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ENERGY ASPECTS OF THE ECONOMIC INTERDEPENDENCE BETWEEN THE UNITED STATES AND DEVELOPING COUNTRIES

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PREFACE

This paper is one of a series prepared under the direction of The Futures Group for the U.S. International Development Cooperation Agency. The overall study to which this paper contributes, addresses the nature and implications of the economic interdependence between the United States and developing countries. Other papers in the series address macroeconomic impacts, trade in manufactures, trade in agriculture, non-fuel minerals, capital flows, labor effects and technology transfer.

The authors are indebted to a number of persons who gave advice and information and provided related work in draft form. In addition to the staff of Energy/Development International and The Futures Group, they would like to thank James Plummer of the Electric Power Research Institute and James L. Sweeney of the Stanford Energy Modeling Forum and particularly Charles Blitzer of the International Development Cooperation Agency for his incisive comments and helpful suggestions.

A Note on Units

Energy quantities are generally expressed in this report in million barrels of oil per day, MMBD. On an annual basis, equivalents in other units are:

1 MMBD = 49.6×10^6 tonnes per year crude oil

= 2.01×10^{15} Btu per year

= 2.12×10^{18} Joules per year

= 72.3×10^6 Metric tons coal equivalent per year

1 MMBD produces, in modern oil fired steam electric plants (at 38 percent efficiency) 224×10^9 Kwh of electricity per year

I INTRODUCTION

"For the United States, born in a revolution of separation from Great Britain, the dominant political myth remains that of independence."

"A Growing Interdependence"
N.Y.Times, February 8, 1981.

In this paper we examine the energy aspects of the interdependence between the U.S. and developing countries. The paper focuses on energy in two senses: first as the principal agent of change in the relationship between the U.S. and the developing world and secondly as a focal point for U.S. policy and action vis-a-vis the developing world.

The issue of energy and economic interdependence is vast and complex. The complexity would be alleviated somewhat if we could focus solely on direct economic impacts; the impacts, for example, of world oil price increases on OECD and U.S. economic growth. This would be misleading, however, because in the long term the most enduring and deep impacts of the increase in OPEC power on the U.S. economy may arise through the indirect avenues of altered global political relationships. Thus, the paper will consider indirect as well as direct avenues of economic interdependence.

Although the paper provides some factual background in the discussion of these issues, it makes no attempt to present a complete historical and analytical view of the world energy situation as it affects the U.S. and developing countries. The intent of the paper is to identify those facts and phenomena and relationships which are critical to the formulation of U.S. policy. Because of the other papers being written in this overall study, the policies that are considered here are those in the energy area. One of the principal contentions of the paper will be that there has been insufficient attention to the foreign policy aspect of U.S. energy policy. Despite the fact that the basic character of the "energy crisis" is international, starting with the initiating OPEC price rises and embargo of 1973 and '74, the principal U.S. response has been in terms of internal policy making. In particular we

will argue that the oil importing developing countries and the energy situation that confronts them, warrant much more serious policy attention than they have received in the last six years.

In anticipation of the conclusion of our analysis it should be said that, in comparison with the scale and complexity of the issues addressed, the time and resources that we have been able to bring to bear in this project have been very modest. Although some specific areas of U.S. initiative are identified in the paper the most important conclusion is that there is a large number of potential beneficial policies and intiatives which thus far have been unexplored, insufficiently analyzed or improperly implemented. Neither the national security nor the energy policy of the U.S. will be complete until a consistent policy framework is established for dealing with the energy aspects of our relationships with developing countries.

The relationship between the U.S. and OPEC and possible U.S. policies towards OPEC have been the subject of a vast amount of analysis and discussion. There is little that this paper could add to that discussion. Thus we have chosen to concentrate our attention on a three sided relationship, that between the U.S., OPEC and the oil-importing developing countries. Each of these entities is complex in itself. The ranks of oil importing developing countries changes with time and includes countries with an extreme range of incomes (from Bangladesh with $80 per capita GNP to Singapore with $3,000 per capita), oil dependence, size and industrial structure. In many cases the discussion of oil importing developing countries will apply to the oil exporting non-OPEC countries namely Angola, Egypt, Malaysia, Mexico, Oman, Peru, Syria and Trinidad and Tobago.

The countries of OPEC are similarily diverse, with a wide variety of political philosophies, strategic importances, world roles and developmental

needs. A common distinction is made between capital surplus OPEC countries and those whose internal needs for capital are at least as great as their oil export earnings. Many of the comments made regarding oil importing developing countries apply as well to the non-capital surplus OPEC countries. These distinctions will be discussed in the next chapter.

In our analysis the U.S. is, in many senses, representative of the OECD countries. Although we will not deal explicitly with OECD-U.S.-LDC energy relationships, many of the conclusions drawn for the U.S. will be equally valid for other industrialized countries.

This simplified conceptual structure - the U.S., OPEC and oil importing LDCs - is imposed on our analysis not only because of the limitations of time. It is a structure that will be found to illuminate some interesting and important policy issues.

II THE ENERGY AND POLICY CONTEXT

"Let us unite in committing the resources of this Nation to a major new endeavor, an endeavor that in this bicentennial era we can appropriately call "Project Independence". Let us set our national goal, in the spirit of Apollo, with the determination of the Manhattan Project, that by the end of this decade we will have developed the potential to meet our own energy needs without depending on any foreign energy sources.

Let us pledge that by 1980, under Project Independence we shall be able to meet America's energy needs from America's own energy resources."

Richard M. Nixon
Address of November 7, 1973

A. THE GLOBAL ROLE OF OIL

If, in Churchill's phrase, the Allies sailed to victory in World War II on a sea of oil, the Western economies also sailed to global dominance on that same sea. In the 20th century oil became not only the necessary fuel for industrial development but also the basis for the mobility of modern societies. As oil, an essentially international commodity, replaced the local resources of wood, coal and water, energy systems became increasingly global in natural scale.

During the last 75 years, the use of energy in all forms has more than doubled every 15 years. Oil, however, has made the most rapid growth of all energy forms - owing primarily to its historically low price, its relative ease of production and distribution, and its widespread utility. In 1950, for example, oil accounted for only 30 percent of worldwide energy consumption; by 1977, it had increased to 55 percent[1]. Continued growth in oil consumption, despite the dramatic price increases of 1973-74, proves that oil is a difficult fuel source to replace. It is still solidly entrenched - both by its utility and by the problems entailed in substituting other fuels.

The developing countries have, if anything, become even more dependent on oil than the industrialized ones. In the OECD countries oil accounts for roughly 30 percent of total energy use. In the U.S. that figure has been between 42 and 47 percent. In the developing countries, however, it is close to 60 percent of commercial fuel use[2]. These differences are due in part to the lack of indigenous energy resources in many LDCs and in part to the leap-frog nature of LDC economic development. Most LDCs' energy infrastructure is of recent origin and imitates the oil dependent growth of the western economies

in the 20th century.

U.S. primary energy consumption increased only 6.6 percent from 1970-74, and then 7.3 percent from 1974-79. Oil consumption, however, increased at rates of 12.5 percent and 11 percent, respectively. Since 1970 oil has consistently occupied more than 42 percent of U.S. energy consumption. In fact, despite the slow economic growth of the mid-70's, oil rose to nearly 47 percent of energy consumption in 1979. Much of this increase in U.S. fractional oil consumption was the direct result of U.S. entitlements, imports and pricing policies which served to insulate the U.S. from world oil price increases. Because of the dominance of U.S. multinational oil companies in the Middle East, more than 53 percent of U.S. oil imports originated from OPEC countries in 1974. From 1970-74 imports from OPEC had increased more than 140 percent in volume. Following the Arab oil embargo, the increase in OPEC imports slowed, but still amounted to 71 percent in 1979. Much of the increase occurred after 1976[3]. Although conservation did finally begin to cut into these trends towards the end of 1979, fuel substitutions in the U.S. were generally as modest as in the rest of the International Energy Agency member countries. In part, this was due to the slowed economy and poor investment climate; but it was due as well to a general inability of the government to articulate and implement a sound, comprehensive energy policy. Technological, institutional, social and economic barriers alike helped to maintain high import levels in the U.S.[4]

B. THE DEVELOPING COUNTRIES

Growth in commercial energy consumption in developing countries has consistently outpaced the world average since 1950. From 1950-74 world annual

average energy growth was 5 percent; developing country growth was 6.9 percent. From 1975-80 The World Bank estimated annual growth to average 2.5 percent worldwide, and 3.7 percent in the LDCs[5]. More significant than total growth, however, has been the degree to which oil has dominated commercial energy consumption among LDCs.

Obviously, the number and diversity of developing countries tends to skew characterizations dependent upon an average, but several qualified characterizations do help to illustrate the general status of oil use in LDCs. Of 123 developing countries, for example, eight accounted for more than 60 percent of the group's total consumption in 1977[6]. Only 8 members of the group are classified as oil exporters. These are shown in Table I[7]. In fact, some 80 percent of the non-oil exporters fulfill less than 2 percent of their own oil needs[8].

Non-commercial fuels continue to supply much of the energy needs of the developing world. One estimate [6] suggests that 80 percent of the people in the LDCs still rely largely on traditional fuels. Depending upon the overall level of development, these fuels can account for as much as 80 - 90 percent of total national energy consumption. The trend of economic development has traditionally been toward the increased substitution of oil for non-commercial fuels as the process of industrialization encourages the use of oil. The severe price increases and impacts of the 70's however, have begun to constrain that substitution, placing an increased burden on already overly-taxed non-commercial fuels. Indeed the increasing shortage of traditional fuels such as wood is creating heavier and heavier environmental and social costs on those regions and countries which can least afford them. This so called "other energy crisis" interacts with the increasing price of petroleum fuels to create one of the most refractory practical policy problems of the third world.

TABLE I

CATEGORIES OF DEVELOPING COUNTRIES

FROM AN OIL PERSPECTIVE

OPEC Oil Exporters

Capital Surplus Countries

Kuwait
Libya
Qatar
Saudi Arabia
United Arab Emirates

Other OPEC

Algeria	Iran
Ecuador	Iraq
Gabon	Nigeria
Indonesia	Venezuela

Other Oil Exporters[a]

Angola	Oman
Egypt	Peru
Malaysia	Syria
Mexico	Trinidad and Tobago

Balanced Importers/Exporters

Argentina	Cameroon
Bahrain	Colombia
Burma	The Congo
Bolivia	Zaire

(a) Net exporters in 1979 of greater than 60,000 barrels per day of crude and products.

C. OPEC

Although OPEC was founded in 1960, and OAPEC (the Organization of Arab Petroleum Exporting Countries) in 1968, it wasn't until the early 70's that it began to realize and exercise its power over world oil markets. During the 1970's OPEC also began to articulate with increasing clarity and influence positions on regional and global economic and political issues.

Pricing strategy has not, however, been one area of high unity or clarity. More than a well-defined expression of strategy, the price hikes of 1973-74 were an added emphasis to the Arab oil embargo - an effective underlining of OPEC's concern for compensation and resource conservation issues, in addition to its political concerns. Since then, OPEC has discussed two and three tier pricing schemes but none has been officially established[9]. OPEC's inability to articulate and implement an effective pricing or production strategy results, in part, from the disparate levels of resources and reserves which are available to its members from their differing political philosophies, and from their wide range of development objectives. OPEC members oil production levels are given in Table II. Moreover, the problem has been compounded by internal disagreement over the need to find a secure investment medium. OPEC's reliance on the dollar, and the dollar's secular decline in value have created problems of no small concern for OPEC as well as for the world's consumers. This is not to say, of course, that somewhat disorganized decisions made by OPEC have not been of immense benefit to these member countries - and other oil producers.

Although OPEC's pricing patterns have been designed to address the need for resource conservation as well as the need for adequate compensation, its control over production and distribution have not ended with price-setting efforts. On the contrary, OPEC has exercized a number of other options in

TABLE II

OPEC OIL PRODUCTION

including natural gas liquids

(Millions of barrels per day)

Country	Production 1978	Production 1980	Sustainable Capacity
Saudi Arabia[a]	8.3	9.8	12.0
Iran	5.3	1.6	3.2
Iraq	2.6	3.5	4.8
Kuwait[a]	2.0	1.55	2.0
UAE[a]	1.9	1.75	2.0
Qatar[a]	0.5	0.5	0.6
Neutral Zone	0.5	0.5	0.6
Libya[a]	2.0	1.8	2.0
Algeria	1.2	1.1	1.2
Nigeria	1.9	2.1	2.4
Gabon	0.2	0.2	0.2
Venezuela	2.2	2.0	2.4
Ecuador	0.2	0.2	0.2
Indonesia	1.7	1.6	1.7
Total	30.5	28.2	35.3

[a] considered capital surplus countries

Source: International Energy Agency[10]

dealing with supply issues. Following the Arab oil embargo of 1973-74, OPEC's production policies began to reflect more its concern for its own resource and reserve conservation than for international demand. Although OPEC members have been willing to assist in meeting demand left unfulfilled because of some international crisis, it is clear that they have in mind individually-set ceilings and longer-range plans for production. In addition to production ceilings, OPEC members have begun regularly to require consumers either to commit resources to exploration in OPEC countries, or to accept less desirable grades of crude in addition to the ligher grades[11].

