ENERGY FOR DEVELOPMENT: AN INTERNATIONAL CHALLENGE

Prepared for the North-South Roundtable
Of the Society for International Development

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With a foreword by Maurice F Strong

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FOREWORD

It was not so long ago that the voices o£ those who warned o£ an impending energy "crisis" *were* unheard and unheeded. Now the rood has changed co fanatically. & ergy is decried by *nervy* as the source of all the economic and financial ills of both the industrialized "North" and the developing 'South". That the energy issue is a critical and important one for the entire world oarmfmity is undeniable. But the present tendency to ascribe to energy the blame for most of our current ailments would be as wrong and misguided as the apathy and skepticism that characterized the attitudes existing before the advent of the energy crisis. Sharp increases in oil prices and potential shortages of supply have indeed produced major impacts on the economies and the prospects of virtually all countries. They have produced a shift of economic power and commemorative advantage that is unprecedented both in its dimensions and its speed.

This dramatic shift towards one group of oil-rich developing countries is fundamentally altering the world's political and economic kslance. While this has roved the international economic order towards the kind of changes all developing countries have been seeking, it has also created new burdens for the energy-deficient countries, particularly the poorest, and given rise to new needs for international action. The consequences for the oil-deficient industrialized countries, the oil-importing developing countries and the oil exporting countries will have a profound effect on the future of each of these groups. On the one hand it sharpens the differences and potentials for conflict annug them; on the other hand, it makes the need for understanding and cooperation note urgent and compelling than ever.

The rapid evolution of the sense of "crisis" surrounding the energy issue has been

accompanied by a great deal of miss-information, misunderstanding, and emotion. In this climate, it has proven extremely difficult to rmunt the kind of constructive and objective dialogue which is needed to facilitate international agreement en the issues. Indeed, attempts to date to negotiate these issues at the international level have been anxiously unsuccessful. They have floundered largely on the unwillingness of the industrialized nations to link negotiations rn energy with a serious consideration of the demands of the developing countries for a note just and equitable "new international economic order," and on the insistence of both oil-exporting and oil-importing developing countries that energy issues can only be effectively addressed within this broader context.

In the meantime, the sense of crisis has yielded a proliferation of energy studies. While these have been helpful, they have also showered the public with such a plethora of facts and viewpoints that they have tended to add to the confusion. More importantly, most of these studies have been carried out in the Western industrialized countries and have been biased towards the perspectives and interests of these countries. There is as yet very little Troad understanding of the interests and concerns of the oil extorting countries and the acute plight of the oil-importing developing countries. And there has still been far too little recognition of the real need and importance of viewing the energy issue, and dealing with it, as an integral part o£ the complex of issues which affect relations between the industrialized and developing countries--the North and the South.

It is against this background that the North-South Hound table of the Society for International Oevelopm nit (whose activities are described at the end of this *volume)* has established an Energy Roundtable to help bridge the gaps in information and understanding which have thus far prevented the establishment of effective dialogue and negotiations on these issues. It is designed to assemble the best available information, analyses, and opinions concerning energy as it affects each of the principal groups of nations-industrialized, oil-exporting, and oil-imp frog developing nations-and the relations among these nations which bear on the prospects for peace, security, and prosperity for the entire world community.

It is not the intent of the Roundtable to produce a single solution to these issues, tot to provide the kinds of information, understanding, and ideas out o£ which solutions may be fashioned. It is not a forum for official negotiations; but it is designed to under gird and supports the processes of official dialogue and negotiations and to feed information and ideas into this process. It is not another energy study; but it draws upon virtually all of the principal energy studies that have been produced recently, and has had the benefit of contributions from tinny of the authors o£ such studies. It is not intended to argue the case for any single group of nations; yet it accepts a special obligation to £ring out the perspectives of the developing countries, both oil-exporting and oil-importing, because there has been far too little understanding and appreciation of the interests and concerns of these countries by the industrialized world.

The Report is a product of the first phase of an ongoing process of dialogue which the North-South Energy Roundtable has initiated. It presents the views of the authors, expressed in their personal capacities, rather than any consensus reached in the Roundtable, even though these views have developed after several intensive discussions in Roundtable meetings.

The second phase is envisaged as a series of in-depth dialogues organized try the Roundtable. These would take place in a variety of fore in both industrialized and developing countries as well as international institutions. It would involve small teams of experts in dialogue with policy-razz kerns. It would be designed to give the policy-makers the benefits of the information and viewpoints assembled by the Roundtable and at the came time add to the insights and knowledge available to the Roundtable.

In the third phase o£ the process a final document would be produced, incorporating the results of the entire process. But this final report, like the framework report, will represent only a portion of the fruits of this process. The host important contribution of the Energy Roundtable will be the can tore o£ knowledge and ~distending, which will be developed throughout the exercise in the process o£ interaction among experts and policy-makers representing a broad and

diversified range of experience and interest. It is in this continuous nurturing of understanding and dialogue which under girds and facilitates the processes of policy-making at the national level and of formal negotiations among nations at the international level.

This initiative originated at the meeting of the North-South Roundtable in Nlombo, Sri Lanka in August 1979. Overall coordination of the project has been the responsibility of its Steering Committee, which I have the privilege of chairing. A number of neetings have been held involving people from all regions of the world representing a wide variety of experience in the field of energy, economic and social policy, governments, international organisations, and private industry. Important contributions were node try a number of others. All participants contributed in their personal capacities. To all I would like to exiaess ny deep gratitude.

I would like to record our special thanks to Mahbub ul Haq, Chairman of the North-South Roundtable, whose leadership and commitment have nude this project possible; also to John Foster, Francisco R. Para, James W. Howe, (Avid H. Pollock, and Efrain Friedman for their indefatigable work in preparing this report. And none of us would have keen able to function without the gracious and efficient support of Khadija Haq who, as Director of the Hound table Secretariat and its principal organizing genius, piffled it all together.

I would also like to record our gratitude for the financial support provided, in cash and in kind, from a number of sources, government and Irritate, and in Particular the generous support of the Government of Sweden, the Atlantic Richfield Company, Petrol-Canada, the Overseas Development Council, and the International Energy Envelopment Corporation.

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Abbreviation and Acronyms

CIEC conference on International Economic Cooperation
CPE Centrally planned economy
DAC t vilipend Assistant

DRE Decentralize cue °it tee of the OECD
ECLA sled renewable energy

Economic Commission for Latin America EC.SC European Coal and Steel Community

EEC European Economic Community

G-77 Group of 77
IAEA International Atomic Energy Agency
IDA International
JOB IF, vvelop NT Association
Inter-American Ikvelopr¢NT Bank TEA International Energy go

IMP International Monetary Fund
EEC Less developed country LNG Liquefied natural gas
NGL Natural gas liquids
NIW New international economic order
NSERT North-South Energy Roundtable
NSRT North-$oath Roundtable
OAPEC Organization of Arab Petroleum Exporting Countries
ODC Overseas Envelopment Council
OECO Organization for Economic Cooperation and Development
OPT Oil-importing developing country
Organization of Petroleum Exporting Countries H(O&D Oil-exporting developing country
Research, development, and demonstrations SDR Special drawing rights
SID Society for International Development
UNCPAD United Nations Conference on Trade and Ik' velolment UNDP United Nations Development Programmed UAE United Arab Emirates
UNICEF United Nations Children's Fund

bid barrel per day
Cfd cubic feet *leer day*

o.e, oil equivalent
Tce metric ton of coal equivalent

OVERVIEW

Summary

The North-South dialogue has encountered many setbacks, but a new attempt is currently being ride to revive it, this tine within a United Nations framework of global negotiations, the corner-stone of a Third Development Decade. This is just the latest in a long series of international efforts to resolve the problems of North-South relations.

The issue o£ natural resources has been at the forefront of developing countries' efforts to improve their concept of the international economic order. During the 1970s, oil extorting developing countries (OXi7Cs) acquired increased bargaining strength, which has led to enormous changes in petroleum arrangements. No other natural resource has yet turned out to he as strategic to the world as oil, which has become a catalyst in the movement towards an improved international order.

This basic framework report is predicated on the existence of a new consensus between the parties involved, even though the international system faces a host of difficulties. One of the failures of the past has been a dialogue of the deaf. What will help is a clearer exposition o£ perspectives and a fuller understanding of each Iarty's objectives and policy options. Nations can make greater progress towards achieving energy security and do so at less cost if they treat the problem as a global one, resolvable through cooperative international action, rather than s leally a unilateral or bilateral one.

I. THE GLOBAL ENERGY

Energy and development

Energy is one of the nest important inputs in the process of development. Hunan material progress and the use of ran-human energy have gone hand in hand. Consequently, there is proper concern whether energy (especially oil and wood fuels) will he available in adequate supply and at prices which will allow progress try continue.

World energy problems are rot confined to oil, though oil is a preoccupation because o£ a) its finite nature and the need to conserve its use and develop alternative energy sources, b) its impact on balance of yeomen's, international financial flows, inflation, and economic growth, c) dangers of supply disruptions, and d) its importance as the prime form of commercial energy in developed and developing countries alike. It is the single largest primary modify by value entering into world trade.

Nor are world energy problems confined to commercial forms o£ energy. These are the ones mainly used in industrialized countries and in the under and urban sectors of developing countries. But equally crucial are the problems of societies lased on non-commercial energy. Some 60% of the world's population are rural and mostly rely on traditional: energy fuels. The fueled crisis and other constraints on. Living standards are a fact of life for the majority of the world's population.

The present world energy prospect can be viewed as a. a virtual stagnation in the overall trade of oil, and little growth in traditional energy sources. These constraints point to a future transition to the accelerated development o£ alternative energy sources and, equally important, to increased efficiency in energy use. Much of the world's population is f faced with a threefold energy problem: I) obtaining enough traditional energy, ii) shifting to hatter-quality fuels and, iii) making the transition to liter plentiful energy sources i than oil.

Oil

Oil has been a key input to economic growth in industrialized and developing countries alike. The remarkable growth in its consumption until 1973 was facilitated by the extraordinary increase in production and low-cost exports from OPEC countries, particularly in the Middle East. Since then oil has entered a high-cost era. Its growth has militated greatly, reflecting the downturn in economic activity in industrialized countries, substitution of other energy forms, and increased efficiency in energy use.

There are now only a few countries where oil production is large and still clearly expending, and in none is it thought likely to exceed by much their national objectives: China, Mexico, North Sea, Iraq, and a few developing countries. There are a number o£ other developing countries where output is smaller but expanding. Four of the rust important OPEC producers do not wish to produce at capacity

and are reluctant to undertake further large-scale expansion: Iran, Kuwait, Saudi Arabia, and the UAE. Undoubtedly the rust contentious issue between industrialized and OPEC countries would be the rate of development and production in the few countries where there is large potential for expansion.

Exploration in oil-importing developing countries (Odes) had been picking up in recent years. A large number can reasonably expect to become medium to small producers.

Throughout roost of 1980s and during the 1990s, oil demand is likely to be constrained by supply availability, though this must he understood in the context of production limits for political and economic reasons in some major oil exporting countries.

Higher oil prices have improved the economic viability of exploitation of small fields, enhanced recovery, and exploration in high-cost areas such as polar and deep water, heavy oil, tar-sand, and oil shale deposits, and fields with poor reservoir characteristics. In many countries snail fields will he found well into the next century. Their cumulative impact nay be great, and their support to economies including Odes will be significant.

The prospects for international oil trade during the next two decades appear to be at best a continuance o£ their present levels, unless incentives can improve prospects for OKDC output.

A particular uncertainty is the extent to which the Soviet Union/Eastern European bloc nay moves from being a net exporter to a net importer of oil. It would be prudent to plan on this prospect, though there are nervy unknown variables which could ameliorate it.

We find a great concentration of oil imports into a relatively few Otis. The upper middle-income countries import the lion's share. Thus, for many countries their oils imports are minuscule in relation to world trade. But to each I of them, these imports could be a heavy burden.

If the prospects for the next taro decades are truly for an increasing constraint on international oil trade, then national oil trade, and if Olds are to just even have a. modest increase in their trade, then the industrialized: countries will import or pore oil than at present, and quite'; likely less. This is recognized by them in the formulation of their oil import targets.

Oil prices are generally expected to continue rising% in real terms during the next two decades. For example, the World Bank now postulates a 3% p.a. increase as an illustrate-r live hypothesis. Of course, price projections are no inner' than illustrative. In no way can they have precision, and the uncertainties are huge. There could he sore alleviation of pressure on prices if steps in oil importing countries to moderate oil import demand are successful. Conversely, there could be Bore severe price pressures, if future world energy supplies turn out to be less than hoped. i

Though the international oil market could ease up in the short term, it still does not appear prudent to plan on such an outcome for the long term. Oil importers are precariously dependent on just a few export sources. There is vulnerability from reliance on physical concentration of large-scale export facilities. There is little flexibility in the supply system.

Natural Gas

Natural gas is likely to make an increasing major contribution to world energy supplies. It will to an important transitional fuel. It could be the fastest growing energy, urge in developing countries as well as elsew'nere. Expansion of the local gas usage should he the main policy aim. But where the domestic market is limited, exports by pipeline or liquefied natural gas (LNG) nay are advantageous.
In recent years pricing, financial, economic,
Technical and envimnmental reasons led to the oil cancellation of many LNG project. In particularly, their high cost has node for a relatively price setback their high the wellhead. Hence lownitrous for gas have typically Pursued other uses for natural gas or have flared s oil prices have greatly improved the en viability of Projects. The economic a other high-cost sources Y have also improved those o£ !d will have to be of energy, and investment decisions will have to be. Justified in relation to other energy popcorn

The potential for deep conventional gas *rely* be great. The world's major fossil fuel sources when oil begins to be depleted in the next century. A major deterrent has been the *high* costs of exploration and development. The Middle Fast could have giant deep gas deposits, but these horizons are unlikely to be tested until oil reserves are fore drastically depleted. Energy resources must also include unconventional survey of which is not yet explored. They include gas dissolved much water, natural gas from coal-beds, B dissolved in Bas from tight sands, and Bas from Devonian shams, gas hydrates.

Coal

The world's resources and reserves of solid fuels are huge, much larger than those of oil and gas. There are rtany countries which are believed to have untapped and unassessed coal reserves. Africa and South America have only sporadically he en examined for coal. Worldwide, a large production base exists which could 6e extended, if narkets were develoxdd There are great opportunities in both industrialisedand developing countries. Divalent lies with government The key to resource policies o encourage e such exploitation.

A critical issue for the expansion of coal use is its Acceptability to end users' particularly in developed resolved questions on environmental issues have Miners and engineers, lead-times, and considerable investments costs. Nevertheless, a large increase is expected in out pain and, even more so, in international trade.

Nuclear Power

The present outlook for nuclear power is very mixed France and the Soviet Union are greatly expanding its developing meet, while in a number o£ industrialized countries it development continues to be retarded by rubric concern safety, economic, and financial issues. The number o d developing countries which can handle the technology and ha a large enough electricity sector is relatively limited' Elsewhere, toast developing countries are going slow in their I approach towards nuclear power at this time. Fear of weapons proliferation has made supplies` countries cautious in supplying technology and fuels. I return, recipient countries are concerned about the principle
Of retaining sovereignty over their national policies. Phi d raises questions of how far existing international agencies can adequately establish nuclear safeguards, and how far p supplier countries should go in balancing the political a C strategic risks in relations with recipient countries,

Hydro electricity

Hydroelectric power is expected to continue growth during the next two decades. New

sites are becoming herder 'P cone by in host industrialized countries other than Canada and Norway. But there are still huge opportunities in developing, 1 countries. The use of snail-scale hydro plants is also seeing I to increase greatly, as has happened in China.

Other Renewable Forms of Energy

Interest in renewable energy has much increased wit the continued rise in oil prices. The technologies for forms of renewable energy are nature, for others are promise and being developed for commercialization, and for others are under research and development and have long-term possibilities. Issues regarding these energy forms will be addressed closely in the UN Inference on New and Renewable Sources of Energy in August 1981 in Nairobi. In developing countries, interest has particularly focused on decentralized and small-scale applications in rural areas. A key problem for OIDCS is the need for energy in food production and tunes hold use. This requires fore effort to improve technologies for use of bias as, particularly fuel wood and charcoal. There has been significant development of processes for large-scale production of ethanol from carbohydrates such as sugar and starchy roots. An outstanding program is the one in Brazil. Biogas is also receiving much interest; it has been prompted extensively in China. Solar energy in its nary varieties, wind power, and methanol all have significant potential.

II. THE PARTIES INVOLVED

1. Oil-Importing Developing Countries

The developing countries consume much less commercial energy than industrialized countries, but their energy consumption is increasing at a faster pace. Their use of energy varies greatly among greatly among countries. There is also great inequality within each country between cities and countryside, and even within cities between the modern rector and urban slums. The rural peoples and those in the urban slums rely upon traditional sources of energy such as wood, crop residues, animal power, and charcoal.

Energy waste abounds in the South as well as in the North but for different reasons. In the South it is due to inefficient practices and equipment. In rural areas, there is waste in the use of fuel for cooking and in the making of charcoal. The cure is to provide the funds and expertise to improve efficiency.

At least 73 countries depend on imports for 100% of their oil needs. There is thought to him a great deal of oil in the Odes. Sate geologists believe that much oil yet undiscovered ray be on or offshore the developing countries. Yet the drilling rates are low in relation to the oil producing industrialized countries. Outside help is needed to find and produce their own fossil fuels, to improve efficiency in energy use, and to adopt new and tore plentiful substitutes for oil. Locus will need help to pay for essential oil imports and to improve their export markets to help iBy for quell their oil imports alts Heavy oil, tar sands, and oil shale's also are great Glow potential energy sources. As drilling increases in the OIDCS, true'

Aft much natural gas *ire* is found. Except for China and India, very little exploration to for coal has been done, perhaps because industrialization inn

The Otis had not begun before oil displaced coal as the': preferred fuel for industry.Many experts feels that the potential for coal in the Oyo's is great.

Nearly two-thirds of the world's conventional hydro-` [1]

Electric potential is in the Third World, but less than 10% of'~ e the conventional hydroelectric potential there has been exploited. A closely related and even less explored energy l. The Chinese source c small-scale or [mini-]heron nun important scarce of experience suggests that this [nay] Energy.

Whether nuclear fission will *prove* to be an important energy source for developing countries depends on whether nuclear technology is successful in solving its cost, safety, and waste disposal problems in the North and, if so, whether it will come in unit's wall enough to hatch the grids in most OIDCS

Traditional energy is in Jeopardy in the Third World, where it is the dominant and indispensable source of energy. The shortage of firewood is acute in most regions,

and the price of firewood and charcoal is skyrocketing. The growing demand for charcoal is accelerating deforestation. Traditional methods o£ production are very inefficient, and the pressure on forests increases. In Hone areas, there has been a movement from wood to kerosene. With the rapid increase in oil prices, however, there has been a reverse trend from kerosene back to wood and charcoal. The firewood problem is serious *everywhere.*

The firewood shortage has led to far-reaching environmental problems. Forests are disappearing at an alarming rate. A sizeable percentage of the world's forests could disappear before the end of the century, with unknown consequences on regional and global climatic changes and on food Production. For frost countries, there are virtually no at alternatives to wood except hydropower or agricultural wastes. Given present rates of deforestation, Senegal will be bare of 5, trees in 30 years, Ethiopia in 20, African Burundi in 7.In nine countries surveyed by the World Bank, present annual

Rates of forestation would need to be increased by g-.g0 'n times, in order to meet domestic fuel needs to the *year* 2000.

While the industrial countries have to love away from oil to other note plentiful energy sources, the developing countries have to lake a double transition: I) they must lake the same transition for the modern sector of their economy and ii) they must make the other transition from traditional energy to lore modern non-oil energy, even as they face the transition to modern energy sources. It cakes little long-term sense for a developing country to flake a transition to oil just at the time it must undertake a transition from oil to successors. The problem is that any decision to forego the shift to oil-based technology is a decision that will immediately hurt development. The dilemma of the OIDCS is this: if they continue to shift to oil, they will be in great trouble now. in a few decades; if they interrupt the shift, they will be in trouble now.

An option that flay be mrticularly open to the ThirdWorld is to give much emphasis to mMern decentralised renew able energy. This is hecause i) people live in rural areas, Far from the reach of grids of modern energy, ii) modern Energy when available is highly priced and iii) there is Relatively little investment in hard energy.

Solar energy is generally in lore abundant supply in the South in one or Rorer of its four forms than in the North: sunshine, falling water, wind, and Morass. Most developing countries have the potential for at least one or note of its forms. They are attractive to Third World countries because I) they can be decentralized in the rural areas where most Third World people live; ii) the costs of certain technologies for the use of decentralized renewable energy are not expected to rise as rapidly as the cost of oil; and iii) the future of oil is increasingly uncertain. But the technologies are still being developed and are not yet sufficiently reliable or cheap enough to compete with conventional energy resources. In the rural areas, lure research and site testing is needed before its full promise comes evident. There is not much prospect: that renewable energy will soon become competitive in the modern rectors of developing countries.

The OIOCS have several energy needs: I access increasing supplies of oil, ii) increased production a improved management of non court-martial energy, iii) improv$_e$ efficiency in energy use, iv) development of indigenous m

Metrical energy and v) a smooth transition to oil's success sores. Finally, they need to strengthen existing institution and in some cases establish new ones which can plan and manage energy services, and they need to expand the numbers of qualified energy personnel.

OIDCS have short-run energy and balance of payments problems. Oil import bills of OIDCs are estimated at about $67 billion in 1980 and in the World Hank's view could rise by 1990 to mine $230 billion ($120 billion in 1980-85). The low-income countries face serious financing problems. Middle-income countries are unlikely to find bilateral official finance as freely available as in 1974-75. The ability of the private sector to maintain as predominant a role in financing the major borrowing countries stands in doubt.

Severe imbalances in the 1980s will impose great human costs. How great the costs will be depends on the

Adoption of suitable national economic policies and on the performance of the external world. There are three basic options: f) developing countries can cut oil imports, ii)they can seek external financing, and iii) they can improve their

merchandise exports.
If the developing countries are to have the possibility
Of even substantially reduced rates of economic growth, they have to have increased, not reduced, access to oil. This point to private and official external financing *as* the chief means of adjusting to high oil costs. There are several current and potential new sources. In particular, there are grounds for optimism that OPEC will yet further increase its development assistance. OECD aid is not likely to increase much over the short-term. There is need for increased assist Trance from IDA and the soft-loan windows of international financial institutions, and the IMF.
'In the long-run, OIDCs' frost constructive course of 't action is to increase merchandise exports. But the inability s to increase exports is severely limited by external factorsover which they have no control. Borrowing nIney is no forethan a temporary solution, albeit highly essential for their mediate future. To get at the roots of the balance-of1 ' payments problem will take much more heroic measures,
Involving international cooperation.
Industrialized countries' markets must be increasingly open to export from OIDCS. Prices of Northern exports to *[Des* must not inflate too much. Oil most remain physically available to OIDCS, along with the mans to finance it.
Proposals for reform of the international economic order include trade reforms (improved access of Southern exports to Northern markets), as well as improved treatment of commodities exported from the South (e.g., Common Fund proposals to finance buffer stock agreements). The South has found particularly burdensome the Northern practice of escalating tariff barriers on Southern goods, to the extent these goods are processed.
Regarding the transfer of resources, the Brandt (envision urged that a concerted effort be need to establish automatic sources of revenue for development finance. Other proposals have been need for debt relief for LDCs. Others are that LDCS should be granted a) preferential access to private capital markets in the North, and b) a greater voice in the decisions on the allocation and management of development aid.
Developing countries complain that multinational corporations have control over technology and effectively prevent or delay its transfer to the South; they seek a general code o£ conduct.
The World Food Conference in 1974 called for a number of reforms to ensure enough food for all. Among proposals under consideration is a buffer-stock of food grains, which would stabilize prices and offer supply security in times of shortfall.
A number of proposals have been heard for reform the international monetary system. One is that 1DCs be give a greater share of the benefits from SDRs. The condition governing access to the IMF by developing countries are see by many to be excessively onerous and inflexible; they al argue that IMF funds should be made available over lunge periods of time. Proposals have been need for a new facility a to help OIDCs adjust to the oil price rises of 1979; this an .j very well call for an expansion of funds available to the IMF (f Others argue that pressure should he brought on countries persistent Valance-of-payments surplus to adjust, instead o putting the entire adjustment burden on the shoulders of thee deficit countries. Some also argue that LUCs should be given a greater voice in managing the international monetary system. Finally, there is a need to consider international rules governing management of currency markets, Winch are now beyond the control of the monetary and tanking authorities in any one country.
Inflation in industrialized countries has placed a' a burden on OXDCs and OIDCs and has damaged the industrialized countries themselves. Oil price increases have contributed to inflation, but have not necessarily caused most of the inflation. There are other factors at work. Many economists believe that in most industrialized countries inflation is now self-perpetuating, so that it will continue even in the absence of any further oil price rises, unless better economic management is forthcoming.
Virtually all the funding for research, development, and demonstration (RD&D) of new or improved forms of energy comes from industrialized countries. small but important exceptions include Brazil's work on gasohol, India's on biomass, and significant work in China. The ability of the entire world to make the critical transition from oil to lore abundant and eventually renewable sources depends *very* largely on the success of these RD&D programs. But there is reason for OXDCS and OIDCs to question taw far the allocation of RD&D funds is relevant to their needs.

2. The Oil-Exporting Developing Countries

Is there sufficient converging interest between OXIX's ` and oil-importing countries to contribute towards the basis of a global energy policy? The little progress during the last seven years gives scant ground for optimism. But the problems are becoming more acute, particularly regarding three central issues: I) the OXIX's' desire to stretch out reserves, ii) planning and managing an orderly transition in industrial countries from dependence on imported oil to alternative energy, and iii) the OIIXs' difficulties in earning foreign exchange to finance oil imports.

There are about 28 OXWs, of which 13 are OPEC members. To sane extent, (COOS share the development problems of other developing countries. But there are four areas which would have to be the subject of accommodation within an overall global energy policy: I) exploration and development of oil (particularly heavy oil and secondary and tertiary recovery projects), ii) develowent and commercialization of natural gas resources, iii) conservation of oil and gas, and iv) the treatment of financial assets held by capital-surplus OXtCS in industrialized countries.

Any approach can only tope to be successful if industrial countries fully comprehend the importance which developing countries and in this instance OXI1CS place on their sovereignty. They view the old long-term concession agreements as unequal treaties, virtually imposed upon them by oil companies with the tacking of their home governments. Having gained sovereignty in the 1970s over their petroleum resources, the aCXs view with great suspicion any attempt try industrialized countries to draw them into political agreements which would once more limit their freedom of action on supply and price. This is the real background to the hostility shown by OPEC to the TEA and to the difficulties inherent in any accommodation with OXDCS.

The central problems for all the ruin OCOCs are the depletion of their petroleum reserves and the economic transition to a *diversified and developed* economy, once the oil revenues decline. The present unlaralted prosperity of the OXOCs obscures to other nations the fact that this transition wilt ultimately 1>e infinitely fore difficult for them than for industrialized nations. It is unfortunate; through natural that the North's attention has been on oil Perch~ prices rather than economic develop largely focus: OXIICS, a field which would meet issues of it dialogue. Provide much *more* for future dialogue.

The financial assets held by fluff abroad are vulner: usse Able to inflation and political action, i.e., blocking. The. In countries are Saudi Arabia, Kuwait, and GAE. Clearly, fut. efficient guaranties could be given to these countries; bare of the constraints on their production would be greatly P '.attenuated. Several schemes have been nil red, mostly centered on long-term bonds indexed to compensate for inflation's "Producing countries fear that such bonds are rroreJog: vulnerable to freezing and are less mobile in the short-run err- that, other financial investments. There are several other obstacles inhibiting the investment abroad by capital-surplus "s'... countries.

Removal of these obstacles would represent ache positive step and could be an element in any rapprochement le between cone o£ the ~.CKS and industrialized countries.

The Arab-Israeli conflict is without doubt one of the g most important obstacles to any solution of energy problems

t between OXOCS and industrial countries. It is rarely Discussed candidly. But no permanent solution on energy will be possible until solution is also found to the Palestinian problem which is acceptable enough to a majority of the oil. Producing Arab states.

Essentially, OPEC pricing polices aim at shifting the price of oil upwards to the cost of alternative energy sources. This cost is not specified, although several OXIJCsthink in vague terms of the cost of coal gasification. There is now firm agreement within OPEC countries that the current price of oil should escalate to keep pace with inflation. They costly believe that the deflator should be an OECD index of export prices. They generally agree that the speed at which the real oil price should nova up towards the undefined cost of alternatives should be rare Issue with the growth of real GNP in OECO countries. The rationale is that the growth In GNP is a measure of ability to pay as well as an indication of the time span within which the alternatives will be needed.

OPEC countries see their administration of prices at manageable and a matter exclusive to the seller at the political (though not commercial) level. It is not a point open for negotiation with industrialized countries, unless the latter were surprisingly willing to regulate their own export prices for manufactured goods and food to XECs. Of growing importance to OXDCs is the future develops P meant of their natural gas reserves. Twelve have excelled prospects for natural gas in large exportable surpluses. View of the much greater difficulties in developing the reserves for export, they nest clearly 6e a further element any global energy strategy.

The policies of {? CIEs towards OJDCS are now acquire some sharpness of definition. The recommendations of the (&'' long-term strategy manatee were unanimously adopted by full Ministerial Inference in May 1980.* They envisage that

I) Orifices be guaranteed oil supply at no 'lore than off ici
Government prices in priority over supply to industrials
Countries, ii) bridging loans be made to the higher-men.
1OIDCs at essentially commercial rates to cover oil-soda P balance of payments difficulties, and iii) sift loans and a grants lie need to other OIDCs to help finance both short-rebalance o£ payments difficulties and longer-term development' of domestic energy sources and other projects.

OPEC policy has consistently rejected a generalized system of two-tier oil pricing. It renders the aid element invisible; there is fear of oil supply leakage into other me.rkets; and it ties the amount of aid to the volume of oilimports regardless of the countries • actual needs. Never the less some oil has teen sold on a two-tier price system. Examples include the agreement between Mexico and Venezuela to set up a system to supply tendril American and Caribbean OIDCs ' at prices effectively discounted by one-third.

OPEC countries have been giving about OS$5 billion in official development assistance to other developing countries through national and international institutions, notably the OPEC Fund for International Develop-rent. Current proposals envisage a sharp escalation in their aid flow. An important part would be earmarked for developrlont of energy resources in other IDCs, with emphasis on hydrocarbon exploration. This proposal runs parallel with that of the World Hank to create a

* Their consideration by OPEC heads of state is temporarily stalled by postponement of their summit meeting (previously scheduled for November 1980 in Baghdad).

Separated affiliate, which would be financed partly by induceialised countries and partly by OPEC countries.It isIsently an open question whether the two proposals will beused. But indubitably this is one area where the interestsY OROCS and industrial countries coincide.

3. Industrialized Countries

C The strong growth of industrialised countries during 1 the 1950s and 19eOs depended on cheap abundant energy.Banestic coal production gave way to low-cost oil, domestic or 1 imported. Reliable access to cheap imported oil was not i 'doubted. This complacency was upset in the 1970s. Industrialised countries now face an era of high-cost oil.policies in OXOCs are now determined by their own governmentsand not by the najor oil companies.

