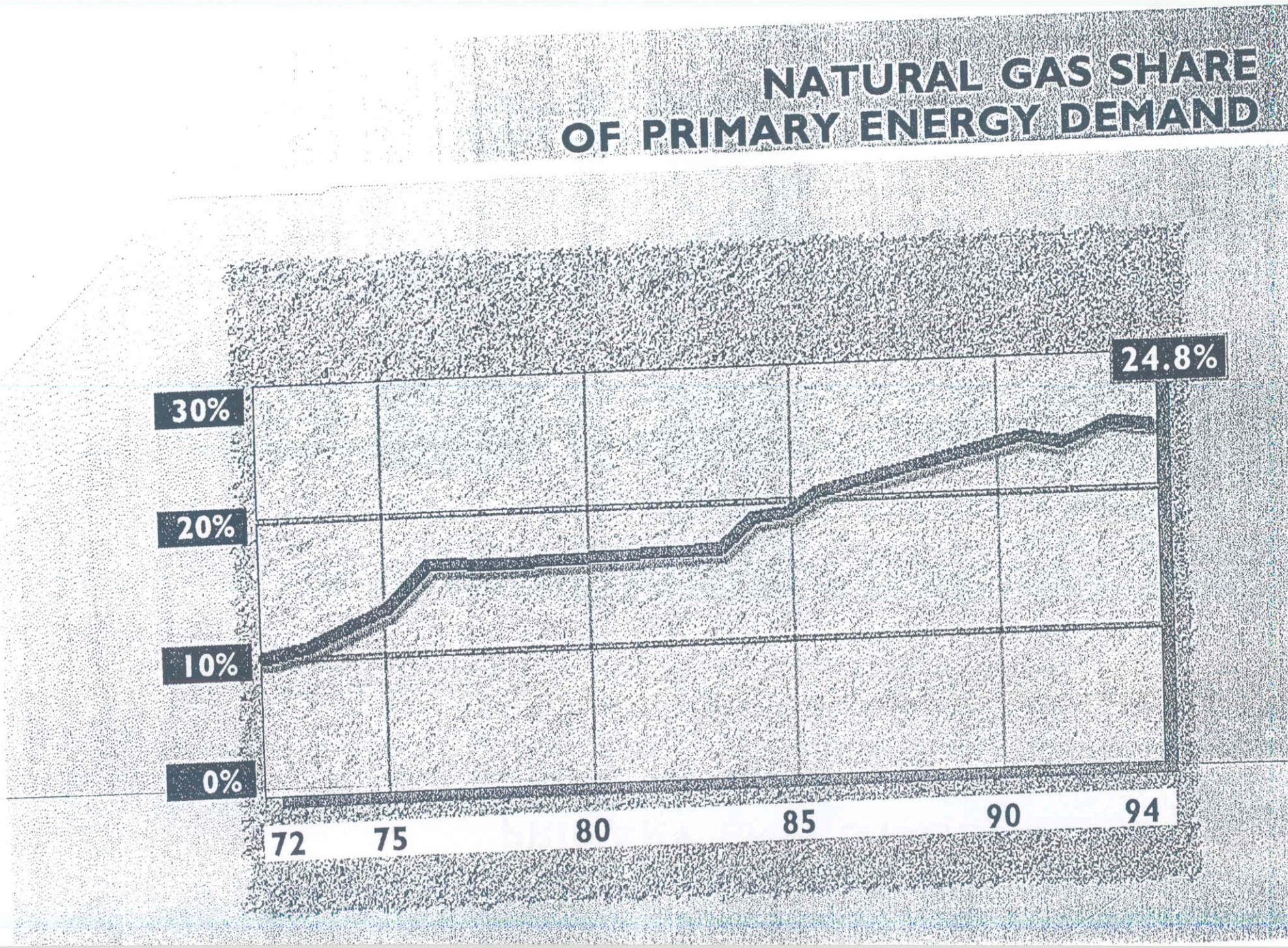
MARKET SHARE OF PRIMARY ENERGY SOURCES IN ITALY



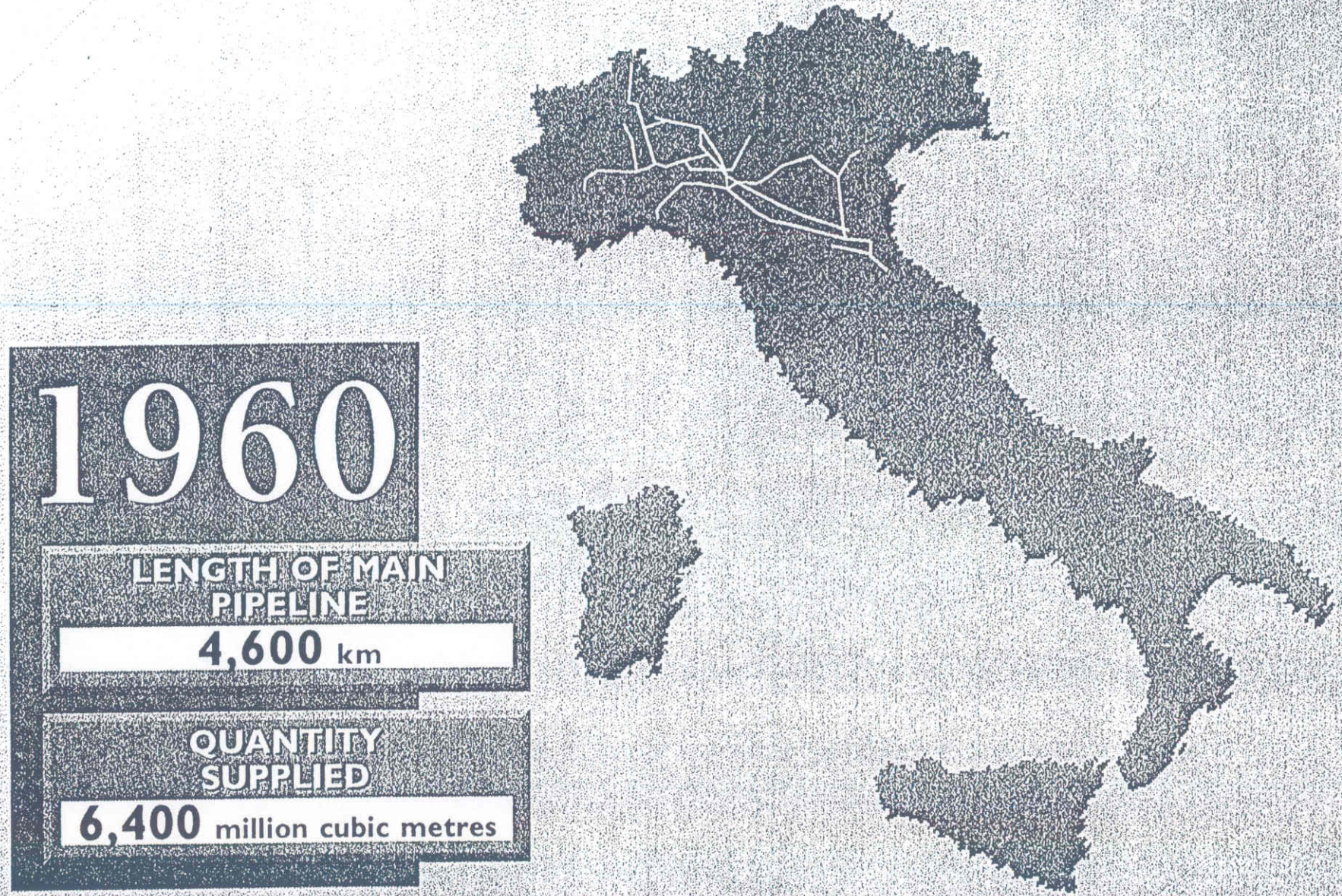
PRIMARY ENERGY CONSUMPTION IN ITALY



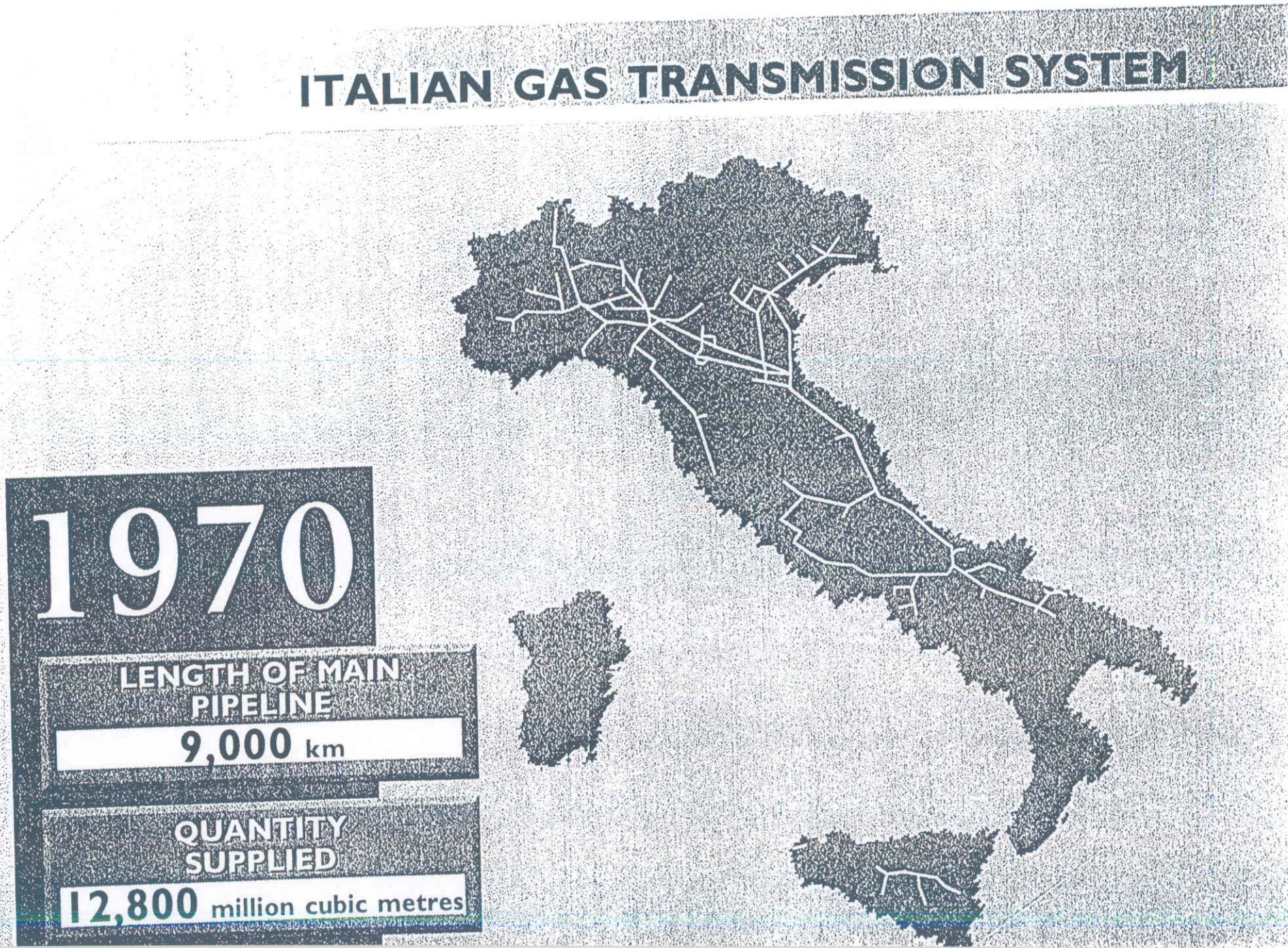
NATURAL GAS SHARE OF PRIMARY ENERGY DEMAND