One important consequence of OPEC's recent efforts in controlling supplies and pricing has been a dramatic shift in the ownership and marketing of oil. Since 1970, producer government ownership has increased from 2 - 80 percent and direct exports by OPEC national companies have increased from 0 to 50 percent[12]. The flip side of this shift is, of course, a dramatically diminished role for the multinational oil companies. As the OPEC countries pursue further downstream capabilities, the multinationals are assured of a steadily decreasing role.

D. OIL PRICES AND THE ECONOMIC IMPACTS OF THE 1970's

Table III shows the history of the relative real price of oil imported by developing countries and the U.S. since 1973[13]. The indices were derived by Dunkerley and Jankowski by converting the dollar price of Saudi Arabian (Ras Tanura) crude oil to national currencies at current exchange rates and then adjusting for inflation using each country's consumer price index.

TABLE III

INDEX OF REAL PRICE OF IMPORTED OIL 1973-1980

(1974 price = 100)

	Year							
	1973	1974	1975	1976	1977	1978	1979	January 1980[a]
Brazil	32	100	102	101	101	95	124	208
India	34	100	108	134	130	122	152	197
Jamaica	30	100	94	92	89	102	136	179
Kenya	30	100	95	104	97	79	95	126
Korea	27	100	82	76	75	67	76	116
Philippines	37	100	109	114	116	113	119	155
Thailand	35	100	104	108	108	102	124	164
United States	31	100	101	102	103	98	118	156

a. Partially estimated

Source: Joy Dunkerley and John E. Jankowski, Jr.[13]

As shown by the table, the jump in prices between 1973 and 1974 was generally greater than a factor of three. For most countries the real price of oil remained relatively stable between 1974 and 1978. In countries with high internal rates of inflation, such as Korea, the real price actually dropped considerably, while countries with low inflation rates, such as India, saw significant price increases (52 percent in India's case) over the period.

In the U.S., world oil price increases have been credited with two recessions, consistent inflation, a sharp drop in the value of the dollar and hefty increases in the U.S. trade deficit. From 1970-1978, the U.S. oil import bill rose from $2.3 billion to $41.8 billion. Due to the enormous increases in imports, and to the slumping value of the dollar, the U.S. current account balance fell from $4.7 billion in 1970 to a deficit of $11.4 billion in 1978. Table IV provides a summary of the effects of the 1973-74 price increases on the U.S. economy[14].

The first round of oil price increases in 1973-74 had a major impact on the economies of the oil importing developing countries. In just one year their oil bill <u>increased</u> by $11 billion, more than the total cost of their food grain imports[15]. The direct and indirect result of the oil price increase was a reduction in their overall economic growth rate by something on the order of 25 percent and their growth in per capita income by roughly 50 percent (comparing the 1974-79 period with the 1964-74 period).

Despite the drastic impacts of the 1973-74 price rises on oil importing developing countries, those countries have been very slow in organizing themselves to cope with the new world energy conditions. (In this

TABLE IV

EFFECTS OF THE 1973-74 OIL PRICE INCREASES

ON THE U.S. ECONOMY[1]

	1973	1974	1975	1976	1977
Loss of Economic Output (GNP Loss in Billion 1972 Dollars)	-	38	63	41	40
(Percent Reduction)	-	3.1	5.2	3.2	3.0
Increased Rate of Inflation (Change in Consumer Price Index)	0.3	2.5	1.7	0.2	-
Increased Rate of Unemployment	0.1	0.7	1.7	0.5	-
Loss of Employment (thousand jobs)	84	600	1,450	500	-

[1] Entries are the differences between actual performance of the economy and simulations of how the economy would have performed had world oil prices not increased. The simulations were performed using the Data Resources, Inc., econometric model and the Interindustry Transactions Model developed by Edward Hudson and Dale Jorgenson.

Source: U. S. Department of Energy[(14)]

at least they closely resemble the United States.) In part this inaction was due to the novelty and massive scale of the energy problem facing them. In part it was due to the lack of technical and planning ability and, in part, it was due to a common perception, supported by the unusual nature of the precipitating cause, that there would be no further increases in price. That perception was, of course correct - at least until 1979 (see, however, the discussion of the real price of imported oil). Because of these perceptual and factual circumstances the 1979-80 increases had an even greater impact in many ways than the earlier ones.

Overall, the price increases of 1979 and 1980 will cost the oil importing developing countries approximately $30 billion a year. In aggregate this represents about 10 percent of their annual investment and 15 percent of their export earnings. In many countries, however, oil imports consume more than 50 percent of export earnings. In some cases the simple combination of debt service and oil imports payment consumes everything earned through exports. While many industrialized countries, and even some of the more industrialized developing countries such as Korea have received some of the back-flow of petrodollars, the commodity exporting LDCs have seen their markets weaken due to world recession and their manufactured imports increase in price due to higher energy costs of manufacturing. These indirect effects have been estimated to represent another $10 billion loss in foreign exchange[16].

E. THE U.S. POLICY RESPONSE

The U.S. entered the seventies with a well entrenched set of policies and and regulations aimed at limiting the amounts of crude oil imported into the

country. Ostensibly based on national security considerations, the mandatory oil import control program initiated by President Eisenhower in 1959 responded to at least a decade of pressure by the oil industry to protect their domestic market against "cheap and insecure" foreign oil. By 1969 a Presidential Task Force estimated that import controls were costing U.S. consumers some $4.8 billion a year. In the face of rapidly growing oil demand and stable domestic supply, President Nixon gradually eased import quotas allowing imports to grow at a rate approaching 20 percent a year between 1970 and 1973. Much of this increase came from OPEC sources.

Just as import restrictions were being relaxed they were aquiring a new and substantial justification: imported oil became more expensive than domestically produced petroleum. The natural, and perhaps necessary, political response was to establish a set of regulations to protect small refiners and consumers from higher prices. But these policies acted very effectively to thwart two essential elements of a national energy strategy: increased domestic energy production and reduced domestic demand resulting from more efficient energy use.

Other aspects of the U.S. policy response to the events of 1973 and 74 were the development and encouragement of substitutes for oil, particularly increased coal use, solar and geothermal energy, synthetic fuels production and energy conservation[17]. It was only in the last year or so, after nearly a decade of effort, that these programs established an effective momentum. In 1981 most of these programs were dismantled or severely cut back as part of the Reagan Administration's overall budget reduction program.

President Nixon's Project Independence serves as an effective indicator of much of American political and economic opinion regarding "the energy problem"[18]. The notion that the U.S. can somehow insulate itself from the vagaries and harsh realities of the international oil market seems still to hold a great

deal of attraction for U.S. policy decision-makers. The continued assertion in political circles that the U.S. supply problem can be overcome simply be increasing U.S. domestic output flies in the face not only of geological reality, but also the U.S. stake in the international energy situation. Energy independence is the "Holy Grail" of American energy policy.

Although there are many different elements to the quest, two of the more illustrative examples of American political thought can be seen in the debates and programs constituting policy efforts in price regulation and import control. In the late 1970's, the oil pricing debate was dominated by two different camps; one favoring deregulation and reliance on "free-market" forces to establish prices, and the other favoring the use of current regulatory mechanisms to facilitate government intervention at critical points in oil production and distribution[19]. Although ostensibly concerned with the levels of prices, the issue really revolved about the power to control prices.

Carter's approach to the issue was to recommend continued regulation as a part of the first National Energy Plan. The proposed crude oil equalization tax (COET) was designed to reflect world oil prices at the level of the consumer, but to deny "windfall profits" to the oil companies. Since the COET failed to pass the Congress, Carter proposed in the National Energy Plan II to allow crude oil controls to expire, provided that a windfall profits tax be passed as a funding source for his proposed Synfuels Corporation. Although this plan did succeed, it was not until January 1981 that President Reagan removed controls from oil pricing and allocation.

It is actually rather ironic that import controls should have become a weapon in the arsenal of energy independence builders, since import controls were designed initially, not to protect the U.S. from too great a perceived dependence on imported oil, but to protect U.S. domestic crude marketers whose prices during the 1950's and 60's exceeded import prices.

After the Arab oil embargo, import controls assumed a new importance and sense of purpose; protecting the U.S. from building too great a reliance on imported oil. Again, however, there are serious doubts on several sides of the issue: what kinds of controls to implement, at what levels to implement them; how to coordinate them with U.S. stockpiling measures; and similar considerations. Despite a willingness, particularly on the part of the Carter Administration to commit the U.S. to certain import targets, a practical means of effecting such a program, particularly in a context of concern for windfall profits, was never formulated.

F. NUCLEAR POWER[20]

Increased use of nuclear power in the U.S. has been one of the potential means of reducing dependence on imported oil. When viewed internationally, however, the nuclear power question is even more complex than the involuted and endless domestic controversies would suggest. Some of the issues that must be added to the usual questions of accident probabilities, normal radiation releases, siting and economics are:

- access to potential nuclear weapons materials, particularly plutonium, which is produced in power reactors, by "unstable" third world governments
- reduction in oil dependence due to nuclear power programs in developing countries
- the significant export market for nuclear power plants.

Each one of these issues is highly complex and the combination of domestic and international interests makes nuclear power one of the most difficult international energy issues.

The mid-70's saw a number of developments which attested to the diminished role of the U.S. and its nuclear industry in world nuclear activities. Not only did India explode its first nuclear device, but growing terrorist activities worldwide began to cast doubt over the ultimate security of nuclear fuel supplies. More immediately problematic for U.S. decision-makers was the increased export activity of the Europeans; in particular, the French and the Germans. Their sales (and refusal to the U.S. to cancel sales) to Brazil, Iran, South Africa, Pakistan and Korea increased concern in the U.S. over proliferation and effective safeguards systems.

In the presidential election of 1976, both Ford and Carter called for greater restraint in the recovery and use of plutonium. Carter followed up his campaign pledges with proposals to the Congress in May 1977, calling for:

> "..an indefinite deferral of commercial reprocessing of spent fuel into plutonium; a restructuring of the U.S. breeder program to give priority to non-plutonium designs; direct funding of U.S. nuclear R&D into alternative nuclear fuel cycles that would not involve weapons-usable materials; increases in U.S. capacity to produce enriched uranium for consuming countries so that they would not be encouraged to reprocess their materials; a continued embargo on the exports of equipment or technology that would permit enrichment or reprocessing; and for an international discussion between suppliers and recipients on alternative programs that would ensure supply while minimizing the danger of nonproliferation, a call which resulted in INFCE."(21)

Although the Congress did not pass Carter's proposals, it did enact the Nuclear Nonproliferation Act of 1978, which incorporated much of the President's intent and design. The ultimate product was, however, a real break with past U.S. practices, which imposed an entirely new set of conditions on U.S. nuclear trading partners, developed and developing alike.

Rather than being seen as guarantees of U.S. reliability as a long-term supplier, consumers viewed the new conditions with considerable dissatisfaction.

The dissatisfaction related both to the nature of the new supply restrictions and to the way in which the new policies were promulgated, without consultation and without consideration of their energy situation[22].

From the perspective of the developing countries, the Carter Administration's nuclear nonproliferation policies were viewed as demonstrating an insensitivity to their future energy needs. Other critics contended that those policies, particularly to the degree that they increase pressure on world oil supplies, increased the probability of nuclear conflict (an ostensible concern in their formulation), rather than reducing it, particularly given the paths to the acquisition of nuclear weapons that are alternate to, and probably easier than, diversion of power reactor fuel[23]. What has made this agreement even less acceptable to consumers has been the few instances where inconsistencies were seen in the American approach to relationships in nuclear power - the most recent example being the controversial supply of fuel to India's Tarapur facility. Recent U.S. international nuclear policies, described by Greenwood and Haffa as constituting a regime of "technological denial"[22] have been antithetical to energy cooperation with the third world.

In a subsequent chapter we explore the potential future role for nuclear power in the developing countries.

III FUTURE PROSPECTS

"At best, it would appear that a series of future emergencies centering around oil will set back world progress for many, many years. And the world, as we know it now, will probably not be able to maintain its cohesion, not be able to provide for the continued economic progress of its people against the onslaught of future oil shocks - with all that this might imply for the political stability of the West, its free institutions, and its internal and external security."

Walter J. Levy
Oil and the Decline of
the West, 1980.

"..men prophesy, and the future makes fools of them"

Hilaire Belloc
The Cruise of the Nona 1925.

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A. FUTURE WORLD OIL DEMAND

A key factor in future relationships between the U.S. and developing countries is the supply and demand for oil at the world levels and the price for that commodity. Predictions in this area are particularly hazardous. The situation on supply, demand and particularly price has changed so rapidly over the last few years that long term historical trends are not a valid base for projection; nor are the essentially transient phenomena of the recent past. A range of numbers from recent studies, however, are sufficiently accurate for our purposes, providing as they do an adequate basis for characterizing issues of interdependence.