Part and JBrcel of the concerns of industrialized countries is that they have diverse interests. Their energy supplies range in source from complete self-sufficiency to utter dependence on imports. This diversity itself can create strains and even divisiveness among industrialized countries themselves.

However, they have made efforts to deal in a concerted runner with energy policy. Particular efforts have been nude within the framework of the European Community, OEQ), and the International airy Agency. The TEA has the roles of I) promoting energy conservation and the enhanced development of secure energy supplies and ii) ensuring the adequate distribution of oil supplies in an emergency. In 1974 the Idea's creation symbolized the confrontation inherent in the energy crisis, though it was not intended by nest participants to be confrontational.

A subsequent attempt to reconcile Tort South viewpoints was nude at the CIEC Conference o£ 1975-77; one cause of its qualified failure was the reluctance of the

North to look at all the issues of North-South relations and instead to prefer discussing only the energy issue.
Since then, cooperation has begun to reduce confrontation, and industrialized countries have taken steps to ease the energy crisis. They have agreed to principles on pricing, conservation, and accelerated development of alternative energy supplies. Some constructive steps were taken by the lEA, including the setting of oil import targets.
Despite such steps, there has been continued strong competition for oil. This competition doubled oil prices in 1979-go which contributed to economic recession, inflation, and unemployment but added ru new oil to the market.
Today there is an overriding concern try all industrialized countries for secure and assured supplies of oil at what they see as reasonable prices. This is part of the current concern over high inflation and Sealy= t. The energy problem is not the mile cause but especially with such large outward flows of honey to (&Y for oil imports.
General economic adjustment in the 19sos is generally expected to prove more difficult than during 1974-7g. Compared with those years, capital surpluses of ale (tD.s could stay at a high level for longer than in recent years;the prospects for capital flows between oil-importing countries are less favourable; and the industrialisedcountries face irore serious economic difficulties. They account
Have to accept a large diminishing deficit, corresponding to their share of the counterpart of the OPEC: surplus, for some time to come·
Conservation and accelerated development o£ new and renewable energy sources are cures for the long-term transition. But in the short-transit editorial co through also need to deal with potential pre- its. as demand restraint, stockpiling, and oil import targets·
Economic success of industrialize energy countries will
depend largely on how well they hangerg £pr maim.The challenge will be to find effective strateg taming reliable access to oil imports which are at test expected to remain constant and could even decline, as thingslook at present.The structural changes needed in theindustrialised countries are very deep but are at last being made.

4· Convergences and Conflict

Some larger importers have sought supply reliability by making bilateral arrangements with individual oil exporters. A system of competing bilateral understandings nay in good for individual importers but not necessarily for the world, as it ignores small importers and financially weakcountries.
Industrialized countries which are IEA particularly have sought short-term supply reliability through emergencies sharing arrangement. Some industrialized countries have programs of official stockpiling; this INS prompted some OPFC nations to threaten retaliation,
It is not easy to correct this patchwork quilt of arrangements. But the dialogue between oil exporters and mporter should search for acceptable formulae which arighthelp.
Many experts believe that the level of oil prices is not as important as the sudden, unpredictable, and uneven [ace of change. They believe that the inflationary impact could be substantially reduced if price changes occurred in small, predictable increments. However, there is another view that economies only adjust to price shock. There is also a strongly told view that prices are much determined by buyers' competition for available oil, and that 'official" OPPC prices merely confirm what the market has already determined.
The host controversial proposal is that a price formula be multilaterally negotiated which would be binding upon oil exporters. They have reacted as negatively to this as to proposals for negotiated formulae for oil supply. They have been reviewing but cot yet agreed on a plan of their own for orderly prices of oil, linking them to the rate of inflation and real GNP growth in the industrialized countries; the OPEC formula would constitute a floor price for oil rather Chars a ceiling or a target.
With oil-induced disturbances, score countries will impose further restrictions on merchandise imports. Trade barriers already exist, especially burdensome to developing countries that cob not have economic power to protect them. Several proposals have been trade to eliminate tariff preponderantly LR) and kerosene for cooking and lighting, diesel oil for commercial transport, and fuel

oil for electricity generation, rather than gasoline for private motoring.

It is helpful to distinguish developing countries into oil-importing and oil-exporting categories, in order to analyses oil's contribution to their foreign exchange burden earnings. This does not neap simplistically that developing countries which import oil are in trouble and those which export are in good shape. Economic performance is the result of many different factors. But oil trade is a highly significant one.

There are fore than 120 OIDCS. Their oil consumption grew rapidly during 1960-73, by S% p.a. It stagnated in the next two years to 1975 but then resumed growth at an estimated 5.5% p.a, to 1979, when it averaged sane 5.6 nm b/d.[t] There have been increasing efforts to conserve the use of oil in these countries without at the sane time harming economic growth. It is still too early to know how successful these efforts have been, This issue is discussed further in su uent chapters.

Oil consumption in OIOCs is highly skewed in distribution. Most consume very little oil, and a relatively few countries account for lost of the trade. (See E. below.)This does not mean that the relatively well oil consumption in eraller countries is not important to their economies. On the contrary, these countries are among the most severely disadvantaged by high costs and potential scarcities of imported oil. But it indicates the order of magnitude of steps whi$_c$h *may* need to be taken in the transition to a broader diversity of energy sources.

* This list excludes the following middle-income countries: Greece, Israel, Portugal, South Africa, Spain, Turkey, DS territories, and Yugoslavia which are defined as developing countries in the World Bank's report WOR III. In 1980 these countries could have consumed about 2.5 m,n b/d of oil (including bunkers). These countries (except for Spain) are also defined by the IMF as developing, consuming 1.5 mm b/d.

Rapidly to reach conceivably 5 mm b/d by 2000. This is way below earlier official aspirations to develop ten fields like I) aging (Ta-chin), i.e., a total of about 10 mm b/d. But it would still be a quantum jump from the present and would represent a great achievement.

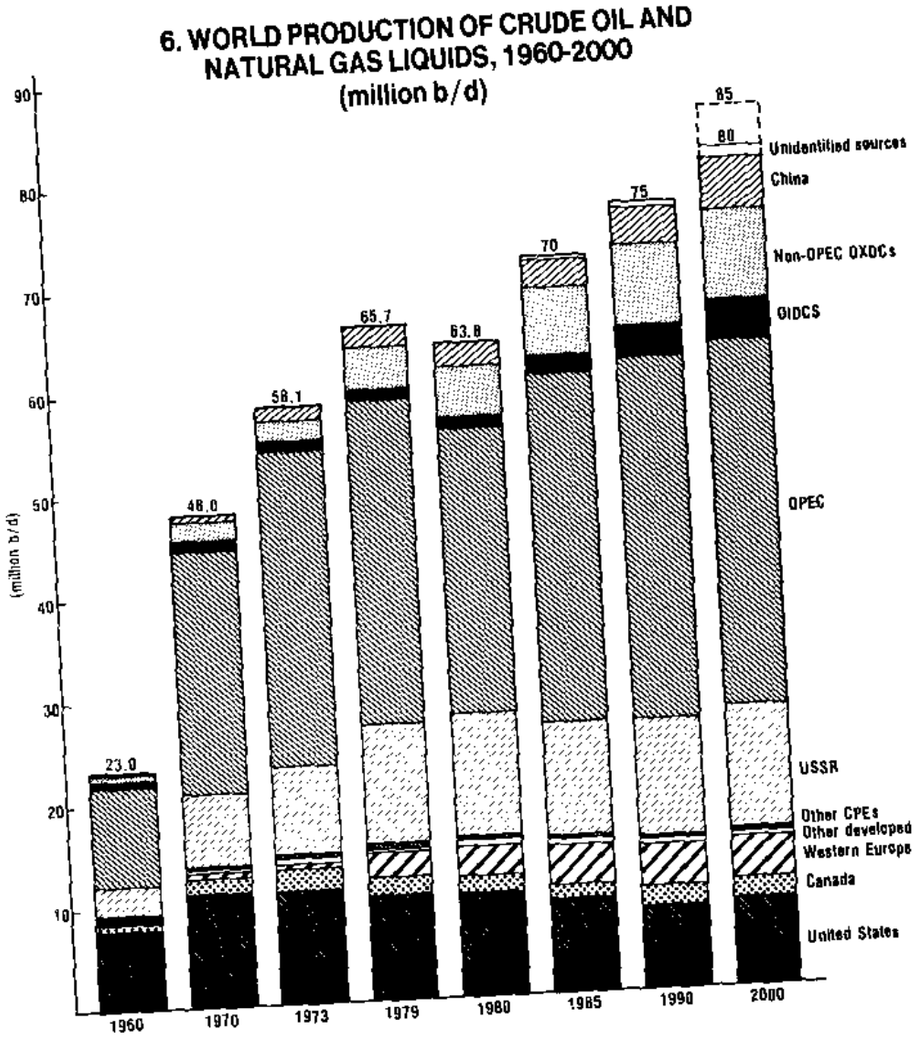
Mexico's output depends on government policies regarding a) the speed of developing new discoveries and b) export ceilings. It is installing enough capacity to supply the growing domestic market as well as exports sufficient to finance the nation's foreign exchange needs for economic development. Production o£ crude and natural gas liquefied (NOL) was close to 2.15 rim b/d in 1980, and exports were 827,000 b/d. Mexico's export ceiling (1.1 Inn b/d) is reported to be 1.45 nm b/d in 1981. Policy after 1982 has not been determined. It is conceivable that output could be in the range of 4 nm b/d by 1990.

North Sea oil production is likely to rise during the next few years but could decline during the 19906, unless new virgin exploration in the more difficult and unknown northern areas ret with success. Prospects for expanded output in other industrialized countries rib not look bright for expanded output, although there could be surprises from the vast areas offshore north-western Australia.

Several producing regions of the world have reached maturity. US production, despite the large contribution of Alaska, has continued to decline slightly. This trend presently looks very difficult to reverse. The huge increase in exploratory drilling has only stabilized the rate of additions to reserves in the lower 48 states. Most studies now envisage a decline in output during the 19806.[n-Q]

Production of conventional light and medium crude oils from existing fields in western Canada appears to have leveled and is expected to decline. But this decline is likely to be fore than offset towards the end of the 19806 by new discoveries in the western provinces and frontier areas, as well as development of tar-sands and heavy oil.

Other important countries where production of crude oil appears to be approaching a plateau are Algeria, Indonesia, Libya, Nigeria, Qatar, and Venezuela (see Chapter Chapter



Source: Petro-Canada/Petroleos de Venezuela, World Oil Supply Prospects, February 1980.

II). All of these happen to ire OPEX members. In 1980, together with the US and Canada, they will account for an estimated 15% of world production.

OPEC countries can be distinguished between those with mature provinces from which little extra production can be expected, and those with substantial potential for expansion but which, with the possible exception of Iraq, no longer are interested in developing capacity rapidly.

Four of the nest important OPEC countries are dedicated conservers. They do not all wish to produce at capacity and are reluctant to undertake further large scale expansion. These are Iran, Kuwait, Saudi Arabia, and the United Arab Emirates. Their production is 1980 is expected to average less than swan 15 mm b/d, accounting for 24% of world production.

OPEC countries at present contribute about 45% of the world's o11 supply. These 13 countries' production of crude oil and natural gas liquids was 27 nm b/d in 1980, and is estimated at about 25 *an* b/d for 1981." As things presently stand, they are unlikely to expand output of crude oil beyond 33 *no* b/d by 1985, hardly rising thereafter

Undoubtedly the most contentious issue between developed consuming nations and OPEC countries will be the rate of development and production in the few countries where there is a large potential for expansion. (See Chapter [11.2.) These are Iran, Iraq, Kuwait, Saudi Arabia, the OAF, and Venezuela.

[N 1979 there were about 15 non-OPEC OXIks.`[a] Together they produced alrtast 4 mm b/d in 1980. This could

"The 13 OPEC countries are: Algeria, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela.

*" The 15 non-OPEC developing countries which were net oil exporters in 1979 are: Angola, Bahrain, Bolivia, Brunei, Cameroon (since 1979), Congo, Egypt, Malaysia, Mexico, on, FRB, Syria, Trinidad & Tobago, Tunisia, and Zaire. Bunter bad was a marginal exporter in 1978.

C. Oil Resources

Is the world's oil resource base large enough t support these expectations for future oil production?

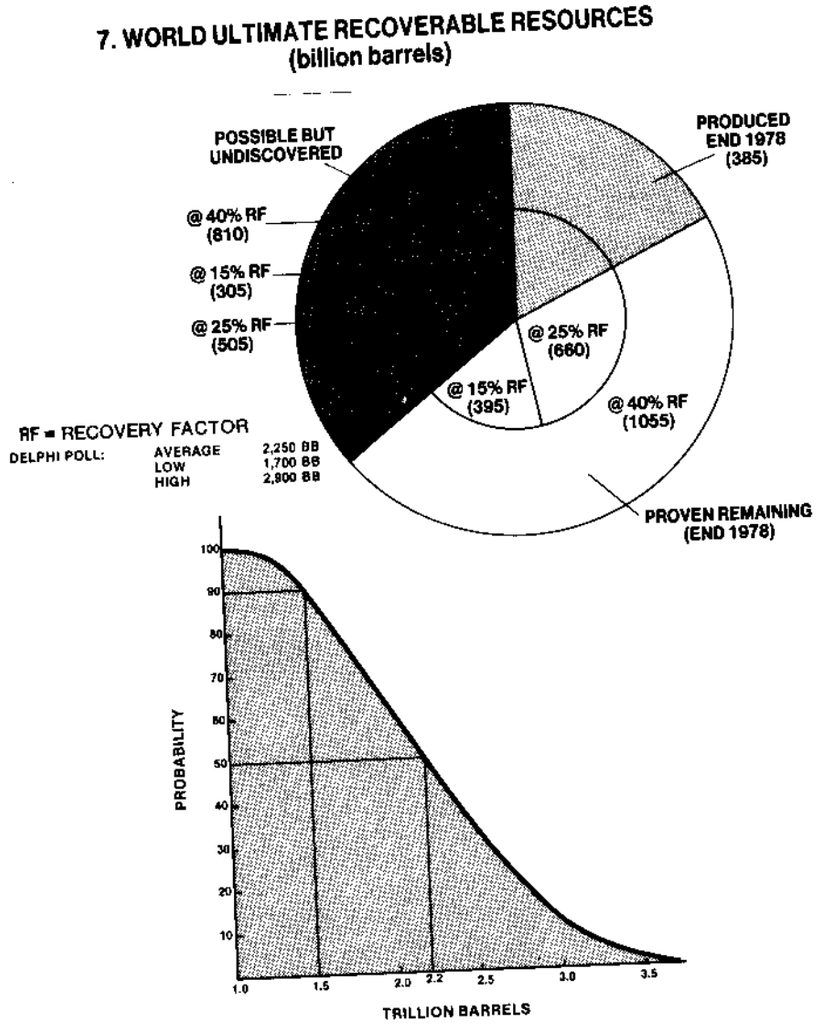
There have been Tinny estimates of ultimate recoverable reserves of conventional oil. They are no more than academic, as they are guesses at the unknown. But the3 Do give some indication of the constraint on the e rate at which additions Tiny be made to presently known reserves of conventional oil.

Past production of oil minutes to about 400 billion *barrels (BB)*. Remaining known reserves are estimated in the order of 660 BB, enough to last 35 years at the present level of output. Additional potential resources could be in the order of 1,200 BB in the average estimate of a range of experts, published in the Iksprairies report to the Conservation Commission of the World theory Conference in 1977.' Thus it estimated total resources at roughly 2,250 BB; the pessimistic end centered around 1,700 BB, and the optimistic around 2,900 BB

The world's known reserves are highly concentrated in a relatively few countries. The ten largest with 20 BB or more each contain 80% of the total: in order, Saudi Arabia, Soviet Union, Kuwait, Iran, US, Iraq, ORE, Mexico, Libya, and China. Alternatively pit, OPEC countries contain 68% of the total, the Middle Eastern member countries 55% and Saudi Arabia alone 25%.

The world's oil reserves are concentrated in a relatively few sedimentary basins. There are roughly 600 worldwide, depending on how they are defined. There are producible hydrocarbons in nearly 240. But just 30 contain 90% of the world's recoverable oil, and two of these (Arabian Iranian and West Siberian) have over half.

Additions to world oil reserves have depended heavily on the discovery of giant of fields, and this is likely to remain true for the future. World reserves are concentrated in just a small number of large fields. Of about 30,000 fields worldwide, there are less than 1,900 (or 6%) which each



Source: World Energy Conference, 1977.
Source: P.J. Wood, World Oil, June 1979.

Contain the equivalent of 50 million barrels or more of hydrocarbons (oil and gas). But they contain 93% of the world's known recoverable reserves.

Unfortunately, estimates o£ world oil resources and *reserves* typically exclude so-called unconventional oil, such as deposits of very heavy oil, tar-sands, and oil-shale's as well as oil in polar regions and beneath deep water. This begs a large question, as these deposits are potentially huge. In the I st, they have been little touched, because their development costs are much higher than those of conventional oil. At today's prices, *however,* they become increasingly economic to exploit. This is clearly the direction for the future, i.e., increasingly from conventional to no conventional oil.

D. Exploration and *Development* Efforts

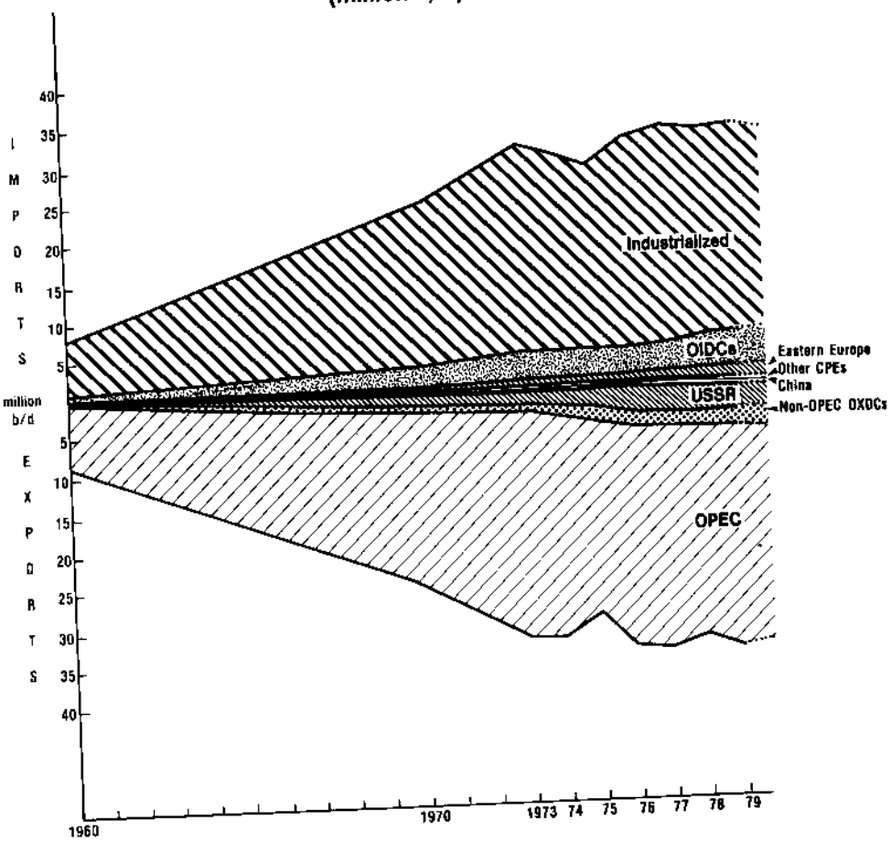
Higher oil prices have improved the economic viability of exploitation of ere11 fields, enhanced recovery, exploration in high-cost areas such as tale and *deep* water, heavy oil, tar-sand, and oil-shale deposits, and fields with root reservoir characteristics.

Even though exploration efforts in new provinces are likely to find the larger fields in the *earlier* stages of exploration program, there could still be seller fields which would U, well worth looking for thereafter. In rarefy countries small fields will continue to be found well into the next century. Their cumulative impact

could be great, and their support to economies including those of the oil-importing developing countries wilt be significant. (See also Chapters III and IV.) Some of the future *increase* in world oil reserves will come from enhanced recovery from existing fields rather than from discovery of new fields. Prospects are strengthened by second phase discoveries in older established basins, encouraged by improved economic viability of smaller fields at today's ail prices, better technology and exploration concepts, offshore extensions, and *deeper* drilling.

Exploration techniques have improved significantly in recent years. Drilling techniques have greatly advanced,

8. WORLD: OIL TRADE, 1960-1979
(million b/d)



Source: BP Statistical Review, 1980.

Particularly in polar and deep water regions such as the Canadian Arctic and offshore Labrador. But good judgment is still fundamental to successful exploration. It still rennin true that the evaluation of geological provinces is very dependent on the degree to which high grade prospects are tested by the drill. Relatively small areas of sedimentary basins can contain significant volumes of oil.

Of the world's ultimate recoverable resources o£ oil, a substantial Fart could lie offshore. Attention has thus far been focused on the continental shelf. Little is known about the deep water basins in the adjacent continental margin. Uncertainties are political, economic, geological, and technological. The problem is development, not exploration. Oil cannot yet technically be produced from potential fields in deep water. Provided this problem is solved, the next will be the cost of producing any oil found.

Heavy oils and--even more so--the bitumen in tar-sand deposits have been the Cinderella of the crude oil market. Their economic feasibility has brightened considerably at today's oil prices. Future extension will involve enormous capital investment with long lead-times a) in extraction, including enhanced

recovery and b) in upgrading. The pace of development will be set not only by technological and environmental constraints but also by government policy. Increasing volumes will come on stream during the next two decades but at a relatively slow pace.

Shale oil production is small, though resources are huge. At present oil prices, projects tray at last be approaching threshold of economic viability, though very little development has begun. There are huge environmental and technological problems in their exploitation on a commercial scale.

E. International Oil Market

World oil trade is mostly supplied from OPEC countries. The balance comes from other OROCS, the Soviet Union, and PR china.

TABLE I-1: WORLD OIL TRADE, 1979-80

Exporters	1979	(million b/d) 1980	Importers	197 9	1980
OPEC countries	28.7	25.0	Industrialized	27.2	24.8
Other OXUCs	2.0	3.0	OIOCS	4.5	4.5
Soviet Union	2.8	2.8	Eastern Europe	1.9	2.0
PR China	0.3	0.2	Other CPES	0.2	0.2
				33.8	31.5
			Stock rundown afloat		0.5
$3.8		al .0		q3 s	BtII

International oil supplies in 1979 were tight, because of the disruption to Iranian exports. During the first quarter, the constraint resulted in a strong rundown o£ stocks ashore and afloat above the usual seasonal rate. Oil importers quickly rebuilt stocks in subsequent months of 1979 to a safe working level, plus an additional stock cushion to provide some treasure of protection against increased insecurity of supply. They were accordingly willing to buy for stockpiling at prevailing spot prices much higher than official export prices, in the expectation that they could pass on the higher procurement costs to customers. This oil balance for 1979 was initially dismaying and certainly strained. It finally resolved itself, Helped in part by the slowdown in oil consumption in industrialised countries (particularly the US).

The oil balance during 1980 was less strained, because of the economic downturn in industrialized countries, and the extraordinary stock build Munich continued during the year. Oil imports were tore than 2 an b/d lower than in 1979. The decline reflects lower consumption in the US and Western Europe. On the supply side, exports from non-OPEC (DUES (above all Mexico) were 1 mm b/d more than in 1979, but OPEC countries' exports were almost 4 mn b/d less.

In 1980, the Iraqi-Iranian conflict did not significantly disrupt world supplies, and any short-term deficiencies were compensated from stocks and increased output from other OXDCS.But the balance was very fragile and could easily have been shattered, for example if oil exports fran the Middle Past or elsewhere were further disrupted or were insufficiently available.

In 1981, the market has eased greatly, reflecting a decline in oil consumption in industrialized countries.

The prospects for the next two decades presently appear to 6e at best a continuance of international oil trade at its 1979 level, on grounds of constraints in exports from OPEC countries and the Soviet Union, together with imports stagnant in industrialized countries but rising in OiDCS.

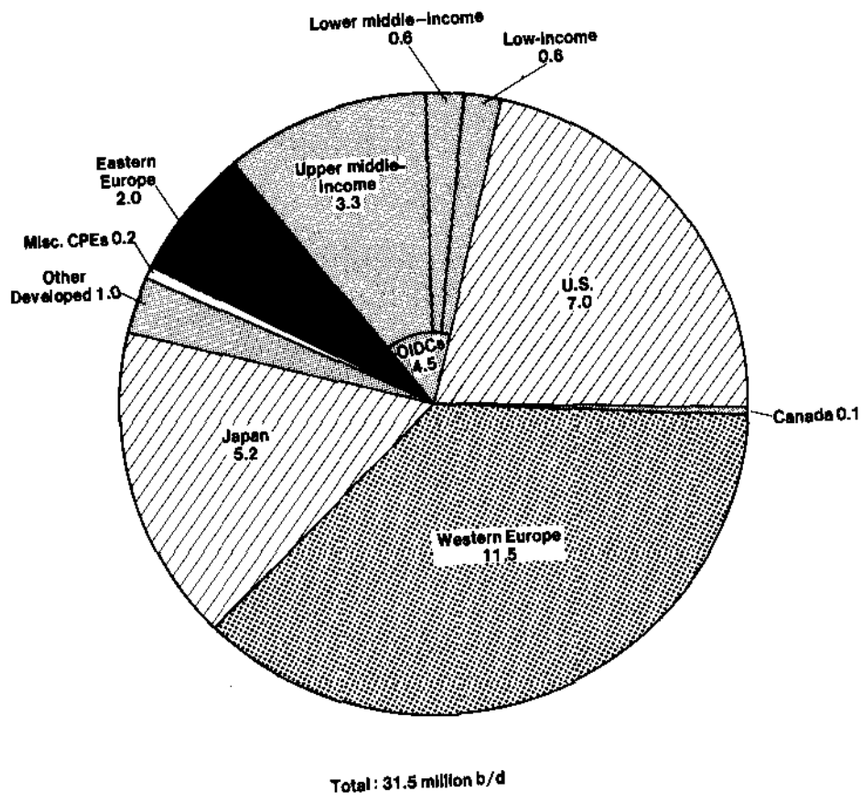
1 Net Export

As things stand at present, exports from OPEC countries are generally envisaged to be less than 30 mm b/d during the next two decades, in view of a) constraints in expansion in capacity and allowable production and h) growth of their domestic oil market

A large increase in production is foreseen for nonOPEC oil exporters during the next two decades. But consumption of energy and particularly oil in aYDCS (including OPEC countries) continues to increase rapidly, fuelled by strong economic and population growth. Pricing and other policies to make for tore efficient energy use are often weak. Thus it does not follow that oil exports from non-OPEC (%DCS will continue their previous rapid expansion. Eben were this technically feasible, these countries tray impose Flinch policy ceilings on production or exlnrts, as Mexico does now. For these reasons, it is felt that exports fran these countries are unlikely to exceed 4 nn b/d through the 1990s.

Chinese policy has shifted significantly since 1977 towards an accelerated develop tent of its oil resources, to fuel its modernization program. Projections of oil exports from PR [] rime remain speculative. There is a general feeling that mast production in the several years ahead may be absorbed by the burgeoning domestic market, leaving a relatively snail share for export. Even this assumption mull proves optimistic, unless the new exploration efforts in *untested* frontier areas on and offshore are successful.

9. WORLD: ESTIMATED OIL IMPORTS, 1980 (Including Bunkers) (millions b/d)



Total: 31.5 million b/d

Source: John Foster, estimate, October 1980.

A particular area of uncertainty is the extent to which the Soviet Union/Eastern European bloc finny nave from being a net exporter (1 mm bfd

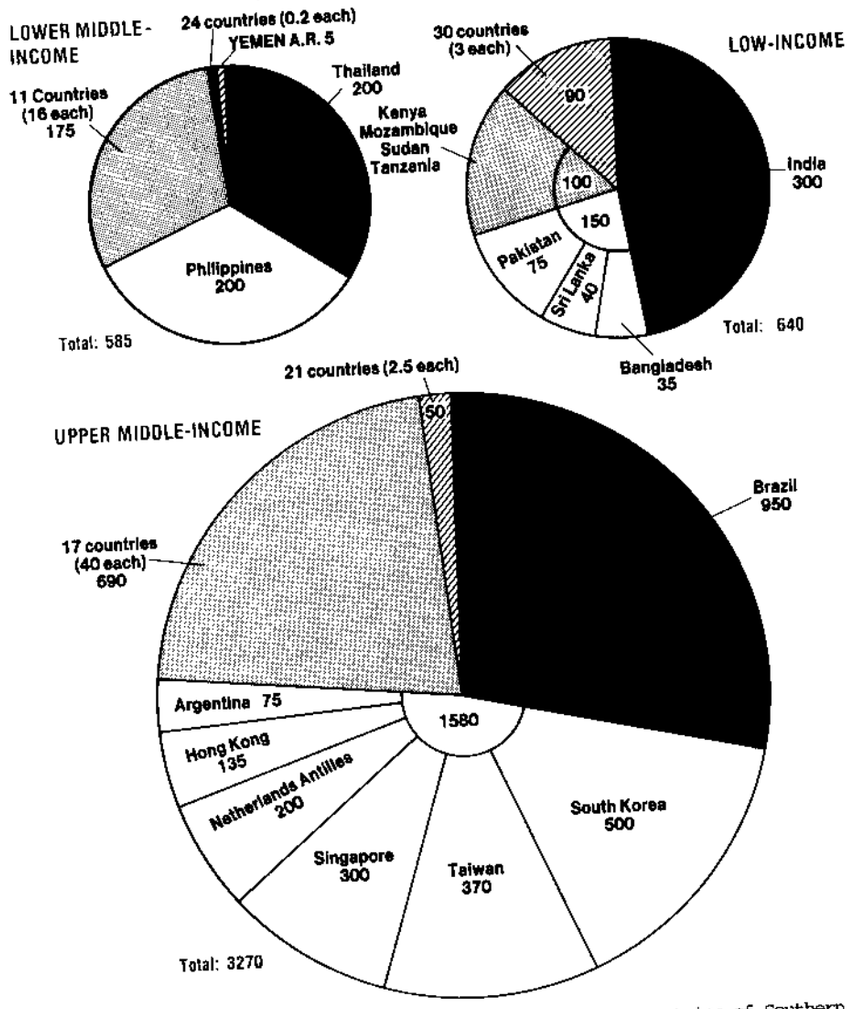
in 1980) to becoming a net importer (see page 24). Eastern European countries' depend for imparted oil is likely to expand from its present level (2 mm b/d), given the limited scope for expansion of domestic energy supplies. Hence they will probably turn increasingly to the Middle Fast for incremental oil imports.

