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POLICY CONSIDERATIONS FOR THE LONG RANGE ENERGY PLAN FOR IRAN

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I INTRODUCTION

Stanford Research Institute's analysis of Iran's economy, conducted in late 1969 and early 1970, resulted in projections of Iran's economy at a sustained rate of 8.75 percent through 1982 (Appendix Volume A). In view of more recent developments, the nation's target is a growth rate of 11 percent per year. Either rate is high, well above the world average of 5 to 6 percent. Iran has an energy-intensive economy, consistent with those of other nations that are self-sufficient in their energy supplies. On the basis of past trends, present pricing policies, and plans for the future, Iran's economy appears destined to become even more energy-intensive. Energy demand is projected to grow at 11.1 percent per year (Volume 2) and revenues at 12.2 percent per year (at current price levels). Such rapid growth, together with the relative importance of the energy industries in the overall economy, makes it apparent that Iran faces a host of policy considerations relating to the internal use of energy. The objective of this volume is to deal with those considerations.

Iran has a relatively open market economy and consumers have the opportunity to select the fuel or energy source they wish to use. At the same time, however, Iran's energy industries are almost completely owned by the Government, and the Government can, by means of pricing and investment decisions, influence not only the magnitude of energy use but also the market shares of each source.

The rapid growth in Iran portends enormous capital requirements. Moreover, if Iran is to maximize its profitability on energy exports, capital expenditures outside the country can absorb any conceivable amount of capital likely to be available. Therefore, a basic assumption of this study is that capital availability is and will continue to be tight. Iran faces one of the basic problems of economics--the allocation of scarce resources among competing ends. The Institute has attempted to construct an energy plan approaching optimization. But it is not claimed to be "optimum" because of the extreme complexity of the problem, nor is the cost of developing the "optimum" necessarily economic or desirable; there are many reasons for believing that the optimum would never be achieved. The gas industry in Iran is so new that optimum goals are probably not achievable, nor can realistic goals be established too precisely at this time; considerations may--although it hardly seems realistic--militate against the "optimum" investments in facilities, and certainly political realities will force some departure from an optimum. However, the directional effort is clearly set forth.

One of the most difficult issues is pricing. Rather than being market determined, prices are established by the government; as a result, prices (and the tax component) may be established with a wide range of objectives in mind. These objectives range from a convenient tax collection system to the encouragement of regional development or the advancement of welfare objectives. Although many of the various possible pricing objectives are examined in Section IV, the primary thrust of the Institute's analysis is a cost-based price system, a defined rate of return, and a tax burden, with appropriate adjustments, if needed, for the different forms of energy by region and class of trade. The Institute's purpose is to provide an economic basis for prices; political realities may necessitate adjustments to this base, but at least the target is there and to some extent the "cost" of the political realities can be measured.

Another major subject of this report is the organization of the energy industries and the allocation of authority and responsibility. The subject is limited to intercompany and intergovernment departmental relationships, as opposed to intracompany roles, and one of the primary purposes of the analysis is to determine if a more efficient system can be developed, one in which the time required to accomplish any set task can be drastically reduced. This applies most specifically to capital expansion programs but other tasks are also considered.

Although the basic subject of this volume is energy policy, it should be understood that there have been many considerations of energy policy in the other volumes, dealing particularly with the relationships among the various sources of energy, and these considerations have not been duplicated herein.

This report was prepared by Sherman H. Clark, Director of Energy and Resources Economics, and Paul T. Davis, Project Leader. The advice, counsel and assistance from friends from the Plan organization, Mr. Ahmad Vatanian and Dr. Syrus Arianpour, proved invaluable in developing the essential perspective and judgment on the Iranian energy economy.

II SUMMARY AND CONCLUSIONS

Energy Balance

Iran is well endowed with energy resources, most of which are low in cost. However, internal and export demand upon these resources--primarily petroleum--can increase so rapidly over the next 20 years that the prevailing assumption of virtually inexhaustible supplies can lead to serious errors in energy policy. The ultimate productive capability of Iran's oil resources could be strained even within the next 20 years, and its gas resources possibly early in the next century. A 20- to 30-year outlook on reserves, their availability and cost, and the internal as well as the export markets for both oil and gas should be developed at the earliest possible date and an overall strategy should be planned. Internal energy prices and degree of emphasis on each form of energy can be affected profoundly by the results of such an analysis.

The coal resources are not particularly large but will be useful for steel mills and may also be economic for coal-fired power plants at some point in the next 20 to 30 years. Conversion of coal to gas or liquid fuels is a further possibility, but probably this would be done only for the internal market.

The country has a large potential hydroelectric capacity that has not been delineated, but hydroelectric capacity should not be much of a factor in meeting the growth in energy requirements to 1982. In the longer range, hydroelectric capacity can meet part of the growth in power demand and can also provide additional water supply.

Because of the concentration of oil and gas reserves in only a few regions of the country, as well as the rapidly changing outlook as to the long term adequacy of oil and gas reserves, an expanded exploration program in regions such as Tehran, Caspian, Azarbayejan, Esfehan, and Kerman is justified. More localized reserves, such as those at Sarakhs, would lower oil and gas transportation costs.

Pricing

The objectives in energy pricing should be to:

- Contribute to the long term economic development of the country.

- Meet all anticipated costs and to yield, as a minimum, sufficient profits to each energy sector to finance its expansion.

- Incorporate a component--probably in the form of a tax--to reflect "value in export."

- Help in minimizing inflation.

- Establish prices that will minimize the cost of providing energy. This could be done, for example, by offering interruptible industrial gas service to keep the transmission line operating at capacity, or by setting relative prices of pertinent forms of energy in a manner that will minimize the growth in middle distillate demand and thereby make it possible to build simpler refineries.

- Set prices, ex tax, that follow costs as much as possible.

- Treat prices as variables rather than as constants.

These objectives are, in many cases, mutually exclusive, and it is then necessary to determine the ones that are more important, which may well vary with time.

Iran should plan on major revisions in petroleum pricing over the next 10 years to:

- Obtain desirable profitability of the oil sector.

- Account for value in export.

- Achieve price relationships that are more consistent with costs and that will minimize them.

The Institute does not have the information necessary to determine the value in export but, on the basis of extensive experience and the present information--quantitative and qualitative--available, the value tax appears likely to evolve as follows:

Year	U.S. Dollars per Barrel
1971	$0.40
1972	0.45
1973	0.50
1974	0.57
1975	0.65
1976	0.75
1977	0.86
1978	0.97
1979	1.08
1980	1.20
1981	1.35
1982	1.60

By 1990 (or even sooner) the value tax could well reach $4.00 per barrel. This value tax is a major additional element in prices; the total tax today is $1.70 per barrel and the average consumer price is $5.30 per barrel.

The present prices and recommended prices for 1977 and 1982 to adjust for all the desired objectives are tabulated below for each product in dollars per barrel:

Product	Present Prices	Recommended Prices 1977	Recommended Prices 1982
Fuel Oil			
Viscosity			
2000	$ 1.20	$1.44	$ 1.73
800		3.00	3.60
400	2.43	3.44	4.60
200		4.30	6.05
Gas oil	5.00	6.38	7.66
Gasoline (regular)	12.60	9.00	9.00
Jet fuel	7.08	8.50	10.20
Kerosene	5.30	7.00	8.40
Bitumen	4.85	7.40	8.88
Gasoline (super)	15.70	10.72	10.72
LPG*	1.10	3.12	3.74
Weighted average	5.24	6.19	7.43

* Refinery price.

To achieve the recommended levels for 1977 and 1982, the prices should be adjusted annually in small increments, generally not by more than 5 percent in any year.

Most of the price increases are attributable to value in export, which is crucially important. Deferring the recognition of value in export will ultimately create an enormous problem in trying to make substantial price changes in a short time; moreover, there would be irrevocable losses to the country. The increases will actually contribute to the long term economic development of the country rather than work against it, even though the proposed increases would contribute to inflationary pressures.

Major changes in gas rates do not appear to be necessary over the next 10 years. The value in export for natural gas is much more uncertain than it is for oil in that much more information is needed than is currently available. However, it appears that value in export for natural gas will be zero for some years into the future; by 1982 it could still be zero but in any case it will not increase more than 10 to 20 cents per thousand cubic feet.

The adjustments in gas rates that are warranted include:

- An interruptible industrial rate, much lower than the present industrial rate, to be offered by 1975.
- Elimination of the high initial charges for residential and commercial service, but higher residential and commercial rates that are more consistent with costs of service and that vary with volume. For example, suggested rates for Tehran are:

Annual Usage (thousands of cubic feet)	Present Rates	Proposed Rates (cents per thousand cubic feet) 1972	1977	1982
0-10.99	83 ¢	100 ¢	110¢	121¢
11-30.99		92	101	111
31-99.99		86	95	105
100-423.8		83.0	91	100
423.8-4,238.4	75.5	75.5	83	91
over 4,238.4	68.0	68.0	75	83

The average rate (in cents per thousand cubic feet) would increase as follows:

	Residential	Commercial
Present	83¢	75¢
1972	88	75
1977	97	82
1982	105	90

Electric rates appear to be reasonable but they need to be evaluated in the near future as better information on costs and markets is developed.

Organization and Control

The major organizational changes in the energy industries that may be warranted are to make the National Iranian Gas Company (NIGC) completely independent of the National Iranian Oil Company (NIOC) and to separate the Ministry of Water and Power (MWP) into only a power company, with the water sector either set off by itself or combined with other municipal services.

Stronger central planning with a longer time horizon than that at present is needed in each energy sector, plus closer liaison between these groups. There is no competition among the energy sectors, and there is virtually no overlap or sharing of functions or personnel. The only overlap of any significance is in the planning of facilities, and this is the area in which maximum cooperation is essential.

The control function should continue to be held by Plan Organization. Some form of control is needed, but there should not be some supra-energy sector bureau to which all of the energy sectors report directly. Plan's role should be strengthened to:

(1) Evaluate proposals for capital expenditures.

(2) Encourage coordinated planning by the three energy sectors.

(3) Conduct or sponsor original studies if the pertinent energy sectors fail to do so.

(4) Review energy prices and recommend changes to the top government circles.

There is also a need for a control organization on investments relating to energy exports including downstream investments outside the country; Plan might be the proper organization for this role, but the subject is outside the scope of the study.

Personnel

A number of steps are needed in the field of personnel requirements and development that would:

- Develop a comprehensive forecast of personnel requirements by skill, trade, and profession and by function, content, and discipline over the next ten-year period.

- Develop an inventory of present personnel by skill, trade, and profession and an estimate of their upward and lateral mobility.

- Develop an inventory of present education and training programs and an estimate of their present and future impact on the available level and numbers of skills, trades, and professions.

- Develop a national and industry-wide education and training program to upgrade both the quantity and quality of available trained and educated personnel. Such a program should include plans for new and expanded facilities, new course materials and instructional aids, and the recruiting of new instructors.

- Within a fairly constant percentage of personnel costs in relation to total energy revenue ex tax in each sector, adjust the employment mix by increasing the share of skilled and professional personnel and increasing upper salary levels.

- Continue to use individual and group consultants.

III THE ENERGY BALANCE

The total demand for energy is projected to increase at about 11 percent per year from 1969 to 1982. This projection was based on a projected growth of GNP (in real terms) of 8.75 percent per year. Since completion of the Institute's analysis of the Iranian economy, considerably higher oil export revenues have been negotiated and the country's target growth rate, which now appears realistic, is 11 percent per year.

The higher targeted economic growth could justify an increase in the projection of energy demand. However, it is recommended that the Institute's present projections continue to be used for planning purposes for the next year or two; a re-evaluation at that time, after gaining another year or two of experience, could justify an increase in the projection. The Institute's projection was based on rapid industrialization of the country, beyond any known plans, and it was indicated in Volume 2 that the projection of energy demand in 1982 could be as high by 10 to 15 percent. The higher projected growth rate of the economy tends to eliminate that uncertainty and makes the energy projection more realistic, but it does not necessarily appear to be too low.

The adopted projections of energy demand are given in Table 1. There is some modification from the original projections given in Volume 2 because of changes in planned power plant locations and choice of fuel and because of gas adjustments described in Volume 5, Part Two.

There is no simple way to present the energy balance; in effect, Volume 2 provides the energy balance in a long series of tables and figures. The energy balance embraces regions, end uses, types of fuel or energy including a number of individual petroleum products, and a series of years. It is not possible to give all this information in a single table or graphical presentation. However, in addition to the data in Volume 2, the regional supply-demand balance for 1972, 1977, and 1982 is given in Tables 2 to 8 for crude oil, each petroleum product, natural gas, coal, and electricity. The map of energy resources--location of oil, gas, and coal reserves and hydroelectric sites--is given in Figure 1. Considering the latter first, one obvious and well-known conclusion is the great concentration of most of the energy reserves in one region (or two adjacent regions) of the country. The present and potential hydroelectric sites are, of course, spread throughout a number of regions

Table 1

INTERNAL ENERGY BALANCE:* TOTAL FOR IRAN
1960-1982
(Trillions of Btu)

	Historical										Projected		
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1972	1977	1982
Petroleum													
LPG	0.1	0.1	0.3	0.4	0.6	0.8	1.2	1.9	2.7	3.9	7.9	15.6	27.6
Aviation gasoline	0.9	0.7	0.7	0.7	0.8	0.8	1.0	11.1	1.0	0.9	0.9	1.1	1.2
Motor gasoline	20.7	21.3	22.0	23.3	24.5	23.7	26.5	28.3	31.3	35.4	49.9	79.7	143.5
Jet fuels													
Gasoline type	0.5	0.8	1.0	1.0	1.2	1.3	1.5	1.6	1.7	3.1	5.1	9.6	15.0
Kerosene type	1.3	2.1	2.7	2.9	3.2	3.5	3.8	5.3	5.1	5.4	8.5	13.3	19.4
Kerosene	33.5	37.8	40.2	43.2	49.3	50.5	52.6	62.1	68.3	80.2	108.5	156.7	204.8
Gas oil	30.4	34.9	38.4	41.1	47.9	56.5	66.7	77.5	87.4	94.2	138.0	203.7	340.4
Fuel oil	42.4	45.2	46.6	46.9	55.8	63.3	73.2	82.8	95.3	104.3	130.3	197.6	311.0
Oil company use	3.5	3.8	4.1	4.4	4.7	5.0	5.3	5.6	5.8	5.8	6.6	7.3	7.5
Subtotal	133.3	146.7	156.0	163.9	188.0	205.4	231.8	266.2	298.6	333.2	455.7	684.6	1,070.4
Natural gas†	38.5	36.8	39.4	41.6	42.4	43.9	51.3	51.4	55.2	60.7	108.9	283.3	562.7
Coal	6.1	5.8	5.7	5.4	5.5	6.6	6.8	6.9	6.9	7.0	6.7	15.6	15.5
Hydroelectric	0	0	1.3	3.4	4.4	5.5	6.8	10.4	13.8	22.5	34.6	77.3	75.4
Charcoal and wood	22.5	22.8	23.0	20.0	19.5	19.0	18.5	18.0	17.4	17.0	15.0	13.5	12.2
Animal matter	11.5	11.0	10.5	10.0	9.5	9.0	8.5	8.0	7.6	7.3	6.0	4.5	3.6
Total energy	211.9	223.1	235.9	244.3	269.3	289.4	323.7	360.9	399.5	447.7	626.9	1,078.8	1,739.7

* Includes international aviation; excludes bunker market.

† Includes Abadan refinery fuel.

Source: Volume 2, "Demand for Energy in Iran by Type of Energy, End-Use Market, and Region"; Table 4, with natural gas modified as indicated in Volume 5, "The Petroleum and Natural Gas Industries in Iran," Table 41.

Table 2

PETROLEUM SUPPLY/DEMAND BALANCE WITH BASIC GAS PROJECTIONS
(Thousands of Barrels per Day)

	Total for Iran			Kermanshah			Northern Iran		
	1972	1977	1982	1972	1977	1982	1972	1977	1982
Supply									
Crude oil									
Production	69.2	96.0	143.9	14.2	14.2	14.2	—	—	—
Exports	(92.0)	(186.7)	(359.4)	—	—	(44.7)	(92.0)	(186.7)	(314.7)
Refinery runs	161.2	282.7	503.3	14.2	14.2	58.9	92.0	186.7	314.7
Refinery production									
LPG	2.9	7.1	12.8	0.5	0.5	1.3	2.4	5.4	9.2
Gasoline	17.0	37.0	57.1	2.8	2.8	4.4*	14.2	25.8	45.6
Kerosene	12.5	45.4	86.7	2.8	2.8	7.2	9.7	32.2	62.7
Jet fuel	4.1	3.8	3.8	—	—	—	4.1	3.8	3.8
Gas oil	29.6	69.4	117.3	2.5	2.5	8.3	24.1	50.9	84.9
Fuel oil	58.9	74.3	138.8	4.4	4.4	31.0	27.6	46.2	67.7
Other	3.3	8.9	14.3	—	—	—	2.3	8.0	13.4
Refinery fuel and losses	8.8	19.0	36.4	1.2	1.3	2.3	7.5	13.4	27.4
Demand									
LPG	5.1	10.2	16.0	0.1	0.7	1.6	3.0	5.5	9.1
Movement in	2.7	5.1	10.9	—	0.2	0.5	0.7	2.4	5.6
Movement out	0.3	2.3	5.7	0.4	—	—	0.1	2.3	5.7
Exports	(2.2)	(3.1)	(5.2)	0.4	(0.2)	(0.5)	(0.6)	(0.1)	0.1
Gasoline†	36.4	42.0	75.4	1.4	2.3	4.4	17.8	27.6	48.6
Movement in	12.3	18.5	28.3	—	—	—	5.1	8.8	17.7
Movement out	2.9	13.5	20.0	1.4	0.5	—	1.5	8.8	14.7
Exports	(9.4)	(5.0)	(8.3)	1.4	0.5	—	(3.6)	(0.8)	(3.0)
Kerosene	51.5	78.3	102.3	4.9	7.2	9.2	36.3	60.0	80.0
Movement in	39.0	39.5	39.9	2.1	4.4	2.0	28.6	27.8	29.3
Movement out	—	6.6	24.3	—	—	—	—	—	12.0
Exports	(39.0)	(32.9)	(15.6)	(2.1)	(4.4)	(2.0)	(28.6)	(27.8)	(17.3)
Jet fuel	7.2	12.0	17.8	0.4	0.6	0.9	5.3	8.2	12.0
Movement in	3.1	8.2	14.0	0.4	0.6	0.9	1.2	4.4	8.2
Movement out	—	—	—	—	—	—	—	—	—
Exports	(3.1)	(8.2)	(14.0)	(0.4)	(0.6)	(0.9)	(1.2)	(4.4)	(8.2)
Gas oil	67.1	99.4	165.9	5.8	9.3	15.1	38.3	58.9	100.2
Movement in	40.9	54.6	77.6	3.3	6.8	6.8	17.6	26.8	42.2
Movement out	3.4	24.6	28.0	—	—	—	3.4	18.8	26.9
Exports	(37.5)	(30.0)	(48.6)	(3.3)	(6.8)	(6.8)	(14.2)	(8.0)	(15.3)
Fuel oil	59.9	88.1	139.0	3.7	15.9	31.0	38.7	46.2	69.6
Movement in	23.7	49.0	51.9	—	11.5	—	13.1	23.0	30.8
Movement out	22.7	35.2	51.7	0.7	—	—	1.0	23.0	28.9
Exports	(1.0)	(13.8)	(0.2)	0.7	(11.5)	—	(11.1)	—	(1.9)
Other	9.7	15.0	21.5	0.5	0.8	1.1	6.2	9.7	14.3
Movement in	7.4	8.8	12.8	0.5	0.8	1.1	3.9	4.1	6.4
Movement out	—	2.7	5.6	—	—	—	—	2.4	5.5
Exports	(7.4)	(6.1)	(7.2)	(0.5)	(0.8)	(1.1)	(3.9)	(1.7)	(0.9)
Total	226.9	344.9	539.9	16.8	36.8	63.5	147.6	216.1	333.8
Movement in	129.1	184.1	235.4	6.3	24.3	11.3	69.2'	97.3	140.2
Movement out	29.5	85.1	136.3	2.5	0.5	—	6.0	54.5	93.7
Exports	(99.6)	(99.0)	(99.1)	(3.6)	(23.8)	(11.3)	(63.2)	(42.8)	(46.5)

