The original documents are located in Box 112, folder "Investment in the U.S. by Oil Producing Nations (2)" of the National Security Council Institutional Records at the Gerald R. Ford Presidential Library.

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G-8. U. S. RESEARCH AND DEVELOPMENT IN THE ENERGY FIELD

Introduction

The Administration has announced a major commitment to expand and accelerate energy research and development to a level of $10 Billion over the next five years, more than doubling our projected current level of effort. As a first step, the President has committed an additional $100 Million above the $772 Million already budgeted for Energy R&D in 1974. Principal objectives of the expanded program are to:

- Minimize future dependence on foreign energy sources.
- Provide an adequate national supply of energy at a minimum cost.
- Develop the components of a national energy system having minimum impact on the environment.
- Develop an energy system of high reliability and maximum security against natural disasters and acts of war or sabotage.

In order to achieve these objectives, we must apply our vast scientific and technological capacities - both public and private - in efforts to develop and make wise use of our domestic resource base.

Currently estimated U. S. reserves of natural gas would be sufficient to meet our needs for at least the next 30 years, if we limited our consumption to present rates; our presently estimated reserves of oil would last at least as long. We have only begun to tap large reservoirs of off-shore oil. By conservative estimates, we have sufficient supplies of coal for at least 500 years, at current consumption rates. Estimated U. S. oil shale resources exceed two trillion barrels of hydrocarbons and with sufficient retort capacity an estimated one million barrels of oil per day could be produced from this source by the mid 1980's. Solar energy, as the technology to utilize it becomes practical for a variety of applications, could provide a potentially limitless quantity of clean energy. In the field of nuclear energy, in addition to the increased electrical generating capacity from nuclear fission in this century, nuclear fusion could provide the key to unlimited, clean energy in the next century. Furthermore, by developing technologies and practices for improved efficiency of energy use and conservation, total U. S. demand for energy can be effectively limited now and in the future.

The major thrust of the expanded energy R&D program is to increase production and utilization from currently available domestic resources to meet the needs of the immediate future while developing new sources of economically and environmentally clean energy to meet longer range requirements.

Major Program Areas

The following section provides a brief review of Federal programs for the energy sources that have the greatest potential for meeting our energy requirements.

Nuclear Fission

The major alternative to fossil fuel energy for at least the remainder of this century is nuclear fission. Nuclear fission already competes economically with fossil fuel technologies as a source of energy for generating electricity. It is significant that, today, energy produced from nuclear plants on line or under construction equals the entire electrical generating capacity of the U. S. in 1950.

The Atomic Energy Commission is conducting research and development efforts in the following areas of nuclear fission:

1. The Liquid Metal Fast Breeder Reactor.
2. Improved methods for producing and processing nuclear fuels.
3. Long term waste management techniques.
4. Development of improved technology for increasing the efficiency and reliability of nuclear energy sources.

The Federal R&D effort for FY 1974 includes $475 million for the AEC's nuclear fission energy programs, an increase of $63 million over the FY 1973 level. This includes a $51 million increase to continue the development of the Liquid Metal Fast Breeder Reactor which has the potential for increasing the utilization of our fissionable resources by a factor of 30. Private industry will spend approximately $250 million on R&D in the nuclear energy field, by far the bulk of this on fission reactors and associated problems. (Approximately $10 million of this will be spent on the development of nuclear-fusion related technology.)

Since a breeder reactor produces more fissionable material than it consumes, it can be developed for use in a nuclear powerplant to provide the heat needed for the generation of electricity, and simultaneously produce an excess of fissionable material that can be used to fuel other plants. Currently underway is a joint private and government sponsored research effort to develop a practical breeder reactor that will lead to the introduction of these reactors on a wide-scale in the 1980's. By the year 2000, it is projected that we will have installed breeder reactors with a combined electrical generating capacity equal to the total capacity now existing in the United States.

Nuclear Fusion

Federal support of controlled thermo-nuclear fusion research is being increased by 40% in FY 1974 to a level of $90 million. The ultimate goal of fusion research is to develop fusion power reactors to generate electric power economically and with a minimal detrimental environmental impact.

Fusion is the process of joining the nuclei of two light atoms. When this occurs, new material is formed of less total weight, and the small loss of material is converted into energy. Fusion reactors would be fueled with deuterium which is abundant in water and can be extracted for only a few cents per gallon. The energy produced from the fusion of the deuterium nuclei present in one gallon of water is equal to that obtainable from the combustion of 300 gallons of gasoline. Therefore, nuclear fusion, once developed can obviate the need for dependence on foreign energy sources.

Coal

In FY 1974, an estimated $170 million will be obligated by the Federal Government for research and development related to coal. This represents almost a three-fold increase over the FY 1973 level of $63 million. The major R&D efforts in this area are directed toward:

- Coal gasification, to produce synthetic pipeline quality gas from coal and synthetic gas of a lower energy content for industrial and utility use.
- Coal liquefaction to convert coal into liquid fuel that could be used as a direct substitute for crude oil or as a boiler feed.
- Technologies to remove sulfur compounds and other pollutants both before and after combustion.

Coal gasification offers to provide a supplement to the diminishing supply of natural gas and a method of burning coal with lower sulfur oxide emissions. There are five major processes being intensively explored for coal gasification, one of which has already been commercialized in Europe. In a joint venture with private industry, the Office of Coal Research of the U. S. Department of Interior has two large-scale plants for coal gasification in operation and a third under construction with anticipated plans for the successful construction and operation of a $250 million plant.

The conversion of coal to a clean liquid fuel can reduce the demand for petroleum products (oil and natural gas). Federal research efforts are being accelerated to develop an acceptable coal liquefaction technology that will provide clean fuel for power generation, for small industrial and commercial type applications that cannot be served by low Btu coal gasification and stack gas cleanup systems, and that will provide coal liquids for use as a raw material for chemical manufacture or for further upgrading to petroleum-type products that can substitute for foreign crude oil.

In addition to the research being conducted to develop ways to convert coal to gas or liquid form, research is also being supported to find practical ways to remove sulfur oxides from coal stack gas. Removing sulfur oxides (desulfurization) is a major step to making coal burning more environmentally acceptable from an air quality control standpoint. Desulfurization, gasification, and liquefaction are all ways to increase coal use for meeting future energy demands.

Domestic Petroleum, Oil Shale and Natural Gas

To avoid an increasing dependence on foreign sources of oil, the President has directed the Department of Interior to triple the annual acreage leased for oil exploration on the Outer Continental Shelf by 1979 and he has also directed the Department of Interior to proceed with a prototype leasing program to stimulate projects for recovering oil from shale.

Oil shale is fine-grained sedimentary rock that contains a solid organic material -- kerogen -- which, when properly processed, will yield a fluid hydrocarbon or oil. Experts believe that it is one of our greatest near-term potential sources of energy and that it may help fill a widening gap in the United States between demand and domestic supply. Estimated resources exceed two trillion barrels of shale oil in the western U. S. alone. With sufficient retort capacity, an estimated one million barrels of oil per day could be produced from this source by the mid 1980's.

There are currently two options to produce oil shale: (1) surface or subsurface mining with retort processing, and (2) in situ processing in which the shale is fractured and heated underground and the oil is then brought to the surface through wells.

The Federal R&D effort in the area of petroleum extraction technology (including secondary and tertiary methods to increase recovery of both oil and gas; and oil shale) in FY 1974, totals about $5 million. Private industry will spend approximately $10 million in oil shale research. This compares with an overall petroleum industry R&D effort of approximately $550 million. This figure is exclusive of petrochemical and non-fuel related R&D.

The gas-related Federal R&D effort is oriented toward the more efficient recovery of gas reserves. The Federal R&D program in this area will provide approximately $4 million in FY 1974 for the AEC's nuclear gas stimulation program. An additional estimated $85 million in R&D will be invested by the gas utility and associated industries.

Solar Energy

The sun pours onto the earth 100,000 times as much energy as the world's present electric power capacity. Conversion of solar energy for use in the home is one potential use receiving increased attention as a near-term payoff. It has been estimated that up to 50% or more in household fuel use may be saved through the use of solar energy.

The Administration has tripled the amount requested for solar energy research in its FY 1974 budget -- from $4.0 million in FY 1973 to more than $12 million in FY 1974. All of the Federally-supported solar energy research will be funded through the NSF. In addition to practical applications of solar energy in the heating and cooling of buildings, future applications are being explored such as converting organic materials into clean fuels. In addition to the Federal effort in this area, private industry is also investing slightly in excess of $1 million.

Geothermal Energy

Geothermal energy, the natural heat of the earth, can be tapped to generate electricity to heat homes and to help meet other energy needs. Although the magnitude of this resource is still largely unknown, 1.8 million acres of land have been classified as known geothermal resource areas and an additional 96 million acres have been identified as having prospective value as geothermal resources.

A substantial amount of the present effort is being conducted by the U. S. Geological Survey to identify potential geothermal areas. The Department of Interior and the National Science Foundation are supporting research designed to enable effective utilization of geothermal resources. AEC and NSF are supporting research to develop methods for extracting energy from fluid reservoirs and from hot, dry rock sources. The total Federal effort in geothermal R&D in FY 1974 will amount to approximately $4 million. Industry will spend approximately $1 million in R&D in this area. This industry effort is primarily devoted to power conversion equipment, geochemistry, and geophysics. The opportunity for substantial expansion of this overall national effort is now being actively explored.

Other R&D Efforts

The development of new and traditional sources of energy is only one aspect of the overall U. S. effort to meet the energy challenge. Further Federally-supported R&D is also underway in:

- Improved electrical power generation, storage, and transmission.
- Pollution control technology.
- Energy Systems Studies
- Advanced automotive propulsion systems.
- Improved Urban and Residential Energy Utilization and Conservation.