This leads to a widely held view that the Soviet bloc may become a net oil importer during the 1980s. The CIA's view published in 1980 *envisaged* net imports of at least 1 mm b/d by 1985, and sonic *others* are beginning to m ve towards it. I£ they are right; pressures on international oil trade could bacon acute. The problem is largely logistical; the, Soviet Union has huge *unexploited energy* sources but they are mainly in *cremate,* I9tysically inhospitable areas and will take great efforts and time to exploit. If successful achievements lead to a brighter outcome for oil production than is generally supposed, this would be global good fortune. There are neny unknown variables which could *ameliorate* their prospects for oil trade. They include improved energy efficiency (for which there is huge potential), *accelerated* development of energy resources, and substitution of other energy forms for oil. *However, even* if oil consumption in the Soviet Union *were* to grow only slightly and output were to hold level, the bloc still might have to phase out its net exp its and could he come a net importer during the second half of the 1980s.

ii. <u>Net</u> <u>Imports</u>

Earlier we had discussed aspects of oil consumption and production in the more than 120 OIDCs. The volume of their oil imports *grew by* just *under* 7% p.a. during the *decade,* similar to that of the 1960s. OIDC imparts in 1980 are estimated at aMut 4.5 nn b/d, after taking into account

10. OIL-IMPORTING DEVELOPING COUNTRIES: ESTIMATED OIL IMPORTS, 1980 (Including Bunkers) (thousand b/d)



Note: Definition of OIDCs excludes the middle-income countries of Southern Europe.
Source: John Foster, estimate, October, 1980.

Total production of 1.25 mm b/d from some 14 countries. The cost of these oil imports and the implication for current account deficits are discussed in Chapter ii.

We find a great concentration of oil imports into a relatively few OIOCs. This is hardly surprising, as it reflects the strong skew in distribution o£ oil consumption between OIDCS, offset for only about 14 countries by domestic oil production.

First, let it Be said that the 14 which produced oil in 1979 account for arrest half or 2.2 mm bid of net imports by OIOCS.** Most of these countries are in Latin America and the others basically in Asia. Despite their oil production, the oil imports of those 14 Owes accelerated in growth tram 7% p.a. in the 1960s to ~a p.a. in the 19706, reflecting their strong economic growth and the slower growth in oil output.

Significantly, several of these producing countries are the largest oil consumers. The three largest producers and largest consumers are: Brazil, Argentina, and India. This may not he entirely coincidental, as they have had the greatest incentives to look for and develop oil fields to supply their large domestic markets.

It is instructive to lock at the oil import of OIOCsm from the viewpoint of per capita GNP. The upper-middle income countries will import the lion's share of all Owes' imparts in 1980, 57rte 3.3 ran b/d. Brazil is the giant of them alt, importing 900-950,000 b/d (approximately 20% of OIDC imports).

* OIDC imports are estimated by the World Bank at 6.2 um b/d in 1980 (president's address to Board of Governors, September 1980). Imports include those of Portugal, Spain, Greece, Israel, South Africa, Turkey, US territories, and Yugoslavia (2.2 mn b/d) and exclude bunkers (0.5 mm b/d).

**z The 14 Outs which produced oil in 1979 are: Argentina, Brazil, Bursa, Chile, Rep. of China, Colombia, Ghana, Guatemala, India, Ivory Coast, Pakistan, Philippines, and marginally Afghanistan and Barbados.

Another six countries import 1.6 urn b/d together. Two o£ them are the other main net importers in Latin America, Argentina and Netherlands Antilles, as others such as Chile and Colombia are closer to self-sufficiency. The other four are the newly industrialised countries of East Asia: South Korea, Hong Kong, Singapore, and Rep. of China (Taiwan). The remaining 740,000 b/d of oil imports into upper middle-income OIDCS is spread over since 38 countries. Almost all goes to the 17 which each import in a range o£ 10-100,000 b/d (40,000 b/d averages). The balance goes to 21 countries (2,500 b/d ~chi), irostly island-states.

In contrast, the lower middle-intone countries import just 600,000 b/d. O£ this amount, Thailand and the Philippines tm port 200,000 b/d each. Another 11 countries import lore than 10,000 b/d each (16,000 b/d each) and one (Yemen AR) 5,000 b/d. The balance of 24 countries import an average of 200 b/d each.

Similarly the low-income OIDCs import just600,000 b/d. India accounts for one half, Bangladesh, Pakistan, and Sri Lanka for one-quarter together, and the remaining quarter is spread over 35 countries, mostly African such of the Sahara. Twenty of them each import vo1~ binge of 1-10,000 b/d, and ten o£ them less than 1, 0 / each. Thus for navy countries, the oil import volume is minuscule in relation to world oil trade. But to each o£ them their oil imports could be a heavy burden.

IF THE PROSPECTS FOR THE NEXT TWO DECADES ARE TRULY FOR INCREASING CONSTRAINT ON INTERNATIONAL OIL SUPPLIES A^N D FOR JUST A NODEST INCREASE IN ACCESS TO THESE SUPPLIES BY OILIMPORTING DEVELOPING COUNTRIES, THE IMPLICATION IS INESCAPABLE THAT DEVELOPED COUNTRIES WILL IMPORT NO MOREI BY AT PRESENT, AND QUITE LIKELY LESS. THIS was recognised yindustrialized countries within the IEA, EEC, and the Seven in the formulation of oil import targets. (See Chapter 11.3.) Except for the few industrialized countries with prospects of expanding their production of hydrocarbons, this raises the key issue of depend restraint. Their oil consumption could be supply constrained during the next two decades to levels lower than in 1979-80.

E. Crude Oil Prices

The international oil scene has turned around since 1978. This is in large Fart due to the recent turmoil of political events in the

Middle East.
International oil prices surged during 1979 due in part to panic buying by consumers in the wake of the Iranian oil disruption. The "spot" market became overheated and crude oil was might at prices several dollars higher than official export prices. Transactions at spot price grew rapidly to become 25-30% o£ international oil trade, as opposed to the 3-5% previously characteristic of the spot market. However, today the differentiation between long-term and spot deals is
Becoming increasingly blurred.
During 1980, international oil was t sic ally traded at different tiers of official prices. Saudi Arabia increased its prices in December 1979 and May 1980 with the announced intention of roving towards price unification. But other prices advanced in step.
In early 1981, the marker price (Saudi Arabian Light) was US$32 Jar Carrel fob. Official prices for roost Middle Eastern crude oils were on the order of US$35-36, to which differing premier were added. It remains to be seen whether international oil prices will finally realign themselves during the next year. The odds on this happening have increased, with lower demand for OPEC oil and continued high Saudi output.
The balance between world energy demand and supply is fragile. The one certainty is continues surprise and uncertainty. The prudent conclusion for policy decisions is that constraints on international oil supplies could remain with us for the foreseeable future. The outcome could, of course, prove quite different. The international oil market could tighten or weaken for a variety of combining factors, it could naked real oil prices jump again, it could conversely put them under downward pressure e.g., if demand for imported oil were by chance to fall below a critical (but unknown and so far untested) level, to which QXDCS might find it hard to adjust output. But this takes no account of disruptions for political, military supply, or other reasons.
On present evidence, we believe it prudent to plan on a continuously tight oil market with modest increases in real Prices (say 2-3% p.a.). 4

ENERGY OTHER THAN OIL

During the 19606 and indeed until 1973-74 When international oil prices quadrupled, there was a strong worldwide substitution o£ oil and gas--and increasingly nuclear power-for coal. By 1973 oil had increased its share of erenergyralmix in developed and developing countries to 54%, and gas to 19%.
Since then, there has been ouch concern expressed in oil-importing countries to reduce dependence on imported oil and to Promote the developTnt o£ indigenous energy supplies. In particular, coal consumption is gradually picking up,,Momentum, growing by 5% p.a. from the during ear o£ 1960sto 1979, compared with (about) 1% p.a.
But the slow pace of economic recovery has dampened energy demand particularly in the industrial and electricitygeneration sectors. This has adversely *affected* conversionback to coal consumption, as have requisite measures. Similar factors plus that of public acceptability have slowed the completion of nuclear power stations. Natural gas is a preferred fuel, but domestic supplies have feed constrained in the US have been Nether lands LBCk by technical, natural gas (LNG) Financial, and regulatory difficulties.
There seems to be a consensus that future non-Oil supplies will grow but slowly during the 19806 and into the 19906. If economic growth were lore ebullient, there could be a faster expansion of non-Oil supplies. For example, more coal might he used in electricity generation. The expansion of non-oil supplies will nevertheless require a huge effort. It could represent virtually a doubling during the next two decades. Coal tray provide about one-third of the increment, and gas and nuclear power about one-quarter each.
In view of growing public concern over ta[r]n n[u]mber issues, rapid expansion of coal and nuclear [cower] of industrialized countries (post-Three Mile Island) is difficult, though planned.
A major constraint in the development of nuclear power in developing countries has

been thee concern of supplier countries about the non-proliferation of nuclear weapons, matched by the concern of recipient countries to retain the principle of sovereignty over national policies.

Hydroelectric power and other forms of renewable energy are seen to provide only a small share of the increment for most countries during the 1980s. But the expectations of strong research and development programs in renewable energy forms such as solar, wind, tides, and biomass should lead to accelerated growth in their use during the 1990s.

5. NATURAL GAS

Natural gas is likely to crake an increasing major contribution to world energy supplies. It will be an important transitional fuel. Gas expansion in the past has been held back by technological and economic constraints. These have recently been greatly reduced. As gas is relatively expensive to transport compared with oil or coal, its production has 4eeically teen developed in countries close to large energy markets, particularly the developed and socialist countries. It has been relatively little exploited in ck; veloping countries. Unlike oil, gas cannot be widely marketed until a costly pipeline network for local distribution is built. Natural gas now looks likely to be the fastest growing energy source in the developing countries as well as elsewhere worldwide. Moreover, international trade in gas is likely to grow even faster than its consumption.

The development of gas resources h_{as} been inadequately pursued in the developing countries. But a substantial art of the growth of conventional natural gas production during the neat taro decades is expected to take place in these countries. Expansion of local gas usage should be considered the rain policy aim. But where the domestic market is limited, exports by pipeline or LNG tanker nay he advantageous. Where the export market is *very* distant, it nay be worth converting the gas into methanol prior to shipment rather than liquefying it.

LNG technology is highly advanced but readily available. The main markets are the US, Western Europe, and Japan.

Existing LNG exporters are OPEC countries (Algeria, Indonesia, Libya, and UAE), Brunei, and the US (Alaska), while gas is exported by pipeline from the Soviet Union. Other LNG projects are under construction cr at the planning stage.

In recent years pricing, financial, economic, technical, and environmental reasons have led to the delay a<' cancellation o£ nary projects. In particular, the high cost of roving gas compared with liquid and solid fuels has nude for a relatively low price netback for gas at the wellhead. Hence petroleum-producing countries have typically pursued other uses for their natural gas. These include reinsertion for oil field pressure maintenance, other field applications, extraction of natural gas liquids for domestic and expert markets, and cc crucial applications for the gas in local markets, particularly energy-intensive industries such as petrochemicals and aluminum-smelting. The balance of the gas is being flared when it is produced in association with crude oil, do is being shut fn when it is non-associated.

Today's international oil prices have greatly improved the economic viability of LNG projects. By the *same* token, they have also improved those of other high-cost sources of energy and gas in countries *which* are now energy deficient, and investment decisions for LNG projects will have to be justified in relation to the possibilities for alternative energy supplies.

Deep conventional gas refers to accumulations found at depths greater than 4,000 metres. The potential for such gas accumulations nay be naich greater than has been assured in the past. They could well be a e of the world's major fossil fuel sources when oil begins to be depleted in the next century.

A major deterrent any be the increased cost of seismic surveys and drilling. In some countries where oil reserves are plentiful, there is little incentive to drill where the sources rocks go deeper, especially if there is no ready market for large gas discoveries. The Middle East could have giant deep gas deposits, but it is doubtful if these horizons will be tested until oil reserves will have to be more drastically depleted.

Considerable attention has recently been given to the possibilities of finding and

producing unconventional natural gas with today's higher energy prices and improved technology. Much o£ this gas is not yet explored. Hence any estimates of gas in place are highly speculative. Even if the gas does exist, we cannot now predict that it can be produced economically in significant amounts. Nevertheless, a comprehensive survey of energy resources must include these unconventional gases. They include gas dissolved in water (including geo pressured gas), natural gas from coal-beds, gas from Devonian shale's, gas from tight sands, and ~.s hydrates.

6. Coal

The world's resources and reserves of solid fuels (coal, brown coal, lignite, and peat) are huge, much larger than those of oil and gas. They are unevenly distributed geographically. Most o£ the known reserves are concentrated in three countries: the Soviet Union, Pit China, and the United States. The balance is mostly in a relatively few other countries, including: Australia, Canada, Britain, FR Germany, South Africa, Poland, DE Germany, Czechoslovakia, and same developing countries, in particular India and Republic of Korea as well as Botswana, Colombia, Mozambique, Vietnam, and Zimbabwe. Much of the world's production is also in these countries.

The geographical concentration of known coal reserves nay also reflects large differences in intensity of exploration effort. The world's ultir, nte recoverable resources o£ addled fuels are still poorly known. There are navy countries which are believed to have untapped and unassisted coal reserves. Africa and South America have only sporadically been examined for coal. Worldwide, a large production base exists which could be expanded, if markets were developed.

The international oil price increases since 1973 have nude coal competitive in nun end-uses where previously it was not. There are now great raw opportunities for expansion. No entirely new technologies would need to be developed, as coal was at one *tine* the dominant commercial fuel worldwide. But improved technology is desirable, to reduce costs and adverse environmental impacts. The single largest end-use for coal in recent years is in electric power generation, where the technology for coal burning has significantly improved, including the introduction of fluidized bed combustion. New opportunities for coal usage, particularly in developed countries, could include the development of plants to produce synthetic oil and gas in future decades.

In early 1980 the World Coal Study (WOX) L)u said that "coal will have to supply between one-half and tyro-thirds of the additional energy needed by the world during the next 20 years, even under rode rate energy growth... To achieve this goal, world coal production will have to increase 2.5-3 times, and the world trade in steam coal will have to grow 10-15 times above 1979 levels."

Industrialised countries are likely to move strongly back to the use of coal. Among them, the US is the single largest coal consumer and producer. *Ik:veloping* countries have new opportunities to exploit smaller coalfields, which mey be large enough to contribute to their domestic energy needs. For these countries, the key to resource development lies with government policies to encourage such exploitation, which UN agencies should increasingly be willing to assist (See ChapterIV).

A critical issue for the expansion of coal demand is its acceptability to end-users. Other problems include reliability of supply from an industry which has not enjoyed the best management/labour relations. Particularly in developed countries, unresolved questions on environmental issues have typically not been adequately covered, for example, air pollution, acid rain, and the accumulation of OJ2 in the atmosphere. It is not known whether there is serious risk of climatic change from the rapid expansion of fossil fuel use. There is a lack of consensus on the seriousness of future accumulations of Q?2 and its implication for energy policies. The problem needs continuous monitoring, but it is not yet generally envisaged to constitute a serious limitation on coal development.

Meanwhile, there are serious constraints on the expansion of coal supplies which need governments' attention. These include the environmental impact of strip-mining, recruitment of miners and engineers, the lead-times and considerable investments needed to establish and expand mines,transport, storage, handling, and port facilities. Despite

these constraints, there is likely to be a substantial increase in coal demand and output. V At present, most exports are from the US, Australia,
South Africa, FR Germany, and Poland; Canada is a growing net exporter. Major importers include France, Italy, and Japan. Most trade is in coking-coal for steel-making, though some steam coal is also traded. There could be a very sharp increase in international trade of coal, in particular steam coal. Australia is likely to expand dramatically its coal exports daring the next two decades. South Africa could also do the sane. } bland will continue to export but nay not be able to expand significantly. Of the developing countries, Botswana, Colombia, Venezuela, India, and Mozambique *raze* become exporters in the future.
Underground coal gasification offers a relatively low-cost, environmentally sound method to produce clean fuels from coal. This opens up the opportunity to exploit coal which is unnamable by present-day techniques. It could thereby enable vast and widely distributed resources to be reclassified as recoverable reserves. The Soviet Union has developed a commercial technology which US interests have purchased. Field tests fn the US to date have confirmed the potential economic and environmental advantages of this technique. Critical technical environmental issues are being resolved, and the process is being scaled-up. Interest could lead to commercial direction to the US by late 1980s.
Often neglected in earlier years, solid fuels of low calorific value have recently seen an unsure in their development. In descending order of heating value, they include sub-bituminous coal, brown coal, lignite, and peat.
World reserves of frown coal and lignite are large, some 10% by heating value of all solid fuels. Production in 1978 amounted to lore than 900 million tons of hard coal equivalent and represented about 14% of all solid fuel roduction. Some countries have exploited }sown coal, lignite, and peatfor nervy decades. The supply of frown coal cares an,inly from the Soviet Union as well as Czechoslovakia, DR Germany, FR Germany and--to a lesser extent--some other Europeancountries, Australia and sane Asian countries. Recently there
Have been large-scale plans to expand the use of lignite in the Gulf States o£ the US. The environmental infect of strip-mining brown coal and lignite is great, and well-designed laws are a pre-requisite.
The cost of transporting solid fuels of low heating value is high. Consequently, it makes economic sense to burn these fuels in applications close to the mine. For example, they can be used as fuel in mine mouth electric power stations. The technology of power generation from large peat-fuel boilers has reached an advanced stage of development in several countries including the Soviet Union, Finland, and Ireland.

7. Nuclear FOWER

Most governments have pinned great hopes on nuclear power. But these aspirations have been frustrated to a considerable degree by a barrage o£ serious obstacles. The present outlook for nuclear power is consequently uncertain in all respects.

A. Industrialized Countries

The outlook for nuclear power is very mixed. The Soviet Union and France are implementing programs which will greatly increase their nuclear capacities, while in the US and some other countries, development of nuclear power continues too be retarded by public concern with safety and economic issues.
In the United States, public confidence in safety was badly shaken by the accident in March 1979 at Three Mile Island, f nnsylvania, *where* the Keenly Commission's report found great inadequacies in operational competence and in government and public utility safety procedures There are concerns catgut reactor safety, radioactive emissions, thermal effects, disposal o£ wastes, and sitting. The treatment of spent fuel elements, radioactive wastes and decommissioned
Reactors are not solved.
Furthermore, in some countries such as the US, nuclear power is rot

demonstrating the clear economic advantages which had earlier been expected. There have been rising capital costs, longer lead-times, high repair cost, longer down-time for repairs and maintenance, and financing difficulties. There are also strong doubts voiced whether economic comparisons o£ nuclear versus other forms of generating electricity have fully taken into account such costs as decommissioning nuclear mover stations, disposing of radioactive wastes, and retrofitting plants with equipment to satisfy improved safety and environmental standards. Long lead-times and the burden of interest-during-construction at today's money costs have compounded the present lack of enthusiasm among host electricity corporations to install new nuclear plants unless they are already advanced in construction.

Meanwhile, the slowdown in economic growth since 1973 has sharply reduced the growth of electricity demand. This has fallen disproportionately on nuclear power which had been expected to account for much of electric incremental capacity.

All these factors have led to the deferral or cancellation of a large number of orders for new plants in a number of industrialized countries.

Despite these radically lowered expectations, nuclear energy is still expected to account for a gradually rising share of electricity generation in a number of industrial countries. A few (particularly France and the Soviet Union) are also moving ahead towards introducing breeders. Plans in Britain, FR Germany, and Japan for breeders have been delayed, and those in the US suspended.

B. Developing Countries

Technical complexity and proliferation have not per se ruled out consideration of nuclear energy for developing countries. However, the number of such countries which can handle the technology and have a large enough electricity sector to accordant major increments of base-load generating capacity is relatively limited. For example, Argentina, Brazil, India, Mexico, Pakistan, and South Korea have active programs. Elsewhere, r toast developing countries are going slow in their approach towards nuclear lower at this time. (See also Chapter IV.)

Non-Proliferation

The issue of nuclear energy in the context of international relations raises concerns of weapons proliferation in developed and developing countries alike. No matter how dangerous these concerns are, nuclear power is still an enticing neap of solving the energy problem. Yet because of the nature of nuclear power, it raises all kinds of internal and external political and social problems within all kinds of societies.

If a developing country wants the nuclear option, either for peaceful or other uses, it must inevitably obtain assistance from a nuclear supplier country, typically one of the industrialized countries. The issue as perceived by nuclear supplier countries is therefore how they can export nuclear power aquiline and technology on a basis which would ensure that nuclear materials would not be directed by governments for weapons or by terrorist groups for non-peaceful ends. This raises questions whether existing international agencies can adequately apply nuclear safeguards, and whether supplier countries should weigh up the political and strategic risks in relations with recipient countries.

The International Consultative Group on Nuclear Energy," which included members from both developed and developing countries, felt that "if nuclear power is to be available to meet an increasing fraction of the world's future energy needs, at least five conditions will have to be satisfied": I) nuclear power, despite the difficulty of the short-term clip, tee, will have to be systematically developed, without interruption or undue delay, ii) nuclear power must earn and retain public acceptance, iii) technologies for using uranium inner efficiently must it developed and tested as soon as possible, with both the coming decades and the 21st century in mind, iv) the fear of nuclear weapons proliferation resulting from an expansion of nuclear power must be further reduced, and v) countries depending on nuclear technology, services or materials to ensure their energy supply must be convinced of continued international access to them, under safeguards, on acceptable terms.

The Nuclear Non-Proliferation *Treaty* had already a decade ago incorporated a

provision that nations without nuclear weapons would agree not to acquire them and would accept international safeguards an their nuclear facilities, including IAEA inspection. In return, nations with nuclear weapons would help rinks the benefits of the "peaceful atom" available to signatories of the treaty and would nice progress on nuclear arms control and disarmament. Thereupon, numerous countries introduced large nuclear power programs.

With a view to reducing the risks of nuclear weapons' proliferation, the Nuclear Suppliers Club was formed in 1975 and has issued guidelines for tightened fuel cycle safeguards in nuclear exports.

The US enacted the Nuclear Non-Proliferation Act in 1978, under which the US would supply nuclear fuel, services, and technology only if recipients would accept a US veto over certain fuel cycle activities. Canada and Australia also nude acceptance of full safeguards can all nuclear facilities the condition for further nuclear cooperation. But Averments of frost European countries, Japan and developing countries took exception to the US restrictions and were unwilling to *defer* reprocessing spent fuel, recycling plutonium in existing reactors, and Introducing breeder reactors.

In response to other countries' adverse reaction to US non-proliferation measures, the US initiated in 1977 the International Nuclear Fuel Cycle Evaluation (INFCE) as a SO-country study which might identify fuel cycles with a minimum danger of weapons proliferation's It completed its report in early 1980. It did not find a technical fix to restricting nations' access to weapons-grade material, though it did indicate fuel cycle nndificattms which could rinks plutonium less easy to steal.

With prospects diminished for nuclear power, and improved for uranium reserves, the early needs for breeder reactors and large-scale reprocessing of spent fuel have also lessened. Nevertheless, some nations' interests continue as ever in access to uranium and in Reeder reactor programs. Nor are sort's countries willing to desist from reprocessing of spent fuel. Many countries continue to believe that the US unduly stresses the possibility of nations acquiring nuclear

Weapons through misuse of nuclear power programs anther than through plants operating in weapons production.

8. HYDROELECTRICITY

The use of hydroelectricity is expected to continue growing during the next taro decades. New sites are becoming harder to come by in mast developed countries other than Canada and Norway. But there are still huge opportunities in developing countries for hydroelectric projects.

Hydroelectricity has nary evident advantages. It is a continuously renewable and widely distributed resource. It is nonpolluting, in that it does rot produce by-products similar to ther, re, l effluents. It can be integrated into multi-use developments. It is one of the more efficient energy conversion technologies. Projects have a long life, low operating costs and no fuel costs, and the technology is well-known. Generating plants can be expanded with relative ease. Energy is storable as water in the reservoirs.

Hydroelectricity dues have certain disadvantages. It is highly capital-intensive. Hobs promising sites are far from markets. Projects can have undesirable envying natal impacts. There are geo-political constraints associated with flooding.

The use of snail-scale hydro plants had generally been declining in niter for years. This trend nay now to changing, particularly in developing countries. A striking example is PR China.

9. GEOTHERMAL ENF CY

Geothermal energy is the energy contained in the natural heat under the earth's surface. There are six kinds of geothermal systems: three of these are fully developed (dry steam fields, hot-water fields, and low-enthalpy fields) and three are at the stage of research and development (magma energy, depressurized zones, and hot dry rocks). Hot water fields are the most commonly exploited form of

geothermal energy. But dry-steam fields have the advantage that steam can be directly used in generating electric power. Geothermal energy can also be used in space-heating, horticulture, and pisciculture.Z

Geothermal resources are very common and commercial nearly everywhere. The technology is nature, and expertise is available. But commercial development has until recently been slow. Development efforts of geothermal energy in recent years are impressive. Iceland is *by* far the leading country in the use of geothermal energy for space and greenhouse heating.

Other countries now exploiting geothermal energy include China, E1 Salvador, France, Hungary, Indonesia, Italy, Japan, Mexico, New Zealand, Philippines, Soviet Union, and the US. The UN has trade a key contribution in technical assistance towards this development. Worldwide, geothermal electric plants now amount to about 1,800 MW of installed capacity, compared with 680 MW in 1969. By 1985 perhaps 10,000 MW could be in operation based on known exploration work and projects.

10. OTHER RENEWABLE FORMS OF ENERGY

Interest in renewable energy has been increasing with the continued rise in international oil prices. In developed countries attention has been particularly focused at concentrated and large-scale application of renewable energy. In developing countries it is focused on decentralized and small-scale applications in rural areas.[2]

Renewable energy covers a range of energy sources. They include biomes, biogas, wind power, solar energy, tidal power, and others more at the research and development stage such as wave energy, salinity energy, ocean thermal energy conversion, electrostatic energy and magnetic electricity, and solar power satellites.

In the developing countries, only about half of the need for useful energy is net from commercial sources. Of the balance (mostly to rural areas), perhaps two-thirds are net from inanimate sources such as wood and me-third by muscular efforts of people and animals.

One single phenomenon which developing countries are experiencing is a high rate of urbanization. This implies a radical change in the supply base. Rural dwellers consume mostly non-commercial, locally produced energy forms, and they produce much of their own food. The basic needs of urban dwellers must be net from commercial and frequently imported supplies. Hence urbanization will lead to a vast expansion in the demand for commercially traded energy. But even by the end o£ the century, most Third World people will still live in rural areas, despite the migration to cities. And if energy based amenities were fore available in the countryside, scone experts believe the migration might to slowed.

The limited availability of energy infrastructure in many developing countries justifies the development of small resources near to markets. Still deposits will have an increasingly vital role, and *they* can supply &mall decentralized systems in rural areas. &mill production units are needed and are available: geothermal, hydra, coal-mines, and oil-shale, oil, and gas fields.

The key problem for 011xs, particularly low-income countries, is the need for energy in food production and household use. This requires fore efforts to develop new technologies for use of biomass, particularly fueled and charcoal. This resource base is fast being depleted or mismanaged. Most developing countries' population lives in the tropical and sub-tropical zones which receive the frost solar radiation. This in principle gives much promise for prospects for solar energy and other renewable energy technologies applicable to rural areas. But much fore will have to be done before these prospects can be realized on a large scale. These technologies were well assessed in the OECD's report on Renewable Energy Technologies for Developing Countries, which suggested the following criteria:

A. reliability,
B. ease of maintenance,
C. feasible and optimum unit size, d. environmental impact,
E. social and cultural suitability,
F. feasibility of local, manufacture of components, g. expected course of future technological

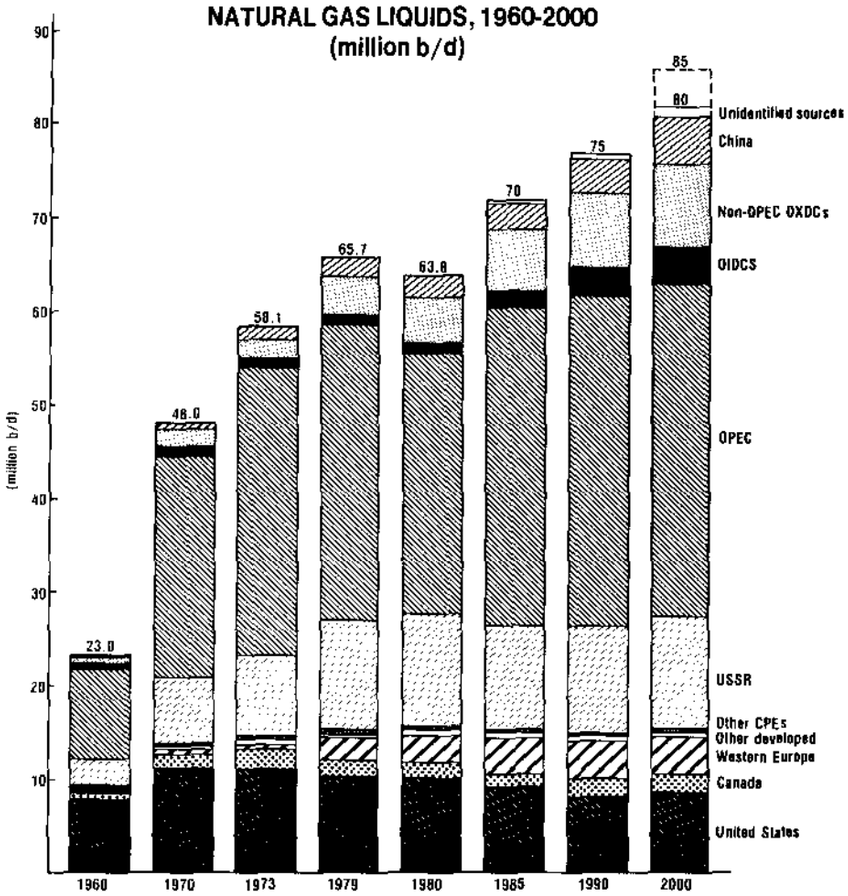
Development.
Preponderantly Lit and kerosene for cooking and lighting, diesel oil for commercial transport, and fuel oil for electricity generation, rather than gasoline for private motoring.
It is helpful to distinguish developing countries into oil-importing and oil-exporting categories, in order to analyses oil's contribution to their foreign exchange Godden or earnings. This does not ran simplistically that developingCountries which import oil are in trouble and those which Exports are in good shape. Economic performance is the result of many different factors. But oil trade is highly significant ale.
There are more than 120 Oils. Their oil consumption grew rapidly during 1960-73, by 8% p.a. It stagnated in the next two years to 1975 but then resumed growth at an estimated 5.5% p.a. to 1979, when it averaged some 5.6 mm b/d.* There have been increasing efforts to conserve the use of oil in these countries without at the same time harming economic growth. It is still too early to know how successful these efforts have been, this issue is discussed further in subsequent chapters.
Oil consumption in Odes is highly skewed in distribution. Most consume very little oil, and a relatively few countries account for mast of the trade. (See E. below.) This does not mean that the relatively small oil consumption in smaller countries is not important to their economies. On the contrary, these countries are among the mast severely disadvantaged by high costs and potential scarcities of imported oil. But it indicates the order of negritude of steps which may need to be taken in the transition to a broader diversity of energy sources.
* This list excludes the following middle-income countries: Greece, Israel, Portugal, South Africa, Spain, Turkey, US territories, and Yugoslavia which are defined as developing countries in the World Bank's report WDB III. In 1980 these countries could have consumed about 2.5 mm b/d of oil (including bunkers). These countries (except for Stain) are also defined by the IMF as developing, consuming 1.5 mm b/d.
Since 1973, oil consumption in OXIXs (OPEC and others) has continued to grow at over 7% p.a., similar to the years 1980-73. A significant part of the oil consumption volume goes to bunkers and refinery fuel. There is a strong concentration of oil consumption in a relatively few countries. Among the OPEC countries, four account for three-quarters o£ consumption: Indonesia, Iran, Saudi Arabia, and Venezuela. Among other oil exporters, Mexico accounts for half their oil consumption.
Oil consumption in OXOCs is generally expected to continue growing strongly.* in sore of these countries, this has given rise to concern that the strong growth of inland denned should not eat into future export earnings, their engine of economic growth. A number of DCS are accelerating the substitution of gas for oil in the inland market and petroleum industry, in order to free up oil for export and to reduce gas flaring

B. Supply Prospects

There are now only a few countries where production is large and still clearly expanding. These are Argentina, PR China, Egypt, Iraq, Mexico, Norway, and the United Kingdom. Between them, in 1980 they will account for about 17% of world oil production. In none of them is future production thought likely to exceed by much that required supporting their national objectives. There are a snw11 number of other countries which are expanding and which could perhaps reach a level o£ 500,000 b/d each before the end of the century: Brazil, India, Malaysia, and Oman.
Chinese output expanded very rapidly in the last two decades to reach just over 2 inn b/d in 1980. PR China is gearing up for an intensive exploration effort in onshore and offshore areas. The program offshore is taking place in rank wildcat areas, and the outcome is just not known. If the geological prospects in these areas prove favorable and if exploration efforts meet with luck, production could rise
*{For example, this is analyzed in studies by OPEC Secretariat, OPEC Fund, UNCLAD and World Bank. Rapidly to reach conceivably 5 no b/d by 2000. This is way below earlier official aspirations to develop ten fields like Oaring (Teaching), i.e., a total of about 10 mm b/d. But it would still he a quantum

jump from the present and would represent a great achievement.
Mexico's output depends on government policies regarding a) the speed of developing new discoveries and b) export ceilings. It is installing enough capacity to supply the growing domestic market as well as exports sufficient to finance the nation's foreign exchange needs for economic development. Production o£ crude and natural gas liquefied (NGL) was close to 2.15 no b/d in 1980, and exports were 827,000 b/d. Mexico's export ceiling (1.1 mm b/d) is reported to he 1.45 mm b/d in 1981. Policy after 1982 has not been determined. It is conceivable that output could he in the range of 4 on b/d by 1990.
North Sea oil production is likely to rise during the next few years but could decline during the 1990s, unless new virgin exploration in the fore difficult and unknown northern areas meets with success. Prospects for expanded output in other industrialized countries do not look bright for expanded output, although there could he surprises from the vast areas offshore north-western Australia.
Several producing regions of the world have reached maturity. US production, despite the large contribution of Alaska, has continued to decline slightly. This trend presently looks very difficult to reverse. The huge increase in exploratory drilling has only stabilized the rate of additions to reserves in the lower 48 states. Most studies now envisage a decline in output during the 19805•n-q
Production of conventional light and radium crude oils from existing fields in western Canada appears to have leveled and is expected to decline. But this decline is likely to Le fore than offset towards the end o£ the 1980s by new discoveries in the western provinces and frontier areas, as well as development of tar-sands and heavy oil.
Other important countries where production of crude oil appears to be approaching a plateau are Algeria, Indonesia, Libya, Nigeria, star, and Venezuela (see Chapter

6. WORLD PRODUCTION OF CRUDE OIL AND NATURAL GAS LIQUIDS, 1960-2000
(million b/d)



Source: Petro-Canada/Petroleos de Venezuela, World Oil Supply Prospects, February 1980.

