THE DEVELOPMENT OF THE GAS INDUSTRY IN IRAN*

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Irān's gas reserves are by all accounts considered to be very large - adequate to meet all known requirements for the next several centuries. This valuable resource has not so far been commercially exploited to the full - the only known uses in the past were confined to fire temples and oracles. It is believed that fire temples were originally built on the sites of natural gas vents and fissures, and it has been suggested that the existence of oil and gas seepages in this part of the world may have contributed to the ancient Irānian belief in the intrinsic purity of fire and the Aryan veneration of light.

Modern Irān is taking steps to catch up with the progressive countries of the world by developing her natural resources to provide greater welfare and opportunities for the nation. Along with the advancement that is taking place in all fields, Irān is planning for the exploitation of her vast gas resources in the context of an integrated development plan. The major steps that have been taken in this direction in the last few years, together with some of the attendant problems, and future plans, are discussed in this paper.

The Development of the Gas Industry

Very little can be said of the history of the gas industry in Irān up to the early years of the 20th century when oil was discovered in the south. Whether the references to ancient ("eternal") fires - mentioned in the accounts of historians, travellers and geographers - referred to

*Text of a paper delivered to the 11th International Gas Congress held in Moscow in June, 1970.

oil or gas seepages, is difficult to verify.

During the first fifty years since the discovery and exploration of oil in Irān, the associated gas, after driving the oil to the surface and coming out of solution, generally was of no practical use except as burner fuel. In fact it was an embarrassment for the producer, who invariably had no alternative but to flare it in the field.

Table 1

Production and Utilisation of Gas in Irān

($10^6 m^3$)

Year	Production	Utilisation		Flaring	
		As raw material	As fuel	After expansion	Direct
1956	4,013	10	430	675	2,898
1957	5,190	10	715	1,165	3,300
1958	5,832	10	734	1,508	3,580
1959	6,687	10	897	1,665	4,115
1960	7,563	10	1017	1,941	4,595
1961	8,400	10	973	1,968	5,449
1962	9,239	10	1043	1,983	6,203
1963	10,403	19	1120	1,934	7,330
1964	11,764	30	1162	2,276	8,296
1965	13,725	29	1200	2,273	10,223
1966	17,912	36	1414	2,141	14,321
1967	21,334	40	1379	2,573	17,342
1968	24,043	41	1404	2,682	19,916

Table 1 shows the production and utilisation of natural gas in Irān for the years 1956 to 1968. It will be seen that gas production was more than doubled in the five years between 1956 and 1961, and again between 1961 and 1966.Only about one tenth of the gas was utilised(mainly for heat generation) and, even when the quantities that were used expansively and then flared are taken into consideration, it is found that more than two-thirds of the gas production has alwsys been flared and lost. It is estimated that some 130 billion cubic metres of gas has been flared during the 60 years since oil was discovered in Irān. In terms of heat units this is equivalent to about 130 million cubic metres of fuel oil. A fleet of heavy road tankers carrying such a quantity of oil, and placed end to

end, would more than encircle the earth.

Wastage of potential energy on such a gigantic scale evidently demanded urgent action. But the market for the disposal of gas in these quantities was non-existant. Irān was too remote from centres of industrial consumption, or large concentrations of affluent population, to make pipelines feasible. Liquefaction techniques had yet to be developed, and in any case transport of liquefied natural gas was - and still is - very costly, putting Irānian gas in the markets of Europe at a definite disadvantage in the face of competition from such more favourably situated countries as Algeria and Libya.

It was in response to the Royal Decree that "the flames which burn our resources must as soon as possible be extinguished" that agreement was reached with the USSR in 1965 for the sale of large volumes of gas to be delivered to the Soviet border. The agreement enabled Irān to plan for the export of one of its potentially richest natural resources.Deliveries were to begin at an annual rate of 6 billion cubic metres, increasing by 1 billion cubic metres each year until an annual rate of 10 billion cubic metres is reached in the fifth year. This agreement provided a powerful impetus to the development of a gas industry in Irān. In fact, it would be no exaggeration to state that, in spite of the brisk market for LPG which has been developing in the country during the past fourteen years, the birth of the gas industry in Irān really starts with the gas sale agreement, and the formation of the National Irānian Gas Company as a subsidiary company of NIOC to undertake all operations in respect of treatment, transportation, distribution and sale of gas, whether for internal consumption or for export.

NIGC's head-quarters are at Tehrān and the company is administered by a board made up of five directors, under the chairmanship of H.E. Dr. Eqbāl the chairman of the board and managing director of the National Irānian Oil Company. The most important source of gas available to NIGC is the associated gas that is produced along with the crude oil by the Irānian Oil Consortium's Producing Company. NIGC takes delivery of these gases at the separator stage in the southern oilfields and, after treatment, has them compressed for transmission through the Irānian Gas Trunkline across the country and to Āstārā on the border with the USSR. The volumes of gas dealt with are considerable - starting with 8,000 million

cubic metres annually and reaching nearly double that figure by 1977. For apart from the export quantities, NIGC has plans for domestic gas distribution, supplying in the first place the industries along the line (most of which are concentrated in the Tehrān and Isfahān areas). Later, other centres of population and industrial development will be linked up, and the network will provide gas for commercial as well as private consumers, serving a population of something like a million people.