Accelerated Energy R&D Effort

On June 29, 1973, the President announced the initiation of a major $10 billion program for R&D in the energy field which will extend over the next five years. At the request of the President, the AEC is reviewing Federal and private energy R&D activities and will recommend to him an integrated energy R&D program for the Nation. The expanded program can be expected to increase significantly the capability of the U. S. to develop and utilize adequate sources of energy to meet near term and future requirements.

G-9 Energy Conservation in the United States

The demand for energy in the United States rose at an average annual rate of 4.2 percent for the 1960-70 decade. Projections of energy demand for the decade of 1970-80 indicate an average rate of growth of 3.6 percent, for 1980-90 the rate is 3.9 percent, and for 1990-2000 the rate is 3.1 percent. The energy demand and rate of growth for these periods are illustrated in the following table:

Year	Gross energy inputs (trillions of Btu) 1/	Average annual rate of growth (percent)
1960	44,565	
1970	67,444	4.2
1980	96,020	3.6
1990	140,080	3.9
2000	191,900	3.1

1/ Based on Department of the Interior forecast, U.S. Energy Through the Year 2000, Dec. 1972.

The stress on both capital and natural resources to sustain these rates of consumption of energy appears obvious. Lessening of these demands would lower the requirements for both types of resources. Although capital resources are important, this paper will concentrate on the natural resources side of energy problems.

To lessen demand for energy requires one of two approaches. Either demand can be decreased by more efficient use of energy (i.e., we avoid energy utilization techniques that are inherently less efficient than the alternatives) or we devise techniques for discouraging the growth in demand for energy. An example of the former would be development of a less energy intensive transportation mode, and an example of the latter would be a fuel tax designed to discourage consumption.

Unfortunately, the whole question of energy conservation is in a state of flux, as very few definitive studies have been completed. We do, however, have knowledge of viable candidates for energy conservation.

Using the Stanford Research Institute [1/] breakdown of end use energy consumption in the United States, Table 1 was constructed. Obviously, any end use of energy that requires only a small percentage

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1/ Stanford Research Institute, Patterns of Energy Consumption in the United States (Government Printing Office, Wash., D. C., 1972) The data for 1968 used by SRI was extrapolated to 1970 and reconciled with actual data.

of the national demand for energy cannot be altered sufficiently to significantly affect energy demand. If only those end uses of energy utilizing over 3 percent each of our total net energy uses are considered viable candidates for energy conservation measures, then our candidates are:

Sector	Percent of net energy consumption
Household and Commercial	
Heating and air conditioning	22.4
Water heating	3.7
Industrial	
Process steam	20.2
Electric drive	3.4
Direct heat	13.1
Transportation	
Fuel	31.4

To this must be added conversion losses in the electrical sector. Initial research efforts are being directed at these areas.

There are five points that need to be firmly set out in the field of energy conservation:

(1) Energy conservation for its own sake is not an acceptable goal when the end result is to significantly increase use of other resources (including capital).

(2) The impact of population on energy consumption is more complex than is normally assumed. A given increase in population will not require an equal increase in energy, but will require a more than proportionate increase because of the necessity for greater social overhead capital such as water and sewage systems, roads, schools, etc. In other words, the per capita impact on energy consumption of increase is non-linear. This is deservedly worthy of greater additional study to determine this impact.

(3) Many opportunities for energy conservation are dependent on other social and economic trends so worthy of consideration in their own right that it is inappropriate to consider them solely as energy conservation measures. Two important examples are, actions to curb the rate of growth of population and gross national product.

(4) Energy conservation can impact the rate of economic growth in this Nation. An example: smaller cars require less resource inputs (including labor), less fuel, and less maintenance than larger cars. This means fewer people working to produce the resource inputs, less

to build the cars, etc. The effect is to slow the rate of increase of GNP induced by the automotive industry. This is worthy of much greater study.

(5) The quality of energy is not equal between fuels. Some energy sources allow us to do things impossible, or else very difficult, with other sources. Some examples: electrical lighting is more efficient (even with conversion losses) than lighting using coal; electric motors allow us to put power where needed more efficiently than other sources; and gasoline is easier to use in automobiles than coal or natural gas.

The President first addressed the need for energy conservatiom in his energy message of June 4, 1971. In his second energy message on April 18, 1973, the President gave more detailed attention to energy conservation programs, which he termed "a national necessity."

A significant action announced by the President in his April 18 message was the formation of an Office of Energy Conservation, to be established within the Department of the Interior to coordinate the energy conservation programs which have been scattered throughout the Federal establishment.

This action gave the Department of the Interior new responsibilities in energy conservation, which they are now organizing to assume. The Office of Energy Conservation, which will be the focal point for these responsibilities, was activated in April 1973 as a staff agency reporting to the Assistant Secretary for Energy and Minerals. The Office of Energy Conservation has three major functions--action programs such as Federal agency cutbacks in energy use and consumer education programs; a research and policy analysis function for evaluating proposals such as incentives to encourage the use of more efficient automobiles; and emergency preparedness planning and organization.

The total staff of the office will remain small because it is not the intent of the office to undertake all research or education activities that relate to energy conservation. Rather, the office will coordinate the existing energy conservation programs which are scattered throughout the Federal Government as well as directly fund overall policy evaluation studies and additional consumer education efforts.

Some of the long term areas of conservation, either under study or contemplated for study are:

Transportation Sector:

(a) The impact of a shift in modal mix to less energy intensive modes.

(b) The impact of increases in load factors for urban travel, aircraft, etc.
(c) Methods for improving the efficiency of vehicles.
(d) The effects of increases in fuel taxes.
(e) The effects of taxes on less efficient vehicles.
(f) The impact of restricting use of automobiles in cities.

Household and Commercial Sector:

(a) The effects of increased insulation of buildings to reduce heating and cooling loads.
(b) A re-examination of present day lighting level requirements.
(c) The impact of total energy systems.
(d) The effects of improving appliance efficiency.
(e) The effect of reduction (or elimination) or resistance heating in favor of heat pumps or fossil-fuel fired heating plants.

Industrial Sector:

(a) The effects of increased recycling of energy-intensive materials.
(b) A re-examination of industrial process energy efficiency.
(c) The use of conversion losses from powerplants as heat sources for direct heat and process steam.
(d) The effects of increased efficiency of motors and engines.
(e) Increased fuel taxes to dampen demand.
(f) The impact of fast write-off for tax purposes of new capital investment that reduces energy consumption.

Electrical Sector:

(a) An examination of the institutional changes necessary to allow utilities to move faster to the scale frontier.
(b) The effects of introduction of advanced power cycles.
(c) The effects of restructuring rates to dampen demand.
(d) An analysis of the impact of inverted rates.

The impact of these proposed studies is not known. That energy will be saved through implementation of some, or all, of these policies is undoubted, but the quantities of savings must be more carefully analyzed.

Table 1.-End use energy consumption in the United States, 1970 1/

	Direct		Purchased electrical energy		Total	
	Trillion Btu	Percent of total	Trillion Btu	Percent of total	Trillion Btu	Percent of total
Residential						
Space heating	6,341	12.3	246	.5	6,587	12.7
Water heating	1,176	2.3	238	.4	1,414	2.7
Cooking	354	.7	101	.2	455	.9
Clothes drying	86	.2	60	.1	146	.3
Refrigeration	9	-	292	.6	301	.6
Air conditioning	8	-	201	.4	209	.4
Other	-	-	494	.9	494	.9
Total	7,974	15.3	1,632	3.1	9,606	18.4
Commercial						
Space heating	4,261	8.2	-	-	4,261	8.2
Water heating	419	.8	86	.2	505	1.0
Cooking	118	.2	8	-	126	0.2
Refrigeration	-	-	253	.5	253	.5
Air conditioning	134	.3	423	.8	557	1.1
Other	-	-	598	1.1	598	1.1
Total	4,932	9.5	1,368	2.6	6,300	12.1
Industrial						
Process heat	10,514	20.2	-	-	10,514	20.2
Electric drive	-	-	1,764	3.4	1,764	3.4
Electrolytic process	-	-	254	.5	254	.5
Direct heat	6,721	12.9	119	.2	6,840	3.1
Other	-	-	73	.1	73	.1
Total	17,235	33.1	2,210	4.3	19,445	37.4
Transportation						
Fuel	16,345	31.4	16	-	16,361	31.4
Total	16,345	31.4	16	-	16,361	31.4
TOTAL 2/	46,831	90.9	5,226	10.0	52,057	100.0

1/ Includes only the Household and Commercial, Industrial, and Transportation Sectors.
2/ 214 trillion Btu miscellaneous and unaccounted for.

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2. Saudi Arabian Aid Programs

Background

As Saudi Arabia's monetary reserves have increased, its interest and ability in becoming a more influential Arab power have led it to grant greater amounts of foreign aid. Cumulative aid commitments from 1967-1971 totaled some $750 million, mostly grants. During 1972 Saudi Arabia made available about $300 million in foreign aid loans and grants, or almost 10% of its total government budget. Saudi aid in 1972 took the following forms: (a) Khartoum annual subsidy payments to Egypt and Jordan totaling $140 million; (b) grants, gifts, and non-repayable loans to Jordan, Yemen Arab Republic, Oman, and several countries of Black Africa totaling some $85 million; and (c) regular loans, chiefly to Pakistan, Somalia, and Sudan, totaling new commitments of $78.5 million.