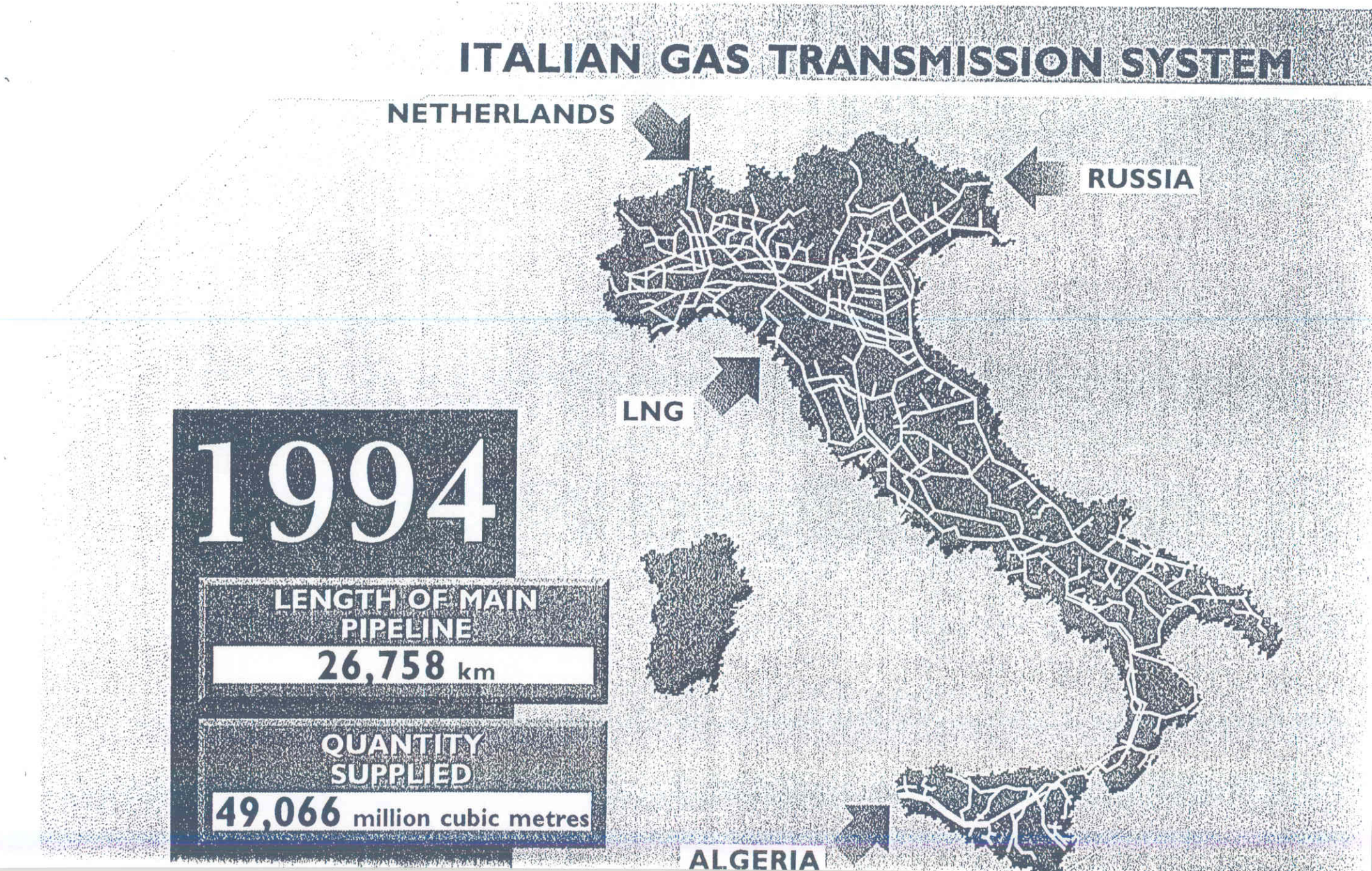
ITALIAN GAS TRANSMISSION SYSTEM



ITALIAN GAS TRANSMISSION SYSTEM

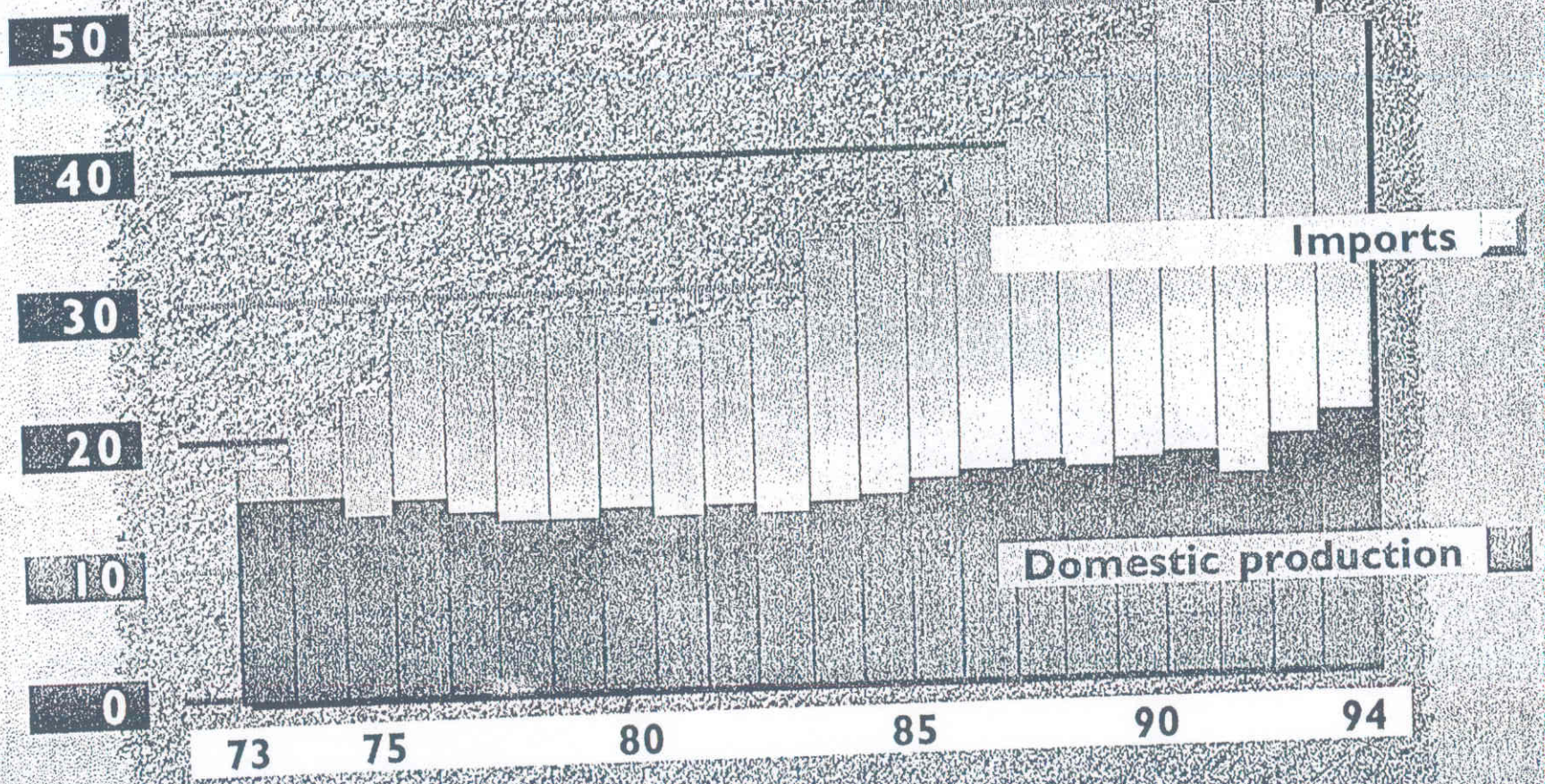


ITALIAN GAS TRANSMISSION SYSTEM



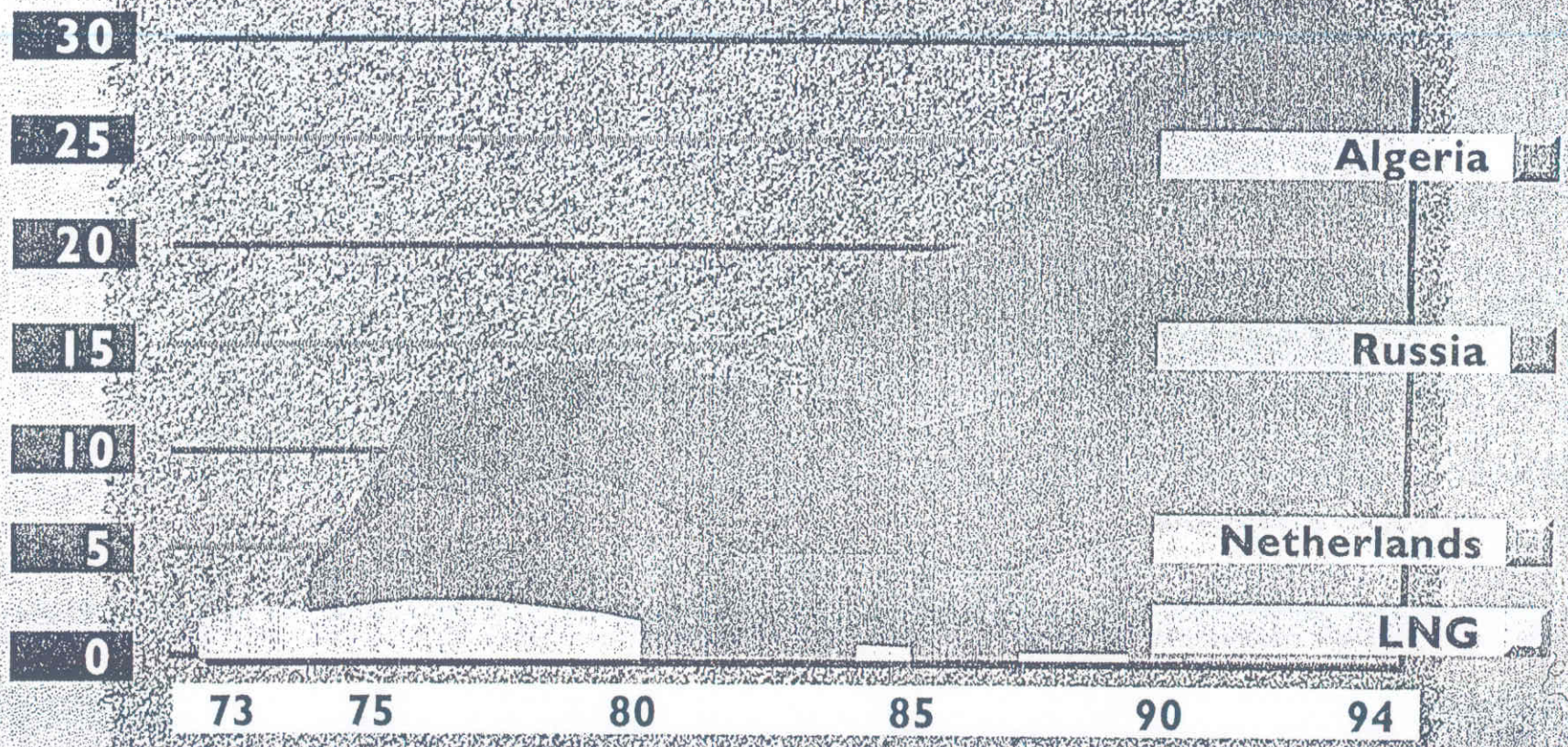
SNAM NATURAL GAS SUPPLIES

Billion cubic metres

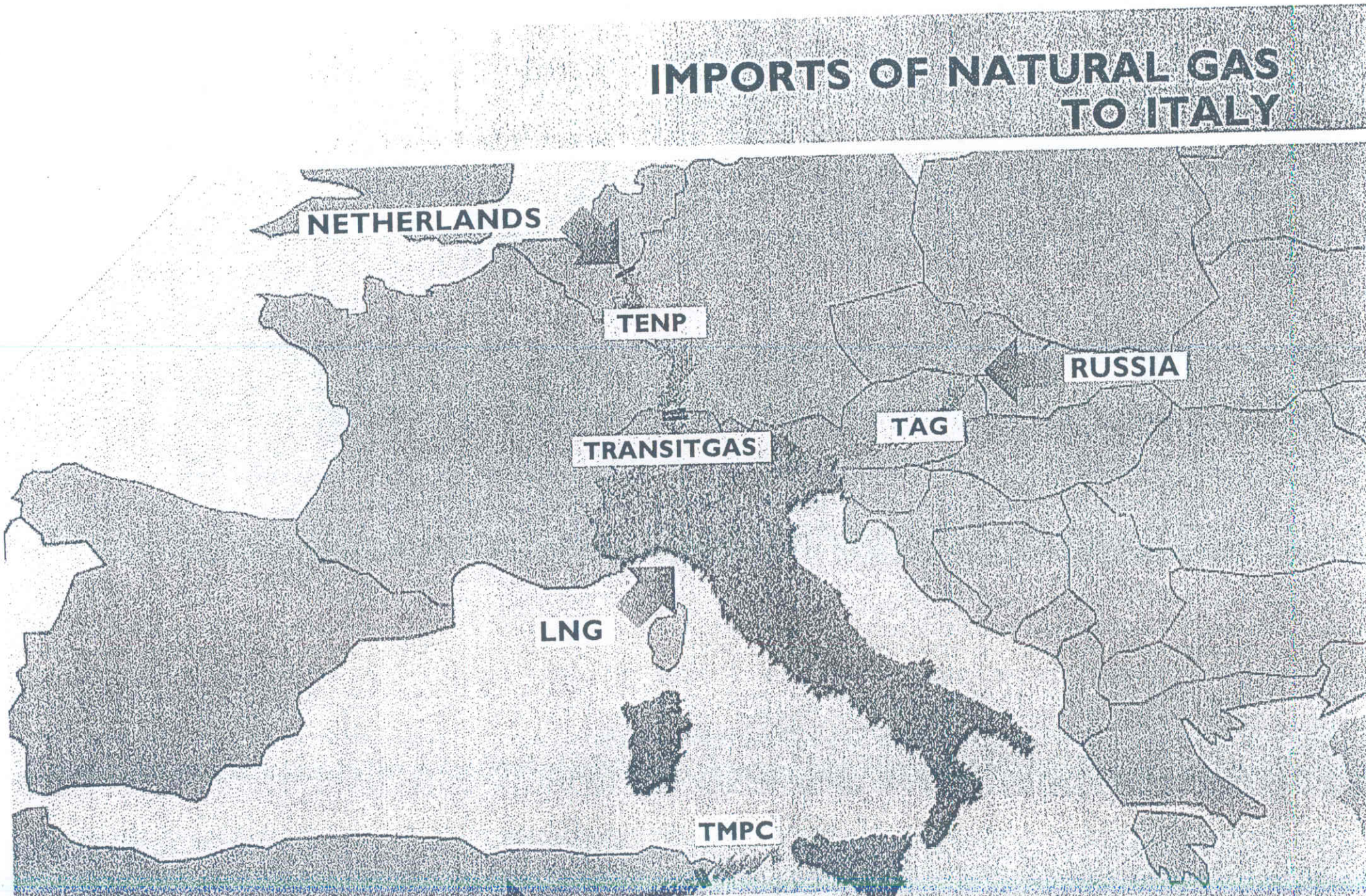


SNAM NATURAL GAS IMPORTS

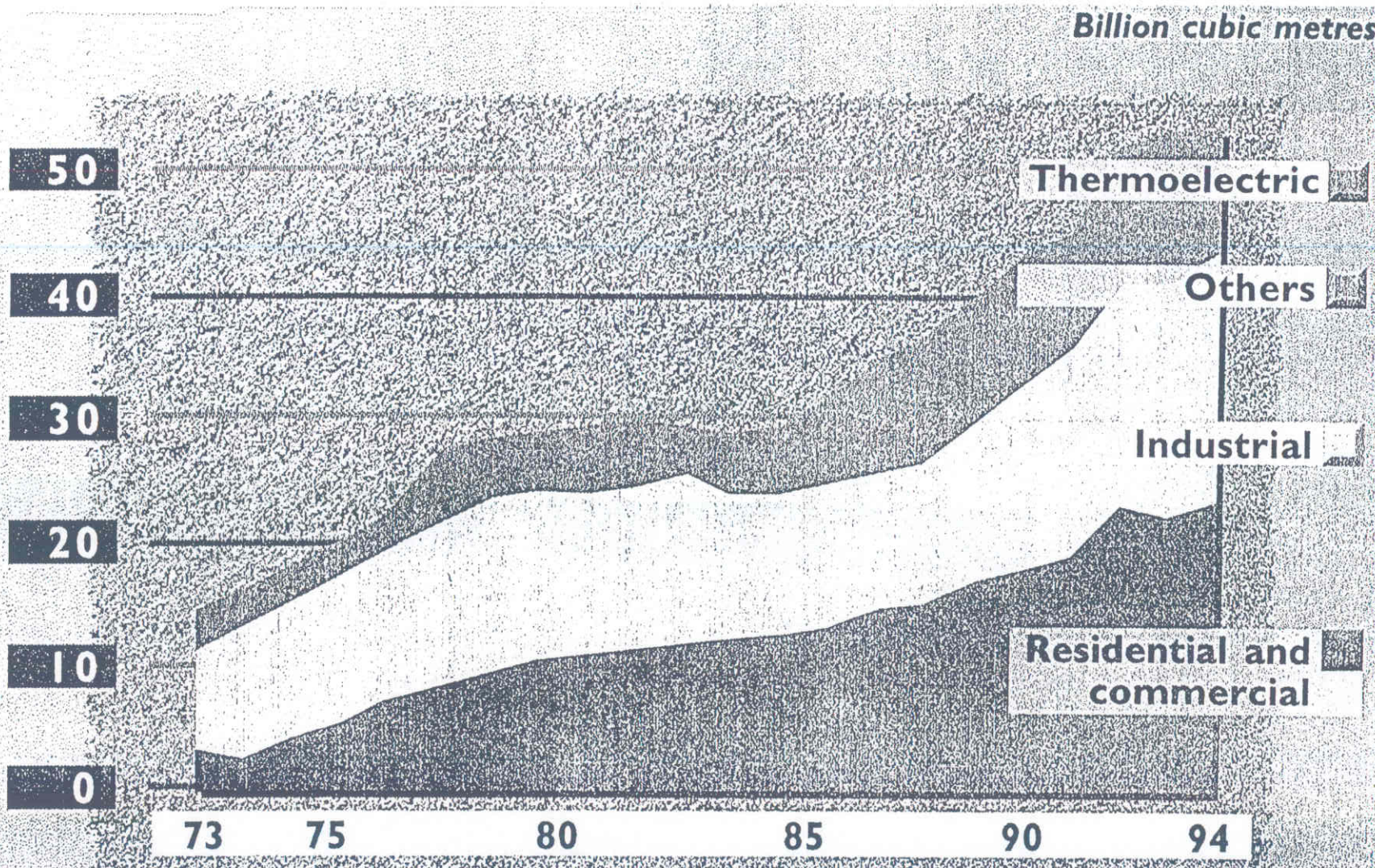
Billion cubic metres



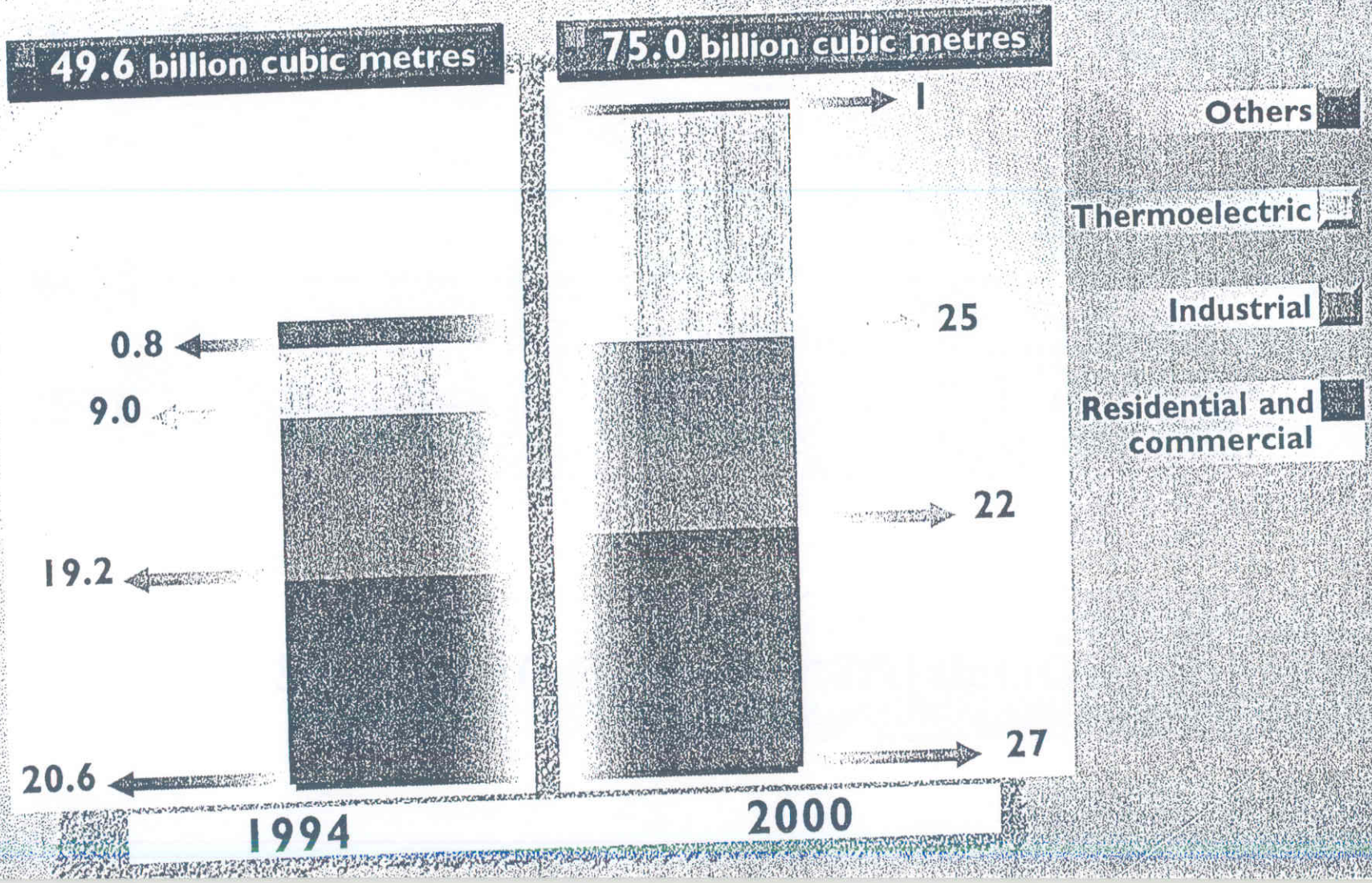
IMPORTS OF NATURAL GAS TO ITALY



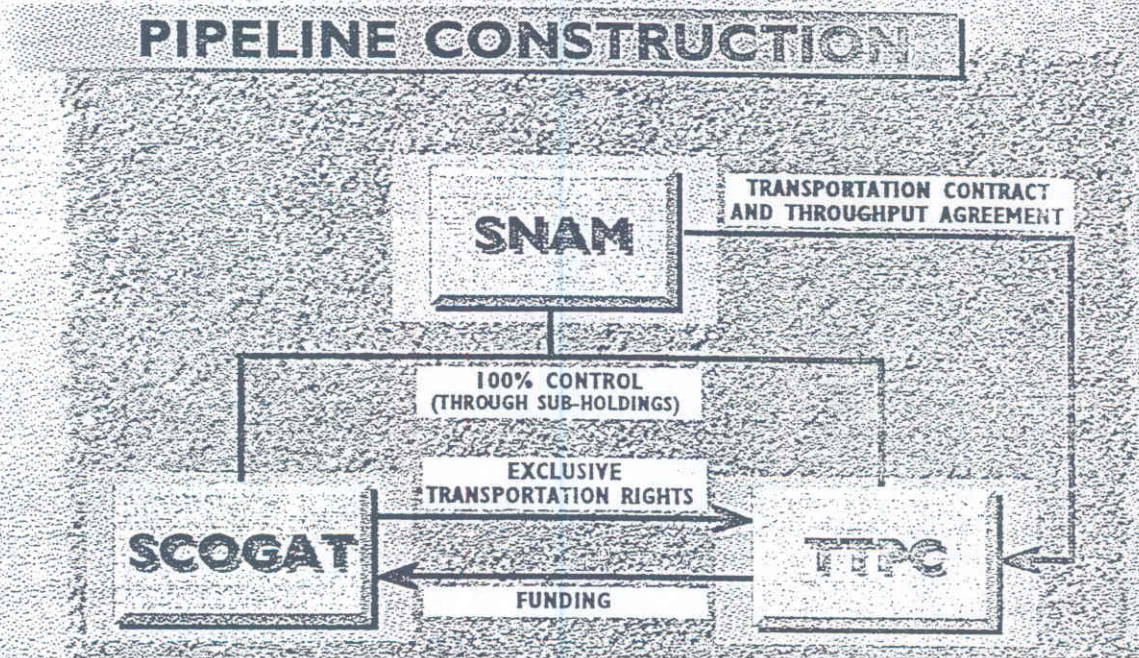
NATURAL GAS CONSUMPTION IN ITALY BY SECTOR

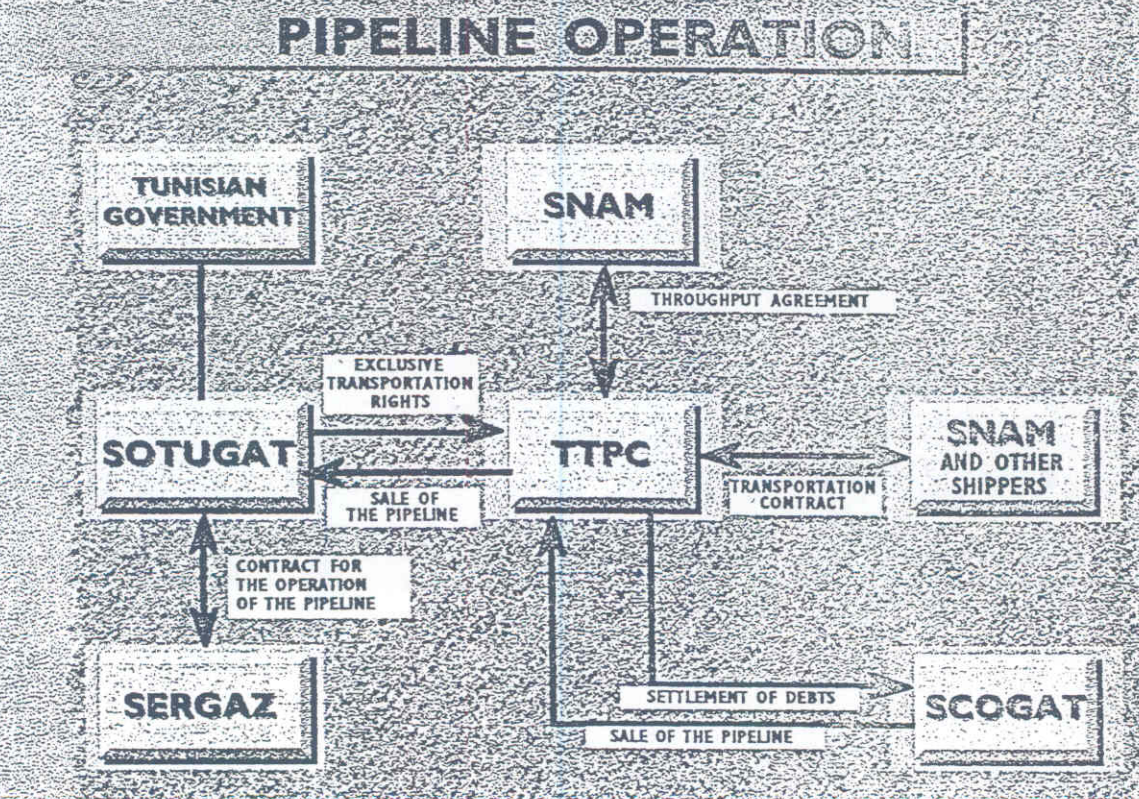


DEVELOPMENT OF NATURAL GAS CONSUMPTION IN ITALY

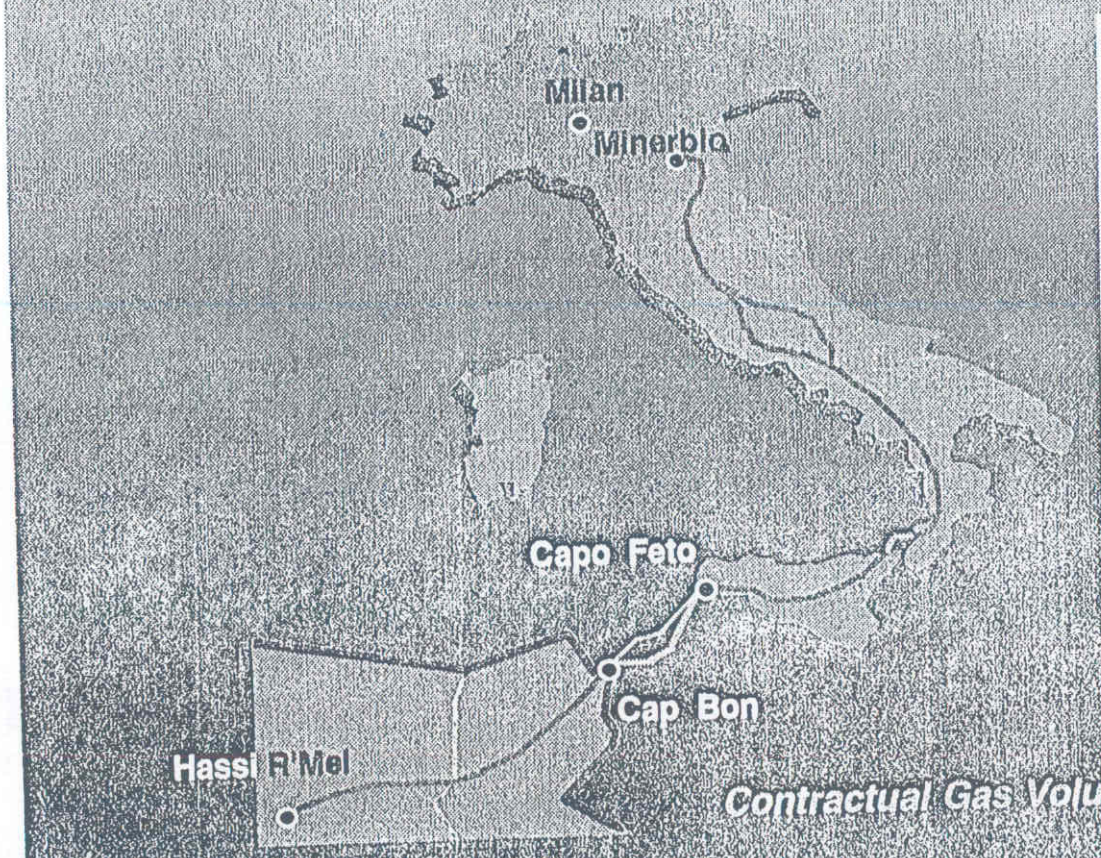


TUNISIAN SECTION: PIPELINE CONSTRUCTION AND OPERATION





Transmed Project development



Section	Km
Algeria	550
Tunisia	370
Sicily Strait	155
Sicily	350
Messina Strait	15
Italian Pen.	915
Total	2355

Contractual Gas Volume: 12 Mld m3 / y 23

Transmed Project — Sicily Strait

ITALIAN-ISRAELI BI-NATIONAL CONFERENCE ON NATURAL GAS

IEC PARTICIPATION IN THE NATURAL GAS PROJECT IN ISRAEL

PRESENTED BY:

G. Schaffer

Israel Electric Corporation Ltd.

JUNE 19th 1996

IEC Participation in the Natural Gas Project in Israel

by G. Schaffer, IEC

The following figures, presented in the conference, illustrate the IEC program for the purchase and use of Natural Gas.

Following the policy statement (Fig.1), policy highlights are outlined (Fig. 2). It should be emphasized that not on all points agreement has been reached with the Israeli government or the sellers. The structure of the negotiation with E.T.G.C. (fig. 3) is very unique and IEC has expressed its desire, as the dominant buyer, to be more involved in all the aspects of the gas chain.

Program objectives are specified in Fig. 4 and the scope of work in Fig. 5. Fig. 6, relating prices of alternative fuels in Israel, including the tax levels, is crucial for understanding the rate of gas penetration to the country. Border gas prices in Europe, Japan and U.S. are enclosed, for comparison, in Fig. 7. An average border price of 2.7$/MMBtu (HHV) would compare to about 3 $/MMBtu (LHV) or 120 $/TON HFO (LHV).
Fig. 8 & 9 compare sources of coal import to Israel with potential Natural Gas sources. The added risks of gas supply becomes very clear.

The share of Natural Gas in the installed capacity, until the year 2010, is shown in Fig. 10, to be over 50%. The location of the gas powered stations, is given for the year 2005, assuming a consumption of 2.5 BCM. The converted HFO stations along the coast will consume over 23% of the gas.

POLICY HIGHLIGHTS

* Direct negotiation with seller

  ** Resell rights

* Partnership in Transportation

  ** Ownership

  ** Operations

* Competitive Gas prices

* Dual-fuel stations

* 50% coal. single Gas source< 25%

* LNG

* Gas quantities as per IRP

* Program synchronization

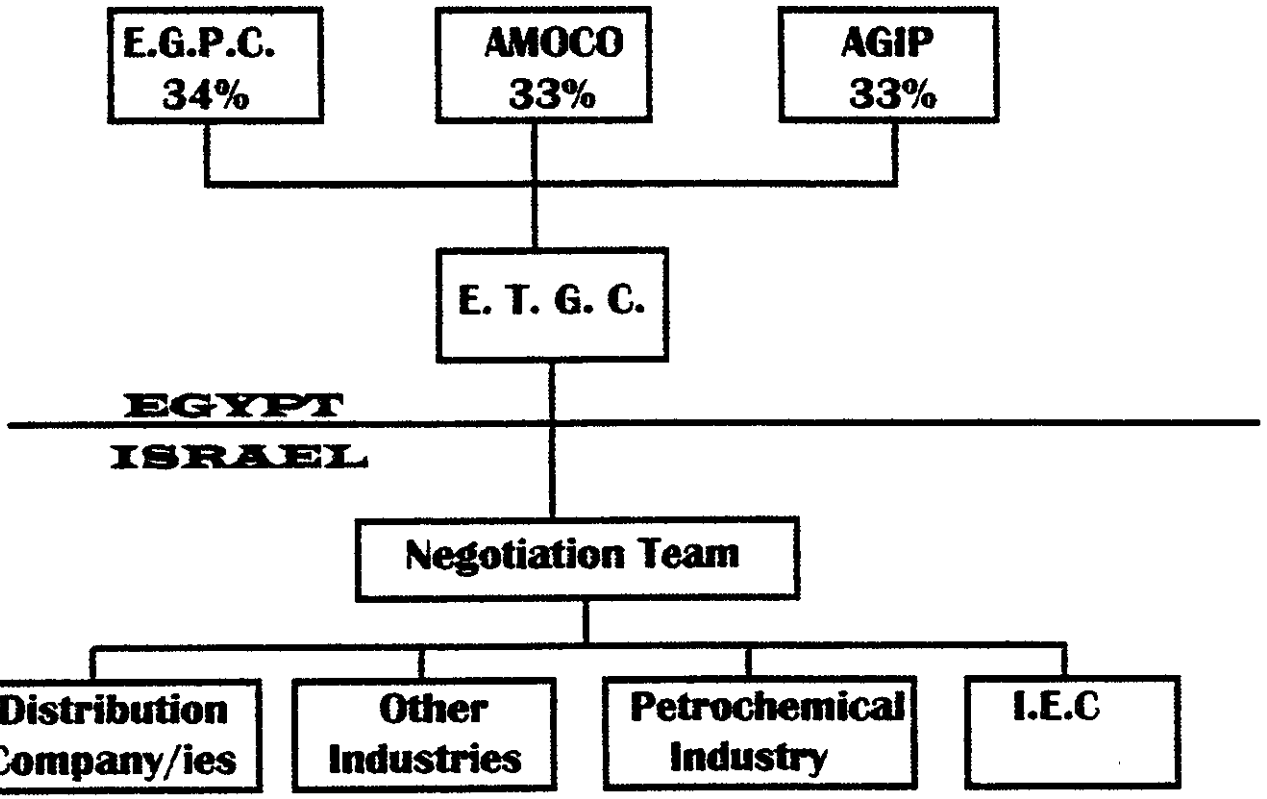
* Tariff synchronization

POLICY STATEMENT

IEC will be the predominant user of gas in Israel and will shoulder the main burden of the cost of infrastructure & operation.