II). All of these happen to be OPEC members. In 1980, together with the US and Canada, they will account for an estimated 15% o£ world production.

OPEC countries can be distinguished between those with nature provinces from which little extra production can be expected, and those with substantial potential for expansion but which, with the possible exception of Iraq, no longer are interested in developing capacity rapidly.

Four of the most to octant OPEC countries are dedicated conservers. They do not all wish to produce at capacity and are reluctant to undertake further large scale expansion. These are Iran, Kuwait, Saudi Arabia, and the United Arab laniaries. Their production is 1980 is expected to average less than cone 15 mm b/d, accounting for 24% o£ world production.

OPEC countries at present contribute about 45% of the world's oil supply. These 13 countries' production of crude oil and natural gas liquids was 27 run b/d in 1980, and is estimated at about 25 mm b/d for 1981.{ As things presently stand, they are unlikely to expend output o£ crude oil beyond 33 rim b/d by 1985, hardly rising thereafter

Undoubtedly the cost contentious issue between developed consuming nations and OPEC countries will be the rate of development and production in the few countries where there is a large potential for expansion. (See Chapter 11.2.) These are Iran, Iraq, Kuwait, Saudi Arabia, the CAE, and Venezuela.

In 1979 there were about 15 non-OPEC OXOCS.'[fi] Together they produced almost 4 mm b/d in 1980. This could

* Th$_e$ 13 OPEC countries are: Algeria, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Infuriates, and Venezuela.

** The 15 non-OPEC developing countries which were net oil exporters in 1979 are: Angola, Bahrain, Bolivia, Brunei, Cameroon (since 1979), Congo, Egypt, Malaysia, Mexico, Oman, Ire, Syria, Trinidad & Tobago, Tunisia, and Zaire. Burma had been a marginal exporter in 1978.

Double to 8 run b/d in 1990 but nay be only a little higher by the year 2000. Mexico alone accounts for about half of production during the whole period.

Exploration in the OII) CS has been picking up in recent years. Drilling intensities, never, are unlikely ever *to coerce* anywhere near US levels. Nevertheless, a large number of countries can reasonably expect to become medium to small producers. Their combined output is estimated at 1.25 mf b/d in 1980 and is expected to triple during the next two decades. Most of the increment would be in the cozen or so countries which produced oil in 1979. But a substantial increment (perhaps 400,000 b/d by 1990) is also envisaged from numerous countries which now produce no oil at all. (See Chapters III and IV.)

The Soviet Union's production expanded quite rapidly during the 1970s. Prospects for future production are an enigma. It is generally expected to have reached its peak of some 12 mm b/d by 1980. The fore pessimistic view is that published in 1980 by the US CIA; it believes that output will then decline throughout the 198OS, and that, even with successful exploration and continued access to Western equipment and technology, output would slide to 10 rim b/d or less by 1985.[s] In contrast, a study by Swedish consultants Petrostudies *sees* potential for further growth in output's On balance, it might be prudent to plan as if output may have leveled out and could perhaps decline somewhat less than foreseen in the CIA report, perhaps to 11 mm b/d by 1985, before reviving again in later years, once the large resources in remote areas of the nation are developed.

Throughout cost o£ the 1980s and during the 1990s oil demand is likely to be constrained by supply availability, although this must be understood in the context of production limits for political and economic reasons in some major oil-exporting countries.

* The 14 OIUCS which produced oil in 1979 are: Argentina, Brazil, Bunm, Chile, (bulimia, Ghana, Guatemala, India, Ivory Coast, Pakistan, Philippines, and marginally Afghanistan, Barbados, and Rep, of China (Taiwan).

C. Oil Resources

Is the world's oil resource &se large enough to support these expectations for future oil production?

There have been navy estimates of ultimate recoverable reserves of conventional oil. They are no more than academic, as they are guesses at the unknown. But they do give some indication of the constraint on the rate at which additions may be node to presently known reserves of conventional oil.

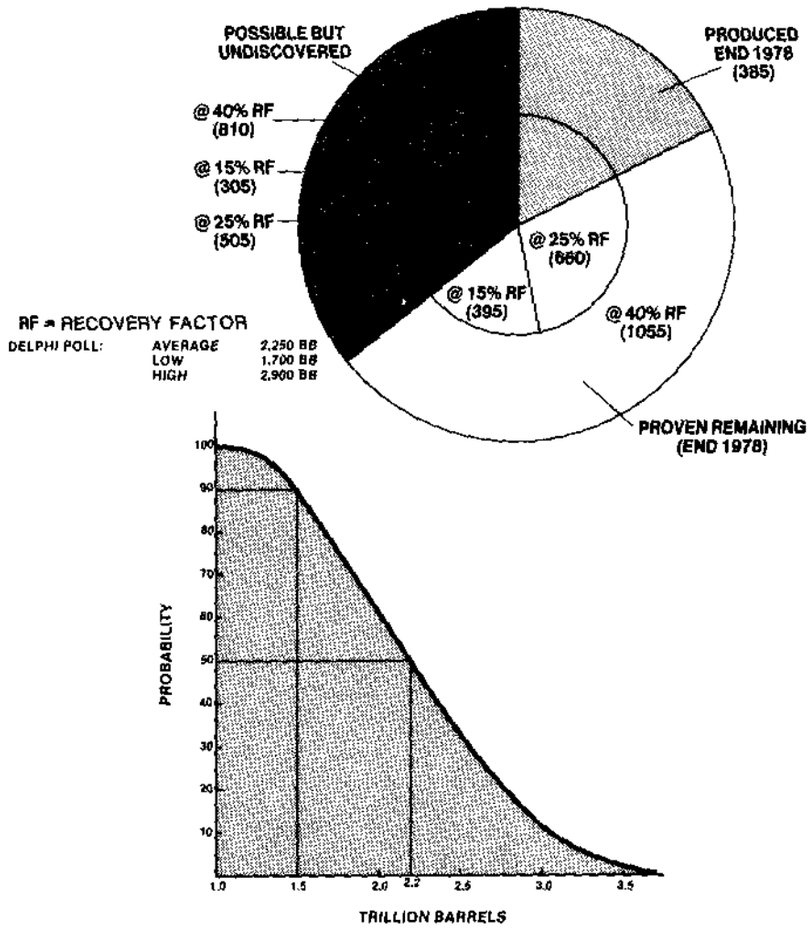
Past production of oil amounts to about 400 billion barrels (BB). Remaining known reserves are estimated in the order of 660 BB, enough to last 35 years at the present level of output. Additional potential resources could be in!the order of 1,200 BB in the average estimate of a range of experts, published in the. Iksprairies report to the Conservation Emission of the World Energy Conference in 1977.' Thus it estimated total resources at roughly 2,250 BB; the pessimistic end centered around 1,700 BB, and the optimistic around 2,900 BB.

The world's known reserves are highly concentrated in a relatively few countries. The ten largest with 20 BB or more each contain 80% o£ the total: in order, Saudi Arabia, Soviet Union, Kuwait, Iran, US, Iraq, UAE, Mexico, Libya, and China. Alternatively pit, OPEC countries contain 68% of the total, the Middle Eastern member countries 55% and Saudi Arabia alone 25%.

The world's oil reserves are concentrated in a relatively few sedimentary basins. There are roughly 600 worldwide, depending on how they are defined. There are producible hydrocarbons in nearly 240. But just 30 contain 90% of the world's recoverable oil, and two of these (Arabian Iranian and West Siberian) have over half.

Additions to world oil reserves have depended heavily on the discovery of giant oilfields, and this is likely to remain true for the future. World reserves are concentrated in just a small number of large fields. O£ about 30,000 fields worldwide, there are less than 1900 ,(or 6%) which each

7. WORLD ULTIMATE RECOVERABLE RESOURCES
(billion barrels)



Source: World Energy Conference, 1977.

Source: P.J. Wood, World Oil, June 1979.

Contain the equivalent of 50 million barrels or gore of hydrocarbons (oil and gas). But they contain 93% o£ the world's known recoverable reserves.

Unfortunately, estimates of world oil resources and reserves typically exclude so-called unconventional oil, such as deposits o£ very heavy oil, tar-sands, and oil-shale's as well as oil in Polar Regions and beneath deep water. This begs a large question, as these deposits are potentially huge. In the Fast, they have been little touched, because their development costs are much higher than those of conventional oil. At today's prices, however, they become increasingly economic to exploit. This is clearly the direction for the future, i.e., increasingly from conventional to no conventional oil.

D. <u>Exploration and Development Efforts</u>

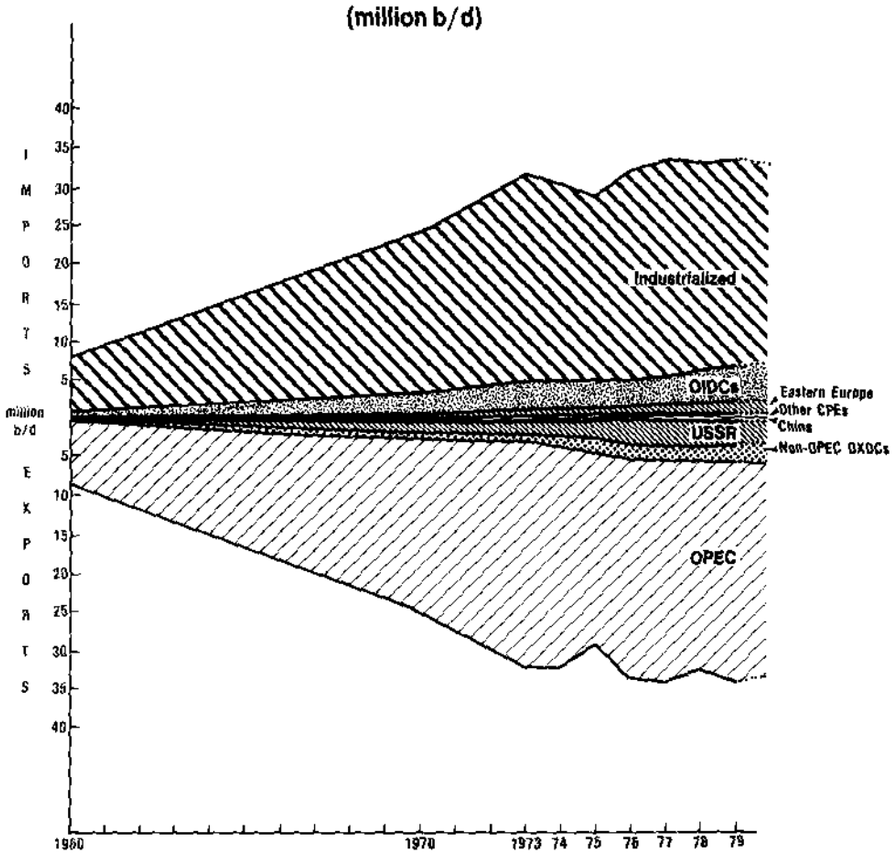
higher oil prices have improved the economic viability of exploitation o£ stall fields, enhanced recovery, exploration in high-cost areas such as polar and deep water, heavy oil, tar-sand, and oil-shale deposits, and fields with poor reservoir characteristics.

Even though exploration efforts in new provinces are likely to find the larger fields in the earlier stages o£ exploration program, there could still be smaller fields which would be well worth looking for thereafter. In any countries stall fields will continue to be found well into the next century. Their cumulative impact could be great, and their support to economies including those of the oil-importing developing countries will be significant. (See also Chapters III and IV.)

Some of the future increase in world oil reserves will come from enhanced recovery from existing fields rather than from discovery of new fields. Prospects are strengthened by second phase discoveries in older established basins, encouraged *by* improved economic viability of sre.ller fields at today's oil prices, better technology and exploration concepts, offshore extensions, and deeper drilling.

Exploration techniques have improved significantly in recent years. Drilling techniques have greatly advanced,

8. WORLD: OIL TRADE, 1960-1979
(million b/d)



Source: BP Statistical Review, 1980.

Particularly in polar and deep water regions such as the Canadian Arctic and offshore Labrador. But good judgment is still fundamental to successful exploration. It still remains true that the evaluation of geological provinces is very dependent on the degree to much high grade prospects are tested by the drill. Relatively small areas of sedimentary basins can contain significant volumes of oil.

Of the world's ultimate recoverable resources o£ oil, a substantial cart could lie offshore. Attention has thus far been focused on the continental shelf. Little is known about the deep water basins in the adjacent continental margin. Uncertainties are political, economic, geological, and technological. The problem is development, not exploration. Oil cannot yet technically be produced from potential fields in deep water. Provided this problem is solved, the next will be the cost of producing any oil found.

Heavy oils and--even awe or--the bitumen in tar-sand deposits have been the Cinderella of the crude oil market. Their economic feasibility has brightened considerably at today's oil prices. Future extension will involve enormous capital investment with long lead-times a) in extraction, including enhanced recovery and b) in upgrading. The pace of development will be set not only by technological and environmental constraints but also by government policy. Increasing volumes will come on stream during the next two decades but at a relatively slow pace.

Shale oil production is snail, though resources are huge. At present oil prices, projects may at last be approaching threshold o£ economic viability, though very little development has begun. There are huge environmental and technological problems in their exploitation on a commercial scale.

E. International Oil Market

World oil trade is mostly supplied from OPEC countries. The balance comes from other Exits, the Soviet Union, and PR Chin.

TABLE I-1: WORLD OIL TINGE, 1979-80

(million b/d)

Exporters	1979	1980	Importers	1979	1980
OPEC countries	28.7	25.0	Industrialized	27.2	24.8
Other OXDCs	2.0	3.0	OIDCs	4.5	4.5
Soviet Union	2.8	2.8	Eastern Europe	1.9	2.0
PR China	0.3	0.2	Other CPI's	0.2	0.2
				33.8	31.5
			Stock rundown afloat ...		0.5
za.u		al.n	:3a.R		'l~.n

International oil supplies in 1979 were tight, because of the disruption to Iranian exports. During the first quarter, the constraint resulted above the usual seasonal rate. Oil importers quickly rebuilt stocks in subsequent fronts of 1979 to a safe working level, plus an additional stock cushion in a strong rundown of stocks ashore and afloat to provide some measure of protection against increased insecurity of supply. They were accordingly willing to buy for stockpiling at prevailing spot prices much higher than official export prices, in the expectation that they could pass on the higher procurement costs to customers. This oil balance for 1979 was initially dismaying and certainly strained. It finally resolved itself, helped in part by the slowdown in oil consumption in industrialized countries (particularly the US).

The oil balance during 1980 was less strained, because of the economic downturn in industrialized countries, and the extraordinary stock build which continued during the year. Oil imports were fore than 2 mm b/d lower than in 1979. The decline reflects lower consumption in the US and Western Europe. On the supply side, exports from non-OPEC OXDCs (above all Mexico) were 1 nm b/d ante than in 1979, but OPEC countries' exports were almost 4 inn b/d less.

In 1980, the Iraqi-Iranian conflict did not significantly disrupt world supplies, and any short-term deficiencies were compensated from stocks and increased output from other OXDCS. But the balance was very

fragile and could

Easily have been shattered, for example I£ oil experts from the Middle Fast or elsewhere were further disrupted or were insufficiently available.

In 1981, the market has eased greatly, reflecting a decline in oil consumption in industrialized countries.

The prospects for the next two decades presently appear to be at best a continuance o£ international oil trade at its 1979 level, on grounds of constraints in exports from OPEC countries and the Soviet Union, together with imports stagnant in industrialized countries but rising in OIDCs.

f. <u>Net Exports</u>

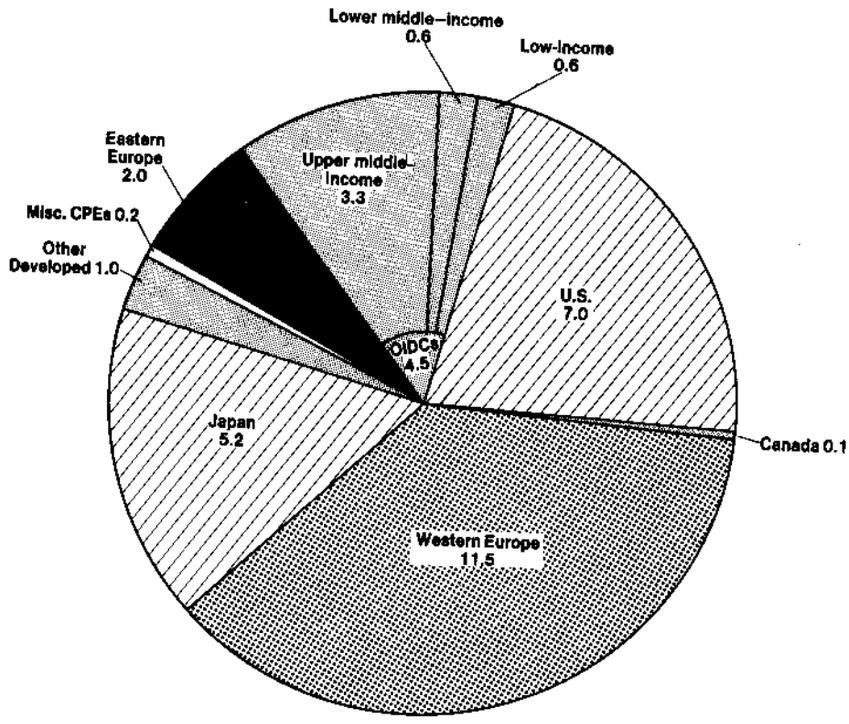
As things stand at present, exports from OPEC countries are generally envisaged to be less than 30 inn b/d during the next two decades, in view of a) constraints on expansion in capacity and allowable production and b) growth of their domestic oil markets

A large increase in production is foreseen for nanotech oil exporters during the next two decades. But consumption of energy and particularly oil in OXDCs (including OPEC countries) continues to increase rapidly, fuelled by strong economic and population growth. Pricing and other policies to make for rare efficient energy use are often weak. Thus it does not follow that oil exports from non-OPEC Oxides will continue their previous rapid expansion. Even was this technically feasible, these countries nay impose policy policy ceilings on production or exports, as Mexico does now. For these reasons, it is felt that exports from these countries are unlikely to exceed 4 con b/d *through* the 1990s.

Chinese policy has shifted significantly since 1977 towards an accelerated development of its oil resources, to fuel its modernization program. Projections of oil exports from PR china remain speculative. There is a general feeling that inst production in the

several years ahead may be absorbed by the burgeoning domestic market, leaving a relatively smelt share for exlnrt. Even this assumption could prove optimistic, unless the new exploration efforts in untested frontier areas on and offshore are successful.

9. WORLD: ESTIMATED OIL IMPORTS, 1980 (Including Bunkers) (millions b/d)



Total : 31.5 million b/d

Source: John Foster, estimate, October 1980.

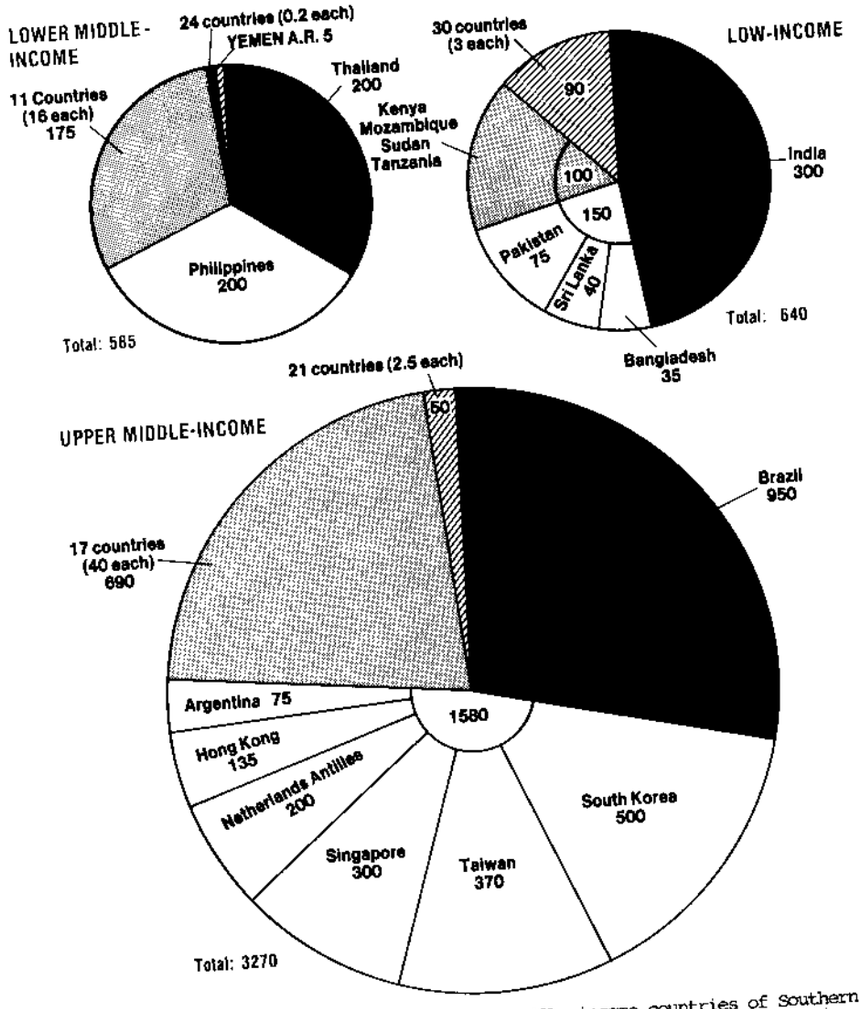
A particular area of uncertainty is the extent to which the Soviet Union/Eastern European bloc nay rove from being a net exporter (1 nil b/d in 1980) to becoming a net importer (see Isle 24). Eastern European countries' darted for imported oil is likely to expand from its present level (2 urn b/d), given the limited scope for expansion of domestic energy supplies. Hence they will probably turn increasingly to the Middle Fast for incremental oil imports.

This leads to a widely IrDA view that the Soviet bloc may become a net oil importer during the 1980s. The CIA's view published in 1980 envisaged net imports of at least 1 run b/d by 1985, and some others are beginning to Trove towards it. If they are right, pressures on international oil trade could become acute. The problem is largely logistical; the Soviet Union has huge unexploited energy sources but they are mainly in remote, physically inhospitable areas and will take great efforts and time to exploit. I£ successful achievements lead to a brighter outcome for oil production than is generally supposed; this could be global good fortune. There are nary unknown variables south could ameliorate their prospects for oil trade. They include improved energy efficiency (for which there is huge potential), accelerated development of energy resources, and substitution of other energy forms for oil. However, even if oil consumption in the Soviet Union were to grow only slightly and output were to hold level, the bloc stilt might have to phase out its net experts and could become a net importer during the second half o£ the 1980s.

ii. <u>Net Imports</u>

Earlier we had discussed aspects of oil consumption and production in the more than 120 OIDCS. The volume o£ their oil imports grew by just under 7% p.a. during the decade, similar to that of the 1960s. OIDC imports in 1980 are estimated at about 4.5 mm b/d, after taking into account

10. OIL-IMPORTING DEVELOPING COUNTRIES: ESTIMATED OIL IMPORTS, 1980 (Including Bunkers) (thousand b/d)



Note: Definition of OIDCs excludes the middle-income countries of Southern Europe
Source: John Foster, estimate, October, 1980.

Another six countries impart 1.6 nm b/d together. Two of them are the other rein net importers in Latin America, Argentina and Netherlands Antilles, as others such as Chile and (Bilabial are closer to self-sufficiency. The other four are the newly industrialized countries of East Asia: South Korea, Hong Kong, Singapore, and Rep. o£ China (Taiwan). The remaining 740,000 b/d of oil imports into upper middle-income oleos is spread over some 38 countries. Almost all goes to the 17 which each import in a range of 10-100,000 b/d (40,000 b/d averages). The balance goes to 21 countries (2,500 b/d each), mostly island-states.

In contrast, the lower middle-intone countries impart just 600,000 b/d. Of this amount, Thailand and the Philippines import 200,000 b/d each. Another 11 countries impart more than 10,000 b/d each *(16,000* b/d each) and one (Yen n AR) 5,000 b/d. The balance of 24 countries import an average of 200 b/d each.

Similarly the low-income 011)03 import just 600,000 b/d. India accounts for one half, Bangladesh, Pakistan, and Sri Lanka for one-quarter together, and the remaining quarter is spread over 35 countries, mostly African south of the Sahara. Twenty of them each import volumes in a range of 1-10,000 b/d, and ten of them less than 1,000 b/d each. Thus for nary countries, the oil import volume is minuscule in relation to world oil trade. But to each of them their oil Imports could be a *heavy* harden.

If the prospects for the next two *decades* are truly for increasing constraint on international oil supplies and for just a nodes increase in access to these supplies by oil importing developing countries, *the* implication is inescapable that developed countries will import no more oil than at present and quite likely less. This was recognized by industrialized countries within the IEA, EEC, and the Seven in the formulation of oil import targets. (See Chapter 11.3.) Except for the few industrialized countries with prospects of ex [ending their production of hydrocarbons, this *raises the* key issue of demand restraint. Their oil consumption could be supply-constrained during the next two decades to levels lower

Than in 1979-80.

P'. <u>Crude Oil</u> <u>Prices</u>

The international oil scene has turned around since 1978. This is in large part due to the recent tonsil of political events in the Middle East.

International oil prices surged during 1979 due in pest to panic buying by consumers in the wake of the Iranian oil disruption. The "spot" ~regret became overheated and crude oil was bought at prices several dollars *higher* than official expert prices. Transactions at spot price grew rapidly to become *25-30%* of international oil trade, as opposed to the *3-5%* previously characteristic of the spot market. However, today the differentiation between long-term and spot deals is becoming increasingly blurred.

During 1980, international oil was basically traded at different tiers of official prices. Saudi Arabia increased its prices in December 1979 and May 1980 with the announced intention of inning towards price unification. But other prices advanced in step.

In early 1981, the marker price (Saudi Arabian Light) was *US$32* per barrel fob. Official prices for most Middle Eastern crude oils were on the order of *US$35-30,* to which differing premier were added. It remains to be seen whether international oil prices will finally realign themselves during the next year. The odds on this happening have increased, with lower demand for OPEC oil and continued *high*

Saudi output.

The balance between world energy demand and supply is fragile. The one certainty is continuous surprise and uncertainty. The prudent conclusion for policy decisions is that constraints on international oil supplies could remain with us for the foreseeable future. The outcome could, of course, prove quite different. The international oil market could tighten or weaken for a variety of combining factors. It could naked real oil prices jump again. It could conversely put them under downward pressure, e.g., if demand for imported oil were by chance to fall below a critical (but unknown and so far untested) level, to *which* OXDCS t find it hard to adjust output. But this takes no account of supply disruptions for political, military, or other reasons. On present evidence, we believe it prudent to plan on a continuously tight oil market with modest increases in real prices (say, 2-3% p.a.).

4. ENERGY OTHER THAN OIL

During the 1960s and indeed until 1973-74 when international oil prices quadrupled, there was a strong worldwide substitution of oil and gas--and increasingly nuclear power-for coal. By 1973 oil had increased its share of the energy mix in developed and developing countries to 54%, and r rural gas to 19%.

Since then, there has been much concern expressed in oil-importing countries to reduce dependence on imported oil and to promote the development of indigenous energy supplies. In particular, coal consumption is gradually picking up momentum, growing by 5% p.a. from the recession year of 1975 to 1979, compared with (about) 1% p.a. during the 1960s.

But the slow pace of economic recovery has dampened energy demand particularly in the industrial and electricity generation Sectors. This has adversely affected conversion back to coal consumption, as have requisite environmental measures. Similar factors plus that o£ public acceptability have slowed the completion of nuclear power stations. Natural gas is a preferred fuel, but domestic supplies have been constrained in the US and the Netherlands, and liquefied natural gas (LNG) projects have been set back by technical, financial, and regulatory difficulties.

There seems to be a consensus that future non-oil supplies will grow but slowly during the 1980s and into the 1990s. If economic growth were more ebullient, there could be a faster expansion of non-oil supplies. For example, pore coal might be used in electricity generation. The declension of non-oil supplies will nevertheless require a huge effort. It could represent virtually a doubling during the next two decades. Coal fray provide about one-third o£ the increment, and gas and nuclear power about one-quarter each.