Saudi aid expenditures are motivated by essentially political and religious considerations, with almost all aid to date going to friendly Arab states, African states with large Muslim populations, and to Pakistan. Economic aid to the Saudis' poorer neighbors has so far been aimed at project assistance and direct budget support and this may change only gradually. Some aid consists of outright gifts while some is in the form of long-term, very low interest or even non-interest loans. Many of these loans are not expected to be repaid. Recently King Faisal has had discussions with North African leaders during which agreement may have been given in principle for Saudi participation in large economic development projects in Morocco and Algeria.

The demands on Saudi Arabia for assistance will likely grow. In addition to regular support for Egypt, Jordan, and Yemen, aid to Oman is expected to rise. Saudi aid to African states, including grants and donations to Islamic institutions, are also expected to increase as the Saudis seek to compete with Israel as well as Libya for influence among African Muslims. In addition, Saudi military aid (largely transfers or purchases of equipment for transfer to third countries) is likely to go up. Yemen (including South Yemeni dissidents), Oman, Jordan and possibly Egypt are the recipients of military aid.

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Saudi Aid Procedures

Saudi Arabia's primary difficulty in providing aid is the conservative approach that its leadership has adopted, both by choice and by inexperience. King Faisal prefers to dole out aid spontaneously, often in connection with State visits or annual pilgrimages. By not regularizing Saudi aid donations, Faisal presumably expects to maintain greater leverage with the donees who must constantly approach him hat in hand for new handouts. (The exceptions to this are the Khartoum payments to Egypt and Jordan where an explicit annual subsidy is agreed upon and payments are made quarterly and automatically.) Prince Musa'id, Minister of Finance and principal architect of Saudi Arabia's financial policies, keeps a tight rein on the exchequer. Musa'id's financial conservatism is supported by other elements of the Royal Family who have long grumbled over the seemingly unending outflow of funds to the Arab "confrontation states" and to Yemen. There is consequently a continued reluctance to plan and budget for aid (other than the Khartoum subsidies), either as a whole or for specific countries. Nor are total Saudi aid figures published, presumably to minimize both domestic criticism of the government's aid policies and to avoid encouraging other potential applicants. There is, moreover, no Saudi Government foreign aid mechanism. Disbursements are made directly from the treasury. The Saudis have arranged for loans to Yemen through a foreign bank, providing a government guarantee and paying an administrative fee to the bank for this service.

Given Faisal's preference for using aid as a very personal vehicle, Prince Musa'id's financial conservatism, and the high percentage of Saudi Government funds already committed to foreign countries, any significant changes in the level or administration of Saudi aid programs will probably have to await the King's demise. In the meantime, however, and provided that Saudi oil production and the government's resulting foreign exchange reserves continue to increase, it is difficult to believe that Saudi foreign aid in subsequent years will fall much below existing levels. Some readjustment in Saudi aid would of course likely follow a Middle East peace settlement which would terminate the Saudis' Khartoum subsidy obligations to Egypt and Jordan. However, reconstruction and other costs attendant to a settlement would likely bring about new requirements from those governments for Saudi aid.

Faisal's eventual successor is likely to pursue a more activist foreign policy and may move then to institutionalize Saudi aid giving, perhaps through creation of a Saudi development bank or fund similar to Kuwait's or by joining the Kuwait-based Arab Fund for Economic and Social Development. Given the lack of experienced administrators and development bankers, the Saudis would require outside assistance to establish and operate such a fund. Some increase in Saudi contributions to the World Bank and to the UNDP may result from recent visits to Riyadh by Robert McNamara and Rudolph Peterson. The Saudis currently have $83 million in IBRD bonds and may purchase more. Since political and religious motives will continue to lie behind most Saudi aid efforts, however, the Saudis are not likely to enter into multilateral aid efforts or to become large contributors to UN aid programs. At best, improved coordination between Saudi bilateral programs and those of other countries or international organizations might be effected.

What Can the U.S. Do

In light of this description of the Saudi foreign aid mechanism and prospects, U.S. efforts to stimulate a greater and more regular outflow of Saudi foreign aid as a device to encourage continued oil production growth are likely to receive a tepid reception in Riyadh. While the Saudis seem resigned to picking up many of the bills for their poorer neighbors, King Faisal has let it be known that he believes the U.S. financial contribution to security and orderly development in the Peninsula should also be substantially increased. Saudi officials are likely to react to U.S. urgings that they extend more foreign aid by pressing the U.S. to increase its own very modest economic aid to Yemen and to initiate large grant military assistance programs for Yemen and possibly Oman. Suggestions that the Saudis extend aid through multilateral programs or the UN are likely to be ignored. So would be an effort to encourage Saudi aid to countries, e.g., in Southeast Asia or Latin America, outside of King Faisal's relatively narrow sphere of interest. It is also unlikely that the Saudis could be convinced to address foreign aid on an economic, rather than on a political or sectarian, basis. Given domestic misgivings about foreign aid programs, Faisal would not consider increasing foreign aid as sufficient justification by itself to expand oil production, unless he felt under considerable pressure from other Arab governments to do so.

With these considerations in mind, we see only limited possibilities for productive discussions with the Saudis on foreign aid matters. The following steps could, however, be taken which may be helpful in improving the effectiveness if not the amount or regularity of Saudi foreign aid:

A. Frank consultation on foreign aid prospects. Members of the high-level mission might outline frankly to King Faisal and other senior Saudi leaders just what requirements we see for external assistance to countries of the Arabian Peninsula and adjoining areas over, say, a five-year period and what the prospects are for U.S. and other industrial countries as well as UN agencies meeting these needs. In identifying likely shortfalls in aid from outside the area, our hope would be to impress upon the Saudis the amount of aid which they and their other wealthier neighbors will have to meet from their own aid programs if stability and orderly development are to be advanced. Mission members could also underscore the problems created for other LDC's by the rapidly escalating costs of Persian Gulf crude oil and oil products.

B. Offer of technical assistance. As noted above, the Saudis are unlikely at this time to set up a development bank or other aid-giving mechanism. We could, however, offer to make available on a reimbursable basis the services of one or more experienced development bankers or AID administrators who could advise Saudi Ministry of Finance personnel on ways to improve the management of their aid programs. It is improbable that such advisers could do much to regularize Saudi aid programs or improve Saudi forward aid planning. They could, however, begin to help develop within the Ministry a cadre of officials who could in time come to staff a Saudi foreign aid agency when and if one is created.

C. Offer of collaboration on specific projects. One major Saudi problem is the absence of any capability to conduct technical surveys or to carry out professional evaluations of project proposals submitted by foreign governments. The Saudis have, for example, had to turn to an American consulting engineer firm to carry out feasibility surveys for a proposed road project in Yemen. We could offer to make available the services of AID technical personnel to carry out, at Saudi expense, such feasibility surveys or technical evaluations.

Alternatively, as we have already proposed, our limited AID program funds in Yemen could be used to perform such studies/evaluations which would then be turned over to the Saudis for implementation, perhaps through a joint Saudi/U.S. arrangement under which U.S. personnel would be employed to let and administer Saudi Government contracts in Yemen or other LDC's.

D. <u>Support a UNDP/Saudi Government arrangement</u>. During his recent visit to Riyadh, UNDP Administrator Peterson explored possible Saudi interest in an arrangement whereby the UNDP would assist the Saudis to carry out project aid programs in neighboring countries. We could, after consulting with Peterson, urge the Saudis to pursue this approach. An advantage of this approach is that it would encourage the Saudis to deal with an international agency and could lead in time to better coordination with UNDP programs in other countries or even to Saudi financial underwriting of UNDP programs elsewhere. A disadvantage is that the UNDP may be willing or able to provide assistance to only a few of the Saudis' politically-motivated aid programs in the Peninsula. An approach extending U.S. assistance along the lines of B and/or C above and including where necessary an arrangement with the UNDP might, therefore, be a more practical approach.

INTRODUCTION

The oil exporting countries of the world are presently being faced with increasing revenues from royalties on their crude oil exported. At the same time, the realization that their oil reserves are becoming increasingly depleted is forcing them to take a policy of most efficient utilization of their revenues and of their raw materials, either through domestic industrialization or international investment.

This paper presents an analysis of three potential areas of industrialization, considering specifically the Persian Gulf countries. The three possibilities considered are:

A. Crude Oil Upgrading -- Desulfurization

B. Production of Petrochemicals

C. Production of Fertilizers.

The selection of these three areas is based on the following factors:

a) All three areas are highly capital intensive requiring an investment of a minimum of $100 million for the smallest size plant to be competitive in world markets.

b) The production of crude oil results in the coproduction of significant quantities of associated gas. This gas is, at present, being flared due to the lack of adequate markets and the cost of liquifying and transporting this gas. Transportation of this gas, either in the form of LNG or methyl fuel, to the U.S. results in a landed cost, even under the most optimistic economics, that is now competitive with the countries' other exports, i.e. crude oil. Transportation to the Japanese market, although economically viable, is limited by market size.

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c) The use of this gas within the country for exportable products could result in the most efficient utilization of fuel both from the viewpoint of th importing and consuming countries.

Table L shows the breakdown of industrial fuel utilization in the U.S. in 1968, from which it will be seen that the major consumers are the primary metals, chemical and allied product and the petroleum refining industries. These three industry classifications accounted for over 50% of total U.S. industrial consumption in that period.

The three areas have therefore been selected on the basis of being both capital and energy intensive.

TABLE L

U.S. Industry Group	Coal	Natural Gas	Petroleum Products	Electricity	Total Energy
Primary metal industries	2,838	863	306	1,291	5,298
Chemicals and allied products	666	1,219	1,426	1,626	4,937
Petroleum refining and related industries	*	1,012	1,589	225	2,826
Food and kindred products	263	593	134	338	1,328
Paper and allied products	467	341	211	280	1,299
Stone, clay, glass, and concrete products	406	449	87	280	1,222
Subtotal	4,640	4,477	3,753	4,040	16,910
All other industries	976	4,781	721	1,572	8,050
Total	5,616	9,258	4,474	5,612	24,960

ncluded in all other industries.
rce: 1968 Minerals Yearbook, U.S. Department of Interior, Bureau of Mines.