Table V presents ranges of numbers for the future demand for oil in the U.S. and various country groups. An interesting aspect of these figures is that the developing countries, which now account for about 14 percent of world oil demand, will increase their share to around 25 percent by the end of the decade. This will result from relatively rapid growth, particularly in the industrially more advanced and oil exporting LDCs and relatively stable demand in the U.S., other OECD countries and centrally planned economies.

Table VI presents a more detailed demand picture for the oil importing developing countries, as viewed by the World Bank[5]. This projection assumes an economic growth rate of 5.3 percent per year and a GNP elasticity of total commercial energy demand of 1.2[24]. The GNP elasticity of energy demand is the fractional rate of increase (e.g. in percent per year) of energy demand divided by the fractional rate of increase of GNP. Previous to 1973

energy growth in the oil importing developing countries was characterized by an elasticity of around 1.3 which fell to 0.8 between 1975 and 1980. The projected economic growth rate of 5.3 percent per year compares with an assumption made in the overall project to which this paper contributes of 4.5-5.0 percent a year and would be considered on the optimistic side by many analysts. Thus the combined assumptions would appear to be on the high side in terms of projected energy consumption.

B. SUPPLY PROJECTIONS

World oil supply cannot, of course, be projected independently of demand. Nevertheless it is quite revealing to do just that, at least to examine the willingness of oil producers, particularly the OPEC countries, to export oil given their internal needs for petroleum and limitations on production capacity. The first study to take this independent supply-demand approach was the Workshop on Alternative Energy Strategies[24]. The study examined a number of scenarios and presented a convincing case that there would be a sharp divergence between world oil demand, as it might be projected under trend conditions, and world oil supply sometime in the period 1985 - 1995. As in most studies of the period, the assumptions on future world oil prices were too low and more realistic (higher) oil prices would delay or reduce that divergence Indeed, even with reduced output from Iran and Iraq, the current world oil situation is at least soft if not characterized by a "glut"[25].

The longer term oil supply picture is represented in Table VII. It is generally anticipated that despite a decline in demand, the U.S. will

TABLE V

WORLD OIL DEMAND PROJECTIONS
(Million Barrels per Day)

Country Group	1980	1990	2000
United States	18	16-17	15-17
OECD	41	35-39	34-38
OPEC	2	5-6	8-10
Non-OPEC LDCs	7	10-13	18-23
Oil Importing LDCs	6	9-11	14-18
Centrally Planned Economies	13	13-15	14-17
WORLD	63	65-75	75-85

Sources: See next page.

Sources for World Oil Demand Projections:

1. Exxon Corporation, "World Energy Outlook" December 1980 (U.S., World, LDC, Centrally Planned Economies).

2. Organization of Petroleum Exporting Countries, "Domestic Energy Requirements in OPEC Countries" Vienna, 1980 (OPEC).

3. World Bank, "Energy in the Developing Countries" Washington, D.C. August 1980 (LDCs, Oil Importing LDCs).

4. U.S. Department of Energy, projections contained in Council on Environmental Quality, "The Global 2000 Report to the President" Washington, D.C. 1980 (World).

5. Central Intelligence Agency, "Some Perspectives on Oil Availability for the Non-OPEC LDCs". Washington, D.C. September, 1980 (Non-OPEC LDCs).

6. Energy Modeling Forum, "World Oil: EMF 6 Summary Report", Draft 3, January 1981 (OPEC, Non-OPEC LDCs, OECD, Centrally Planned Economies).

7. Conoco Inc., "World Energy Outlook through 1990" (U.S.).

8. International Energy Agency, "Energy Prospects of OPEC and Non-OPEC Developing Countries" IEA/SLT (80)64, September 20, 1980 (OPEC, Non-OPEC LDCs).

9. International Development Cooperation Agency, Energy Annex from IDCA FY1982 Budget Submission (Oil Importing LDCs).

TABLE VI

OIL IMPORTING DEVELOPING COUNTRIES

PRIMARY COMMERCIAL ENERGY BALANCE

(Million Barrels per Day Oil Equivalent)

	1980		1990	
Source	Production	Consumption	Production	Consumption
Oil	2.0	6.5	3.6	11.4
Gas	1.5	1.4	2.6	2.6
Coal	2.4	2.5	3.3	3.4
Hydro	1.5	1.5	3.2	3.2
Nuclear	0.1	0.1	1.0	1.0
Other[a]	0.3	0.4	1.5	1.2
Total	7.8	12.4	15.2	22.8

(a) "Other" includes alcohol, other nonconventional primary energy sources, unallocated energy, and exports of gas.

Source: World Bank[5]

continue to need to import oil at significant levels through the end of the century. Oil imports and exports in the Centrally Planned Economics are expected to remain roughly in balance. In several of the largest OPEC producers, specifically Iran, Kuwait, Saudi Arabia and the United Arab Emirates there is strong political pressure on motivation to restrain future production below levels experienced in the past. The expectation is that even by 2000 OPEC production will not exceed 35 MMBD [26]. Critical and some of the most uncertain elements in the changing future world oil supply picture are the non-OPEC developing countries. Current non-OPEC exporters are envisioned to increase production from 5 MMBD currently to 8-9 MMBD by 2000.

Mexico is expected to account for about half of these quantities with Egypt, Malaysia and Oman also producing above 0.5 MMBD by 1990 [26].

In order for supplies to balance increased demand in the 2000 period, large new sources of supply must become availabe. In the Exxon study [27], on which Table VII is partially based the balance in 2000 required 6 MMBD of very heavy oil production or synthetic fuels from coal or oil shale. In addition, more than one third of the production required in 2000 must come from oil reserves yet to be discovered. Thus, although there may be some temporary softness in the world oil market, it is generally felt that over the long term increasing world demand will place severe pressure on world oil supplies, leading to sustained upward pressure on world oil prices.

C. FUTURE OIL PRICES

Because of the supply-demand situation outlined above and the control exerted by OPEC over marginal supplies of oil, it is generally assumed that world oil prices will continue to increase over the next 10 - 20 years.

TABLE VII

WORLD OIL PRODUCTION
(Million Barrels per Day; includes Natural Gas Liquids)

	1979	1990	2000
U.S.	10	7-8	7.5-8.5
OPEC	32	30-35	27-35
Non-OPEC LDCs	5	8-10	9-17
Centrally Planned Economies	14	15	16-17
Others[a]	5	8	11-20
WORLD	66	68-75	75-85

(a) Includes, OECD other than U.S., oil shale, synthetic fuels, etc.

Source: As for Table V ; overall balance is taken from Exxon Corp., "World Energy Outlook", December 1980.

Also: Petro-Canada and Petroleos de Venezuela, "World Oil Supply Prospects", February, 1980.

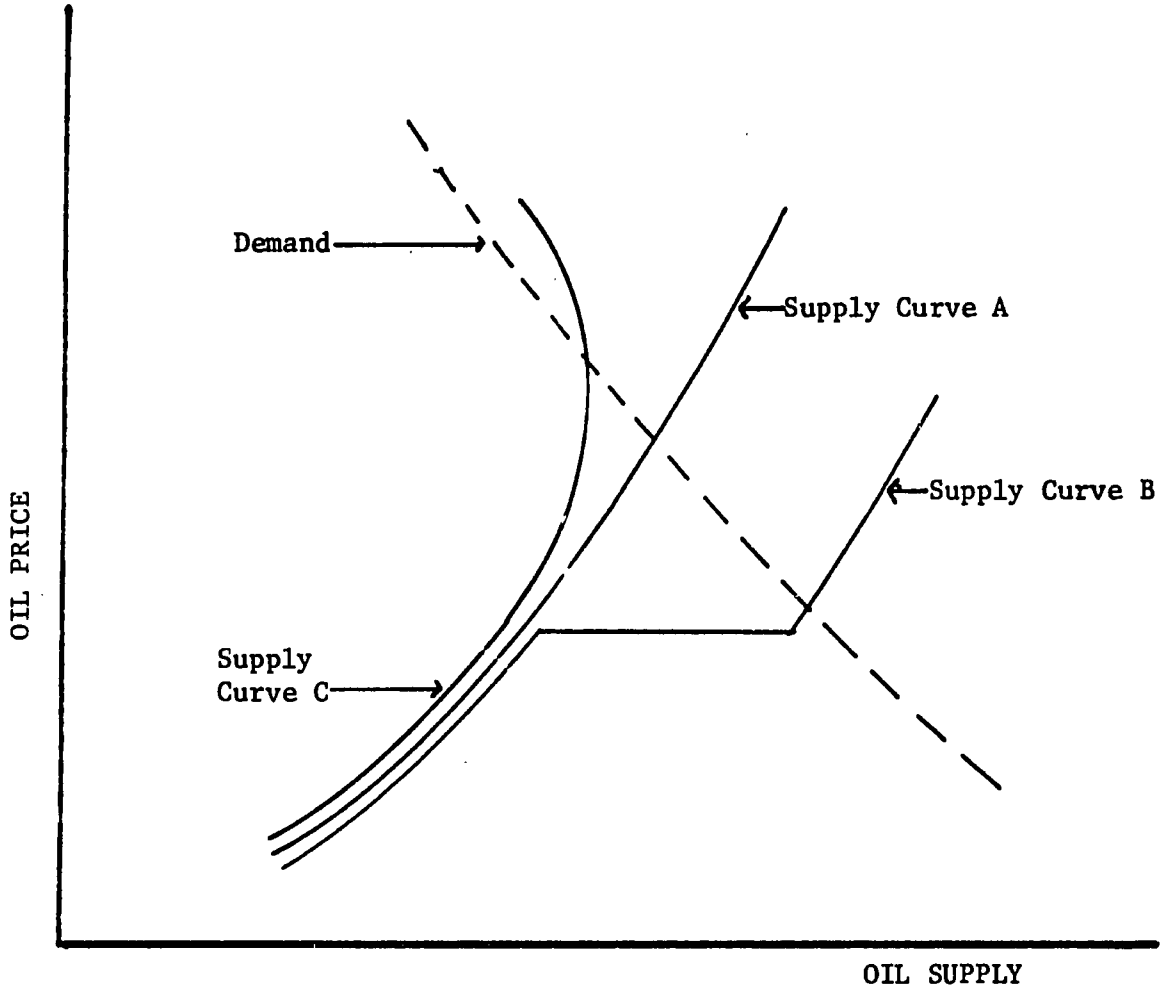
For this study we have assumed a real price increase of 2-4 percent per year, representing a widely held consensus view. This would lead to a real (current dollar) price in 1990 of $44 - $53/bbl based on a 1980 price of $36/bbl.

This projection is, of course,highly speculative depending, as it does on relatively stable world political conditions, the cohesiveness of OPEC and other tenuous factors. Even the question of the OPEC price response to changing world oil demand, for example, is controversial. Some would say that in tranquil times, over the long run, world oil price-supply relationships will follow classical equilibrium relationships or supply curve, such as curve A in Figure 1 . There are a number of factors which could alter the curve significantly, however. In curve B we have indicated the effect of a major alternative source of oil such as coal liquefaction or oil shale, a large quantity of which enters the market at a certain price. Another possible phenomenon is that under certain circumstances some producers (particularly the OPEC capital surplus countries) will judge that rather than increasing supply to meet growing demand, they will restrict supply and allow prices to increase. Under this strategy they are able to maintain their export earnings and also keep more of their resource in the ground. This phenomenon would produce a "backward" bending supply curve as shown in curve C in the figure. (Since this revenue preserving or backbending supply curve is influenced by the shape of the demand curve, it is conceptionally somewhat different from other supply curves).

Because of the prospects of future world oil supply outlined above world oil prices may be affected as much by increased non-OPEC production or by short term phenomena such as supply disruption. Predicting the effects of such phenomena is difficult at best.

FIGURE 1

REPRESENTATIVE WORLD OIL SUPPLY CURVES



Note: Curves are illustrative, not meant to infer any demand or supply elasticity.

There now exist several mathematical models of world energy supply and demand based on different structural views of the situation. Although world oil demand-price-supply phenomena may be too uncertain and complex to be captured by a single model, the combined and comparative results of analyses using a variety of models are considerably more revealing. Indeed, in some senses the variety of projection results obtained by a group of models addressing the same questions gives an indication of the uncertainties which characterize the future as well as "consensus" estimated of effects of changes in world conditions. It is for these reasons that recent results of the Energy Modeling Forum at Stanford University are particularly interesting [28]. Ten different energy models [29] were used by their developers to address several specific issues in world energy supply and demand under common assumptions.

One of the questions addressed by the Forum study was the impact on world oil prices of changing the quantity of non-OPEC oil production. In particular, every million barrel per day increase in estimated OECD oil production was calculated to reduce the projected world oil price by about $2.40 per barrel in 1990. Increased non-OPEC LDC oil production was calculated to reduce the long term price by $0.60 to $2.30 per barrel for each million barrels per day increase.