	Azarbayejan			Caspian			Tehran		
	1972	1977	1982	1972	1977	1982	1972	1977	1982
Supply									
Crude oil									
Production	—	—	—	—	—	—	—	—	—
Exports	—	—	—	—	—	—	(92.0)	(186.7)	(314.7)
Refinery runs	—	—	—	—	—	—	92.0	186.7	314.7
Refinery production									
LPG	—	—	—	—	—	—	2.4	5.4	9.2
Gasoline	—	—	—	—	—	—	14.2	26.8	45.6
Kerosene	—	—	—	—	—	—	9.7	32.2	62.7
Jet fuel	—	—	—	—	—	—	4.1	3.8	3.8
Gas oil	—	—	—	—	—	—	24.1	50.9	84.9
Fuel oil	—	—	—	—	—	—	27.6	46.3	67.7
Other	—	—	—	—	—	—	2.3	8.0	13.4
Refinery fuel and losses	—	—	—	—	—	—	7.4	13.4	27.4
Demand									
LPG	0.1	0.4	1.1	0.4	1.3	2.6	2.3	3.1	3.5
Movement in	0.1	0.4	1.1	0.4	1.3	2.6	—	—	—
Movement out	—	—	—	—	—	—	0.1	2.3	5.7
Exports	(0.1)	(0.4)	(1.1)	(0.4)	(1.3)	(2.6)	0.1	2.3	5.7
Gasoline†	1.4	2.7	6.1	2.2	3.5	6.4	12.7	18.8	30.9
Movement in	1.4	2.7	6.1	2.2	3.5	6.4	—	—	—
Movement out	—	—	—	—	—	—	1.5	8.0	14.7
Exports	(1.4)	(2.7)	(6.1)	(2.2)	(3.5)	(6.4)	1.5	8.0	14.7
Kerosene	6.3	9.5	11.5	6.4	9.3	11.6	20.8	35.2	50.7
Movement in	6.3	9.5	11.5	6.4	9.3	11.6	11.1	3.0	—
Movement out	—	—	—	—	—	—	—	—	12.0
Exports	(6.3)	(9.5)	(11.5)	(6.4)	(9.3)	(11.6)	(11.1)	(3.0)	12.0
Jet fuel	—	—	0.1	—	—	0.1	5.2	8.0	11.5
Movement in	—	—	0.1	—	—	0.1	1.1	4.2	7.7
Movement out	—	—	—	—	—	—	—	—	—
Exports	—	—	(0.1)	—	—	(0.1)	(1.1)	(4.2)	(7.7)
Gas oil	4.9	9.5	16.4	5.9	8.9	13.5	20.7	32.1	38.0
Movement in	4.9	9.5	16.4	5.9	8.9	13.5	—	—	—
Movement out	—	—	—	—	—	—	3.4	18.8	26.9
Exports	(4.9)	(9.5)	(16.4)	(5.9)	(8.9)	(13.5)	3.4	18.8	26.9
Fuel oil	4.2	13.1	18.4	3.3	4.6	7.5	26.6	33.3	38.8
Movement in	4.2	13.1	18.4	3.3	4.6	7.5	—	—	—
Movement out	—	—	—	—	—	—	1.0	23.0	28.9
Exports	(4.2)	(13.1)	(18.4)	(3.3)	(4.6)	(7.5)	1.0	23.0	28.9
Other	0.9	1.6	2.1	0.8	1.3	2.2	3.8	5.6	7.9
Movement in	0.9	1.6	2.1	0.8	1.3	2.2	1.5	—	—
Movement out	—	—	—	—	—	—	—	2.4	5.5
Exports	(0.9)	(1.6)	(2.1)	(0.8)	(1.3)	(2.2)	(1.5)	2.4	5.5
Total	17.6	36.8	55.7	19.0	28.9	43.9	93.1	126.0	201.2
Movement in	17.8	36.8	55.7	19.0	28.9	43.9	13.7	7.2	7.7
Movement out	—	—	—	—	—	—	6.0	54.5	93.7
Exports	(17.8)	(36.8)	(55.7)	(19.0)	(28.9)	(43.9)	(7.7)	47.3	86.0

	Khorasan			Southern Iran			Khuzestan		
	1972	1977	1982	1972	1977	1982	1972	1977	1982
Supply									
Crude oil									
Production	—	—	—	55.0‡	81.8	129.7	45.0‡	33.8	71.7
Exports	—	—	—	—‡	—	—	—‡	—	—
Refinery runs	—	—	—	55.0‡	81.6	129.7	45.0‡	23.8	71.7
Refinery production									
LPG	—	—	—	—	1.2	2.3	—	—	1.1
Gasoline	—	—	—	—	7.4†	17.1	—	—†	9.7
Kerosene	—	—	—	—	10.4	16.8	—	1.9	8.3
Jet fuel	—	—	—	—	—	—	—	—	—
Gas oil	—	—	—	3.0‡	16.0	24.1	—	3.5	10.6††
Fuel oil	—	—	—	36.9**	23.7	40.1	26.9**	14.6	31.0
Other	—	—	—	—	0.9	0.9	—	—	—
Refinery fuel and losses	—	—	—	—	4.4	6.5	—	0.6	2.9
Demand									
LPG	0.2	0.7	1.9	2.0	4.0	7.1	1.0	1.7	2.3
Movement in	0.2	0.7	1.9	2.0	2.8	4.8	1.0	1.7	1.2

	Esfahan			Fars			Kerman		
	1972	1977	1982	1972	1977	1982	1972	1977	1982
Supply									
Crude oil									
Production	—	—	—	10.0‡	58.0	58.0	—	—	—
Exports	—	—	—	—‡	—	—	—	—	—
Refinery runs	—	—	—	10.0‡	58.0	58.0	—	—	—
Refinery production									
LPG	—	—	—	—	1.2	1.2	—	—	—
Gasoline	—	—	—	—	7.4	7.4	—	—	—
Kerosene	—	—	—	—	8.5	8.5	—	—	—
Jet fuel	—	—	—	—	—	—	—	—	—
Gas oil	—	—	—	3.0‡	13.5	13.5	—	—	—
Fuel oil	—	—	—	—	9.1	9.1	—	—	—
Other	—	—	—	—	0.9	0.9	—	—	—
Refinery fuel and losses	—	—	—	—	3.6	3.6	—	—	—
Demand									
LPG	0.3	1.0	2.2	0.6	1.2	2.1	0.1	0.1	0.5
Movement in	0.3	1.0	2.2	0.4	—	0.9	0.1	0.1	0.5

	Khorasan			Southern Iran			Khuzestan			Esfehan			Fars			Kerman		
	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982
Fuel oil	59.9	89.1	139.0	3.7	15.9	31.0	38.7	46.2	59.6	4.2	13.1	18.4	3.3	4.6	7.5	26.6	33.3	36.8
Movement in	23.7	49.0	51.9	—	11.5	—	12.1	23.0	30.8	4.2	13.1	18.4	3.3	4.6	7.5	—	—	—
Movement out	22.7	35.4	51.7	0.7	—	—	1.0	23.0	28.9	—	—	—	—	—	—	1.0	23.0	28.9
Exports	(1.0)	(13.6)	(0.2)	0.7	(11.5)	—	(11.1)	—	(1.9)	(4.2)	(13.1)	(18.4)	(3.3)	(4.6)	(7.5)	1.0	23.0	28.9
Other	9.7	15.0	21.5	0.5	0.8	1.1	6.2	9.7	14.3	0.9	1.6	2.1	0.8	1.3	2.2	3.8	5.6	7.9
Movement in	7.4	8.8	12.8	0.5	0.8	1.1	3.9	4.1	6.4	0.9	1.6	2.1	0.8	1.3	2.2	1.5	—	—
Movement out	—	2.7	5.6	—	—	—	—	2.4	5.5	—	—	—	—	—	—	—	2.4	5.5
Exports	(7.4)	(6.1)	(7.2)	(0.5)	(0.8)	(1.1)	(3.9)	(1.7)	(0.9)	(0.9)	(1.6)	(2.1)	(0.8)	(1.3)	(2.2)	(1.5)	2.4	5.5
Total	225.9	344.9	539.9	16.8	36.8	63.5	147.6	216.1	333.8	17.8	36.8	55.7	19.0	28.9	43.9	92.1	126.0	201.3
Movement in	129.1	184.1	235.4	6.3	24.3	11.3	69.2	97.3	140.2	17.8	36.8	55.7	19.0	28.9	43.9	13.7	7.2	7.7
Movement out	29.5	85.1	135.3	2.5	0.5	—	6.0	54.5	93.7	—	—	—	—	—	—	6.0	54.5	93.7
Exports	(99.6)	(99.0)	(99.1)	(3.8)	(23.8)	(11.3)	(63.2)	(42.8)	(46.5)	(17.8)	(36.8)	(55.7)	(19.0)	(28.9)	(43.9)	(7.7)	47.3	86.0

	Khorasan			Southern Iran			Khuzestan			Esfehan			Fars			Kerman		
	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982
Supply																		
Crude oil																		
Production	—	—	—	55.0‡	61.6	129.7	45.0‡	23.8	71.7	—	—	—	10.0‡	58.0	58.0	—	—	—
Exports	—	—	—	—‡	—	—	—‡	—	—	—	—	—	—	—	—	—	—	—
Refinery runs	—	—	—	55.0‡	61.6	129.7	45.0‡	23.8	71.7	—	—	—	10.0‡	58.0	56.0	—	—	—
Refinery production																		
LPG	—	—	—	—	1.2	2.3	—	—	1.1	—	—	—	—	1.3	1.2	—	—	—
Gasoline	—	—	—	—	7.4†	17.1	—	—†	9.7	—	—	—	—	7.4	7.4	—	—	—
Kerosene	—	—	—	—	10.4	16.8	—	1.9	8.3	—	—	—	—	8.5	8.5	—	—	—
Jet fuel	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gas oil	—	—	—	3.0§	16.0	24.1	—	2.5	10.6	—	—	—	3.0§	13.5	13.5	—	—	—
Fuel oil	—	—	—	26.9**	23.7	40.1	26.9**	14.6	31.0††	—	—	—	—	9.1	9.1	—	—	—
Other	—	—	—	—	0.9	0.9	—	—	—	—	—	—	—	0.9	0.9	—	—	—
Refinery fuel and losses	—	—	—	—	4.4	6.5	—	0.6	2.9	—	—	—	—	3.6	3.5	—	—	—
Demand																		
LPG	0.2	0.7	1.9	2.0	4.0	7.1	1.0	1.7	2.3	0.3	1.0	2.2	0.6	1.2	2.1	0.1	0.1	0.5
Movement in	0.2	0.7	1.9	2.0	2.8	4.8	1.0	1.7	1.2	0.3	1.0	2.2	0.6	—	0.9	0.1	0.1	0.3
Movement out	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Exports	(0.2)	(0.7)	(1.9)	(2.0)	(2.8)	(4.8)	(1.0)	(1.7)	(1.2)	(0.3)	(1.0)	(2.2)	(0.6)	—	(0.9)	(0.1)	(0.1)	(0.5)
Gasoline*	1.5	2.6	5.2	7.2	12.1	22.4	2.4	4.1	7.6	2.2	3.5	6.6	1.6	2.4	4.2	1.0	2.1	4.0
Movement in	1.5	2.6	5.2	7.2	9.7	10.6	2.4	4.1	—	2.2	3.5	6.6	1.6	—	—	1.0	2.1	4.0
Movement out	—	—	—	—	5.0	5.3	—	—	2.1	—	—	—	—	5.0	3.2	—	—	—
Exports	(1.5)	(2.6)	(5.2)	(7.2)	(4.7)	(5.3)	(2.4)	(4.1)	2.1	(2.2)	(3.5)	(6.6)	(1.6)	5.0	3.2	(1.0)	(2.1)	(4.0)
Kerosene	4.8	6.0	6.2	8.3	11.1	13.1	1.0	1.4	1.8	4.0	5.2	5.7	1.9	2.4	2.7	1.4	2.1	2.9
Movement in	4.8	6.0	6.2	8.3	7.3	8.6	1.0	—	—	4.0	5.2	5.7	1.9	—	—	1.4	2.1	2.9
Movement out	—	—	—	—	6.6	12.3	—	0.5	6.5	—	—	—	—	6.1	5.8	—	—	—
Exports	(4.8)	(6.0)	(6.2)	(8.3)	(0.7)	3.7	(1.0)	0.5	6.5	(4.0)	(5.2)	(5.7)	(1.9)	6.1	5.8	(1.4)	(2.1)	(2.9)
Jet fuel	0.1	0.2	0.3	1.5	3.2	4.9	1.2	2.1	3.0	—	0.3	0.6	0.3	0.6	1.1	—	0.2	0.3
Movement in	0.1	0.2	0.3	1.5	3.2	4.9	1.2	2.1	3.0	—	0.3	0.6	0.3	0.6	1.1	—	0.2	0.3
Movement out	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Exports	(0.1)	(0.2)	(0.3)	(1.5)	(3.2)	(4.9)	(1.2)	(2.1)	(3.0)	—	(0.3)	(0.6)	(0.3)	(0.6)	(1.1)	—	(0.2)	(0.3)
Gas oil	6.8	8.4	12.3	23.0	31.2	50.6	7.0	10.5	16.5	5.5	8.1	13.6	6.5	7.5	11.4	4.0	5.1	9.1
Movement in	6.8	8.4	12.3	20.0	31.3	28.6	7.0	8.0	5.9	5.5	8.1	13.6	3.5	—	—	4.0	5.1	9.1
Movement out	—	—	—	—	6.0	2.1	—	—	—	—	—	—	—	6.0	2.1	—	—	—
Exports	(6.8)	(8.4)	(12.3)	(20.0)	(15.2)	(26.5)	(7.0)	(8.0)	(5.9)	(5.5)	(8.1)	(13.6)	(3.5)	6.0	2.1	(4.0)	(5.1)	(9.1)
Fuel oil	4.6	5.3	4.9	17.5	26.0	38.4	5.9	8.0	11.9	7.7	8.2	10.2	2.1	3.5	5.4	1.8	6.3	10.9
Movement in	4.6	5.3	4.9	11.6	14.5	21.1	—	—	—	7.7	8.2	10.3	2.1	—	—	1.8	6.3	10.9
Movement out	—	—	—	21.0	12.2	22.8	21.0	6.6	19.1	—	—	—	—	5.6	3.7	—	—	—
Exports	(4.6)	(5.3)	(4.9)	9.4	(2.3)	1.7	21.0	6.6	19.1	(7.7)	(8.2)	(10.3)	(2.1)	5.6	3.7	(1.8)	(6.3)	(10.9)
Other	0.7	1.2	2.1	3.0	4.5	6.1	1.2	1.7	2.3	1.1	1.7	2.0	0.5	0.9	1.3	0.2	0.2	0.5
Movement in	0.7	1.2	2.1	3.0	3.9	5.3	1.2	1.7	2.3	1.1	1.7	2.0	0.5	0.3	0.5	0.2	0.2	0.5
Movement out	—	—	—	—	0.3	0.1	—	—	—	—	—	—	—	0.3	0.1	—	—	—
Exports	(0.7)	(1.2)	(2.1)	(3.0)	(3.6)	(5.2)	(1.2)	(1.7)	(2.3)	(1.1)	(1.7)	(2.0)	(0.5)	—	(0.4)	(0.2)	(0.2)	(0.5)
Total	18.7	24.4	32.9	62.5	92.0	142.6	19.7	29.5	45.4	20.8	28.0	40.9	13.5	16.5	28.2	8.5	16.0	28.1
Movement in	18.7	24.4	32.9	53.5	62.5	83.9	13.8	17.6	12.3	20.8	28.0	40.9	10.5	0.9	2.5	8.5	16.0	28.1
Movement out	—	—	—	21.0	30.1	42.6	21.0	7.1	27.7	—	—	—	—	23.0	14.9	—	—	—
Exports	(18.7)	(24.4)	(32.9)	(32.6)	(32.4)	(41.3)	7.2	(10.5)	15.3	(20.8)	(28.0)	(40.9)	(10.5)	22.1	12.4	(8.5)	(16.0)	(28.1)

Notes: 1. This supply/demand balance is for Iran only; excludes bunkering or export of either crude oil or products; exports on this table mean net interregional movement.

2. Products not supplied from NIOC facilities assumed to come from Abadan refinery.

3. Refinery production figures shown are based on Case 2A.

* Production—8.6 MBD; 4.2 MBD of naphtha recycled from Kermanshah #2.

† Gasoline figures include both motor gasoline and aviation gasoline.

‡ Assumed production and refinery runs for MIS topping—45 MBD; and Lavan topping—10 MBD.

§ Assumed output from Lavan topping; balance of products (naphtha and fuel oil) sold to Consortium for export.

** Assumed output from MIS topping; some fuel oil recycled to structure and balance of products (middle distillates) sold to Consortium for further processing or export.

†† Production—39.1 MBD, 8.1 MBD of fuel oil recycled from Ahwaz simple refinery.

Source: Stanford Research Institute.