1. General

Very few proven reserves of crude oil are located close to the ultimate markets, and hence the logistics of refining the oil, transporting and distributing the products leads to a number of possible permutations. The best location for a refinery to transform crude oil into the final products is never clear cut, but will depend on a number of factors:

- Relative economics of transporting products versus crude oil.
- Availability of cheap fuel for the refining process.
- Size of market or markets.
- Crude Oil reserves - flexability of alternate sources of supply.
- Tariffs or other import barriers.
- Strategic considerations - both national and company specifics.

Historically, it has been the general custom to locate refineries at the source of production of the oil, where advantages could be taken of large installations to supply numerous markets as well as cheaper fuel costs. After World War II in the early 50's, % of world refining capacity was located at the wellhead. Outside the U.S., the major oil producing areas of the Middle East and the Far East, accounted for % of refining capacity.

The nationalization of the large Abadan refinery in 195 by the Persian Government resulted in a flight of new refining capacity from the producing countries to the consumer countries, close to the market place where they would: a) not be subject to nationalization and b) would have the possibility of alternate sources of supply in the event of disruption of one source of oil. The 1950-1960 period has therefore seen a buildup of refining capacity close to the markets in Europe and Japan, predominantly in the port areas of these countries, i.e. Rotterdam, Marseilles, etc.

In the U.S., the refining industry has built up in the past to a major extent close to the source of oil, predominantly in Texas, Louisiana and Oklahoma, these three States presently accounting for % of the total U.S. capacity. Products from these refining areas are delivered into the major areas of the East Coast either by pipeline or waterborne transportation. The Midwest and Central U.S. areas have been predominantly served by market located refineries based either on local or piped in crude oil due to the economic considerations of relatively small market concentrations and high la[illegible] transportation costs for product distribution.

Increased imports of crude oil into the U.S. would give rise to a buildup of refining capacity close to the major market areas, especially the East Coast area, if this were environmentally acceptable to the local populations. In the present emotional environmental climate, this is not possible and the major expansions occurring today are still taking place in the Gulf Coast area, even though this may be the less than economically optimum location for these installations.

In addition to the traditional refineries located either at the well-head or near the final consumer, during the 1960's, a number of "halfway" refining centers based on foreign crude oils and directed at the U.S. market have emerged offshore on the Caribbean Islands and in Canada, e.g., Borco in the Bahamas, Hess in the Virgin Island, the Come by Chance and the Point

Tupper refineries in Canada.

The rationale behind these refinery centers was to take advantage of the gradual derestriction of the import of selective foreign fuel oil products under the various modifications to the Mandatory Oil Import Policy, while the importation of crude oil per se was still being restricted.

The approximate capacity of the halfway refineries presently amounts to BPD, while projected refineries in various stages of promotion or planning in the last few years were an order of magnitude larger. Prior to President Nixon's April 18th Energy Message modifying the Oil Import Program, there was a refinery project being planned for virtually every island in the Caribbean and most deepwater Canadian ports.

2. Present Status

The future location of refining capacity to refine foreign crude oil destined for the U.S. market is at present being subjected to a number of pressures based on national interest, special interests, environmental considerations, as well as economic factors. These can be summarized as follows.

U.S. National Policy - The recent Energy Message abolished the restriction of imports of foreign crude oil and/or products on a volumetric basis. The Presidential Proclamation of April 18th allows for unrestricted imports of crude oils or products subject to a sliding tariff differentiating between crude oil, unfinished oils and final products. These differential tariffs (shown in Table I) place the highest immediate tariff on gasoline of 52¢ per barrel escalating to 63¢/bbl by 1975. Other finished and unfinished oils are subject to an immediate tariff of 15¢ escalating to 63¢ by 1975. Tariffs of crude oil start off at 10.5¢ escalating to 21¢ by 1975.

TABLE I

Import Fee Schedule
All Countries Except Canada
(¢ per bbl)

	May 1 1973	Nov.1 1973	May 1 1974	Nov.1 1974	May 1 1975	Nov.1 1975
Crude	10.5	13.0	15.5	18.0	21.0	21.0
Motor Gasoline	52.0	54.5	57.0	59.5	63.0	63.0
All other finished products and unfinished oils (except ethane, propane, butanes, and asphalt)	15.0	20.0	30.0	42.0	52.0	63.0

The essence of this differentation between crude oil and products in the tariff structure is to provide incentive for the construction of refining capacity within the U.S. rather than offshore, and appears to have had the necessary incentive if gauged by the announcement of refinery construction programs in the U.S. well in excess of 1 million BPD during the last 3 months.

Oil Producing Countries - The oil producing countries view the buildup of refining capacity both in the consumer countries and especially the halfway refineries as providing nothing for the industrialization of their countries. It is reported that the OPEC secretariat in Vienna is at present carrying out a study on the topic of worldwide refining capacity.

Although various recommendations have been made from time to time that the members should participate in the refining and even sale and distribution of their oil, no clear-cut pattern has as yet emerged of whether and how this should be done. The alternates of constructing upstream refineries located in the producing country, or downstream facilities in the consuming country both have advantages and disadvantages.

In this context, it is interesting to note that the recent agreement between the Persian Government and the Oil consortium did not include any provisions for the buildup of refining capacity within Iran, only the guarantee of full utilization of the existing refinery at Abadan. Furthermore, the Iranian National Oil Company has started to expand downstream by acquisition of a portion of Ashland Oil in the U.S., at the same time negotiating with both German and Japanese interests to build a large integrated refinery in Iran.

Oil Companies - The historic position of the oil companies has been to control the production, refining and distribution of crude oil from wellhead to final consumer as far as possible. The present loss of control of foreign oil reserves through participation/nationalization has weakened the position of the international oil companies. Control of the refining step by the oil producing nations would further weaken the bargaining position of the oil companies vis a vis the OPEC countries, and hence it can be expected that the companies will in general favour consumer located refineries rather than such facilities under direct or indirect control of the producing countries.

Environmental - The present concern over environmental quality both here in the U.S. and Japan has brought about serious resistance to the utilization, production and refining of crude oil. The last few years has seen vigorous resistance to the siting of any new refineries on the Eastern Seaboard of the United States. At the same time, the environmental demand for clean energy has increased demand and required additional processing of products to meet required sulfur level restrictions.

Attempts to provide desulfurization capacity to desulfurize fuel oil on the East Coast have met with serious environmental opposition and has resulted in the buildup of this capacity in the Caribbean Islands.

3. Persian Gulf Based Refineries

Refining Technology

As a general simplification, the process of refining crude oil to produce environmentally acceptable products today can be defined as a combination of the following two major operations.

a) Gasoline Productions

b) Fuel Oil Desulfurization

The complexity of these refining operations will depend on the crude quality (gravity and sulfur content), sulfur level required for the fuel oil products and the relative quantities of gasoline and fuel oil required.

Crude oils differ substantially in the quantity of potential gasoline (virgin naphtha) and the quantity of sulfur in the heavier portion of the barrel. Arabian crude oils generally contain in the order of 15-20% naphtha and have sulfur contents in the range of 1.5-3%.

Catalytic reforming of the naphtha portion would yield in the order of 20% motor gasoline from such a crude and catalytic hydrotreating would be required to reduce the fuel oil portion to acceptable limits of 0.3 to 0.5 wt% S required by U.S. standards.

In the U.S., at present, the relatively high gasoline requirement dictates that gasoline production from crude oil must amount to approximately 50% of total products produced. It is therefore common practice to produce

extra gasoline by the conversion of fuel oil or distillates to gasoline by cata-
lytic cracking or hydrocracking. For the European or Japanese market where gasoline is a smaller requirement relative to fuel oil (10% on crude), no fuel oil upgrading would be needed.

For any proposed Persian Gulf refinery the final configuration of the refinery would depend on whether the products from this refinery were to serve the American, European or Japanese markets. For the American market, gasoline production from distillates, and fuel oil desulfurization would be required. For the European market where sulfur restriction on fuel oils are very liberal, neither of the above would be required at present, though desulfurization may be necessary in the future when and if tighter sulfur restrictions are enacted.

The complexity and cost of refining operation will be greater for the U.S. market followed by Japanese and finally the European markets. Third world markets, such as Africa, Asia, etc., tend to be higher gasoline oriented and hence are similar to the U.S. pattern.

In a comparison of the relative merits of locating a refinery in the producing country rather than a consuming country, it is important to distinguish the market that will be served to the extent to which the refining operation will be taken to meet the relative final market demand requirements.

In the study, it has been assumed that the crude oil would only be treated to remove sulfur from the fuel oil portion of the barrel and reconstituted to give a low sulfur synthetic crude oil which would further be processed in the host country to upgrade it to gasoline and fuel oil products.

Comparative Economics of Persian Gulf Based Refinery

The relative economics of desulfurizing Arabian crude oils in the Persian Gulf relative to the same operation in the U.S. are shown in Table 2 and are based on the following factors:

a) The fuel consumption for desulfurization of Arabian crude amounts to between 5% and 9% of the total crude oil processed depending on the type of crude, product sulfur specifications, etc. If this operation is carried out in the U.S. (or Japan), this amount of "fuel" must be transported to the refinery and desulfurized prior to utilization.