IEC will therefore strive to maximize its involvement in all stages of purchasing the gas & transporting it to the power stations to verify its compatibility in quality, availability & price.

NEGOTIATIONS WITH THE ARAB REPUBLIC OF EGYPT



N.B.

1. **E.T.G.C. holds the sole concession to export Egyptian gas.**

2. **Any company desiring to export gas from Egypt will need to do so through E.T.G.C.**

3. **The agreement reached with E.T.G.C. will be endorsed by the Egyptian Ministry of Petroleum.**

4. **E.T.G.C. requires that the supply of gas to the Palestinian Authority or Jordan will be negotiated directly with the E.T.G.C.**

PROGRAM OBJECTIVES

1. Diverse & secure fuel supply.

2. Reduce fuel costs.

3. Reduce environmental effects

BE COMPETITIVE !

IEC NATURAL GAS PROGRAM

Includes all aspects of converting to the use of Natural Gas as fuel for Power Generation.

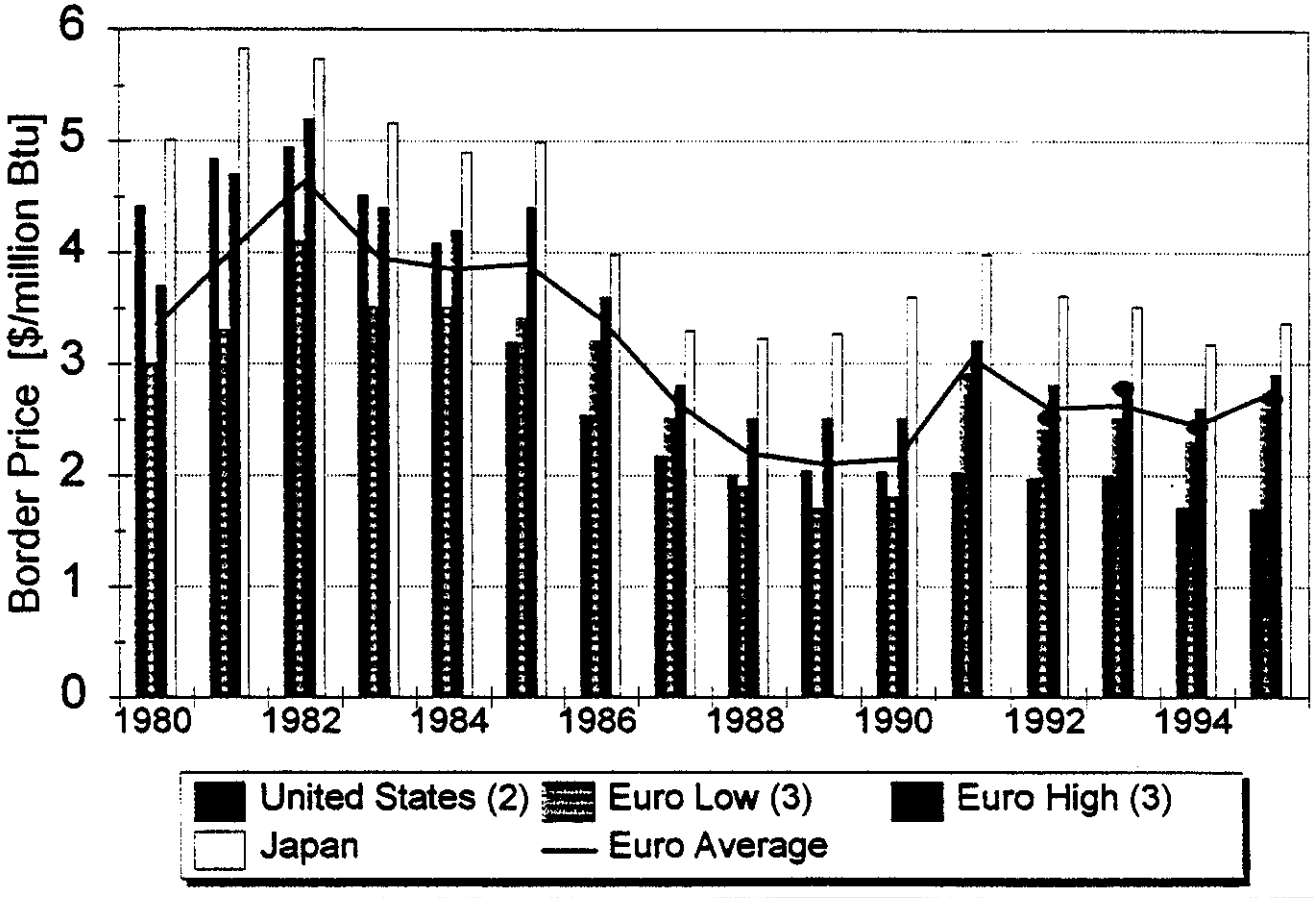
* **HFO station conversion**
* **New combined-cycle power station**
* **Purchase & transportation of the gas**
* **Storage**
* **Safety, licensing & training**
* **System operation**

COST OF FUEL
FOR POWER PRODUCTION
ISRAEL, JUNE 96'

	$/TON	$/TOE	%TAX
COAL(6500 KCal/Kg)	43.5	67.4	3.8
HFO (2%S)	112.5	112.5	2.1
(1%S)	125.5	125.5	2.2
(0/5%S)	143.5	143.5	2.0
DIESEL OIL			
(0.2%S)	220.0	209.0	14.0

Natural Gas Prices

1980 - Jan.1995 (Cedigaz)



COAL SOURCES

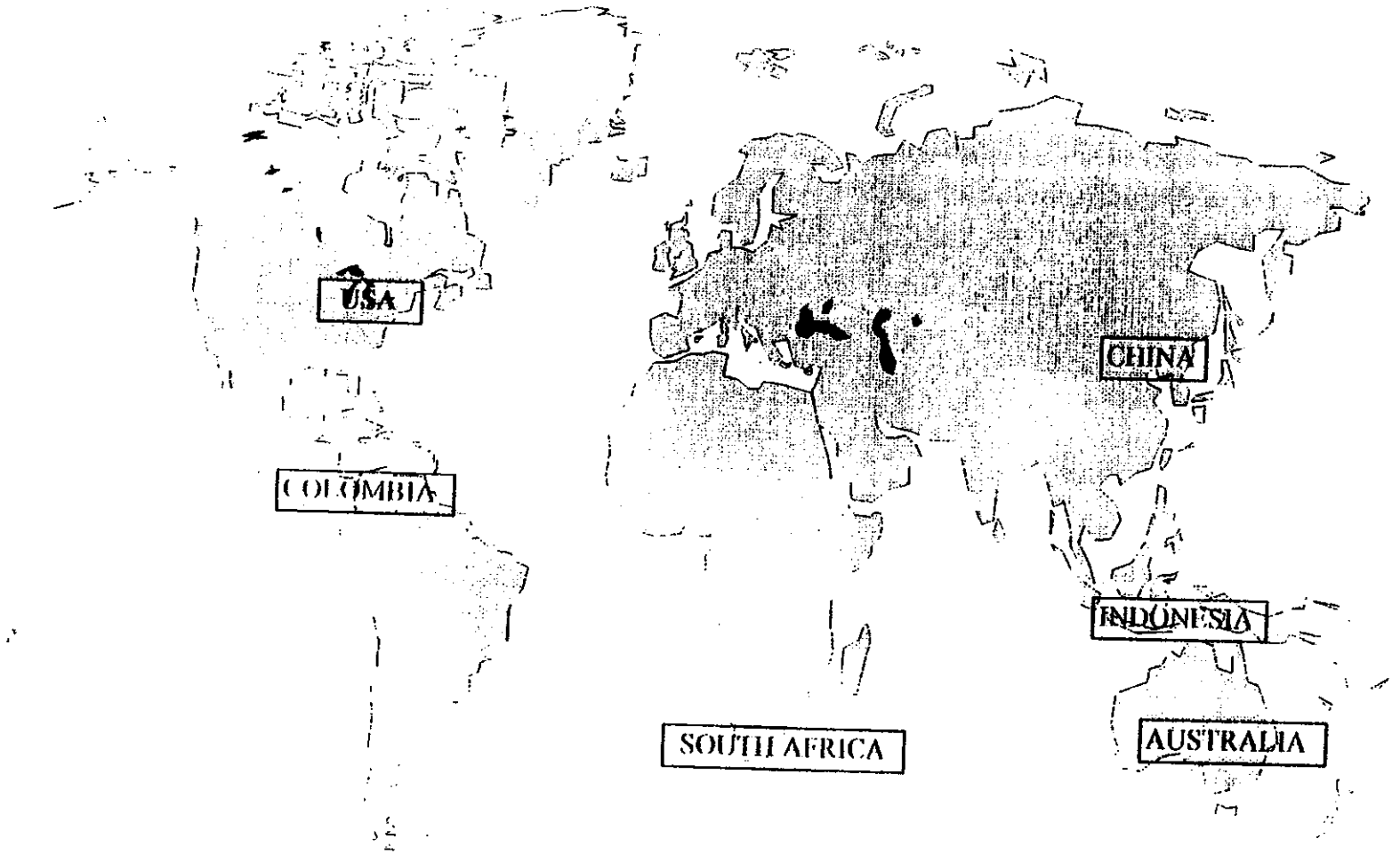


FIG. No. 8

POTENTIAL GAS SOURCES

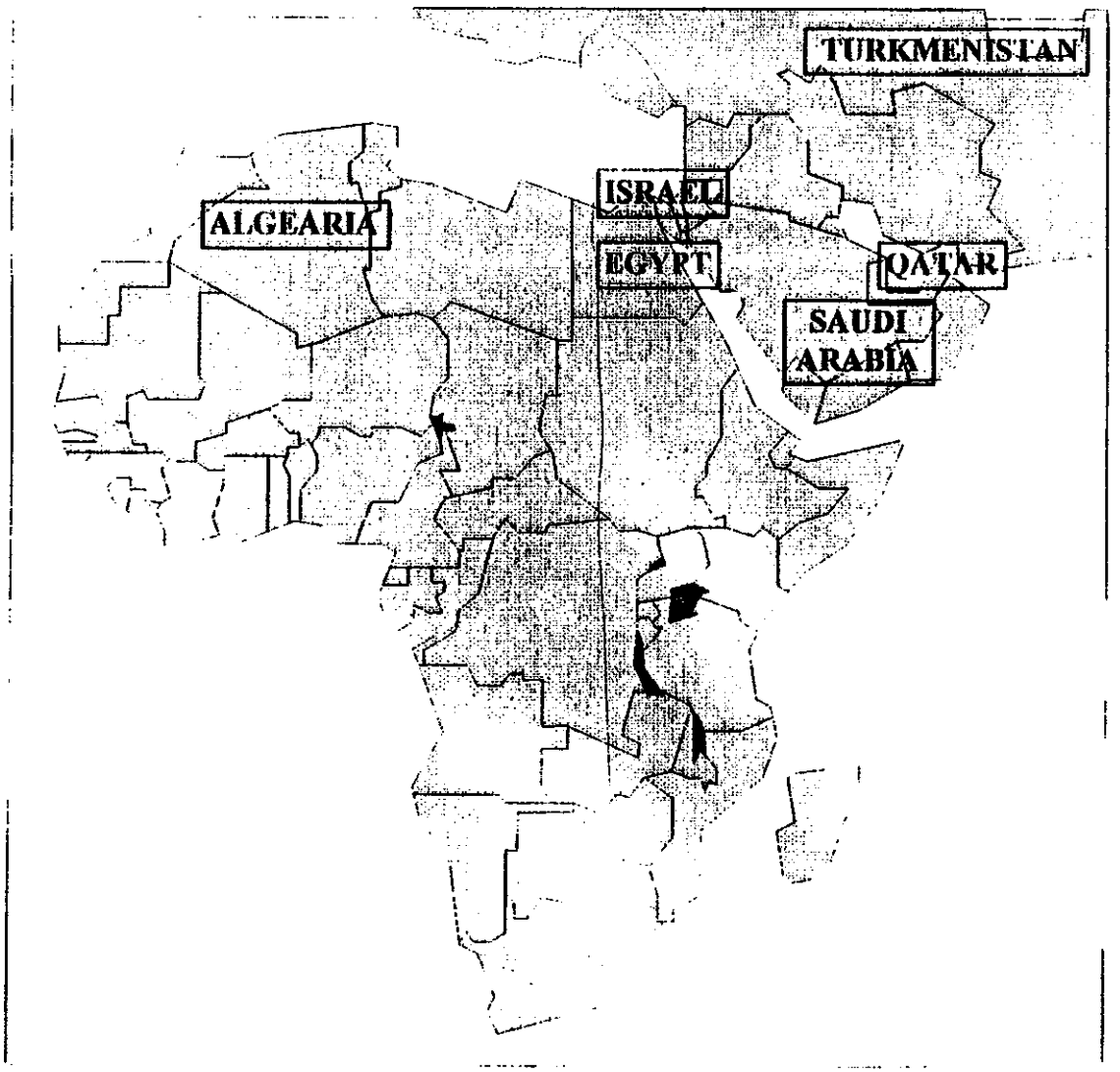
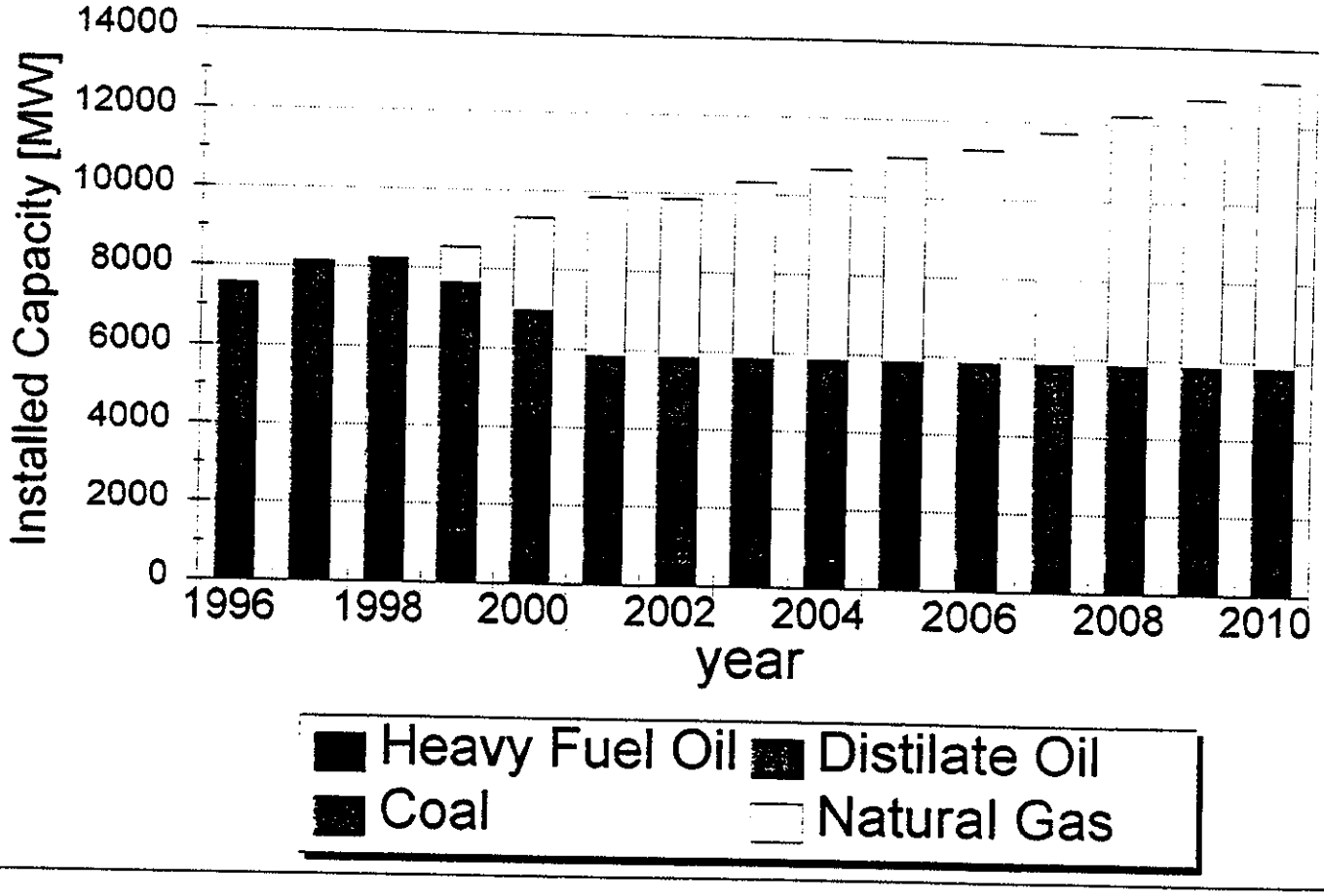


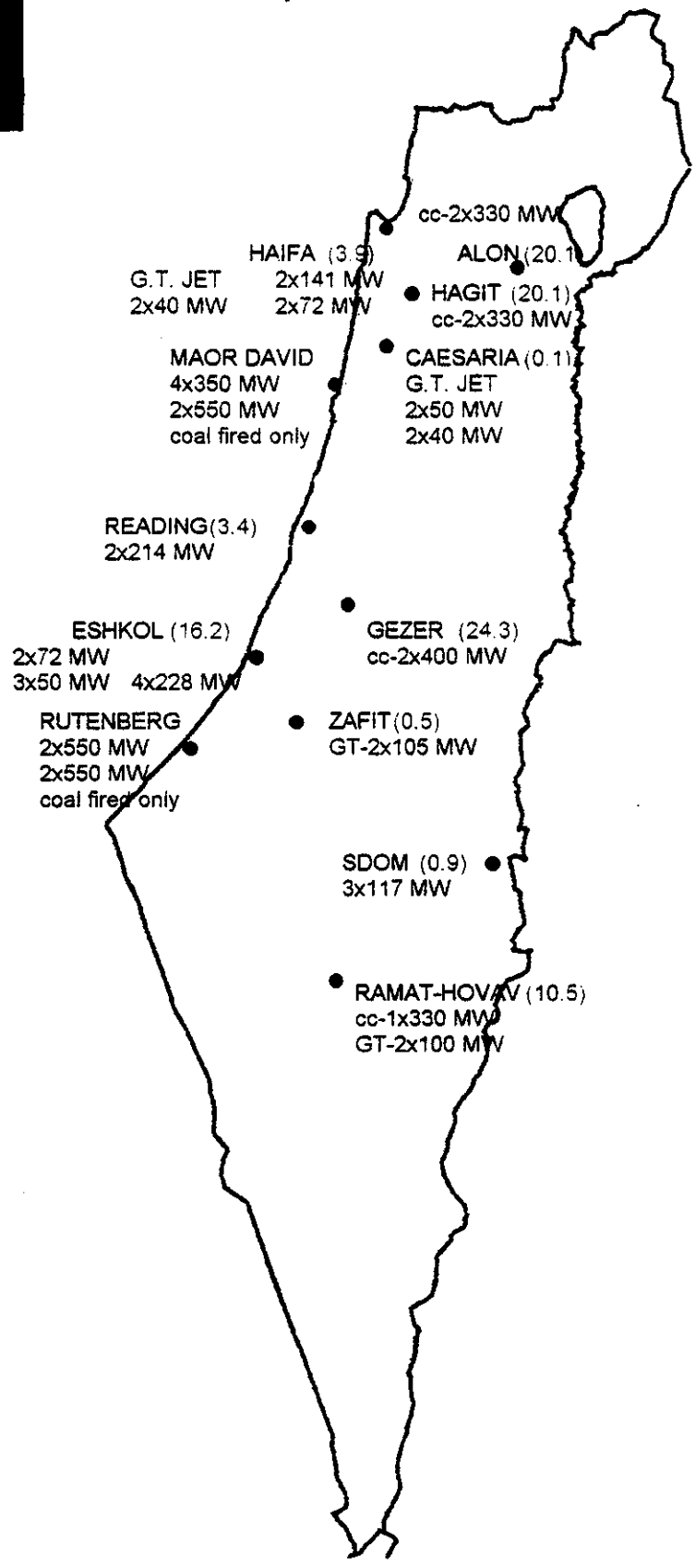
FIG. No. 9

IEC Generation Plan

Natural Gas Scenario



Development Plan Based on Natural Gas (2005)



(XX) - PERCENTAGE OF TOTAL NATURAL GAS CONSUMPTION IN 2005 (2.5 BCM)

Snam

BREAKDOWN OF ENERGY CONSUMPTION AND PRINCIPAL USES OF NATURAL GAS IN THE INDUSTRIAL SECTOR IN ITALY

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Head of Technical Consultancy Service

Butler Auditorium, The S. Neaman Institute
Technion, Israel
June 19th, 1996

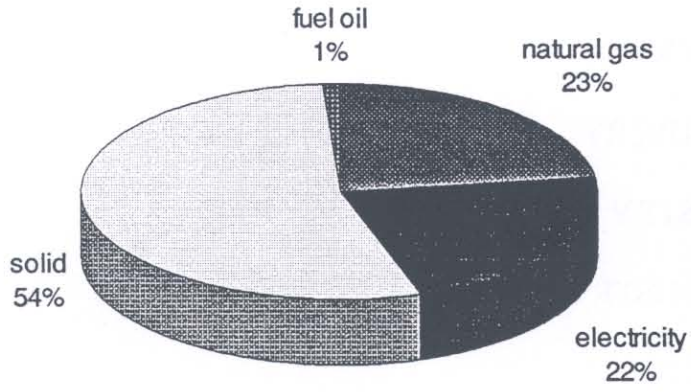
CONTENTS

The document explains the most important uses of natural gas in the several industrial sectors and shows the other energy sources which are compatible with the technology in use and could be substituted for it.

Attention is also drawn to the various energy source percentages with respect to the production sectors examined, the gas share of the thermal use market and the ratio sector gas consumption over total gas consumption for the industry.

IRON AND STEEL INDUSTRY

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES



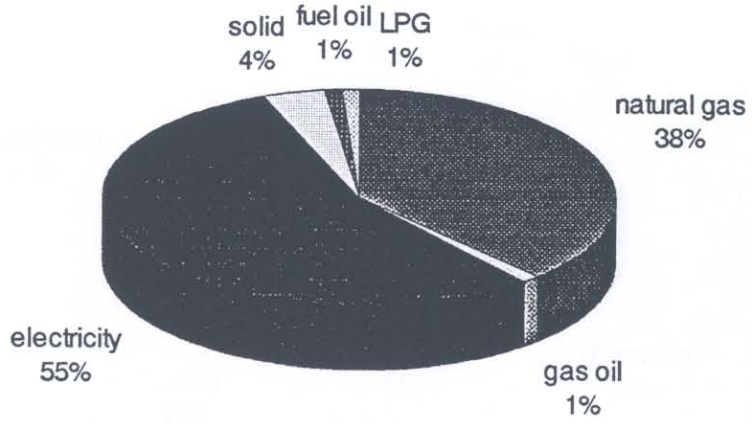
Percentage share of natural gas in the market of thermal uses = 94%
Percentage share of natural gas sector sales on natural gas industry sales = 11%

IN THE IRON AND STEEL INDUSTRY, NATURAL GAS IS MAINLY USED IN THE REHEATING FURNACE, WHERE SEMI-FINISHED PIECES FROM THE STEELWORKS ARE BROUGHT TO THE RIGHT TEMPERATURE FOR THE FOLLOWING PROCESSES SUCH AS LAMINATION, EXTRUSION AND FORGING. ANOTHER GAS USE, ALTHOUGH TO A LESSER EXTENT, IS THE INJECTION TOGETHER WITH OXYGEN (OXICOMBUSTION) IN THE ARC FURNACE, IN ORDER TO ENCOURAGE AND ACCELERATE SCRAP MELTING.
GAS IS ALSO USED IN BLAST-FURNACES AND CONVERTERS, BUT THESE ARE AUXILIARY AND FAIRLY MARGINAL USES.