Fuel oil	38.9	91.3	145.7	3.7	15.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Movement in	23.7	49.4	53.1	—	11.5	—	12.1	33.1	31.2	4.2	13.1	18.4	3.3	4.6	7.5	—	—	—
Movement out	22.7	35.9	52.8	0.7	—	—	1.0	33.7	30.4	—	—	—	—	—	—	1.0	23.7	30.4
Exports	(1.0)	(13.5)	(0.3)	0.7	(11.5)	—	(11.1)	0.6	(0.8)	(4.2)	(13.1)	(18.4)	(3.3)	(4.6)	(7.5)	1.0	23.7	30.4
Other	9.7	15.0	21.5	0.5	0.8	1.1	6.2	9.7	14.5	0.9	1.6	3.1	0.8	1.3	2.2	3.6	5.6	7.9
Movement in	7.4	8.8	12.6	0.5	0.6	1.1	3.9	4.1	6.4	0.9	1.6	3.1	0.8	1.3	2.2	1.5	—	—
Movement out	—	3.4	6.9	—	—	—	—	3.1	6.8	—	—	—	—	—	—	—	3.1	6.8
Exports	(7.4)	(5.4)	(5.9)	(0.5)	(0.8)	(1.1)	(3.9)	(1.0)	0.4	(0.9)	(1.6)	(2.1)	(0.8)	(1.3)	(2.2)	(1.5)	3.1	6.8
Total	227.8	357.4	568.6	18.8	36.6	63.5	147.5	224.7	353.3	17.6	36.8	55.7	19.0	29.2	44.6	92.0	132.2	217.5
Movement in	130.0	188.8	247.1	8.3	24.3	11.3	69.1	98.3	143.4	17.8	36.8	55.7	19.0	29.2	44.6	13.6	6.8	7.7
Movement out	29.5	90.4	148.0	2.5	0.5	—	6.0	60.0	106.4	—	—	—	—	—	—	6.0	60.0	106.4
Exports	(100.5)	(98.4)	(99.1)	(3.8)	(23.8)	(11.3)	(63.1)	(38.3)	(37.0)	(17.6)	(36.8)	(55.7)	(19.0)	(29.2)	(44.6)	(7.6)	53.2	98.7

	Khorasan			Southern Iran			Khuzestan			Esfahan			Fars			Kerman		
	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982
Supply																		
Crude oil																		
Production	—	—	—	55.0‡	61.8	129.7	45.0‡	23.8	71.7	—	—	—	10.0‡	58.0	58.0	—	—	—
Exports	—	—	—	—‡	—	—	—‡	—	—	—	—	—	—‡	—	—	—	—	—
Refinery runs	—	—	—	55.0	61.8	129.7	45.0	23.8	71.7	—	—	—	10.0	58.0	58.0	—	—	—
Refinery production																		
LPG	—	—	—	—	1.2	2.3	—	—*	1.1	—	—	—	—	1.2	1.2	—	—	—
Gasoline	—	—	—	—	7.4	17.1	—	—	9.7	—	—	—	—	7.4	7.4	—	—	—
Kerosene	—	—	—	—	10.4	16.6	—	1.9	6.3	—	—	—	—	6.5	8.5	—	—	—
Jet fuel	—	—	—	—§	—	—	—	—	—	—	—	—	—‡	—	—	—	—	—
Gas oil	—	—	—	3.0**	16.0	24.1††	—	2.5	10.8††	—	—	—	3.0	13.5	13.5	—	—	—
Fuel oil	—	—	—	26.9	23.7	40.1	26.9**	14.6	31.0	—	—	—	—	9.1	9.1	—	—	—
Other	—	—	—	—	0.9	0.9	—	—	—	—	—	—	—	0.9	0.9	—	—	—
Refinery fuel and losses	—	—	—	—	4.4	6.5	—	0.8	2.9	—	—	—	—	3.6	3.6	—	—	—
Demand																		
LPG	0.2	0.9	2.3	3.0	6.6	13.3	2.0	4.2	7.9	0.3	1.1	2.6	0.6	1.2	2.3	0.1	0.1	0.5
Movement in	0.2	0.9	2.3	3.0	5.4	11.0	2.0	4.2	6.8	0.3	1.1	2.6	0.6	—	1.1	0.1	0.1	0.5
Movement out	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Exports	(0.2)	(0.9)	(2.3)	(3.0)	(5.4)	(11.0)	(2.0)	(4.2)	(6.8)	(0.3)	(1.1)	(2.6)	(0.6)	—	(1.1)	(0.1)	(0.1)	(0.5)
Gasoline†	1.5	2.6	5.0	7.2	12.1	22.4	2.4	4.1	7.6	2.2	3.5	6.6	1.6	2.4	4.2	1.0	2.1	4.0
Movement in	1.5	2.6	5.0	7.2	9.7	10.6	2.4	4.1	—	2.2	3.5	6.6	1.6	—	—	1.0	2.1	4.0
Movement out	—	—	—	—	5.0	5.3	—	—	2.1	—	—	—	—	5.0	3.2	—	—	—
Exports	(1.5)	(2.6)	(5.0)	(7.2)	(4.7)	(5.3)	(2.4)	(4.1)	2.1	(2.2)	(3.5)	(6.6)	(1.6)	5.0	3.2	(1.0)	(2.1)	(4.0)
Kerosene	4.8	6.6	7.8	8.3	11.5	14.3	1.0	1.4	1.9	4.0	5.5	6.5	1.9	2.5	3.0	1.4	2.1	2.8
Movement in	4.8	6.6	7.8	8.3	7.6	9.4	1.0	—	—	4.0	5.5	6.5	1.9	—	—	1.4	2.1	2.8
Movement out	—	—	—	—	6.5	11.9	—	0.5	6.4	—	—	—	—	6.0	5.5	—	—	—
Exports	(4.8)	(6.6)	(7.8)	(8.3)	(1.1)	2.5	(1.0)	0.5	4.4	(4.0)	(5.5)	(6.5)	(1.9)	6.0	5.5	(1.4)	(2.1)	(2.8)
Jet fuel	0.1	0.2	0.3	1.5	3.3	4.9	1.2	2.1	3.0	—	0.3	0.4	0.3	0.7	1.1	—	0.2	0.2
Movement in	0.1	0.2	0.3	1.5	3.3	4.9	1.2	2.1	3.0	—	0.3	0.4	0.3	0.7	1.1	—	0.2	0.2
Movement out	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Exports	(0.1)	(0.2)	(0.3)	(1.5)	(3.3)	(4.9)	(1.2)	(2.1)	(3.0)	—	(0.3)	(0.4)	(0.3)	(0.7)	(1.1)	—	(0.2)	(0.2)
Gas oil	6.8	8.6	12.6	33.0	31.6	51.4	7.0	10.6	16.7	5.5	8.3	14.0	6.5	7.6	11.6	4.0	5.1	9.1
Movement in	6.8	8.6	12.6	20.0	21.5	29.2	7.0	8.1	6.1	5.5	8.3	14.0	3.5	—	—	4.0	5.1	9.1
Movement out	—	—	—	—	5.9	1.9	—	—	—	—	—	—	—	5.9	1.9	—	—	—
Exports	(6.8)	(8.6)	(12.6)	(20.0)	(15.6)	(27.3)	(7.0)	(8.1)	(6.1)	(5.5)	(8.3)	(14.0)	(3.5)	5.9	1.9	(4.0)	(5.1)	(9.1)
Fuel oil	4.6	5.4	5.3	17.5	26.3	39.7	5.8	8.0	12.0	7.7	8.5	11.1	2.1	5.5	5.7	1.6	6.3	10.9
Movement in	4.6	5.4	5.3	11.6	14.8	21.9	—	—	—	7.7	8.5	11.0	2.1	—	—	1.6	6.3	10.9
Movement out	—	—	—	21.0	12.2	22.4	21.0	6.6	19.0	—	—	—	—	5.6	3.4	—	—	—
Exports	(4.6)	(5.4)	(5.3)	9.4	(2.6)	0.5	21.0	6.6	19.0	(7.7)	(8.5)	(11.0)	(2.1)	5.6	3.4	(1.6)	(6.3)	(10.9)
Other	0.7	1.2	2.1	3.0	4.5	6.1	1.2	1.7	2.3	1.1	1.7	2.0	0.5	0.9	1.3	0.2	0.2	0.5
Movement in	0.7	1.2	2.1	3.0	3.9	5.3	1.2	1.7	2.3	1.1	1.7	2.0	0.5	0.3	0.5	0.2	0.2	0.5
Movement out	—	—	—	—	0.3	0.1	—	—	—	—	—	—	—	0.3	0.1	—	—	—
Exports	(0.7)	(1.2)	(2.1)	(3.0)	(3.6)	(5.2)	(1.2)	(1.7)	(2.3)	(1.1)	(1.7)	(2.0)	(0.5)	—	(0.4)	(0.2)	(0.2)	(0.5)
Total	18.7	25.5	35.4	63.5	85.9	152.1	20.7	32.1	51.4	20.9	26.9	43.4	15.5	14.8	29.2	8.5	16.1	28.1
Movement in	18.7	25.5	35.4	54.6	86.2	92.4	14.8	20.2	16.2	20.8	26.9	43.4	10.5	1.0	2.7	8.5	16.1	28.1
Movement out	—	—	—	21.0	29.9	41.6	21.0	7.1	27.5	—	—	—	—	22.8	14.1	—	—	—
Exports	(18.7)	(25.5)	(35.4)	(33.6)	(36.3)	(50.8)	6.2	(13.1)	9.3	(20.8)	(26.9)	(43.4)	(10.5)	21.8	11.4	(8.5)	(16.1)	(28.1)

Notes. 1. This supply/demand balance is for Iran only; excludes bunkering or export of either crude oil or products; exports on this table mean net interregional movement.

2. Products not supplied from NIOC facilities assumed to come from Abadan refinery.

3. Refinery production figures shown are based on Case 2A.

* Production--8.6 MBD; 4.2 MBD of naphtha recycled from Kermanshah #2.

† Gasoline figures include both motor gasoline and aviation gasoline.

‡ Assumed production and refinery runs for MIS topping--45 MBD; and Lavan topping--10 MBD.

§ Assumed output from Lavan topping; balance of products (naphtha and fuel oil) sold to Consortium for export.

** Assumed output from MIS topping; some fuel oil recycled to structure and balance of products (middle distillates) sold to Consortium for further processing or export.

†† Production--39.1 MBD; 8.1 MBD of fuel oil recycled from Abadan simple refinery.

Source: Stanford Research Institute.

Table 3

PETROLEUM SUPPLY/DEMAND BALANCE WITH LOWER GAS ESTIMATES
(Thousands of Barrels per Day)

	Total for Iran 1972	Total for Iran 1977	Total for Iran 1982	Kermanshah 1972	Kermanshah 1977	Kermanshah 1982
Supply						
Crude oil						
Production	69,2	98,0	143,9	14,2	14,2	14,2
Exports	(92,0)	(200,2)	(391,4)	—	—	(44,7)
Refinery runs	161,2	296,2	535,3	14,2	14,2	58,9
Refinery production						
LPG	2,9	7,6	13,9	0,5	0,5	1,3
Gasoline	17,0	39,4	71,8	2,8	3,6	4,4*
Kerosene	12,5	48,2	93,6	2,8	2,8	7,2
Jet fuel	4,1	3,8	5,8	—	—	—
Gas oil	29,6	72,6	135,3	2,5	2,5	8,3
Fuel oil	58,9	77,8	145,3	4,4	4,4	31,0
Other	2,3	9,6	15,6	—	—	—
Refinery fuel and losses	6,8	18,4	39,5	1,2	1,2	2,5
Demand						
LPG	6,1	13,5	25,5	0,1	0,7	1,8
Movement in	3,7	8,3	17,8	—	0,2	0,5
Movement out	0,5	2,4	6,2	0,4	—	—
Exports	(3,2)	(5,9)	(11,6)	0,4	(0,2)	(0,5)
Gasoline†	26,4	42,0	75,2	1,4	2,3	4,4
Movement in	12,3	18,5	28,1	—	—	—
Movement out	2,9	15,9	24,7	1,4	0,5	—
Exports	(9,4)	(2,6)	(3,4)	1,4	0,5	—
Kerosene	51,5	61,7	111,6	4,9	7,2	9,2
Movement in	39,0	40,0	42,5	3,1	4,4	2,0
Movement out	—	6,5	24,5	—	—	—
Exports	(29,0)	(33,5)	(18,0)	(2,1)	(4,4)	(2,0)
Jet fuel	7,1	12,2	17,8	0,4	0,6	0,9
Movement in	3,0	8,4	14,0	0,4	0,6	0,9
Movement out	—	—	—	—	—	—
Exports	(3,0)	(8,4)	(14,0)	(0,4)	(0,6)	(0,9)
Gas oil	67,1	101,7	171,3	5,8	9,3	15,1
Movement in	40,9	55,4	78,7	3,3	4,8	6,8
Movement out	3,4	26,3	32,9	—	—	—
Exports	(37,5)	(29,1)	(45,8)	(3,3)	(4,5)	(6,8)
Fuel oil	59,9	91,3	145,7	3,7	15,9	31,0
Movement in	23,7	49,4	53,1	—	11,5	—
Movement out	22,7	35,9	52,6	0,7	—	—
Exports	(1,0)	(13,5)	(0,3)	0,7	(11,5)	—
Other	9,7	15,0	21,5	0,5	0,8	1,1
Movement in	7,4	8,8	12,8	0,5	0,8	1,1
Movement out	—	3,4	6,9	—	—	—
Exports	(7,4)	(5,4)	(5,9)	(0,5)	(0,8)	(1,1)
Total	227,8	357,4	568,9	16,6	36,8	43,5
Movement in	130,0	166,8	247,1	6,3	24,3	11,3
Movement out	29,5	90,4	148,0	2,5	0,5	—
Exports	(100,5)	(96,4)	(99,1)	(3,8)	(23,8)	(11,3)

	Northern Iran 1972	Northern Iran 1977	Northern Iran 1982	Azarbayejan 1972	Azarbayejan 1977	Azarbayejan 1982
Supply						
Crude oil						
Production	—	—	—	—	—	—
Exports	(92,0)	(200,2)	(346,7)	—	—	—
Refinery runs	92,0	200,2	346,7	—	—	—
Refinery production						
LPG	2,4	5,9	10,3	—	—	—
Gasoline	14,2	29,2	50,3	—	—	—
Kerosene	9,7	35,0	69,6	—	—	—
Jet fuel	4,1	3,8	5,8	—	—	—
Gas oil	24,1	54,1	93,1	—	—	—
Fuel oil	27,6	49,7	71,2	—	—	—
Other	2,3	8,7	14,7	—	—	—
Refinery fuel and losses	7,6	13,8	30,5	—	—	—
Demand						
LPG	2,0	6,2	10,4	0,1	0,4	1,1
Movement in	0,7	2,7	6,3	0,1	0,4	1,1
Movement out	0,1	2,4	6,2	—	—	—
Exports	(0,6)	(0,3)	(0,1)	(0,1)	(0,4)	(1,1)
Gasoline†	17,8	27,6	48,4	1,4	2,7	6,1
Movement in	5,1	8,8	17,5	1,4	2,7	6,1
Movement out	1,5	10,4	19,4	—	—	—
Exports	(3,6)	1,6	1,9	(1,4)	(2,7)	(6,1)
Kerosene	38,3	63,0	88,3	6,3	9,5	11,5
Movement in	28,6	28,0	31,1	6,3	9,5	11,5
Movement out	—	—	12,6	—	—	—
Exports	(28,6)	(28,0)	(18,5)	(6,3)	(9,5)	(11,5)
Jet fuel	5,2	8,3	12,0	—	—	0,1
Movement in	1,1	4,5	8,2	—	—	0,1
Movement out	—	—	—	—	—	—
Exports	(1,1)	(4,5)	(8,2)	—	—	(0,1)
Gas oil	38,3	60,8	101,8	4,9	9,5	16,4
Movement in	17,6	27,1	42,7	4,9	9,5	16,4
Movement out	3,4	20,4	31,0	—	—	—
Exports	(14,2)	(6,7)	(11,7)	(4,9)	(9,5)	(16,4)
Fuel oil	38,7	49,1	75,0	4,2	13,1	18,4
Movement in	12,1	23,1	31,2	4,2	13,1	18,4
Movement out	1,0	23,7	30,4	—	—	—
Exports	(11,1)	0,6	(0,8)	(4,2)	(13,1)	(18,4)
Other	6,2	9,7	14,3	0,9	1,6	2,1
Movement in	3,9	4,1	6,4	0,9	1,6	2,1
Movement out	—	3,1	6,6	—	—	—
Exports	(3,9)	(1,0)	0,4	(0,9)	(1,6)	(2,1)
Total	147,5	334,7	353,2	17,8	36,8	55,7
Movement in	69,1	98,3	143,4	17,8	36,8	55,7
Movement out	6,0	60,0	106,4	—	—	—
Exports	(63,1)	(38,3)	(37,0)	(17,8)	(36,8)	(55,7)

	Caspian 1972	Caspian 1977	Caspian 1982	Tehran 1972	Tehran 1977	Tehran 1982
Supply						
Crude oil						
Production	—	—	—	—	—	—
Exports	—	—	—	(93,0)	(200,2)	(346,7)
Refinery runs	—	—	—	93,0	200,2	346,7
Refinery production						
LPG	—	—	—	2,4	5,9	10,3
Gasoline	—	—	—	14,2	29,2	50,3
Kerosene	—	—	—	9,7	35,0	69,8
Jet fuel	—	—	—	4,1	3,8	3,8
Gas oil	—	—	—	24,1	54,1	93,1
Fuel oil	—	—	—	27,6	49,7	74,2
Other	—	—	—	2,3	8,7	14,7
Refinery fuel and losses	—	—	—	7,6	13,8	30,5
Demand						
LPG	0,4	1,4	2,9	2,3	3,5	4,1
Movement in	0,4	1,4	2,9	—	—	—
Movement out	—	—	—	0,1	2,4	6,2
Exports	(0,4)	(1,4)	(2,9)	0,1	2,4	6,2
Gasoline†	2,2	3,5	6,4	13,7	18,8	30,9
Movement in	2,2	3,5	6,4	—	—	—
Movement out	—	—	—	1,5	10,4	19,4
Exports	(2,2)	(3,5)	(6,4)	1,5	10,4	19,4
Kerosene	6,4	9,4	11,8	30,8	37,5	57,2
Movement in	6,4	9,4	11,8	11,1	2,5	—
Movement out	—	—	—	—	—	13,6
Exports	(6,4)	(9,4)	(11,8)	(11,1)	(2,5)	13,6
Jet fuel	—	—	0,1	5,1	8,1	11,5
Movement in	—	—	0,1	1,0	4,3	7,7
Movement out	—	—	—	—	—	—
Exports	—	—	(0,1)	(1,0)	(4,3)	(7,7)
Gas oil	5,9	9,0	13,7	20,7	33,7	62,1
Movement in	5,9	9,0	13,7	—	—	—
Movement out	—	—	—	3,4	20,4	31,0
Exports	(5,9)	(9,0)	(13,7)	3,4	20,4	31,0
Fuel oil	3,3	4,6	7,5	26,6	24,0	43,8
Movement in	3,3	4,6	7,5	—	—	—
Movement out	—	—	—	1,0	23,7	30,4
Exports	(3,3)	(4,6)	(7,5)	1,0	23,7	30,4
Other	0,6	1,3	2,2	3,6	5,6	7,9
Movement in	0,6	1,3	2,2	1,5	—	—
Movement out	—	—	—	—	3,1	6,8
Exports	(0,6)	(1,3)	(2,2)	(1,5)	3,1	6,8
Total	19,0	29,2	44,6	92,0	133,3	217,5
Movement in	19,0	29,2	44,6	13,6	6,8	7,7
Movement out	—	—	—	6,0	60,0	106,4
Exports	(19,0)	(29,2)	(44,6)	(7,6)	53,3	98,7

	Khorasan 1972	Khorasan 1977	Khorasan 1982	Southern Iran 1972	Southern Iran 1977	Southern Iran 1982
Supply						
Crude oil						
Production	—	—	—	55,0‡	81,8	129,7
Exports	—	—	—	—‡	—	—
Refinery runs	—	—	—	55,0	81,8	129,7
Refinery production						
LPG	—	—	—	—	1,2	2,3
Gasoline	—	—	—	—	7,4	17,1
Kerosene	—	—	—	—	10,4	16,6
Jet fuel	—	—	—	—‡	—	—
Gas oil	—	—	—	3,0‡	16,0	24,1††
Fuel oil	—	—	—	26,9**	23,7	40,1††
Other	—	—	—	—	0,0	0,9
Refinery fuel and losses	—	—	—	—	4,4	6,5
Demand						
LPG	0,3	0,9	2,3	3,0	6,6	13,3
Movement in	0,2	0,9	3,3	3,0	5,4	11,0
Movement out	—	—	—	—	—	—