A Persian Gulf based refinery would have the advantage of utilizing natural gas, a raw material presently being flared as a fuel source at a significantly lower cost in terms of refining and transportation as well as a more efficient total utilization of resources.

b) Transportation costs for finished products tend to be significantly higher than for crude oil today, predominantly due to the larger size of vessels used for crude oil. It is assumed that, given large enough volumes of either crude oil, synthetic crude, or finished products using comparable sized tankers, the relative transportation cost would be a standoff.

c) Processing Plant costs tend to be higher in the Persian Gulf than in the U.S. and a debit equivalent to 15% of capital charges has been added to the Persian Gulf location to reflect the higher cost.

Tables 3 and 4 show the overall economics for desulfurization of two typical Arabian Crude Oils, if this operation were to be carried out in the U.S. In such an installation, the fuel required for processing the crude and generating the hydrogen requirement would be derived from the crude oil, itself.

Table 3

~~Table II-6~~

Production of Fuel Oil from 100,000 BPSD Light Arabian Crude

Cost of Production

Basis: Plant Operation 330 Days/Year

Sulfur Level	0.3% Fuel Oil	0.5% Fuel Oil
Liquid Product, BPSD	94,610	94,800
Plant investment, ex. land	$51,040,000	$47,860,000
Payroll Cost, Annual	$3,000,000	$3,000,000
Daily Operating Costs (ex crude cost)		
	$/SD	$/SD
Payroll	9,100	9,100
Catalyst Makeup	2,440	2,120
Maintenance	4,700	4,500
Taxes & Insurance @2 1/2% Invest.	3,870	3,630
Depreciation @10% of Invest.	15,500	14,500
Profit before taxes @20% of Invest.	31,000	29,000
	66,610	62,850
Crude @ $3.00/Bbl., $/SD	300,000	300,000
Daily Operating Cost	$366,610	$362,850
Fuel Oil Price, $/Bbl.	3.87	3.83
¢/MM BTU (LHV)	69.1	68.4
Crude @ $5.00/Bbl., $/SD	500,000	500,000
Daily Operating Cost	566,610	562,850
Fuel Oil Price, $/Bbl.	5.99	5.94
¢/MM BTU (LHV)	107	106

Notes: 23.2% of liquid product is naphtha, see Table 1.
Naphtha taken as same price per barrel as fuel oil.
Capital charges for working capital and investment for land not included; but amounts to less than 1% of final price.
Sulfur disposal at cost.

Source: Chem Systems Report - Desulfurization Strategy Options OST-35.

Table 4
~~Table 12~~

Production of Fuel Oil from 100,000 BPSD Heavy Arabian Crude

Cost of Production

Basis: Plant Operation 330 Days/Year

Sulfur Level	0.5% Fuel Oil	0.3% Fuel Oil
Liquid Product, BPSD	93,460	91,320
Plant Investment, ex. land	$73,550,000	$87,900,000
Payroll Cost, Annual	3,250,000	3,500,000
Daily Operating Costs (ex crude cost)		
	$/SD	$/SD
Payroll	9,850	10,600
Catalyst Makeup	9,880	11,100
Maintenance	7,120	8,700
Taxes & Insurance @2 1/2% Investment	5,560	6,700
Depreciation @10% of Investment	22,300	26,600
Profit before taxes @20% of Investment	44,600	53,200
	99,310	116,900
Crude @ $3.00/Bbl., $/SD	300,000	300,000
Daily Operating Cost	$399,310	$416,900
Fuel Oil Price, $/Bbl.	4.27	4.57
¢/MM BTU (LHV)	75.0	80.2
Crude @ $5.00/Bbl., $/SD	500,000	500,000
Daily Operating Cost	599,310	616,900
Fuel Oil Price, $/Bbl.	6.41	6.76
¢/MM BTU (LHV)	112	117

Notes: 17.5% of liquid product is naphtha in 0.5% fuel oil case; 16.2% in 0.3% case.
Naphtha taken as same price per barrel as fuel oil.
Capital charges for working capital and investment for land not included, but amounts to less than 1% of final price.
Sulfur disposal at cost.

~~The relationship between crude oil price and the fuel product price is shown in Figure 7.~~

If this same operation were to be performed in a Persian Gulf location rather than in the U.S., the following changes in the overall economics could be expected.

a) Natural gas would be used instead of crude oil for fuel and hydrogen generation, resulting in a lower overall cost. It is estimated that the quantities of gas that would be used for the above operations is as follows:

TABLE 5

Natural Gas Consumption

	Light Arabian	Heavy Arabian	
Crude			
Product wt % S.	0.3	0.3	0.5
Gas Consumption			
~~[illegible]~~ mm Btu/hr.	990	1700	1120
SCF/Bbl	230	380	240

c) Desulfurization in the Persian Gulf would decrease transportation costs proportionally to the fuel that would be required if this operation were carried out in the U.S. This is estimated to vary between 5.7 and 9% for the three operations considered.

c) Capital associated costs would be somewhat higher in the Persian Gulf reflecting the higher cost of construction in this area. Although this varies fairly widely in general, it is estimated that construction costs would be of the order of 15% higher than for a similar installation in the U.S. Gulf Coast area.

Using an assumption of the availability of natural gas at 10¢/non Btu in the Persian Gulf, a crude oil price of \$3.50 per bbl. FOB Persian Gulf, and a transportation cost of 61¢/bbl. from the Persian Gulf to the U.S. east coast, the overall economic advantage for desulfurization of crude oil in the Persian Gulf rather than in the U.S. comes out at between 15¢ and 25¢ per bbl. for the three operations considered.

The economic advantage derived here is relatively small and well within the limit of the assumptions made. Furthermore, the desulfurized crude oil would, under present interpretations of the U.S. Oil Import Program, be subject to unfinished oil fee schedule of 63¢ in 1975, which is 42¢ higher than that for crude oil. Hence, on a purely economic basis, the desulfurization of PG crudes would best be done in the U.S.

→ If the desulfurized crude oil were to be considered under the crude oil classification the economics would favor the Persian Gulf location. The fee differential between crude oil and finished products would however continue to inhibit expansion of this type of desulfurization refinery in the production of gasoline and fuel oil products.

B. PETROCHEMICAL INDUSTRY

1. General

The manufacture of petrochemicals today is based on the upgrading of basically three raw materials:

a) Olefins - Ethylene and Propylene

b) Aromatics - Benzine, Toluene, and Xylenes

c) Chlorine

The above raw materials amount to over % of the total input to the petrochemical industry today. The production of these raw materials is highly energy intensive, both in the use of feedstocks and fuel required for the production of olefins and aromatics, and of energy in the form of electricity for the production of chlorine.

The basic sources and technology used for producing these petrochemical raw materials is as follows:

a) Olefins - Ethylene is produced today almost exclusively by the high temperature cracking of hydrocarbon feedstocks. The feedstocks used range from liquids derived from natural gas production - ethane and propane, through the light and heavy fractions derived from crude oil, i.e. naphtha and gas oil. The selection of the feedstock depends on the availability and price of these feedstocks, and other considerations such as the requirement for the co-products produced. In general, the heavier the feedstock, the more byproducts are produced, i.e. - propylene, benzene, toluene, and fuel oil. The main factor, in the overall economics of production of ethylene, however, is the price of the fe stock.

In the U.S., the production of ethylene has historically been based on ethane and propane feedstocks derived from natural gas production. A readily available amount of ethane and propane at low prices, in the past, has allowed the chemical industry to produce ethylene at prices substantially lower than world prices in general.

Over the last few years, the emergence of a national shortage of natural gas and the resulting higher prices, have forced chemical manufacturers to turn to alternate sources of feedstock. The first choice was the potential of importing foreign naphtha, which in the late 60's was in excess supply outside the U.S. and available at relatively depressed prices. This led the chemical industry to request special allocations for the import of foreign feedstocks to remain competitive in world markets and resulted in the formulation of Rule 9A and 9B under the mandatory oil import policy.

Subsequent to this, the potential demand for naphtha feedstocks for synthetic natural gas (SNG), shortages of gasoline in the U.S. and the recent modification to the Oil Import Program has resulted in unanticipated increases in world naphtha prices. The chemical manufactures are now faced with having to compete for their feedstocks at substantially higher price levels than in the past.

Of the six ethylene production facilities recently announced, all six will be based on naphtha and or gas oil feedstocks derived from crude oil.

Outside the U.S., in Europe and Japan, historically the prime feedstock has been naphtha derived from crude oil refining. In both of these geographic areas, a lack of natural gas availability, together with a relatively low demand for motor gasoline has resulted in an excess of naphtha which was available to the chemical industry at relatively low price. The recent opening of the U.S. market to foreign suppliers has resulted in rapidly escalating prices for chemical feedstocks. The application of the present import fee structure to chemical feedstocks will depend upon the relationship of U.S. feedstock prices to those in Europe and Japan.

b) Aromatics - Most of the aromatics required for chemical manufacture are derived as a byproduct of crude oil refining for gasoline manufacture. The catalytic reforming of naphtha to increase the octane number of the final motor gasoline product, results in the production of benzene toluene and xylenes. The products are generally extracted from the gasoline pool and subsequently refined for chemical production. Some aromatic production does occur as a coproduct of ethylene manufacture when heavy liquid feedstocks are used. Hence in Europe and Japan, where naphtha is the main feedstock, some aromatics used for chemical manufacture are derived from cracking operations. In the U.S. where light feedstocks have been traditional, virtually no aromatics are produced from steam cracking, although this will change in the future.

In general, therefore, aromatic raw materials both here and abroad, are derived as a byproduct of gasoline production and hence the economics are generally based primarily on the price of naphtha and hence of crude oil.

c) Chlorine - The manufacture of chlorine is based on the electrolytic decomposition of salt into gaseous chlorine and caustic soda. The overall economics of chlorine manufacture, therefore, depends primarily on the cost of electrical power, and the value obtained for the caustic product. The cost of fuel generally amounts to almost half of the cost of power generation, and hence the fuel availability plays a significant part in the overall cost of chlorine manufacture.