COMPETING ENERGY SOURCES	FUEL OIL
	ELECTRICITY

NONFERROUS METAL INDUSTRY

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES



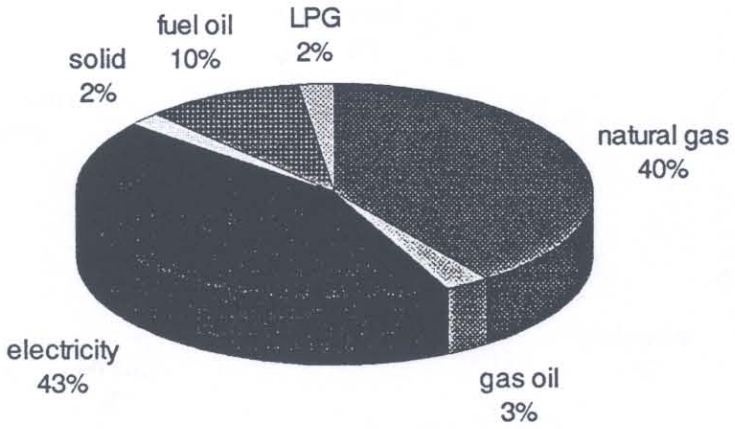
Percentage share of natural gas in the market of thermal uses = 94%
Percentage share of natural gas sector sales on natural gas industry sales = 2%

IN TERMS OF NATURAL GAS CONSUMPTION THE NONFERROUS METAL SEGMENT IS NOT A PARTICULARLY IMPORTANT ONE.
NATURAL GAS IS MAINLY USED IN SECONDARY PRODUCTION (SCRAP MELTING AND REFINING) AND IN THE HEATING OF BILLETS FOR LAMINATION, EXTRUSION ETC..

COMPETING ENERGY SOURCE	FUEL OIL

MECHANICAL INDUSTRY
CAR INDUSTRY – FOUNDRIES – MISCELLANEOUS MECHANICAL

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES



Percentage share of natural gas in the market of thermal uses = 70%
Percentage share of natural gas sector sales on natural gas industry sales = 11%

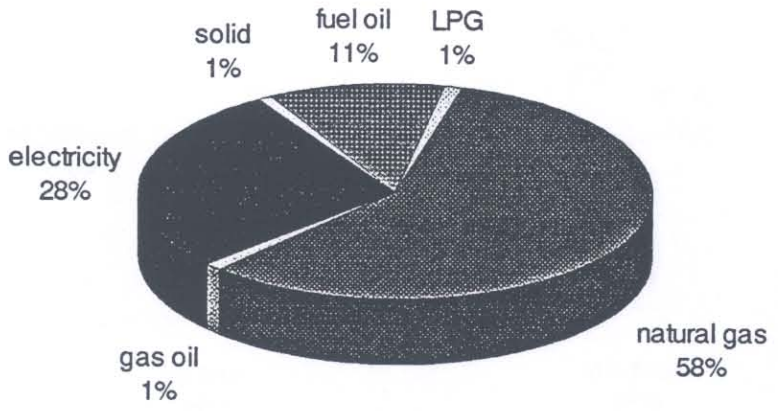
THE MOST IMPORTANT USES OF NATURAL GAS IN THE MECHANICAL INDUSTRY ARE: PRODUCTION OF SECONDARY THERMAL CARRIER FLUIDS (STEAM, SUPER-HEATED WATER ETC.) USED FOR ENVIROMENTAL HEATING OR TREATMENT TANKS, SECONDARY CASTING OF CAST-IRON INGOTS AND INGOTS OF OTHER NON-FERROUS METALS FROM METAL INDUSTRIES AND IN THE THERMAL TREATMENT OF PRODUCTS TO GIVE THE REQUIRED MECHANICAL CHARACTERISTICS OF RESISTANCE, TOUGHNESS AND HARDNESS.

COMPETING ENERGY SOURCES	FUEL OIL
	LPG

FOOD INDUSTRY

SUGAR INDUSTRY – CONFECTIONERY – MILK/CHEESE – PASTA – OTHERS

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES



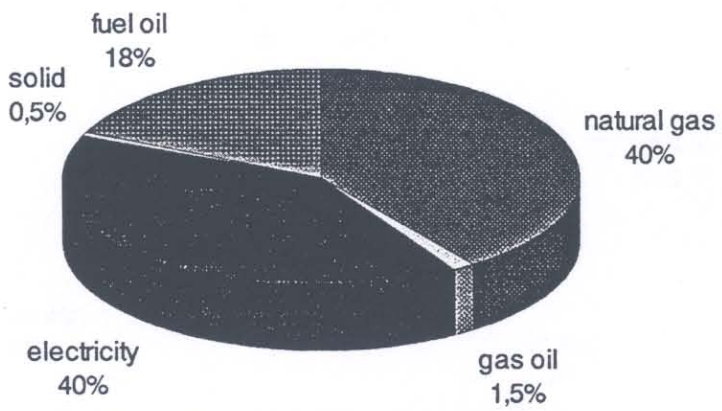
Percentage share of natural gas in the market of thermal uses = 79%
Percentage share of natural gas sector sales on natural gas industry sales = 10%

IN THE FOOD INDUSTRY, NATURAL GAS IS MAINLY USED TO PRODUCE STEAM, SUPER-HEATED WATER AND HOT WATER. THERE ARE ALSO A NUMBER OF DIRECT USES FOR COOKING AND DRYING PRODUCTS FOR MASS CONSUMPTION, ALTHOUGH THESE ARE DEFINITELY MINOR USES COMPARED WITH BOILER USES.

COMPETING ENERGY SOURCES	**FUEL OIL**
	GAS OIL
	LPG

TEXTILE INDUSTRY
TEXTILE FINISHING – TEXTILE INDUSTRIES

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES

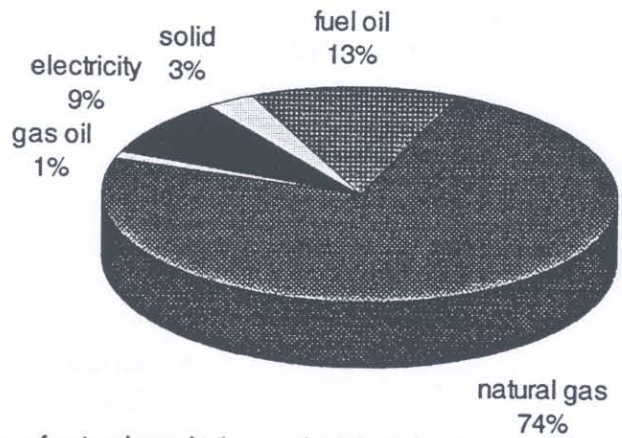


Percentage share of natural gas in the market of thermal uses = 67%
Percentage share of natural gas sector sales on natural gas industry sales = 6%

TEXTILE INDUSTRY OPERATIONS SUCH AS WASHING, DYEING, PRINTING, FINISHING, DRYING ETC. USE LARGE QUANTITIES OF STEAM, HOT WATER AND DIATHERMIC OIL.
THE MAIN USE OF NATURAL GAS IN THIS SECTOR IS IN BOILER. THERE ARE ALSO SOME DIRECT USES OF NATURAL GAS IN THE PRODUCTION PROCESS (E.G. HEAT FIXING (RAMEUSE)), BUT OVERALL CONSUMPTION FOR THESE PURPOSES IS FAIRLY SMALL.

COMPETING ENERGY SOURCES	FUEL OIL
	LPG

BRICK INDUSTRY



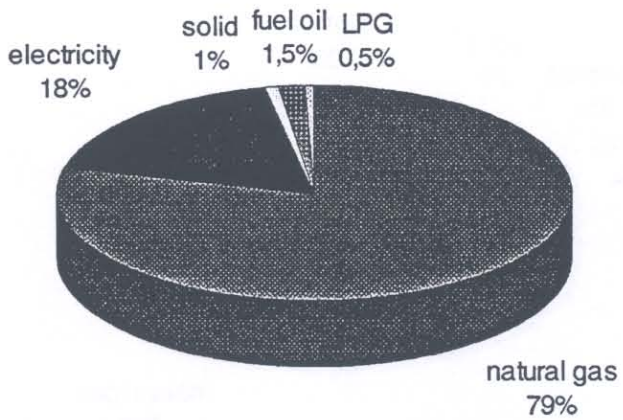
Percentage share of natural gas in the market of thermal uses = 81%
Percentage share of natural gas sector sales on natural gas industry sales = 4%

THE MAIN THERMAL PROCESSES INVOLVED IN THE BRICK INDUSTRY ARE DRYING, WHICH USES 35% OF GAS CONSUMED, AND FIRING, WHICH USES 65%.
DRYING IS USUALLY DONE USING DIRECT OR INDIRECT TYPE HOT AIR GENERATORS.
THE TUNNEL KILN IS INSTEAD THE PREDOMINANT TECHNOLOGY FOR FIRING THE MATERIAL.
NATURAL GAS IS ALSO USED, ALTHOUGH TO A LESSER EXTENT, IN NEW SYSTEMS, SUCH AS FAST FIRING ROLLER KILNS, WHICH ARE A RECENT INNOVATION IN THIS SECTOR.

COMPETING ENERGY SOURCES	FUEL OIL
	LPG

CERAMIC INDUSTRY
TILES - POTTERY - SANITARY WARE - REFRACTORY

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES



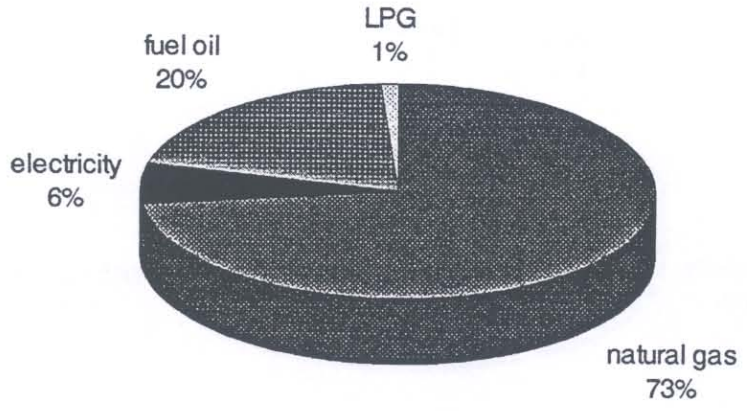
Percentage share of natural gas in the market of thermal uses = 96%
Percentage share of natural gas sector sales on natural gas industry sales = 8%

IN THIS SECTOR NATURAL GAS HAS REACHED A PRIVILEGED POSITION, THANKS TO ITS CHARACTERISTICS THAT ENABLE TO HAVE HIGH-QUALITY FINISHED PRODUCTS AND TO ITS USE IN HIGH-EFFICIENCY SYSTEMS, SUCH AS ROLLER KILNS, SPRAY DRIERS, FAST DRIERS ETC..
ITS UNIQUE PROPERTIES MAKE IT VIRTUALLY IRREPLACEABLE WITH OTHER FUELS, OR AT LEAST REPLACEABLE ONLY WITH ENERGY SOURCES CAPABLE OF OFFERING THE SAME RESULTS (E.G. LPG).
THE REFRACTORY SEGMENT IS AN EXCEPTION, NOTABLE FOR ITS MUCH LOWER LEVEL OF TECHNOLOGY AND FUEL SUBSTITUTION CONDITIONS.

COMPETING ENERGY SOURCES	LPG
	FUEL OIL (refractory materials)

GLASS INDUSTRY
BOTTLE GLASS – FLAT GLASS – OTHER PRODUCTS

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES



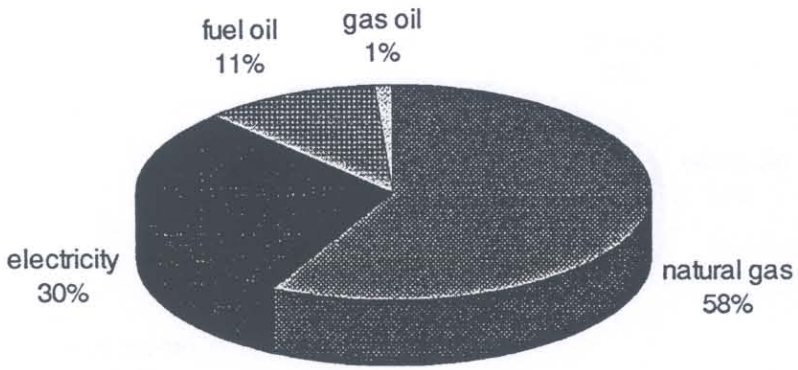
Percentage share of natural gas in the market of thermal uses = 78%
Percentage share of natural gas sector sales on natural gas industry sales = 5%

THE GLASS INDUSTRY INCLUDES THE PRODUCTION AND WORKING OF BOTTLE GLASS, FLAT GLASS, TECHNICAL GLASS AND ARTISTIC GLASS. MELT IS THE MOST IMPORTANT THERMAL PROCESS AND THE ONE WITH THE HIGHEST CONSUMPTION, IT IS CARRIED OUT IN KILNS WHICH DIFFER CONSIDERABLY IN CONSTRUCTION AND CAPACITY.
THE MOST COMMON TYPES ARE THE TANK FURNACES PRODUCING INDUSTRIAL GLASS, WHILE POT FURNACES ARE TYPICALLY USED FOR ARTISTIC GLASS PRODUCTION.
THE THERMAL TREATMENT OF THE FINISHED PRODUCTS (TEMPERING, RE-FIRING ETC.) IS LESS SIGNIFICANT IN TERMS OF CONSUMPTION.

COMPETING ENERGY SOURCES	FUEL OIL
	LPG (heat treatment)

PAPER INDUSTRY

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES



Percentage share of natural gas in the market of thermal uses = 82%
Percentage share of natural gas sector sales on natural gas industry sales = 10%

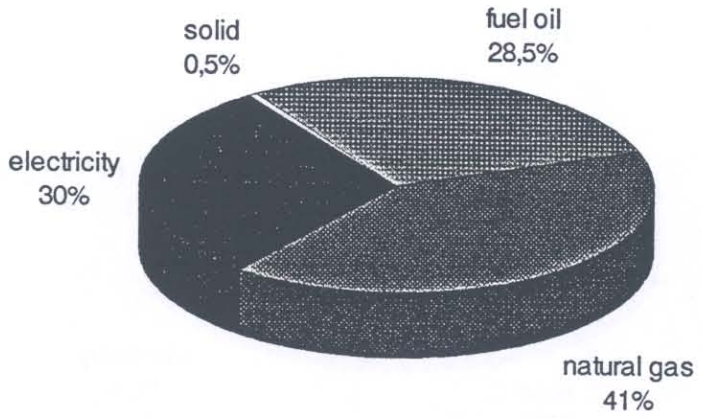
IN THE PAPER INDUSTRY NATURAL GAS IS MAINLY USED IN BOILERS. THE PAPER PRODUCTION PROCESS REQUIRES LARGE QUANTITIES OF STEAM AND HOT WATER, BOTH FOR PULP PREPARATION AND, ABOVE ALL, FOR THE DRIER DRUMS USED TO DRY THE SHEET BY THE PRODUCTION LINE.

COMPETING ENERGY SOURCE	FUEL OIL

CHEMICAL INDUSTRY

PRIMARY CHEMICAL PROCESSES – SECONDARY CHEMICAL PROCESSES – PHARMACEUTICALS – PETROLEUM AND COAL

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES



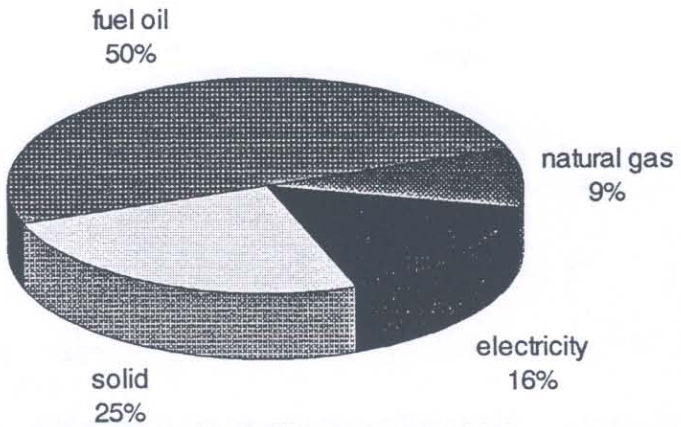
Percentage share of natural gas in the market of thermal uses = 76%
Percentage share of natural gas sector sales on natural gas industry sales = 17%

IN THE CHEMICAL INDUSTRY THE MAIN USE OF NATURAL GAS IS IN HEATING PLANTS PRODUCING STEAM, HOT WATER AND DIATHERMIC OIL.
NATURAL GAS IS FREQUENTLY USED IN ENERGY MIXES, ALONG WITH LIQUID FUELS AND OFF GAS FROM THE PROCESS.

COMPETING ENERGY SOURCE	FUEL OIL

LIME, CEMENT AND PLASTER INDUSTRY

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES



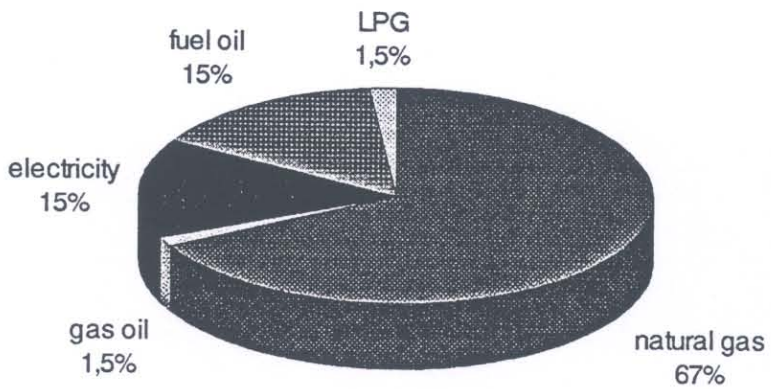
Percentage share of natural gas in the market of thermal uses = 11%
Percentage share of natural gas sector sales on natural gas industry sales = 2%

NATURAL GAS IS MAINLY USED IN THE PRODUCTION OF LIME FOR THE STEEL INDUSTRY, THE CHEMICAL INDUSTRY, MINERAL PROCESSING, FLUE-GAS DESULPHURISATION ETC.
FOR WHAT CONCERNS THE CEMENT PRODUCTS, NATURAL GAS PRESENCE IS FAIRLY MARGINAL, BECAUSE THE PROCESS ALLOWS USE OF LIQUID AND SOLID FUELS WITHOUT ANY PARTICULAR PROBLEMS IN REGARD TO POLLUTANT EMISSIONS OR PRODUCT QUALITY.

COMPETING ENERGY SOURCE	FUEL OIL

RUBBER AND PLASTICS INDUSTRY

PERCENTAGE SHARE OF THE DIFFERENT ENERGY SOURCES



Percentage share of natural gas in the market of thermal uses = 50%
Percentage share of natural gas sector sales on natural gas industry sales = 2%

IN THE RUBBER INDUSTRY NATURAL GAS IS MAINLY USED FOR THE PRODUCTION OF STEAM AND HOT WATER IN THE TYRE PRODUCTION. THERE ARE ALSO DIRECT USES OF GAS, ABOVE ALL IN THE PLASTICS SEGMENT FOR PRODUCT MODELLING AND MOULDING.

COMPETING ENERGY SOURCES	FUEL OIL
	LPG

Italian-Israeli Bi-National Conference on Natural Gas

The Use of Natuaral Gas in Power Generation

G. Visigalli
SNAM

Haifa, June 19, 1996

THE USE OF NATURAL GAS IN POWER GENERATION

Author : G. Visigalli - SNAM (Milan)

The subject of this paper is the generation of electricity, particularly using natural gas.

The natural gas demand in the world is forecast to increase rapidly over the next period, as shown in fig. 1.

Two scenarios have been considered: **Capacity Constraints**, where trends in past behaviour are assumed to continue to dominate future energy consumption patterns, and **Energy Savings** case, where external imposed additional energy efficiency improvements are assumed to be greater than those suggested by past behaviour.

Under the capacity constraints assumption natural gas is the fastest growing fossil fuel; with an average annual growth rate of 2.5 per cent from '92 to 2010.

In absolute terms, world gas consumption rises from 1745 Mtoe in '92 to 2708 Mtoe by 2010 and increases its fuel share in total primary energy demand from 22 per cent to 23.6 per cent over the same period.

In the **Energy Savings** case the global demand for natural gas is forecast to grow considerably less, and by less than the demand for total primary energy.

Thus, instead of increasing by more than 50 per cent over the period from '92 to 2010, as in the capacity constraints case, it grows by less than a third over the same period in the energy savings case.

The reasons for this significant difference in growth under the two set of assumption is linked to natural gas being the most economic fuel and thus the fuel of choice for new power generation projects.

With less growth in power generation, less gas is introduced.

In the recent past, technological improvements in the design, efficiency and operation of combined cycle gas turbines have moved the economics of power generation in favour of natural gas.

Gas fuelled power plants have lower capital costs, are quicker to build, have more efficiency and emit less air pollutants than other fossil fuel based power plants.

Consequently to the penetration of combined cycle plants, a major share of new power generation capacity is based on natural gas, and gas input into power generation is projected to grow at an annual average rate of about 5 per cent over the outlook period in the capacity constraints case.

In the energy savings case, however, demand for electricity is projected to grow more slowly. As a result, gas for power generation accounts for a significantly smaller share of the annual increase in gas demand, and gas accounts for a smaller share in primary energy demand by 2010 than in the capacity constraints case.

The increase in annual world electricity generation between 1992 and 2010 is projected to amount to around 8000 TWh in the capacity constraints case and 6000 TWh in the energy savings case.

Electricity generation per capita is expected to increase from 2.3 MWh per capita to 2.9 MWh per capita in the capacity constraints case and 2.6 MWh per capita in the energy savings case over the outlook period.

As shown in fig. 2, in the OECD, electricity generation per capita in the Pacific and Europe is projected to rise considerably faster than in North America, although the latter is expected to remain the region with the highest electricity generation per capita.

In the rest of the world, electricity generation per capita is expected to almost double from just under 0.7 Mwh per capita to around 1.2 Mwh per capita, still less than one sixth of electricity generation per capita in the OECD countries.

As said before, natural gas fuelled power plants have less air pollutants than other fossil fuel based power plants.

Much progress has been made in recent years to reduce the environmental impact of fossil fuels, but much has yet to be done, particularly to favour cleaner fuels and to develop low pollutant and highly efficient technologies. The use of natural gas in place of oil and coal is indicated by many authoritative sources as one of the most effective options to reduce the environmental impact of energy production.

Just because the emission of atmospheric pollutants are a consequence of the energy production from fossil fuel combustion, the quality and quantity of those ones are related to fuel characteristics and combustion technologies.

Natural gas combustion produces negligible amounts of sulphur oxides (SOx) and particulate matters (PST) and small quantities of carbon monoxide (CO) and volatile organic compounds (VOC), lower than those produced by the combustion of coal and oil. The only pollutants significantly produced by natural gas combustion are nitrogen oxides (NOx), but even NOx emissions are lower than those produced by other fuels for the same utilization, as natural gas does not contain organic nitrogen and favours the application of low-NOx combustion technology.

As shown in the fig. 3, carbon dioxide produced by natural gas is around 45% less than from coal and 25% less than from petroleum products, at the same level of energy utilization. The differences become even more significant if we consider emissions per unit

of usable energy, because natural gas can give higher combustion efficiencies than other fuels. Also the emissions of nitrous oxides (N2O) from natural gas combustion are lower than those from coal and oil products.

To understand how the use of natural gas can help to get the goal to reduce the pollutants, we can show what happened in Italy during the period 1970-1990, where the energy consumption increased from 120 to 163 Mtoe.

In percentage terms, the contribution to energy consumption remained practically constant for coal and primary electricity, dropped from 72.6% to 56.7% for oil products and increased from 8.8% to 24% of natural gas.

Making the reasonable conservative assumption that the increased consumption of natural gas was in substitution of petroleum products, atmospheric pollutants and carbon dioxide emissions in 1990 were reduced as shown in the table 1, relative to what would have been the case without this substitution.