It is important to note that in a situation of deregulated domestic oil prices, a $1 per barrel increase in the world price applies to total U.S. consumption, not just the imported fraction. Thus, the above figures indicate that an increase in world oil production of a million barrels per day would have a benefit to the U.S. of between $4 and $16 billion annually.

In considering the interdependence between the U.S. and developing

countries one must also consider the impact on the LDCs of variations in U.S. oil consumption. From the figures given above it can be estimated that, under equilibrium conditions a reduction in U.S oil consumption of 10 percent (or 1.8 MMBD) would reduce 1990 oil prices by roughly $4.30 a barrel. This would reduce the oil importing LDC import bill by some $15 billion in that year.

Another issue of concern is the effect on world oil prices of a disruption in supply due, for example, to a major curtailment in the production of one or more OPEC countries. Existing models project widely varying impacts of a curtailment both in terms of the peak price increment reached and the time pattern of the effects. For a sudden disruption of about 6 MMBD, several models predict a peak oil price of around $150/bbl., while others range between 50 and $100/bbl. The impacts are highly sensitive to the distribution and use of spare production capacity, the types of import reduction measures in place and many other factors.

The price repercussions of the 1979 Iranian revolution are not reassuring in this regard. The war resulted in a supply reduction of only 4 percent of free world consumption. Yet the result was an incrase in oil prices of 120 percent in one year [30]. This result was strongly influenced by policy responses and perceptual factors, however, as well as the status of world oil storage. Such an impact is by no means inevitable.

IV ENERGY/ECONOMIC INTERDEPENDENCE

"The Survival of NATO is as likely to be decided in the Middle East/Persian Gulf as on the plains of Central Europe".

Richard C. Steadman
"Report to the Secretary of Defense on the Military Command Structure".
Department of Defense, July 1978.

A. THE TAXONOMY OF ENERGY/ECONOMIC INTERDEPENDENCE

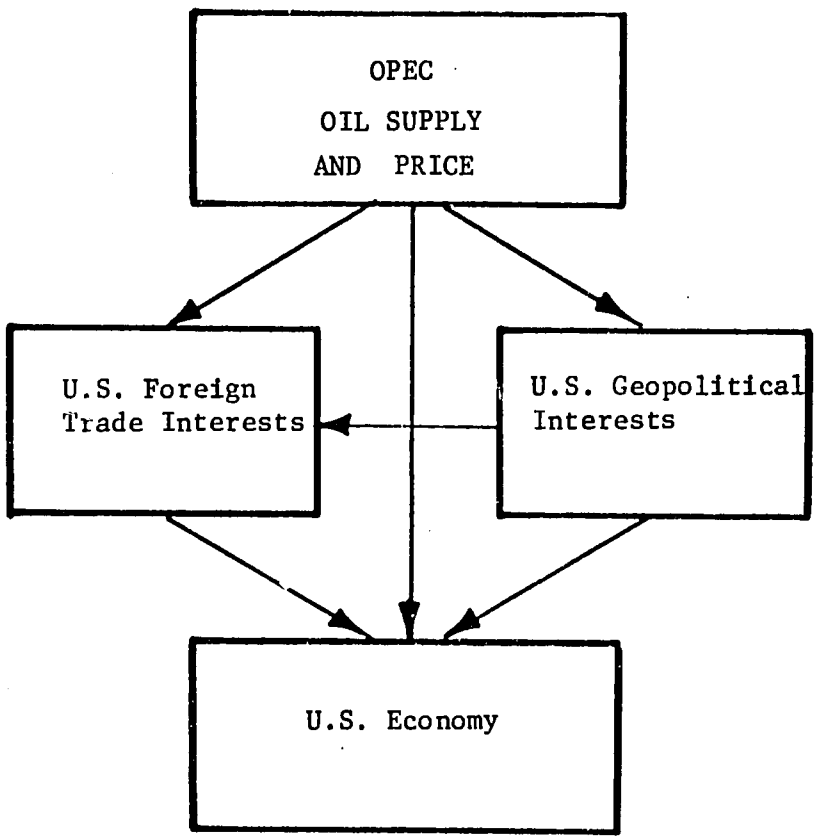
Energy/economic interdependence between the US and developing countries is dominated by the phenomenon of OPEC and the implications of rapidly increasing world prices for oil. Within that general context, however, interdependence flows through a variety of effects and relationships. At the most general level one can distinguish three avenues of interdependence illustrated in Figure 2 as follows:

1. The direct effects of higher world oil prices and potential oil shortages on the U.S. economy both in the short term (following a price rise or curtailment) and the long term (in the way of reduced economic growth).
2. The effects of higher world oil prices and recycled petrodollars on the demand for U.S. exports and thereby on the U.S. economy.
3. The effects of higher world oil prices and OPEC control of oil supply on political allignments, U.S. geopolitical interests and, thereby on U.S. economic interests.

The ways in which OPEC supply on pricing actions affect these interests are complex and change with time. Even the basic structure of the world oil market is changing rapidly, generally in ways to increase the power of the producing countries[31].

Figure 2

U.S. INTERESTS AND OPEC ACTIONS



For example, before 1974 the great majority of OPEC oil was brought onto the world market by the private oil companies. In 1973, 92 percent of international oil flows passed through the control of these companies. The interests of the OPEC countries in selling directly to other governments or national oil companies has grown rapidly, however, and by 1979 only 58 percent of international oil sales were made by the private companies. Concessionary arrangements such as those being implemented by Mexico and Venezuela in the Caribbean and Central American regions, although of immediate benefit to the importing countries tie their economies more and more tightly to the political interests of their oil suppliers. This trend increases the power of individual OPEC countries to influence importing countries on a wide variety of issues such as Palestinian rights and the increases in oil prices themselves. It is also introducing rigidities into the supply system which will adversely affect its ability to respond in case of disruption of supply.

The phenomenon of the increased participation of producer countries in down stream activities (refining, petrochemical operations and marketing of oil products) further increases the variety and extent of OPEC's involvement in the world economy. From the point of view of U.S. economic interests there would appear to be both positive and negative aspects of this phenomenon. The movement of refining operations to the oil producing countries moves both control and economic activity away from the OECD countries. In a future world of production capacity matching demand, the movement of economic activity would not be of great significance because of the highly capital intensive nature of refining and petrochemical activities and the probability that much of the design and construction of new refineries and petrochemical plants will be by U.S. firms. The more important danger

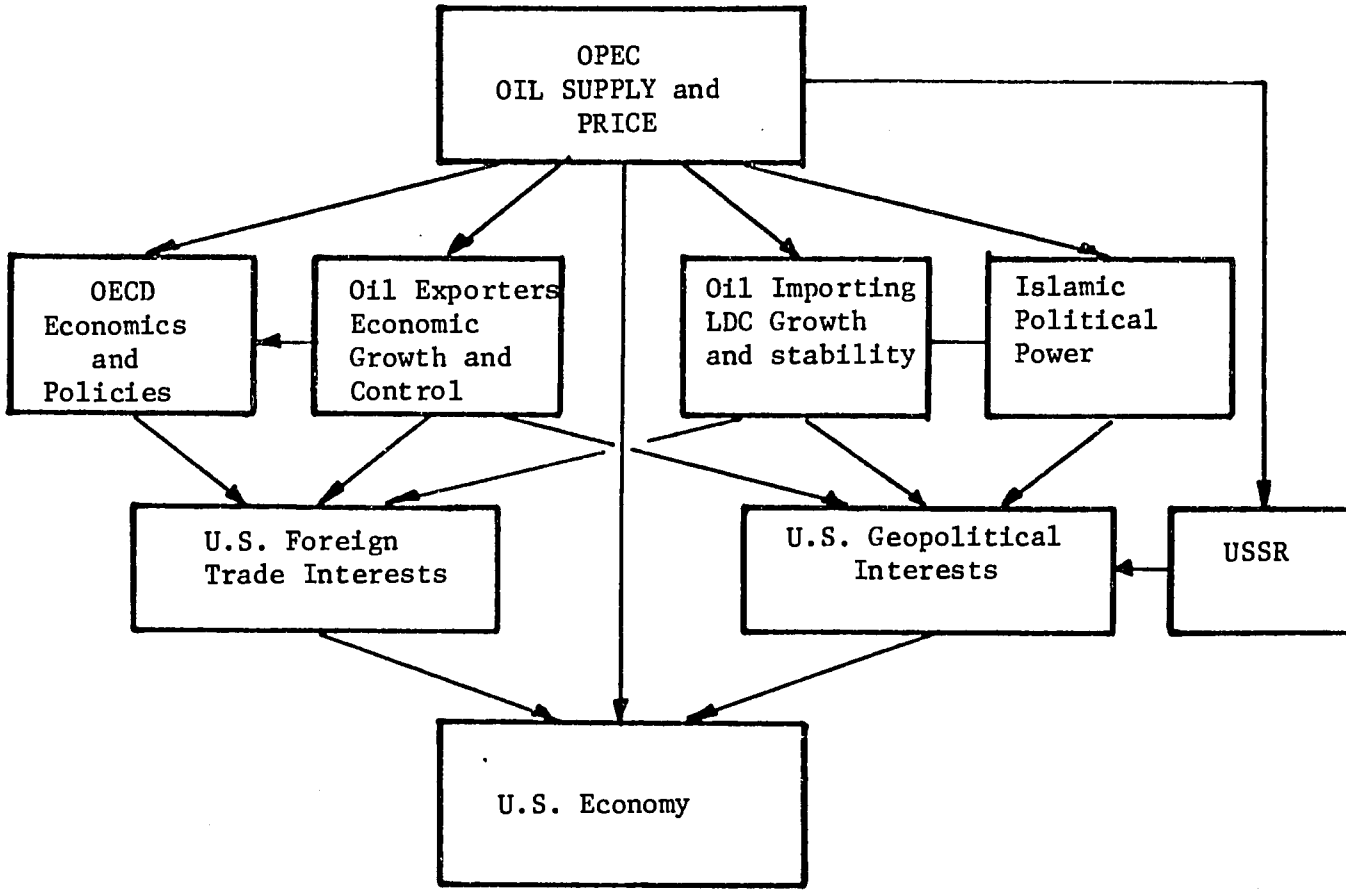
lies in the capability of the OPEC producers, through the context of inexpensive crude supplies, to undercut world prices and capture world markets to their aggregated benefit. This possibility would add to the protectionist tendencies induced by balance of payments problems arising from high OECD imports of high priced crude oil. Another form of OPEC participation in the marketing phase, was discussed actively some years ago but shows no sign of materializing.

In Figure 3 we have expanded the relationships of Figure 2 to include some intermediating phenomena. The effects just discussed are included in the box marked "Oil Exporters' Economic Growth and Control".

The relationship between the U.S. and OPEC also involves the other industrialized countries, of course. The creation of the International Energy Agency in 1974, and much of the work of that agency since that time recognizes the advantages of joint action and consistent policies in dealing with supply interruptions. But U.S. geopolitical interests may also be affected through OPEC's possible influence over the policies of the oil importing developing countries. One example of such an influence is suggested by recent discussions between the gulf states: Saudi Arabia, the United Arab Emirates, Qatar and Iraq, and the European Economic Community. The concept would involve the gulf states guaranteeing long term oil supplies at fixed prices in return for "long term cooperation" on the part of the EEC. That "cooperation" would include investment of oil export surplus funds in guaranteed European investment vehicles <u>and</u> EEC cooperation in seeking a "global solution" to the Palestinian issue (i.e., recognition of the PLO and Israeli withdrawal from occupied territories).

Figure 3

THE TAXONOMY OF U.S. LDC
ENERGY/ECONOMIC INTERDEPENDENCE



Note: only principal arrows directed toward U.S. economy are indicated. A complex set of influences upward from the U.S. through various policy vehicles could also be shown.

One of the most important consequences of the emergence of OPEC as a global economic force will be manifested, over time, as that force operates through political avenues. Political action was taken very early, in the oil embargo of 1973 but the accumulation of effective political confidence is a gradual process. The exertion of force will become more complex and consequential as the OPEC states become modern industrial and military powers.

OPEC, if it weren't so successful, would be as notable for its diversity as for its unanimity. It is probable that the economic and political power of the OPEC states will be exercised through allignments other than OPEC itself, but whose power depends ultimately upon the success of OPEC.

New political confidence and strength may also operate through Islamic or pan-Arab movements such as the Organization of Islamic Conference as well as through individual states or ad hoc allignments between states. As an example, in September 1980, Saudi Arabia and Kuwait were withholding funds to the International Monetary Fund in protest to the denial of observer status to the PLO. This is the significance of the box labelled "Islamic Political Power" in Figure 2.