In view of growing public concern over environmental issues, rapid expansion of coal and nuclear power in a number of industrialized countries (post-Three Mile Island) is difficult, though planned. A major constraint in the development of nuclear power in developing countries has been the concern of supplier countries about the non-proliferation of nuclear weapons, matched by the concern of recipient countries to retain the principle of sovereignty over national policies.

Hydroelectric power and other forms of renewable energy are seen to provide only a snail share of the increment for rest countries during the 1980s. But the expectations o£ strong research and develolsnent programs in renewable energy

forms such as solar, wind, tides, and biomass should lead to accelerated growth in their use during the 1990s.

5. NATURAL GAS

Natural gas is likely to make an increasing major contribution to world energy supplies. It will be an important transitional fuel. Gas expansion in the just has been held back by technological and economic constraints. These have recently been greatly reduced. As gas is relatively expensive to transport compared with oil or coal, its production has basically been developed in countries close to large energy markets, particularly the developed and socialist countries. It has been relatively little exploited in developing countries. Unlike oil, gas cannot be widely marketed until a costly pipeline network for local distribution is built. Natural gas now looks likely to be the fastest growing energy source in the developing countries as well as elsewhere worldwide. Moreover, international trade in gas is likely to grow even faster than its consumption.

The development of gas resources has been inadequately pursued in the developing countries. But a substantial part of the growth of conventional natural gas production during the next two decades is expected to take place in these countries. Expansion of local gas usage should be considered the rain policy aim. But where the domestic market is limited, exports by pipeline or UC tanker ray to advantageous. Where the export market is very distant, it nay be worth converting the gas into methanol prior to shipment rather than liquefying it.

LNG technology is highly advanced but readily available. The main markets are the US, Western Europe, and Japan.

Existing Lhi exporters are OPEC countries (Algeria, Indonesia, Libya, and UAE), Brunei, and the US (Alaska), while gas is expected by pipeline from the Soviet Union. Other LNG projects are under construction or at the planning stage.

In recent years pricing, financial, economic, technical, and environmental reasons have led to the delay or cancellation of finny Projects. In Particular, the high cost of unhinge gas ccwnpared with liquid and solid fuels has rode for a relatively low bide netback for pas at the wellhead. Hence petroleum-producing countries have typically pursued other uses for their natural gas. These include reinsertion for oil field pressure maintenance, other field applications, extraction of natural gas liquids for domestic and export markets, and commercial applications for the gas in local markets, particularly energy-intensive industries such as petrochemicals and aluminum-smelting. The balance of the gas is being flared when it is produced in association with crude oil, or is being shut in when it is non-associated.

Today's international oil prices have greatly improved the economic viability of LN projects. By the satire token, they have also improved those of other high-cost sources of energy and gas in countries which are now energy - deficient, and investment decisions for LNG projects will have to be justified in relation to the possibilities for alternative energy supplies.

Deep conventional gas refers to accumulations found at depths greater than 4,000 meters. The potential for such gas accumulations may le filch greater than has been assumed in the ~sty. They could well be one of the world's major fossil fuel sources when oil begins to be depleted in the next century.

A major deterrent may be the increased cost of seismic surveys and drilling. In some countries where oil reserves are plentiful, there is little incentive to drill *where* the sources rocks go deeper, especially if there is no ready market for large gas discoveries. The Middle East could have giant deep gas deposits, but it is doubtful if these horizons will be tested until oil reserves will have to be more drastically depleted.

Considerable attention has recently been given to the possibilities of finding and producing unconventional natural gas with today's higher energy prices and improved technology. Much o£ this gas is not yet explored. Hence any estimates of gas in place are highly speculative. Even if the gas does exist, we cannot now predict that it can be produced economically in significant *and aunts.* Nevertheless, a comprehensive survey of *energy* resources must include these unconventional gases. They include gas dissolved in water (including geopressured gas), natural gas from coal-beds, gas from Devonian shale's, gas from tight sands, and gas hydrates.

6. COAL

The world's resources and reserves of solid fuels (coal, brown coal, lignite, and peat) are huge, much larger than those of oil and gas. They are unevenly distributed geographically, host of the known reserves are concentrated in three countries: the Soviet Union, PR China, and the United States. The I lance is mostly in a relatively few other countries, including: Australia, Canada, Britain, FR Germany, South Africa, Poland, DR Germany, Czechoslovakia, and some developing countries, in particular India and Republic of Korea as well as Botswana, Colombia, Mozambique, Vietnam, and Zimbabwe. Much of the world's production is also in these countries.

The geographical concentration of known coal reserves may also reflect large differences in intensity of exploration effort. The world's ultimate recoverable resources of solid fuels are still poorly known. There are nervy countries which are believed to have untapped and unassisted coal reserves. Africa and South America have only sporadically been examined for coal. Worldwide, a large production base exists which could be expanded, if markets were developed.

The international oil price increases since 1973 have made coal competitive in nervy end-uses where previously it was not. There are now great new opportunities for expansion. No entirely new technologies would need to be developed, as coal was at one time the dominant commercial fuel worldwide. But improved technology is c~sirable, to reduce costs and adverse environmental impacts. The single largest end-use for coal in recent years is in electric power generation, where the technology for coal burning has significantly improved, including the introduction of £fluidized bed combustion. New opportunities for coal usage, particularly in developed countries, could include the development of plants to produce synthetic oil and gas in future decades.

In early 1980 the World Coal Study (W (COL) n said that "coal will have to supply between one-half and two-thirds of the additional energy needed by the world during the next 20 years, even under moderate energy growth... To achieve this goal, world coal production will have to increase 2.5-3 times, and the world trade in steam coal will have to grow 10-15 times above 1979 levels."

Industrialized countries are likely to move strongly back to the use of coal. Among them, the US is the single largest coal consumer and producer.

Developing countries have new opportunities to exploit smaller coalfields, Wench nay be large enough to contribute to their domestic energy needs. For these countries, the key to resource development lies with government policies to encourage such exploitation, which UN agencies s null increasingly be willing to assist (See Chapter IV).

A critical issue for the expansion of coal demand is its acceptability to end-users. Other problems include reliability of supply from an industry which has not enjoyed the best management/labors relations. Particularly in developed countries, unresolved questions on environmental issues have typically not been adequately covered, for example, air pollution, acid rain, and the accumulation of W2 in the atmosphere. It is not known whether there is serious risk of climatic change from the rapid expansion of fossil fuel use. There is a lack of consensus on the seriousness of future accumulations of IX) 2 and its implication for energy policies. The problem needs continuous monitoring, but it is not yet generally envisaged to constitute a serious limitation on coal development.

Meanwhile, there are serious constraints on the expansion of coal supplies which need governments' attention. These include the environmental impact of strip-mining, recruitment of miners and engineers, the lead-times and considerable investments needed to establish and expand mines,

Transport, storage, handling, and port facilities. Despite these constraints, there is likely to l>e a substantial increase in coal demand and output."

At present, most exports are from the is, Australia, South Africa, FR Germany, and Poland; Canada is a growing net exporter. Major importers include France, Italy, and Japan. Most trade is in coking-coal far steel-making, though some steam coal is also traded. There could Fe a very sharp increase in international trade of coal, in Particular steam coal. Australia is likely to expand dramatically its coal exports during the next two decades. South Africa could also do the same. Inland will continue to export tout may not be able to expand significantly. Of the developing countries, Botswana, Colombia, Venezuela, India, and Mozambique *nay* become exporters in the future.

Underground coal gasification offers a relatively low-cost, environmentally sound method to produce clean fuels from coal. This opens up the opportunity to exploit coal which is unmemorable by Resent-day techniques. It could thereby enable vast and widely distributed resources to be reclassified as recoverable reserves. The Soviet Union has developed a commercial technology which US interests have purchased. Field tests in the US to date have confirmed the potential economic and environmental advantages o£ this technique. Critical technical environmental issues are being resolved, and the process is being scaled-up. Interest could lead to criteria direction in the US by late 1980s.

Often neglected in earlier years, solid fuels o£ low calorific value have recently seen an upsurge in their development. In descending order of heating value, they include sub-bituminous coal, Frown coal, lignite, and peat.

World reserves of Frown coal and lignite are large, some 10% by heating value of all solid fuels. Production in 1978 amounted to nude than 900 million tons of hard coal equivalent and represented about 14% of all solid fuel production. Some countries have exploited brown coal, lignite, and peat for nervy decades. The supply of brown coal comes mainly from the Soviet Union as well as Czechoslovakia, DR Germany, and FR Germany and--to a lesser extent--some other European countries, Australia and some Asian countries. Recently there have been large-scale plans to expand the use of lignite in the Gulf States

of the US. The environmental impact of strip-mining brown coal and lignite is great, and well-designed laws are a pre-requisite.

The cost of transporting slid fuels of low heating value is high. Consequently, it retakes economic sense to burn these fuels in applications close to the mine. For example, they con be used as fuel in lineout electric power stations. The technology o£ power generation from large peat-fuel boilers has reached an advanced stage of development in several countries including the Soviet Union, Finland, and

Ireland.

7. NUCLEAR POWER

Most governments have pinned great topes on nuclear power. But these aspirations have been frustrated to a considerable degree by a barrage of serious obstacles. The present outlook for nuclear power is consequently uncertain in all respects.

A. Industrialized Countries

The outlook for nuclear power is *very* mixed. The Soviet Union and France are implementing programs which will greatly increase their nuclear capacities, while in the US and one other countries, development of nuclear power continues to be retarded by public concern with safety and economic issues.

In the United States, public confidence in safety was badly shaken by the accident in March 1979 at Three Mile Island, Ikennsylvania, where the Kenny Commission's report found great inadequacies in operational competence and in government and public utility safety procedures." There are concerns about reactor safety, radioactive emissions, thermal effects, disposal o£ wastes, and sitting. The treatment of spent fuel elements, radioactive wastes and decommissioned reactors is not solved.

Furthermore, in some countries such as the US, nuclear power is not demonstrating the clear economic advantages which had earlier been expected. There have been rising capital costs, longer lead-times, and high repair cost, longer down-time for repairs and maintenance, and financing difficulties. There are also strong doubts voiced whether economic comparisons of nuclear versus other forms of generating electricity have fully taken into account such costs as decommissioning nuclear power stations, disposing of radioactive wastes, and retrofitting plants with equipment to satisfy improved safety end environmental standards. Long lead-times and the burden of interest-luring-construction at today's money costs have compounded the present lack of enthusiasm among most electricity corporations to install new nuclear plants unless they are already advanced in construction.

Meanwhile, the slowdown in economic growth since 1973 has sharply reduced the growth of electricity demand. This has fallen disproportionately on nuclear power which bad been expected to account for much of electric incremental capacity.

All these factors have led to the deferral or cancellation of a large number of orders for new plants in a number of industrialized countries.

Despite these radically lowered expectations, nuclear energy is still expected to account for a gradually rising share of electricity generation in a number of industrial countries. A few (particularly France and the Soviet Union) are also moving ahead towards introducing breeders. Plans in Britain, FR Germany, end Japan for breeders have been delayed, and those in the US suspended.

B. Developing Countries

Technical complexity and proliferation have not per se ruled out consideration of nuclear energy for developing countries. However, the number of such countries which can handle the technology and have a large enough electricity sector to accommodate major increments of tale-load generating capacity is relatively limited. For example, Argentina, Brazil, India, Mexico, Pakistan, and South Korea have active programs. Elsewhere, frost developing countries are going slow in their approach towards nuclear power at this tine. (See also Chapter IV.)

C. Non-Proliferation

The issue of nuclear energy in the content of international relations raises concerns of weapons proliferation in developed and developing countries alike. No natters how dangerous these concerns are, nuclear power is still an enticing creams o£ Solving the energy problem. Yet t cause of the nature of nuclear power, it raises all kinds of internal and external Analytical and social problems within all kinds of societies.

if a developing country wants the nuclear option, either for peaceful or other uses, it must inevitably obtain assistance from a nuclear supplier country, typically one of the industrialized countries, The issue as received by nuclear supplier countries is therefore *how they* can export nuclear *power* equipment and technology on a tasks which would ensure that nuclear materials would not to directed by governments for weapons or by terrorist groups for non-peaceful ends. This raises questions whether existing international agencies can adequately apply nuclear safeguards, and whether supplier countries should weigh up the elliptical and strategic risks in relations with recipient countries.

The International Consultative Group on Nuclear hhergy,x which included members from both developed and developing countries, felt that if nuclear rower is to he available to meet an increasing fraction of the world's future energy needs, at least five conditions will Pave to he satisfied": i) nuclear power, despite the difficulty of the short-term curate, will have to be systematically developed, without interruption or undue delay, ii) nuclear power must earn and retain public acceptance, iii) technologies for using uranium *fore* efficiently rust be developed and tested as soon as possible, with tots the carting decades aid the 21st century in mind, iv) the fear of nuclear weapons proliferation resulting from an expansion of nuclear power must he further reduced, and v) countries depending on nuclear technology, services or materials to ensure their energy supply must be convinced of continued international access to them, under safeguards, on acceptable terms.

The Nuclear Non-Proliferation Treaty had already a decade ago incorporated a provision that nations without nuclear weapons would agree not to acquire them and would accept international safeguards on their nuclear facilities, including IAEA inspection. In return, nations with nuclear weapons would help make the benefits of the "peaceful atom" available to signatories of the treaty and would nuke progress on nuclear arms control and disarmament. Thereupon, numerous countries introduced large nuclear power programs.

With a view to reducing the risks of nuclear weapons' proliferation, the Nuclear Suppliers Club was formed in 1975 and has issued guidelines for tightened fuel cycle safeguards in nuclear exports.

The US enacted the Nuclear Non-Proliferation Act in 1978, render Winch the US would supply nuclear fuel, services, and technology only if recipients would accept a US veto over certain fuel cycle activities. Canada and Australia also made acceptance of full safeguards on all nuclear facilities the condition for further nuclear cooperation. But governments o£ most European countries, Japan and developing countries took exception to the US restrictions and were unwilling to defer reprocessing spent fuel, recycling plutonium in existing reactors, and introducing breeder reactors.

In response to other countries' adverse reaction to US non-proliferation reassures, the US initiated in 1977 the International Nuclear Fuel Cycle Evaluation (INFCE) as a 50-country study which might identify fuel cycles with a minimum danger of weapons proliferation's it completed its report in early 1980. It did not find a technical fix to restricting nations' access to weapons-ode material, though it did indicate fuel cycle modifications which could make plutonium less easy to steal.

With prospects diminished for nuclear power, and improved for uranium reserves-, the early needs for breeder reactors and large-scale reprocessing of spent fuel have also lessened. Nevertheless, some nations' interests continue as ever in access to uranium and in breeder reactor programs. Nor are same countries willing to desist from reprocessing of spent fuel. Many countries continue to believe that the US unduly stresses the possibility of nations acquiring nuclear weapons through misuse of nuclear power programs rather than through plants operating in weapons production.

8. HYDROELECTRICITY

The use o£ hydroelectricity is expected to continue growing during the next two decades. New sites are becoming harder to crotch by in nuns developed countries other than Canada and Norway. But there are still huge opportunities in developing countries for hydroelectric projects.

Hydroelectricity has denied evident advantages. It is a continuously renewable and widely distributed resource. It is nonpolluting, in that it does not produce by-products similar to thermal effluents. It can be integrated into multi-use develop-rents. It is one of the none efficient energy conversion technologies. Projects have a long life, low operating vests and no fuel costs, and the technology is well-known. Generating plants can be expanded with relative ease. Energy is storable as water in the reservoirs.

Hydroelectricity does have certain disadvantages. It is highly capital-intensive. Most promising sites are far from markets. Projects can have undesirable environmental impacts. There are geo-political constraints associated with

flooding.

The use o£ small-scale hydro plants had generally been declining in number for years. This trend may now be changing, particularly in developing countries. A striking example is PR arena.

9. GEOTHERMAL F ERGY

Geothermal energy is the energy contained in the natural heat under the earth's surface. There are six kinds of geothermal systems: three of these are fully developed (dry steam fields, bat-water fields, and low-enthalpy fields) and three are at the stage of research and development (magma energy, depressurized zones, and hot dry rocks). Hot water fields are the nil) sty commonly exploited form of geothermal energy. But dry-steam fields have the advantage that steam can be directly used in generating electric power. Geothermal Energy can also be used in space-heating, horticulture, and pisciculture.

Geothermal resources are very common and coma racial nearly everywhere. The technology is nature, and expertise is available. But ccmttercial development has until recently been slow. Development efforts of geothermal energy in recent years are impressive. Iceland is by far the leading country in the use of geothermal energy for space and greenhouse heating.

Other countries now exploiting geothermal energy include China, E1 Salvador, France, Hungary, Indonesia, Italy, Japan, Mexico, New Zealand, Philippines, Soviet Union, and the US. The UN has nude a key contribution in technical assistance towards this development. Worldwide, geothermal electric plants now amount to about 1,800 MW of installed capacity, compared with 680 MW in 1969. By 1985 perhaps 10,000 MW could be in operation bused cm known exploration work and projects.

10. OTRER RENEWABLE FORMS OF ENERGY

Interest in renewable energy has 17een increasing with the continued rise in international oil prices. In developed countries attention has been particularly focused on concentrated and large-scale application of renewable energy. In developing countries it is focused on decentralized and small-scale applications in rural areas

Renewable energy covers a range of energy sources. They include biomes, biogas, wind power, slay energy, tidal power, and others more at the research and development stage such as wave energy, salinity energy, ocean thermal energy conversion, electrostatic energy and magnetic electricity, and solar power satellites.

In the developing countries, only about half of the need for useful energy is net from commercial sources. Of the balance (mostly in rural areas), perhaps two-thirds are net from inanimate sources such as wood and one-third by muscular efforts of people and animals.

One single phenomenon which developing countries are experiencing is a high rate of urbanization. This implies a

Radical change in the supply base. Rural dwellers consume mostly non-commercial, locally produced energy forms, and they produce much of their own food. The basic needs of urban dwellers must be net from commercial and frequently imported supplies. Hence urbanization will lead to a vast expansion in the denned for commercially traded energy. But even by the end of the century, most Third World people will still live in rural areas, despite the migration to cities. And if energy based amenities were more available in the countryside, *wile* experts believe the migration might be slowed.

The limited availability of energy infrastructure in many developing countries justifies the development of stall resources near to markets. Stall deposits will have an increasingly vital role, and they can supply stall decentralized systems in rural areas. Small production units are needed and are available: geothermal, hydro, coal-mines, oil-shale, oil, and gas fields.

The key problem for OIDCs, particularly low-income countries, is the need for energy in food production and household use. This requires more efforts to develop new technologies for use of biomass, particularly fuel wood and charcoal. This resource lBse is fast being depleted or mismanaged. Most developing countries' population lives in the tropical and sub-tropical zones which receive the frost solar radiation. This in principle gives much promise for prospects for solar energy and other renewable energy technologies applicable to rural areas. But much more will have to be done before these prospects can be realized on a large scale. These technologies were well assessed in the OECD's report on Renewable Energy Technologies for Developing Countries, which suggested the following criteria:

A. reliability,

B. ease of maintenance,

C. feasible and optimum unit size, d. environmental impact,

E. social and cultural suitability,

F. feasibility of local manufacture of components, g. expected course of future technological

Development.

The use o£ these technologies will depend on financing, transfer of technology, and expertise. The key to their adoption is a better understanding and quantification of the resource base.

A. Biomass

Biomass refers to a variety of plant materials which can be used as feedstocks for conversion to useful fuels and products. The plant materials with the greatest potential are trees, forestry, and agricultural residues (such as sugar-cane, cassava, and sorghum).

I. Plant Biomass

Wood and charcoal meet about 80% of rural requirements for lighting and cooking in the developing countries. The £Ellwood crisis is the result of deforestation for those energy needs, and the opening of arable land for agricultural uses. Due to deforestation, the populations of some developing countries are forced to travel large distances to acquire their fuel cod needs, thus taking tine out from other valuable activities. (See also Chapters II and IV.)

The decreasing amount of available fuel wood has pant that manure has had to replace fuel wood as an energy source, thus depleting a valuable source of fertilizer. Therefore the two-edged *sword* of the fuel wood crisis reduces both the fertility and exploitation of agricultural lands.

The ratio of forest use for fuel purposes to industrial uses is 5:1 in industrialized countries as opposed to 1:6 in developing countries. This would indicate that industrialization will decrease *even* note the availability of forest uses in the future.

According to recent studies, the capital cost of reforestation required is quite high. The World Bank estimates that roughly 50 million hectares o£ forest will be needed to be planted by the year 2000; the present rate of reforestation is estimated at only one-tenth that required.

ii. <u>Ethanol</u>

There has been significant development of *processes* for large-scale production of ethanol by £fermentation from carbohydrate raw materials. This ethanol could replace a significant proportion o£ gasoline in rotor engines. It is often described as *power* alcohol or colloquially as gasohol. All starch crops can be fermented to alcohol. But the roast important ones are sugar (raw sugar and relapses) and starchy roots (such as cassava). One or more are grown in Europe, North America, and nary developing countries. These crops are expensive and subsidized in Europe and North America and cannot serve as cheap raw arterials for ethanol fermentation. In contrast, they are usually cheap in developing countries.

There are a number of Latin American and Caribbean countries as well as the Philippines, India, Thailand, Sudan, and Ivory (best which have the potential to grow sugar-cane and molasses for ethanol fermentation. The rigor producers of starchy roots such as cassava (Brazil, Nigeria, Indonesia, India, Thailand, and Zaire) also have this potential. The total ethanol potential from these producers is nearly 7 million tons (135,000 b/d) by 1985. Brazil and Thailand account for some 40% of this potential, Cuba and India another 20%, then the Philippines, Nigeria, and Zaire. In particular Brazil's National Alcohol Program aims at producing 11 million m^3 (185,000 b/d) of ethanol by 1985.

iii. <u>Biogas</u>

Among various renewable energies, biogas is now receiving much interest. It is produced from anaerobic digestion of amine’s and vegetable wastes. A Inusehold-sized plant can produce gas for cooking and lighting. The effluent and sludge from the digester can be used as fertilizer. The process is generally referred to as "biogas technology" (I33T). It has been promoted extensively in same countries, particularly China and India. The degree of its success in Bone countries is controversial. In Thailand the adoption of

BOT has been relatively slow in rural areas due to high capital cost, the availability of firewood and charcoal, and corrosion of digester covers. The feasibility of large-scale biogas

Plants need investigation.

Methanol can be synthesized from biomass, low calorific coals, natural gas, or any material with enough carbon. It has value as a fuel, a>event, petrochemical, and gasoline feedstock. It can easily be transported by pipeline or tanker. If natural gas is produced unreal than a few thousand miles from market, it will be cheaper to ship it as methanol than to transport the gas by pipeline or LNG tanker, to be economically viable, methanol conversion would *have* to be done in very large high-cost plants.

B. Wind power

Wind energy has been used since tine informal for ships and windmills. But during this century the use of wind energy has become restricted to rennet areas.

In recent *years* there has been a revival of interest in wind power based on modern technology. Wind energy can be used to generate electricity or direct heat, to drive pumps, and to propel ships of increasingly large size. Prototype and experimental wind energy converters have been built in a number of countries as part of research or demonstration programs by private and government institutions. These programs include study of wind data, the performance and reliability o£ wind turbine generators, their environmental acceptability, and their integration into electric supply systems. Similar units are available commercially.

The best sites are along ocean shorelines or offshore where the wind's velocity is unimpeded; sites may exist onshore at greater heights or special locations. Swum_ national energy programs envisage that wind energy could be used to generate significant amounts of electricity by the mid-1980s. There is also a significant market for smaller converters to supply farms and isolated houses.

C. Solar Energy

The economic aspects of solar water and since-heating have been studied in navy countries, with conflicting conclusions. Cost comparisons can only be wade m a country-by country Tansies, taking into account local conditions, including the price of alternative energy forms.

For example, in developed countries solar energy systems normally cost rove initially than conventional alternatives. The economic merits o£ solar systems are longer-term. Consumers might 6e willing to trade off higher initial costs for future energy savings.

In developing countries, the actual cost of every resource in remote areas should he considered. Sane countries are conducting research into and developing renewable energy systems including solar box cookers, water-

heating, and distillation systems. Efforts are concentrating m finding energy technologies applicable in rural areas, which are ouch more affected by the firewood crisis than the oil-import burden.

Solar ponds are a potential source of low-temperature heat in large quantities, unlike solar collectors which are typically small-area devices.

There are two methods of generating electric power from sunlight. One is the sequential conversion of sunlight to heat, mechanical energy, and ultimately eclectic energy. The other uses solar (photovoltaic) cells which directly convert sunlight to electricity. The technology of solar cells is well proven for use in satellites and space vehicles, but solar cells have been of relatively high cost. Large-scale programs of research and development are being carried out with a view to reducing the cost of solar cells, and commercial companies are now showing great interest in investing in solar cell technology.

Photovoltaic energy is also beginning to be introduced for rural applications in developing countries, typically through international or bilateral programs of technical assistance. Indications are that it is becoming economically viable, particularly in remote areas.

Conclusion

This chapter has outlined some future difficulties confronting the world energy scene. Perhaps the greatest danger is a continued perspective that the world is faced with a zero-sum game, where any change in one party's position is seen to 6e another party's loss. What is needed is more flexibility, both technically and diplomatically. Confrontation between Parties is self-defeating when it clouds points of convergence and agreement. The following chapters discuss the world energy scene in more detail, in terms of the (artier involved and future global opportunities.

CHAPTER II: THE PARTIES INVOLVED 1.

OIL-IMPORTING DEVELOPING WHNTRIES

A. Introduction

The oil-imputing developing countries (OIDCs) have over half the world's population. Although the life expectancy of the people is low and infant mortality rates are high, the population in these countries is growing rapidly. The majority of the people are poor, and a substantial number of them suffer from hunger and malnutrition. In many of the OIDGS, food production

grows sore slowly than population, and the basic needs of life for many are not net. A sizeable proportion of the ~opal live at subsistence level, and navy are rarely surviving.

These countries are basically agrarian; and industrial development, generally, is in its infancy. The agricultural sector provides employment to the majority of the people, and its contribution to GDP is very high. Agricultural products also account for a high Percentage of export earnings. Basically, the OIDCs get their export earnings from a limited number of primary commodities. For imports of capital and technology, the OIDCs depend rosily on the industrialized countries with an increasing flow of capital coning from OPEC countries. Unstable maskers, fluctuating Irises, falling real [s ices for their empts, as well as tariff and non-tariff terriers to their exerts have cut their export earnings and thereby slowed their development efforts. For many of them the international terms of trade have been unfavorable.

In most of the OIDC,e, the level of unemployment and underemployment is very high. When vxsk is available, the Fay is always very low, and the working conditions are frequently intolerable. The per capita income of the people is very small, and mast of the countries has very low GNP. Furthermore, the economies of these countries are characterized by highly unequal distribution of income and wealth. The purest people, who are usually in the majority, have a very stall share of the national income. Despite decades of development efforts, the strategy of development which assumed that the fruits of growth will "trickle down" to the poorest ~gents o£ society has been a failure in many countries. In fact, in many nations the gap between the privileged few and the majority have been widening. Therefore, many countries have been inclined towards a deliberate intervention to redistribute income and wealth in their societies.

Although the spread of education is an important element in development, the number of school-age children that are enrolled in schools is relatively low. A very large percentage of the population is illiterate, and in tinny cases there is a serious shortage of skilled and trained tin power. Frequently, too, the skills supplied in the schools nay not match the skills that are required by employers.

In tinny developing countries, the envision of health services is biased towards the urban areas and is basically tailored to beet the requiretients of the rich. People living in poverty normally do not have access to health facilities. Although preventive medicine is widely believed to serve the people better, the health care system in *tinny* of these countries gives emphasis to curative medicine, which can reach only the richer few.

Urbanization has been an important phenomenon in developing countries. Although there is a difference in characteristics of urbanization in the different regions, the rate of population growth in most of these countries has been very high. The shift in the unlace between rural and urban sectors has been leading to rapid changes in social, cultural, political, and economic conditions in these countries. Urban services and facilities, in nary cases, have been unable to keep up with the increasing population. Many people come to the cities in search of jobs and better living conditions. However, few of them are absorbed into the labors force at rates of sly which are sufficient to beet minimum needs.

The OIdCS have many economic, political, social, cultural, and environmental differences and similarities. The difference between a huge and nucleated India and a Snell, underdeveloped Nepal, an industrialized Korea and a poor Somalia, a highly urbanized Argentina and a basically rural Ethiopia is self-evident. There is a great disparity in their resource potential, economic structure, development approach, level of education, quality of health,

and income distribution. They also differ in their political systems, ideological orientations, and social philosophies.

But whatever their differences, they have also tent' things in common. Their ax n heritage as colonies, their present status as producers of Isonomy moralities, and their future interests, lopes, and aspirations bind them together. Their historical, cultural, religious, linguistic, and other affinities give them a degree of unity in diversity.

B. The Energy Characteristics of the Oils

In considerable measure, what is said in this section about the energy characteristics of the OIDCS applies to oil exporting developing countries (OXecs) as well. This is true of each of the characteristics identified below, except that O%OCS are not dependent upon oil imports.

I. Low Consumption of Commercial Energy

OIDCs consume inch less o>, metrical energy (oil, mss, coal, and electricity) than industrialized countries. For example, the average North Mexican uses about 1,000 times as much commercial energy as the average Nepalese, 800 times the average Upper Volta, and 25 tines the average Indian. The average Dutchman also consumes 266 times as inch as the average Ethiopian, 31 tines as the average Pakistani, and 14 times as the average Bolivian. The average Mexican uses tore in a day than the average Third World person uses in a year.

ii. Increasing Consumption o£ Unmusical Energy

Between 1950 and 1976, world use of commercial energy increased fore than three times. But in the Third World it increased tore than seven tines, doubling every eleven years. Since the oil crisis of 1973, consumption in the industrialized countries fell to 0.5% p.a., but in the developing countries it continued strong growth at 5.7% p.a. By the year 2000 the Third World's con axial energy (including China) will be nearly 2.5 times higher than today and will account for about 30% of the world's total, compared with 20% today. a

iii. Unequally Distributed Use of Energy

There is, of course, great variation among the OIDCs in their use of energy. Far example, on a par capita basis India uses 16 times as ouch commercial energy as neighboring Nepal, and Argentina 26 times as much as Zaire. Moreover, only ten countries account for 74% o£ the net oil imports o£ all OIDCS, while 58 others import ally 12%. There is also great inequality within countries. For example, in India x - r racial energy used per capita in

the city is nearly 20 times and electricity 28 tines as great as in the countryside, even though rural electrification programs have Oxen gashed by the Indian Government for 30 years. Even within cities great disparity exists, with the modern sector getting the lion's share and the informal sector (e.g., backyard industries, domestic employees, street vendors, and service providers) and urban slums getting very much less. For example, modern industry alone consumes about 40% in Mexico and lore than 80% in China's

Iv. <u>Substantial Reliance on Non-Commercial Energy</u>

Rural people, urban slums and, to a lesser extent, the informal economies of the Third World rely upon traditional energy. Anion other forms, this includes wood, crop residues, charcoal, and animal power. In urban areas, this kind of energy often nay is bought and sold; in rural areas it is more often used by the gatherer.