2. World Petrochemical Markets

The future requirements and expansion of the world petrochemical industry can best be illustrated by looking at the future projections of ethylene demand in the major consumer areas in the world, these being the U.S., Europe and Japan which account for 90% of total world consumption today. Consumption of ethylene by these three geographical areas is expected to increase at an average rate of 11% per year during this decade, reaching a total consumption of 102 billion lbs. per year by 1980. Total installed production capacity in 1972 amounted to approximately 48 billion lbs. per year. Recently announced additions in production capacity, now under design or construction, amounts to approximately 15 billion lbs. per year. In order to meet the projected 1980 demand for petrochemicals, an additional 39 billion lbs. of capacity will be required between now and 1980.

The largest single installation being constructed today is of the order of 1 billion lbs. per year of production capability, and it is anticipated that plant size will not increase significantly above this level. On this basis, an anticipated requirement of 40 new installations will be required between now and the end of the decade.

YEAR	US	WESTERN EUROPE	JAPAN	TOT
1970	16.3	14.3	7.10	37.
1975	27.0	25.9	12.8	65.
1980	40.0	42.0	20.0	102.

* Does not include third world market

Projections of the U.S. situation indicate a shortage situation between now and 1977. If all the announced projects are committed, a further 10 installations will be required before then and the end of the decade.

Present projections made by the Japanese Ministry of International Trade and Industry call for four billion pounds per year ethylene plants by 1976/77. The decision has not been made whether these will be made in Japan or overseas. Recent announcements of Japanese projects to be constructed in Persia and in Singapore reflect this indecision. Irrespective of where these installations are located, a further seven plants will be required to satisy the Japanese market between then and the end of the decade.

The supply demand situation in Europe, as far as Europe is concern is no better. At present, supply and demand are basically in balance and an additional eight plants are required between now and 1975 with a further sixteen between 1975 and 1980.

Overall, approximately thirty additional plants will be required between 1975 and 1980 to satisfy the major U.S. markets in the latter part of this decade.

2. PETROCHEMICAL PRODUCTION ECONOMICS

The production of petrochemicals is both capital and energy intensive. In general, the cost of producing the raw materials and first derivatives is highly influenced by the cost of fuel and feedstocks. The further downstream one goes, the less important the feedstock price becomes and the more important the capital and associated production costs become. To illustrate this point, the production cost of several raw materials and derivatives are shown in Table I as a function of fuel/feedstock costs.

These economics are based on the assumption of a large petrochemical complex based on ethane feedstocks similar to a number of complexes in existence in the U.S. today. Plant capacities have been taken consistent with the size of individual production units that would be competitive in world markets today. Capital requirements and profitability of the operation are also taken basically consistent with today's requirements.

The details of the various cost components assumed in the derivation of these economics is shown in the appendix.

3. Persian Gulf Based Petrochemical Industry

Generally, the location of the petrochemical industry has been dictated by the availability of raw materials. In the U.S. 90% of the industry is located in the Gulf Coast states close to the source of natural gas derived feedstocks. One would expect, therefore, as is being advocated by many people at present, that with the decline in domestic natural resources, future petrochemical capacity will move to the oil producing countries. Evidence of this already becoming apparent with the announcement of petrochemical projects ... the government of Algeria and the joint venture of Iran and Japanese interests ... Iranian NIPC/Mitsui joint venture petrochemical program.

The economic viability of a Persian Gulf petrochemical complex will depend primarily on the following factors:

a) The availability of low price feedstocks for chemical manufacture.

b) The cost of transporting the end products to the marketplace.

c) Tariff barriers to chemical products in the consuming countries.

d) Marketing ability.

e) Production economics.

f) Competition from other OPEC producing countries.

Looking at these factors in the context of a Persian Gulf based petrochemical market directed at the U.S. market, the following factors must be considered:

a) Feedstocks and fuel in the form of natural gas and natural gas liquids ... presently being flared. Saudi Arabia is presently flaring the equivalent ... 30 billion pounds per year of ethylene with similar volumes being disposed ... in Iran and other oil producing nations. It has been rumored that the ethane feedstock for the petrochemical project in Iran will be supplied at 2¢/mon Btu. ...is compares with a feedstock price of close to $1.00/mon Btu prevalent today ... the U.S. Making an assumption of feedstock availability at 10¢/mon Btu in ... Persian Gulf and $1.00/mon Btu in U.S., Europe and Japan, the differential ... production cost for the chemical products shown in Fig. 2 would be between .3¢ and 2.8¢ lower in the Persian Gulf based on feedstock costs alone, This

shown in Table.

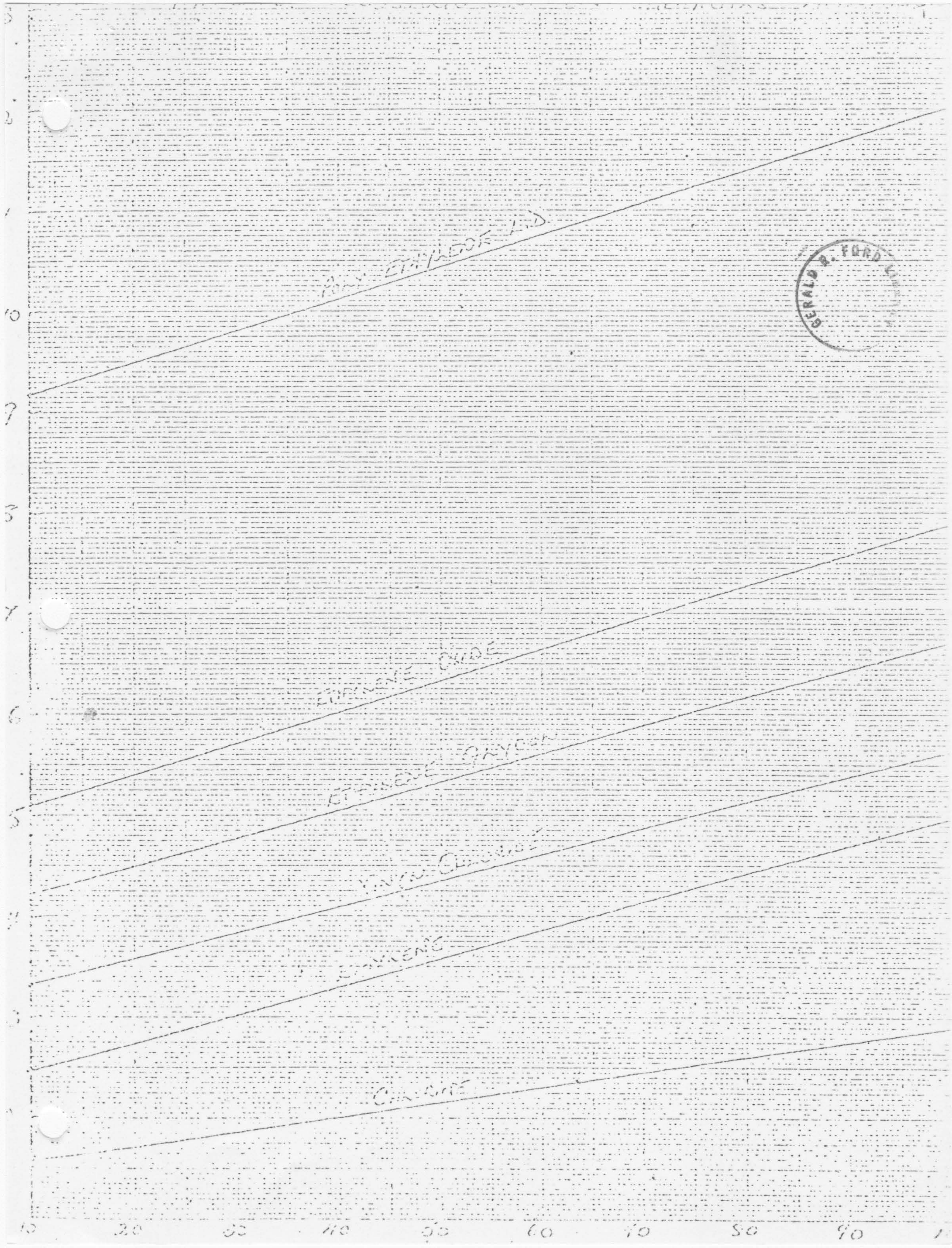
20
40
50
60
70
80
90

TABLE 1

CHEMICAL MANUFACTURING COSTS VS. FUEL FEEDSTOCK

Feedstock/Fuel Costs ¢/mm Btu		10	100	Δ
Product				
Ethylene	¢/lb	2.4	5.0	2.6
Ethylene Oxide		5.1	8.9	3.8
Ethylene Glycol		4.2	8.5	4.3
Ethylene Glycol Ether		7.1	10.7	3.6
Low Density Polyethylene		9.2	14.0	4.8
Chlorine		1.66	2.64	0.98
Vinyl Chloride		3.3	6.3	3.0

c) Approximate transportation costs for liquid and solid chemical products from the Persian Gulf to the U.S. and Japan are shown in the following table:

TABLE

Transportation Costs ¢/lb.

Market:	US	Japan	Europe
One Way Distance miles			
Product – LNG	2.0	1.2	2.0
LPG	1.1	0.6	1.1
Solid/Liquid Products	0.7	0.4	0.7

d) Capital costs for chemical plant are estimated to be higher in the Persian Gulf than in the U.S. or Japan and would be reflected in a somewhat higher production cost.