	Khuzestan 1972	Khuzestan 1977	Khuzestan 1982	Esfehan 1972	Esfehan 1977	Esfehan 1982
Supply						
Crude oil						
Production	45,0‡	23,8	71,7	—	—	—
Exports	—‡	—	—	—	—	—
Refinery runs	45,0	23,8	71,7	—	—	—
Refinery production						
LPG	—	—†	1,1	—	—	—
Gasoline	—	—	9,7	—	—	—
Kerosene	—	1,9	8,3	—	—	—
Jet fuel	—	—	—	—	—	—
Gas oil	—	2,5	10,6††	—	—	—
Fuel oil	38,9**	14,6	31,0	—	—	—
Other	—	—	—	—	—	—
Refinery fuel and losses	—	0,8	2,9	—	—	—
Demand						
LPG	3,0	4,2	7,9	0,3	1,1	2,6
Movement in	2,0	4,2	6,8	0,3	1,1	2,6
Movement out	—	—	—	—	—	—

	Pars 1972	Pars 1977	Pars 1982	Kerman 1972	Kerman 1977	Kerman 1982
Supply						
Crude oil						
Production	10,0‡	58,0	58,0	—	—	—
Exports	—‡	—	—	—	—	—
Refinery runs	10,0	58,0	58,0	—	—	—
Refinery production						
LPG	—	1,2	1,2	—	—	—
Gasoline	—	7,4	7,4	—	—	—
Kerosene	—	8,5	8,5	—	—	—
Jet fuel	—‡	—	—	—	—	—
Gas oil	3,0	13,5	13,5	—	—	—
Fuel oil	—	9,1	9,1	—	—	—
Other	—	0,9	0,9	—	—	—
Refinery fuel and losses	—	3,6	3,6	—	—	—
Demand						
LPG	0,6	1,2	2,3	0,1	0,1	0,8
Movement in	0,6	—	1,1	0,1	0,1	0,5
Movement out	—	—	—	—	—	—

Table 4

PETROLEUM SUPPLY/DEMAND BALANCE AND EXPORTS FROM IRAN
(Thousands of Barrels per Day)

	Basic Gas Projections			Lower Gas Estimates		
	1972	1977	1982	1972	1977	1982
Supply						
Crude oil						
Production	4,700	7,500	12,000	4,700	7,500	12,000
Exports from Iran	4,109	6,787	11,067	4,109	6,774	11,035
Refinery runs*	591	713	933	591	726	965
Refinery production						
LPG	48[†]	69[‡]	74[‡]	48[†]	69[‡]	75[‡]
Gasoline	92	114	144	92	116	148
Jet fuel	42	42	42	42	42	42
Middle distillates	167	234	323	167	240	339
Fuel oil	233	253	318	233	257	325
Other	10	16	22	10	17	23
Total production	592[†]	728[‡]	923[‡]	592[†]	741[‡]	952[‡]
Refinery fuel, losses, and recycle	43	45	70	43	45	73
Total product demand[§]						
LPG	5	10	18	6	14	26
Gasoline	26	42	75	26	42	75
Jet fuel	7	12	18	7	12	18
Middle distillates	122	182	274	122	187	289
Fuel oil	154	199	255	154	202	262
Other	10	15	22	10	15	22
Total demand[§]	324	460	662	325	472	692
Total product exports**						
LPG	43	59	56	42	55	49
Gasoline	66	72	69	66	74	73
Jet fuel	35	30	24	35	30	24
Middle distillates	45	52	49	45	53	50
Fuel oil	79	54	63	79	55	63
Other	--	1	--	--	2	1
Total exports**	268	268	261	267	269	260

* Includes all NIOC refining facilities, Abadan refinery, MIS (for 1972), Lavan topping, and Bandar Mashahr NGL facility.
† Includes 44 MBD estimated output from Bandar Mashahr.
‡ Includes 60 MBD estimated output from Bandar Mashahr.
§ Includes internal demand and bunkers.
** Estimated, assuming difference between refinery production and total product demand including bunkers.

Source: Stanford Research Institute.

MBD
Mill Barrel per Day

Table 5

SUPPLY/DEMAND BALANCE FOR NATURAL GAS WITH BASIC GAS PROJECTIONS
(Millions of Cubic Feet per Day)

	Total for Iran			Kermanshah			Northern Iran			Azarbayejan		
	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982
Production	3,200	4,500	5,800	3	3	3	11	62	718	0	0	0
Flared	2,247	2,582	1,394	1	1	1	0	0	0	0	0	0
Exports	600*	1,000*	2,700*	0	0	0	0	0	0	0	0	0
Net available for internal market	353	918	1,706	2	2	2	11	62	718	0	0	0
Demand	353†	918†	1,706†	2	2	2	84	387	892	0	0	0
Movement in	0	0	0	0	0	0	73	325	174	0	0	0
Movement out	0	0	0	0	0	0	0	0	0	0	0	0

	Caspian			Tehran			Khorasan			Southern Iran		
Production	0	0	0	0	0	0	11	62	718	3,186	4,435	5,079
Flared	0	0	0	0	0	0	0	0	0	2,246	2,581	1,393
Exports	0	0	0	0	0	0	0	0	0	600*	1,000*	2,700*
Net available for internal market	0	0	0	0	0	0	11	62	718	340	854	986
Demand	0	49	24	73	276	750	11	62	118	267†	529†	812†
Movement in	0	49	24	73	276	750	0	0	0	0	0	0
Movement out	0	0	0	0	0	0	0	0	600	73	325	174

	Khuzestan			Esfehan			Fars			Kerman		
Production	3,186	4,435	5,079	0	0	0	0	0	0	0	0	0
Flared	2,246	2,581	1,393	0	0	0	0	0	0	0	0	0
Exports	600*	1,000*	2,700*	0	0	0	0	0	0	0	0	0
Net available for internal market	340	854	986	0	0	0	0	0	0	0	0	0
Demand	221†	359†	456†	25	122	209	21	48	147	0	0	0
Movement in	0	0	0	25	122	209	21	48	147	0	0	0
Movement out	119	495	530	0	0	0	0	0	0	0	0	0

Note: Assumes no reinjection.

*

	1972	1977	1982
Deliveries to USSR via IGAT	600 M^2cfd	1,000	1,000
LNG exports from Khuzestan	0	0	1,700
	600	1,000	2,700

Note: This is a higher export number than given in Volume 5 because a higher LNG market is assumed.

† Includes Abadan refinery fuel use of 92 million cubic feet per day, field use, and petrochemical use.

Source: Stanford Research Institute.

Table 6

SUPPLY/DEMAND BALANCE FOR NATURAL GAS WITH LOWER GAS ESTIMATES
(Millions of Cubic Feet per Day)

	Total for Iran			Kermanshah			Northern Iran			Azarbayejan		
	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982
Production	3,200	4,466	5,667	3	3	3	11	57	704	0	0	0
Flared	2,247	2,596	1,388	1	1	1	0	0	0	0	0	0
Exports	600*	1,000*	2,700*	0	0	0	0	0	0	0	0	0
Net available for internal market	353	870	1,579	2	2	2	11	57	704	0	0	0
Demand	353†	870†	1,579†	2	2	2	84	346	787	0	0	0
Movement in	-	-	-	0	0	0	73	289	83	0	0	0
Movement out	-	-	-	0	0	0	0	0	0	0	0	0

	Caspian			Tehran			Khorasan			Southern Iran		
Production	0	0	0	0	0	0	11	57	704	3,186	4,406	4,960
Flared	0	0	0	0	0	0	0	0	0	2,246	2,595	1,387
Exports	0	0	0	0	0	0	0	0	0	600*	1,000*	2,700*
Net available for internal market	0	0	0	0	0	0	11	57	704	340	811	873
Demand	0	47	20	73	242	663	11	57	104	267†	522†	790†
Movement in	0	47	20	73	242	663	0	0	0	0	0	0
Movement out	0	0	0	0	0	0	0	0	600	73	289	83

	Khuzestan			Esfehan			Fars			Kerman		
Production	3,186	4,406	4,960	0	0	0	0	0	0	0	0	0
Flared	2,247	2,596	1,388	0	0	0	0	0	0	0	0	0
Exports	600*	1,000*	2,700*	0	0	0	0	0	0	0	0	0
Net available for internal market	340	811	873	0	0	0	0	0	0	0	0	0
Demand	221†	358†	453†	25	118	196	21	46	141	0	0	0
Movement in	0	0	0	25	118	196	21	46	141	0	0	0
Movement out	119	453	420	0	0	0	0	0	0	0	0	0

Note: Assumes no reinjection.

*

	1972	1977	1982
Deliveries to USSR via IGAT	600 M^3cfd	1,000	1,000
LNG exports from Khuzestan	0	0	1,700
	600	1,000	2,700

Note: This is a higher export number than given in Volume 5 because a higher LNG market is assumed.

† Includes Abadan refinery fuel use of 92 million cubic feet per day, field use, and petrochemical use.

Source: Stanford Research Institute.

Table 7

SUPPLY/DEMAND BALANCE FOR COAL
(Thousands of Metric Tons)

	Total for Iran			Kermanshah			Northern Iran			Azarbayejan		
	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982
Production	835	1,883	1,893	0	0	0	173	637	622	14	14	14
Demand	835	1,883	1,893	8	8	8	165	129	114	14	14	14
Movement in	0	0	0	8*	8*	8*	0	0	0	0	0	0
Movement out	0	0	0	0	0	0	8	508	508	0	0	0
	Caspian			Tehran			Khorasan			Southern Iran		
Production	44	40	40	83	559	548	32	24	20	661	1,246	1,273
Demand	44	40	40	75	51	40	32	24	20	661	1,746	1,773
Movement in	0	0	0	0	0	0	0	0	0	0	500	500
Movement out	0	0	0	8†	508‡	508‡	0	0	0	0	0	0
	Khuzestan			Esfehan			Fars			Kerman		
Production	3	3	3	62	47	40	10	10	10	586	1,186	1,220
Demand	3	3	3	632	1,147	1,140	10	10	10	16	586	620
Movement in	0	0	0	570§	1,100**	1,100**	0	0	0	0	0	0
Movement out	0	0	0	0	0	0	0	0	0	570††	600††	600††

* From Tehran.
† To Kermanshah.
‡ To Kermanshah (8) and Esfehan (500).
§ From Kerman.
** From Kerman (600) and Tehran (500).
†† To Esfehan.

Source: Stanford Research Institute.

Table 8

SUPPLY/DEMAND BALANCE FOR ELECTRICITY
(Millions of Kilowatt Hours)

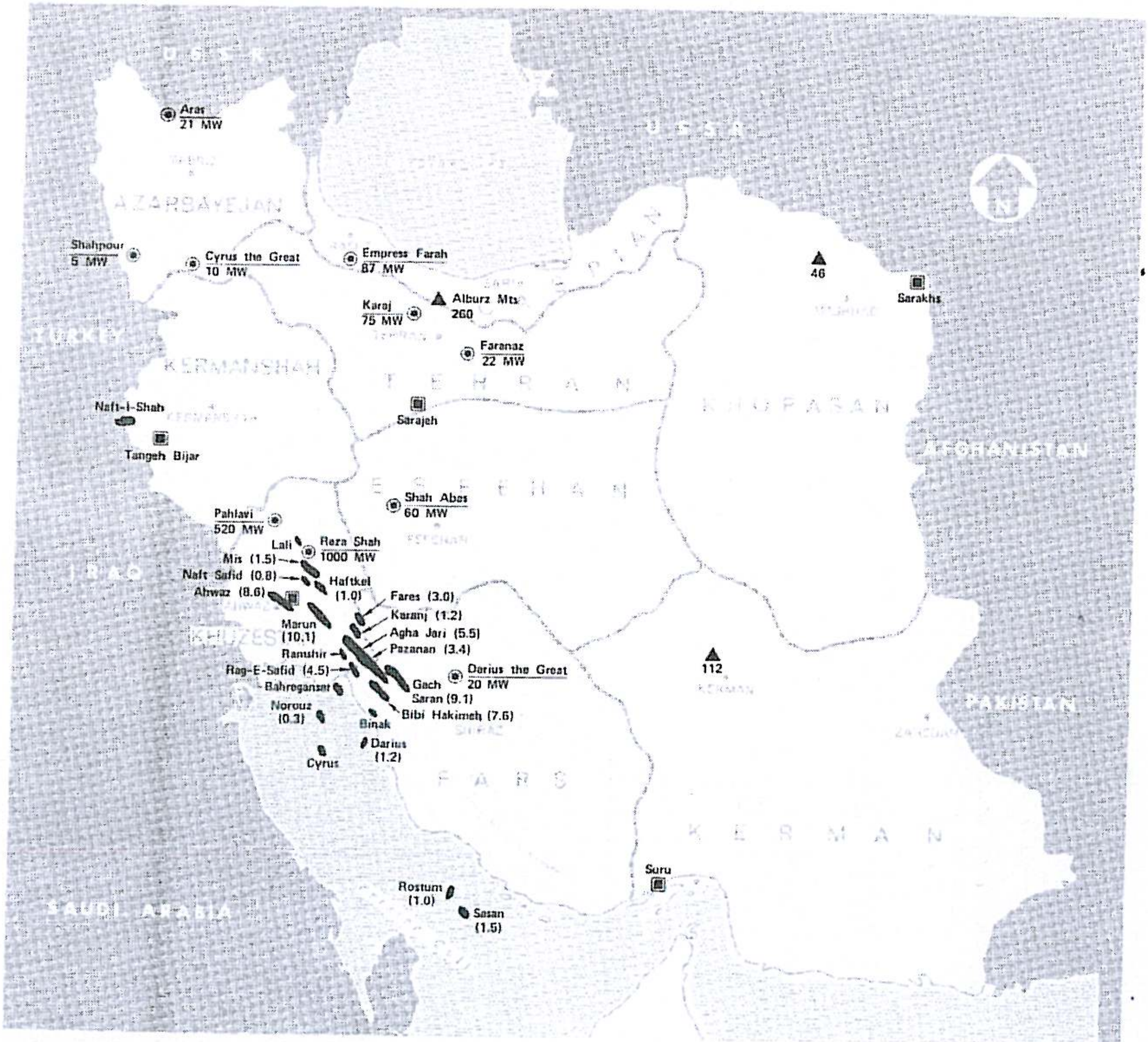
	Total for Iran			Kermanshah			Northern Iran			Azarbayejan		
	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982
Production	11,000	20,450	37,860	20	2,185	4,610	6,718	8,990	20,360	135	1,045	765
Hydroelectric	3,082	7,225	7,225	0	0	0	770	770	770	105	105	105
Thermal	7,918	13,225	30,635	20	2,185	4,610	5,948	8,220	19,590	30	940	660
Demand	11,000	20,450	37,860	165	307	606	6,424	11,390	21,353	297	491	871
Net movement in	0	0	0	145	0	0	0	2,400	993	162	0	106
Net movement out	0	0	0	0	1,878	4,004	294	0	0	0	554	0

	Caspian			Tehran			Khorasan			Southern Iran		
Production	1,894	1,969	684	4,304	5,276	18,146	385	700	765	4,259	9,275	12,890
Hydroelectric	464	464	464	201	201	201	0	0	0	2,312	6,455	6,455
Thermal	1,430	1,505	220	4,103	5,075	17,945	385	700	765	1,947	2,820	6,435
Demand	649	982	1,666	5,093	9,181	17,453	385	736	1,363	4,411	8,753	15,901
Net movement in	0	0	982	789	3,905	0	0	36	598	0	522	0
Net movement out	1,245	987	0	0	0	693	0	0	0	152	0	3,011

	Khuzestan			Esfehan			Fars			Kerman		
Production	3,244	6,362	6,372	498	1,878	3,123	286	425	2,725	231	610	670
Hydroelectric	2,059	6,202	6,202	228	228	228	25	25	25	0	0	0
Thermal	1,185	160	170	270	1,650	2,895	261	400	2,700	231	610	670
Demand	2,970	5,746	11,055	924	1,493	2,726	286	532	984	231	982	1,136
Net movement in	0	0	4,683	426	0	0	0	107	0	0	372	466
Net movement out	274	616	0	0	385	397	0	0	1,741	0	0	0

Source: Stanford Research Institute

FIGURE 1 ENERGY RESOURCES MAP



OIL AND ASSOCIATED GAS FIELDS

Numbers in Parentheses are Estimated Crude Reserves in Billions of Barrels, as of 1/1/70.

HYDROELECTRIC FACILITIES

Numbers Refer to Capacity of Facility.

DRY GAS FIELDS

Dry and Associated Gas Reserves are Estimated as Follows:

Consortium....177 Trillion Cubic Feet
Offshore....... 2 Trillion Cubic Feet
NIOC.........21 Trillion Cubic Feet

COAL DEPOSITS

Numbers Refer to Estimated Reserves in Millions of Tons.
Note: Deposits are Located Over a far Greater Range than Indicated.

SOURCE: Developed by Stanford Research Institute.

of the country, but oil and gas reserves are highly concentrated and form the bulk of the energy reserves, as demonstrated below:

	Units	Billions Barrels Oil Equivalent	Ultimate Production, Million Barrels per Day Equivalent
Oil	50-150 billion barrels	50-150	8-16
Gas	200-300 trillion cubic ft	40-60	6-9
Coal	1.8 billion tons *	7	Not yet evaluated
Hydro	Over 20 million kW *	--	<1
Total		98-220	15-30

Since information on oil and gas reserves is considered highly confidential, the Institute was not privileged to receive and evaluate any information on reserves. The above data are therefore speculative but are included to provide some indication of the energy reserve base of this country. As will be discussed later, a sound evaluation of ultimate reserves, and particularly of the ultimate productive potential, is of extremely great importance to energy policies for both internal and export considerations, as well as to long range economic and development planning.

Oil reserves in Iran have been estimated by several different sources at 50 to 70 billion barrels, which are presumably the known reserves today. If these estimates are in the correct range, then ultimate recoverable reserves are surely much higher, likely in the range of 100 to 200 billion barrels. However, oil production will increase rapidly, from 4 million barrels per day today to 8 to 10 million barrels per day by 1980 and to 16 million barrels per day by 1990, if productive capability is that high. Cumulative production between now and 1990 is likely to be at least 60 billion barrels and will be possible only if the ultimate

* The hydro potential and the coal potential have not yet been evaluated sufficiently to provide realistic estimates of ultimate reserves and production capability.

reserves existing today total at least 150 billion barrels. Assuming such a magnitude does exist, then production would effectively peak in the 1990s at 16 million to 17 million barrels per day (roughly 100 billion barrels of remaining reserves in 1990, with a minimum achievable reserve life index of 15 to 20 years). This is of critical importance to Iran, and a broad 20- to 30-year plan should be developed, integrating internal and export strategy.

Hypothetical trends in oil reserves, production, and reserve life index, based upon the above assumptions, are given in Figure 2. Historically, production has been growing very rapidly and the outlook for continued rapid growth, at least for the next few years, is excellent. Reserves, as reported by various sources, have also increased but not so rapidly as production; hence the reserve life index has dropped down to 40 to 50 years.

The projections must be considered as hypothetical because the Institute was unable to obtain any evaluation of reserves. No evaluations of petroleum export potential were made. It has been assumed that the trends will be as shown, with continuing increase in reserves and production through the 1970s but tapering off rapidly in the 1980s as the reserve life index bottoms out in the range of 15 to 20 years.

Until 1980 to 1985, Iran can probably meet all the potential demand for its petroleum. However, if production does taper off rapidly thereafter, Iran will increasingly be unable to meet all potential markets, which should continue to increase by at least 5 to 6 percent per year. Thus there could be a supply deficit, commencing in the 1980s and reaching several million barrels per day by 1990.