The IGAT Project

The Irānian Gas Trunkline (IGAT), which is to be the means of transmission of these vast quantities of gas from the southern oilfields is, therefore, the most important single factor in the future development of the gas industry in Irān, and as such deserves mention. The line spans the country for more than 1,100 kilometres, winding its way through flat lands and deserts, across swift mountain torrents and deep ravines, crossing heights of some 2,700 metres (twice the highest altitude of the Transalpine Pipeline), and skirting the thickly wooded hills of the Caspian littoral before reaching Āstārā on the USSR border. Engineers of fifteen nationalities have been involved in the design phase, and construction crews from six countries have worked on it. Installed equipment, too, is international in nature: Soviet-built turbines and compressors on the main-line stations receive gas from British-built turbines and compressors, which themselves receive gas from French-built compressor sets of American design. The gas sweetening plant - the world's largest - was designed in America and Britain, and was built from plant supplied from West Germany, Britain and France. Control instruments are of Soviet, British and American design: valves are British-made, but are fitted with American-made actuators, and the whole system is remotely monitored and controlled by a British-built electronic system using a French-built communication system. It is probably unique in the small number of differential pressure recorders used for flow measurement and recording. Metering throughout the system utilises analog flow-rate computers - used not only for the greater accuracy they provide, but also to derive corrected flow-rate signals for an electronic telemetry system. The degree of automation employed permits the compressor stations to be operated with no shift

operating personnel. Not only is automatic protective monitoring and automatically-controlled start-and-stop sequencing provided, but automatic optimisation of the number of operating compressor sets is also included.

A description of the IGAT project can conveniently be divided into three parts: The Gathering System, The Treating System, The Transmission System, (comprising compressors and the pipeline proper).

Since much of the equipment is probably unique in some respects, it is considered that the following brief notes serving to highlight the salient features of the various items, will be of general interest.

The Gathering System. This consists of about 104 kilometres of gas gathering lines taking the gases from the Aqā-Jārī and Mārun fields (operated by the Irānian Oil Consortium) to NIGC's Bid-Boland treating plant (Fig. 1).

At each of the Aqā-Jārī production units (and later, Mārun and Karana units) the Consortium Operating Company, after removing the heavy ends of the gas and lowering the dew point to - 10° C by refrigeration, delivers the gas to the field gathering compressor stations. At this stage the gas is dry and sour, principally methane, but containing 0.16% H_2S and 2.10% CO_2 in addition to mixed hydrocarbons. At the Aqā-Jārī stations the pressure is increased in two stages from 220 psig to 950 psig. The natural gas liquids - mainly naphtha, propane and butane - are sent by the Consortium Operating Company to the LPG plant at Māh-Shahr for export. The lean dry sour gas is then metred at the plant battery limit, where it is pumped by the IGAT compressors.

The Gas Treatment Plant. The treatment plant is situated near Bid-Boland village, about 20 kilometres from Aqā-Jārī oil fields, and close to Mārun river. By 1979 it is planned to have eight parallel trains, each with a capacity of 240 MMSCF/D, of which five are being installed initially.

The purpose of the treating plant is to remove H_2S and CO_2, as well as H_2O, and to provide sweet dry gas to the trunkline. Gas specifications, as delivered by the Consortium Operating Company, and as required in accordance with the agreement with USSR, are as shown in Table 2.

Each of the identical trains consists of a sweetening section (utilising MEA aquaous solution for the removal of acid gases) and a dehydration section using solid dessicants so as to ensure that the final dew