Taking into account these three factors, the following cost advantages for a [illegible] located plant become evident.

TABLE

Comparison of Persian Gulf and U.S. Based Production Facilities

Product	Cents per lb. Feed/Fuel	Capital	Transportation	Advantage
Ethylene	-2.6	+0.3	–	–
Chlorine	-1.0	+0.4	–	–
Vinyl Chloride	-3.0	+0.18	0.7	-2.2
Ethylene Oxide	-3.8	+0.2	0.7	-2.9
Ethylene Glycol	-4.3	+0.1	0.7	-3.5
Poly Ethylene	-4.8	+0.9	0.7	-3.2

The above chemical products are a number of the more obvious chemical products that have been chosen as an example of the many products that could be produced and exported to the U.S. and other markets, provided they can overcome an[illegible] tariff barriers. Present tariffs for these commodities in the U.S. are shown in Table

~~produced and the same analysis would have to be carried out for each individual chemical and an overall complex considered.~~

As an example of such a complex, it is interesting to review the Mitsui/Iran petrochemical project. This complex will be a 50-50 National Petrochemical Company and Japan's Mitsui venture producing olefins and aromatic compounds as follows:

1) 500,000 tons of olefins

2) 450,000 tons of aromatics

3) 250,000 tons of caustic soda

4) 300,000 tons of ethylene dichloride

5) 150,000 tons of polyethylene

The capital investment for this plant is estimated at $350 million; $100 million provided jointly by the two parties while the remaining $250 million will consist of long term Japanese credits obtained by Mitsui. The raw materials for the complex will be natural gas and naphtha at favorable prices. The major portion of the products are for the export market with Mitsui doing the marketing.

Implementation of this complex will be in two stages with the core complex consisting of the ethylene plant, aromatics plant, chlorine plant and a dozen first-line derivative plants to be in operation by 1976, with most of the products being exported. Further expansion into downstream products will take place as a second stage primarily directed at the domestic market.

~~Tables 3 and 4 show the overall economics for desulfurization of two typical Arabian crude oils, if this operation were to be carried out in the U.S.~~

c. Fertilizers

General – The production of nitrogen based fertilizers is based on the production of ammonia by the steam reforming of hydrocarbon, the usual feedstocks being naphtha derived from crude oil or preferably natural gas when available. In the U.S., the fertilizer industry has been based on natural gas inclusively. In Europe, naphtha was used as a raw material prior to the discovery of natural gas in Europe. Today, most plants are being based on natural gas.

Natural gas consumption and ammonia production amount to approximately 37 thousand cubic feet per ton of ammonia produced. In the U.S., natural gas consumption for ammonia manufacture amounted to 0.4 trillion cubic feet or approximately 2.5% of total natural gas consumed in the country.

Consumption of all types of fertilizers is increasing rapidly in all areas of the world primarily due to the change in the nature of farming practices. Over the next three years, the worldwide consumption of nitrogen fertilizers is expected to increase at average annual rates of about seven percent. Due to the limited increases in production capabilities, this growth rate will lead to a very tight supply demand picture by 1975.

The developing countries are expected to increase their nitrogen fertilizer consumption at rates averaging about ten percent per annum between now and 1975. Consumption growth rates in Latin America and the Asian countries are expected to be the highest. In Asia, the largest single importer will be the Peoples Republic of China. This country with India, Pakistan, Turkey, S. Vietnam and Indonesia will take more than 90 percent of total imports to Asia.

Summarizing the world supply-demand situation for nitrogenous fertilizers is currently essentially in balance. By 1975, barring any unforeseen circumstances, the situation will become one of very tight supply. In gross numbers, it is estimated that world nitrogen production will increase from 38.9 million tons in 1972 to 47.5 million tons by 1975. Between 1975 and 1980, a growth rate between 4-6 percent can be anticipated amounting to an average increase of 3 million tons per year of new capacity.

The normal economic size of new fertilizer production facilities today is of the order of 0.4 million tons per year. Thus, between 1975 and 1980, approximately 40 new installations will be required worldwide.

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The normal economic size of new fertilizer production facilities today is of the order of 0.4 million tons per year. Thus, between 1975 and 1980, approximately 40 new installations will be required worldwide.

Shown in Table 1 are the current (1971) and forecast (1975) demands for various nitrogenous fertilizers. At present, approximately 90 percent of the nitrogenous fertilizer productive capacity and consumption in N. America is in the U.S.

TABLE I

N. AMERICAN N FERTILIZER PRODUCTION

(Million Tons)

	1971	1975
Anhydrous Ammonia	13.8	16.4
Ammonium Nitrate	6.3	6.6
Urea	3.3	4.2

Of the 13.8 million tons of anhydrous ammonia produced in N. America in 1971, just over three million tons were applied as such. The remainder was used as an intermediate in the manufacture of other nitrogenous fertilizers (e.g., ammonium nitrate and urea) as in various non-agricultural industrial applications (e.g., synthetic fibers and petrochemicals).

The U.S. capacity to produce ammonia, the source of virtually all fertilizer nitrogen, will remain considerably above demand in 1973. However, the gap is likely to narrow as older uneconomical units are shut down. U.S. producers could make about 17 million tons of ammonia in 1973 operating at design capacity. Currently, the rate is 85% of capacity. Shortages of natural gas are critical and could force a noticeable cut in ammonia production as gas is the source of hydrogen in producing ammonia.

The factors influencing the inability of a fertilizer complex in the Persian Gulf are similar to those outlined in the previous section for petrochemicals. Once again, the major factors being the cost of fuel and feedstock and transportation of the final products.

A comparison of production economics for producing a number of fertilizers in the Persian Gulf with comparable production in Japan and the U.S. is shown in Table 2. Natural gas is assumed to be available at 10¢ per million Btu at the PG location and priced at $1 per million Btu in either Japan or the U.S.

From these economics, it will be seen that a PG based installation would have a competitive advantage of approximately $5 per ton in U.S. markets and $10 per ton in Far East Markets.

Product-Production Cost	Ammonia	Urea	Ammonium Nitrate
		$/Ton	
PG Location	28.4	34.7	32.5
U.S. or Japan	64.1	55.7	53.6
Differential	35.7	21.0	21.1
Transportation			
PG - U.S.	24	16	16
PG - Japan	13	9	9

The economics used in deriving these production costs are based on a fertilizer complex based on the production of 1500 tons/day of ammonia. Unit capacities and the corresponding capital investment requirements are shown in Table 3.

TABLE 3

Fertilizer Complex

Product	Production Capacity ST/Day	Investment $million
Anhydrous Ammonia	1500	34
Nitric Acid	900	11
Urea	1000	16
Ammonium Nitrate	1100	10
Offsites		10
		81

Total natural gas requirement for this complex would be of the order of 20 billion SCF per year.

Volcker to Reuss

November 29, 1973

Question: What are your expectations about the volume of investment in the United States by the Arab oil producers? What inducements do you expect the U.S. will offer to attract these investments?

Answer: We foresee that the receipts of the Arab oil-producing nations from petroleum exports will very substantially exceed their likely expenditures for imports of goods and services. Except to the extent they choose to use their funds for aid to other Arab states or to developing nations, the bulk of this surplus of receipts will, almost inevitably, be invested initially in the industrialized world. It is my general assumption that, given the relative size and dynamic role of the U.S. in the developed world economy, this country will directly and indirectly be the recipient of considerable Arab investment flows.

The large, highly developed, and open capital market of the United States is a natural outlet for Arab countries that have a need to invest profitably substantial amounts of funds. Such investments might be placed directly or through portfolio managers in Switzerland and other countries whereby the identity of the owners might be cloaked. Furthermore, our productive and diversified economy is also in an excellent position to attract resources that the Arab oil countries may wish to place in the form of direct investment, such as in downstream energy facilities and in the acquisition of ownership shares in petroleum-producing companies.

It is also assumed that a significant portion of increased Arab investments will be channeled to the Euro-markets. Such investments, as well as Arab investments in third country markets, can also have a positive effect on the United States balance-of-payments position. Some of these investments can be expected to be re-invested in the U.S. by Euro-market intermediaries or agents. More indirectly they should also tend to expand lendable resources in Europe or elsewhere for projects in the developing nations which might otherwise be financed in our market.

As implied in the foregoing, an increased flow of Arab investments to the U.S. should develop as a natural consequence of market forces. I do not believe that it is either necessary or desirable for the U.S. Government to offer special inducements or incentives designed specifically to attract Arab investments to this country. We are, however, continuing to review U.S. policies and regulations, such as the withholding tax, that may act as deterrents to foreign investment. In this connection we believe that the forthcoming removal of controls on the outflow of capital from the U.S. will be beneficial in enhancing the psychological security of foreigners investing in the U.S. Finally, it should be noted that the Committee of Twenty in formulating improvements in the international monetary system is discussing adaptations needed to accommodate the special situation created by the growing investments of the oil-producing nations.

[12/73?] 3

DEPARTMENT OF STATE

Washington, D.C. 20520

Honorable Thomas E. Morgan
Chairman, Committee on Foreign Affairs
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

The Secretary has asked me to reply to your letter of December 5 requesting the Department's comments on H. Con. Res. 389, providing for the breaking of diplomatic relations with, and the cutoff of exports to, Arab nations engaged in restricting shipments of their oil to the United States.

The Department of State considers that the actions called for in this resolution would not be in the national interest nor would they assist our efforts to achieve a just and lasting peace settlement in the Middle East. Moreover, we question whether these actions would be effective in achieving their objective--the end of the oil embargo and an elimination of other restrictions on oil exports by the Arab producing states. Our reasons for this opinion are set forth in the following paragraphs.