There are many other indirect routes of influence of OPEC oil supply and price actions on U.S. interests. One which should be mentioned, although it is not within the scope of this paper, is USSR-US relationships. There are large differences of opinion on the prospects for Soviet oil production with at least some possibility of the necessity for the Soviet Union to import oil within the decade. The significance of this possibility stems from the difficulties that they would have paying for imported oil. Net petroleum exports now account for 50 percent of the

Soviet's hard currency earnings. If the USSR had to import 2 million barrels of oil per day, their total deficit would be an unmanageable $40 billion. At the least, this would add upward pressure on world oil prices, of the order discussed above. The pressure thus put on the Soviet Union to secure access to oil could also have, in the understated words of one writer, "important political and military consequences for all of us"[32].

In Figure 3 we have concentrated our attention on the flows of influence or effects from OPEC and the other developing countries toward the U.S. One could also show a number of effects flowing in the other direction, of course. For example, U.S. energy decisions and policies (e.g. on stockpiling, synthetic fuel development, and import quotas or fees) and foreign policies (including military and developmental assistance can have a strong influence both on the policies and actions undertaken by developing countries, including OPEC, and upon the impacts resulting from those actions (e.g. the price impacts of supply reductions). Implications of the taxonomy of Figure 3 for U.S. policies towards the oil importing countries are discussed briefly in the final section of the paper.

The relationships to which we will pay particular attention in this paper are those involving the non-OPEC or oil importing developing countries. As we shall see, those countries represent a vehicle for constructive relationships with OPEC, for there are some basic concerns and interests shared by those countries, the U.S. and OPEC.

B. U.S. ECONOMIC AND SECURITY INTERESTS

The U.S. is carrying a heavy economic burden due to current dependence on imported oil. At current levels of oil imports and prices, oil imports

represent a balance of payments cost of about $90 billion and is expected to grow over the next several years. But the real cost of an imported barrel of oil is even greater than what is apparent on the surface[33]. A reduction (or increase) in oil imports (say by a million barrels per day) by the U.S. affects the world price of oil and thus affects the total cost of imports. This "monopsony effect" also has an influence on the inflation rate. There is also an effect on the overall balance of payments and thereby on the dollar exchange rate. The import premium due to these various effects has been estimated at $1 - $28 per barrel, but we would give greater weight to the lower end of this range. Estimates of the premium that should be attached to imported oil to account for the price, inflationary and other macroeconomic effects of supply interruptions range from $1 to $20 per barrel. Clearly this number depends both on a number of imponderables such as the probability distribution of cut-offs of various amounts and durations as well as on future U.S. actions such as stockpiling. Overall, however, a range of $2 - $30 per barrel appears reasonable as a total import premium[33].

The direct cost to the U.S. economy of possible supply disruptions can be severe and represents a cost that must also be attributed to imported oil. The Energy Modeling Forum concluded that an uncompensated disruption of 6 MMBD could have an economic cost to the OECD countries easily in excess of $500 billion. The Congressional Budget Office has estimated that the loss of Saudi Arabian production (9-10 million barrels per day) would cost the United States over $250 billion and increase the inflation rate by 20 percent; other estimates are consistent with these[34].

Of course, these are hypothetical numbers and they are important only in terms of the probability of military, political or social events causing a disruption in supply. Predictions of Gulf politics are not very reliable. Nevertheless, it is pertinent and disquieting to be reminded (by Walter J. Levy) that "13 of the present Arab heads of state, or more than half of them, have reached power by forcibly removing their predecessors in one way or another; and in the past 15 years Arabs have fought Arabs in 12 fierce wars"[35].

Our current energy situation in which over a third of our total oil supplies come from OPEC suppliers and much of that from the potentially unstable Middle East represents a clear and present national security problem. This situation has become considerably worse since 1973 and during that time we have looked inward for solutions to the "energy crisis" as though unaware that the "crisis" was inately international. Some are coming to believe that with our $200 billion dollar defense budget we are building a Maginot line to face the Soviet Union in one direction while a threat of at least equal magnitude builds up behind us.

A recent study, directed by David Deese and Joseph Nye explored these national security issues in some detail and the resulting book presents an eloquent and persuasive case for an egregious failure of national perception[36]. Although there are no simple solutions to the energy-security problem, as to other national security issues, it is clear that insufficient attention has been paid to it. Diversification of world oil production, substitution of domestic fuels, creation of an effective national allocation plan, creation of strategic production capacity, a much more serious international stockpiling effort and more effective regional and international emergency allocation planning would move in the

right direction.

As seen in the next section some specific measures taken with regard to the oil importing developing countries could have multiple benefits, including a contribution to a resolution of the national security problem.

C. THE IMPACTS OF HIGHER OIL PRICES ON OIL IMPORTING DEVELOPING COUNTRIES

In Chapter II we discussed some of the direct effects of higher world oil prices on developing countries. At current import levels, about 5 MMBD, those countries will have paid about $65 billion in 1980 for oil. As pointed out by Blitzer, the increase in oil import costs over the past two years, over $30 billion, is greater than the entire OECD development assistance effort[37]. In several countries shortages of petroleum fuels have reduced agricultural and industrial production and hampered the shipment of crops to market. Higher kerosene prices have created greater and greater pressure on already scarse wood fuels with resultant social costs and environmental damage.

While these direct effects of oil price increases are dire enough they are augmented by the indirect effects due to the impact of higher energy prices on the industrialized economies. Recession in the OECD economies have reduced markets for LDC commodity exports and, perhaps equally as important in the long run, have stimulated protectional attidutes towards manufactured goods.

One result of all of these trends has been a rapid growth in the total debt of the non-oil LDCs from $60 billion to $300 billion since 1970. Debt service has increased steadily from approximately $5 billion to $50 billion in that time. Although the increased borrowing has dulled or delayed somewhat the total impact of oil price increases, it is clear

that productive investment, on which economic and social development depend, is being seriously affected and overall growth substantially reduced.

Referring to the projections contained in Table VI above, and assuming that real world oil prices will increase at around 3 percent per year, the LDC net annual oil import bill will increase from its current level of $65 billion to $139 billion (in constant dollars) by 1990. Even with more moderate assumptions, it is clear that, even under calm world political conditions, the oil import burden in developing countries will be increasingly intolerable.

The huge capital flows produced by increased oil prices are stretching the capability of the world financial system. The balance of payments deficit of the developing countries for 1980 has been estimated at nearly $70 billion, and that of the developed countries at $50 billion. The OPEC surplus could reach $115 billion in 1980 and up to $500 billion by 1985. These issues are dealt with in another paper in this series, but raise a serious question of whether "our national and international financial system can cope with this problem without risking sustained recessions, a slow rate - if any - of economic growth, high rates of inflation, widespread unemployment, industrial and national bankruptcies, and political upheaval"[35].

D. THE INTERRELATIONSHIP OF INTERESTS: U.S. AND OIL IMPORTING LDCs

The effects of higher oil prices and supply insecurity on oil importing developing countries are of concern both to the US and to OPEC. From the US perspective there are several national interests involved:

1. World Oil Price

The only group of countries expected to increase their oil demands between now and 2000 is the LDCs. Currently accounting for 14 percent of world oil consumption they are expected to account for over 30 percent by 2000. OPEC and the oil importing developing countries are expected to increase their demand between now and 1990 by roughly the same amount: 4 - 4.5 MMBD, while total world demand itself is expected to grow by only about 4 MMBD. Thus variations in the growth of demand in the oil importing LDCs can have a strong influence on world oil prices. Consequently, reductions in that growth which don't harm economic development are in the US interest. As discussed previously, a demand reduction of 1 MMBD could reduce prices by up to $2.40 a barrel, and result in benefits to US consumers of some $14 billion. As discussed above, there is a corresponding interest of LDCs in reduced U.S. oil consumption which would have corresponding benefits.

2. Security of Supply

Although difficult to quantify, an improvement in the oil production-demand balance in non-OPEC LDCs would reduce the impact of a supply disruption on the US economy. This would come about for two reasons; increased supply from non-OPEC LDCs could reduce the market share of OPEC producers and lessen the impact of their loss. Secondly, if there were a world-wide disruption in oil supply it would be incumbent on the US, perhaps through the IEA, to share available supplies. Reduced LDC import requirements would be beneficial under these circumstances.

3. Geopolitical Interests

Current levels of oil prices and imports into several developing countries are such as to raise serious questions of social and political stability. In

several countries over the last several years, (e.g., Egypt, Peru and Jamaica) attempts to increase fuel prices towards world price levels, have lead to serious social unrest. Diversion of funds earmarked for investment to pay for imported oil, and the resultant reduction in growth and employment, can also lead to social and political problems. The resultant national and regional instabilities, whether or not reinforced by outside political forces, can have serious security implications for the U.S.

4. International Financial Concerns

There were wide-spread concerns after the 1973-74 price rises that the international financial system could not handle the unprecedented shifts in capital flows. For various reasons those fears were exaggerated[15]. The level of debt now being amassed by the oil importing developing countries (estimated at around $300 billion), however, poses new threats to the stability, or at least the health of the international banking system. Although this issue is beyond the scope of this paper, it is obvious that US private banking interests as well as the US national interest in a stable international financial system are engaged in finding solutions to LDC oil import dependence.

5. Commercial Interests

U.S. commercial interests are affected by the energy problems of oil importing developing countries in two basic ways. First, reductions in economic growth rates due to higher oil prices reduce the growth of demand for US exports. Second, as will be explored in some more detail below, the energy strategies that must be pursued by LDCs to reduce oil import dependence can provide new export markets for US manufactures.

6. Humanitarian Concerns

In recent years one element of the rationale for the US foreign assistance program - or at least for the way in which the program has been carried out - was a humanitarian concern with the poorest populations of the poorest countries. The satisfaction of basic human needs - food, shelter, health and education - was a basic aim and the processes of aid "trickling down" from more macroeconomic assistance were found to be too "absorbent" or imperfect. The importance of this criterion is clear from the requirements of justification of AID projects and the fact that above a certain income level, (about $1200 per capita GNP) countries "graduate" from the foreign aid program. It may be true that when the "basic human needs" criterion was established in the early '70's it reflected a concern with political and social stability and Western orientation. Nonetheless it must be assumed that a humanitarian concern for the world's poorest populations is a common concern of the developing and developed countries.

7. Global Environmental Concerns

Global environmental concerns also tie the interests of the US closely to those of the developing countries. For example, increased energy consumption in the LDCs will be predominately through increased combustion of fossil fuels. This will increase the emission rates and atmospheric concentrations of carbon dioxide with eventual risk of global climate modification. Deforestation due to pressure on wood supplies has implications for productivity at the continental scale.

U.S. concerns for the proliferation of potential nuclear weapons materials could also be classified a global environmental concern. As discussed above, concern with increased access to plutonium in developing countries was a major argument for the nuclear policies of the Carter administration.

These seven concerns should form the basis for the U.S. foreign assistance program in energy. Unfortunately, despite the existence knowledgeable advocates for these interests, they have not been translated into a consistent set of policies and programs. Until very recently, the content of the program and the countries involved have been determined almost entirely by "humanitarian concerns". Nuclear non-proliferation concerns entered the picture in 1977 and increasingly, the issue of world oil supply has been a consideration.

E. THE INTERESTS OF OPEC REGARDING OTHER DEVELOPING COUNTRIES

To what degree do the OPEC countries have interests which are common to those of the U.S. with respect to oil importing developing countries? There is, in fact, very fundamental commonality. There is a clear congruence of interest in the stability of the international financial system as that might be affected by inadequate petrodollar recycle or debt failure. Furthermore, in addition to national and regional assistance and concessionary pricing programs, OPEC as an organization has demonstrated a practical concern with the impact of oil price increases on the oil importing developing countries. Some in the West have expressed amazement at OPEC's success in maintaining solidarity with and the support of other LDCs, considering the crushing impacts of increased world oil prices on many LDC economies. Such amazement, however, underestimates both the international trade grievences of the developing countries and the historical significance of OPEC's success as viewed by much of the third world. OPEC can be justifiably viewed as "the single most successful attempt by a group of developing countries to reverse

sharp and often disadvantageous fluctuations in export prices of raw commodities"[38]. The support of OPEC in the UN and fora such as the Conference on International Economic Cooperation results in large part from the envious endorsement of the concept of stability and control over commodity export prices. OPEC fosters this view by avoiding where possible the discussion of energy pricing outside of the context of broader international trade and pricing issues[39].

OPEC has also, since 1974, been developing a vigorous bilateral and multilateral aid program which in recent years has expanded from a rather narrow political and cultural focus to a broad scale assistance effort. According to The Development Assistance Committee of the OECD, OPEC's official development assistance, including grants and loans at concessionary terms, totalled about 5 billion dollars a year between 1975 and 1978[40, 41]. Disbursements in 1979 were reduced considerably due to the critical disappearance of Iranian aid. Although OPEC assistance as a fraction of GNP dropped from a level of 3.7 percent in 1975 to 1.8 percent in 1979 this was still far greater than the U.S. figure of 0.2 percent (in 1979).