To get a further limitation in the future of pollutants produced by fossil fuels the following options have to be considered:

- improvement of energy efficiency
- use of cleaner fuels
- development of low pollutant technologies.

The choice of strategy must take into account the availability of the different energy sources and their overall environmental impact.

Natural gas, thanks to its physical and chemical properties, can be utilized in low pollutant and highly efficient technologies and applications, such as combined cycles and low-NOx burners for gas turbines.

The use of natural gas for power generation in Italy is expected to increase significantly in the next few years, particularly in gas turbines for repowering existing plants and in combined cycles for new plants, with important benefits for energy saving and environmental protection.

Gas combined cycles have efficiencies of about 50-53% with a fuel saving of about 25% compared to traditional systems.

The efficiency of combined cycle gas turbine is expected to reach, within a few years, almost 60% by using the steam produced by the recovery boiler as gas turbine cooling fluid.

The major environmental impacts of different fossil fuelled power plants, that fulfil the emission limits of atmospheric pollutants established by the Italian law for large combustion plants, are presented in table 2.

As you can see, the natural gas fuelled plants, particularly combined cycles ones, have higher efficiencies and lower emissions and do not require expensive pollutant abatement plants that produce large amounts of waste products.

Besides its potential for improved efficiency in the major power plants, the use of gas turbines and gas combined cycles offers the opportunity for significant energy saving in industrial and commercial applications, when used in combined heat and power plants.

Gas turbines are the most important component of natural gas based cogeneration systems. Their efficiency raised from 25% to 36% , as you can see from the figure 4, and a further increase to 39% or more is expected in four or five years .

A problem for gas turbines is their relatively high NOx emissions as the higher flame temperatures required to improve efficiencies also give rise to NOx formation.

Many gas turbine manufacturers have undertaken extensive research and development programs to reduce NOx emissions. At present, large gas turbines (bigger than 50 MW) for power generation with NOx emissions lower than 100 mg/cubic meter (at 15% of oxigen at the chimney) are commercially available.

Low NOx combustion technologies for aeroderivative and smaller gas turbines will probably be fully commercially available from 1996.

Let's now examine the electrical energy production costs.

Three kinds of plants have been considered :

- combined cycle gas turbine (CCGT)
- Rankine cycle fuelled by coal, by high sulphur fuel oil, by very low sulphur fuel oil
- integrated gasification combined cycle (IGCC) fuelled by coal and by TAR.

For every kind of plant the following components of production cost have been evaluated:

- capital expenditure
- operating costs and maintenance
- fuel.

The assumptions used to calculate the production cost of electricity for those plants are shown on the following table 3.

The production cost of electricity on the basic case is between 4.51 and 6 c$/kWh; on the figure 5 it is also possible to see the components of production cost.

The electricity production cost of a combined cycle gas turbine depends mainly on the fuel cost: this one accounts for 63% on the total cost, while capex is far less important: only 28%.

The capex and the operating costs of Rankine cycle fuelled with very low sulphur fuel oil are less than those of Rankine cycle fuelled with high sulphur fuel oil because the desulphuration plant is not required.

The electricity production cost using IGCC fuelled by Tar depends on the value we give to the fuel (there is no price market for this fuel). To reach the same combined cycle production cost the Tar should cost about 20 $/t. In the chart I am showing you I have considered a price of 38 $/t.

In the figure 6, that shows the cost production of electricity versus the capex, it is possible to see that the Rankine cycles fuelled by oil should reduce the capital expenditure to practically impossible values to compete with combined cycles fuelled by natural gas.

The IGCC fuelled by Tar is competitive with the combined cycle gas turbine only having a capex around 1600 $/kW, keeping the fuel price at 38 $/t.

As far as the coal plants are concerned, we have to point out that reducing capex, in order to compete with combined cycle, is not sufficient; it is necessary, therefore, to reduce the other cost components.

From the point of view of efficiency, the figure 7 shows that an IGCC fuelled by Tar never can compete with an CCGT while Rankine cycle plants cannot, reasonably, increase their efficiency. The IGCC fuelled by coal, as you can see, is completely out and the main reason for this is the high capex.

CCGT, on the other hand, has still the possibility to go on increasing efficiency, as the curve trend suggest. It will be necessary, of course, to compromise energy savings with the increase in capex necessary to achieve efficiency improvements.

The figure 8 shows the electricity production cost versus the equivalent running hours per year, defined as the ratio between the annual electrical energy produced and the nominal power.

The low sensitivity of CCGT to the equivalent running hours per year is due to the low capex.

If we suppose a CCGT working for 4500 equivalent hours per year, the cycles fuelled by oil have to work for more than 5500 equivalent hours per year to get the same production cost of electricity.

Figure 9 is the most important: it shows the relation between the electricity generation cost and fuel price.

On the X axis I've put the electricity generation cost; on the Y axis (left hand) I've put the cost of natural gas and on the right hand the other fuel costs.

If we suppose a natural gas cost of 4 $/MMBTU and keep fixed the other components of electricity production cost (O&M, Capex), we can note that to balance the CCGT electricity production cost, a Rankine cycle plant fuelled by very low sulphur fuel oil should have a fuel cost of about 98 $/t, and a Rankine cycle fuelled by high sulphur fuel oil should have a fuel cost around 71 $/t. A Rankine cycle that use coal should pay the fuel about 30 $/t and an IGCC plant fuelled by coal should pay less than 4 $/t. An IGCC plant fuelled by Tar should pay that fuel around 24 $/t.

We could also consider the figure backwards: a CCGT fuelled by natural gas should pay the fuel about 4.6 $/MMBTU to get the same electricity production cost of a plant fuelled by very low sulphur fuel oil paying the fuel 119 $/t.

The sensitivity analisys on the electricity production cost shows that capex (see fig. 10) and running equivalent hours per year (see fig. 11) have the lowest influence in the case of a CCGT fuelled by natural gas. The generation cost of a CCGT fuelled by natural gas is mainly influenced by the fuel cost, as shown in fig. 12.

An opposite behaviour have the gassification plants: they have high capex and so should be designed to work in a base load way. For these kinds of plants any change on the fuel cost or on the efficiency has a scarce influence on the final cost of electricity production.

The position of plants based on Rankine cycle is in the middle.

The figure 13 shows the influence, for a CCGT, of efficiency on the generation cost.

The considered efficency range is 50-60%.

As said before, the influence of efficiency on the final production cost is quite high: a variation of efficiency from 50% to 60% involve a generation cost reduction of about 11%, supposing a fuel cost of 4 $/MMBTU.

To sum up the advantages of combined cycle gas turbine fuelled by natural gas as follow:

- short time to build the plant (less than 18 months)
- absence of fuel tankers and relevant ancillaries
- absence of additional desulphuration plants (and relevant costs)
- low specific capital expenditure
- very high efficiency
- low cost per unit of produced electrical energy

Milan,13/06/96

WORLD NATURAL GAS DEMAND BY REGION

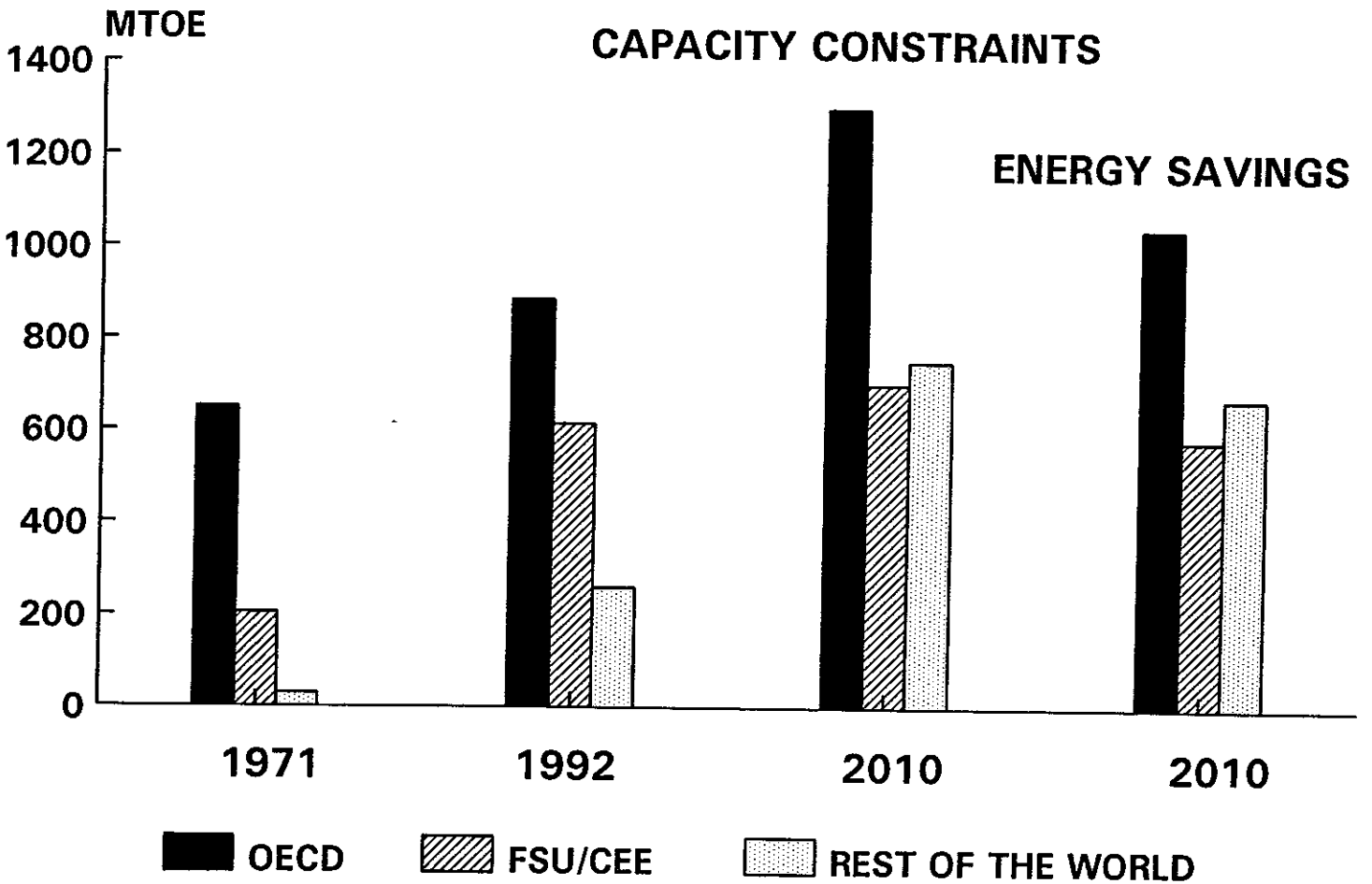


fig. 1

ELECTRICITY GENERATION PER CAPITA

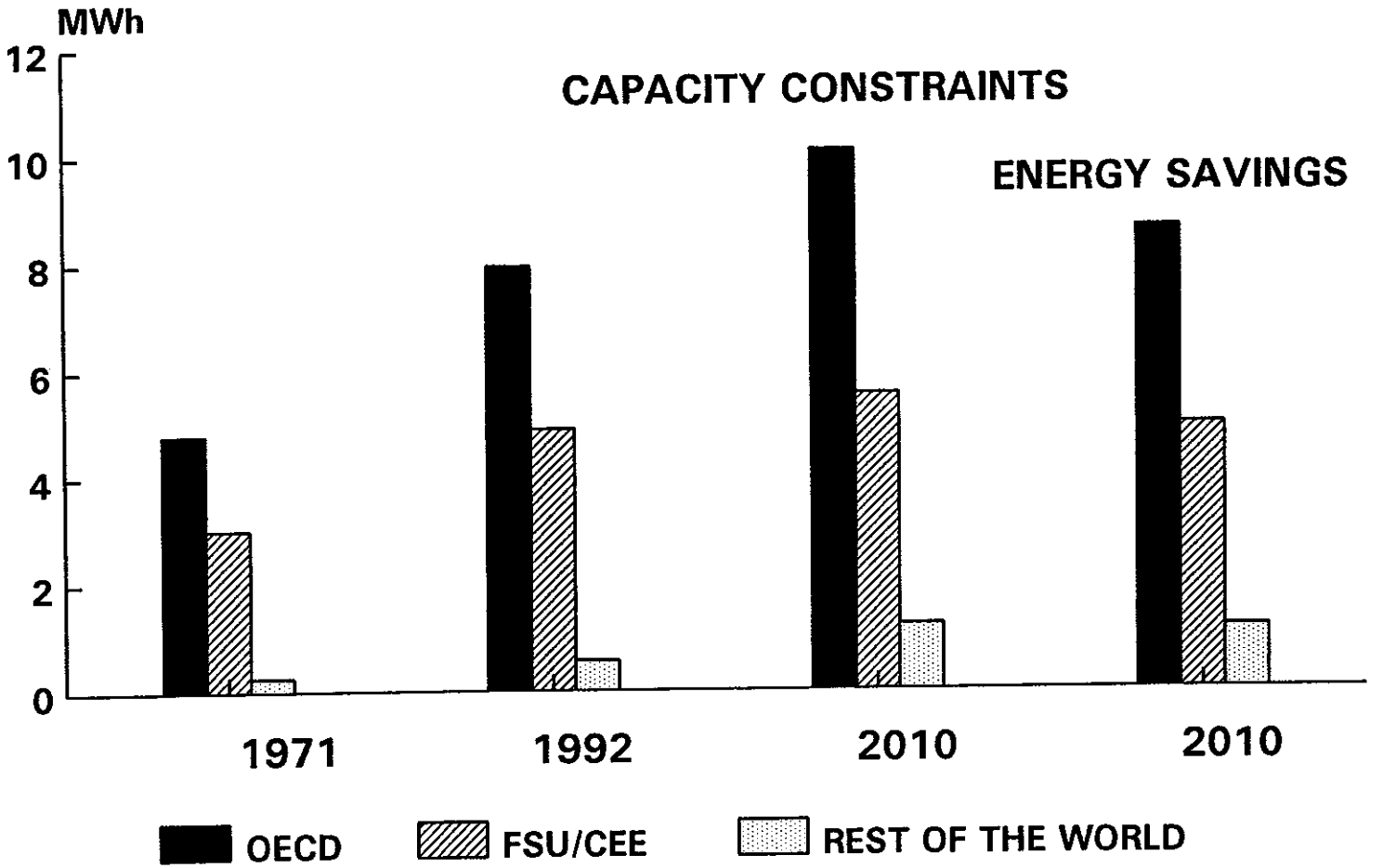


fig. 2

CARBON DIOXIDE EMISSION FROM FOSSIL FUEL COMBUSTION

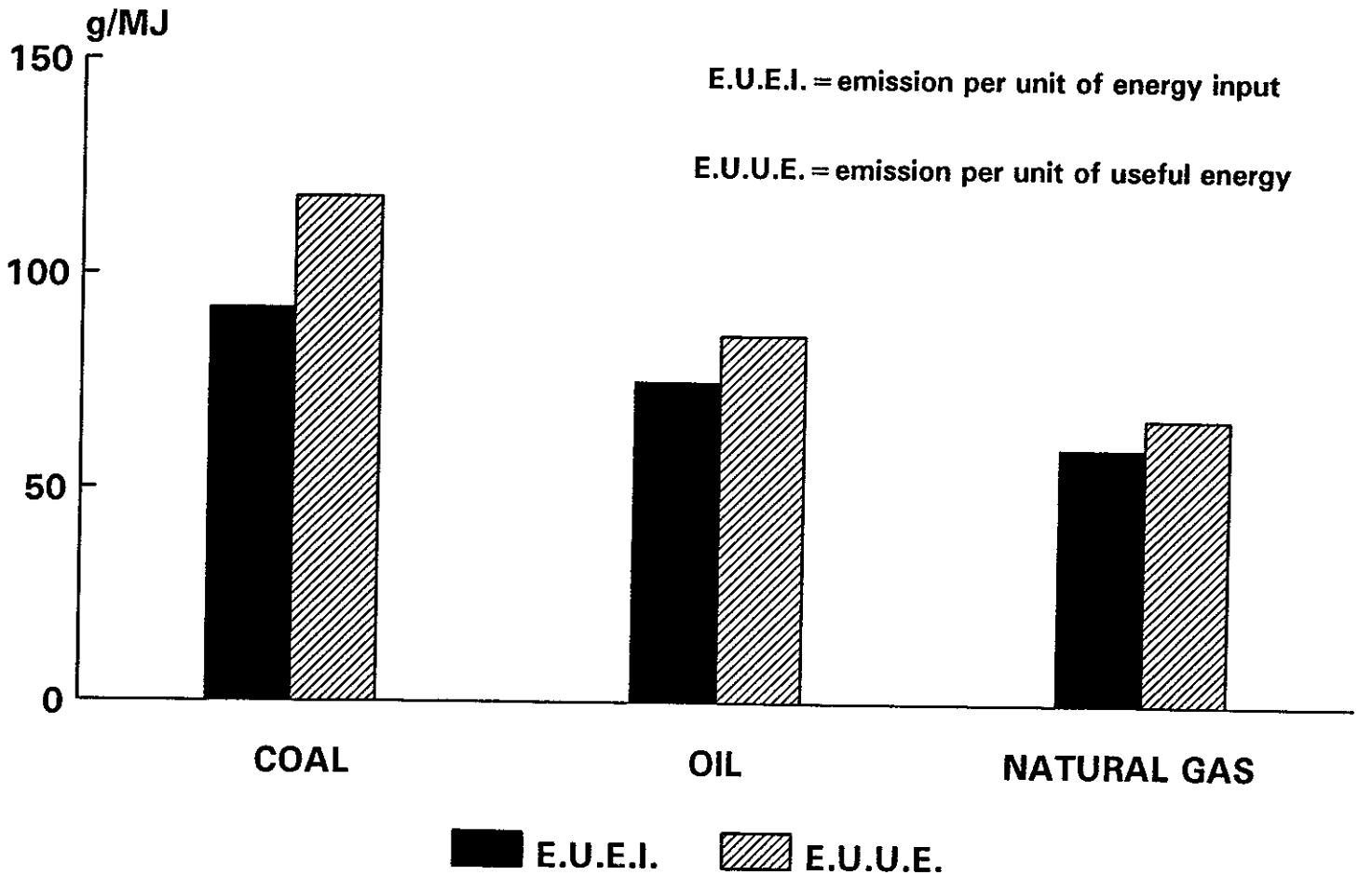


fig. 3

CONTRIBUTION OF NATURAL GAS TO THE REDUCTION OF ATMOSPHERIC POLLUTANTS AND CARBON DIOXIDE EMISSIONS IN ITALY IN 1990

POLLUTANT	ACTUAL EMISSIONS	SIMULATED EMISSIOI (*)
	10 ^3 TON	10^3 TON
SOx	1931	2922
NOx	2098	2145
Dust	464	532
CO	6335	6339
VOC	889	895
CO2	402 x 10^6 ton	442 x 10^6 ton

(*) Emissions we would have without the increase of gas penetration in Italy from 1970 to 1990.

Table 1

ENVIRONMENTAL EFFECTS OF THERMOELECTRIC PLANTS

	Coal plant	Fuel oil plant	Natural gas plant	Nat. gas comb. cycle
Power (MWe)	1000	1000	1000	1000
Consumption :				
Fuel (t/y)	2.2x10^6	1.4x10^6	1.6x10^6	1.2x10^6
Limestone (t/y)	59000	133000	-	-
Emissions :				
S. Oxides (t/y)	8750	6580	NEGLIG.	NEGLIG.
N. Oxides (t/y)	4360	3300	3190	3580
Dust (t/y)	1090	830	77	58
CO2 (t/y)	5400000	4390000	3090000	2320000
Solid Wastes :				
Total Ash (t/y)	330000	5200	-	-
Gypsum (t/y)	101000	229000	-	-
Thermal losses :				
In air (MJ/y)	8.8x10^9	8.5x10^9	8.2x10^9	8.5x10^9
In water (MJ/y)	27.9x10^9	26.7x10^9	25.6x10^9	12.2x10^9
Electricity(GWh)	6000	6000	6000	6000

Atmospheric emissions under the limits fixed by the law.
For combined cycle gas turbines the NOx emissions limit is assumed 100 mg/cum (15% O2) and for conventional boilers that one is fixed in 200 mg/cum (3% O2).

Table 2

TREND OF GAS TURBINES EFFICIENCY

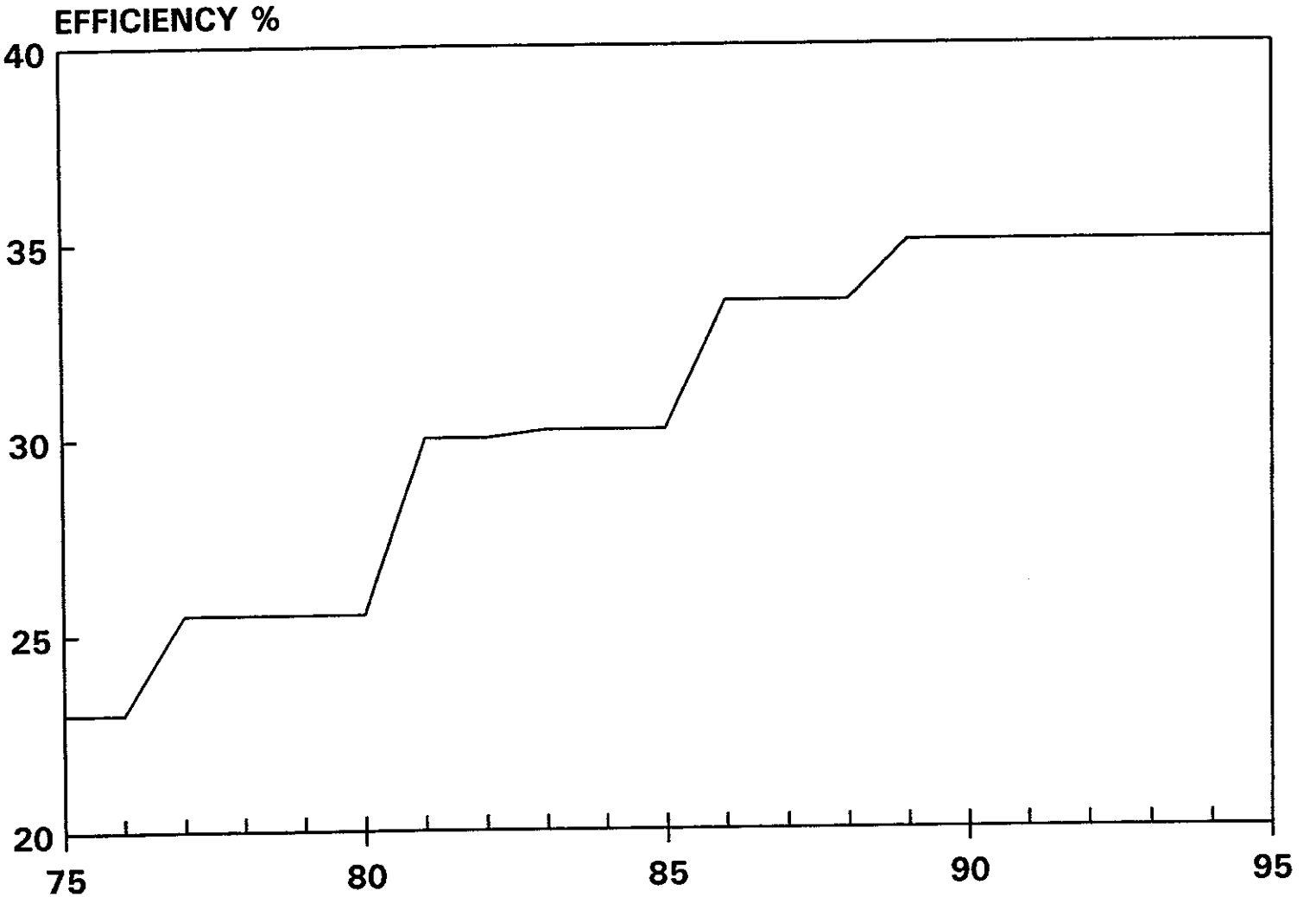


fig. 4

ASSUMPTIONS

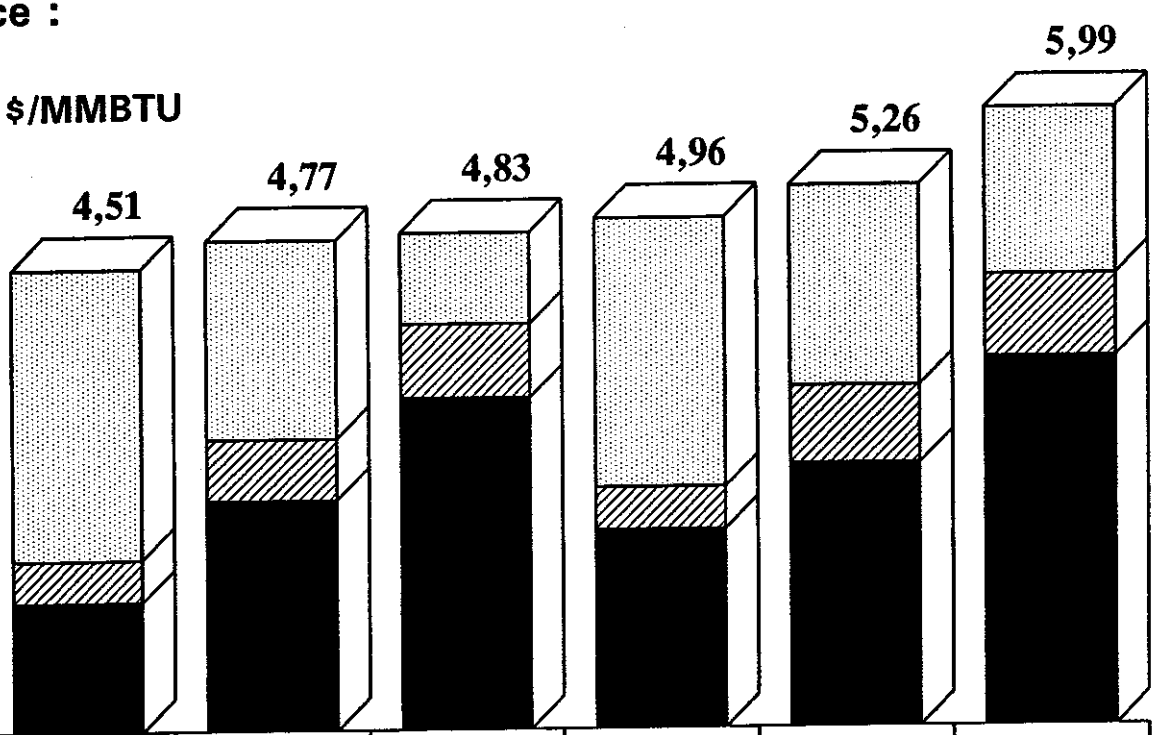
	CCGT	HSFO R.	VLSFO R.	COAL R.	COAL IGCC	TAR IGCC
Size (MW)	250	500	500	500	250	250
Constr. (y)	3	4	4	5	5	5
I.D.C. (%)	7	7	7	7	7	7
Lifetime (y)	25	25	25	25	25	25
Capex ($/kW)	650	1100	950	1550	2000	1800
O&M ($/kW/Y)	26	38	26	48	60	54
Load Factor	0.72	0.72	0.72	0.72	0.86	0.86
Electr. Eff. (%)	53	38	39.5	35.5	43	40
Fuel Cost	4 $/MMBTU	82 $/t	119 $/t	50 $/t	50 $/t	38 $/t
Rate of Return	10 %	10 %	10 %	10 %	10 %	10 %