In his Foreign Policy Report to Congress of May 3, 1973, President Nixon listed as United States objectives in the Middle East the following: a settlement of the Arab-Israeli conflict through a process of negotiation; restraint by the great powers together with stable and dependable supply relationships among energy consumers and producers; strengthened ties with all traditional United States friends in the Middle East and restoration of bilateral relations where they have been severed; and a contribution by the United States to modernization, progress, and stability in the area. The actions called for in H. Con. Res. 389 would be totally contrary to the spirit of that policy. By creating new barriers between the United States and the Arab governments, they would hinder our efforts to maintain a dialogue with the Arabs and to explore ways in which the present strains in our relations can be removed.

injury to important American political and economic interests in the Arab world. With one or two exceptions, the countries at which this legislation is aimed are those with which we have a long tradition of close and friendly relations. They are also countries where there is over three billion dollars in American private investment and where we still have important commercial and other interests. Severing of diplomatic relations or an embargo on American exports, as called for in H. Con. Res. 389, would seriously jeopardize these interests.

For the reasons indicated above, the Department of State is opposed to H. Con. Res. 389 and to any similar legislation or resolution that would, in our opinion, unnecessarily impede the efforts of the President and the Secretary to achieve our foreign policy objectives in the Middle East.

The Office of Management and Budget advises that from the standpoint of the Administration's program there is no objection to the submission of these comments on the proposed resolution.

Sincerely,

Marshall Wright
Assistant Secretary for
Congressional Relations

OIL PRODUCER REVENUES

[12/13?]

4

Assuming prices remain at January levels for the remainder of the year, oil revenues flowing to producing nations will run approximately 95 billion dollars, roughly 3.5 times their level in 1973. Arab producers will receive over one half of this increase with Saudia Arabia showing the largest income gain (See Table 1).

Only a small portion of these revenues can be spent for foreign goods and services during 1974, even under liberal expenditure assumptions. For instance, in the case of Saudia Arabia, assuming a billion dollar transfer in grants-in-aid to other less affluent Arab nations (primarily Egypt) and a 20% growth in the import of goods and services, Saudia expenditures in 1974 would only run about 3.5 billion dollars. This represents only 24 % of estimated increased revenues and only 17.4 % of estimated total 1974 earnings.

Other oil producers will have similar absorptive difficulties during 1974, even those with a greater current need for oil earnings to finance their economic development or military programs. Normal delays in planning and decisionmaking make it almost impossible to spend all increases in revenue generated by the price hike during the current year. Because of these expenditure lags, all oil producing countries will show massive current account surpluses in 1974 (See Table II)*.

Arab surpluses on current account will most likely be invested in short term dollars denominated assets in Western Europe, and secondary financial flows will subsequently spread this wealth through most world capital markets. An influx of funds of this magnitude can be absorbed by these markets with only moderate adjustment, (IE ~~although~~ short-term interest rates on dollar assets may decline to some extent).

---

* 1974 projections assume an increase in imports over 1973 of 25% except in the case of Saudia Arabia, where imports are assumed to increase by 20% and grants in aid by 1 billion.

TABLE 1

PRODUCER REVENUES FROM
OIL EXPORTS
(Billion U.S. $)

Country	1973 Estimated	1974 Projected
Total	27.0	94.7
Arab	15.1	50.6
Saudi Arabia	5.5	19.9
Kuwait	1.9	7.3
Libya	2.3	7.0
Algeria	1.0	3.4
Iraq	1.7	6.4
Other	2.7	6.6
Non-Arab	11.9	44.1
Iran	4.5	18.5
Indonesia	1.2	4.1
Nigeria	2.4	7.9
Venezuela	3.0	10.6
Other	.8	3.0

TABLE II

OIL REVENUES, IMPORTS, AND CURRENT ACCOUNT BALANCES OF OIL PRODUCING COUNTRIES
(Projected 1974) Billion U.S. $

Country	Oil Revenue	Imports[1/]	Current Account Balance
Total	94.7	30.2	67.4
Arab	50.6	11.5	40.3
Saudi Arabia	19.9	3.5	16.6
Kuwait	7.3	1.6	6.0
Libya	7.0	1.7	5.3
Algeria	3.4	1.8	2.1
Iraq	6.4	1.0	5.5
Other	6.6	1.9	4.8
Non-Arab	44.1	18.7	27.1
Iran	18.5	5.9	13.1
Indonesia	4.1	2.3	1.9
Nigeria	7.9	4.0	4.7
Venezuela	10.6	4.0	6.9
Other	3.0	2.5	.5

1/ Also includes grants and other transfers imports for all countries are assumed to have increased by 25% over 1973 estimated levels.

2/ Saudi Arabian estimate postulated on the basis of a 20% increase in imports and 1 billion transfer of grants-in-aid

Official reserve holdings of oil producing countries are not great by Western European standards at the present time. For ~~in~~ example the largest reserve balances of any OPEC country ~~xxxxx~~ in December we were held by Saudi Arabia, 3.7 billion (see table III)

This compares with 6.1 for Italy, 6.2 for the Netherlands, 8.5 for France, and over 34 billion for Germany. However, reserve levels of producer countries should increase dramatically during 1974 as expendatures lag massive oil revenue inflows.

TABLE III

Present Total Reserve Assets of Oil Producers
(dollar denominated)

Country	Month	Total Reserves
Saudi Arabia	Nov. 73	3.7
Kuwait	Dec. 73	.5
Libya	Dec. 73	2.1
Iraq	Nov. 73	1.3
Non Arab		
Iran	Dec. 73	1.2
Indonesia	Dec. 73	.8
Nigeria	Dec. 73	.6
Venezuela	Dec. 73	2.4

5

THE DEPARTMENT OF THE TREASURY

DATE 1/8/74

TO The Honorable Peter Flanigan

Here is the check list of methods of handling oil company investments that I mentioned on Saturday.

PAV

PAUL A. VOLCKER

Room 3312 Ext. 5635

CHECK LIST OF APPROACHES TOWARD OIL COUNTRY INVESTMENTS

The listing below is designed to be comprehensive, not analytic. A number of the items are vaguely stated, because the possible approaches have themselves not been well developed. Some of the ideas seem promising, others not. One immediate question is which should be more fully developed and considered internationally. A number of the approaches are complementary rather than competitive, on the assumption that no single technique is adequate to handle the problem.

1. "Investment Fund Approach" -- Proposed by U.S. in C-20; would (a) limit oil country holdings of primary reserves, and (b) provide agreed framework, through statistical reporting and mutual host-investor country agreements, for channeling investment funds. No new institutions or mechanisms envisaged; the proposal is essentially designed to deal with funds the producers will be investing "on their own".

2. Provision of a "special reserve (or investment) asset" to oil countries.

   a. Create an SDR-like instrument for oil countries, protected against currency depreciation and with reasonably attractive interest rate. The question of a purchasing power guarantee has been raised. Funds invested in the new instrument would be distributed among oil importers, presumably in government or money market paper, but method of allocating funds obscure.

   b. IMF borrowing from oil countries, which would carry a guarantee and interest rate, as above. The IMF would relend for long terms to consuming countries. To permit relending in adequate volume and appropriate term, a change in the Articles would presumably be necessary.

c. A regional EC instrument could be developed for same purpose.

d. Oil countries could be permitted or encouraged to invest in SDR's, with additional allocation of SDR made by present techniques to the world generally in volume sufficient to match absorption by producers. The effect is that oil countries would receive a guaranteed asset, with the corresponding flow of funds and SDR liability distributed through other countries depending upon their overall balance of payments position.

3. New Investment Institutions.

a. A consumer-producer investment bank could be created under joint supervision and control, but with producers presumably controlling certain basic policies and the size. The idea would be to provide a sort of jointly managed mutual fund providing diversification and expertise. More important, the institution would hopefully provide a multilateral shield to help reassure (a) host countries about the stability of the investment and absence of "political" control of their industry; and (b) investing countries about ample investment outlets and absence of retaliatory action. Large questions of organization and control have not been adequately studied.

b. A "consumer bank" could be established to negotiate loans from producers with certain joint guarantees, the funds to be distributed by consuming country decision.

c. A "producing-country" bank, to diversify risk and pool investment programs.

4. Recycling Proposals -- Under the auspices of the IMF, or otherwise, massive swap-like facilities could be established to "recycle" short-term funds among consuming countries, roughly offsetting differential investment patterns of producing countries. Terms and conditions, as well as determination of extent of borrowing rights, would pose formidable problems, but this is one approach being explored on intra-EC basis.

5. Special Securities -- Consuming countries could offer special securities and guarantees against currency depreciation and/or inflation for direct bilateral dealings with producers.

6. Import Credits. -- Producing countries could simply permit payment for oil in part through long-term import credits, deferring balance of payments impact from oil price increases.

7. Gold Sales -- By Whom?

8. Normal Market Channels.

   a. Direct Investment

   b. Real Estate

   c. Portfolio Investment

   d. Euro-Markets

9. Repayment of Debts.-- Producing countries have several billions of indebtedness to the U.S. and others that could be prepaid.

10. Special LDC investments

    A. Long-term low or zero interest export loans (or even grants) to LDC's by oil producers in amounts equivalent to all or some of money flows related to higher prices. In effect, this would be a substitute for two-tier pricing.

B. World Bank (and other development institution) financing -- The producers will have more than enough money to fully fund these institutions, and terms could vary from equivalent of high grade bonds to heavily subsidized rates. Except for rate subsidy, this will be of no net benefit to LDC's unless lending is larger than any reduction in borrowing in consumer countries; to the extent there is substitution, consumer country capital markets and balance of payments are relieved.

C. Producer-LDC Investment Bank -- The producers could pool funds for lending to LDC's on concessional terms.