A significantly expanded energy assistance program has been under conceptual development within OPEC for some time. The Long Term Strategy Committee has recently decided to set up a new global Fund for Energy and Development. The Fund is viewed as receiving capital from the industrialized and OPEC countries. The amount contributed by the industrialized countries would depend on the world inflation rate as reflected in price increases of goods exported to the poorer LDCs[41]. Grants or loans would be based in part on future oil price increases. For the purpose of this paper it is of interest to note that one purpose of the loan policy would be to promote the procurement of goods and services

available within the OPEC countries.

There appears to be disagreement within OPEC as to how to raise capital for the new development agency. Lybia, for example, has proposed a flat 50¢/bbl. levy on export prices while Saudi Arabia prefers a per capita basis. Differences of opinion also exist on participation of OECD countries in this or related facilities. In the meanwhile a number of more specific concessionary supply agreements or regional programs have been initiated. A particularly interesting one is the Venezuela-Mexico Oil Support Program whereby those two countries would guarantee approximately 160,000 barrels of oil a day to nine Central American and Caribbean nations[42]. The supplier countries will charge the prevailing world rates for the oil but will return 30 percent of the cost in the form of a five year loan at 4 percent annual interest.

Despite a number of difficulties related to the replacement of Venezuelan oil by Mexican crude, the program is significant in a number of ways. First, the Venezuelan-Mexican oil supply program is representative of one among many viewpoints within OPEC regarding the problems of oil importing countries. It manifests the concern of at least those two countries with the potentially crucial regional economic and political impacts of continued high costs of oil imports to poorer LDCs.

Secondly, the agreement is of interest in demonstrating the fluidity of de facto OPEC boundaries. Mexico, like other non-OPEC oil exporters, has been happy to go along with increasing world oil prices. All oil exporters can, in a sense, be considered de facto members of OPEC, although the exploiters of the North Sea may not be happy with such a designation. At the same time, Venezuela has created important links now with a non-OPEC producer and regional consumers.

For our purposes a third aspect of this program is of particular significance. There are strong indications that the program may not achieve its objectives of improving the energy balances of the countries in the region for lack of well formulated alternative energy programs in the recipient countries. This does not result from a basic lack of opportunities for significant increases in energy efficiency or the lack of alternative energy resources in the countries. Several recent studies have, in fact, suggested the contrary[43]. The problem is in translating those opportunities into well formulated projects that can justify significant investments.

These issues are addressed in other sections of this paper but suffice it to say here that the effective application of OPEC funds to energy projects in the oil importing developing countries is part of a very large international problem which will require both institutional and policy innovations on a very large scale.

V FUTURE PROGRAMS AND CONCLUSIONS

"The critical interdependence of nations in the energy field requires an unprecedented degree of international collaboration in the future. In addition it requires the will to mobilize finance, labor, research and ingenuity with a common purpose never before attained in time of peace; and it requires it now."

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A. INTRODUCTION

There have been two basic concepts developed through this paper. First, that energy/economic interdependencies between the United States and developing countries are highly complex and of great strategic and economic importance to the nation. Second, that there are a number of policy and programmatic avenues open to this country which would be of significant benefit both from the point of view of national security and U.S. economic development. These opportunities arise particularly in the context of the triangular relationship between the U.S., OPEC and the non-OPEC LDCs. Some of these opportunities are discussed in more detail in this section. A third element which will be added to the logic in this chapter is that there has not yet been developed a solid intellectual and policy foundation for a consistent set of government and private programs in this area. The development of such a foundation is of urgent importance.

Although it is beyond the scope of this brief paper to formulate potential programs or policies in any sense, one can identify, based on the discussion of this paper a number of areas which warrent increased attention. Many of these are highly interrelated. The following should be considered more as representative than as complete.

B. PETROLEUM DEVELOPMENT IN NON-OPEC DEVELOPING COUNTRIES

There has been a great deal of discussion recently about the prospects of increased oil production in non-OPEC developing countries. The discussion takes many forms but often is based on the argument that: 1) from a macro-geological point of view there should be substantial petroleum resources

to be found in the non-OPEC LDCs. 2) Much of the developing world has not been adequately explored. Less than 4 percent of the wildcat wells completed in 1978 were drilled in the non-OPEC developing countries[44].

The World Bank has estimated that the oil importing developing countries will be producing 3.6 MMBD in 1990 and requiring imports of 7.6 MMBD. They estimate that a more active exploration and enhanced recovery program in those countries could lead to increased production by 1990 of about 1.2 MMBD and up to 4 MMBD by 2000[5]. Of course, there are a wide variety of problems or constraints associated with actually achieving those levels of incremental production. Investment is discouraged in many instances by political uncertainties, risks of nationalization and even territorial disputes[45,37].

There has been considerable controversy over the years as to whether the international oil companies would explore for and produce this oil in an optimal fashion. The large oil companies have generally not supported U.S. or World Bank programs to supplement exploration and production in LDCs. But the interests of the oil companies and those of both the U.S. and LDC governments may be quite different in this situation. For example, for many countries a small production of a few tens of thousands barrels per day could be very significant but may be very low on the list of promising and economic areas available to a multinational company. Political risk is also costed quite differently by the host country, the U.S. Government and an international oil company.

James Plummer[46] has calculated the benefits that would accrue to oil importing countries through a lowering of world oil prices from an accelerated oil development program in non-OPEC LDCs. He assumed increased investments in oil exploration of $800 million in 1981, increasing to $3 billion in 1985 and remaining at that rate thereafter. This program would lead to

1 - 4 MMBD by 2000 depending on discovery success and world oil price reductions of $0.50 - $1.50 in 1980$. (Note that these are conservative assumptions compared to estimates of the Energy Modeling Forum cited earlier.) Under other very conservative assumptions (for example, that multilateral investment of this kind stimulates no new private investment), the indirect rates of return calculated for such a program range from 5 percent (low finding rates and $0.50/barrel effect on world oil prices) to 33 percent (high findings rates and $1.50/bbl. effect).

In 1980 and 1981 discussion of U.S. activities in LDC oil development became closely tied to the question of a new energy affiliate of the World Bank. Increased loans for oil development was to be a major element of the new entity which was not supported by the Reagan administration, in part because of its emphasis on bilateral aid rather than multilateral vehicles. Nonetheless oil development in non-OPEC developing countries warrents serious attention in any U.S. foreign assistance program which responds to the needs outlined in this paper.

C. INCREASED ENERGY EFFICIENCY

Increased energy efficiency, particularly in the transportation and industrial sectors, appears to be the quickest and most cost effective way of improving the energy economy of most oil importing developing countries. This is, however, an area of foreign assistance which is virtually entirely neglected. Along with support for national energy planning, the technical, policy and investment analysis of increased energy efficiency should be a high priority in a revamped assistance program.

Based on studies in a number of developing countries it has been

estimated that determined conservation measures in industry and transportation could reduce LDC oil demand by 10 - 20 percent in the year 2000[47]. Roughly one half of this savings would result from better management practices and measures requiring very little capital investment. The remaining 5 - 10 percent savings would result from capital investments with various, but generally short, payback periods.

There are basically two stages that should be distinguished in an energy efficiency program for a developing country. The first consists of a progressively more detailed set of energy assessments, surveys and audits. They progress from the level of national accounts to sectoral demands for energy products to audits of individual firms or transportation means. From these surveys and audits specific recommendations can be made for those management and policy initiatives which, with little capital investment, can accomplish the initial energy improvements. This stage is costly only in terms of the use of specialized, trained professionals. It is potentially an extremely effective area for technical assistance.

The second stage of implementing a national energy efficiency program is in preparing, financing and implementing retrofits, mode shifts and other actions requiring some amount of capital investment. Here again, the most serious constraint may be in trained manpower since capital appears to be available for cost effective conservation projects at the multilateral lending institutions. In the next section we discuss some implications of these conservation strategies for U.S. commercial interests.

D. U.S. ALTERNATIVE ENERGY EXPORT POTENTIAL

Given the disastrous potential consequences of current levels of oil imports, many developing countries are now taking initial steps towards diversifying their energy systems. An overview of national energy programs and advanced planning of the major international financial institutions reveal several recurrent components to these strategies for reducing oil imports, in addition to conservation measures:

- increased domestic production of conventional fossil fuel resources
- continued expansion of hydro-based electrical systems and possibly nuclear systems
- increased use of renewable energy sources such as solar thermal and electric systems, wind power, biomass alcohol and small scale hydropower.

The World Bank has estimated that the investment required for these programs over the next ten years - solely in oil importing developing countries - will total over $600 billion[5]. The average annual rate of $60 billion is a factor of five higher than the corresponding rate of investment during the 1966-1975 period.

These figures suggest a significant potential for exports of U.S. energy equipment. In the remainder of this section we examine, in a very preliminary way, the order of magnitude of those possibilities. In particular we consider technologies and resources which can substitute for imported oil. Investment in these technologies will be supplemental to investment in oil development, refinery construction, oil based thermal power stations and other central station power generation.

In a recent report Palmedo and Baldwin analyzed the potential contribution of various renewable energy technologies in reducing LDC oil imports[47]. These estimates were of technical feasibility, considering cost competitiveness, but not financing constraints.

The major biomass-based technologies and their estimated potential contributions to substituting for total non-OPEC LDC oil demand in 2000 are:

- o ethanol, made primarily from sugar cane and used primarily as a transportation fuel (mixed with gasoline): 1-2 percent of demand.
- o methanol, made from wood materials and also used for transportation: 1-2 percent.
- o biogas (methane), made by anaerobic digestion of animal and plant wastes in rural areas and used for cooking, lighting and other rural uses: 0-0.5 percent.
- o biomass for industry, used either for direct burning or for a charcoal/oil slurry: 1-2 percent of LDC oil demand.

Thus, biomass technologies are considered to be able to replace 3 - 6 percent of LDC oil demand by 2000.

Among the other new technologies, solar offers the greatest potential. Solar applications and their potential for oil substitution for non-OPEC LDCs are as follows:

- o solar thermal, i.e., direct uses primarily for water heating in industry and in commercial and residential buildings: 3-4 percent of demand.
- o solar electric (central), a still experimental and highly capital-intensive technology involving large land areas of collectors, a tall receiver tower, special boilers and conventional turbo-generators: optimistically, 0-1 percent.

- o solar electric (decentralized), photovoltaics for rural areas where the costs of central-station generation and long-distance transmission are prohibitive; used for irrigation, village street lighting, public buildings and residences: 0.5-1.5 percent.

Other renewable technologies include wind, small-scale hydroelectric power and geothermal. Their potential contributions are as follows:

- o wind, used for electrical generation to substitute for oil-fired (primarily diesel) generators and for water pumping: 1-1.5 percent of LDC oil demand.
- o small scale hydro, used to electrify villages far from central grids, replacing or avoiding diesel generation: 0.2-0.4 percent of LDC oil demand.
- o geothermal energy, used for industrial process heat, residential-commercial hot water, and electricity generation: 0.5-1 percent of demand.

Thus, solar and other renewable technologies are estimated to be able to replace 5 - 9 percent of oil demand by 2000.

In the short to intermediate term coal can substitute for oil in two ways: replace oil in current and new electricity plants; and replace oil in industrial steam generation. Longer term possibilities are the use of coal as chemical feedstocks and as a basis for synthetic fuels. In terms of new export potential, coal use for industrial steam generation or cogeneration would appear to be important. The World Bank projects that 144,000 Mwe of new thermal capacity will be built over the next decade in the LDCs[5]. In many countries at least 10 percent of such capacity could be coal or natural gas based cogeneration in industry.

In Table VIII we have summarized the oil substitution potential of these various technologies. In some cases we have scaled our original estimates for the year 2000 back to figures which might apply to 1990 giving consideration to rates of market penetration and economic competitiveness. As shown in the table, by 1990 a total of 2.5 million barrels of oil equivalent per day can be saved or, in other words, can be supplied by alternative technologies. By 2000, that figure becomes 7.4 million barrels per day, or 35 percent of total LDC oil demand.

The figures given above can be used to make a very rough estimate of the potential market for non-conventional US energy equipment in oil importing LDCs. The very large uncertainties in this analysis should be emphasized. Table IX presents estimates of the capital costs of various new and renewable technologies discussed above. These costs correspond to the capital investment that must be made to produce the amount of energy equivalent to a barrel of oil per day. For comparison, note that at current world oil prices, it costs $13,000 per year to import 1 million barrels of oil per day. Since we are interested in exports of equipment and services, we must estimate the fraction of that investment that is imported. Those estimates are given in the second column of the table. The final column gives, for each technology, an estimate of the imported capital equipment required to achieve the levels of oil savings estimated previously (given in Table VIII and repeated in column 3 of this table). It is obtained by simple multiplication of the first three columns.