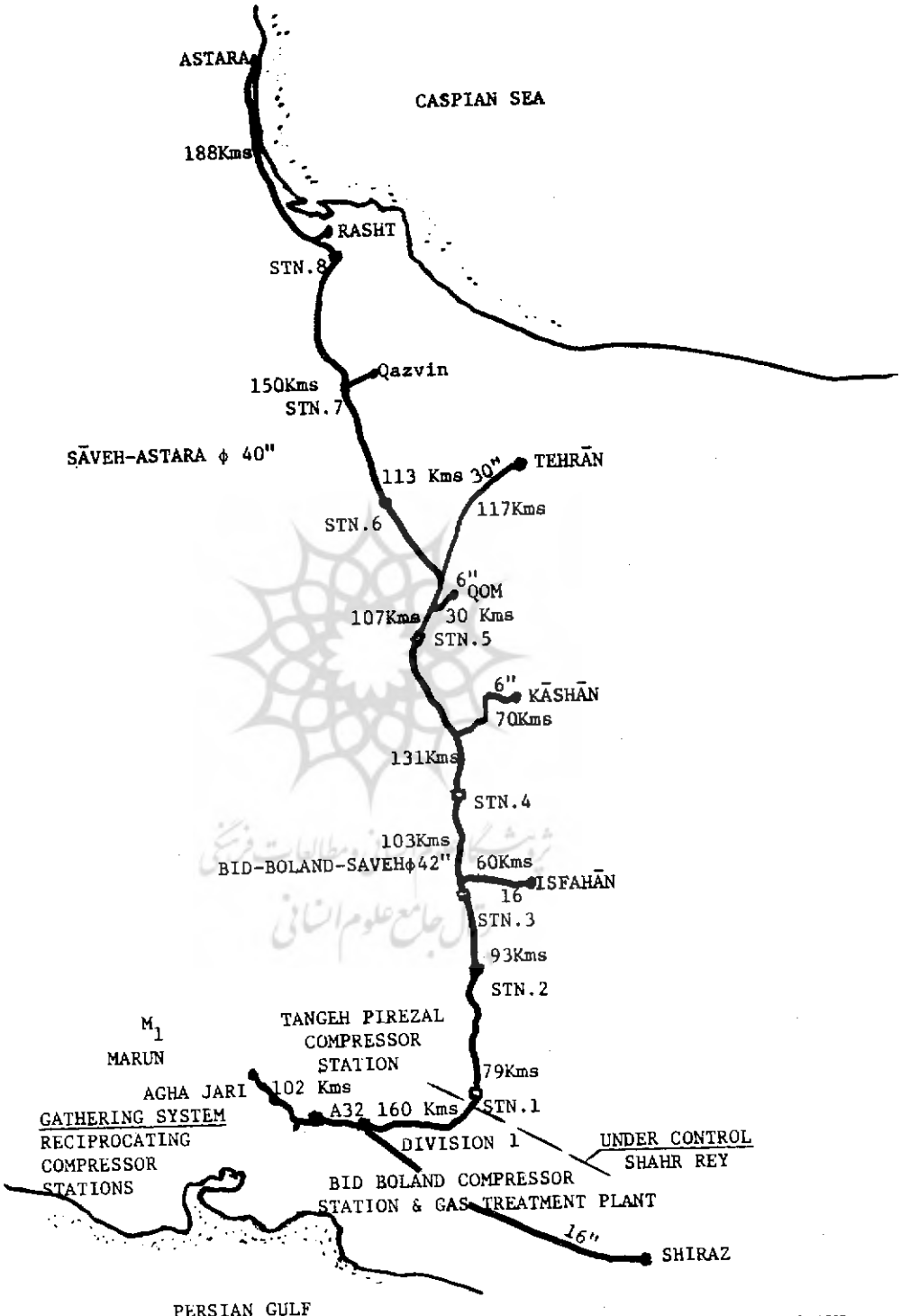


FIG. 1 IRANIAN GAS TRUNKLINE AND SUPER LINES

specifications (-10°C) are met.

Table 2

IGAT Gas Composition

(Mol. Per Cent)

	Incoming	Outgoing
H_2S	0.16	trace
CO_2	2.10	trace
C_1	81.40	83.15
C_2	11.90	12.36
C_3	3.42	3.45
iC_4	0.29	0.27
nC_4	0.54	0.58
C_5+	0.20	0.19

The Transmission System. The transmission system consists of 1,120 kilometres of 42"/40" main pipeline, and 675 kilometres of spur lines to Shirāz, Isfahān, Kashān, Qom and Tehrān (Fig. 1).

The main trunkline is 42" in diameter from the central gas treating plant at Bid-Boland to the Tehrān take-off point near Kuh-e-Namak. From Kuh-e-Namak to Āstārā the line diameter is reduced to 40". The pipeline will operate at 1030 psig, except for two short sections downstream of Bid-Boland and Tan-e-Pirezal compressor stations which will operate at 1065 psig. The 42" section has a wall thickness of 0.500" in unpopulated areas, and 0.600" where heavier construction is called for by the ASAB 31.8 code. The 40" section has a wall thickness of 0.477". The high operating pressure in the first section of the line is dictated by the limitations imposed on station spacing as a result of the terrain, and the very rapid change in altitude.

The pipe specifications are API LX 60 with a minimum yield strength of 60,000 psig. This steel has been selected for its resistance to embrittlement at low temperatures, as well as for its high strength, allowing small wall thickness, with consequent economies in steel as well as transport costs.

The pipeline is appropriately coated and wrapped and buried under approximately one metre of earth cover - except in very rocky terrain,

where this may be reduced to 30 cm. and is properly protected against corrosion. Cathodic protection for the main-line, as well as for the spur lines, is effected by the use of an impressed electric current. Sectionalising valves are installed along the line at intervals of only 30 kilometres in certain sections, and at all river crossings or other potentially hazardous locations. At major road and rail crossings the line is cased, and at minor crossing the pipe wall thickenss is increased. River crossings, where not elevated, are continuously concrete-coated and the line is installed at a minimum of one metre cover below the depth of the greatest detectable scour.

Station spacing along the IGAT line is dictated not only by the usual factors of installed horsepower and pipe size, but by such additional features peculiar to mountainous country, like site accessibility, water availability, etc. Apart from the compressor station at the Bid-Boland Treating Plant, there will be a further nine compressor stations by 1979 - one at Tang-e-Pirezāl and eight along the line - with an installed horsepower totalling 539,630 H.P.

The Economics of the IGAT Project

As is well known, pipelines are notoriously costly pieces of equipment, and a project involving the transmission of over 1½ billion cubic feet of gas per day (16 billion cubic metres annually) across more than 1100 kilometres of some of the roughest terrain in the world, naturally requires vast capital investments. Current estimates for total capital costs of the IGAT project are nearly $680 million most of which is to be financed from foreign loans and suppliers' credits, and the balance from the Irānian Government. Considering the gas volumes to be transmitted, it will be readily appreciated, therefore, that the need to apply the greater portion of the net operating revenue towards the payment of interest and loan retirements means that little surplus will remain during the early years. By itself, therefore, the sale of gas to the USSR would not repay the investment capital within a reasonably short period.