Table 3

PRODUCTION COST OF ELECTRICITY

assumed fuel price :

NATURAL GAS - 4 $/MMBTU
HSFO - 82 $/t
VLSFO - 119 $/t
COAL - 50 $/t
TAR - 38 $/t



	CCGT	HSFO R.	IGCC T.	VLSFO R.	COAL R.	IGCC C.
Fuel	2,84	1,93	0,88	2,62	1,94	1,6
O & M	0,41	0,6	0,72	0,41	0,76	0,8
Capex	1,26	2,24	3,23	1,93	2,56	3,59

Costs are given in c$/kWh

fig. 5

SENSITIVITY (CAPEX)

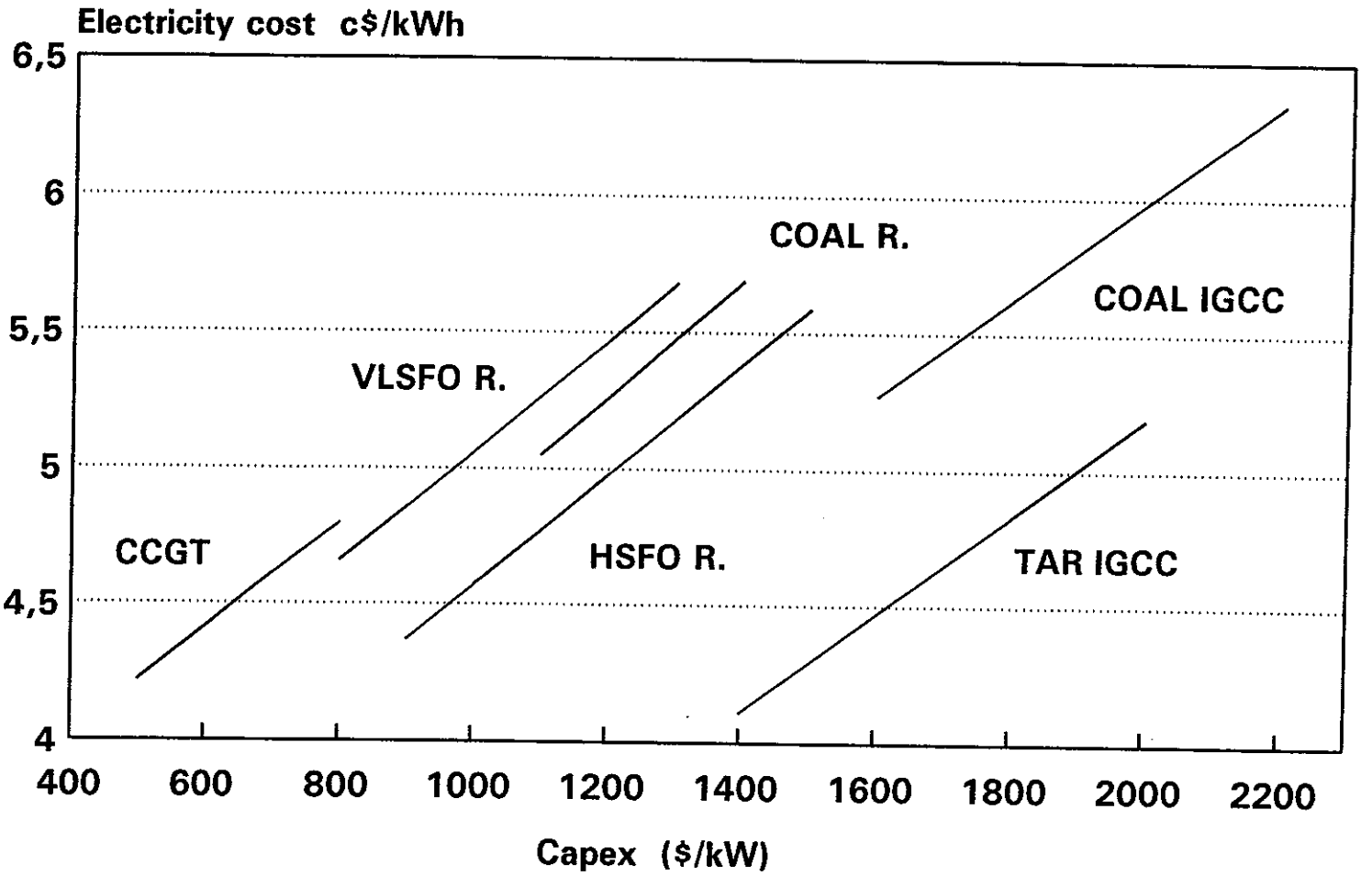


fig. 6

sensitivity
(efficiency)

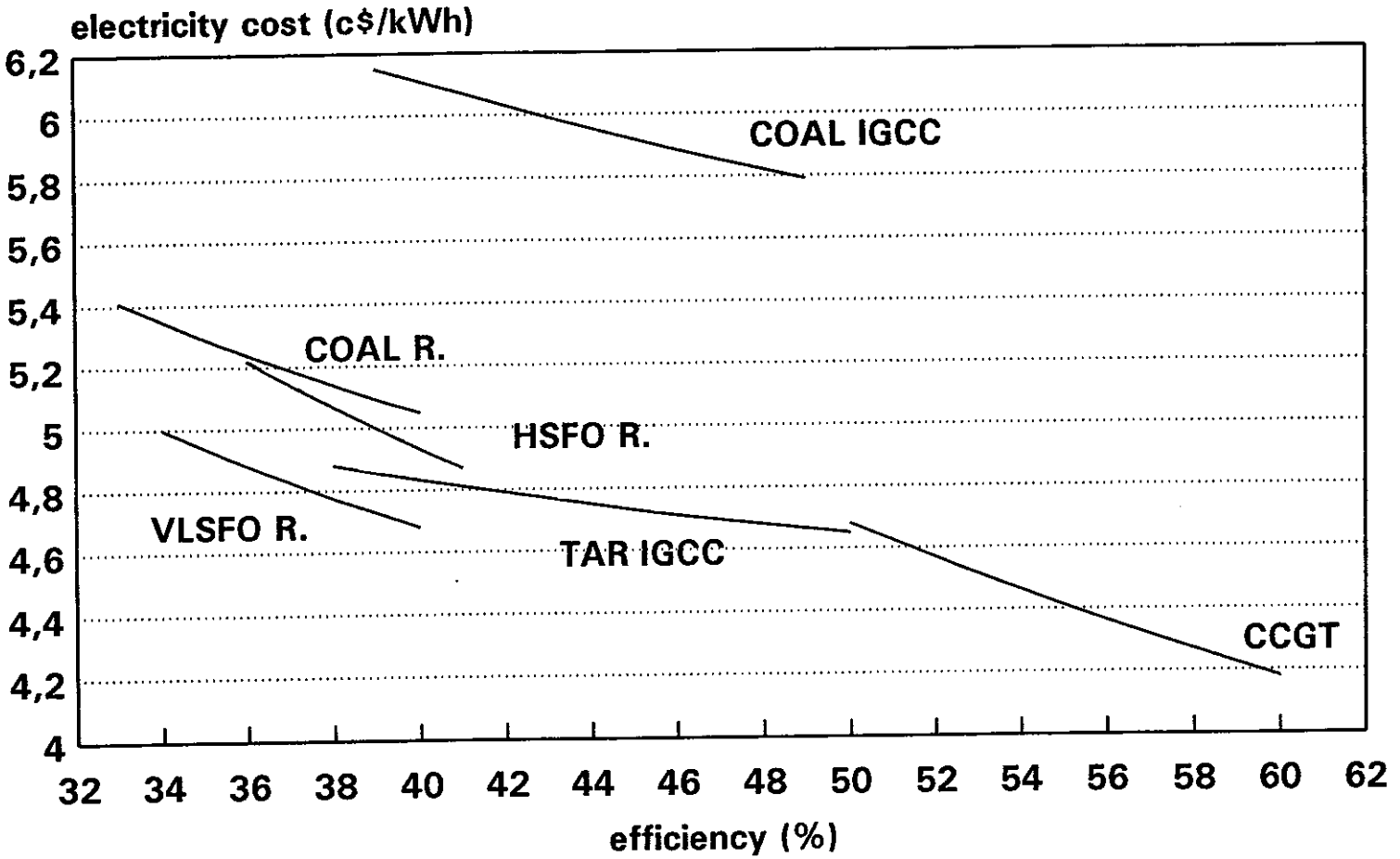


fig. 7

sensitivity
(eq. running hours/y)

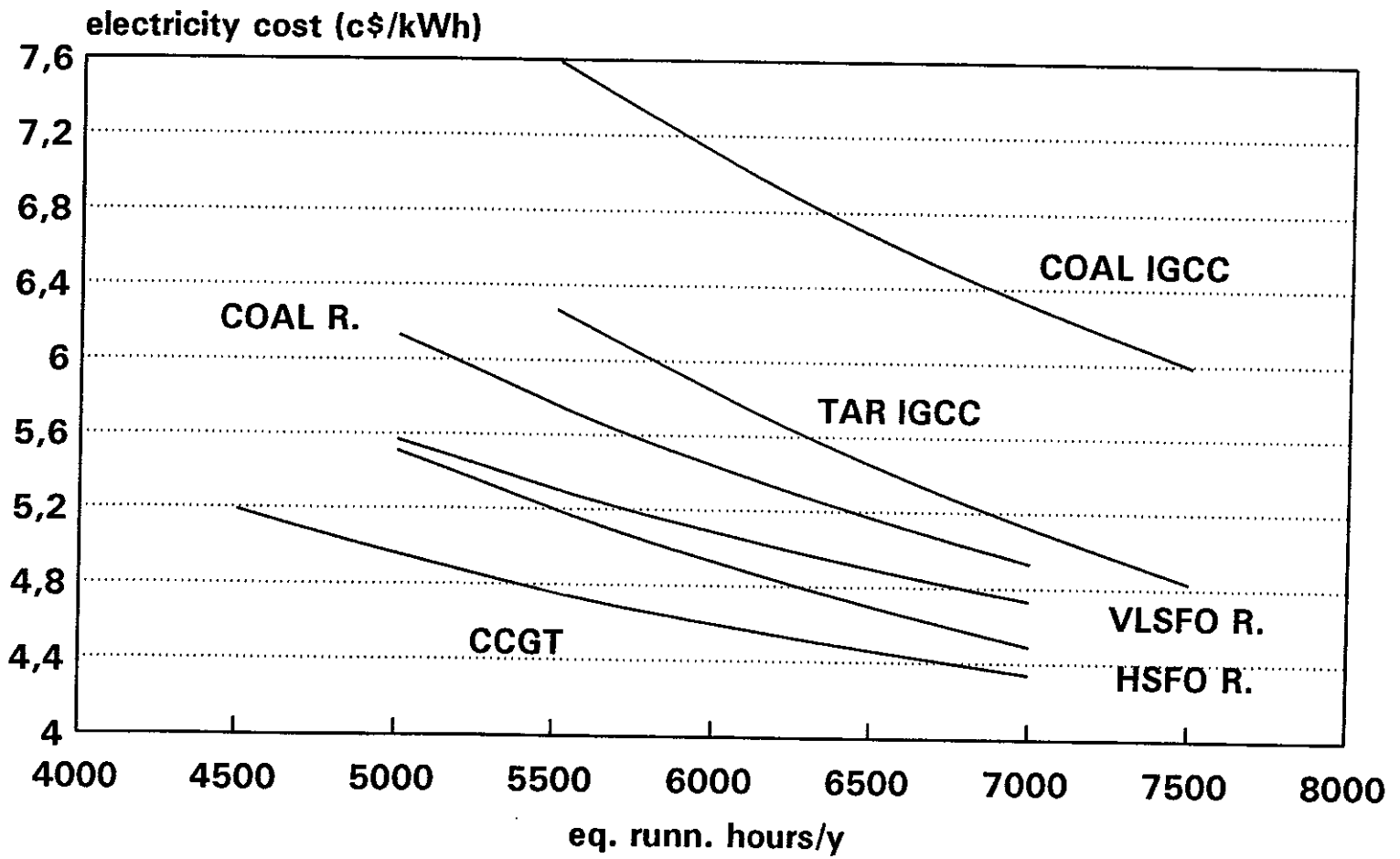


fig. 8

sensitivity
(fuel cost)

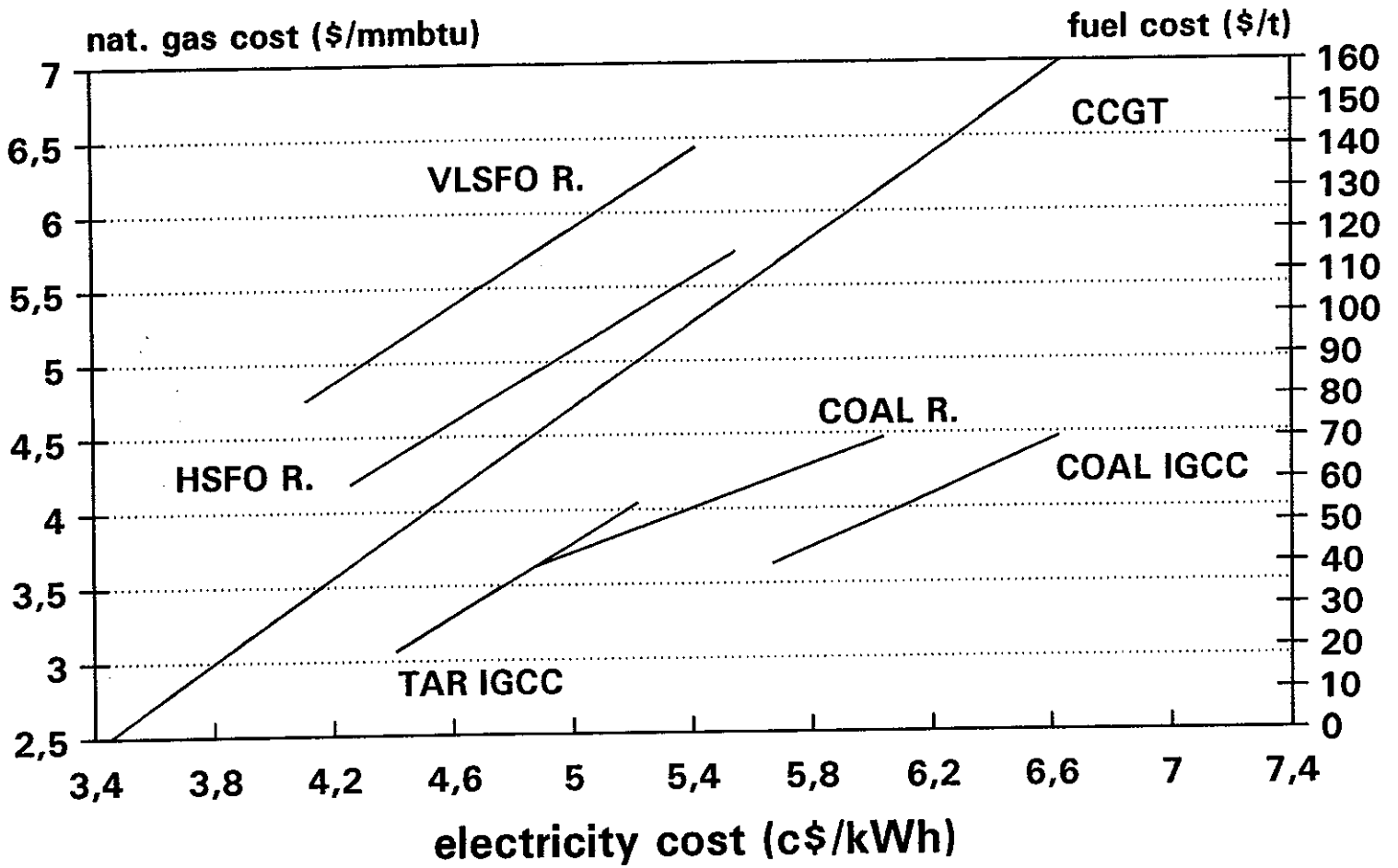


fig. 9

sensitivity
(capex)

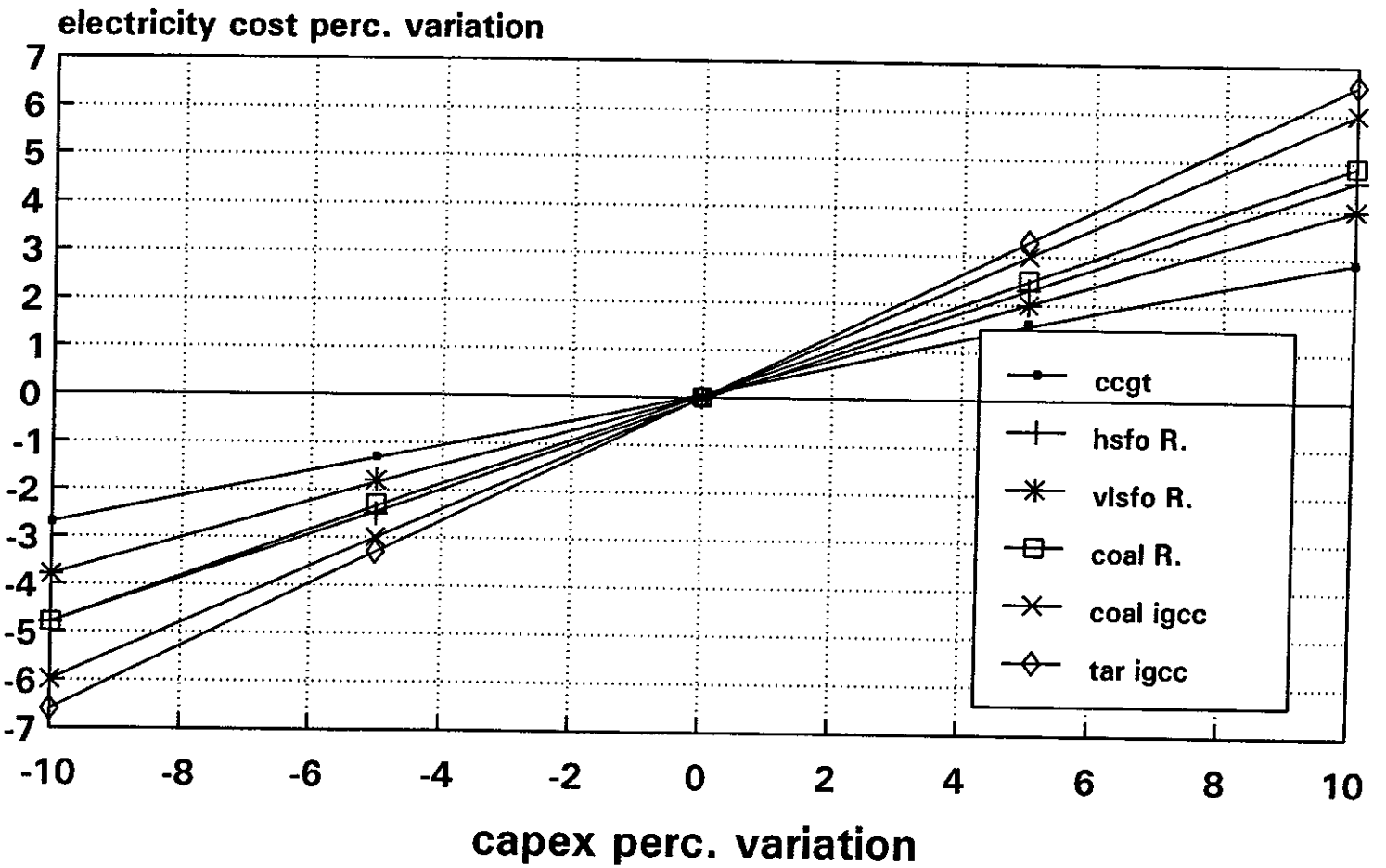


fig. 10

sensitivity
(eq. running hours/y)