TABLE VIII

EFFECTS OF LDC OIL SUBSTITUTION STRATEGIES

(Million Barrels per Day Oil Equivalent)

	1980	1990	2000
Base Case Oil Demand	6.5	11.4	20.9
Savings from:			
Biomass		0.2	0.9
Solar and other renewables		0.3	1.3
Conservation		1.0	2.9
Coal		1.0	2.3
Total Savings		2.5	7.4
Adjusted Demand		8.9	13.5

TABLE IX

1990 IMPORTED CAPITAL REQUIREMENTS TO

ACHIEVE TARGETED OIL SUBSTITUTION

Technology	Average Capital Cost per Barrel of Oil saved per day ($ thousand)	Fraction of Capital Cost Imported	Oil Savings 1990 (Million of Barrels per day)	Imported Capital Expenditures $ Billion
Biomass	40	0.4	0.2	3.2
Solar and Other	70	0.6	0.3	12.6
Conservation	25	0.6	1.0	15.0
Coal	40	0.7	1.0	28.0
				58.8

The conclusion of the analysis is that there is a potential market for new energy technology in the third world of between $50 and $60 billion between now and 1990. The corresponding figure for the decade between 1990 and 2000 is about $150 billion. These are profitable investments in themselves and would add up to 2.5 MMBD to world oil supplies by 1990 and 7.4 MMBD by 2000.

As a check on the reasonableness of those figures, we can compare them with the World Bank estimate, cited above, that the energy investment required in oil importing developing countries over the next ten years will be on the order of $600 billion. Given the fact that, as shown in Table VIII, we are affecting about 20 percent of oil demand in 1990, and oil represents 60 percent of total energy demand, the two sets of numbers are at least consistent. We have not estimated the fraction of this total export market which could be captured by the U.S. Although other countries currently appear to have more vigorous national marketing efforts under way, U.S. industry should be competitive in virtually all the technologies considered.

It should be noted that we have focused on a part of the energy export market with special characteristics in focusing on new and renewable technologies. Unlike the traditional, large scale, market for energy equipment and services (pipelines, refineries, large power plants, etc.) these technologies have small unit size. They also are produced to some degree by U.S. firms with limited overseas experience, firms which require some assistance in exploiting fully this potential market.

A further U.S. interest in promoting these kinds of energy technology exports should be considered. Reducing oil imports in developing countries will both contribute to economic (and social) development of those countries and will reduce pressure on world oil supplies and world oil prices. These are increasingly recognized as important goals of U.S. foreign assistance.

E. NUCLEAR POWER

The installed nuclear power capacity in developing countries is now approximately 2,400 Mwe and another 10,300 Mwe of capacity is under construction. Various studies have projected LDC nuclear capacity at 80 - 200,000 Mwe. by 2000[48]. These estimates have been decreasing monotonically with time. The role of nuclear power is limited by its economic competitiveness including the high imported fraction of the capital investment and unit size considerations. In countries with significant accessible hydro potential; it is unlikely that nuclear power can compete economically. Its competitiveness with indigineous and even imported coal requires evaluation at the national level. But for those many countries dependent on imported oil for future electricity generation, nuclear power may indeed be competitive.

A crucial consideration, however is one of size. For reasons of system stability a general rule of thumb is that a single plant in an electric system should not represent more than 10 to 15 percent of total installed capacity. Since the smallest Western nuclear plant commercially available has a capacity of over 600 Mw., the system must be at least

4000 Mw to accomodate such a plant. By 1990 it has been estimated that 19 developing countries will have a total system capacity of at least 5000 Mw[50]. If a smaller nuclear power plant were available, say one with a capacity in the 200 - 300 Mw range, then the system need only be 2000 Mw and an additional 13 countries would qualify by 1990. Thus the potential application of nuclear power plants increases rapidly as the size of commercial plants decreases. New utility system load shedding technology is also increasing somewhat the size of a unit that can be accomodated in a given size system.

The difficulty of producing a marketable power reactor in the 100 - 300 Mw size range is one of economics not technical feasibility. The International Atomic Energy Agency has estimated that a 600 Mwe plant costs only 20 percent less than a 1000 Mwe plant[51] and the scale-economy curve is even steeper at lower power levels[52]. Nevertheless, several non-U.S. firms are developing smaller scale power plants for the world market, including developing countries. These include a U.K. conglomerate led by Rolls Royce and Associates, the French firm Alsthom-Atlantique and the German firm Interatom[53]. But the most active "small" reactor program is that of the Soviet Union which has already sold under favorable terms at least 20 of its 440 Mwe reactors. Finland is working with the USSR in developing markets in the third world for this reactor.

What impact would the use of nuclear power in developing countries have on world oil demand? If an additional 80,000 Mw of nuclear power is committed by 1990 and in operation by 2000, this would eventually amount to an oil savings of about 2 MMBD and an incremental nuclear power investment of around $150 billion.

F. SECURITY AGAINST SUPPLY INTERRUPTIONS

As discussed above, the amount of attention and effort thus far devoted to reducing the impacts of major oil supply interruptions has been minimal compared to the magnitude of the threat to U.S. economic and security interests. Serious stockpile programs, emergency allocation schemes, supply diversification programs warrent much more serious attention in an analytical context that accounts properly for the real cost of imported oil. Supply interruptions and their management must be viewed from an international perspective, not only within the IEA context - which clearly needs more effective definition - but also in terms of maintaining life-line supplies to oil importing developing countries.

G. THE OPEC CONNECTION

Despite discouraging precedent in the North-South dialogue, there would appear to be substantial opportunities for combining U.S. technology and management with OPEC capital to implement energy programs in developing countries which are of policy concern to both parties. These mutual interests are not restricted to energy. Indeed, the triangular system of capital from the capital surplus oil exporters, capital and technology from the industrialized countries and development of the oil importing developing countries can have greater benefits than resolving energy problems. Raul Prehisch, for example, views this combination as accomplishing an investment in "energy, agriculture and changes in the production structure to increase Third World reciprocal trade"[55]. In the energy area, the early experience with Kuwait's lending program in Africa and the Mexican-Venezuelan program

in Central America and the Caribbean indicate that the objectives of both the donors and the recipients are being thwarted by lack of well defined energy development projects. The introduction of U.S. planning capability and technology, if carefully carried out, could be of benefit to all concerned. If experience is any guide, the best way of bringing about a partnership between the U.S., OPEC countries and oil importing developing countries is not through large political fora, but in the context of specific regional and national energy projects.

H. U.S. FOREIGN ENERGY ASSISTANCE

Although the importance of energy as part of our overall foreign assistance program has been recognized by many people for some time, energy is still a small and poorly structured part of that program. The most severe current problem of economic development is being treated if not with complete neglect at least inadequately. The program has been divided between the Department of Energy (including large scale country energy assessments and bilateral technical cooperation) and AID (including smaller scale planning assistance, rural energy development and, particularly fuelwood programs). It has suffered from inadequate definition and coordination and a portfolio of activities which has been imbalanced and incomplete. We have cited above a number of areas including increased energy efficiency, alternate fluid fuel production and conventional energy resource development that clearly need more attention.

The very large uncertainties that must be associated with our knowledge of current energy supply and demand in developing countries and the uncertainties of the future supply-demand situation, coupled with the

increasing importance of LDCs in the world oil supply-demand balance argues strongly for a more substantial effort in policy research in this area. This recommendation should be extended, in fact, to overall world energy futures, in line with the discussion of the OPEC connection above.

Most importantly a reappraisal should be made of U.S. energy assistance activities starting with a clear definition of U.S. interests and an open mind as to programmatic content, participating countries and the U.S. organizational framework.

I. CONCLUSION

Energy-economic interdependence between the U.S. and the developing world is a difficult area in which to develop coherent policy. The difficulty arises because of the multiple national objectives which are joined; the number of countries and regional interests; the rapidity of change in basic factors of importance and the very large uncertainties that characterize the future. But the importance of energy-economic interdependence, as briefly reviewed in this paper, justifies a much larger effort in policy and program formulation than has been exerted thus far by this country. We must view our energy problems and policies much more from an international perspective. It must be recognized, however, that because of the very large uncertainties that characterize the future of the world energy situation, there must be considerable flexibility and contingency planning built into the formulation of international energy policy. Major features of the current world and U.S. economic situation have been determined by energy and the Third World. There is every reason

to believe that that situation will continue into the foreseeable future.

NOTES AND REFERENCES

1. J.C. McCaslin, et al., International Petroleum Encyclopedia 1980 The Pennwell Publishing Co., p 294.

2. "Commercial" fuels in developing countries include oil, gas, coal, and hydropower. Non-commerical fuels include wood and animal and agricultural wastes. See Philip F. Palmedo, et al., "Energy Needs, Uses and Resources in Developing Countries" BNL-50784, Brookhaven National Laboratory, March, 1978.

3. For additional detail, see Table 5, Appendix A.

4. See Figure 1,Appendix A, for more on U.S. energy production lead times.

5. World Bank, Energy in The Developing Countries Washington, D.C. August 1980.

6. Philip F. Palmedo, Pamela Baldwin, et. al., The Contribution of Renewable Resources and Energy Conservation as Alternatives to Imported Oil in Developing Countries, Energy/Development International, Port Jefferson, N.Y., February 1980, p.11.

7. World Bank, op. cit., p.5.

8. U.S. Central Intelligence Agency, Some Perspectives on Oil Availability for the Non-OPEC LDC, Report # ER80-10493, Washington D.C., September 1980.

9. For additional detail, see: Petroleum Intelligence Weekly issues of 3 March 80, pp. 1,6; 12 May 80, pp. 1-2; 6 Oct 80, pp.7-8; 22 Dec 80, pp.3-4

10. International Energy Agency, "Energy Prospects of OPEC and non-OPEC Developing Countries", Report No. IEA/SLT (80) 64 September, 1980.

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12. Mohnfeld, J.M., "Changing Patterns of Trade", Petroleum Economist, August 1980, pp. 329-332.

13. Joy Dunkerley and John E. Jankowski, Jr., "The Real Price of Imported Oil" The Energy Journal 1, 3, 113-118, July 1980.

14. U.S. Department of Energy, "National Energy Plan II", Washington, D.C. See also Energy Modeling Forum, "Energy and The Economy " Stanford University, Stanford California, September 1977.

15. Wouter Tims, "The Developing Countries" Chapter 5 in Edward R. Fried and Charles L. Schultze, Ed., Higher Oil Prices and the World Economy, Brookings Institution, 1975.

16. Edward R. Fried, "Energy Assistance to Developing Countries: Outlines of a U.S. Strategy", October 23,1980.

17. The first serious energy initiatives, other than nuclear power development, date from President Nixon's 1971 energy message which had its first impact on the FY 1974 Budget.

18. President Nixon, in his address of November 7. 1973, announced Project Independence and called for energy independence "by the end of the decade". See quote on p. 5.

19. For a more complete assessment of the debate and its historical development, see, D.C. Goodwin. et al., Energy Policy in Perspective Brookings Institute, Washington, D.C., 1981. Also, see Figure 1, Appendix A for an overview of the historical levels of regulated prices.

20. Much of the insight and historical information for this section was afforded by Mr. Richard Kaufmann of The Futures Group, Glastonbury, Ct., whose account of U.S. nuclear policies appeared in: "Trade and Foreign Relations Impacts", Report # 405-117-04R, a draft report prepared for the U.S. Department of Energy.

21. R. Kaufman, op.cit., p.5. INFCE is the International Fuel Cycle Evaluation.

22. Ted Greenwood and Robert Haffa, Jr., "Supply-Side Non-proliferation", Foreign Affairs, April, 1981.

23. See particularly David Rose and Richard Lester, "Nuclear Power, Nuclear Weapons and International Stability", Scientific American, April, 1978, 45-47.

24. Workshop on Alternative Energy Strategies, Energy: Global Prospects 1985-2000, McGraw-Hill, 1977.

25. Iran and Iraq have a production capacity of about 8 MMBD. They are now (March 1981) producing at a level of about 2.5 - 3 MMBD. The difference has been taken up in part by reduced world demand and in part by increased Saudi Arabian production (now at 10.3 MMBD compared to recent levels of 8.5 - 9.5).

26. Petro-Canada and Petroleos de Venezuela, "World Oil Supply Prospects", February, 1980.

27. Exxon Corporation, "World Energy Outlook", December 1980.

28. Energy Modeling Forum, "World Oil; EMF 6 Summary Report", Stanford University, January 1981. Draft # 3.

29. The models used were:

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IEES/OMS (International Energy Evaluation System/ Oil Market Simulation)	U.S. Department of Energy
IPE (International Petroleum Exchange)	MIT
Salant/ICF	U.S. Department of Energy/ICF, Inc.
ETA-MACRO	Stanford University
WOIL	U.S. Department of Energy
Kennedy/Nehring	University of Texas/Rand Corporation
OILTANK	Christian Michelson Institute
Opeconomics	British Petroleum Corporation
OILMAR	Energy and Power Subcommittee: U.S. House of Representatives

30. An interesting analysis of the effects of Iranian and Iraqi curtailment in 1979 and 1980, and policy implications are contained in Alvin Alm, "Energy Supply Interruptions and National Security" Science, 27 March 1981, 1379-1385.

31. See for example, Thomas L. Neff, "The Changing World Oil Market" in D.A. Deese and Joseph S. Nye, Ed., Energy and Security, Ballinger, 1981.