But only two-thirds of the line capacity has been earmarked for exports. By 1977 nearly 6,000 million cubic metres of gas will be supplied annually for internal consumption, mainly to the burgeoning industries

around Tehrān and Isfahān, but also for industrial, commercial and household use there, and in Shirāz, Kāshān, Qom, Qazvin, Rasht and Āstārā. Since the tariffs for the sales of gas to households, commercial concerns and industrial consumers are higher than those for export, it will be found that the total revenue from domestic sales will soon exceed that obtainable from exports - even though the volume exported will be nearly twice the volume sold on the domestic market. Thus, although the economic feasibility of the IGAT project is dependent upon export sales, the project relies rather heavily on internal sales in order to speed up debt retirements and shorten the payout period.

Based on present programmes, the payout period is conservatively calculated to be about 10 years.

The Rationale of Gas Distribution

The need for supplementing the profitability of the IGAT project is not the sole reason why gas distribution, and the development of a gas industry, is being pursued with such vigour in Irān. Part of the inducement stems from the fact that the pattern of energy demand in the country is undergoing fairly considerable changes as a result of differing growth rates for the different petroleum products. Latest forecasts, based on historical trends, product end-use analyses, and development plans, indicate that in the absence of alternative supplies of energy becoming available during the next seven years, the demand for petroleum products in 1977 would be as shown in Table 3.

Table 3

Petroleum Products Demand in Irān

	1968		1977	
	1000 M^3	%of total	1000 M^3	%of total
Motor gasoline	943	10.9	2,050	9.0
Kerosene	1,990	23.1	4,560	20.0
Gas oil	2,467	28.6	6,970	30.5
Residual fuel oil	2,577	29.9	7,530	33.0
Other products	651	7.5	1,730	7.5
Total	8,628	100.0	22,840	100.0

This means that the 1977 pattern of demand for petroleum products would be such as to increase the shares of gas oil and residual fuel oil by 2 per cent and 3 per cent respectively, at the expense of motor gasoline and kerosene. In other words, the higher growth rates for the two former products tend to aggravate an already difficult situation resulting from an imbalance between market demand for the various products and refinery yields. Residual fuel oil requirements do not pose much of a problem when it is considered that facilities are available for crude topping at Masjid-i-Suleimān, and that additional amounts may be obtained from the rising crude production from NIOC's joint-ventures in the Persian Gulf. To provide for the gas oil shortages by conventional refining methods would, however, result in embarassing surpluses of residual fuel oils. This is all the more noteworthy in view of the fact that with the current products price structure in Irān, the distribution and sale of fuel oil (which has to be hauled by road tankers) results in certain losses for NIOC in some parts of the country. It will therefore be appreciated that the introduction of gas - which in the main replaces middle distillates in the commercial and domestic sector, and residual fuel oils in the industrial sector - is indeed a timely remedy.

In effect any evaluation of the IGAT project properly should take into account the savings that accrue to NIOC as a result of its exoneration from having to subsidise a large volume of fuel oil sales.

Gas Distribution

The IGAT project calls for transmitting the agreed volumes of gas (about two-thirds of the design capacity of the line) for export to the USSR and utilising the balance for internal consumption in Irān. Table 4 shows the planned volumes for domestic consumption and for export during the first eight years.

By 1977 gas (including that obtained from Ahwāz and Saraxs) is expected to replace annually some 6½ million cubic metres of residual fuel oil and nearly one million cubic metres of middle distillates, representing approximately one-fifth of the total petroleum requirements of the country.

Distribution to industrial consumers in Tehrān and Isfahān will

Table 4

Planned Consumption and Export of IGAT Gas

Year	Domestic consumption (10^6 cubic metres)	Export to USSR (10^6 cubic metres)
1970	2,000	6,000
1971	2,700	7,000
1972	3,500	8,000
1973	4,100	9,000
1974	4,500	10,000
1975	5,000	10,000
1976	5,400	10,000
1977	5,900	10,000

commence in 1970 and will later on extend to commercial and domestic consumers. Initial estimated demand of industries in Tehrān is fairly high, and the expectations are that once the first batch of 660 industries receive piped gas, and the advantages of gas are seen in practice, demand will rise fast. Tables 5 and 6 show the classification of the 660 industries (representing nearly one-third of the present total in Tehran) by type of manufacture and by gas consumption.

The first phase involves the laying of the main distribution lines along the main routes and the provision of connections to these 660 industrial consumers (including nearly 300 brick kilns which dot the plains south of Tehrān, and which continue to belch out their unsavoury sulphurous smoke into the atmosphere). Later plans call for the laying of gas mains along the streets for the use of commercial and residential consumers. Connections for these consumers will be gradually provided - starting with 8,000 in the first year and, it is expected, reaching more than 100,000 connections in 1977. In the domestic sector gas displaces LPG and kerosene for cooking and space (including water) heating, as well as gas oil for heating units. It is estimated that to deliver the liquid fuel equivalent of the gas consumption of the domestic and industrial sectors in the Tehrān area alone would require a fleet of some 100 heavy road tankers and trucks. Their withdrawal from the congested streets would doubtless help to reduce air pollution in the built-up areas to a great extent, and would contribute to better health in the metropolis.

Table 5

Classification by Type of Manufacture of 660 Industries in Tehrān Receiving Gas in the First Stage

Type of Manufacture	No.	Gas consumption ($10^6 m^3$/yr)
Auto	6	6.4
Textile	14	53.4
Plastics	5	1.4
Leather	6	1.3
Dyes	1	0.1
Lubricants	4	14.5
Cement	3	170.5
Glass	14	24.9
Pharmaceuticals, soap, cosmetics	59	6.9
Food	25	61.1
Metallurgical	32	50.4
Ceramics	5	13.0
Rubber	8	11.2
Building materials (*)	470	399.9
Beverages	4	1.1
Miscellaneous	4	1.4
Total	660	817.5

(*) Mainly brick kilns.