In the cities, most low-income people (and some middle-income people) cook with charcoal. Charcoal may also fire the tack lot furnaces or black smithies used to heat metals for hand fabrication of such items as kerosene lanterns. A host of domestic servants perform tasks that in the industrialized countries are increasingly assigned to machines. Goods and people are transported as much by pushcarts, triceps, porters, horse-drum vehicles, and bicycles, as by truck and car.

In the rural areas most people live out their lives largely untouched by modern energy. Instead they rely on traditional energy. About 60 to 80% of rural energy goes to the growing and cooking of food. &ops are planted, tended, harvested, and processed by human and animal labors. A

Typical rural scene in Africa features the picturesque but onerous Isomers of woo en pounding grain. Another in Asia or Africa is the long lines of women and children bearing firewood on their heads or lacks far long distances that become longer over the years as available woodlands recede. There is increasing evidence o£ deforestation and desegregation, and a consequent decline in water tables and an increase in soil erosion and downstream silting and flooding.

Prices of wood and charcoal (usually in cities) are climbing. A poor family during save! Arts of the year spend up to 30% of its inane a fuel for cooking. As the price of kerosene has gone up, a tad situation is rude worse by increasing demand for scarce wood. It is cannon for a large fraction o£ rural wood supplies to be harvested for use in cities, where people have been forced to buy charcoal for cooking because of the high price of kerosene. This leaves less wood for use by rural people. They also suffer from the higher pieces of modern energy such as electricity or gasoline in the countryside, compared with the cities. For example, in West Africa gasoline in 1977 cost about $1.60 in the port cities but $2.00 only a few miles inland, while electricity soared from $0.24 per kilowatt-hour in Dakar to between $0.40 and $0.90 in inland towns In the rural areas, this not only limits personal amenities and essential educational and health services but also cuts agricultural production and hence income and jobs. One of the consequences is the continuing flow of rural people to already overcrowded and overburdened cities.

v. <u>Inefficient Use of Energy</u>

When one thinks of energy waste, a host of luxuriously wasteful p-act ices commonly observed in the North Moue to mind such as buildings overheated in winter and over Mauled in summer, large single-passenger commuter vehicles, and recreational driving. Energy waste also abounds in the South but for reasons quite different from those described above. Typically, energy waste is due to inefficient practices and equipment. The cure for this problem is not to exhort people to restrain consumption or to raise the price of energy dot to provide the funds and expertise required to improve efficiency.

In rural areas, there are two outstanding examples of

Waste:

a. in the use of fuel for cooking and b. in the making of charcoal.

In the use o£ fuel for cooking, about two-thirds of all rural household energy is used for cooking. A frequent method is over an open fir$_e$ using three stones to define the fire area. With this method only 5% or so of the energy in the fuel (typically wood or crop residues) is transferred to the cooking pot. It is generally believed that the use o£ inexpensive stoves could increase this rate of efficiency dramatically.

In the making of charcoal, a typical method is to dig a pit, pit in wood or other fibrous material, light it and reduce the oxygen available to the fire by covering over the wood with earth. This paralysis processes my yield charcoal containing no fore than 15% of the energy in the wood or other raw material. The rest is charcoal or charges which are lost, or heat which escapes. The use of snail continuous combustion kilns could greatly increase the efficiency of ranking charcoal.

For urban areas, a few examples will illustrate the problem. In industries, management practices are wasteful of energy; fuel-to-air mixtures on boilers are often badly out of adjustment; steam pipes leak or are clogged; pipes and hot water storage are not insulated; machines are scheduled to start up at peak energy tines; energy equipment is not properly maintained; compressed air leaks are tolerated; and furnaces are not loaded to efficient capacity levels. These problems would not take major capital inputs to correct.

Even greater savings would be possible by investing in more efficient equipment. Another example of urban energy waste is in transportation. In the long run, dramatic savings would be possible through better urban layout so that people would live closer to jobs, schools, and shopping, and through improving the spatial organization of production w that there is less unnecessary irreverent of materials and goods (e.g., hauling logs from Northern to Southern Brazil to fabricate doors that are used in Northern Brazil). In the shorter run,Improved traffic management would reduce gasoline-wasting traffic delays, and a program o£ engine maintenance could increase miles per gallon.

vi. <u>Energy Dependence upon Outsiders</u>

The average OIDC is so what less dependent on oil imports than Europe but pore dependent than the US. Mgt of the non-oil commercial energy consumed by the OIDCS is consumed by a few larger OIDCS (India, Pakistan, Zimbabwe, South Korea, and Zambia).° ^{On} the other hand, at least 73 OIDCS (excluding some wall island-states) depend an imports for 100%

of their oil needs

Moreover, most OIDCs are dependent on outside technology to reduce their dependence on oil imports, whether by finding and producing their own fossil fuels or by improving their energy use efficiency or by adopting new and mire plentiful-including renewable-substitutes for oil. In addition, scores of OIDCS will need outside help a) to pay for their essential oil import needs and b) to improve their exports = that they can increasingly pay for their oil imports.

Vii. Great Potential for Conventional E7iergy

Most OIDCS have large potential for conventional energy. To begin with, there is thought to be a g- eat deal of oil in the OIDCs. Some geologists believe that a substantial fraction of the oil yet to be discovered in the world nay be on or offshore the OIDCS.e There are about 30 million square miles of promising sedimentary basins, of which CP countries have only 4 million, the US only 3 million, and the OIDCS 13 million. Yet the drilling rates in the OIDCs are low in relation to the oil-producing industrialized countries. For example, the chilling intensity (ratio of number of wells to area o£ potentially oil-bearing terrain) in the US is 50 times greater than in Latin America and nearly 1,000 tines than in Africa. Heavy oils, tar sands, and oil shale's also are g eat potential energy sources, which nay to exploited one day when the price of conventional oil is high enough and the cost of extraction and refining these potential sources is low enough relative to one another. Natural gas is often found in prospective oil-bearing terrain. Hence it is likely that as drilling increases in the OIDCS, a great deal of gas will be found. Coal reserves in the OIDCS are officially not counted as great; these countries have only about one-sixth of the (world's) known recoverable reserves, and more than 90% of the OIDCs' reserves are in just two countries: PR China and India. However, very little exploration for coal has been done, ~rhaps because the indus-trialisation of the Oltxs had not begun before oil had displaced coal as the preferred fuel for industry. Many experts believe that when a search for coal in the OIDCs takes place, a great deal will be found.

Major hydroelectric conventional projects offer great potential energy. Nearly two-thirds of the world's conventional hydroelectric potential is in the Third World. However, less than 10% of the Third World's conventional hydroelectric potential has been exploited a closely related and even less explored energy source is snail-scale or mini-hydropower. Units are available that will generate as little as a few hundred watts and can be operated from very small streams. It is widely observed that a significant fraction of rural people live near a year 'round stream and that there are navy sites where electricity might be produced for nearby villages. The experience o£ the Chinese with more than 60,000 of these units suggests that this my be an important source of energy.

Whether nuclear fission will prove to be an important energy source for developing countries depends on whether nuclear technology is successful in solving its cost, safety, and waste disposal problems in the Froth, and if so, whether it will come in units stall enough to notch the grids in most OIDCs.

Viii. Great Potential for Renewable Energy

Solar energy is generally in abundant supply in the Outs. The amount of energy coming to the Earth each day from the sun is about 10,000 times as ranch as is used each day from all conventional sources. It comes in four forms:

a. direct sunshine;

b. falling water (powered by the sun and gravity); c. wind (driven by the sun's energy); and d. biomass, the basis of all life on earth.

In general, the OIDCs, host of which are in the tropics or semi-tropics, have ~more energy from each of these systems (except for wind) than countries in the temperate zones. Although not alt Ionic have all four solar energy forms in abundance, m>sty of them have much potential of energy from one or rare of them. The problem is not in roost cases one of limited supply. Indeed, the more that is used, the cheaper it becomes as experience is gained in gathering it and converting it to useful form. The problem, rather, is that the technologies for doing 97 are--with several exceptions-still being developed and are not yet sufficiently reliable or cheap enough to compete with conventional energy works. Already several decentralized renewable technologies are cost competitive with oil and the electrical grid in areas that are remote from the cities. If the price of oil continues to rise faster than the cost of such technologies, the area of cost competitiveness will increase.

These energy sources have characteristics that rifle them especially interesting for Third World countries. First, they are inherently decentralized to the rural areas Where frost Third World people live (except for Latin America where slightly less than half are rural). This is important because distributing centrally produced energy (e.g., electricity and diesel fuel) to rural areas has proved to be a problem in navy countries. A World Hank report of 1975 estimated that only 4% of the rural people of Africa lived in areas served by electricity, and the pace of extension seems very slow Second, the costs o£ certain technologies to collect and use decentralized renewable energy (DRE) are not expected to rise as rapidly as oil, and the costs of at least one. (Photovoltaic) is expected to decline. Third, the long term future of oil does not seem bright and even the short and median term outlook is uncertain, adding to the interest in technologies that can collect and convert into useable form the generally very ample renewable supply of locally available energy.

However, despite these evidences of ironies, there is not mach prospect that (except for conventional hydroelectricity) renewable energy will soon become competitive in the modern sectors of the OlUOs. Even with respect to rural areas, renewable energy needs a great deal more research and site testing before its full premise bequest evident.

ix. <u>Traditional Energy is in Jeopardy</u>

Most o£ the people in the world rely upon traditional energy such as wood, a op or animal residues, animal power, or sunshine (for drying) as their p incipit energy source. The vast bulk of such energy is the fourth kind of solar energy discussed in Section viii above, i.e., biomass. Although it is abundant on earth, there are many areas where, due chiefly to the pressure of population on the available sand, this kind of energy is in jeopardy.

The majority of the people in developing countries, particularly the poor, depend on firewood as their rim source of fuel. While the contribution of traditional energy sources is minimal in the industrialized nations, firewood is the dominant

and indispensable source of energy throughout the Third World. In many countries in Africa, for example, it accounts for fore than four-fifths of the total energy used.

In nary regions demand exceeds supply. The shortage of firewood is acute in most regions, and the prices of firewood and charcoal are skyrocketing everywhere. Many families, especially the poorer ones, spend a sizeable fraction of their meager income an firewood. Others walk long distances to procure wood, frequently taking an entire day which can add up to fang man-days per year.

Although the pattern and amount of consumption vary from place to place, most firewood and charcoal is consumed in the hone. This is mainly for cooking and heating, both in rural and urban areas. A sizeable amount is also used for agricultural and industrial imposes. For example, countries like the Philippines and Tanzania consume hundreds of thousands of tons of wood for curing tobacco, while countries like Mall use large quantities of wood for ~taking fish. Partly because it can be made relatively easily, charcoal has become increasingly popular in developing countries, especially in Bran areas. In nanny countries a considerable amount of charcoal is used for brick-making, and in other places it is n places it is an important fuel for railways. Countries dike Brazil are highly dependent on charcoal for their steel moduction.[h] Furthermore, sane nations in Africa and Asia alert charcoal to the oil-exporting countries, industrialized actions and cone developing countries Consequently, in any areas where its use is uncontrolled, the growing denned or charcoal is accelerating deforestation. As traditional ethos of charcoal production are very inefficient (often Melding a product having only 25% or Less o£ the heat value

TABLE II-1: ENERGY IMPORTS AND DWINDLING FIREWOOD: AFRICA'S DOUBLE BIND

COUNTRY	ENERGY IMPORT DEPENDENCE		FUEL WOOD DEPENDENCE		The *squeeze* on	
	Export Firings		Forest & Firewood			
	Merck. Exports 1976 (U5$ run)	Energy Imports as % offal Energy Consumption: 1976				
	Merck. Cbnm'1 Exports 1976	Conn'1 Energy 1976 (%)	Wood- Energy 1975 (%)	Wood fuel (Per cap. in kg of coal e.g.)		as % of Energy (%)
Ethiopia	278	27	95	27	352	93
Ghana	804	18	78	157	452	74

Kenya	656	54	97	152	430	74
Mali	97	25	97	27	956	97
Niger	86	NA	100	35	239	87
Senegal	426	15	96	156	265	63
Tanzania	459	22	100	66	1,021	94
U. Volta	53	19	100	18	274	94
Zaire	930	16	76	62	200	76

Sources: **World Bank Report** 1978 and 1979, Cots. 1, 2; UNCPAD Compilation, Col. 3; ODC (J. Tarrant) compilation for Cols. 4-6: from UN World Energy Supplies, Series J, for Col. 4; from FAO Forestry Statistics Series, energy value calculated on basis 2.3 cubic meters of wood to 1 metric ton of coal equivalent.

In some places the demand for wood for cooking is so intense that all the trees are cut for *many* miles around population centers. In some areas there had been a movement from wood to kerosene for cooking. With the rapid increase in oil prices, however, there has been a reverse trend from kerosene tack to wood and charcoal thus putting additional pressure cu the forests. The firewood problem is serious in most PERTs of the developing world. Whether it be in the tropical regions o£ Africa, the Indian subcontinent, or the Andean valleys in Latin America, wood is fast becoming scarce and expensive.

In such diverse countries as South Korea, Pakistan, Mali, Ethiopia, Bolivia, and Peru, for instance, massive use o£ firewood is creating acute problems. The problem is not confined to the supply and price o£ fuel; there are also far-reaching and in the long-run are lounging environmental problems associated with it. Forests, which are the richest ecosystems, are disappearing at an alarming rate. And if the present trends continue, many studies indicate that a sizeable percentage of world forests is likely to disappear before the end o£ the century. This has unknown consequences (XI regional and/or global climatic changes and on food production. Furthermore, the alternative use of animal dung and crop residues for cooking is depriving the soil of much needed apicultural nutrients and is damaging the soil structure, fertility, and quality. Sore of the consequences are falling food production and the expansion of deserts in many regions.

Awareness of the critical importance of energy to the development of LDCS has grown rapidly in the past few years. LDCS and donor countries alike have watched with increasing unease as sharply rising commercial outlays for oil imposts eat into scarce export earnings and development resources, while growing urban and rural demand for firewood strip many countries of trees and erode their watersheds. Long overlooked, the dominating role o£ firewood in the developing countries' overall national energy balances is beginning to be recognized as its longer-term availability has come into doubt. And for most countries there are virtually no alternatives to wood except hydropower--still largely untapped-or agricultural wastes.

Despite the dire consequences of excessive burning of wood for fuel, the world continues to tonsure gore and unreel of it. As population grows and consumption increases, forests continue to be depleted. According to one source, the amount of wood that the people in the developing countries (excluding China and other centrally planned economies of Asia) burn in a year "would stand at least 20 feet high and 20 feet wide and extend completely around the equator" or 1.3 billion cubic meters, which a any think is a rather conservative estimate.

A brief look at the problem on the continent of Africa will illustrate the point.[1]

Given Resent rates o£ deforestation, Senegal will be bare of trees in 30 years, Ethiopia in 20, Burundi in seven. Outside of Ouagadougou, the land has been stripped of trees for 45 miles in all directions. In Accra and Lagos, people in search of fuel tear the scaffolding from construction sites.3 According to a 1978 energy experts' report, much of the eight nation region of the Shale will have become desert by the year 2000 unless passive reforestation and fuel wood planting--"50 times" the resent plans--is undertaken soon .k

In nine African countries surveyed by the World Bank, present annual rates of forestation would need to be increased by 8-50 times in order to meet domestic fuel wood needs to the year 2000. Even this assumes that a third to one-half of total rural energy requirements could be met by other forms of energy than wood, or through increased end-use

Efficiency. (See Table II-2.)

For Africa as a whole, Abider Personal estimates that annual new plantations will be needed to retest rural and urban fuel cod needs over the next 20 years at about one million hectares a year. Of this total, 700,000 ha. are in the savannah and steppe zones, about 100,000 ha. in rural areas of North Africa (excluding Egypt), about 50,000 ha.

Around large urban centre in rain-forest canes, and another 100-150,000 ha. in highland and cry areas. Additional plantations would be required for domestic timber and pulpwood needs, but these are quite modest comlared with the plantations needed for fuel wood: 150-200,000 ha. For domestic

TABLE II-2: COMPARISON OF CURRENT ANNUAL RURAL AFFORFSTATION PIIOORAMS IN SELECTED DEVEUJPIN3 COUNTRIES WITH THE APPROXIMATE SIZE OF PROGRAM NEEDED TO MEET DOMESTIC FUELWOOD RE UIRFMENTS TO THE YEAR 2000

WUNTRY	Current	Approximate Total	Factor
Annual	Annual	Planting	Indicating
Afforest- Program	Target	How Much	
Action	To Meet	Required	the Present
Program	mimetic	by 2000	Annual Rate
Fuel nod	To Meet	of Planting	
Needs to	*Thin stick*	Must Be	
2000	Needs	Increased to	

Meet Domestic

Needs to 2000

	(000's ha.)	(000's ha.)a	(rtm ha.)	
Ethiopia	1.0	50.0	1.00	50.0
Burundi	1.5	5.4	0.11	3.6
Malawi	2.5	13.0	0.26	5.2
Mali	0.5	4.0	0.08	8.0
Niger	0.5	3.5	0.07	7.0
Nigeria	10.0	100.0	2.00	10.0
Rwanda	1.5	13.0	0.26	8.6

Sierra	0.5	2.5	0.05	5.0
Leone				
Tanzania	2.5	20.0	0.40	8.0

Note: `Assumes that one-third to one-non ox u Lai rue energy requirements could be fret by other forms of energy than wood, such as biogas plants or solar cookers and by introducing greater end-use efficiency.

Source: World Bank Rata. Table by John S. Spare, Forestry Advisor, World Bank, Washington, D.C., in paper presented at the 103rd Annual Meeting o£ the American Forestry Association, October 8, 1978, entitled "Wood as an Energy Source: The Situation in the Enveloping World."

Timber and about 30-40,000 ha. for pulpwood, outside of South Africa.

Current annual planting rates for all of Africa appear to be under 10% of this targeted need.

Estimates o£ the costs of an adequate planting program vary widely. For the Shale, an illustrative average for village woodlots is $725 per hectare (CILSS estimate, based on recent field experience). This covers the first year's major capital cost of planting, plus the next four years of maintenance to get the lot established. It also includes Repayment for labors and fencing, with labors accounting for 59% of the costs

World Bank estimates range between $300 and $1,000 or more per hectare, in specific projects which are considered pilot trials before large-scale plantation efforts are undertaken. An Algerian program reportedly has averaged $290 per ha. With itch of the local labour being laid in kind with World Food Program assistance. One Ethiopian village claims costs of only $66 per ha. Excluding village labour which was volunteered. Cwnlmrable costs for commercial plantations operated by the Ethiopian Forestry and Wildlife Authority (FAWOA) were cited at $400 to $1,250 per hon.

Reasons for these variations need to be examined very closely. Whether financed from meager African national trudged resources me Fran already stretched and inadequate official development assistance funds, deforestation on the scale needed to net fuel wood demand from sustained yield will require significantly larger outlays of public funds.

We do not have cost estimates for an adequate response to the deforestation problem in the entire Third World but it would likely be at least twice the size of the African task. Using the Shelia figure of $750 per ha., this would suggest costs in the order of $1.5 billion per year. This is Isolable a minimum figure.

An offer by the countries with capital and technical knowledge (including perhaps both oil exporters as well as importers) to undertake a program of these dinensions could be a significant part of a negotiating package on energy. The problem is one that all nations share an interest in resolving. Ni adequate response to deforestation would help in the medium-term to save oil, it would slow the process of soil erosion and, according to some authorities, it would help to resolve the problem of increasing $Q)_2$ in the atmosphere.

x. OIDCS Face a Double Transition

The industrialized countries must nuke a transition *from oil* to other more plentiful energy bourses including, eventually, inexhaustible sources. It is a gainful process that has unsettled people and governments in the North. The acute problems of the US in setting a sensible oil pricing policy illustrate the difficulties of this transition. The problems of many OIUCs in making the transition will be equally or mare tratna.tic, because most of them depend even more than the US on imported oil for their modern sector, and many of them lack the capital and the technical and entrepreneurial know-how to make the changes. Yet host of them have an even greater problem in making another transition: from traditional energy to note modern energy. Wt(y must they nuke this transition? *Why not* continue to rely on traditional energy? There are two reasons.

First, the transition from traditional *energy* (notably wad and animal power) is necessary because that source o£ energy, although renewable, is failing behind demand. As we saw in item I above, there is simply not enough wood to keep up with demand in nun's areas, and land formerly used to 7asture draft animals is needed to raise crops to feed the expanding population. Whether the absolute quantity of traditional energy is diminishing is not certain; but in many areas the per capita availability of much energy is declining. There is therefore a shift from traditional to modern energy, and unless there is astonishingly good management of the problem, the shift will continue.

Second, even if traditional energy were everywhere abundant, the transition to modern energy is still necessary, because the quality of traditional energy is not good enough to help developing countries meet their development goals. It does an adequate job of cooking and heating, and an acceptable but not fully adequate job of transport and pulling farm implements. But it does not meet the needs for lighting, electronic communications, refrigeration (e.g., redefines), or shaft power.

For these two reasons, developing countries must rake this second, more important, and more difficult transition from traditional to modern energy, even as they face the transition from oil to successor energy works.

xi. OIDCS Must Make a Difficult Choice

Unfortunately, the transition from traditional to modern energy, which is already under way, is taking an ominous turn. With few exceptions, it is a shift to oil. To what extent the oil price rises of recent years have arrested the trend is not clear. But a series of case studies and much anecdotal evidence and personal observations strongly suggest that the trend continues toward oil in the traditional energy using areas of the Third worlds

If, as 'most experts believe, the world is in the last few decades o£ the petroleum era and will see oil production peak at or before the end of the century, it makes little sense for a developing country to make a transition to oil just at the time it must undertake a transition from oil to successors. Why not nuke the transition directly to those successors? The problem is that those successors are not yet fully proven and available. Oil-based machines and equipment are highly perfected, they are on-the-shelf and easy to purchase, a cadre of people are at hand who can maintain and repair them, and--with seine exceptions--they perform better and cost less than alternatives. Any decision to forego the shift to oil-based technology is a decision that will hurt

developing. In short, the dilemma of the OIOCs is this: if they continue the shift to oil, they will be in great trouble in a few decades; if they interrupt the shift, they will be m trouble now.

This discussion reveals an option that ray be more open to the Third World than to the industrialized countries: i.e., to give much greater emphasis to modern decentralised renewable energy. Advocates of "soft energy" paths tout small decentralised renewable energy. But they have made little headway in the industrialized countries, because:

a. most people live in urban areas,

b. modern large-scale energy does a good job of meeting those people's needs,

c. it is cheaper than soft energy, given present market conditions-many of which reflect government decisions rather than the free play of competitive forces, and

d. there is a gigantic capital investment in "hard energy" systems (large, centralized, and delectable) that would be lost, along with nervy personal fortunes if those systems were replaced; hence a opposition to change may be expected.

By contrast, in lost of the Third World:

a. people live in rural areas, far from the reach of grids of modern energy,

b. modern energy (i.e., oil and electricity), when available to those remote people, is very highly priced --often higher than soft energy is expected to be (though uncrate evidence to prove this is lacking), and

c. there is relatively little investment in hard energy; the expansion of soft energy to the majority of people could proceed for merry years before it threatened to displace hard energy. To this date, no government has nude a decision to give priority to soft energy (though PR China and a few others are giving it extended trials). But the option is relatively fore open to OIIICs than to industrialized countries.

Xii. Energy in OIOCs Is Little Studied and Itorly Understood

There is relatively less quantitative information on commercial energy use and availability in the OIDCS than in the industrialized countries. But in the area of traditional energy, the lack of reliable information is almost absolute. Indeed, energy experts have woe to use the term "energy" as synonymous with "commercial energy," even though the great majority of the world's people rely on traditional, and have little contact with commercial, energy. The reason for this seemingly gross oversight is simple: there is virtually I reliable quantitative information about ton-cortical energy. A few surveys have been made of energy use in villages on a given day and the results multiplied to approximate annual energy use; but these fragmentary reports contain great errors. To obtain reliable data, reports would be needed by reliable observers who live in a sample of villages over a period of time.

xiii. Energy Institutions Are Young and Inexperienced

With some important exceptions (e.g., India, Korea, Egypt, and Brazil), *OIDC* governments have not had much experience in dealing with the kinds of energy problems described above. So long as commercial energy (mostly oil) was considered to be inexhaustible and was sold at prices s~ low that the cost of energy was not a constraining factor in government or business planning, few *OIDCs* paid very much attention to the subject, except for the work of electrical utilities in providing electricity to existing grids, and that of oil companies in distributing petroleum products. Thus there is little experience in collecting the information needed for sound planning, in designing plans, in designing *RD&D* programs, or in implementing energy plans. There are few private companies that can build energy technologies or service and supply them, perform energy audits, or m the wide range of activities needed in the 1980s. Skilled and experienced personnel are lacking in rust energy specialties at all levels.

C. The *Needs* of the *OIDCs*

The above summary of the energy characteristics of the *OIDCS* suggests several needs (these will be discussed further in Chapter III). First, the *OIDCS* need to have access to increasing supplies of oil. Second, they need m increase the production and improve the management of non-commercial energy, specifically to reverse the process of deforestation and to exploit solar energy sources. Third, they need to improve the efficiency of energy use, both commercial and non-commercial. Fourth, they need to discover and develop their indigenous cormrercial energy. Fifth, they need to make progress in the transition to oil's successors. Sixth, they must decide whether to permit the continuation of the transition toward oil or to interrupt it. Seventh, they need to learn a great deal more about energy regimes of their economies, particularly in the rural areas.Finally, they need to strengthen existing institutions and in some cases establish new ones which can plan and manage energy services, and they need to extend the numbers of qualified energy personnel.

D. Short-Run Energy and Balance of Payments Problems I.

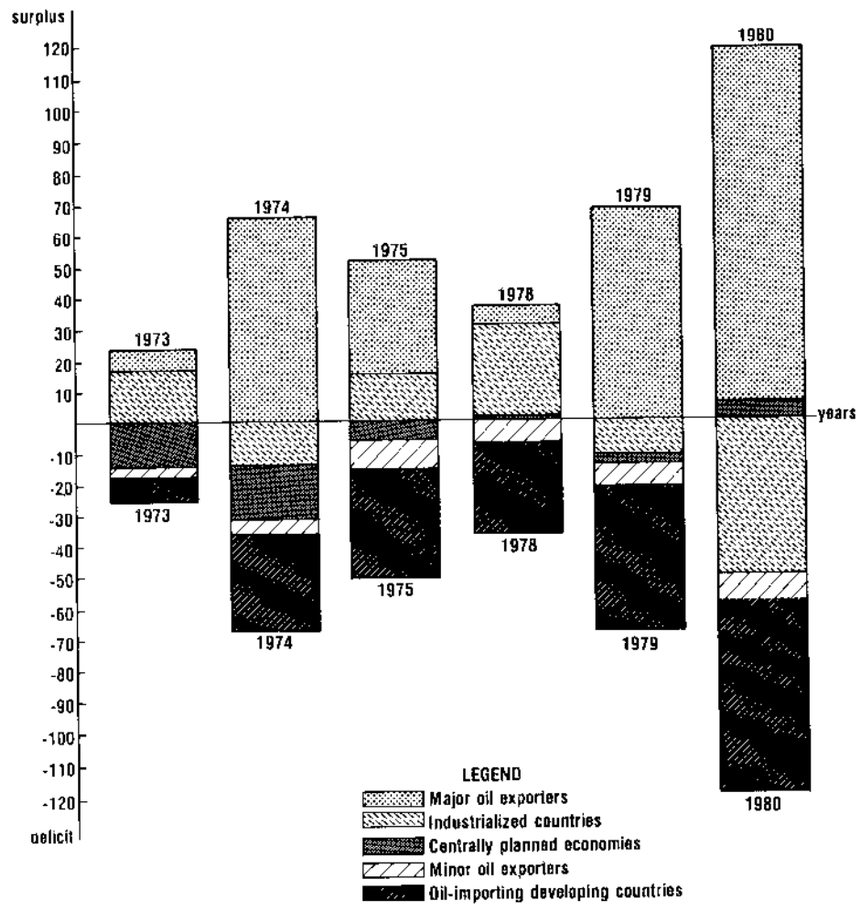
Dimension of the Problem

It is normal for some countries' external accounts to be in surplus and others' to be in deficit at any given tire. Beginning in the 1970s, these imbalances became larger than normal, triggered by sudden and steep oil price rises, and aggravated by the struggle within and tarring countries over which groups of people would bear the cost of those price rises. Throughout the decade, the

major OXDCs have run surpluses on current account (including private transfers) each year, which the IMP estimates to have grown from $6 billion in 1973 to $68 billion in 1979 and $115 billion in 1980 (Table I1-3). It estimates that non-oil developing countries (including some minor OXDCs) as a group have had current account deficits each year, growing from $11 billion in 1973 to $55 billion in 1979 and $68 billion in 1980, although several advanced developing countries have managed surpluses during several years of the decade. The industrialized countries as a group basically stayed in surplus throughout the decade (except for 1974 and minor deficits in 1976-77) but moved into deficit in 1979 which reached an estimated $52 billion in 1980. However, some of these countries have incurred very large deficits throughout most o£ the decade.

The second and third waves o£ oil price rises which occurred in 1979-80 are expected to result in a somewhat similar pattern, in which *(1KLEs* rmy generate surpluses in 1980 exceeding $100 billion and OIDCs *Tray* incur much *of* the corresponding deficit. Even in the 19705 which had relatively manageable imbalances, there were serious hump costs. The annual growth in production (GDP) fell sharply during rest of the decade for a large group of OlOcs, hurting bath agricultural and manufacturing output. For many countries there was little or no growth on a per capita basis, and for secret there were declines in some years. Buried in these aggregates are many human tragedies: cases where, because the cost of kerosene skyrocketed, wood was used which accelerated the

11. PAYMENTS BALANCE ON CURRENT ACCOUNT, 1973-1980
(US $ billion)



Source: IMF, World Economic Outlook, 1980.

process o£ costl cases where, because diesel fuel as deforestation; y,
crock were not irrigated; and cases unavailable or too
growth slowed, people did not find where, because industrial
Jobs and their children suffered from elutriation.

TABLE 11-3: PAYMENTS BALANCE ON CURRENT AMOUNT, 1973-1980a

	1973	1974	1975	1978	1979	1980
In dust. Countries	18.1			30.8	-10.6	est.
		(US$ billion)				
						-51.5
		-13.2	16.2			
Diving Countries	6.6	67.8	35.0	5.0	68.4	115.0
a. Major OXI1Cs of which:	6.7	43.3	30.8	19.8	55.7	n.a.
six surplus b. Non-oil	-11.3	-36.9	-45.8	-36.2	-54.9	-68
of which:	-2.6	-5.1	-9.8	-7.1	-8.2	-6
minor Oxlips Oil's	-8.7	-31.8	-36.0	-29.1	-46.7	-62
Others	13.4	17.7	5.4	-0.4	2.9	-4

Notes: payments exclude official transfers.

BPR China, Soviet Unction and pastern Europe, plus errors, omissions and asymmetries in data.

Source: **1MP, World Economic Outlook, 1980**.