It is impossible to say how realistic the above trends are; much depends on the ultimate reserves. The ultimate reserves that have been assumed are enormous; they could be understated, but it is not likely. If they have been overstated, their production will peak even sooner and at a lower level, and the impact on internal pricing will be even more severe than that assumed in the next section.

The assumed trends for natural gas are given in Figure 3. The uncertainty for natural gas is far greater than for petroleum because:

(1) The level of LNG export is difficult to project.

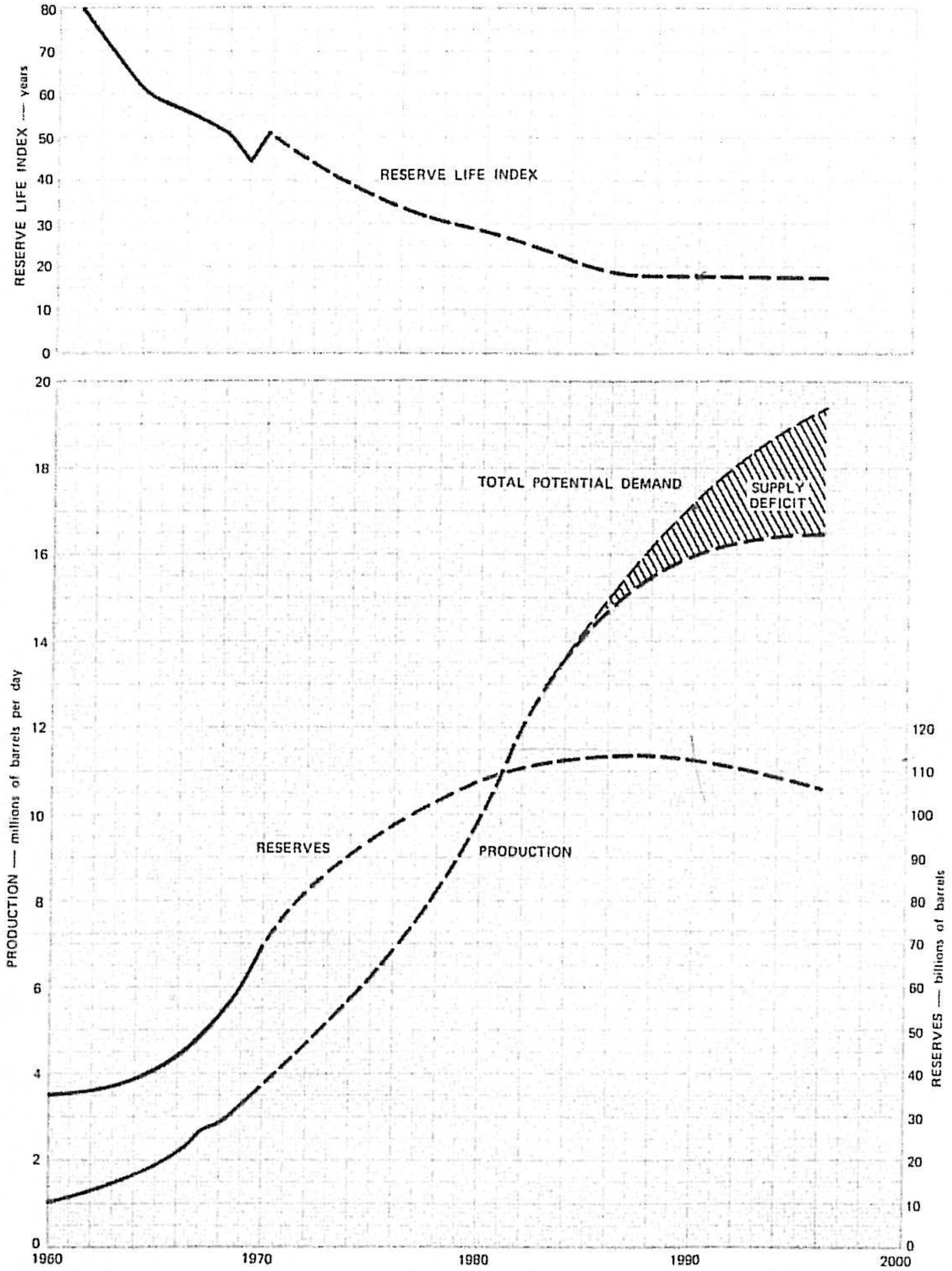
(2) The availability of gas cap reserves is unknown.

(3) Repressuring requirements are unknown.

$\frac{R}{C \times 365} \rangle 25$

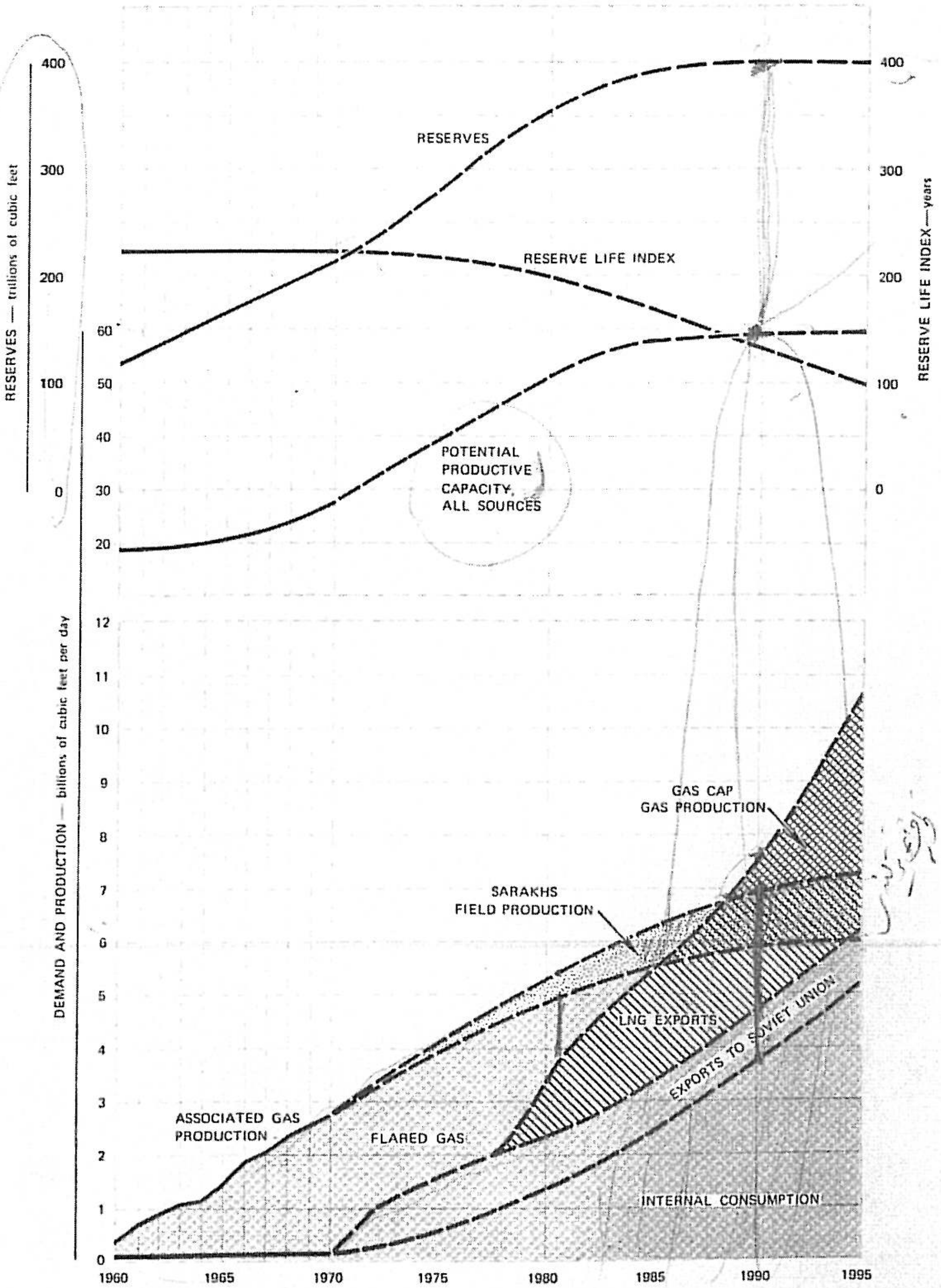
IRL = $\frac{R}{C(P)}$

FIGURE 2 HYPOTHETICAL TRENDS IN OIL PRODUCTION, RESERVES, AND RESERVE LIFE INDEX



SOURCE: Stanford Research Institute.

FIGURE 3 HYPOTHETICAL TRENDS IN NATURAL GAS RESERVES, RESERVE LIFE INDEX, AND PRODUCTION



NOTE: Assumes no reinjection.

SOURCE: Stanford Research Institute.

(4) Associated gas production is difficult to project.

(5) The degree of reliance on the Sarakhs field is still speculative.

(6) The gas/oil ratio for new discoveries can change substantially; hence, the trend in proven gas reserves is quite speculative.

Despite the uncertainties, it is most probable that associated gas production plus Sarakhs production will not be sufficient to meet all potential markets at some point in the 1980s, even without reinjection. If a large scale reinjection program was commenced during the present decade, the supply--if gas cap reserves are not used--will be insufficient, possibly by 1980. The trends in flared gas in Figure 3 also assume that flaring will be completely eliminated, which is actually quite unlikely.

Despite all the limitations described above, it is certain that if gas reserves are presently 200 trillion cubic feet or more, reserves are sure to increase further, and the ultimate productive capability will be substantially greater than any conceivable requirement for internal and export markets, plus repressuring. As with oil, this type of analysis is of critical importance to Iran; a 20- to 30-year program should be developed.

The supply-demand energy balance by region (see Tables 2 to 6) demonstrates that there are only a few regions supplying crude oil and natural gas and that through 1977 there will still be less than half the regions supplying petroleum products (i.e., have refineries). However, well before 1982 at least six of the nine regions will have refineries (and quite possibly seven regions), and effective dispersion of refining capacity will be achieved economically. Premature dispersion would be very costly and would be of limited value from the position of national defense.

Electric power production is already dispersed and will continue to be, although interregional shipments will continue wherever large production facilities--in excess of local requirements--are justified.

In summary, Iran's energy balance indicates a nation extremely well endowed with energy sources, most of which are low cost but are rapidly increasing in value. Despite the abundance, the rapid growth in internal and export demand could strain the ultimate productive capability of its oil resources within the foreseeable future and of its gas resources possibly early in the next century. The coal resources are not particularly large but will be useful for the steel mills and for coal-fired power plants at some point within the next 20 to 30 years; conversion of coal to oil and/or gas may be a further possibility, but the location of the coal reserves probably means that the output would have to be dedicated to the internal market. Finally, the regional concentration of energy reserves is great, but rapidly increasing demand and resulting economy of scale will make possible an efficient energy supply system. Nevertheless, discovery of oil or gas deposits in energy deficient regions such as Tehran, Caspian, Azarbayejan, Esfehan, and Kerman would make it possible to lower the costs even further. Iran's oil and gas exploration program could well be increased by orders of magnitude.

IV PRICING OF ENERGY

Several of the other volumes have discussed the price patterns for energy, the components of the price and the probable trend in the components, the concept of value in export, and price comparisons. The objective of this section is to bring all this material together with a minimum of duplication and to arrive at both an overall and a detailed pricing policy geared to conditions that are likely to prevail in the future.

Effect of Past Pricing

Energy prices have been held at the same level for many years, apparently at a low enough price for most of the population to purchase some form and some quantity of energy. Energy consumption has increased rapidly in rural and urban areas and in the poorer sections of the cities. On an overall basis at least a constant share of income and GNP has been devoted to the purchase of energy. However, for many people the purchase of energy has represented an increasing share of income--in the early 1960s, for example, they made no purchases of energy.

There is no real experience in sustained price changes by which it is possible to determine the elasticity of demand with respect to price; i.e., the effect of price changes on the level of demand. Gas oil and kerosene prices were raised dramatically at one point--a 50-percent increase for one and a 100-percent increase for the other--but were reduced to the original prices after a short period. During that brief period of increased prices, the effect on demand was dramatic, but the effect over a sustained period is not known, although certainly such drastic and sudden changes in price would surely have a sustained effect of significant proportions.

Effect of Price Changes in the Future

Energy is becoming more valuable, and Iran cannot avoid this fact internally for too long a period. Energy prices should increase in Iran over the long term, and it would be most useful to know for facilities-planning purposes, what the effect on demand is likely to be.

Without any precedent but with the continuing need for some judgment on elasticity effects, it becomes useful to speculate on the potential range of the effect of price changes and then to arrive at some best estimate.

The elasticity is probably not constant over a wide range in price changes but is rather a function of the percentage change in price. In other words, a small percent increase in price might have no effect on demand (zero elasticity), but a 50- to 100-percent increase in price would undoubtedly have close to an equal percentage of reduction in demand (elasticity approaching -1, or unit elasticity). However, there is no point to considering major sudden changes in price because it is politically infeasible and damaging to the economy to increase energy prices drastically at any one time, although it is necessary to consider repeated small changes over a period of years. The largest percentage increase in any one year should generally not exceed 5 percent, and there is not much point to raising prices by less than 3 percent. In the following discussion, a 5-percent change will be used.

In the developed economies with high incomes per capita, a 5-percent change in energy prices would have no noticeable effect on demand; in Iran there probably would be some reaction. If an absolute amount of money were available for expenditures on energy, demand would have to be 5 percent lower. On people with higher incomes and on most of industry, the 5-percent price increases would have no effect, but those with low to median incomes would have to reduce their energy consumption for residential and some commercial and transportation uses about 5 percent. The overall elasticity is therefore probably somewhere between -0.3 and -0.6. Considering the mix of end uses and the income distribution, the best single estimate appears to be about -0.4. If so, a 5-percent increase in all energy prices in 1972 would reduce energy demand in subsequent years by 2 percent (5 percent multiplied by 0.4, or 2 percent). With 2 annual increases of 5 percent per year in 1972 and 1973, the demand would be lowered by 4 percent; in 1982, instead of a total energy demand of 960,000 barrels per day equivalent and an 11 percent per year growth rate between 1972 and 1982, total demand would be about 920,000 barrels per day and the 10-year growth rate would be 10.5 percent per year--not too significant a reduction and within the margin of error of the basic projection.

If the analysis period is extended another 10 years to 1992 and energy demand continued to grow at 10 percent per year, total demand would reach 2.4 million barrels per day equivalent in 1992. If a 50-percent increase in energy prices were sustained over this period, demand in 1992 would be reduced by 20 percent or almost 500,000 barrels per day.

If this were all oil and if Iran were at or near peaking in oil production and were unable to meet further growth in world oil demand, this 500,000 barrels per day could be exported instead of used internally and would generate an oil export revenue of US$500 million to US$1 billion dollars per year.

The cross elasticity of relative price changes on the demand for oil, gas, and electricity is also important to consider. In the industrial and power plant markets, the cross elasticity for oil and gas is quite high. If oil becomes much more expensive than gas, industrial and power plant consumers will all want to use gas exclusively. In the residential and commercial markets the cross elasticity is less, but there is a point in the relative prices between oil and gas at which gas would rapidly take over most of the market, even if customers have to pay for piping their homes and converting their appliances. That point is probably somewhere between a 25- and 50-percent differential in gas and oil prices. The cross elasticity with electricity is very low. Electricity would have to drop a great deal in price in relation to oil or gas for electricity to penetrate the cooking, water-heating, and space-heating markets.

Broad Objectives in Pricing

There are a number of broad objectives for energy pricing in Iran. As in all pricing systems some of the objectives tend to be mutually exclusive, and it is then necessary to decide which objectives are more important at any one time--each objective may in fact vary in importance over a long time period. The Institute recognizes that energy pricing and its objectives are matters for the top circles in the Imperial Iranian Government to decide on and that there are political and other realities that can justify quite a different pricing system from that recommended by SRI. The purpose of this subsection is therefore to inform the government of the Institute's findings in terms of the perspective for the future, the economic objectives that appear to the SRI team to be of major importance, and the implications of departing from economic solutions. Hopefully, this material will assist Iran's decision-makers even though the final decisions may not coincide with SRI's recommendations.

Probably the major objective of energy pricing is to assist, to the extent possible, in the long term economic development of the country.

This objective does not provide much guidance but it is meaningful to the following extent:

- Industrial energy prices may have a bearing on economic development. This is applicable primarily (and likely only) to energy-intensive industry competing with imports and/or geared to export markets. This does not necessarily require that all industrial fuel or electric prices be held to a low level, but only that high viscosity fuel oil and interruptible gas be available at relatively low prices, including negotiated prices at quite a low level under special circumstances (e.g., large plants to serve export markets that contribute to economic development for fostering the introduction of supporting industry).

- In general, residential and commercial, most transportation, and most industrial fuel prices will not be a factor in economic development.

- In Iran's specialized circumstances, the value in export of each form of energy is of major importance to its economic development because the revenue from energy exports provides the principal financial vehicle for development. The value in export is likely to become the single most important variable in energy pricing.

In considering the future level of industrial energy prices, it will be pertinent to monitor industrial energy prices in the industrial countries of Western Europe, Japan, and North America. The Institute's current evaluation of industrial fuel price trends is that prices are increasing and will continue to increase, reaching, on the average a price of $1.00 per million Btu in 1980 and $1.25 to $1.50 per million Btu in 1990.

A second broad objective is that energy prices, ex tax, should be set high enough to cover all anticipated costs and to yield, as a minimum, sufficient profits to each energy sector to finance expansion. A lesser profitability means that a portion of the tax component must be put back into the energy sector, which makes the tax component rather meaningless. In the oil industry a further argument could be raised to the effect that profitability should be even higher to provide a surplus cash flow to NIOC to help in financing downstream investments in the international oil industry. This has been characteristic of the industry and it has some merit because these investments can contribute to the long term economic development of the country. This is a suggested possibility that is favorably viewed by the SRI team but it could well be politically untenable and will not be stated as a recommendation. Moreover, it applies only to the oil sector, and there must be consideration given to oil/gas price relationships.

A third objective, which applies primarily to the tax component, is to incorporate a tax--in effect a field or wellhead price--that reflects value in export, as discussed in Part 3 of Volume 5. The value of energy is increasing and Iran is benefitting thereby. It would be a gross error to shield Iran's energy consumers from this worldwide fact. Conversely, incorporating a value in export in the energy prices will yield the following benefits:

- The government will derive additional revenue for economic development.
- Prices will rise gradually. The alternative is a drastic upward revision in a short period, which will take place within the next 10 to 20 years. All oil prices will probably increase by about $4 per barrel, and all gas prices by 5 to 20 cents per thousand cubic feet.
- Prices will reflect relative values of each fuel, ensuring a fuel mix that is in Iran's best long term interests, and could include the introduction of nuclear power and renewed emphasis on hydroelectric power.
- Energy demand will develop consistently with energy value.

A fourth objective in energy pricing is to help in minimizing inflation, which would require that energy prices remain essentially constant. This objective and pricing to reflect value in export are likely to be mutually exclusive. Important as the containment of inflation is, pricing in relation to the value of energy is considered to be of greater importance. The price of energy is one of many components of the economy and is not a controlling factor in inflation. But the value of energy can be of overriding importance in the energy sector. Moreover, there is a great deal of flexibility in the timing of changes in energy prices and the magnitude of the increase at any one time, so that price increases can be effected at times in which the inflationary pressures are the least.