Table 6

Classification by Gas Consumption of 660 Industries in Tehrān Receiving Gas in the First Stage

Gas consumption	No.	Total consumption ($10^6 m^3$/yr)s
upto 200,000	635	448
200,001-2,000,000	21	166
above 2,000,000	4	203
Total	660	817

It is anticipated that, during the initial years at least, the load factor is not likely to lead to any major peaking problems. However, to provide a remedy in the event that this should pose a problem later, when full capacity is reached and residential consumers begin to affect performance, studies are being undertaken to assess the economics of utilising underground reservoirs to provide peak-shaving facilities. The most convenient natural reservoir is the Kuh-e-Namak salt plug outcropping at the surface as a salt mountain near the town of Qom, 115 kilometres south of Tehrān. The provision of such undergound storage, by drilling into the salt plug and leaching with water, would be a more economic alternative to the early looping of the main line. There is also the possibility of using the Sarajeh gas reservoir near Qom for additional peak-shaving. The sweet gas from this field does not need any sophisticated treatment in order to meet gas specifications, for export, or for domestic consumption.

The city of Isfahān too, is planned to be provided with gas for its textile, building materials and manufacturing industries in the first stage, and for commercial and domestic requirements later. The Āryā-Mehr Steel Mill, though not planned to operate on gas for smelting purposes, will nevertheless consume sizeable volumes of gas, starting with about 180 million cubic metres annually and reaching more than double that figure in five years. Commercial and domestic consumption in Isfahān is not likely to be substantial (starting with about 6 million cubic metres annually and reaching nearly 190 million metres in 1977). To these figures will have to be added the consumption of the Steel Town being constructed for the steel mill workers.

In addition to the cities of Tehrān and Isfahān, IGAT gas will be distributed in Shirāz, Kāshān, Qom, Qazvin, Rasht and Āstārā. Qazvin is planned as an industrial centre, and plans are already afoot for the sitting of several large-scale industries there. Shirāz, the only city outside the southern oilfields which currently enjoys gas supplies for domestic purposes, used to receive its gas (about 200 million cubic metres annually) from the Gachsārān field via a 10" line built several years ago. A new 16" line is being constructed and will soon be in operation doubling the throughput capacity and making the present 10" line available for crude oil transportation to feed the proposed Shirāz refinery. The largest gas consumer in Shirāz at present is the fertilizer factory operated by a subsidiary company of the National Petrochemical Company (itself a

subsidiary of NIOC), but there are also fairly large thermal power stations, cement factories and sugar and vegetable oil refineries, all of which use gas at present.

The city of Ahwāz, though not on the main pipeline route, is nevertheless an important centre for many new industries, and NIGC has a gas distribution project under construction there. Gas supplies are being obtained from the Consortium Operating Company's crude oil production unit, which is rather close to the town, and it is envisaged that with a relatively small investment it will be possible to provide piped gas for the area's industries as well as domestic consumers.

Besides the above-mentioned programmes for gas distribution to towns and cities, there are plans for the provision of gas to the villages situated at a distance of 25 kilometres around the main line. It is believed that in much the same way that the early 19th century extension of railroads speeded the economic development of Western Europe and North America, the supply of gas to the rural districts around the IGAT line will considerably boost the development of agriculture and the modernisation of the village communities, and help to improve economic and social conditions in these areas. A pilot project involving the supply of gas, and attendant provision of electricity supply, to the village of Goyum (some 32 kilometres north-west of Shirāz) is already in operation, and it is planned to have this type of scheme eventually extended to many of the villages along the main gas lines. The provision of electricity and cheap fuel, together with the excellent work that is being done by the Literacy Corps and Health Corps, will undoubtedly have far-reaching consequences in revolutionising social conditions and changing the face of rural Irān.

Gas Tariffs

Since in most applications natural gas has to compete with other forms of energy (principally liquid petroleum fuels), it is evident that price policy is of crucial importance in the development of markets for the different fuels. Although gas can be considered as a by-product of crude oil production, with consequently low imputed production costs, the fact remains that by the time it reaches the consumer's premises it has attracted considerable costs, not the least of which is in respect of

capital investments amortizations. It goes without saying therefore, that the continuation of sales at prices lower than total long-term costs results in a loss, and is indicative of bad allocation of resources. Costs, therefore, set a lower limit to price. But the existence of alternative substitutable fuels - e.g., residual fuel oils for industry, and middle distillates for household use - sets the ceiling. The National Iranian Oil Company, as NIGC's parent company and sole nationalised corporation entrusted with petroleum affairs, could theoretically set gas prices anywhere between these limits which are determined by economic forces outside its complete control.