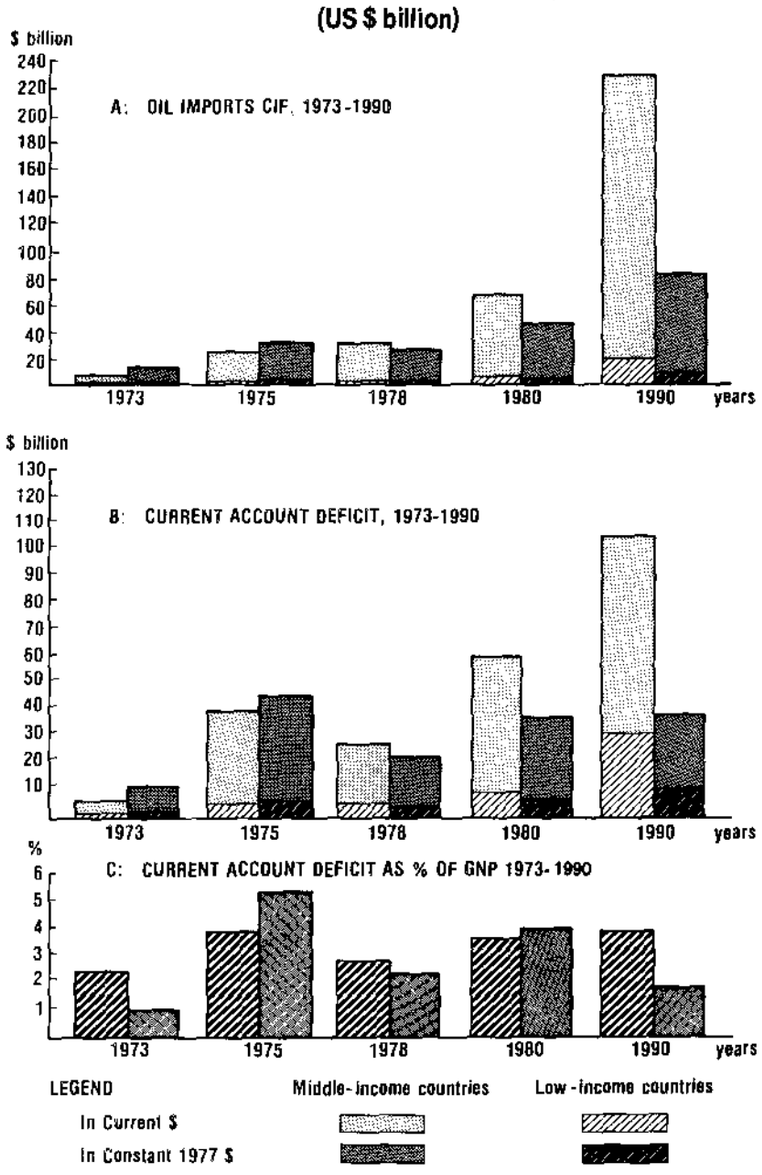
In the 1980s there is concern that severe imbalances will impose much greater human costs. A nim4er of the! Tore advanced developing countries i.e. be able to continue to b3rrow from private financial markets. Even this is not assured, because tanks nay consider Sam of those countries to be too indebted already. But there is little chance that the tow-income countries will be able to borrow in the private market, and in any event most observers tab not consider the terms of that nerket suitable for these countries. How great the hurzan costs will be depends upon how vigorous these countries are in adopting suitable economic policies and, to an important degree, upon the lerformance of the external world. These external factors are discussed in section E below. Judging from past experience, the problem will strike with different force in different countries. (See Table II-1).

In the 1970s, the average annual growth in GNP of Fast Asian countries continued at 8% and that of the Middle Fast and North Africa at more than 7% (both up from the previous decade), giving per capita GNP increases of 5.7% and 4.4% respectively. But in South Asia the rate of increase in GNP dropped from 4.3% to 3.5% and in Southern Europe from 7.1% to 5.1%, and the corresponding per capita figures dropped from 1.8% to 1.3% and from 5.6% to 3.5%.P

Out of imre than 120 OIOCS, just over 100 do not produce any oil at all. Another 13 must import at least 45% o£ their oil and more than three-quarters of them are mire dependent on oil imports than the US. The World Bank estimates OIDCS' oil imports in 1980 at 6.2 million b/d of oil, increasing to 8 million b/d by 1990 (Table 11-4). Indeed, if present trends hold, import volume could double from today's level by the end of the century. It estimates the cost of OIIAIS' oil imports in 1973 at about $7 billion, or 8% of their total imports of goods. This rocketed to $25 billion (20% of imports) in 1975 and to about $30 billion in 1978 (a decline to 17% of imports). With the price rises of 1979-80 this is expected to rise in 1980 to about $67 billion, or about 23% of their total imports. It estimates the OIDCS' oil imports to rise by 1990 to sons $230 billion ($120 billion in 1980-$), as shown in Table II-4.

Meanwhile, the sluggish economic Performance in industrialized countries will pose sore additional problems for O1DC8. The World Bank estimates that their deficit on current account (including private transfers) rose sharply from US$ 9 billion (in 1977-$) in 1973 to $44 billion in 19759 the deficit declined in the next few years but hit the same level again in 1980 (Table IV-4). It is expected to stay in the order of $40 billion (in 1980-$) during the decade. Expressed as a percentage of GNP, the deficit jumped from 1% in 1973 to 5% in 1975; it declined in the next three years but rose to 4% in 1980.

12. OIDC CURRENT ACCOUNT DEFICITS, 1973-1990
(US $ billion)



Source: World Bank, World Development Report, 1980.

TABLE II-4: OIDC_CURRENT ACWUNT DEFICITS, 1973-90a

1973 1975 1978 1980 1985 1990 (USS billion, current prices)

a. Oil Imports c.i.f.

Total OIDCs 7 25 32 67 124 229 tow-income 1 n. a. 2 6 13 23 Middle-income
6 n. a. 30 61 111 206

(Million b/d)

Total 01X28 4.6 n .a. 6.4 6.2 6.8 8.0

b. Current Account Deficit

Total OIDCS 6.7 39.6 27.1 61.0 78.4 104.2 Iowan-intone 2.3 5.4 5.7 10.0 18.6
32.0 Middle-income 4.4 34.2 21.4 51.0 59.7 72.2

(US$, billion, 1977 prices)

Total OIDCS 9.2 44.4 23.5 43.2 38.7 38.5 (% of GNP)

Total 0IDCS	1.1	5.1	2.3	3.9	2.8	*2.1*	Low-intone	2.2	3.8	2.7	3.6	3.8	3.9
Middle-intone			0.9		5.3		2.2		4.0		2.6		1.8

Notes: deficits exclude official transfers. High-case projections, which assume successful economic adjustment and better economic growth than in their low-case.

Source: World Bank president's address to Board o£ Governors, September 1980 (updating WDR III).

The low-ancon countries face serious financing

Problems. In the World Bank's an (illustrated in

Table IV-4), the deficits can only be financed if a) aid from industrialized (DAC) and OPEC countries were to treble in current prices during the next decade, b) support from multilateral institutions were increased, and c) the share of low-income countries in bilateral aid from industrialized countries were to rise to about 50% from the present 40%.

For middle-income countries, bilateral official finance is unlikely to be as freely available as in 1974-75. Lending by multilateral institutions at near-market terms will depend on increases in the capital which backs their own borrowing. As for private finance, same OIDCs which have borrowed heavily and have high debt service obligations wilt have to be cautious about further borrowing. Debt service payments of middle-income OIDCs could peak in 1985 at almost 30% of experts of goods and services.

The ability of the private sector to maintain as predominant a role in financing the major borrowing countries stands in doubt. In Morgan Guarantee's view", the IMF is still groping towards a meaningful capability to address those recycling needs which the private sector may be unable to meet. It points out the need to balance responsibilities among official and private lenders and governments, to achieve orderly financing and adjustment. The unpredictable growth of oil prices and balance-of-payments disequilibria rakes highly uncertain the size of recycling needs and the ability of industrial countries to restore healthy economic growth. Unless developing countries can be assured of adequate finance, many will have or alternative but to curtail severely their economic growth. Continued growth in the developing countries is also vital to the economic prosperity of industrial countries, which exported $180 billion to non-OPEC LDCs in 1979.

ii. <u>Options Open to OIDCs</u>

Two basic options are available to developing countries to deal with this problem, which do not involve basic international reforms. First, they nay cut oil imports by reducing oil waste, substituting other energy sources for oil or cutting lack development. Second,

they nay seek extern nap finance. A third option is that of undertaking to improve their exports, but it is as much dependent upon reform of the international economic order as upon internal reactions (See Section E below.)

a. Cut Back on Imports

There is a significant waste of oil in the OIIICs, albeit rot = large relative to that in the North. It is the result of energy inefficiency fore than that of luxurious use. Over the next few years, a program of improving efficiency could significantly save on oil costs.

Opportunities in the 'Third World to substitute fore plentiful forms of energy for oil also are significant. For example, oil is frequently used to generate electricity. Yet, only a snail fraction (an estimated 4%)[s] of the hydroelectric potential in the Third World has been exploited. In a number of countries, there nay be coal that could be used to generate electricity.

Another course of action that OIDCS may take is to follow a policy of economic restraint. This would reduce the pace of development. Thus, for example, the Managing Director of the International Abettor Fund, J. de Tarsiers, recently urged Africans to avoid dealing with their partly oil-induced economic problems by borrowing too much or by increasing taxes. Rather, they should do so by cutting back on demand, by such steps as cutting their budgets, tightening honey supply, and keeping the costs of imports high through exchange rate policies. He admitted candidly that "this will no doubt involve difficult choices regarding education, housing, health, and even public employment. But these choices have to be node."t

b. Seek External Help

The second option for oil-importing Third World countries is to seek more external financial support. The deficit of the non-oil developing countries (including minor exporters) is estimated by the IMF to reach about $68 billion in 1980, which will leave a number of them in need o£ external assistance.°

TABLE II-5: NET OIL IMK)RTS AND THEIR RELATIONSHIP TO EXPORT EARNINGS FOR EIGHT DEVEWPIM WONTRIES, 1973-1979

	Net Oil Imports				Imports in Relation o .. Earn nags			
	1973	1974	1977	1979	1973	1974	1977	1979
	(US$ million)				(%)			
Kenya	47	191	252	280	9.0	28.9	20.2	25.2
Zambia	32	89	108	NA	2.8	6.4	11.6	NA
Thailand	175	510	806	1147	11.1	20.9	23.1	21.6
Korea	278	810	1926	3103	8.6	21.7	19.2	20.6
Philippines	167	548	863	1109	9.2	21.0	27.7	24.6
Brazil	986	3233	4201	6898	15.9	40.7	34.7	45.3
Argentina	83	328	338	351	2.5	8.3	6.0	4.5
Jamaica	7L	193	242	NA	18.1	27.3	32.4	NA

Sources: IMP, International Financial Statistics, Vol. 33 No. 10, (bomber 1980, lines 70 and 71 a. Note also data for 1973 and 1974 in UN E(AS(X, Committee on Natural Resources, "Recent Fledgy Trends and Future Prospects," Report of the Secretary-General, April 1977, Tables 8 and 9, pp 31-2.

c. Reviewing the Options

Reviewing these options, it seems evident that energy efficiency and substitution of other energy rogueries for oil offer important opportunities for cutting the oil deficit, hit not in the immediate future. Tb achieve these savings will take substantial amounts of capital. Nevertheless, investments in efficiency and in substitution are frequently good investments that should be made as soon as possible. The returns on merry such investments will be very high in a few years, though they rob not help with the immediate crisis.

With respect to the option of cutting I ck on develop m nit, we do not think that is in the interests of oil exporters, industrialized countries, or OIDCS. Arguments as

TABLE 11-6:

WORLD OIL CONSUMPTION: ANNUAL RATE OF CRANCE,1970-78a

	1970-73	1973-75	1976	1977	1978
	(percent p.a. change)				
World	7.1	-1.8	7.1	3.7	3.4
Dev'd Market Economies	6.2	-4.4	6.5	2.3	2.2
Delving Countries	10.8	2.3	10.7	7.7	5.2
a. OXIXS	9.2	3.0	11.8	13.7	4.4
b. OIDCS	9.3	0.3	9.4	4.1	4.7
Sub-total	9.2	1.4	10.5	8.3	5.2
c. Asian CPES	21.5	6.6	11.4	5.1	8.6

Note: °Oil consumption includes inland demand for refined products, bunkers, refinery fuel and loss.

This definition of developing countries includes Asian centrally planned economies (CPES): PR Q in, Cambodia, Laos, Mongolia, North Korea, and Vietnam.

Source: UN World Energy Supplies, Series J, No. 22.

to why it is in the global interest to keep growth rates high in the Third World are nude elsewhere.°

The Third World increased its consumption of oil at almost 11% p.a. during 1970-73 (see Table II-6). This growth rate fell dramatically to Just over 2% p.a. during the two years o£ oil shock 1974-75, before resuming at its earlier rate of 11% p.a. in 1976. But it fell off sharply in 1977 and again in 1978 to 5% p.a., the latest year for which the UN has published data. This Third World definition comprises not only OIIXs but also CACDCS and Asian centrally planned economies, where the growth in oil consumption has typically been higher than the average.

To cut these rates in OIOCS much further would take a toll on development. There are few non-oil based machines ready to be put to use for certain modern industrial processes or for transport o£ goods and people. Even in rural areas, diesel or gasoline generators or Fwmp, and kerosene lames and stoves are the easiest to order, the simplest to maintain and

Operate, and frequently the cheapest to buy. A policy decision to cut Lack a oil, before substitutes are available, would inevitably slow the pe.ce o£ development in the countries that can least afford such a turn of affairs. Because the oil-importing Third World uses only 8.5% o£ the world oil consumption, belt-tightening (not to be confused with improving the efficiency with which oil is used) in this past of the world at such a high cost in human well-being can hardly be justified. Moreover, if the developing countries are to have the possibility o£ even substantially reduced rates of growth (as compared to recent years), they have to have increased, not reduced, access to oil.

Leaving aside exports of goods and services which are discussed in Section E below, this leaves the option o£ increased reliance on foreign financing as the chief means of adjusting to high oil costs. This is discussed below.

U. Sources of External Finance

Broadly, such foreign sources rid y be classified under two headings: private and official. On the assumption that industrialized countries make *every* effort to adjust and continue a foreign trade policy relatively free o£ import restraints, cone might expect the middle-income countries to be able to borrow to cover a part o£ their deficit, say $10 billion p.a. on foreign capital markets (against bonds m frank foreign international tanks). As mentioned above, sine of the poorest developing countries cannot borrow on commercial markets nor can they adjust their economies except at unacceptable cost in human and other terms. Accordingly, highly concessionary aid needs to be secured for these countries for an appreciable period ahead. Fortunately, the total financing required on a grant basis for these countries is relatively small and can be taken care of by increases of aid to them by OFCD and OPFx countries.

Since the total OIDC deficit in 1980 is expected to be about $20 billion higher than in 1979, $10 billion will be left to be financed by public sources over and above current flows. There are several current and potentially new somces for such funds. First, there is OPFx aid. OPFS official development assistance to the OIDCS now runs at about $5.0 billion. At a meeting of the OPEC Ministerial Committee on Long-Term Strategy in London on 21-22 February 1980, a recommendation was approved that i) the OPFG Special Fund be made into a development agency with an initial

authorised capital of $20.0 billion and ii) OPFG assist OIOCS with loans and grants to meet the cost of their oil imparts.w Although this is not *yet* a final decision, there are grounds for aDme optimism that OPFC may increase its contribution.

OECD aid to OIDCS is not likely to increase much in the short term. There t 6e hope for another $1-2 billion, including aid from IDA, the soft-loan windows of the regional banks as well as the regular windows of the several international banks, additional aid in the form of postponements of payments on past debts due to donors, and increases in food aid.

This leaves same $8-10 billion to be financed each year by the IMF for 1980 and 1981 at least. In the three years 1979-81 the IMF has or will distribute ~ch January 1 four billion stets to its members, of which about 700 million SDRS accrue to 0IOCs. Moreover, there are still resources available in the frost Fund which is to be lent an highly concessionary terms (ten years repayment period at half percent and repayment starting at the end of the fifth year ofthe loan outstanding). Besides this, the terms of the loan at the end of the ten-year period can be reviewed and may be extended by the Executive Board of the Fund.

Furthermore, the Fund is in general reasonably liquid to provide resources to the higher-income developing countries to meet their urgent Balance-of-payment needs on suitable terms. Its ability to provide necessary finance would be considerably enhanced, if the number governments were to agree to increase their quotas as provided for in the seventh General *Review* of Fund quotas. Moreover, the Supplementary Financing Facility under Winch the Fund borrowed from number countries has not been sub- statically utilized, and the Managing Director has been encouraged to start discussion with potential lenders on the terms and conditions under Which the Fund could borrow funds to increase its resources.

Considering the nature of the adjustment problems faced by member countries, the Fund has been encouraged by its interim committee to review its pDlfcies b>th in regard to the length of adjustment by member countries and also to explore the possibility of obtaining other resources to subsidise its lending to low-income developing countries. It was felt that the Fund should study the possibility of using a Bart of the Trust Fund re~yn~ents for ameliorating the conditions of loans to low-income developing countries.x

E. Long-Run Energy and Balance o£ payments Problems and Reforms in the International Economic Order

I. Introduction

In Section D above, we dealt with two courses of action a country can take to improve its external account: cutting imports and seeking outside help. This left out of account the mast constructive course of action, i.e., increasing exports. To an important extent, good management of the internal econcxny will lead to increased exports. But the ability of ninth countries to increase exports is severely limited by external factors over which they nave no control. Borrowing money (discussed in Section DJ is no more than a temporary solution, albeit *highly* essential for the immediate future. To get at the roots of the balance-of-payments problem will take much gore heroic measures, involving international cooperation.

Industrialized countries' regrets must be increasingly open to exports from OIOCs. Industrialized countries' demand for those products must remain buoyant and grow even stronger. Prices of Northern exports to the Oils must not inflate too much. Oil must remain physically available to OIDCS, along with the moans to finance it. Given these conditions, the external accounts of most Ours can be kept manageable, and consequently the human costs of the transition from oil to its successors can be minimized. Indeed great progress can be achieved during the transition. But if trade Terriers is erected, inflation remains unchecked, recession occurs, physical shortages of oil take place, and credit is not available on suitable terms, then the transition will exact high costs in human suffering in the nations of the South, and its consequences will take a toll in the North as well.

ii. Structural Reform of the International Economic Order

Below we describe briefly several o£ the more familiar and a few newer proposals for reforms of the international economic order, tonic link logically with the efforts of the OIDCs to resolve their long-run energy and balance-of payments problems.

a. Trade

The term "trade" is used in this context to include processed and manufactured goods. Raw arterials are discussed below under the heading "commodities." The key trade reform needed is that the South's exports be given improved access and preferential treatment to Northern markets. A Generalized System of Preferences (GSP) for

[DC exports was agreed to in the early 1970s, which eliminated import duties on a broad range of Southern exports. But during the same period tariff reductions were being negotiated that applied to other Northern countries as well, thus reducing the margin of preference accorded to Southern exports. Moreover, a number of Northern countries have erected non-tariff barriers to discourage imports of labour-intensive manufactured goods, as their own domestic laborers complained of being displaced by "cheap labour" imports from the South. These non-tariff barriers included, for example, actual quotas or maximum limits on imports of a given kind from a given developing country, or export restraints exercised "voluntarily" by LDCs (under threat of a quota). Ik: lopping countries have sought the progressive elimination of all non-tariff barriers and the reduction of tariffs, and have asked that revenues which are collected as a result of tariffs on imports from LDCs be rebated to the South as development aid.

b. Commodities

Closely related to trade is improved treatment of commodities exported from the South. A common fund has been proposed to finance buffer stocks agreements to support and stabilize the prices of such exports. The initial goal was a (inn Fund of $6.0 billion (both to operate buffer stocks and to help LDCS diversify and develop new products, and process raw materials). In March 1979 agreement was reached on a small piece of this goal, including a fund totaling $750 million.

The South has found particularly burdensome the Northern practice of escalating tariff barriers on goods from the South to the extent these goods are processed. Thus a saw material may enter free of barriers; but if it is semi processed, barriers are imposed. If it is further processed, barriers escalate accordingly. The elimination o£ escalating tariffs is sought especially by those countries which export raw materials and aspire to improve their earnings by exporting finished or semi-finished goods.

c. Transfer of Resources

In the IM strategy of the Second Development Decade, donor countries promised their best efforts to provide 0.7% of their GNP in Official Development Assistance. Currently the average is 0.35%, although

several DAC countries have reached the target and a number of OPEC countries exceed it by a considerable margin. Recently the Brandt submission, recognizing the difficulties s>,me DAC countries have in nesting the target through annual appropriations, urged that a concerted effort be made to establish automatic sources of revenue for development finance. Such sources might include a tax on internationally traded oil, profits from exploiting the resources of the oceans (or space or the Antarctic), an "SDR link" rebate of taxes collected on imports from LDCs, abates of income taxes collected from skilled migrants to the North (the "brain drain"), rebates of taxes collected by the North on income earned in the South by multi-national corporations (MNCS), and other sources

Another proposal has been ands for debt relief for LDCs. Since the reverse flows from some LDCs to the North in payment for past aid loans have become large, canceling or softening these debts further would be the equivalent of new aid to those countries. Not all developing countries are enthusiastic about a generalized kind of debt relief, because its benefits would be distributed unevenly and not always to the poorest countries; and moreover, it might change the credit standing of countries which have been able to Arrow in private capital markets.

A related plan is that U should be granted preferential (subsidized) access to private capital markets in the North. Finally, it is often urged that the South be given a greater voice in the decisions on the allocation and management of development aid.

d. Mufti-National Reparations

Developing countries complain that bICs which have control over technology effectively prevent or delay its transfer to the South. They have demanded that a code of conduct he established, which would guide MNCs in their relations with WCs not only as regards transfer of technology but also spelling out rules on interference in domestic affairs of 1DCs, corrupt practices, and other subjects. A general cede of conduct is being prepared by the Centre for Transnational Corporations under ECOSOC.

e. Food grains

The World Food conference at Rome in 1974 called for a number o£ reforms to ensure enough food for all. One of the proposals under active consideration is a buffer stock of food grains, which would stabilize prices and offer poor countries security of supply in times of shortfall. Until recently, negotiations have been active in the case o£ wheat; the issues involve technical mechanisms for the operation of a wheat buffer stock and a guarantee of exports of confessional food aid to]DCS. These negotiations, unfortunately, are at an impasse.

f. Reform o£ the International Monetary System

Since well before the US Government decision to abandon the gold standard, it was becoming apparent that the monetary system established at Drayton Woods was in need of reform. In recent years a number of proposals have been heard.

One was that UXs be given a greater share of the benefits from the SDRS that for several years were created by the IMF. The conditions governing the access to the Fund by developing countries are seen by many to be excessively onerous and inflexible. These critics argue that IMF funds should be made available over longer periods o£ tint, because the adjustments which funds are intended to facilitate in many eases (e.g.,

the adjustments to higher oil prices) are adjustments that take a number of years to complete.

Proposals have been trade for a new facility to help Outs adjust to the oil price raises o£ 1979. This nay very well call for an extension of funds available to the IMF. Some reform plans argue that pressure should be brought on countries in persistent talance-of-pa.ynents surplus to adjust also, instead of putting the entire adjustment burden on the shoulders of the deficit countries. In addition, reformers argue that U) Cs should be given a greater voice in managing the international monetary system. Finally there is a need to consider international rules governing the management of currency markets (i.e., the Eurocurrency Market), which are now beyond the control of the monetary and banking authorities in any one country. Until now, the discussions on this subject have involved only the OECD countries; and little has been heard on the subject of any special interest from OPEC countries or Outs. As the issue comes to the fore, it nay be that these two parties will have particular points of view that need to be heard.

g. The Management of the Economies of the Industrialized North

Oil price increases have been a triggering mechanism which in navy countries has led to inflation. These increases have not caused rrnst of the inflation. The major cause has undoubtedly been the struggle within each country (and to some extent among countries) over how to share the burden of these oil price increases. One economist calculates the direct effect of oil price increases on inflation to be only about 1% in 1979. The rest of the 13% was due to wage-price escalation, government budgetary deficits, and other factors Others have thought that the direct effects were 3% or 4%.

Many economists believe that in most OECD countries the inflation is now self-perpetuating, so that it will continue even in the absence of any further oil price rises, unless better economic management is forthcoming. It is also clear that the oil price rises need rot have triggered inflation. Evidence for this is that in three countries dependent

on oil (FR Germany, Japan, and Switzerland) general inflation was controlled for extended periods o£ time, although control was made more difficult by the continuation of uncontrolled inflation to other countries.

The inflation in the OECD countries has placed a burden on OPEC countries and OIDCS. It has also damaged the OECU countries themselves. It may by argued that it is just as important that there be a general system of surveillance of the management of these economies as it is that oil price and volume be the subject of such a system.

h. The Allocation of RD&D Energy

Virtually all the funding for research, development, and demonstration (RD&D) of new or improved forms of energy comes from the industrialized countries of the North. Snail but important exceptions include Brazil's work on gasohol, India's on biomass, and significant work in China. The ability of the entire world to make the critical transition from oil to more abundant and eventually renewable sources depends very largely on the success of these WD&D programs. At present there are no technologies ready to take *over* all o£ the jobs oil is doing. How soon there will be depends in lard on the wisdom with which the RD&D funds are allocated, and on the quality of work in laboratories and in test projects. The whole world depends on RD&D decisions being mode in a handful of countries.

There is reason for OXDCs and OIDCs to question whether the allocation of RD&D funds is very relevant to their needs. Most energy RD&D fund go to centralized electric systems of very large size, often too large for the grids in the Third World. The OLd) countries are raking those HD&D decisions because they control the funds, just as OPEC countries make oil volume and price decisions because they control the oil. Yet the future of the entire world will be affected by both sets of decisions. A case can be made that the allocation of energy RD&D funds is a topic which should go on the negotiating table along with oil price and wlume.

F. The Intimidate and Long-Penn Interests of OIDCs

The enduring energy-related interests of the OIDCs *rimy* be grouped under three headings:

i. to have enough oil to meet their needs over the years immediately ahead,

ii. to rake a smooth transition from oil to inner plentiful energy sources, and

iii. to develop the improved internal management to rake these two goals possible.

Each of these wills he described briefly in turn. i**. Access to Oil**

OIDCs need a reasonable assurance of supply of oil. They also need the means to pay for it. As stated in Section D above, some can get financing from private sources; others will need public sources. This latter need assurance of aid of the kind which would he provided if major automatic sources of aid were available. They also need to improve their export earnings, so they can pay for oil (and other) Longport themselves. This, in turn, logically calls for a variety of improvements in the international economic order, including (as stated in Section E above) reforms in trade, rotundities, the monetary system, and improvements in management of the economies of the industrialized nations to avoid inflation and recession. Finally, they need to find and develop any oil sources that nay exist on or offshore their own territories. This process would be supported by NIX) reforms that would make advanced technology available to OIIxs.

ii. Smooth Transition to Oil's Successors

To rake a transition from oil to more plentiful sources o£ energy requires at least three things. First, the transition wills he smother if there is enough time. Discovering and producing indigenous oil (see Section i above) will provide rote time. Using available oil as efficiently as possible will stretch out the available tine. Improving energy efficiency will he facilitated by reforms in the international economic order which would

Provide gore aid, make technology available to DIDCs, and improve the allocation o£ RD&D funds to develop energy efficiency technologies applicable to the Third World.

Second, discovering, producing, and employing fore plentiful but delectable energy forms such as coal will sake the transition from oil more reliable and smother.

Third, the transition will be accelerated by more RD&D, testing, and installation o£ technologies which can capture and convert to useable forms the very large aunts of renewable energy available in most developing countries. Reforms which ensure that fore RD&D funds are available for work on renewable--including notably decentralized renewable--energy will speed the transition. Beyond RD&D on decentralized renewable energy technologies, the transition will be improved if such technologies are tested in Third World rural sites to determine whether *they* perform village tasks well and inex~nsively and are acceptable to villagers.Fourth, if wood fuels and other traditional fuels are gore plentiful, the transition will be supported by slowing the shift row underway from traditional energy to oil.

All of these efforts to s(uoth the transition would be improved by reforms in the international economic order, which would ensure more development assistance, more RD&D on relevant systems, and a reduction in impediments to the transfer of technology to the OIDCs.

iii. <u>Effective Internal Energy Management</u>

In addition to reforms in the international system, achievement o£ both the above goals (access to oil and a smooth energy transition) depends upon the internal energy actions taken by individual DIDCs. The design and implementation of sound energy strategies require institutions and experts with experience and skills. But even with good institutions, sound planning must begin with a good grasp of the facts which currently prevail. Surveys of energy regimes (particularly rural and urban slum areas) and sites of energy technologies for those areas will help to supply those facts. In turn, these needs can be facilitated by a strong reliable flow of development assistance.

2. OIL-EXPORTING DEVELOPING COUNTRIES A. Introduction

he present section examines the objectives and policies o£ the oil-exporting developing countries (OXDCS), with a view to determine whether there is a sufficient area of converging interest with the oil-importing countries (both developed and developing) to contribute towards the Tries for a global energy policy. The fact that there has been little progress during the past seven years towards an accommodation between the two groups of countries gives scant ground for optimism. However, as time goes by, the problems are becoming more rather than less acute, particularly with respect to three of the central issues:

i. the desire in the exporting countries to stretch out reserves over as long a period as possible

ii. The planning for and management of an orderly transition in industrial countries from heavy reliance on imported oil to alternative sources of energy, and

iii. the difficulties faced by the OIDCs in corning sufficient foreign exchange to finance the oil imports which they will need for a long tints, in order to maintain an acceptable rate of economic growth.

B. Production and Reserves

There are approximately 28 developing countries which are net oil exporters (OXDCS). Their production and reserves are shown in Table II-7 below. Thirteen of them are members of the Organization of the petroleum Exporting countries (OPEC). Among the others, it now seems likely that 1ru will be a small net exporter for some years. But Bahrain and Bolivia are fore or less self-sufficient and nay not have been net exporters in 1979.

In addition to being net exporters of oil, several of the countries have very large reserves of natural gas, ratably Algeria, Indonesia, Iran, Nigeria, attar, Saudi Arabia, the United Arab Emirates, Malaysia, Mexico, and possibly Kuwait and Venezuela. These reserves are, for the most pert, undeveloped but represent a major potential source of energy

For the implanting countries. This source could eventually lx a factor in swathing the transition away from oil. (See Section 0 below.)