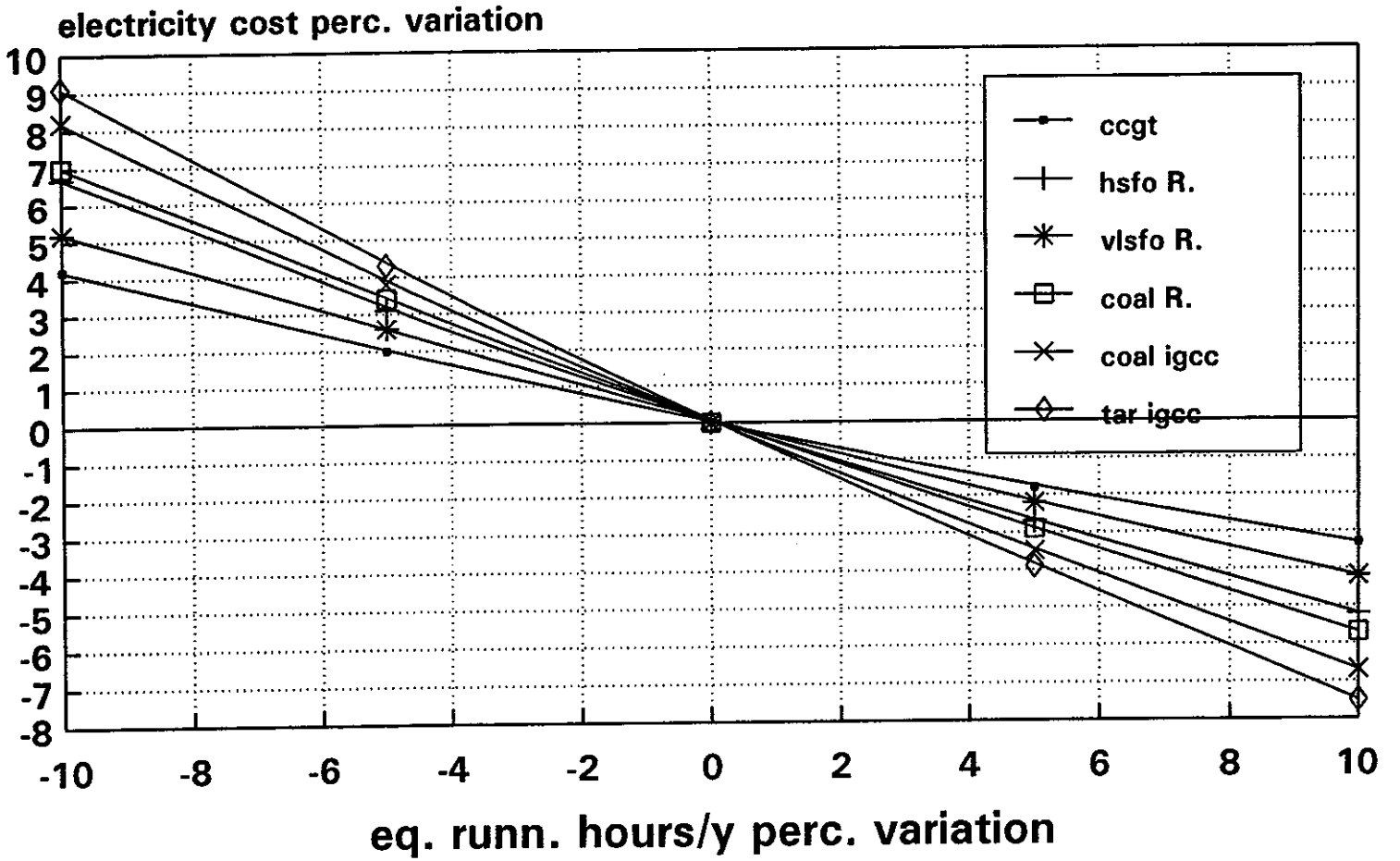


fig. 11

sensitivity
(fuel cost)

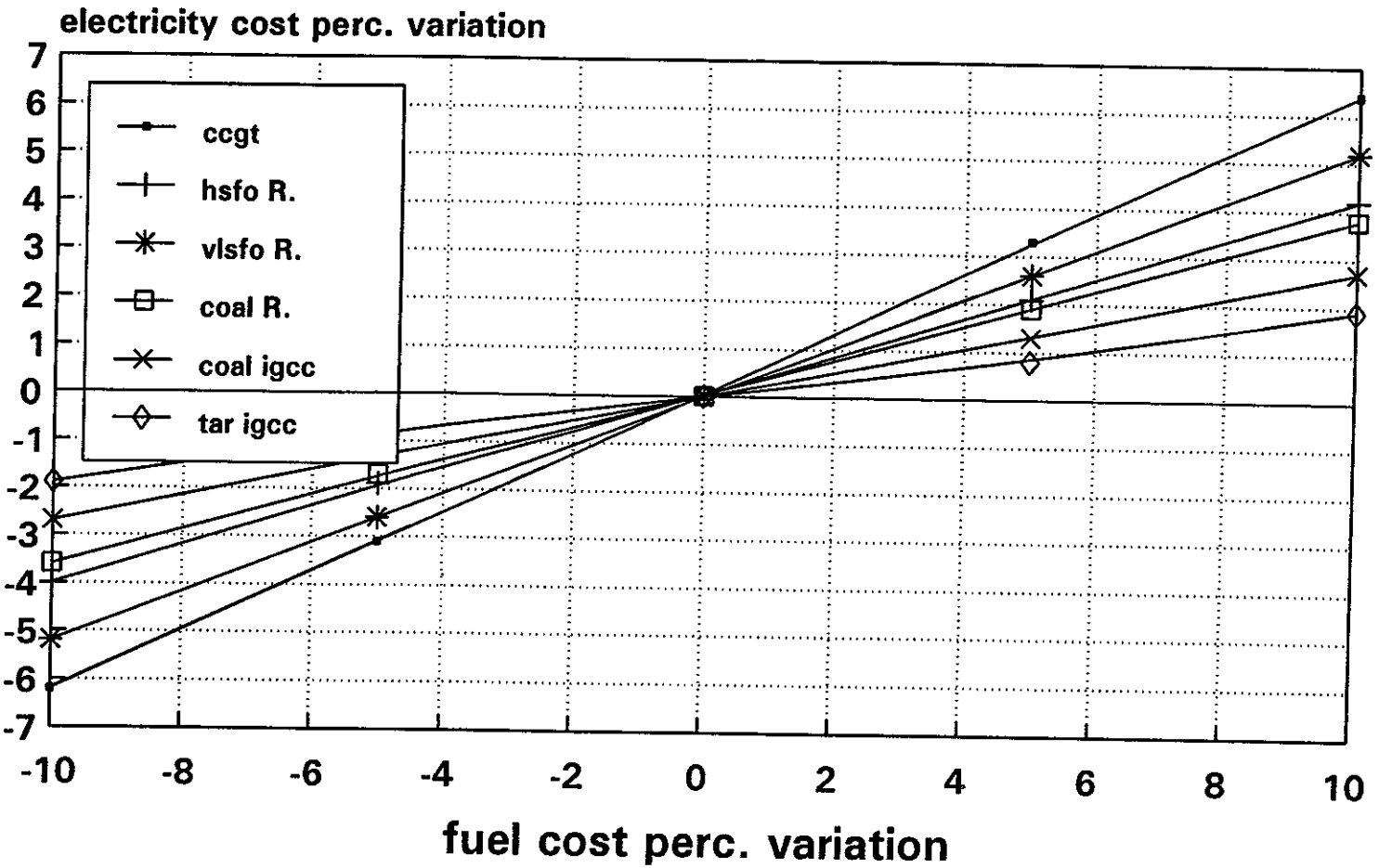


fig. 12

sensitivity
(efficiency)

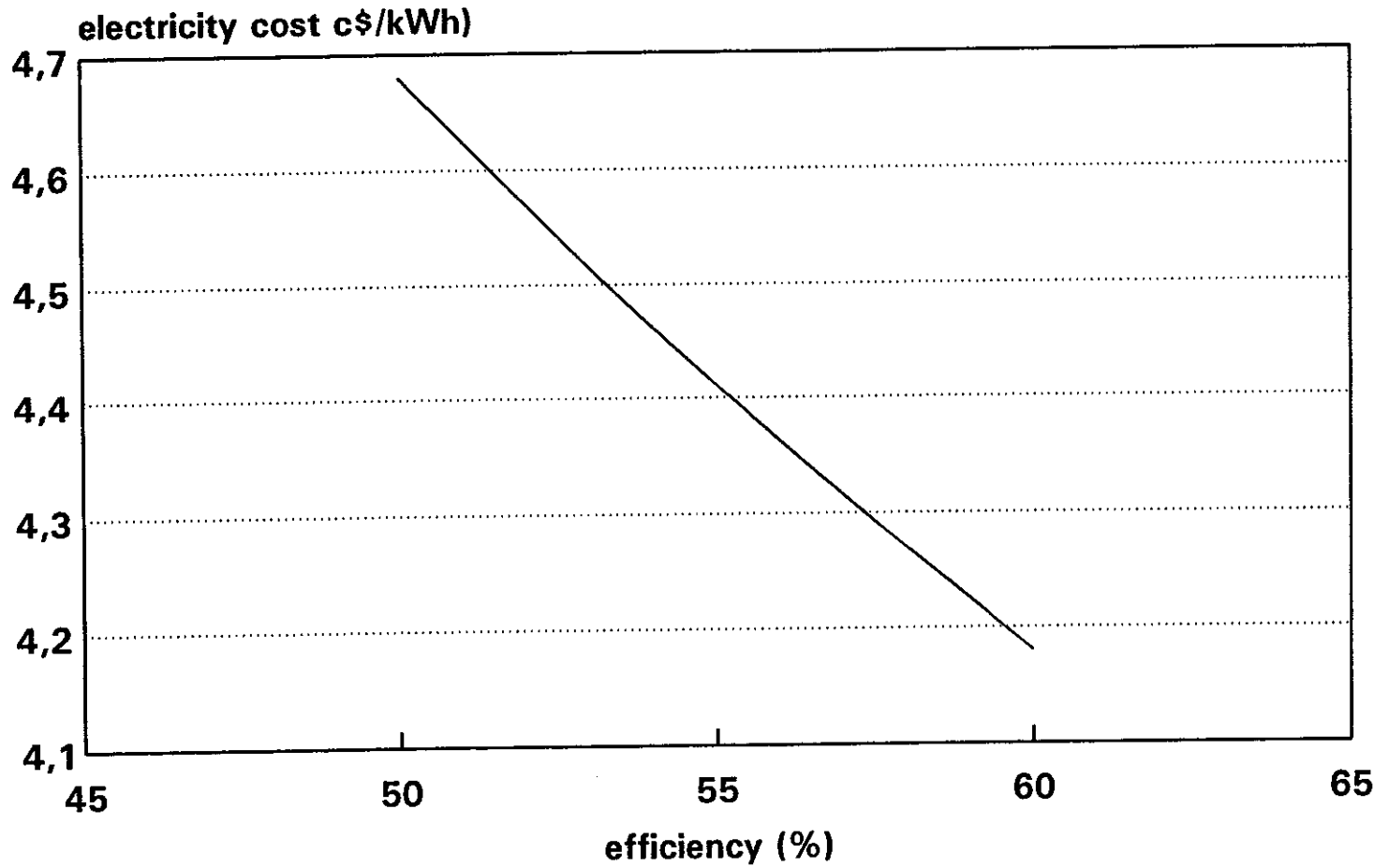


fig 13

base case: eff. = 53%

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CURRICULUM VITAE

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He received the degree in electrical engineering (electrical plants) from Politecnico o
Milan, 1974.

He joined SNAM, the italian company for natural gas transmission, in 1980.

Now he is working in the Strategic Planning Division in the power production field.

He has worked as Project Manager on the construction of a gas turbines power plant.

He worked also for energy conservation of Snam plants.

For a short period he was the technical responsible of all plants of Liquipibigas, an italia
company for Liquified Petroleum Gas.

During the period 1974-1980 he worked on the electrical power station of a petroleu
refinery as crew shift responsible.

He is member of Subcommittee F-4 (industrial utilization and power generation) of IG
(International Gas Union) .

Italian-Israeli Bi-National Conference on Natural Gas

Italgas and its Foreign Experience

E. Daneo
Assistant to the Vice President
Italgas

Haifa, June 19, 1996

ITALGAS AND ITS FOREIGN EXPERIENCE

The objective of the present paper is to present the particular experiences of a natural gas distribution Group, the Italgas Group, in urban service networks, due to its particular references for operations in a Mediterranean setting, and with conclusions, as far as regards investment, which should also be of interest for the particular audience we have today.

A paper delivered by Dr. Vola, of our commercial department, will treat gas distribution as a market prespective.
My paper can be considered Italgas promotion. The paper of Dr. Vola can in turn be considered gas distribution promotion.

Let us start with some essential data on Italgas.

Italgas is a mixed-capital joint stock company with State and private participation.

Shareholders include the ENI Group which holds, through SNAM (its head sector company for gas purchase and transport), about 41% of the stock, and over 52,000 other shareholders, including employees of Italgas and users of Italgas services, the Bank of Italy, and investment funds. In particular, important non Italian investors include American "pension funds" and the principal American, English and German investment houses.

Italgas was one of the first companies to be quoted on the Italian Computerised Share Dealing Circuit, and in February 1991 it was listed on the Stock Exchange Automatic Quotation of the London Stock Exchange, the computerised circuit which deals in all stocks and securities in the City, as well as the most important ones from other European Stock Exchanges. This privilege has only been extended to nineteen other Italian companies.

The Group is able to self finance its investments.

The Group's relationship with shareholders and the attention shown to investors is based on four strategic lines: an adequate policy of remuneration of risk capital, the distribution of a dividend in line with the market, increase of capital stock and a policy of financial transparency.

An important part of this strategy has been the direct involvement, of both employees and customers. In 1986, an emission of over 15 million ordinary shares was offered to Italgas employees, of whom over 70% subscribed; in 1990, a convertible stock loan was issued in favour of Italgas customers and was fully converted into shares two years in advance of the foreseen expire date.

Let us sum up the advantages of such a Group:

a) Italgas shareholders are numerous and happy;

b) Italgas shareholders include some very competent gas people: besides 70% of its own employees (and we might add that the Group counts over 10.000 people), it includes SNAM , for instance, of the powerful ENI Group, whose dedication to the Mediterranean energy scene either directly or through sister companies such as AGIP, SAIPEM. or SNAM PROGETTI, is probably well known to the audience, and shareholders such as SNAM can certainly be inspiring.

I will be telling you of a very important example of this, but let me first give you a couple of points on the story of this gas distribution group.

To begin with, a minimum of ancient history.

This is not very different than that of several other European Distribution Companies.

Its ancestor, the "Compagnia di Illuminazione Gas per la Città di Torino" was founded, as other european companies were, in the early nineteenth century.

The company, eventually registered as "Società Italiana per il Gas" from the unification of Italy, extended its operations in much of the north and center of the italian peninsula .

The company stepped, again as other european competitors, into modern history when, with the generalised use of electricity, the company adapted new strategies and switched from its main activity of street lighting to the distribution of gas for cooking and heating purposes.

Nothing again really very particular about this phase, apart from some very good management with which Italgas, as the company was now called, overcame the 1929 crisis and Second World War damages.

The contemporary history of the company, however, registers three very unique events on which we must concentrate our attention.

In succession:

a) the increase in the use of natural gas discovered in the Italian Po Valley;

b) speed in Italian economic growth known as "the Italian Miracle";

c) SNAM's entrance in 1966 into Italgas.

These points are very important.

Gas discoveries at home had been a real boon to industry and households, during the active italian post war years.

Soon the Italian Government and ENI were making growth forecasts for the use of natural gas which compelled to foresee supplies well beyond national ones.

In the sixties, after a purchasing policy had been well debated, long term contracts with Holland, the Soviet Socialist Republic, and Libya were signed.

Except for Libya, whose gas arrived in liquefied form at the terminal of Panigaglia, pipelines to secure supplies to Italy were built, and the italian consumer could consider himself to be reasonably supplied.

But this was the center and the north of Italy, and not yet at full satisfactory level considerating the use increase forecasts which were being made at the time.

Finally, the purchasing policy of ENI/SNAM brought negotiations with SONATRACH in Algeria to a close.

In the seventies, the largest contract of them all to secure natural gas to Italy was signed, with SONATRACH.

SNAM sister companies in the ENI Group: SAIPEM, SNAM PROGETTI, and NUOVO PIGNONE were then called to perform an engineering task of gigantic size, that of establishing a pipeline link between Africa and Europe.

The 160 kilometre Channel of Sicily was crossed with three pipes laid at depths of up to 600 meters.

The "umbilical cord between two continents" as the Transmed system was also called, granted alone a build up, starting its inauguration in 1982, of up to 12 billion cubic meters per year of Algerian natural gas to Italy.

The Transmed system brought gas to the southernmost tip of Sicily, at Mazara del Vallo, till then really only a very large fishing port.

Then, crossing all of Sicily, the perilous Straits of Messina, mountainous Calabria and up the Apennines, the pipe with Algerian gas was brought to connection with the existing SNAM high pressure system at Minerbio.

This event is very important for Italgas and its references.

Italgas was already working with commercial and contracting activity when the Transmed Pipe was inaugurated in 1982, having commenced a very important compaign that lasted all the eighties to create, or to convert and extend existing networks all along the pipeline route, from the south of Italy to the north of Italy.

More on this compaign will be told to you by Dr. Vola. Do consider, however, that it was sizeable:

From the 300 municipalities of the seventies, Italgas concessions, which had grown to 1000 by the late eighties, were brought to number 1400.

In the first five years of the eighties alone, consumption of gas in Italy increased by 50%.

This network building compaign can be considered, actually, as one of the most significative for Countries bordering the Mediterranean.

Peninsular Italy is notably a compendium of climatic and social conditions of the region, and Italgas is proud to recall this compaign to the audience of a Country, such as yours, which borders the Mediterranean.

Besides the construction and management of gas distribution networks, Italgas would offer, as it progressed through the Country, also water distribution services.

We must consider that the Group, which now has about 34% of the Italian household gas distribution market (with more than 4.500.000 users and sales of more than 6.500.000.000 metric tons/year of natural gas, distributing gas to cityes and towns both large and small listing Rome, Turin, Venice, Naples, and Florence among them) is also a water distribution group.

The water distribution companies of the Group, perhaps not concerned directly with the progress of the pipeline bringing Algerian gas from the south to the north of Italy, must anyhow be mentioned as, through them, Italgas results the single biggest Italian water management company, listing 400 concessions and a total of 2.500.000 users.

First on gas, eventually on water, sewage treatment and waste disposal, it was inevitable that Italgas dedicate itself beyond italian frontiers, choosing the Mediterranean first, as its culture developed in a Mediterranean setting indicated it to do, and then beyond.

I will list a few examples:

In Algeria, a consultancy and engineering contract in the early eighties with SONELGAZ, on stockage of GPL.
In Tunisia, a relationship of cooperation with STEG on several issues: a contract for technical assistance on a conversion of city gas to natural gas for the city of Tunis, and another for studies related to the Tunis network rehabilitation.

In Egypt on personnel training.

In the Middle East, where references abound for an ENI presence, we are establishing our first direct contacts.

In Turkey with technical assistance in Bursa related to the construction of the local gas distribution network.

In Greece, Italgas has been attentive to the establishment of the planned three gas distribution companies between DEPA and Greek municipalities: Salonicco, Larissa-Volos, and Athens-Pireo, which should subsequently be the objective of tenders for foreign minority participation.

In former Yugoslavia, on a construction project for the first several kilometers of the Belgrade urban distribution network, and its start up.

In Slovenia, the municipalities bordering the Adriatic: Koper, Izola, and Pirano have been reviewed and included in the Business Plan of a company with Italgas as main shareholder, set up in Lubiana for the construction and management of natural gas distribution networks.

The company, Adriaplin is its name, has thus a good basis to work on when natural gas is going to be available to Slovenian Istria.

Crossing over to the Western Mediterranean, Spain has been the objective of several Italgas initiatives, both on the technical and the industrial side.

On the technical side we will mention the conversion of town gas grids to natural gas of the cityes of Oviedo and Gijon, and agreements with GAS NATURAL for common programs of research.

On the industrial side we shall mention an engineering company having been registered with Italgas and Spanish shareholders: GAS ENERGIA IBERICA, having service lines and household installations maintenance as one of its locally important contracts, cogeneration of industrial and commercial installations being another.

Apart from the Spanish industrial initiative, the engineering, consultancy, and construction contracts which we have listed, do not have a sense "per se".

The Italgas Group is not to be considered, in its foreign activities, except in a few rare cases, as an engineer or a contractor.

We like to insist on this.

Specially since the late eighties, any contract must have, for the Group, an added promotional role in function of possible future participation, through investment, in the management of gas distribution companies and companies connected to this function.

The Countries that I have listed can all be considered to be of interest for Italgas industrial investment.

Italgas wants to invest in gas distribution, and wishes to be involved in the management of distribution companies, and accepts to be a constructor or engineer, or to be involved in consultancy or personnel training, in as much as this might improve its stand as a possible investor.

Besides investment in Spain and in Slovenia, which I have mentioned because of theyr Mediterranean setting, let me briefly illustrate three cases of gas distribution participation which Italgas has recently entered into, which exemplify the size of its interests and which will allow a few concluding remarks (I might add that the conclusions can apply to other types of services, as water and waste management).

The three initiatives are in non Mediterranean Countries: in Portugal, Argentina, and Hungary, but their study can help us on the Mediterranean scene:

Portugal

In 1988, with the purpose of favouring the introduction of natural gas into the Country as a privileged energy source, the Portuguese Government called for tenders from international companies: one for entrusting the management of transport at national level, the other for the management of distribution services. The Country was divided into four areas:

- north
- centre
- south
- Greater Lisbon

Italgas, having formed a consortium together with Portuguese partners(both private and State), offered its services for the areas of the centre and the south and, following the success of its bid, entered with a minority shareholding, into two Distribution Companies (LUSITANIAGAS and SETGAS, respectively).

To give some idea of the dimension of the two participations, we provide the following data:

	Central area	Southern area
Extension of network	2000 km	2000 km
Potential Users	210 000	340 000
Sales	200 Mm3	130 Mm3

The process of introduction of natural gas into Portugal came about in the presence of a well-defined legislative and institutional framework, in which from the very outset, roles, geographical areas of responsibility, technical standards, etc. were clearly identified.

It should here be added that, already before the call for tenders, suitable legislation had regulated possible inter-company investment both among distributing companies and between these and the transmission company.

A fundamental contribution came from the action of the Portuguese Government, which provided strong backing for the implementation of the project of import, transport and distribution of natural gas in Portugal in spite of various difficulties encountered and which, right from the start, made it possible to choose measures aimed at favouring the use of natural gas, all of which were duly adopted (among these we cite the example of a 10 point VAT advantage over other forms of fuel, and specification of standards on the basis of which all new buildings must be provided with internal systems sized to run on natural gas).

A further substantial contribution came from the financial support granted by the EEC directly to the Distributing Companies via financing, with contributions of "write-off" capital in order to ease burdens attached to investments.

Argentina

In 1992 the Argentine Government, following its decision to privatise the company Gas Del Estado, invited international tenders for the concession of distribution services in the most important areas of the Country.

Italgas presented a bid in partnership with one of the most qualified local operators, SIDECO. The joint bid was successful, and ITALGAS-SIDECO were entrusted with the task of managing gas distribution services in two areas: Cuyo and Central, located in the North-West.

The ITALGAS-SIDECO Consortium, in which Italgas is the technical operator, now manages such services through two operating companies, Ecogas Distribuidora del Gas del Centro and Ecogas Distribuidora del Gas Cuyana.

In both companies Italgas is present in the operative management, occupying several leading positions.

Altogether the users in the two areas, reached by the service in 1993, were 550,000. More specifically, the territory of Central serves 300,000 users by means of 7480 km of gas piping for a volume of gas sales estimated at over 1420 cubic metres. Through a network of 4870 km, the company of the territory of Cuyo serves in turn 250,000 users for a volume of gas sales estimated at 1102 million cubic metres.

The setting up of these companies has meant profound processes of reorganisation, the injection of men and of adequate information technologies, with programmes of staff training and restructuring of the working environment and, obviously, with a great deal of attention directed towards customer needs.

Such an approach has made it possible, from the earliest months of company life, to achieve many of the technical and quality objectives that we had set ourselves. At a year's distance from the start-up of operations, we are able to confirm that choices have been appropriate.

Again, a notable contribution to successful results must be attributed to the preparatory phase with which the Argentine Government set in motion the process of privatisation of Gas del Estado, and more precisely to the drawing up of a Marco Regulador (Law of Implementation) and of complementary laws that regulate the Gas Industry in Argentina.

Hungary

In November 95, the Hungarian Government Privatisation Agency and a consortium between Italgas (with a quota of 80%) and SNAM (with the remaining 20%) signed a contract for the purchase of 50% plus one share of the Hungarian company TIGAZ.

The Italgas led consortium had been successful in its bid following an international tender published by the Hungarian Government for the privatisation of its regional companies.