32. Marshall I. Goldman, "The Role of Communist Countries" in D.A. Deese and J.S. Nye, Energy and Security, Ballinger, Cambridge, Mass. 1981.

33. For a discussion of the import premium, see William W. Hogan, "Import Management and Oil Emergencies", Chapter 9 in D.A. Deese and J.S. Nye, Energy and Security, Ballinger, Cambridge, Mass. 1981. See also Energy Modeling Forum, op. cit. and R. Stobaugh and D. Yergin, Ed., Energy Future, Random House, N. Y. 1979.

34. Congressional Budget Office, "The World Oil Market in the 1980's: Implications for the United States", U.S. Government Printing Office, 1980 and other sources cited in D.A. Deese and J.S. Nye, Energy and Security, Ballinger, Cambridge, Mass. 1981.

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36. D.A. Deese and J.S. Nye, Energy and Security, Ballinger, Cambridge, Mass. 1981.

37. Charles Blitzer, "Energy and Development: An Overview of Selected Issues". EPRI Workshop on Energy and the Developing Nations, March 1980.

38. Bijan Mossavar-Rahmani, "OPEC and NOPEC: Oil in South-South Relations", Journal of International Affairs 34, 1, 41-58 (Spring/Summer 1980).

39. A typical statement was contained in the final communique of the 1979 meeting of the heads of state of the Non-Alligned movement: "emphasized that the international energy issue should be discussed in the context of global negotiations within the United Nations with the participation of all countries and in relation with such other issues as the problems of development of developing countries, financial and monetary reforms, world trade and raw materials, all of which have an import bearing on the establishment of the New International Economic Order".

40. Organization for Economic Cooperation and Development, Development Co-operation, OECD, Paris, 1980.

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42. Joint Declaration, President of Mexico and Venezuela, San Jose, Costa Rica, August 3, 1980.

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47. Philip F. Palmedo, Pamela Baldwin, et al., "The Contribution of Renewable Resources and Energy Conservation as Alternatives to Imported Oil in Developing Countries", Energy/Development International, February 6, 1980.

48. See, for example T.J. Connolly,et al., "World Nuclear Energy Paths" Rockefeller Foundation (N.Y.) and The Royal Institute of International Affairs (London) 1979; A.M. Strout,"Prospects for Nuclear Power in Developing Countries" Advances in the Economics of Energy and Resources. Vol. 1, p. 291-310 JAI press 1979.

49. The World Bank, for example, estimates the following delivered power costs from various technologies (in 1980 dollars).

Generator Type	Power Cost ¢/kwh
Large, High Head Hydropower	2.4
Small Inland Diesel Generator	13.2
Large Imported Coal Fired Steam Plant	5.2
Large Imported Oil Fired Steam	7.5
Large Multiple Nuclear Units	5.1
Single Small Nuclear Plant	7.4

From: World Bank, "Energy in the Developing Countries" Washington, August 1980.

50. V. Mubayi et al., "Some Considerations on the Choice of Countries for U.S. Assistance under Title V of The Nuclear Nonproliferation Act of 1978" BNL-24274, Brookhaven National Laboratory, Upton, N.Y., April, 1978.

51. R Krymm, "Energie Nucleaire et Pays en Voie de Developpement: Problemes Economiques." Paper presented the IAEA training program, Role de L'Energie Nucleaire dans le Cadre d'un Plan Energetique National, Saclay, France, May 1979.

52. N.J.D. Lucas, "Economics of Scale in Nuclear Power Plant "Energy Research Vol. 3, 297-300 (1979).

53. J.R. Egan and S. Arungu-Olende, "Nuclear Power for The Third World?" Technology Review May, 1980, 46-55.

54. Charles Blitzer has estimated that the potential market for coal exports and exports of industrial equipment associated with coal "could grow to $5 billion or more annually". C. Blitzer,"Energy and Development: An Overview of Selected Issues" EPRI Workshop on Energy and The Developing Nations, March, 1980.

55. Raul Prebisch, "Third World Lecture 1981". Third World Foundation, New York, 1981.

APPENDIX A

ENERGY STATISTICS

TABLE A-1

Exploration Activity
(Seismic Party Months)

	1970	Percent Annual Total	1974	Percent Annual Total	1978	Percent Annual Total	Percent Change 70-74	Percent Change 74-78
Developed Countries	3840	62.66	4812	63.65	6036	72.31	25.31	25.44
U.S.	2340	38.2	3661	48.43	4223	50.6	56.45	15.35
Developing Countries	2288	37.34	2748	36.35	2311	27.7	20.1	-15.9
OPEC	772	12.6	926	12.25	919	11	19.95	- 0.8
Others	1516	24.74	1822	24.1	1392	16.7	20.2	-23.6
World Total*	6128		7560		8347		23.4	10.4

* Excludes Centrally Planned Economies

Data Source: Energy and Economics Research, Ltd.
Oil and Energy Trends: Statistical 1980 Review

TABLE A-2

World Proven Crude Oil Reserves
(Billion Barrels)

	1970	Percent Annual Total	1974	Percent Annual Total	1979	Percent Annual Total	Percent Change 1970-74	Percent Change 74-79
Developed Countries	64.2	11.6	67	10.5	65.9	10.1	4.4	- 1.6
U.S.	46.7	8.4	40.6	6.4	32	4.9	-13	-21.2
Developing Countries	384.2	70.3	462.3	72.4	499.6	76.23	18.8	8.1
OPEC	360.4	65.1	429	67.2	434	66.2	19	1.2
Others	28.8	5.2	33.3	5.2	65.6	10	15.6	97
CPES	100.3	18.1	109.4	17.1	90	13.7	9.1	-17.7
World Total	553.7		638.7		655.5		15.4	2.6

Data Source: Oil and Energy Trends

TABLE A-3

World Crude Oil Production
(Thousand B/D)

	1970	Percent Annual Total	1974	Percent Annual Total	1979	Percent Annual Total	Percent Change 1970-74	Percent Change 74-79
Developed Countries	13299	28	13187	22.7	14627	22.5	- .84	10.92
U.S.	11312	23.8	10462	18	10189	15.7	- 7.5	- 2.61
Developing Countries	26268	55.3	33941	58.4	35970	55.3	29.2	5.98
OPEC	22823	48	30192	51.93	30359	46.7	32.3	.55
Others	3445	7.3	3749	6.45	5611	8.6	8.82	49.7
CPES	7925	16.7	11015	18.94	14403	22.14	39.0	30.76
World Total	47492		58143		65057		22.43	11.9

Data Source: Oil and Energy Trends

8

TABLE A-4

World Oil Demand
(Thousand B/D)

	1970	Percent Annual Total	1974	Percent Annual Total	1979	Percent Annual Total	Percent Change 1970-74	Percent Change 74-79
Developed Countries	31308	68.12	36866	64.81	39589	60.5	17.8	7.4
U.S.	14716	32.0	16653	29.3	18300	28.0	13.7	9.9
Developing Countries	6842	14.9	9491	16.7	12341	18.9	38.7	30.0
OPEC	1027	2.23	1633	2.9	2072	3.2	59.0	26.9
Others	5815	12.6	7858	13.8	10269	15.7	35.1	30.7
CPES	7812	17.0	10527	18.5	13500	20.6	34.8	28.2
World Total	45962		56884		65430		23.8	15.0

Data Source: Oil and Energy Trends

TABLE A-5

Dependence and Vulnerability
in U.S. Energy Requirements
(Thousands B/D)

		1970	1974	1979	Percent Change 1970-74	1974-79
Primary Energy Consumption (PEC)						
	Total	33561.2	33571.2	38380	6.6	7.3
Oil Consumption (OC)						
	Total	14350	16150	17930	12.5	"
As Percent of PEC		42.76	45.15	46.72		
Oil Imports (OI)						
	Total	3419	6112	8351	78.8	36.6
As Percent of OC		23.8	37.85	46.6		
Oil Imports OPEC						
	Total	1344	3276	5599	143	70.9
As percent of OI		39.3	53.6	67		

Data Source: The Energy Factbook
Committee Print 96-IFC-60
Interstate and Foreign Commerce Committee
U.S. House of Representatives
November 1980
pp. 19, 229, 121

TABLE A-6

Crude Oil Wellhead Prices, 1949-1979
(Current and Constant 1972 Dollars per Barrel)

Year	Lower Tier (current)	Upper Tier (current)	Stripper Oil (current)	Domestic Average (current)	Domestic Average (constant)
1949	Not Applicable			2.54	4.83
1950				2.51	4.68
1951				2.53	4.42
1952				2.53	4.36
1953				2.68	4.55
1954				2.78	4.66
1955				2.77	4.54
1956				2.79	4.44
1957				3.09	4.75
1958				3.01	4.56
1959				2.90	4.29
1960				2.88	4.19
1961				2.89	4.17
1962				2.90	4.11
1963				2.89	4.04
1964				2.88	3.96
1965				2.86	3.85
1966				2.88	3.75
1967				2.92	3.69
1968				2.94	3.56
1969				3.09	3.56
1970				3.18	3.48
1971				3.39	3.53
1972				3.39	3.39
1973				3.89	3.68
1974	5.03	10.13		6.87	5.92
1975	5.03	12.03		7.67	6.03
1976	5.13	11.71	12.16	8.19	6.13
1977	5.19	11.22	13.59	8.57	6.05
1978	5.46	12.15	13.95	9.00	5.92
1979[2]	5.94	13.22	22.92	12.64	7.64

Footnotes continued on next page.

Footnotes to Table A-6

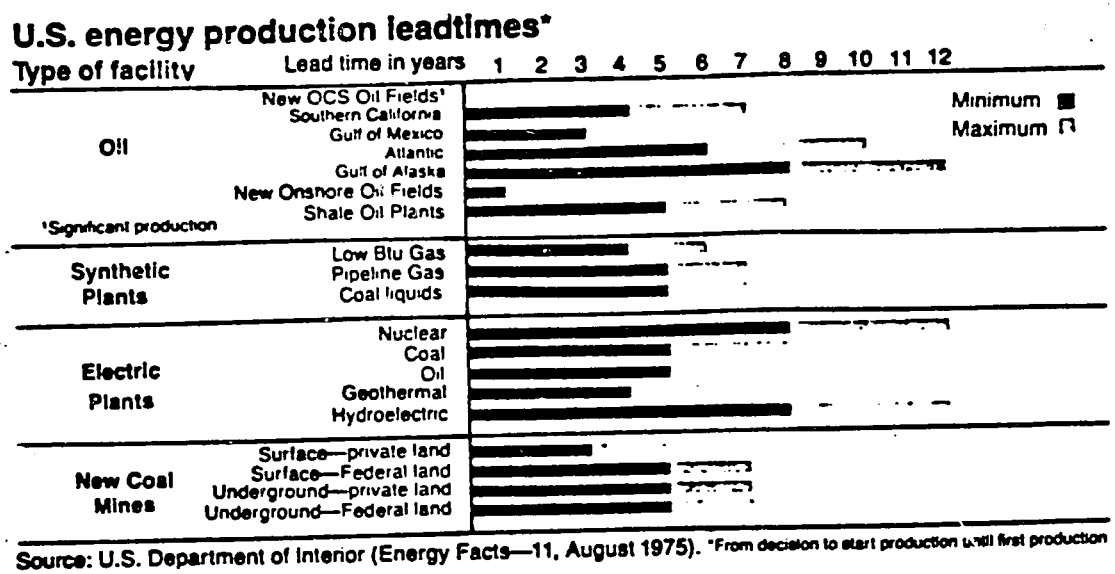
1 Constant 1972 dollars calculated using GNP implicit price deflators. 1972=100. See Units of Measure. Conversion Factors, and Energy Equivalents Section.

2 Data are for January through October.
Note: Crude oil wellhead prices for each category and for the domestic average are derived by dividing the sum of the value of all first purchases by the total volume of all first purchasers' purchers.
Note: Prior to February 1976, Lower Tier crude oil was called Old Oil, and Upper Tier crude oil was called New Oil. Alaskan North Slope crude oil is included in Upper Tier and Domestic Average.

Sources: 1949 through 1973 - U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, Volume 1. 1974 through January 1976- Federal Energy Administration. FEA Form 90. "Crude Petroleum Production Monthly Report." February 1976 through August 1976 - Federal Energy Administration, FEA Form P124-M-O, "Domestic Crude Oil Purchasers Report" for Lower Tier percentages and EIA estimates for Upper Tier percentages. September 1976 through September 1977- Federal Energy Administration. FEA Form P124-M-O, "Domestic Crude Oil Purchasers Report." October 1977 through 1979- Department of Energy, Energy Information Administration, FEA Form P124-M-O, "Domestic Crude Oil Purchasers Report.

Source: Energy Factbook, p. 266.

FIGURE A - 1



Source: U.S. Department of Interior (Energy Facts—11, August 1975). *From decision to start production until first production

Source: Energy Factbook, p. 11