A fifth objective is to establish prices that will minimize the cost of providing energy. Incredible as it sounds, this is possible--and important. There are at least two areas in which this objective can be applied. One area is the well-known middle distillate problem. The last increments of middle distillate supply tend to be quite costly, and gasoline tends toward surplus. If automotive gas oil and gasoline prices reflect costs more closely, the gasoline surplus could be eliminated and the middle distillate problem would be lessened. Lower petroleum refining costs and improved product utilization can also be achieved by offering fuel oil of several different viscosities, each with a different price. The higher the viscosity, the less the middle distillate content and the lower the price. With sufficient price incentive a number of the larger industrial customers would use 700- to 1500-viscosity fuel oil, this has happend in other countries and it can be accomplished in Iran. A final price mechanism that can reduce the average costs of producing middle distillates is to alter the relationship between natural gas prices and the prices of kerosene and gas oil. A more rapid acceptance of natural gas in the residential and commercial market would lessen the demand for middle distillate. No one of the above three pricing changes will solve the problem, but all three would make it possible to build less complex refineries in the future.

The second area is a technique of pricing that lowers costs. This is achieved by offering interruptible industrial gas service at a lower rate than firm industrial service. The effect is to keep the gas transmission line operating at capacity, which reduces unit transmission costs.

There is still another objective in energy pricing that is quite controversial. A frequently recognized objective is that prices should follow costs, which is generally consistent with the avoidance of discrimination. However, Iran's pricing system does not follow costs in a number of ways and for these specific reasons:

- Prices are uniform throughout major regions of the country. Petroleum products are sold at a loss in most of the more remote regions because the transportation costs are so high. The principal reason for this practice is to lessen the relative attractiveness of the Tehran region and to encourage the continued growth of less developed regions.

- Fuel oil prices are uniform, regardless of volume or location. A customer buying a liter a year enjoys the same price as an industrial customer buying a thousand barrels per day, even though the costs differ substantially. Presumably, one of the reasons for this practice is to help small industry.

- Both kerosene and automotive gas oil are taxed at a low rate. Kerosene is probably taxed at a low rate to make cooking and heating fuel available to the poor at the lowest possible price, and automotive gas oil is probably taxed at a low rate to help industry and to provide transportation for the poor at the lowest possible cost.

These motives are difficult to disagree with; however, the practice can lead to problems. For example, if a new source of fuel becomes available in a remote region, such as natural gas in Mashhad, the new source has a difficult time to penetrate the market as rapidly and to the degree it should because petroleum product prices do not reflect costs.

Despite some degree of hardship, a closer relationship than now exists between costs and prices is deemed to be in the long term interests of Iran. If prices were higher in the more remote regions, a greater effort would undoubtedly be expended to lower the costs and therefore the prices. If there were volume discounts on fuel oil, industrial concerns might try harder to increase their orders. Certainly, if high viscosity fuel oil were available at a lower price, more middle distillate would be released for other uses. If kerosene were higher in price, natural gas would capture more of the market more readily. Thus, what seems to be in the interests of the people is often not the case. A cost-based system--with adjustments for value--will in most cases prove in the long term to be in best interests of the country.

In all of the above discussion there has been no mention of marginal cost pricing. This was deliberate because marginal cost pricing does not appear to shed much light on Iran's energy pricing policy. The energy industries operate at capacity on a monopoly basis, i.e., they serve 100 percent of their respective markets and obligated to do so. Their growth is rapid but, despite economies of scale derived from building larger units and more efficient transportation systems, inflation is likely to offset the lower costs that would otherwise be possible. Incremental costs--for expansion--are therefore about equal to the average unit costs that currently prevail. Incremental cost pricing becomes equivalent to a cost-based pricing system.

One last comment on pricing objectives is that prices should be considered as variables rather than as constants. The Institute cannot prepare a fixed program of price changes that should be instituted over the next 10 years. The time has come for Iran to experiment with energy prices, not to extremes but within fixed limits. By doing so, a price system will evolve that will accomplish the desired objectives to the maximum extent possible.

Recommended Overall Price Levels

Petroleum

It may be possible to achieve relatively stable unit costs for petroleum, although this will depend on the degree of inflation in capital goods and construction. At the present time there is no reason to adjust prices because of cost changes, but an annual review of the cost outlook will be needed because of the indeterminacy of future inflation.

The outlook for NIOC's profitability is not so favorable as it should be in relation to (1) the profitability of the international oil industry, (2) the objective of self-financing (at least for a few years), and (3) certainly not the objective (if desired) of a surplus cash flow to help in financing international investments in the oil industry. The average price level should be increased by 5 to 10 percent to attain, on balance, an overall desirable level of profitability.

The government tax on petroleum products (other than taxes to municipalities and income tax) appears to be reasonable, although there is no economic basis for determining reasonableness. The combined government tax on gasoline and automotive gas oil should provide sufficient revenues for an ambitious road-building program. The current tax produces about US$70 million.

The overall average government tax for all products is about $1.70 per barrel. Crude oil has been valued at the cost of production or 10 to 12 cents per barrel, as it should have been, because there has been surplus production capability, with surplus capability foreseen for the long term future and export unit revenue at less than $1.00 per barrel. The government tax has not in any sense represented a value of the crude oil. The tax has instead been a convenient means of raising tax revenues, part of which can be construed as a road tax for expenditures on road improvements. The remainder could be considered for general purposes, although a case could be made that these revenues have been put back into NIOC's capital expansion program for both oil and gas.

Currently, the value of petroleum is changing rapidly. Unfortunately, SRI has not been provided with the essential information to make a judgment on the future trend in the value in export, but a hypothetical estimate has been prepared that may actually prove to be quite realistic. Figure 2 in the last section showed a hypothetical projection of Iranian petroleum reserves, production, reserve life index, and unit export revenue to the end of the century. Production is assumed to peak in the 1990s at 16 to 17 million barrels per day, at which time unit export revenue is assumed to be $4.00 per barrel. Also shown in Figure 2 is the assumed potential market for Iranian crude oil (internal plus export), which is identical to the production curve until the mid-1980s. Thereafter production begins to level off but the market potential continues to increase at a gradually dropping growth rate. By 1990 Iran, if it used no petroleum at all, could instead export the oil and derive $4.00 per barrel in unit export revenue. Thus, by 1990 Iran should be charging its internal use for the same value that it derives in export, i.e., $4.00 per barrel. As explained in Part Three of Volume 5, there is even a value in export that would also be applicable under the above circumstances, which is equal to the $4.00 per barrel in 1990 discounted to the present because the crude now being used internally could instead be held until 1985 to 2000 to be produced. Moreover, a higher price charged for petroleum use internally between now and 1990 would lessen the country's reliance on petroleum, as explained earlier. Total energy use would probably be reduced, and petroleum's share of the lesser total energy demand would be reduced.

The hypothetical value in export, which Iran should charge for internal use over and above all costs, profits, and taxes being charged today, is:

Year	U.S. Dollars per Barrel	Year	U.S. Dollars per Barrel
1971	$0.40	1981	$1.35
1972	0.45	1982	1.60
1973	0.50	1983	1.95
1974	0.57	1984	2.10
1975	0.65	1985	2.40
1976	0.75	1986	2.70
1977	0.86	1987	3.00
1978	0.97	1988	3.30
1979	1.08	1989	3.60
1980	1.20	1990	4.00

The $0.40 per barrel that should be added today compares with $1.70 per barrel of government tax and a total average consumer price of $5.30 per barrel. By 1977, $0.86 per barrel should be added for value in export and, as mentioned earlier, 5 to 10 percent should be added to improve NIOC's profitability--roughly $0.25 to $0.50 per barrel. The total increase over the next 6 or 7 years should be about $1.10 to $1.35 or 20 to 25 percent, which can be accomplished without extreme annual increases if the increase applies to all products. Four 5 percent per year increases applied in 4 of the 6 years between 1972 and 1977 would accomplish this; a 4-percent annual increase would raise the price in 1977 to $6.71 per barrel--an increase of $1.41 per barrel. Or a 3-percent annual increase would increase the price in 1977 by $1.03 per barrel, which is a little under the target but, continued to 1982, would come close to the required increase by then. However, NIOC needs revenue in the short term; there have been no price increases for a long time and there may be years in which it will be desirable to avoid price increases. It therefore seems advisable to increase the prices by 5 percent as soon as possible and to increase the prices another 5 percent a year later. Thereafter, the prices could be increased by 3 or 4 percent per year, and an increase could be avoided occasionally. However, it should be emphasized that the above is hypothetical and needs to be re-evaluated using the most realistic data available.

Applying the increase to individual products will be considered later.

Natural Gas

The prices for natural gas service do not need much, if any, adjustment because of costs, profitability, or taxes. However, as discussed in Volume 5, Part Two, the attachment fee for residential and commercial service should be eliminated or reduced and should be offset by an increase in the residential and commercial rate. The value in export was also discussed in Volume 5 but, as with the above analysis on oil, a hypothetical projection will also be made below for natural gas.

Figure 3 in the last section showed the hypothetical trends of reserves, total gas produced, total gas flared, and net production for use purposes--both internal and export markets. There is no value in export for Sarakhs gas, and there is no value in export for gas that would otherwise be flared. At least through the 1970s there is no value in export that should be applied to internal consumption, and it may well be the late 1980s before there is a value in export, if then. This will depend heavily on the amounts that can economically be reinjected.

Through 1977 there should be no increase in gas price for value recognition. If the Sarakhs field contains sufficient gas to support a pipeline to Tehran, there should be no increase in gas prices for value; if the Sarakhs field does not contain sufficient gas, it is still doubtful that a value tax should be applied because export markets for LNG will not develop to a sufficient extent that rapidly. At some point in the mid- to late 1980s the value in export of about 20 cents for thousand cubic feet might develop ($1.00 per barrel equivalent, one-third to one-fourth the export value for petroleum). However, productive capacity in 1990 still may be far in excess of likely actual production (in Figure 3 it was assumed to be 5 times greater), in which case the value in export may still be quite low.

Electricity

The rates for electricity are relatively high, and MWP has enormous problems in meeting future demand as well as in upgrading or replacing existing facilities that are inadequate. It appears that income tax payments can commence by about 1977 and profitability will be reasonable; i.e., the industry should be able to self-finance its replacement and expansion program.

However, unless electric rates are increased, it is extremely doubtful that a government tax (other than income tax, value tax, and municipal tax) like the tax on oil ($1.70 per barrel) can be applied. Gas should also be in a position by the late 1970s to pay a tax of more or less comparable magnitude. There is no conceivable reason why electric power should not also pay such a tax. The tax component of the power plant fuel purchased is quite small; electric power is of no greater importance to the economy or to long range economic development than oil or gas. Its availability for industry is essential, but so are oil and gas. Sometime in the late 1970s a government tax should be applied to electricity.

For the next five years electric rates should remain at about the same level; they should definitely not be reduced. In the 1977 to 1982 period some upward revision is likely, with a government tax averaging several mills per kilowatt hour being added. This amount of tax would be equivalent on an absolute basis, not as a percentage of total revenue.

Product and End Use Prices

Petroleum

The components of petroleum product prices were shown in Table 39 of Volume 1 and in Part One of Volume 5. The obvious conclusion to be drawn from these data is that the prices do not follow costs; in fact, the departure is extreme. The total costs for each product--cost price at refinery gate, transportation, cost of containers, and distribution--vary from a low of $1.87 per barrel for fuel oil to a high of $2.74 per barrel for gasoline, super grade, which is 50 percent higher than the cost of fuel oil. Present sales prices, however, vary from a low of $2.43 per barrel for fuel oil to a high of $15.70 per barrel for gasoline, super grade, which is 650 percent of the fuel oil price. Also, the tax component and the profit taken on each product vary enormously, creating the distortion in prices compared with costs. The increasing sequence by product of prices does not even follow the product sequence of costs; i.e., some products that have higher costs are actually priced below others that have lower costs.

If taxes and profits were assigned to each product in proportion to its average cost so that prices actually followed costs (i.e., were in proportion to costs) with the total taxes and profits derived equal to the total derived with the present system, the results would be as shown in Table 9. A comparison of cost-based prices with present sales prices is also given; the differences are striking. Under the cost-based price system, the price of fuel oil would be $4.44 per barrel (about 80 cents per million Btu), almost twice the present price, and the highest price would be $6.49 per barrel for gasoline, super grade, less than half its present price. The changes are extreme, and they appear to conflict with other objectives as well as to be politically awkward for these reasons:

- Assigning refining costs to each product entails many imprecisions, but most other cost components can be identified rather closely. There is a margin of uncertainty in the overall cost estimates, but since refining costs are only a portion of the total costs, the total costs can be identified with fairly good precision.

- To the extent that low industrial fuel prices contribute to economic development, the high fuel oil price would work against the single most important objective in energy pricing, namely, its contribution to long term economic development.

Table 9

COMPARISON OF COST-BASED PRICING SYSTEM WITH PRESENT PRICES FOR PETROLEUM PRODUCTS
(U.S. Dollars per Barrel)

Product	Market Share* (percent)	Costs	Taxes and Profits	Sales Price	Present Sales Price	Present Price Higher (Lower)
Fuel oil	30%	$1.87	$2.57	$4.44	$ 2.43	($2.01)
Gas oil	29	2.07	2.83	4.90	5.00	0.10
Gasoline regular	12	2.44	3.34	5.78	12.60	6.82
Jet fuel	2	2.52	3.45	5.97	7.08	1.11
Kerosene	23	2.54	3.48	6.02	5.30	(0.72)
Bitumen	5†	2.57	3.52	6.09	4.85	(1.24)
Gasoline super	‡	2.74	3.75	6.49	15.70	9.21
Weighted average		2.22	3.04	5.26	5.26	0

* Of total petroleum
† Includes all other products.
‡ Included with gasoline regular.

Source: Stanford Research Institute.

- Assuming a rapidly increasing supply system for natural gas, gas would displace fuel oil in the industrial and commercial sectors in all regions served by gas. The displacement of fuel oil would be so pronounced that refinery yields of fuel oil would have to be low, thus increasing refining costs. This tends to defeat the objective of a pricing system that minimizes costs.

- Gasoline might become so popular in preference to gas oil that, instead of a surplus, gasoline could tend toward a short supply. It could be claimed that this would also raise refining costs, but relatively more offtake of gasoline and relatively less of gas oil from Abadan would readily meet this change with no higher cost of refined product supply.

- Jet fuel price is really established by international pricing; this price should definitely remain where it is. In the future, the international price is certain to increase and Iran's price should increase along with international prices.

- The price change suggested appears to hurt the low income group by increasing kerosene prices 13 percent and to help the high income group by lowering gasoline prices to less than half the present price. Actually, however, almost everyone uses kerosene, and the high income group uses more than the low income group. Up to a point the total annual taxes paid by purchase of kerosene is a function of personal income. Would a 13-percent increase in the price of kerosene make it impossible for the less affluent to use kerosene? Almost certainly not, although the amount used might change. Kerosene price has been constant for a long time and demand for it has grown rapidly in all regions. The need for the fuel far outweighs the importance of any single price level.

Decreasing gasoline prices will undoubtedly create political difficulties, but the fact is that car ownership in most cases is no longer a luxury, but a necessary part of the living and working conditions brought on by modern civilization. A large sector of the population own cars and the proportion is increasing rapidly. Moreover, a relatively large proportion of those owning cars have relatively low incomes. Taxing gasoline far more heavily than other products has extremely little logic behind it today; it is a carryover from the early days, when only the wealthy could afford an automobile. Finally, the taxes derived from the annual gasoline consumption are literally unimportant in relation to income taxes.

If the cost-based pricing system were to be put in effect (except for the price of jet fuel), quite a few changes would take place over a five- to ten-year period. First, there would be considerable pressure to reduce the cost of fuel oil because the fact is that natural gas would proceed to increase its sales at only so fast a pace. The petroleum industry would be concerned with its long term position and would lower costs as much as possible, and industrial customers would exert great pressure to have prices reduced. And costs would be reduced in at least two ways: customers would be willing to use the higher viscosity fuel oil if the price were lower; and by 1978 to 1980 the output from localized refineries in Shiraz, Esfehan, Azarbayejan, and Khorasan would drastically reduce fuel oil transportation and distribution costs.

A second change brought about by the cost-based pricing system would be a gradual increase in gasoline's share of the transportation market at the expense of gas oil's share. Gasoline engines cost much less than diesel engines and, if there is not much difference between the price of gasoline and that of gas oil, except for the largest trucks the gasoline engine vehicles would capture a large share of the new market.

A third change, attributable as much to increased prices caused by value taxes as to the adjustment being discussed, would ultimately be an increased acceptance of gas for residential and commercial use. It will probably be in the 1977 to 1982 period before NIGC is in a position to maximize its efforts on residential and commercial sales, but by 1982 the SRI basic gas projections could still be achieved.

The net effect of cost-based pricing on costs and market shares is shown in Table 10, which reflects conditions at some time between 1977 and 1982 except that price adjustments for value and for improved NIOC profitability have not yet been added. LPG has been included--it should be taxed just like any other petroleum product. Jet fuel has been priced at the present level, reflecting international conditions rather than costs. The features of the cost-based pricing system and the resulting product mix are:

- The overall fuel oil percentage drops somewhat because natural gas increases its penetration of the industrial and commercial market.

- The gas oil percentage drops and the gasoline percentage increases because there is only about 2 cents per gallon difference between gas oil and regular gasoline. Premium gasoline

Table 10

APPROXIMATE COST-BASED PRICING SYSTEM FOR PETROLEUM PRODUCTS AND RESULTING PRODUCT MIX
(U.S. Dollars per Barrel)

Product	Product Mix (percent)	Costs	Taxes and Profits	Sales Price	Present Sales Price	Present Price Higher (Lower)
Fuel oil						
2000 vis	2%	$0.80	$0.40	$1.20	$ 1.20	0
800	6	1.30	1.20	2.50	2.43	(0.07)
400	8	1.60	1.60	3.20	2.43	(0.77)
200	7	1.87	2.33	4.20	2.43	(1.77)
Gas oil	26	2.07	3.25	5.32	5.00	(0.32)
Gasoline regular	13	2.44	3.80	6.24	12.60	6.36
Jet fuel	3	2.52	4.56	7.08	7.08	0
Kerosene	20	2.54	3.30	5.84	5.30	(0.54)
Bitumen*	5	2.57	3.60	6.17	4.85	(1.32)
Gasoline super	6	2.74	4.70	7.44	15.70	8.26
LPG	4	1.10+	1.50	2.60	1.10	(1.50)
Weighted average		2.13	3.03	5.16		

* Includes all other products.
\+ At the refinery gate.

Source: Stanford Research Institute.

sharply increases its share of the gasoline market because there is only 3 cents per gallon difference between regular and premium.

- A tax is added on LPG because there is no reason to exclude it from taxation. The tax is collected on the refinery price and increases the consumer price a little more than 10 percent.

- The gas oil price is increased about 6 percent and the kerosene price is increased about 10 percent.

- A viscosity-adjusted price for fuel oil takes account of lower costs for higher viscosity (and lower costs for volume, which will also generally be higher per customer, the higher the viscosity).

- The taxes and profits applied depart to a relatively small extent from a straight cost basis but certainly far less than today's taxes and profits.

- On the whole the product mix is somewhat improved. Refining costs would be no higher and might be slightly lower.

- Some grades of fuel oil--and natural gas industrial service--would be available at low enough prices to foster industrial development.