Table 7

Natural Gas Tariffs in Iran

(Price in U.S. cents per cubic metre)

Monthly consumption rate	Xuzestan	General	Tehran
Commercial & domestic tariff			
up to 1,000 m^3	2.53	2.67	2.93
1,001-10,000 m^3	2.27	2.40	2.67
above 10,000 m^3	2.00	2.13	2.40
Industrial tariff			
up to 20,000 m^3	1.07	1.47	1.67
20,000-200,000 m^3	0.93	1.33	1.47
200,001-2,000,000 m^3	0.80	1.20	1.33
above 2,000,000 m^3	0.80	1.07	1.20

Thus, price is a most potent factor, not only under conditions of competition where it regulates supply and demand, but under a planned economy, as an additional means of directing resources in the desired direction. The policy of NIOC has throughout been to ensure that price fulfills its function as an instrument for guiding the economy along the line most appropriate for its rapid development. Considerable care has therefore been given to the problem of pricing a new fuel like natural gas, and the guiding principle has been to allow gas to displace, on a clorific value basis, part of the middle distillate market, and also to curb a too rapid growth in the residual fuel oil demand. As in most countries, the tariff employed provides for differential prices both as regards end use, and region. There are of course, the usual escalating

discounts for large-volume use, and the additional "service connection fees" and "service connection deposits" schedules are similarly fixed in a manner which would somewhat favour large-volume use, as well as encouraging high load factors. Table 7 shows the tariff currently in use for natural gas sales to industry, and to commercial and residential consumers, in each of the three main regions of the country.

These rates are all below those for comparable rates (on a calorific value basis) payable for liquid petroleum fuels. Figures 2, 3, 4, and 5 graphically show the extent of these price differentials (discounts)relative to the prices of liquid fuels that gas replaces, for each fuel, region, type of consumer and consumption range.

It will be noted that in general the discounts are highest in the Xuzestān region, followed by regions of the country other than Tehrān ("General" region), and that the Tehrān region gets the lowest discounts.This is in order to discourage further concentration of industries and population migration in the Tehrān area, and to encourage the development of Xuzestān and other regions. Another point worthy of note is that the relative price advantages of gas for commercial and domestic consumers are higher for kerosene displacement than for gas oil displacement. Similarly in the industrial sector the relative price advantages of substituting gas are higher for gas oil than for residual fuel oil. The general effect is to provide the domestic consumer with a strong incentive to switch over to gas from kerosene (used mainly in cooking, water heating and space heating) - considering that the domestic consumer of gas oil (who generally uses this fuel for central heating purposes) does not need as much encouragement. Again, in the industrial sector, it is anticipated that the large-volume fuel oil consumer is generally cost-conscious enough to need much less encouragement in the way of price discounts than the smaller-volume consumer of gas oil.

NIGC's Future Plans

Since NIGC is entrusted with all aspects of gas operations(gathering treating, transmission, storage, distribution and sales), it is necessary that the company continuously studies plans for the expansion of gas distribution networks, reduction of costs and improvement of services. At

Figure 2
NATURAL GAS COMMERCIAL AND DOMESTIC TARIFF DISCOUNTS
RELATIVE TO KEROSENE PRICES
(ON A CALORIFIC BASIS)

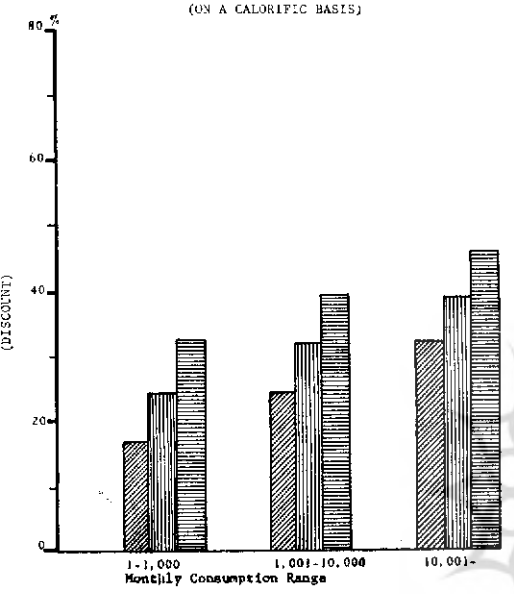


Figure 3
NATURAL GAS COMMERCIAL AND DOMESTIC TARIFF DISCOUNTS
RELATIVE TO GAS OIL PRICES
(ON A CALORIFIC BASIS)

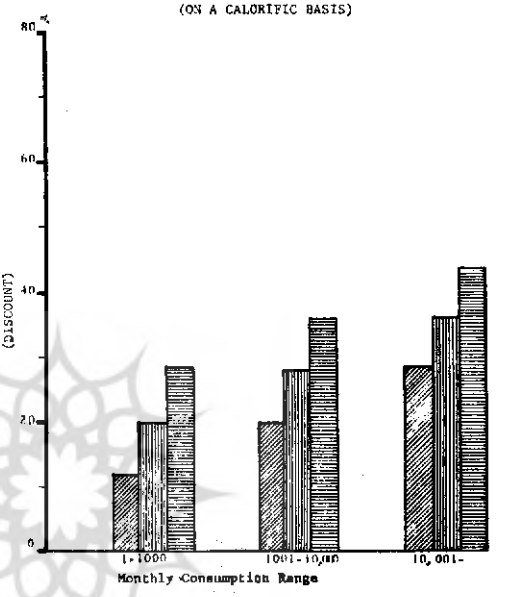


Figure 4
NATURAL GAS INDUSTRIAL TARIFF DISCOUNTS
RELATIVE TO GAS OIL PRICES
(ON A CALORIFIC BASIS)