Tigaz, operating in the Hungarian North East, is the largest of these regional companies, and investments foreseen by Italgas are important (about 172 million dollars).

There are 800.000 users on about 600 networks. Gas deliveries in 94 were registered at 2.3 billion cubic meters with programs of rising to 3 billion by the year 2000.

Italgas has a very operative presence in the Company responsible, as it is, for top management nominations and the determination of strategic lines.

We think that a good part of the success we foresee in operations is, however, going to be due to an efficient regulatory framework for the natural gas sector, prepared by the Hungarian Government, and its close enforcement.

The main lines are:

- A gas Law and a gas Law enforcement Act.
- A gas tariff Decree and a gas tariff enforcement Act.
- Government Decrees pertaining to the entire gas sector, inclusive of details as, for instance, customer connection charges.

Basic considerations drawn from our international experience in gas distribution.

Experience so far acquired at international level allows us to draw certain basic conclusions, which we wish to view from the angle of the entry of private companies as shareholders in distribution companies.

In Countries where a privatisation programme is undertaken, gas distribution projects have to be considered within the framework of diminishing public sector involvement and increasing reliance on private sector financing and operating capabilities.

What does the private investor ask for?
In the first place, assurances as regards energy policies of the Country, and assurances regarding standards.

We all know that the distribution of natural gas involves the setting up of infrastructures by means of long-term projects (the pay-back period is usually more than 12 years).

Likewise, we all know the large number of variables that have to be taken into account when evaluating a new distribution project. Many of these variables are linked to the customs, traditions and culture of the Country.

The introduction of natural gas into a Country inevitably alters consolidated situations in the energy market, and it is not only necessary that at government level there should be well defined general guidelines on energy policy, but that above all there should be a plan for practical measures that will favour its use (generally this comes about via tax relief on natural gas, and constraints on the use of more polluting fuels).

Here it should be added that Governments ought to take into account also assistance of a financial nature to users (above all households), in as much as the spread of the use of natural gas comes to terms with the high costs that the individual user has to bear at an initial stage (conversion or purchasing of gas appliances, installation or modification of internal plants, connections up to the grid).

Public service delegating involves entering into arrangements which can work effectively only if they adequately satisfy the different interests of the three main actors:

Government or municipal authorities, companies, and customers:

- Government or municipal authorities seek political and social goodwill which can accrue if services are provided widely, reliably and at an acceptable cost;
- Commercial entities providing the service seek business continuity, reasonable returns for risks taken, and minimum intervention in operating decisions;
- Customers are mostly interested in a safe and easily accessible service for the lowest direct or indirect contribution.

We may unfortunately be perfectly sure that the development of gas distribution in urban areas is going to be held back indefinitely in case an institutional framework is not defined in advance, and in case duties and responsibilities of these three main actors are not well defined.

From our point of view it is essential, as prospective investors, to have a clear picture of the institutional framework within which we are to operate.

Basically, procedures for the setting up of the natural gas distribution company and its very special rights and obligations.

Our experience leads us to underline, however, two further aspects, whose importance Italgas continues to be aware of, whose competence is that of a distribution company, and which I would like to list before thanking you and taking my leave:

These are, the necessity to identify ones self, as much as possible, in local situations and acquainting ones self with the customs and ways of thinking of the area of operations.

For these last aspects really, to be brief, the use of experience and imagination.

Thank you

HAIFA, 19.6.96

TRENDS IN ITALIAN GAS DISTRIBUTION

from a

MARKET PERSPECTIVE

Giuseppe Vola
ITALGAS

Haifa, June 19, 1996

FOREWORD

I am glad to have the opportunity to cast a glance at Italian gas distribution from a market perspective.
I'll touch on the following topics:

- the structure of the Italian gas industry
- the structure of the gas distribution system
- market trends and current situation
- basic pre-conditions allowing for market penetration and expansion
- activity put in place by the Italian gas industry
- the results achieved
- new opportunities

My goal with this presentation is to show how the Italian gas market has been developed, what initiatives were needed for this purpose and within what framework they took place.
In doing so, I hope that the differences between Israel and Italy notwithstanding, some aspects might be stimulating for your own approach.

Many of the figures and the market situations reported in this paper refer to the residential market.
In a broader sense they may also be referred to the commercial sector, which in many respects is similar.

THE STRUCTURE OF THE ITALIAN GAS INDUSTRY

SNAM is the Company which purchases natural gas from national producers and abroad.
It transports the natural gas through an extensive pipeline system and supplies it to gas distribution companies, power stations and major industrial users.
So, while SNAM is entrusted with the direct supply of natural gas to large industries and power plants, the local gas distribution companies are entrusted with supplying end-users: households, small and large businesses, public premises and small industries.

THE STRUCTURE OF GAS DISTRIBUTION

In Italy, gas distribution for residential and commercial uses is a service which can be decided upon by the municipalities (local councils), and distribution may either be carried out via a concession to a private gas company, or by formation of a special municipal enterprise or, again, the service may be directly run by the municipality. This situation explains the relatively large number of companies operating in Italy, approximately 800.

Italgas is by far the leading company in the distribution sector.
It accounts for one third of overall gas distribution customers and more than one fourth of gas sales.

The difference between Italgas customers and gas sales performances can be explained by the commitment to extend the number of new municipalities, especially in the South of the country, thus becoming more 'South-oriented' than other companies, and because of the smaller mean consumption per customer in the South, as a result of the milder climate.

Anyhow the pace of expanding sales is clearly illustrated comparing Italgas sales growth rate with the overall gas distribution rate.
While over the period 1980-1995 the whole gas distribution sector sales grew at an annual rate of 6.7%, Italgas grew at 9.8% per annum.

ITALGAS'S MARKET SHARES

Italgas gas sales and customers broken down by type of market and utilisation are as follows.
The table gives the 1996 forcast and the predicted market share.
It can be noted that beyond the domestic and commercial markets, small and large industrial sales and customers are shown.
In fact, gas distribution is such that all small industries, with a yearly consumption of up to 200,000 cubic meters, are directly served by the local gas company. Also larger industries, on the basis of special accords and under the same conditions as those directly supplied by SNAM, can be served by local gas companies.
In industry gas is used in many process technologies, for steam production, for combined heat and power generation, as well as space heating by means of a whole series of specific gas installations.
Thanks to its characteristics as a fuel, to its competitiveness and low environmental impact, natural gas can thus contribute to alleviate air pollution in urban areas while allowing for economic growth.
When it comes to the branch of activity of Italgas small industrial customers, sales are largest in the mechanical industry, chemical and plastics, textile, paper and glass.

ITALGAS
1996 projected sales

	sales (million c.m.)	customers (thousands)	sales market share %
Residential			
- individual uses	3,595.0	4,662.4	
- collective uses	1,488.0	76.6	
	5,083.0	4,739.0	68.7%
Services sector	1,475.7	231.6	53.4%
Industry			
- small industry	165.8	9.3	88.3%
- large industry	1,161.7	1.1	
	1,327.5	10.4	
TOTAL	7,886.2	4,981.0	67.8%

STATE OF DIFFUSION OF GAS DISTRIBUTION

In Italy we have 8,100 municipalities, the smallest unit of local governement. At the end of 1995, 4,703 municipalities, 60% of the total, if we exclude Sardinia, were connected to the gas pipeline system, with a population exceeding 83%.

In 1980, 1,651 municipalities were connected, and the population served was 31,5 million, or 55% of the total.
Most of the increase has taken place in Southern Italy, since in the North and Centre most areas were already served.

The period of greatest expansion can be said to be practically concluded; short term plans for network extensions concern only quite a small fraction of the population (some 5%).

If we look back in the past we can recognise how big an effort was made to bring natural gas to the vast majority of Italians.

From 1973 to 1993, the length of the transmission network has more than doubled, from 10,488 Km to 25,058 Km; in the same time, local gas distribution networks increased from 37,507 Km to 155,613 Km.

THE PRESENT SITUATION

During the last two decades, natural gas has gained an important position in the Italian energy market.
This source of energy has provided the means of substantially decreasing Italy's dependence on oil.

In 1973, with just over 17 billion cubic metres, about 14 Mtoe, natural gas satisfied 10% of the national energy requirement from primary sources, whereas oil covered 75%.
Last year (data are still provisional) natural gas covered over 26% of the requirement, with a record high of 54 billion cm.
Oil has gone down to 55%.

Today Italy ranks among Europe's largest natural gas consuming countries together with Germany and Great Britain.
Prospects are for a further consistent expansion.

I'd like to summerize the reasons for this development:

- fair size of national reserves
- difficulty of increasing the use of coal and nuclear energy, owing to growing opposition from public opinion
- high social acceptability of natural gas
- lower environmental impact.

Natural gas is the only source of energy which Italy possesses in better-than-marginal quantities.

In the last few years the sustained development of the market is the outcome of a singularly active gas industry moving in a favourable environment: the cancellation of the nuclear power programme, the absence of competition from coal and a generally strong consumer preference for gas as an alternative to oil products.

In particular, a considerable rise of gas consumption in the residential and commercial sector has resulted from an aggressive commercial policy mainly oriented towards large cities, but also designed to take advantage of the growing Southern Italian market.

EVOLUTION OF RESIDENTIAL AND COMMERCIAL CONSUMPTION.

Going on now to look more closely at the evolution of the consumption of natural gas for residential and commercial uses, it is important, as we have already mentioned, to stress that during the eighties natural gas became a source of energy which was available to the great majority of Italians.

During the 1970s and the1980s, overall residential and tertiary consumption continued its steady long-term increase. In 1973, total consumption was 29.6 million Toe. The sector has undergone deep-seated internal changes: petroleum products (mainly gas oil), which were 69.4% of the total in 1973, had fallen to 18.1% by 1995; natural gas, during the same period, rose from 13.6% to 52.7%.

The internal structure of the residential and commercial consumption has also changed. During the whole period there was a growth in consumption in the services sector, which now accounts for 26% of the total, and a corresponding contraction of the residential sector, 74%.

Natural gas's share of the market is more ample in the residential than in the services sector.

Whereas the domestic market has become more stable, linked as it is to the declining population growth, low construction activity, the use of more energy efficient appliances and an attitude oriented more toward energy saving. The increase in the market for services is bringing about an expansion in total consumption.
In this market, a more and more important role is played by electricity (42 percent of the overall consumption of the sector).
Naturally, this growth of the tertiary sector is not surprising, considering that the economy, in line with all developed countries, is moving progressivly and ever faster towards the services sector.

As already mentioned, the rapid growth of domestic uses of natural gas can be attributed to the increasing extension of the distribution network, the strong consumer preference for gas and intense marketing activity.

The Italian gas industry has proved to be capable of successfully seizing market opportunities within a most favourable legislative framework provided by the national energy policy.

In 1980 a law was passed by the Italian Parliament to encourage the extension of natural gas to Southern Italy.
A national methodology for the calculation of the gas tariffs, which were applicable at town level, was set up in 1975.
While setting targets aimed at effectively providing the service, this methodology also encouraged investments in new networks and in upgrading of existing ones on the part of the gas companies.
During the eighties, the tax burden on natural gas for residential and commercial uses was kept significantly lighter than on competing liquid fuels. A reduced tax burden was introduced for Southern Italy, so as to boost natural gas use in conjunction with the new transmediterranean gas pipeline to import gas from Algeria which linked Sicily with Tunisia under the Sicilian canal.

I will come back to these issues in a moment.

Surrounding favourable circumstances were constituted by the presence of Italian manufacturers of gas appliances: cookers, water heaters, gas boilers, room heaters, and so on.
Gas appliances were also imported, mainly from other European countries.

The Italian gas industry's strong commitment was also combined with the building up of a partnership with installers; the skilled craftsmen upon whom depends the safe, swift and cost-effective laying of gas pipes at the customer's premises and the installation of the gas appliances.
Training courses were organized by the Italian gas industry all over the country, as were joint initiatives to promote the spread of natural gas utilizations.

THE NATIONAL ENERGY PLAN

Now I would like to briefly comment on some of the issues listed above.
As far as the national energy policy is concerned, a number of National Energy Plans were launched by the Italian governement after the first 1973 Oil Crisis.
The last of such documents was issued in 1988, after the Chernobyl nuclear accident and a popular referendum which decided to abandon nuclear energy production.
The 1988 National Energy Plan set 5 main objectives to face the national energy situation:

- encourage energy saving
- protect the environment
- enhance the contribution of national energy resources
- allow for geo-political diversification of energy imports
- better the economy competitiveness of the country

Not surprisingly, the plan consistently envisaged a further expansion for natural gas which was due to increase from 32.3 Mtoe in 1987 to 50 Mtoe by the year 2000, or from 21 percent to 28 percent of overall primary energy sources.
A remarkable increase was expected in the residential and commercial sector, from 13.1 Mtoe to 22.3 Mtoe.
Updated forecasts are even more ambitious.

THE LAW FOR THE DIFFUSION OF NATURAL GAS TO SOUTHERN ITALY

The Law for the diffusion of natural gas to Southern Italy was passed on 30th November 1980 (law n. 784).
It granted subsidies to municipalities in terms of non refundable contributions for the reduction of the investment cost (10-30 percent) and low interest rate loans for another 10-30 percent of the investment cost.
At the end of 1994 the number of municipalities connected with the natural gas transmission system was 612 compared with 93 in 1980, while the population served increased from 5.1 million (25% of the population) to over 12.0 million (roughly 60% of the total population living in the South).

THE COMPETITIVENESS OF NATURAL GAS VS. OTHER FUELS AS A DRIVE TO MARKET PENETRATION

A major market drive for the rapid and broad diffusion of natural gas has proved to have been its price competitiveness versus other energy sources.
If we just focus on the main competitor on the market place for space heating utilisation, gas oil, it can be recognized that, compared to gas oil, the cost saving enjoyed by natural gas consumers in the eighties was in the range from 20 to 30 percent in most towns.
In recent years, though maintaining its cost saving attractiveness, the remarkable competitive margins have declined mainly as a consequence of an increased tax burden.

CONSUMER ACCEPTANCE

The fast diffusion of natural gas on the Italian scene couldn't be explained without taking into account the highly positive image that it was able to create.
In a recent market survey that Italgas conducted, 91.2% of the people interviewed expressed a positive opinion of natural gas (in 48.6% of cases, the opinion was 'very' positive).
Gasoil and electricity enjoyed much poorer outcomes: 26.9% ("very positive" 3.6%) and 62% ("very positive" 26.6%) respectively.

Natural gas is recognized as economical and environmentally friendly.

NATURAL GAS, AN ENVIRONMENTALLY FRIENDLY ENERGY SOURCE

As we have just seen, the low environmental impact is regarded as one of natural gas's main features.

Environmental balance of natural gas

Compared with the other fossil fuels natural gas ranks highly:

- Natural gas is used directly as a primary energy source by final consumers. This avoids energy losses and emissions that occur with conversion into a secondary energy source.

- As it is a gaseous fuel, natural gas can be mixed homogeneously with combustion air. Together with precise regulation of the air supply, this leads to almost complete combustion. Thus virtually no uncombusted components, such as soot, are emitted.

- Natural gas contains practically no pollutant-forming components such as sulfur and its compounds. The exhaust of gas-fired combustion plants is therefore virtually free of sulphur dioxide and dust.

Carbon dioxide as the main cause of the greenhouse effect

Carbon dioxide (CO_2) is the main cause of the anthropogenic greenhouse effect. Anthropogenic CO_2 emissions are chiefly due to the combustion of fossil fuels. However, the various fuels contribute different amounts. Natural gas's rate of CO_2 release is the lowest because it has the highest proportion of hydrogen and the lowest share of carbon.

NATURAL GAS IN VENICE

A well renowned example of how natural gas can contribute to curb pollutant emissions and alleviate environmental concern is that of Venice.
The canal city suffered from heavy air pollution which threatened its historical heritage as well as the health of its citizens.
In 1973 a special law was passed by the Italian Parliament aimed at safeguarding Venice: no other fuel except natural gas was allowed within the lagoon area.
Venice is a city served by Italgas. Natural gas started being distributed in 1971 and the conversion was completed in 1978.
Sulphur dioxide levels declined in parallel with the increase in natural gas consumption: from 50 ppb in 1971 to below 20 while natural gas increased from 40 to 120 million cubic meters.

JOINT MARKETING INITIATIVES OF THE ITALIAN GAS INDUSTRY

Marketing activities have accompanied the extension of gas networks and favoured market penetration by means of enhanced consumer preference.

Italgas has a long standing tradition in marketing activities, the main tools being: advertising and sales promotion, not to mention gas tariffs which cannot be considered a marketing lever in Italy because of the existing national methodology.
In the early seventies the conversion from the so-called town gas (manufactered from petroleum products) to natural gas was accompanied by communication campaigns aimed at creating awareness of the new energy source and illustrating its positive features (cost saving, environmentally friendly, etc.)
New small domestic clients benefitted from discounts on the connection cost.
Economic incentives, mainly in the form of non refundable contributions to the equipment conversion cost, were addressed to large customers.
In the eighties the ambitious targets set for the development of the natural gas market needed additional efforts and a substantial shift in the marketing activities.
A broad initiative was jointly undertaken by Italgas, as well as other major gas companies, and Snam, to boost sales in the residential block heating segment and in the large services sector.

The "Iniziativa Riscaldamento Centralizzato" (IRC), or "Block Heating Scheme", was particularly successful: this campaign, entailed non-returnable contributions which substantially covered the cost of converting collective heating systems to natural gas in multi-family apartment blocks, these being the prevailing type of building in Italian cities at that time.
To support this campaign on the market, SNAM and Italgas launched huge advertising campaigns.
The IRC campaign lasted for 3 years, from 1986 to 1989, and proved to be very successful.

THE GROWTH OF GAS UTILIZATIONS

The outcome of the efforts made by the Italian gas industry can be witnessed by the growth in gas utilizations. The evolution of the Italian domestic market, as shown by extensive market surveys jointly carried out by Italgas and Snam, makes it possible to determine the main trends, from a comparison with the situation in previous years.

In particular, a strong increase in natural gas's share in the various domestic utilisations can be seen.

In many respects the growth of domestic gas utilisations can also be regarded as an indication of what is going on in the commercial and tertiary sector.

Cooking: Natural gas has increased its share from 42.1% in 1980 to 63,3% in 1995, from 7.8 to 12.9 million households..

Production of domestic hot water for sanitary purposes: in 1995, natural gas conquered the leading role in this segment (51,4%) as compared with a 20.3% share in 1980, 10.5 as compared to 3.7 million households.

Heating: in the field of heating (individual central heating, collective block heating and stoves) the great protagonist is natural gas, which stands as the leading fuel (56.2%, 11.5 million households), well ahead of all its competitors.
It accounted for just 21.6% and 4.0 million households in 1980.

These figures refer to the whole country and include also those parts that are not connected to the gas transmission system. If we consider only the municipalities connected to the gas pipeline system, the 1995 market shares of natural gas are as follows:

- cooking 76.2%
- hot water 61.9%
- heating 67.6%

NEW UTILISATION TECNOLOGIES: GAS COOLING

In recent years Italgas has been developing a new market which represents a good opportunity for expanding sales and one which may be of interest to Israel: gas cooling.
For this reason I think it's worth spending a few words on this issue with a little more in-depth analysis.
The high summer temperature, particularly in the South, the spread of the services sector (office buildings, supermarkets, hotels, department stores, and so on), the search for more comfort have spread summer air cooling in Italy.
This market has become increasingly important in recent years. In the early nineties cooling systems were powered almost exclusively by electricity, whereas interesting gas fired equipment had become available on the market.
Intense Research and Development efforts taken place mainly in Japan and USA, where many equipment manufacturers were present on the market. For Italgas gas air-cooling appeared to be new challenging opportunity for pushing gas sales, in a period of the year when gas sales are lowest.

There are two types of cooling systems used for commercial or residential buildings.
One type relies on mechanical compression to increase refrigerant vapor pressure and temperature, the other employs an absorption cooling cycle and uses heat for this purpose.

Most existing cooling systems are of the mechanical compression type, using electric motors to drive the compressor.
In many cases, however, gas engines are used to drive the compressors.
It should be noted that gas drives make far better use of resource energy (or primary energy) than electric motors. Three Btu of resource energy must be used to deliver one Btu of electricity on site.

Compressors

In the compression system a compressor supplies the forces necessary to keep a mechanical compression system operating. It maintains the low side pressure at which the refrigerant evaporates, and the high side pressure at which it condenses, thus creating the pressure difference which causes refrigerant to circulate. Mechanical energy needed to drive the compressor can be provided by an electric motor or a gas engine.

Absorption system

In an absorption system a sorbent solution in the refrigerant circuit absorbs refrigerant vapor from the cooler. This mixture is then heated in a generator to boil off the refrigerant and strengthen the sorbent. The refrigerant vapor is liquified in the condenser and returned to the absorber.

Absorption systems generally are lithium-bromide salt-water systems or ammonia-water systems. Lithium bromide systems use lithium-bromide to absorb refrigerant water vapor: ammonia-water systems use water to absorb the refrigerant ammonia vapor.

Specific characteristics of the two gas systems are:

- absorption units: safety due to lack of CFCs, long life of units, low maintenance costs;
- compression units: high efficiency, thanks to heat recovery from engine and from exhaust gases.

While availability of gas-powered models was good in Japan, both of the compression and of the absorption types, in the early nineties in Italy availability was limited to only a few makes and models, exclusively of the absorption type.

Furthermore, these units were not very competitive compared to the electric models, since the investment cost was higher and energy efficiency lower.

It was then necessary to encourage the introduction of new gas machines onto the market and to support their popularization through specific promotional activities.
A supply side intervention was to be accompanied by a demand side initiative.

To enhance the availability of gas cooling equipment of the type and the capacity needed, a series of agreements were reached between Italgas and major

Italian manufactures and importers, in which precise sales targets in terms of installed cooling capacity, were set.

As regards the demand side, a promotional campaign was started to support gas air-conditioning, by introducing reduced gas tariffs and non- returnable contributions to cut investment costs.

The contributions, which varied with the cooling capacity of the unit, covered some 25% of the list price and aimed to reduce the extra investment cost the client had to make to install a gas-powered unit, compared to an electric one.

The reduced gas tariff allowed the client a saving of between 100 and 300 lire/m3 (or 25 to 45%) over the normal rate and in most cases it brought the cost of production per kWf with a gas-powered unit to below that of electricity.

In order that both technologies should enjoy equal opportunities and to ensure that the client got the investment back in a relatively short time, for absorption units, which are penalized compared to compression units, both from the standpoint of efficiency and from that of initial cost, the promotion included extending the special tariff from the summer period to the winter months for the first five years after installation.

The efforts made have produced clear results. Indeed, gas air-conditioning plants in the area served by Italgas total 693 (at December 31st, 1995) with 1,251 units installed, for a total capacity of 60,550 kWf.
Office buildings and hotels were the most common clients.
Despite these positive results a serious blow to the diffusion of gas air cooling has been caused by the economic recession, particularly harsh in Italy, in 1992-93; the increased taxation on the end-price of natural gas; the devaluation of the lire against other currencies.

The main weakness that has prevented gas air conditioning from becoming more widespread concerns its market price, which is considerably above the equivalent electric system at present (in round figures, the price ratio is 1.7 - 2.5 for absorption systems, 1.5 - 1.9 for compression systems). The cause of the high cost of gas-powered systems lies in the fact that production of gas-engine

driven units, assembled in Italy, is low, and for absorption units, imported from Japan, the unfavourable exchange rate for the yen is prohibitive.

In Japan, where gas cooling systems began operating in 1970, half of the newest large buildings (3,000 mq or more in total floor area) are equipped with this type of technology.

This can be explained considering that, in Japan, electric power consumption peaks in summer, when as much as a third of demand is for cooling.
Gas systems in Japan are enhanced by various tax and financing incentives which have been provided in line with the Japanese Governement's policies designed to alleviate seasonal power demand variations, to encourage alternative sources of energy to replace oil, and to reduce energy consumption.

Together with reduced gas rates provided by the gas company, customers enjoy a substantial 7% tax exemption from the acquisition value of the equipment or a special depreciation of 30% for the first year.
Loans at low interest rates are also available.
So, the diffusion of the gas cooling technologies can be substantially enhanced by the implementation of appropriate energy policies.