The above adjustments to produce an essentially cost-based pricing system have not taken into account the adjustments discussed earlier to improve NIOC's rate of return and to add a tax for value in export. Over $1.00 per barrel should be added to the average price by 1977 to account for these two adjustments and about $1.00 per barrel additional between 1977 and 1982. Most of this increase is based upon the hypothetical analysis of value in export made earlier, but it is assumed that this hypothetical analysis will prove to be quite realistic. If not, then the evolution of prices should later be adjusted to incorporate more realistic projections of value.

Table 11 incorporates the adjustments for improved NIOC profitability and the hypothetical value in export for 1977 and 1982 but still retains a pricing system that is essentially cost-based. Only gasoline prices drop; all other products would have to be increased in price. Possible year-by-year trends are shown in Figure 4, which alters the

Table 11

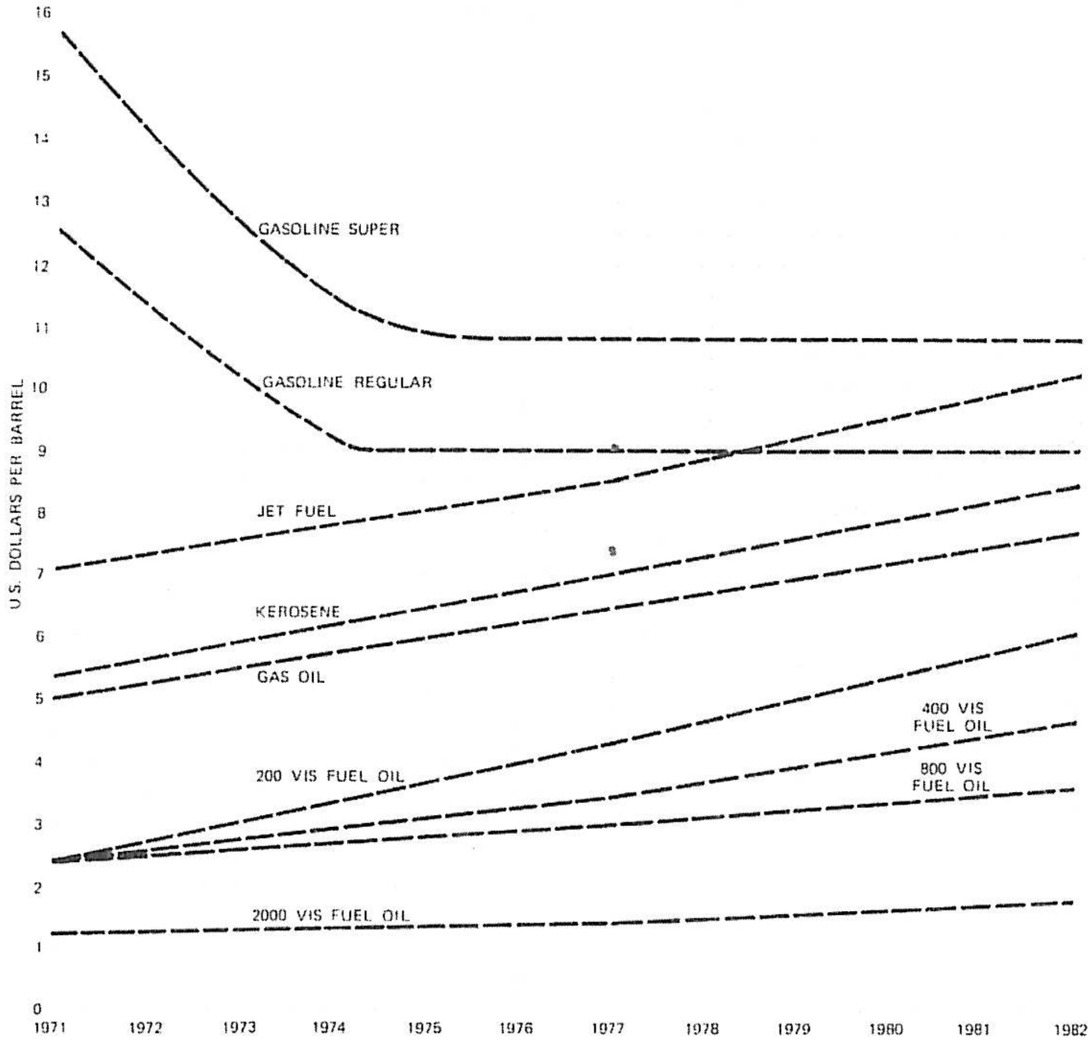
PETROLEUM PRODUCT PRICES IN 1977 AND 1982 REFLECTING ALL RECOMMENDED ADJUSTMENTS
(U.S. Dollars per Barrel)

Product	Present Price	New Pricing System Without Value Adjustment	1977 Pricing with Value Adjustment	1982 Pricing with Value Adjustment
Fuel oil				
2000 vis	$ 1.20	$1.20	$1.44	$ 1.73
800		2.50	3.00	3.60
400	2.43	3.20	3.84 (3.44)*	4.60
200		4.20	5.04 (4.30)*	6.05
Gas oil	5.00	5.32	6.38	7.66
Gasoline regular	12.60	6.24	7.49 (9.00)*	9.00
Jet fuel	7.08	7.08	8.50	10.20
Kerosene	5.30	5.84	7.00	8.40
Bitumen	4.85	6.17	7.40	8.88
Gasoline super	15.70	7.44	8.93 (10.72) *	10.72
LPG	1.10	2.60	3.12	3.74
Weighted average	5.24	5.16	6.19	7.43

* These are more realistic prices for 1977, considering more practical long term adjustment.

Source: Stanford Research Institute.

FIGURE 4 SUGGESTED PETROLEUM PRODUCT PRICE TRENDS, 1971-82



SOURCE Stanford Research Institute

1977 prices in some cases to some extent to provide for more feasible annual price increases or, in the case of gasoline, to avoid lowering the price to 1977 to such an extent that some of the reduction would then be revoked in the ensuing 5-year period.

Most of the 1977 and 1982 price targets can be achieved with no more than a 5-percent annual increase. However, 400-viscosity fuel oil requires an annual increase of 7 percent, 200-viscosity fuel oil target requires an 11 percent annual increase, and LPG requires a major increase in price at the refinery but would mean only a few percent annual increase in consumer prices.

The most difficult situation would be experienced with 200-viscosity fuel oil, yet this is one of the most important changes to be made. Moreover, since other grades of fuel oil can be made available at lower prices, with a more reasonable price increase it should be politically possible to effect this adjustment even though above 5 percent per year is needed. Two-hundred-viscosity fuel oil is such a high quality fuel oil and contains so much middle distillate that it should be much closer in price to gas oil than it has been. But for those who want to use 200-viscosity fuel oil, it would still be 20 to 30 percent cheaper than gas oil. Considering the types of customers that would still want to use 200-viscosity fuel oil, there can certainly be no claim that the proposed price would be any obstacle to their contribution to the long term economic development of country.

Undoubtedly, the proposed pricing will be strongly objected to. Any system that proposes such substantial increases will be disliked. However, most of the increases are attributable to value in export, and this increase is crucially important. Deferring the recognition of value in export will ultimately create an enormous problem in trying to adjust prices rapidly, and there will still be irrevocable losses. The increases will contribute to the long term economic development of the country rather than work against it.

If it is felt that the proposed increases will add to inflationary pressures to too great an extent, then offsetting adjustment can be made. By 1982 the average per barrel tax and profit will exceed $5; the total tax and profit will exceed $1 billion. The total tax generated by all the energy industries will be $1 to $1.5 billion. If fighting inflation is of overriding importance, there will probably be sufficient government revenue to reduce some other tax rates. Reductions should coincide with the energy price increases and the purpose of the increases and the reduction should be well publicized. It would be a great error to hold energy prices constant as one means of battling inflation. The populace should not continue to use energy as though it were going to be cheap forever, totally immune to international and domestic inflation and to changing supply-demand relationships.

The strongest objection may be to lowering the price of gasoline, which has been proposed as part of the cost-based system and is designed to create a more logical gas oil, gasoline price relationship that will help ease the middle distillate problem and absorb the surplus gasoline. It is infeasible to accomplish this by holding the gasoline price at the present level and raising the gas oil price by 100 percent or more. The objection to the price reduction for gasoline will likely stem partly from the tax men's adage, "Never lower a tax rate," and partly from the age-old concepts that gasoline demand is inelastic, that there is no competitive product, that automobiles and automobile driving are a luxury rather than a necessity, and therefore that gasoline should be taxed to the hilt. The fact is that virtually all components of energy demand are inelastic, and the world over the next 20 years will likely be testing for the point at which rising prices may lead to elastic behavior. There is absolutely no reason to single out one product and one use to which to apply the major tax (and profit) burden, particularly when such application leads to the product imbalances that have been created in Iran.*

If it is determined that gasoline prices should not be reduced, then the price rise for some of the other products can be lessened somewhat. An infinite variety of price relationships and price levels can be developed once arbitrariness is decided on, although objectives such as "aiding the poor" can easily be cited.

Still another objection may be that the petroleum product prices for industrial and residential and commercial markets become too high in relation to natural gas prices. If there were aggressive competition between oil and gas, this would be true. But presumably gas expansion will be geared to some rate that will not be damaging to oil. Of course, the intent of the value in export tax is partially to adjust over the long term the relative reliance on gas and oil with comparative values fully reflected. Even so, oil demand growth will still be rapid, and oil will still have the major market share of total energy even 20 years from now.

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* There is an exception to this because of the need for tax fund for road building. However, the tax should be uniformly applied to all automotive products, i.e., to gas oil as well as to gasoline.

Natural Gas

The pricing situation for natural gas is much less complex than that for oil, and major changes in gas rates over the next ten years do not appear to be necessary.

It was shown in Volume 5, Part Two, that the profit on industrial gas sales was likely to be far greater than on residential and commercial sales. A cost-based pricing system would call for a reduction in the industrial rate and an increase in the residential and commercial rate. The latter is certainly most desirable and, with the price increases proposed for gas oil and kerosene, there should be no problem with consumer acceptance--providing the initial cost is eliminated or greatly reduced. The attachment fee, deposit, cost of piping within the dwelling, and cost of appliance conversion and/or new appliances becomes staggering. The fees for new electric service are also high, but people literally have to use electricity whereas they do not have to use gas. The use of gas oil or kerosene can still suffice.

Considering the proposed increases for fuel oil, it would hardly make sense to lower the industrial gas rate. However, an interruptible industrial rate, much lower than the present rate, is justified and should be offered by 1975.

The present residential and commercial rate schedule provides for lower rates with increasing annual usage per customer, but in effect all residential customers will pay the same rate. The present rate is the same for annual usage between zero and 423,800 cubic feet per year. The average residential usage per customer is expected to be no more than 125,000 cubic feet per year even in 1982, and the maximum residential usage of 423,800 cubic feet per year could be exceeded only by a few very large homes. Since the unit cost of service per customer is definitely a function of the magnitude of customer usage, there is a great deal of merit in having a rate schedule that provides for a variation in the unit charge as a function of residential usage.

There is no precise way of preparing a rate schedule that reflects costs, and as a result there is quite a variation in rate schedules around the world. Other schedules provide for a minimum monthly charge plus a varying rate, depending on volume; in effect, this is somewhat comparable to the demand and commodity system. Still other schedules simply vary the rate with volume.

Developing a system for determining the volume-rate relationship is not too easy and, since precision is not possible, there is little to be gained by making a complex analysis. There are many texts on rate-making principles and therefore such material will not be repeated here. The following recommendations are intended solely to correct for two present problems: too low a residential and commercial rate and no variation in the residential and commercial rate as a function of volume used. The proposed rates shown below are for the Tehran region; a comparable variation as a function of volume would also be applicable to the other regions:

Annual Usage (thousands of cubic feet)	Present Rate	Proposed Rates (cents per thousand cubic feet) 1972	1977	1982
0-10.99	83 ¢	100 ¢	110¢	121¢
11-30.99		92	101	111
31-99.99		86	95	105
100-423.8		83.0	91	100
423.8-4238.4	75.5	75.5	83	91
Over 4238.4	68.0	68.0	75	83

The average rate would in cents per thousand cubic feet increase as follows:

	Residential	Commercial
Present	83¢	75¢
1972	88	75
1977	97	82
1982	105	90

The average rate would increase gradually, hopefully attaining a level that would provide reasonable profit on residential and commercial sales. This activity is so new in Iran that it is difficult to project costs and profitability by sector at this time. As experience is gained in the residential and commercial sector, costs should be evaluated and the rates revised accordingly. They should follow the above trend but may well depart from it to some extent.

The declining rate with increased volume is important because it will encourage complete conversion to natural gas by each customer. For the last portion of the residential grid (which amounts to about half the cost of the total grid), the capacity (and therefore the costs) are set to meet the peak conceivable loads for the long term future. The total costs for the last part of the system are therefore unaffected by the magnitude of customer usage as are most of the distribution expenses; hence the unit costs at 10,000 cubic feet per year are much higher than at 100,000 cubic feet per year. The cost variation is more extreme than indicated by the above variation in proposed rates, but not so extreme as might appear to be the case because the heating load has such a poor load factor. However, on a cost basis the rate for the first 10,000 cubic feet per year could be set as high as $1.50 to $2.00 per thousand cubic feet.

Electricity

The electric rates were discussed in Volume 4. A major review of the rates should be made within the next year or two when better cost and market data become available. However, if rates are revised, the average should not be reduced until the electric power industry is in a position to pay taxes to the same relative extent as NIOC, (except for a value tax). Electricity is of no greater importance than oil or gas to the well-being of the populace, industrialization, or general economic progress. Iran is essentially an oil-based economy and it should depart from the international practice of taxing electricity to a much lesser degree than oil.

The regional variation in electric rates is in considerable contrast to the uniformity of oil prices. Steps should not be taken to make electric rates uniform throughout the country but should be set to follow costs, or approximately so.

The relationship among residential, commercial, and industrial rates appears to be reasonable, but it is impossible with the data available to determine if the rate relationship is consistent with the cost relationship.

The industrial rates appear to be reasonable and are likely to become more and more attractive in relation to international standards because electric power rates in most of the world are expected to increase substantially over the next 10 to 20 years.

V ORGANIZATION AND CONTROL OF THE ENERGY INDUSTRIES

The organization and control of Iranian energy industries is a difficult and sensitive subject, yet it is obvious that improvements can be made in the system. The discussion herein will concentrate on the problem strictly from an economic and functional aspect. There may be sound reasons for having the system depart from such a restricted basis and the system may actually work better with such a departure. But certainly the current system does have problems, many of which should be resolvable.

The energy industries today and the organizations that control them are:

Electricity - MWP, wholly owned by the government.

Petroleum - NIOC, wholly owned by the government.

Gas - NIGC, wholly owned by NIOC.

LPG - Produced by NIOC but marketed by private companies as well as by NIGC.

Production of petrochemicals, which is not strictly an energy industry, is handled by NIPC, which is also wholly owned by NIOC.

The private sector handles most of the road transportation and distribution of petroleum products and owns most of the market outlets for gasoline, gas oil, and kerosene. The private sector also produces and markets a portion of the lube oil. However, the private sector has not been permitted to participate in the energy industries to create competition; basically, there is no competition and competition is not encouraged even among the different sources of energy (gas, oil, and electricity). There is no over-investment; all facilities operate at or close to capacity except for the tank trucks, which have been underutilized.

No foreign oil companies operate in Iran in an integrated sense; i.e., they are limited to the exploration and production phases of the business. It appears that the country will likely have available sufficient capital to meet the growth in energy demand without inviting foreign company participation, and it is extremely doubtful that there will be foreign company participation to any greater extent than exists today, if even as much, and then only in exploration and production. Iran is an "energy country" and should endeavor to do everything possible itself in this field, with an aim to being more competent in energy matters than all other organizations. Thus, it is difficult to visualize any greater role of any advantage to Iran from increased participation by foreign companies, and it is also difficult to visualize any greater role for the private sector in the energy industries.

Should oil, gas, and electricity be encouraged, or even permitted to compete vigorously by means of advertising, promotional rates, premature installation of facilities, or other means? Probably not. The theory of promotional rates is to build load as rapidly as possible, thereby achieving maximum possible economy of scale and reducing costs as rapidly as possible. Since the growth rate for all forms of energy is already very high and all the companies are hard pressed to meet the growth in demand, there is no point to attempting to grow even faster by capturing loads that would be gained in any case 5 or 10 years later. Similarly, there is no point in advertising, although advertising of not too repetitive a nature on the availability and cost of various services should be permitted.

There is a school of thought today that believes electricity should not be allowed to serve the energy-intensive uses such as space heating and water heating that other fuels can handle, because electricity requires a much greater use of primary fuel than does oil or gas to accomplish the same purpose. However, the Institute believes that if some consumers prefer electricity for space heating or water heating and are willing to pay for it, the electric utility should be allowed to serve these customers within capacity limitations. As a practical matter, there will be extremely limited acceptance in Iran of electricity for space heating and water heating over the next 10 to 15 years. Within 20 to 30 years direct energy conversion, with efficiencies of 60 to 70 percent, will be commercially available, and at that point electricity will require no greater fuel input for the same purpose than gas or oil. But, conversely, there is no justification for promotional rates (or extensive advertising). The rate for electric heating should cover all allocable costs, full profit realization, and taxes (when the electric sector is in a position to pay taxes).

The individual sources of energy do not have to compete; on the other hand, each sector should pursue its market potential vigorously, at the lowest possible cost, and with satisfactory service because it is in the broad interests of Iran to do so. Rather than compete, the oil, gas, and electric sectors should jointly plan for future facilities to a far greater extent than is practiced today. There should be a planning committee or frequent meetings with a planning director, and a complete exchange of all pertinent planning documents including feasibility studies, long range plans, fuel selection, proposed price changes, and so forth. NIOC, NIGC, and MWP should cooperate to the fullest extent possible, and the primary point of cooperation is in the planning stage up to the point of final recommendation of facilities. However, there are bound to be irreconcilable differences of opinion from time to time; the desirable procedure at that point will be discussed shortly.

NIOC needs a strong, central, long range planning group to coordinate the planning within the distribution, refining, and pipeline departments and also the export planning activities. NIGC's planning activity is probably much less complex than NIOC's, but the principal drawback to NIGC's planning is that the time horizon is much too short. Considering the time required to gain approval for major facilities, arrange financing, select contractors, and complete facilities, detailed plans should be prepared for a 10-year period ahead; currently, generalized plans for at least 20 years ahead are proving to be essential for many decisions. MWP is still quite new at long range planning; its central planning should be strengthened and highly capable outside assistance should be retained for a period of several years.

One of the most difficult questions to face is whether the present industry structure is satisfactory. In this regard, there are two main questions:

- Is NIGC to remain indefinitely a part of NIOC?
- Should MWP combine two dissimilar functions, one of which is not energy oriented?

NIGC is still relatively new and small and has needed (and received) the assistance of NIOC. However, there is virtually no overlap of functions or personnel; the mutuality of interests is solely in the marketplace in that oil is completely substitutable for gas. The latter is actually justification for complete separation of the two companies, because NIOC should not have the final authority as to the desirable gas/oil market share. NIGC should be free to make its own independent recommendation (which it appears to have done to date--but may conceivably be unable to do at some point in the future).

As for MWP, there is little commonality to water and power. The only real overlap is in meter reading and collection, which hardly justifies the two as a single department. Water should be combined with sanitation or municipal services in general, and electric power should be a single entity. Electric power has a tremendously difficult task ahead, with a capital expenditure requirement larger than NIOC's and NIGC's combined. The Ministry should be free to concentrate on the electric power problems and for consistency should probably become a company; e.g., National Iranian Electric Company (NIEC).