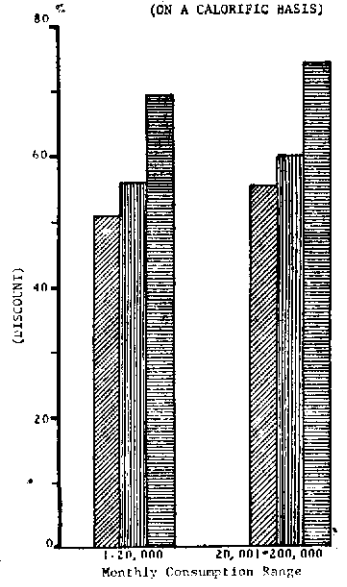
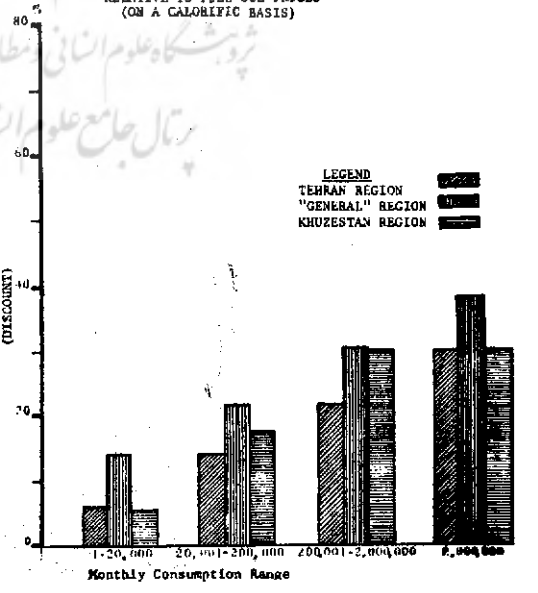


Figure 5
NATURAL GAS INDUSTRIAL TARIFF DISCOUNTS
RELATIVE TO FUEL OIL PRICES
(ON A CALORIFIC BASIS)



present supply is no problem, and therefore NIGC does not have to get involved in drilling for gas. But as and when gas is found by NIOC or any of its operators or joint-venture partners, NIGC comes forward to study the possibilities of its development. So far there are the associated gases from Ahwāz oilfields (operated by the consortium companies), the Saraxs and the Sarājeh gas fields waiting for development.

Ahwāz gas, as mentioned above, is being developed for distribution to the expanding industries of Xuzestān, and for commercial and residential consumption in the Ahwāz area. Sarājeh gas is rich in condensates and will probably be integrated with the IGAT system - it could be used for peak-shaving to supplement IGAT gas, after the extraction of liquid fractions.

The Saraxs gas field at Xān Girān some 120 kilometres from Mashad on the border with Russian Turkestān, is a major discovery in its own right, and studies are being made to determine the feasibility of transmitting natural gas from the field by pipeline to other centres of consumption. Preliminary studies indicate that on the basis of even the relatively limited market for gas in the city of Mashad, investment payout is of the order of five years. Should projects for the manufacture of fertilizers in the area be included, it is expected that the profitability prospects may be even better.

NIGC is also actively studying the possibilities of exporting liquefied natural gas. Recent advances in the building of LNG carriers have shown that natural gas can be delivered in the Far Eastern markets, and even in Southern Europe, at competitive prices, despite the long ocean haul. These plans will probably involve a tri-partite joint-venture between NIGC as the supplier of the gas, a second party representing the supplier of capital, and a third party representing the gas consuming company in the importing country.

LPG

As would be expected, the first use of LPG in Irān was in Ābādān, where it was used to a limited extent in the oil company personnel houses for cooking purposes. But the marketing of LPG on a commercial basis in Tehrān was begun in 1955. At first it was used by only the relatively

well-to-do classes who could afford the imported gas equipment, and who are willing to pay the higher fuel price in order to benefit from the superior performance of gas ranges compared with kerosene cookers. The need to obtain supplies from the only refinery at Ābādān meant that by the time all costs had been accounted, the selling price in Tehrān became rather high. But the public soon came to appreciate the advantages of gas, and a number of enterprising firms began importing (and later manufacturing) more economical cooking ranges, with the result that over the years average annual LPG consumption growth has been sustained at a very high rate, as shown in Table 8.

Table 8

Consumption of LPG in Irān

Year	Consumption (1,000 metric tons)	Annual increase (%)
1955	0.08	-
1956	0.20	150
1957	0.30	50
1958	0.55	83
1959	1.38	150
1960	2.57	86
1961	2.59	1
1962	6.20	140
1963	7.93	28
1964	12.15	53
1965	17.96	48
1966	26.17	46
1967	39.25	50
1968	58.09	48
1955-1968	Average annual increase	66
1960-1968	" " "	48
1965-1968	" " "	48

The increase in consumption of LPG is estimated to be maintained at the high rate of 40 per cent, at least for the next three years, so that by 1972 some 220,000 metric tons of LPG will be required to meet household demands throughout the country. LPG will replace middle distillates (which

are in short supply) and its consumption growth will tend to bring the pattern of demand for energy more in line with refinery yields.

At present there are seventeen LPG distributing companies drawing their bulk requirements from the refineries at Tehrān and Ābādān and distributing LPG in steel cylinders of 10, 11, 12, 15 and 45 kilograms to some 300,000 households in the country. There are plans for the production of LPG at the Kermānshāh refinery as well as at Sarajeh (near Qom)to meet the rapidly rising demand.

NIGC itself is entering the business of LPG distribution, and is planning to retain a limited share of the market in order to set acceptable standards for service and safety, and generally to educate the consumer in the proper utilisation of gas. LPG is pioneering the way in familiarising the public with gas appliances and preparing the ground for the introduction of piped natural gas, and NIGC's entry in the market will ensure that other distributors will comply with safety standards.

Since pipeline networks for the supply of natural gas cannot economically be extended to cover all areas, it will be seen that LPG distribution in the smaller towns and rural areas is going to be an expanding business, particularly as a result of the rising population and per capita income, as well as of the general improvements in living standards.

LPG is also being used in city buses in Tehrān, which are equipped with diesel engines, as a means of improving combustion and reducing smoke and atmospheric pollution. A pilot project involving the study of performance of ten city buses using LPG injection has been going on for some months and, depending on the result, a project is being developed which will equip all the Tehrān buses for utilisation of LPG. Studies are also under way to determine the feasibility of having city buses equipped with engines using only LPG in future. This would be an important step in reducing air pollution and improving general health standards in the cities throughout Irān.

The Impact of Gas Development on the Economy

By its very nature the natural gas industry in Irān (where both oil and gas are found in profusion, and where associated gas as a by- product of oil production is more than adequate to meet the likely requirements

of the country for many years to come) is very much tied to the oil industry. It would be very difficult to separate the impact of the gas industry, as distinct from the oil industry, upon the development of the economy. So far there has been no drilling in Irān specifically for gas - at least no wildcat drilling. However, the development of the gas industry has had, and will continue to have, very far-reaching effects, socially as well as economically.

A most prominent symbol of the new order being ushered in by the gas industry is the IGAT line itself, which, although buried underground and mostly invisible, nevertheless makes its presence conspicuous all along the route. The magnitude of the project and the sheer concentration of skilled personnel and mechanical equipment that has gone into its construction, as well as the enormity of engineering works, and the pace at which they were handled, must have had a profound effect on the simple rustics through whose territory the line was passing. This psychological impact itself must have been a most effective jolt in awakening the denizens of sleepy little villages along the route, and literally bringing the haste and bustle of industrial life to their door-steps. For them things will never be the same: their whole outlook has changed, and the diffusion of this awareness will be the first prerequisite for social and economic advancement.

Along with this transformation in outlook there is the impact that the supply of cheap energy, and the subsequent introduction of electricity, will have on the social life of the smaller villages. What was available only to the inhabitant of the towns and larger villages before will now be within reach of the little hamlet, and it will eventually lead to a demand for piped water and labour-saving appliances. Soon it will literally change the face of the countryside, providing better housing and improved sanitation.

The availability of a cheap and clean source of energy like gas will encourage the establishment of new industries along the line. Such high energy consuming industries as aluminium works, wood pulp processes and metallurgical and building materials manufacture could profitably be set up anywhere along the route where other advantages are available, tending to reduce the need for industrial concentration in cities. The fact that the line will require service roads, too,will facilitate communication not

only along the line, but right across it with satellite centres.This will open up adjoining agricultural communities, and, by reducing transportation costs, will tend to widen the market for local produce.

Again, gas availability for domestic use leads to the setting up of factories for the manufacture of gas appliances and related industries. Economies of scale will reduce the costs of production, and soon competition will lower the prices of such household appliances as water heaters, space heaters and cookers, which have so far been generally beyond the reach of all but the high-income groups. This will have a snowballing multiplier effect in terms of employment and investment in other industries, such as sheet metals, machine tools, and so forth. The impact of this has already been seen in the setting up of manufacturing works for the production of LPG cylinders and cookers. On a bigger scale there is the Ahwāz Pipe Mills which has been supplying something like 12 per cent of the total pipe requirements of the IGAT line, and which is to produce most of the distribution network pipe.

The role of natural gas in regularising the demand for the different petroleum products has already been touched upon. Because of its advantages of cleanliness, economy and convenience, gas will quite naturally displace kerosene and gas oil for cooking and heating in the domestic sector and fuel oil in the industrial sector and in power generation. This will tend to bring the demand pattern for energy more in line with refining yields, and obviate the need for specialised processes, or for uneconomic disposal of surplus refined products, and thus result in higher oil revenues - greater foreign exchange earnings in respect of export refineries and less need for the continuance of a system of costly subsidies on sales of fuel oil in the country. The provision of piped gas in the towns and cities would also reduce the problem of traffic congestion by withdrawing a number of fuel delivery road tankers off the streets, thus helping to reduce air pollution.

The vital need for the observance of safety precautions in the use of gas appliances and the construction of city gas lines will have a salutory effect on the establishment and maintenance of safety codes, standards and practices. Inspection procedures, work permits and manufacturing standards will have to be tightened up, with concomitant improvements in quality of manufactured goods and in industrial training methods,not only

in the gas industry but in other industries as well. The gas industry will demand better standards of workmanship, and will force the other industries providing it with materials or services to observe the standards set. Thus, there will be a general move towards adherence to international standards and codes in respect of manufactured goods - a first prerequisite for entry into export markets.

Conclusion

How far these various forces will contribute to the growth of Irān's GNP is something that cannot easily be measured but there is no doubt at all that the development of the gas industry, in conjunction with parallel developments that are taking place in other fields, will result in the raising of the GNP at a rate higher than population increase and secular inflationary tendencies. Real per-capita income will, therefore, continue to rise, and the nation will benefit from the greater prosperity contributed by the development of the gas industry.