Within NIOC there is some pressure for making each group a separate company, still owned by NIOC but separately operated. Thus, distribution would be operated as a separate company, as would refining, pipeline, and exploration and production. Certainly each function is quite distinct and in some cases is much larger than NIGC--which is a separate company. Moreover, if each company were a separate profit center, there could be a greater incentive to control costs. Aligned against such reasoning are the lack of precedent throughout the world for such a structure; the problems inherent in establishing reasonable transfer prices of crude end products between companies; and the close liaison required--literally on a daily basis--among the companies in scheduling and in planning. Operating as separate companies would tend to increase the problems of planning and coordination rather than to decrease them. Although each of the oil company functions is quite distinctive, they are all concerned with the same product, petroleum, as it moves from sources to the end consumers.

Forming a separate company for each oil function would be premature today. The development of profit centers is a necessary first step that should be completed and tested before action on the formation of companies is undertaken. In-depth studies of the advantages and disadvantages of separate companies should also be conducted, and a final decision on the question should be made after completion of these studies and the testing of the profit centers, probably in one or two years' time.

The most difficult question to face is control of the energy industries or whether, in fact, any control is even needed. At the present time control is exercised largely by the Plan Organization, primarily in terms of approving capital expenditures, with some form of continuing control throughout the capital expenditure period. Prices of all forms of energy are established by the Government. The procedure for changing prices is not clear but is apparently extremely cumbersome and inevitably the High Council of Ministers is probably involved. In a sense this is also true of capital expenditure appropriation requests, because literally any Minister seems to have the power to challenge the appropriation and hold it up indefinitely, and to suggest an alternate plan for facilities.

The impression gained during the Institute's study is that all the energy sectors seem to feel that the approval mechanism is a "bottleneck" that prevents timely completion of needed facilities and serves no useful purpose. Each of the sectors appears to want complete freedom to decide upon the facilities they want and to proceed immediately to obtain those facilities without having to obtain any approval outside their own organization.

In one sense, Plan has been a bottleneck. Capital has been extremely tight, and there have undoubtedly been deliberate delays in approving capital expenditures to strain all existing facilities to the maximum extent possible and to minimize the overall level of expenditures. This is a distasteful but necessary role that some organization must serve when capital is tight. The fault is not Plan's; it has been a shortage of capital to meet all the demands of an economy that is growing extremely rapidly. However, sufficient capital should be available for the next 10 to 20 years, and it should be possible to minimize or eliminate the deliberate delays caused by capital shortages.

In another sense, Plan has been a bottleneck because the planning information and feasibility studies furnished Plan have been inadequate. All the energy sectors have been strained to the hilt with the day-to-day problems of meeting the burgeoning demand for energy. The complex, integrated basis of projected energy demand by region, end use, type of fuel, comparative unit costs by function, and other essential information has not been available until recently. Now that this information is available (although there are still some gaps) complete economic feasibility studies can be prepared more readily, with a full comparison of alternatives. Moreover, Plan can act on these studies more readily because of the availability of information and the quality of the studies that are now feasible to prepare.

As for each energy sector being completely free to invest in facilities without gaining any outside approval, there are very few organizations in the world that have the freedom that these sectors would then enjoy. Most organizations are constrained by a combination of competition and boards of directors that are heavily engrossed in profitability considerations. When the organization has a monopoly position, there is generally a regulatory agency concerned with rates, facilities, and many other questions. Only in diamonds, nickel, and a few other commodities have monopolies without regulation been enjoyed, and these situations generally lead to inadequate supply, high prices, and high profits, which is wonderful for the organization but does represent an imbalance between the interests of the organization and all the other interests of the country or the world.

Since each of the energy sectors enjoys a monopoly, some form of control of these sectors is recommended. The need for this control is emphasized by the honest disagreements likely to emerge among the energy sectors as to the facilities that should be built. If each sector were free to invest its cash flow as it desired, possibly MWP would proceed to build a nuclear plant and more hydroelectric facilities, NIGC would build another transmission line to Tehran, and NIOC would avoid isomax units in its refineries and maximize its output of fuel oil. Whereas uncontrolled monopolies outside Iran tend toward undersupply, the situation within Iran would tend toward overinvestment and oversupply.

There are several possibilities for achieving this control. There have been suggestions in Iran as well as in other countries to have an overall head or "czar" of energy in the government to ensure a coordinated approach to all energy problems. The achievement of a coordinated approach is appealing. However, in Iran it would undoubtedly continue to be necessary to obtain approvals from Plan for all capital expenditures--this is probably a requirement by law. Having an energy "czar" would then add another level of bureaucracy and would surely create an additional bottleneck and strained relationships. The advantage of a coordinated approach would be more than offset by the disadvantages. Moreover, Plan can, if it is strong enough, lead the energy sectors into achieving a coordinated approach.

An extreme example of creating an energy "czar" is to transfer the electric power sector to NIOC and to keep NIGC as a part of NIOC. The head of NIOC would then have complete responsibility for all the energy sectors. This, it seems, works against logic and encourages unnecessary concentration of power. As stated earlier, oil, gas, and electricity have almost no common functions or joint use of personnel. The primary overlap is in the marketplace and the control of the trend in market share--within obvious limits--is dictated by the facilities made available (and by relative prices). So long as outside control is exerted by Plan, there is literally no overlap and there is no logic behind having the oil, gas, and electric sectors under common ownership or, as stated earlier, even having oil and gas under common ownership. A coordinated approach to planning should be achievable by the three sectors without having common ownership, but if they fail to achieve such an approach, it becomes Plan's responsibility to see that, in effect, an overall plan is accomplished. If it is left to Plan, the three sectors must realize that the time required to gain approvals will lengthen considerably.

Another suggestion has been to accomplish coordinated planning and approvals through the Energy Council, which consists not only of representatives from the three energy sectors and Plan, but also from the various Ministries. The Council suffers from several unavoidable problems: (1) the three energy sectors are or should naturally be reluctant to drag all the other branches of government into their business, (2) there are literally too many members to be effective, and (3) most of the members offer too little energy expertise to apply to the problems at hand to play a constructive role.

The Institute recommends a strengthened Plan organization role in exercising control over the energy industries. Plan's responsibilities and procedures should include the following:

(1) Plan should evaluate proposals for capital expenditures. It should have complete access to all pertinent data, information, reports and the like. Plan should, on receipt of each proposal, establish a review period, the length of which will depend on the complexity and controversiality of the problem. Simple proposals should take no more than a month to review; the most complex proposals should require no more than three or four months. Plan should invite comments from the other energy sectors and from the Ministries, and these comments, in writing, should flow into Plan. Plan should prepare a written, overall critique of all the material received from all sources, which should be made available to all parties. If the appropriation request is denied or an alternate plan is proposed that is unacceptable to the originator, a written rebuttal should be prepared by the originator--and other organizations desiring to do so--and submitted to Plan within a fixed period of time. Plan should then make its final decision, again in writing.

If everything is in writing, the risk becomes substantial. Plan's responsibility and risk becomes substantial, but then the risk of all parties submitting recommendations in writing is quite sobering because a record should be maintained and evaluated from time to time in the light of subsequent events.

Ultimately, the energy sectors can make Plan into a "rubber stamp" in granting approvals to investment appropriations request by submitting such sound and thorough studies that all the options are covered and the most economic solution is clearly identified. This will require a coordinated approach to planning by the three energy sectors, which is the ideal ultimate objective. A number of years will undoubtedly be required before the three energy sectors attain such competence and cooperation.

(2) Plan should encourage a coordinated approach by the three sectors to the planning of facilities.

(3) Plan should continue to conduct or sponsor original studies in the absence of evidence that the pertinent energy sectors are failing to do so. In Volume 1 the Institute recommended a number of studies to be conducted; Plan should be responsible for determining if the energy sectors are doing this research (to the extent that Plan agrees that the research is necessary), and if not, Plan should conduct or sponsor the studies themselves.

(4) In the future, energy prices should be reviewed more frequently. Energy is rapidly becoming increasingly valuable throughout the world and this fact will ultimately affect Iran. Some government organization should receive reports from each of the energy sectors on costs, profitability, and taxes, as well as the recommendations for changes in prices. Since Plan must delve into many of the pertinent subjects in evaluating investment proposals, it seems logical that Plan should also review the material on pricing submitted by the energy sectors and prepare a written, overall recommendation on changes in prices. Final decisions on price changes will undoubtedly be handled by top government circles.

(5) The Institute's study has been restricted to internal energy matters and it can only raise the question of how much and what kind of control there should be on strategy and investments relating to energy exports. Because of the capital that is likely to be available for this purpose, careful consideration should be given to this question. It is not suggested that Plan be given this responsibility; this is one of a number of alternatives.

Unfortunately, Plan Organization has many internal problems, which are beyond the scope of this study. But Plan itself urgently needs extensive research on objectives, policies and procedures, planning, management information system, organization, and so on. Until this work is completed and changes are implemented, Plan's effectiveness will suffer. If the country is to grow indefinitely at 10 or 11 percent per year, this key organization must be drastically modernized.

VI PERSONNEL REQUIREMENTS

Introduction

As was the case with data on energy reserves, the Institute was unable to obtain useful information on personnel requirements despite a number of requests for such data. A quantitative appraisal is therefore not possible, but a number of pertinent general observations are made, followed by a consideration of each energy sector.

The universal employment situation in the energy industries appears to be one of overemployment of nonskilled workers and underemployment of professional personnel. The most competent professionals generally carry too much responsibility and are overworked (although such people tend to overwork themselves, regardless of the availability of other professionals).

As sales and revenue increase, every effort should be made to hold the level of unskilled workers at or close to the present level as long as possible. The number of professional personnel should increase at least as rapidly as total sales. To attract competent personnel, the salary levels for such people should be increased substantially. If salaries are not increased, the energy sectors are unlikely to be able to retain many of the professional personnel that they have today.

A number of individual and group consultants are used on a semipermanent basis. It would be most unwise to dismiss these people prematurely. It is most essential to have a properly installed and operating energy system--the alternative can be extremely costly and tragic. The staff of consultants should not be reduced or dismissed until there is complete assurance that Iranian personnel are fully trained and competent.

In addition to on-the-job-training, both day and night school education and training should be locally available. Short courses at Abadan or in other countries are not sufficient. Adequate background education and training may often require years of part-time effort. An historically nontechnical society must be converted--in part--into a technical society in the shortest possible time. The cost of doing so is high, yet it is small in relation to total energy revenue or to the alternative of a permanent cadre of on-the-job consultants.

The special situation in each energy sector is discussed in the following paragraphs.

Electric Power

The development of the electric sector that has been discussed in SRI's work will never materialize if skilled personnel in adequate numbers are not available to implement the plans that have been outlined. The personnel that will be required can be divided into two general categories: (1) those in the engineering-construction industry that will be responsible for the detailed engineering and actual construction of the facilities required; and (2) those in the utility industry that are responsible for (a) the planning required to define the facilities; (b) the operation of the facilities after they have been turned over to the utility sector by the engineering-construction sector; and (c) the overall administration of the utility industry including such functions as raising the capital required to expand the system, establish rates, and account for cash receipts and expenditures.

Engineering and Construction

The engineering and construction industry plays a vital role in the economy as a whole and the utility sector is only one of many activities that use its services. The personnel employed in the engineering and construction industry can be divided into three general categories: (1) managerial, (2) technical, and (3) labor. Labor can be further subdivided into skilled and (2) common labor.

Management

It is axiomatic that an able management is essential if the engineering and construction industry is to perform well. The development of the personnel required to carry out the management function is a long term process. Formal education may assist in developing people into managers but it is certainly not the only qualification. The lack of a university education certainly is not an adequate reason to preclude a person from becoming a manager.

One of the most important qualifications is many years of experience in the field. There is no substitute for knowing what has to be done, when it has to be done, how it has to be done, and how to get people to do it. The only way that this knowledge can be developed is by actually working on projects. Formal education can assist in developing these talents but it can never be a substitute for actual experience.

The essence of the problem is how this experience is to be gained. As noted above, further formal education will not do the job and it would be impractical to give an inexperienced man a construction job to manage so that he could learn the business. The most practical solution might be to hire experienced foreigners to (1) administer jobs that are under way and, (2) to develop the skills of Iranians so that they can administer future jobs.

It is doubtful that meaningful training will result from the present contracting methods. The obligation of the contractor is to build a facility in a given amount of time at a given cost. For training to be meaningful the trainee must be given responsibility so that he will develop. He must be given some specific function to perform on the condition that if he does not get it done, it will not be done at all. He should be free to ask for advice but no one should stand behind him to carry on if he falters. It should be realized that mistakes will occur, that efficiency will be sacrificed, and that additional costs will be incurred. These penalties should be viewed as investments in the future.

Evaluating performance will be difficult. On the other hand, mistakes must be expected and accepted since these are a part of the learning process; on the other hand, lack of performance must not be permitted. The differentiation between the honest mistake caused by the lack of experience and the lack of managerial talent or the lack of desire to do well will not always be easy to make, but it must be attempted.

A good deal of ingenuity will be required in designing a program that is workable. However, the gains to be realized from the development of managerial talent are well worth the effort. This matter is very important and a substantial study effort directed toward setting up a workable program is certainly justified.

Technical

Technical personnel are the engineers of various disciplines necessary to design and construct power plants, transmission lines, and distribution systems. There are several levels in each of the disciplines and what has been said about management also applies to the higher level technical personnel.

Typically, the lower levels will consist of university graduates who are directed and trained by higher level personnel. It would appear that the procurement of these people is the least of Iran's problems since so many Iranians have, or are obtaining, university degrees in engineering. However, providing these people with the direction necessary to produce personnel with meaningful experience does present a serious problem because the experienced supervision that they require can be provided only by experienced engineers that are not now available and cannot be produced in short order.

To produce a competent project engineer from a university graduate will take from 10 to 20 years. To produce chief engineers in each discipline will take at least that long. Consequently, in all probability it will be necessary to obtain foreigners until normal development produces Iranians qualified for the higher level jobs. It should be pointed out that carrying out on-the-job training is an important part of the foreigners' responsibilities.

Skilled Labor

An adequate number of skilled tradesmen such as welders, boilermakers, and pipefitters are essential if the electric sector is to develop in the manner required to meet the nation's needs for electric service. To build a steam unit requires something on the order of 2 million to 3 million man-hours spread over a 3-year period. This means that on the average, some 500 men are required to build one unit and many of these are skilled craftsmen.

During the latter part of the period of analysis, 2 units per year are scheduled to go into service. With a 3-year construction period, 6 units will be under construction at any one time and this will require a labor force of some 3,000 men, many of whom must be highly skilled.

Fortunately, vocational training will probably prove to be highly effective in producing most of the required labor force in a comparatively short time. However, it should be pointed out that the apprenticeship phase in the United States typically takes something on the order of 3 to 5 years. In addition, the supervisory levels (foremen and superintendants) cannot be developed this rapidly. Again, it may be necessary to use expatriates for several years until trained Iranians become available for supervisory positions.

Common Labor

This labor force should present no particular problem and little needs to be said because the level of skill required to performs tasks satisfactorily is quite low.

Electric Utility Sector

The comments made in respect to the engineering-construction sector also apply to the utility sector. There is one major difference, however: The utility sector has already implemented the program that is suggested. For example, the Harza team is carrying out the function that has been outlined. This program is reported to have been successful to date and its continuation is suggested.

Petroleum

One of the more difficult problems facing the oil and gas industry in Iran is to find and train the various personnel required to meet a product demand that will be approximately three times larger in 1982 than it is at present. Fortunately, the industry already has a substantial and fairly well-trained manpower pool from which to expand. Most of these people--particularly those at the supervisory, clerical, and skilled labor levels--have received their formal training within the country and their on-job training with the Consortium. On the other hand, many of the present-day administrative group, as well as the engineering and technical people, have received their formal education out of the country, at both the undergraduate and graduate levels, but in general they, too, have had a number of years with the Consortium. NIOC and NIGC have now reached the point where much of the on-job training can now be handled by the companies, although presumably they will always have the option of placing people with the Consortium to learn special skills or to receive specific training for any particular job.

As a means of keeping their present engineering and technical people current in their professions and, more particularly, in their specific jobs, and as a basis for upgrading new technical employees, NIOC may well consider the idea of establishing a continuing education program for head office staff and for the refining and pipelining people. This type of program has been successfully incorporated as part of the normal work period by a number of oil companies in the United States.

Basically, this probably should be an in-house program at the university level. Technical people within the company should prepare the course outlines and the curricula, although they may need outside assistance for instructors or in development of the program. Preferably, the instructors should be company people. The voluntary-enrollment courses should be given during the day and the company itself should pay all teaching and administrative costs. The students, however, should purchase their own textbooks and study on their own time.

Typically, courses might be given in weekly 2- or 3-hour sessions that include lectures, assignments, quizzes, and examinations. Average length of the courses might be as short as 12 weeks, but a 16-week period would probably be more useful and productive. Any laboratory or other physical equipment would be provided by the company.

In a technically oriented company like NIOC--and also NIGC, for that matter--one of the real problems that faces management is to prepare the middle-level engineers and technical personnel for management responsibilities in future years. Various approaches have been used for this kind of training. Training can be either formal or informal and often includes university extension sources, professional consulting programs, management development activities (often sponsored by the engineering or technical societies), as well as in-house management development.

Likely candidates might be moved into such interim jobs as directors of specific projects, as heads of groups within a department, and perhaps even as head of departments. They should be given close supervision and yet be allowed to make decisions affecting the activities of those in the group. Responsibility for these decisions, however, should be on a joint basis. Learning from experience, by doing, and by practice, people will make mistakes, and to make mistakes in developing and practicing management skills in a working situation can be damaging and costly. Furthermore, men placed entirely on their own in this manner are normally reluctant to experiment. Thus, present managers--including those both involved and not involved in a training program--should accept joint responsibility for the actions and decisions for the men in training.

The focus of any program for training these future managers should be on the "how-to-do it" aspects of management. But such a program will be successful only if there is a basic understanding of what management means to the individual within the Iranian environment. Management is an art and a science; it cannot be learned as a series of procedures or as a body of principles. The success of any engineering-management program that the NIOC might establish will be dependent on whether or not it captures the real essence of a managers job--that is, what he does and how he does it.

Natural Gas

The natural gas industry is so specialized and so new in Iran that many years will be required before the Iranian staff will prove adequate. NIGC not only will have to add a large number of additional staff over the next 12 years (the trend in operating and maintenance costs is a good indicator of this increase), but also will need to retain most of the existing consultants and to hire an additional team of consultants to assist in conversions and attachments.

Recommendations

In approaching the problems of Personnel Requirements and Development, the following specific recommendations are to:

(1) Develop a comprehensive forecast of personnel requirements by skill, trade and profession and by function, content and discipline over the next ten-year period.

(2) Develop an inventory of present personnel by skill, trade, and profession and an estimate of their upward and lateral mobility.

(3) Develop an inventory of present education and training programs and an estimate of their present and future impact on the available level and numbers of skills, trades, and professions.

(4) Develop a national and industry-wide education and training program to up-grade both the quantity and quality of available trained and educated personnel. Such a program should include plans for new and expanded facilities, new course materials and instructional aids, and the recruiting of new instructors.

(5) Within a fairly constant percentage of personnel costs in relation to total energy revenue ex tax in each sector, adjust the employment mix by increasing the share of skilled and professional personnel and increasing upper salary levels.

(6) Continue to use individual and group consultants.