TABLE II-7: CRUDE OIL PRODUCTION & RESERVES IN OXDCS, 1979

I

Production (Thousand bid)		Proven Reserves at Year-end (billion barrels)	
TOTAL OXI1CS	34,881	491.4	
OPEC Countries	30,919	440.3	Algeria 1,240 8.4 Ecuador 214 1.1 Gabon 204 2.0 Indonesia 1,595 9.6 Iran 3,117 58.0 Iraq 3,451 34.0 Kuwait 2,511 65.2 Libya 23.5 Nigeria 2,302 17.4 Qatar 506 3.8 Saudi Arabia 9,527 169.1 0AE 1,830 30.3 Venezuela 1,356 17.9
Other OXDCS	3,962	51.1	Angola 140 1.2 Bahrain 50 0,2 Bolivia 32 0.2 Brunei 255 1.8 Cameroon 32 0.1 Congo 59 0.4 *Egypt* 510 3.1 Malaysia 285 2.8 Mexico 1,593 32.5 Qilan 295 3.0 Peru 195 0.7 Syria 170 2.0 Trinidad & Tobago 223 0.7 Tunisia 102 2.3
Zaire	21	0.1	

Total crude oil production in OXIX's reached 35 con b/d in 1979, o£ which 31 con b/d were produced by OPEC countries. Total proven reserves at year-end 1979 were 490 billion barrels, approximately three-quarters of the world's total reserves. A sra11 number of other developing countries benefit from the oil trade by importing crude oil, processing it in intermediate refineries, and exporting the products. These countries are Bahamas, Bahrain, Netherlands Antilles, Singapore, and South Yemen. Two of them (Bahamas and Netherlands Antilles) also have traps-shipment terminals. Finally, relatively minor benefits accrue to six transit countries which collect transit fees or tolls x revetments of crude originating in another country for export to third country destinations. These are Jordan, Lebanon, Panama, Syria, Turkey, and Egypt, although the pipelines are not currently operating through Jordan and Lebanon (mid-1980). Both Egypt and Panama benefit from canal tolls on oil cargoes in transit and tankers transmitting in ballast on the return leg of the journey. Penance, is also an important bunkering point, as are sane of the "intermediate" refineries mentioned above. Of the 28 exporting countries, 12 have potential for significant expansion of either oil or gas production or both. Of these, 11 produce well over 1 con b/d of oil each. They are the only countries which are o£ much interest to the importing countries for the purposes of reaching an accommodation which will facilitate an overall global energy policy. The others are either too 9m11 or do not appear to have any promise for significant expansion.

The 12 countries referred to above are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Fulminates, Venezuela, and Mexico. All of them, except for Mexico, are members of OPEC. To Name extent, they share the development problems of other developing countries. But there are four rain areas that directly concern energy which would have to be the subject of an accommodation between the industrial countries and so rte or all of the 12 exporting developing countries, if the objectives of both are is reconciled in a mutually advantageous way. These areas are:

I. exploration and development o£ oil, particularly heavy oil, and secondary and tertiary recovery Projects,

ii. Development and commercialization of natural gas reserves,

iii. The conservation of oil and gas resources, and

iv. The treatment of financial assets held in the North by the capital-surplus oil-exporting countries.

Each o£ these issues will be touched upon below along with other important factors affecting relations between the OX [Es and the industrial North.

C. The Importance of Sovereignty

Any approach to a global energy policy can curly tope to be successful if the countries of the industrial North fully comprehend the importance which developing countries generally, but fn this instance, oil-exporting countries in particular, place upon their sovereignty. The industrial countries of the North, none of which has in recent times been subjected to colonial occupation and exploitation, view their own sovereignty in a relaxed manner, and indeed take it largely for granted. By the sane token, they tend to view the importance which developing countries attach to sovereignty as exaggerated, and largely definitional. They suspect that emphasis a it by politicians from Third World countries is merely empty rhetoric, designed to massage the amour proper of their people. But, in fact, as far as OPEC countries are concerned, the memory of colonial and semi-colonial domination remains fresh in people's minds. Of the present 13 member countries of OPEC, eight were European colonies or protectorates until well after the Second World War, another had been militarily occupied by the Allied Powers during the war, and the remaining four were nominally independent, although the independence of two of these was more a matter of form than of substance.

The references to sovereignty, which form part of the Solemn Declaration of Algiers of March 1975 by the Conference of the Sovereigns and Heads of States of the OPEC Member

Countries are not therefore to be taken lightly. The following quotations are taken from the third and fourth paragraphs of the 11 coloration:

The Sovereigns and Heads of State of the Member Countries of OPEC) stress that world peace and progress depends on the mutual respect for sovereignty and equality of all member nations of the international annuity, in accordance with the UN charter.

The Sovereigns and Heads of State reaffirm the solidarity which unites their countries in safeguarding the legitimate rights and the interests o£ their peoples, re-asserting the sovereign and inalienable right of their countries to the ownership, exploitation and pricing of their natural resources, and rejecting any idea or attempt that challenges those fundamental rights end thereby the sovereignty of their countries.

The Solemn fkclaration of Algiers is of vermicular importance because it is the only occasion on which the heads of state of OPEC countries have net to formulate and put forward their points of view with respect to the development of their principal natural resource. Lt stilt remains largely representative of their views.

As far as their oil resources are concerned, the producing countries attach a special importance to the notion of sovereignty. The reason is that, until recently, their oil was being produced in accordance with a series of concession agreements which completely *revved* the industry from any kind of national control, so that the country itself was entirely excluded frank any decision related to investment and extrusion plans, levels of production, destination of export, or indeed of any imp) rants matter whatsoever. Their sole remaining rights were to tax revenues in accordance with a formula that could not be changed without the consent of the concessionaire. In fact, in the Middle Fast and Africa,

the, governments *were* not even entitled to information concerning the price at which their oil was being sold for expert (taxes being levied on a notional price set *by* the companies themselves, without consultation with the governments concerned).

The concession agreements had been voluntarily entered into by previous governments, and numerous revisions of a relatively minor kind had in fact been introduced into them by mutual agreement with the concessionaire. But on key decisions, the concession agreements were becoming, in the view of the host governments, increasingly burdenscxre and anachronistic as the host country and its government developed and became more sophisticated. Hence, the view was widely held that the concession agreements, which were of unusually long duration (all in the Middle East lasted until at least near the end of the century and one to the year 2025), and not subject to the jurisdiction of local courts, were "unequal treaties" virtually imposed upon them by the oil companies with the backing of their home governments who, at the time, were immeasurably stronger in political terms.

When the events o£ the early 1970s brought to a head trends which had been gathering force during the previous decade, resulting in a virtually complete transfer to the governments of control of the industry in their countries, these governments felt for the first tine that they had achieved in substance what they had previously claimed as their right in theory, namely the right of permanent s variegate over their natural resources (which had been, in fact, the object of an earlier United Nations resolution). They have now exercised these rights for the past seven years, including the right to nuke or at least control all decisions concerning investments, the level of production and export prices.

Having once gained the substance of sovereignty over their petroleum resources, the governments of producing countries naturally view with great suspicion any attempt by the industrialized imputing countries to draw them into political agreements which would once more limit their freedom o£ action with respect to supply and price. The derogation to sovereignty which the concession agreements with the oil companies represented having been eliminated, it is not, in the governments' view, to be simply replaced by a r w limitation to be introduced into international agreements nude, this time, essentially with the governments of the oil companies' home countries. This is the real tack ground to the unremitting hostility which OPEC has shown towards the International Energy Agency, created by the industrial importing countries to coordinate their energy policies as a counterweight to OPEC. It is also an important part of the broad background to the difficulties inherent in any general accommodation with the OXIX .

D. <u>Depletion and Transition</u>

The central problems for all of the principal OXDCs are a) the depletion of their oil and gas reserves and b) economic transition from dependence on their petroleum resources to a diversified and developed economy. Both of these problems exist in widely differing degrees smog the exporting countries. As far as depletion is concerned, the following table gives some indication of the disparities among them by showing the ratio o£ crude oil production in the year 1979 to proved reserves at year-end 1979 for the main 12 exp raters.

<u>TABLE II-8: RATIO OF CRUDE OIL PROIXICTION TO PROVED RESERVES:</u> F D 1979

<u>OJUNTRIES</u>	RATIO OF CRUDE OIL PRODUCTION TO PROVED RESERVES: END 1979
Indonesia	17
Algeria	19
Nigeria	21
Qatar	21

Venezuela	21
Iraq	27
Libya	31
United Arab Emirates	45
Saudi Arabia	49
Iran	51
Mexico	56
Kuwait	71

Clearly, the countries which have 6e en relatively well explored and whose ratio of current production to proved reserves is in the low twenties or less have ample reason for concern. Indonesia, Algeria, Nigeria, star, and Venezuela all fall in this category, and all of them are anxious to

Stimulate further exploration, although Qatar has limited acreage to offer. But their approach to the problem differs from country to country: Algeria and Indonesia have been signing exploration and production agrees nits with foreign oil companies; policy in Nigeria appears at present (mid-1980) to be uncertain as reorganization of the country's petroleum administration continues; while Venezuela is attempting to carry out all exploration through its own national company.

In two instances, the above table is misleading. First, it shows Iraq with a rather low ratio of current production to reserves (27), whereas in fact the geological prospects in Iraq are very good, though little data is available on recent discoveries. It is best classified as a country with ample possibilities for expansion. It nay be noted that spokesmen for the country have on occasion stated that assistance from industrialized countries in increasing exploration and develop-rent (especially of heavy oils) is among their objectives in any future dialogue. The second misleading feature of the table is that Libya is shown with a relatively high ratio of current production to reserves (31) whereas in fact there is serious concern in Libya over depletion, and the country has been signing a limited number of exploration and production agreements with foreign companies. It should be noted that Libya has in the past experienced sustained production levels of well over 3 mm b/d (compared with its present 2 ran b/d), and that over-production of certain fields was an important factor in determining government policies and attitudes towards the foreign oil companies in the early 1970s.

Taken as a whole, this group of countries has a keen interest in stimulating further exploration; but it must be said that in most cases the acreage is attractive enough to permit them to attract foreign risk capital, if they so wish, on reasonable terms, as is being done in Indonesia, Libya, and Algeria.

The remaining countries, namely the United Arab Frigates, Saudi Arabia, Iran, Mexico, and Kuwait, can all afford to take a more relaxed view about the proving up of further reserves, though here again substantial differences exist within the group as to prospective acreage. The United Arab &irates and Kuwait have limited possibilities for finding large new oil deposits, and p licies are consequently highly conservationist. Saudi Arabia, Iran, and Mexico, on the other hand, still have highly prospective unexplored acreage (this is less true of Iran than the other two countries). 'their interest therefore lies gore in a slow-tonoderate (ace o£ exploration, a renark which must bs qualified by other policy considerations, notably in the case of Iran. In any event, their need for outside assistance is either non-existent in their own opinion (Iran and Mexico) or already proceeding se.tisfactorily (Saudi Arabia).

Closely linked to the question of depletion, and underlying nearly all policy concerns of OXFCs highly dependent on oil, is the transition that all of them mist money or later make to a gore danced and diversified economy. In some countries, notably Venezuela, the investment of oil revenues in economic diversification has been a constant preoccupation and policy since Wfore World War IT. Today, post of the major exerting countries is

vitally concerned with a diversified economic development which will permit continued overall economic growth, once oil revenues start their ultimately inevitable decline.

The *present* unparalleled prosperity of the principal OXDCS obscures the fact from the rest of the world that, in the long run, the transition from dependence on oil to other sources of energy will ultimately be infinitely more difficult for them than the consumers. It is post unfortunate, though perhaps natural, that as far as any energy dialogue is concerned, the attention of the North has been largely focused on the question of prices rather than the economic *development* objectives of nuns of the n joy OXECS, a field which would provide much rare roan for future dialogue.

Senior officials of the Organization of Arab Petroleum Exporting (bun tries (OAPEC) and of OPNU itself have repeatedly pointed out that in their *view* the energy problem must he faced in the context of the economic development of the oil-exporting countries. The transition period into *which* the world's energy secondary' will soon to entering will take on markedly different proportions in the North. In the countries of the industrial North, the major concern is whether the supply and price of energy will impose a serious constraint on the growth of the economy; but inst scenarios, despite pessimism over the level of unemployment, do not include rtejor political and social upheaval. In the (Z([Xs, on the other hand, the major concern is not with an eventual slowing down of growth once production starts to shrink, but rather with the effects of a steady decline in the economy and the pnlitical and social upheavals that would alnnst certainly accompany it.

Economic development and industrialization within the life span o£ existing oil and gas reserves are unmoor objectives of roost of the principal exporting developing countries. Hut this is not true for three of them (apart from s>,%e downward integration into local refining petrochemicals and Lea), namely Kuwait, United Arab F3nirates, and Qatar. All three now appear to have understood the futility o£ attempting to industrialize arid and sparsely populated areas devoid of suitable infrastructure and far removed from the main industrial markets. After some attempt at industrialization in the 1960s, Kuwait was the first to understand this and nuke a conscious decision to prepare for transition by a careful program of investment abroad, mainly in the form of indirect investments (though more recently there appears to be increasing emphasis on direct investment). This decision seems to have been taken even before the first large increase of oil prices in 1973-74. In Qatar and the United Arab animates, the initial reaction to the increase in prices was, as earlier in Kuwait, to draw up plans for industrialization which included a number of expensive projects not directly related to the oil and gas industries. More recently, low ever, there has been some disillusionment with this policy, and neither country has within the past year approved any new major industrial project not directly related to oil and gas.

In rather general term, the implications for supply and price o£ the depletion and transition problems which will be faced by all OPEC member countries in the medium or long-term reflect somewhat different approaches by different members of OPEC.

Countries already producing close to their physical limits and without great tope of an expending reserve tale in the future, such as Algeria, Indonesia, Libya, Nigeria, as well as all the minor producers, will tend to place increasing emphasis on obtaining the maximum price. Conservation is an important part of overall oil policy, but because they have already attained a certain *level* of spending based on production *levels* close to the maximum, they have limited scope for cutting tack.

Venezuela lies in an intermediate position because, while its conventional oil resources place it on a par with countries such as Algeria and Indonesia, it still has vast hydrocarbon resources in the Orinoco petroleum belt to develop. Hence, for Venezuela, the transition is a natter not only o£ a transition to a diversified economy, but also from

conventional petroleum resources to the heavy oils o£ the Orinoco, which are capable of supporting production at a level o£ 2 or 3 con b/d for a period that is indefinite (about three hundred years) for all practical purisms. Hence, a certain ambiguity surrounds

Venezuelan policy towards supply and price, since it sees its relations with important consuming countries, both at the commercial and technical levels, as lasting indefinitely into the future.

At the other end of the spectrum are the countries *which* still have an ample resource base relative to their current and immediately prospective needs--notably Iraq, Kuwait, Saudi Arabia, and the United Arab Denigrates. The chief emphasis of petroleum Inlay in these countries is bound to be on conservation, because the accumulation of financial surpluses which must be held outside the country is politically undesirable and, so far, economically unprofitable. Consequently, these countries, like Venezuela, also see themselves in a much longer-term relationship with the major consuming countries, although mislay at the on racial level.

In summary, between the two groups of countries there is therefore a sharp distinction o£ emphasis between the attitudes towards supply and price, and towards the consumer.

E. The Supply and Price of Oil

There are a number of interrelated factors *which* affect the decisions of OXIAIS with respect to the supply and price of oil. The crust important of these is at present the question of conservation, but others include investment policies, the security of financial assets held abroad, and political factors.

i. Conservation policies

The most important factor determining the supply o£ oil from the principal OXUCs is conservation, meaning in this context a policy of production restraints, designed primarily not to maintain price but to prolong for as long as possible the economic life of the country's petroleum reserves, with due regard to a level of government revenues which permits continued economic growth. This is possibly the rest widely misunderstood aspect of act policies--it being too easily and too commonly assumed by observers in industrial countries that the so-called conservation policies of producing countries are a mere camouflage for price maintenance. Consequently, over the past few years, these observers have found their expectations repeatedly frustrated when surpluses appear on the market without leading to a serious weakening in what *they* suppose to be a conventional cartel seeking to maximize revenue. In practice, several countries have been only too happy to reduce production, and thereby reduce surplus revenues which can neither be spent profitably at tone nor invested safely abroad.

Production ceilings in the OPEL area at present (mid1980) are in aggregate about 6 mm b/d lower than already developed capacity, and probably about 15 con bid below minimum potential capacity.

ii. Investment Policies

To a large extent, policies governing investment in exploration and the development of producing capacity are a facet of conservation policies viewed in the long run. Unimportant in the short-term, they are critical in the radium and long-terns because, i£ and when conservation policies are relaxed to allow production to catch up with already developed physical capacity, the result of past investment policies will impose a constraint that cannot be overcome except with a considerable *tine* lag.

Policies vary from country to country. At one extreme is Kuwait, where there has been no investment in the development of new capacity for some years and only very limited investment in exploration. The present exploration activity is oriented costly towards the discovery of gas.

The frost notable and important example o£ muted investment policies in the development o£ new capacity and exploration is, of course, Saudi Arabia where plans originally laid a few years ago by Arcane for the development of capacity up to 20 rim b/d have been successively scaled down. There are, at present (mid-1980), no plans to develop capacity beyond 12 mm b/d by the year 1985. By and large, twelve, other member countries o£ OPEC and other exporting developing countries are pursuing active exploration policies, sore of them indeed quite vigorous. These include, as noted above, Indonesia, Algeria, Libya, Mexico, Venezuela, and probably Iraq, although not much is known about the level of activity in that country. In sane of them, vigorous exploration is accompanied by ceilings on present production.

iii. The Security of Financial Assets

Some six OPEC countries (Saudi Arabia, Kuwait, OAE, Qatar, Iraq, and Libya) have been consistently in surplus on current account during the 1970s. The financial assets which they have consequently accumulated abroad could be as much as $300 billion (net of private and public transfers), rest of it held in dollars and much of it in short-term notes. These funds are vulnerable both to inflation and to political action (i.e., blocking). Since the producing countries with large funds invested abroad are largely confined to Saudi Arabia, Kuwait, and the United Arab Emirates, their vulnerability is clearly a matter of limited importance for OPEC as a whole, but it is of major importance to the countries concerned. The issue has attracted a great deal of attention in recent years, because it is clear that, if sufficient guarantees could be given to Saudi Arabia in particular as well as to the other two countries, rune of the constraints on production selected in the countries' conservation policies and investment policies would be either entirely reproved or greatly attenuated. Hence, some observers have seen the question o£ financial security for the assets of the producers held overseas as the key to avoiding production restraint in the future.

A number of different schemes have been mtoted, nost of them centred on the issue of long-term bonds indexed in

such a r, inner as to compensate for inflation. Some of these proposals have come from the producers themselves, particularly (several years ago) from Iran when the country expected to remain in surplus for sane time. More recently, nearly all of the perusals have come from sources in industrial countries. Among the difficulties in establishing such inflation-proofed Inns is the political difficulty to the US necessarily associated with the creation of a special class of investor who would have privileges not extended to others? Conversely, the producing countries feel that such bonds are rare easily identified than other financial investments and therefore inner politically vulnerable to freezing as well as less nubile in the short-run. These fears nay to meter theoretical than practical, but they nevertheless exist and color the attitudes of the surplus countries.

There are a number of other obstacles, which vary from country to country, placed in the way of the financial surplus countries and inhibiting their invest rents abroad. There are, nuns notably, constraints in several countries, either of a statutory or political nature on the acquisition of assets (especially, the raking of direct investments), as well as tax considerations which tend to inhibit the investor. The removal o£ some of these obstacles would no doubt represent a positive step as far as the capital-surplus countries are concerned and could be an element, though mt a major one, in any rapprochement between the oil-exporting countries (or sore of them) and the industrial countries of the North, Particularly the US.

iv. Political Factors

The Arab-Israeli conflict is, without any doubt, one of the most important of the obstacles in the way of any general agreed solution to the energy problems between the exporting developing countries and the industrial ones. It is rarely discussed openly and candidly; but it should constantly be borne in mind that no permanent solution or

agreement will be possible as far as energy is concerned, until a solution is found to the Palestinian problem which is acceptable to a majority o£ the petroleum-producing Arab states. The dependence of the West in general and the US in particular on imported oil is seen by the Arab countries as one of the few potent weapons which they can bring to bear in their favour to solve the problem of the Palestinians. It is idle to think that this weapon will le abandoned in order to reach a broad energy agreement on the economic and financial issues involved. Nothing could be *note* unrealistic; and the only apparent point in any "dialogue" or preliminary talks on the economic and financial issues eems to be to prepare the ground for an energy agreement once a broad political settlement can be achieved, if ever, on the Palestinian issue.

F. <u>Factors i) determining Pricing obloquies</u>

The setting of oil prices has, in the past, been largely a pra~na.tie affair, with the exporting countries reacting to nurket forces conch they themselves have in large measure created *through* the enforcement of conservation policies curbing production for reasons other than price support. There are, never, underlying objectives which find general agreement a on the exporting countries, despite (or perhaps because of) their vagueness when it cares to concrete detail. Essentially, OPEC pricing policies aim at shifting the price of oil upwards to the cast o£ alternative sources of energy. Neither the cost nor the supply volumes that such a price would bring out is specified, *although,* again in vague terns, many of the producers tend to think of the cost of alternatives as being represented by gasification of coal in the western US in relatively widest quantities with a number of other alternatives being produced at below this cost, in particular steam coal, nuclear power, shale oil, oil from the tar-sands, LNG from outside the *OPFF* area, possibly some deep gas, and at the margin, same of the exotics such as green petrol.

Of less fundamental importance, there is now firm agreement within OPFG that the price of oil should escalate to keep loses with inflation. Most, rotor countries are in agreement that the deflator should be an OECD index of expert prices, possibly in combination with an index that gives sine measure of the increase in the price of services in OECD countries. There is also general agreement in (WEC countries that the speed at which the price of oil should move up from its present level to the (undefined) cost of alternatives should be Sri Peso with the growth of GNP in real terms in the OECD area. The rationale for this linkage is that the growth in GNP is pith a measure of ability to pay as well as

an indication o£ the time span within which the alternatives will be needed. If GNP grows fast, the alternatives will be needed sooner, and the price of oil will have novel up correspondingly quickly.

Opinion is divided on the desirability of establishing price ceilings. Most, though not all, exporting countries feel that a price ceiling is, in principle, desirable, partly to maintain order in the markets, and partly to prevent premature devaluate not of alternatives. However, those countries that recognize the desirability in principle of a price ceiling are themselves divided wrong the ones that believe a price ceiling can be administered and those that believe it is impractical because it would not be respected for long and that, therefore, any attempt to impose one is futile and divisive.

Finally, it may be remarked that OPEC, at any rate, sees the administration of prices as entirely manageable and a letter which pertains exclusively to the seller at the political (though not wnwercial) level. It is not a point which is open for negotiation with the industrial countries, except in the case of the rather far-fetched hypothesis that industrial countries would agree to regulate the prices of their own exports of manufactured goods and food to the producing countries.

G. <u>Natural Gas</u>

Of growing importance and concern among the OYOCs is the future development of their natural gas reserves. Nmng the OXfLs, twelve countries either already possess

or have excellent prospects for natural gas in large exportable surpluses. They are Algeria, Indonesia, Iran, Iraq, Kuwait, Nigeria, Qatar,. Saudi Arabia, the United Arab &iirates, Venezuela, Brunei, and Mexico. The latest published proved reserve figures for natural gas are shown below for the countries mentioned, but there is little doubt that they vastly underestimate the true position of these countries, in particular with respect to the recent discoveries of large gas deposits in Qatar, Saudi Arabia, and Venezuela. In addition, Kuwait is confident that its deep drilling program will encounter large reserves of gas.

TABLE II-9: PROVED NATURAL GAS RESERVES Countries Trillion O bic Ft.

Algeria 132 Indonesia 24 Iran 490 Iraq 28 Kuwait 31 Nigeria 41 Qatar 60 Saudi Arabia 93 OAF 21 Venezuela 43 Brunei 8 Maxi o 59	
T(7FAL	1,030
The above countries account for 63% of the world's gas reserves (excluding CPES),	

And their aggregate reserves are equivalent to 170 billion tares of oil, or about twice as much as the combined oil and gas reserves of Canada and the US together. As noted above, they are (with the usable exception of Iran) possibly greatly understated.

Saudi Arabia's gas program will, when completed, utilize virtually all of the associated natural gas produced with its oil. The country is already recovering 300,000 b/d of natural gas liquids, and the stripped gas will be used as fuel for electricity generation, seawater desalination, and feedstock for petrochemicals, as cell as reinsertions for pressure maintenance to the maximum extent technically possible. The large discoveries of non-associated gas which have been ride are not being developed. Saudi Arabia, having accounted for virtually all of its associated gas production and because of its very large liquid hydrocarbon reserves, can afford to take a relaxed view o£ the development of its non-associated gas resources and does not consider them a problem for the near-term future or an important element in its relations with industrial countries.This is not true of n st countries, particularly Algeria, where natural gas reserves are nnre important than oil and where passive investment has already been made in LhG facilities. For Algeria, the question of natural gas pricing is, at the time of writing (mid-1980), a highly controversial issue and the government's stand on pricing has practically brought gas shipments to the US to a halt and greatly reduced shim nts to European destinations. Plans to build a pipeline overland through Tunisia and undersea to Sicily and Italy are well-advanced and ray be followed by a pipeline to Slain.

Other exporters of gas include Indonesia, Brunei, Libya, the United Arab Aspirates, and Mexico, all of them except Mexico in the form of liquefied natural gas (LNG) and natural gas liquids (NGLs). For the nest part, thievery, these expires are nearly scratching the surface of the various countries' natural gas potentials. As crude oil production reaches a peak in sore o£ them, there will be increasing efforts to mount export-oriented projects. A major problem, of course, is that with gas, unlike oil, the production and liquefaction phases cannot be prudently undertaken and certainly mt financed without at the same time raking provision for the long-term sale of the gas (a 15-20 year contract seems to be the norm), with provision for the shipping facilities in the form o£ LNG carriers, reception facilities at the port of unloading, and degasification plants. Shipment of LNG in large quantities to the markets therefore necessarily implies, at the commercial level, agreement on price over the long term, a coordinated investment program encomlsssing the whole chain of operations from production of gas in the producing country to degasifications of LNG in the consuming country and involving the producing government, operating companies, purchasing companies, the government of the importing country, and financial institutions.

In view o£ the very large reserves of natural gas now being discovered in the oil-producing countries and the much greater difficulties involved in their develowent for explore, it is clear that they rust

be a further element in any global energy strategy.

H. Polices Towards Oil-Importing Developing Countries

The policies of OPEC member countries and re other OXDCS towards the OIDCS are now acquiring sore sharpness o£ definition. The recommendations of OPEC's Ministerial Committee on long-Term Strategy were unanimously adopted by the full Conference when it fret in Saudi Arabia in May 1980. Briefly, these recommendations envisage the following treasures with respect to OIDCS:

a. OIDCS are to be guaranteed supply of alt their domestic oil needs at ro more than official government prices, receiving priority over supply to industrial countries.

b. For the better off wrong the OIDCs (countries such as Brazil, Singapore, South Korea, Taiwan, and Hang Kong), bridging loans are to be made available at essentially commercial rates to cover periods of balance-of-Segments difficulties caused partly by increases in oil prices.

c. Soft loans and grants are to 62 made available to other OIDCS to provide financing for the develops nt of indigenous energy sources in the longer-term, as well as broad-based lending on confessional terms for specific projects not necessarily related to energy.

As far as pricing is concerned, OPEC policy has consistently rejected a generalized system of two-tier pricing for the following reasons:

a. it renders the aid element virtually invisible,

b. fear of leakage into other markets, and

c. differential pricing ties the amount of aid to the volume of oil imports, regardless of the country's actual needs. It also gives the impression that high oil prices are chiefly responsible for the economic problems of the OIDCs. In fact, OPEC country aid has been extended to a number of countries which are either close to oil self-sufficiency or are themselves net exporters, such as Egypt and Zaire.

Nevertheless, there has been size limited selling o£ oil on a two-tier price system with confessional prices to developing countries by Iraq and Venezuela. Venezuela's moles have been mainly to the Central American and Caribbean importing countries. Mr'ng the recent examples of sales to Outs at confessional prices is the agreement between Mexico and Venezuela to set up a system to supply the Central American and Caribbean importing countries with all of their domestic requirements of oil at prices which will, in the final analysis, equate to a discount of 33% on the official government price.

OPEC countries have recently been giving about $4-5 billion per year in official development assistance to other LNCS through a variety of national and international institutions, including notably the OPEC Fund for International Development.

Table II-10 sets out the OPEC aid record during 1976-1979. The figures shown are net disbursements of confessional aid and exclude financial flows at commercial rates. On average, it amounts to about 2% of aggregate GNP in the OPEC area. Current proposals within OPEC envisage a sharp escalation in the flow of aid to other LOOS, although r specific sum has yet been fixed. Multilateral aid is row running at about $2.5 billion per year.

An important part of this would be earmarked for the development of energy resources in other LOOS with epitasis on exploration for hydrocarbons. This proposal runs parallel to the proposal part forward by the World Bank for the creation of a serrate affiliate, which would be financed lordly by industrial countries through the World Bank itself and pertly by OPEC

member countries. Its funds would be exclusively voted to the developing of indigenous energy resources in developing countries.

At the tine of writing (mid-1980), it is an open question whether the two proposals can be fused, but it is indisputable that this is one area where the interests of industrial countries and OXOCS fully coincide. The industrial countries, by assisting LOOS to develop their indigenous energy resources, will free up oil supplies from the OPEC area and thereby increase import availability as well as reduce

Pressure on price. The OPEC countries similarly have an interest in assisting other LDCS to he come as close to energy self-sufficiency as possible, since this would reduce their need for economic aid and would also attenuate the pressure on supplies from OPEC countries that wish to lower production rates in order to conserve.

TABLE II-10 DEVELOPMENT ASSISTANCE

NET DISBURSQIENTS OF OFFICIAL BY OPEC COUNTRIES (US$ million)

	1976	1977	1978	1979
TOTAL Bilateral and Multilateral	5,586.8	5,846.8	4,344.0	4,708.2
Bilateral Aid in:	4,532.8	3,887.5	2,970.4	3,519.7
Elubpe	14.9	5.0		
Latin America	9.6	-	n.a.	n.a.
Africa	1,535.7	1,428.3	n.a.	n.a.
Middle East	1,337.4	1,253.3		n.a.
Other Asia	1,464.8	510.7	n.a.	n.a.
Others	170.4	690.2	n.a.	n.a.
Multilateral Aid through:	1,054.0	1,959.3	1,373.6	1,188.5
Non-OPFL Agencies & Funds	222.8	214.9	n.a.	n.a.
Arab/OPEC Agencies & Funds	831.2	1,744.4	n.a.	n.a.

I. Conditions for New Dialogue Between Producers and North

From the outset, producing countries have insisted that any discussion of energy with the industrial countries should he linked to discussion of other problems of developing countries and issues between North and South. Thus, to quote again from the Algiers Declaration,

The Sovereigns and Heads of State declare that, parallel with and as a counterpart to the efforts, guarantees and commitments which the OPEE Member Countries are prepared to

make, the developed countries must contribute to the progress and development of the developing countries through concrete action and, in particular, to achieve economic and monetary stability, giving due regard to the interests of the developing countries.

In this context, they emphasize the necessity for the full implementation of the program of action adopted by the United Nations General Assembly at its Sixth Special Session.

In discussing the conditions for an international conference in which energy would be discussed, the Algiers Declaration stated that:

The agenda of the aforementioned Conference can in no case be confined to an examination of the question of energy. It evidently includes the questions of raw materials of the developing countries, the reform of the international monetary system, and international cooperation in favors of development in order to achieve world stability.

The reference was, of course, to the conference which became known as the Conference on International Economic Cooperation or the North-South Dialogue of Paris. The question of linkage touches upon a whole series of issues between North and South, chief among them being commodity price stabilization, aid commitments by developed countries, implementation of an effective food program, the transfer of technology, access to industrialized countries' markets for the manufactures of developing countries, protection against the depreciation of financial assets held by OPEC countries in the industrialized ones, the security of those financial assets, and the reform of the international monetary system.

It was evidently unrealistic to hope to ram through reforms on all these issues on the back of the relatively limited "guarantees and comitments which the OPEC Member Countries are prepared to nuke." The CIEC Conference ended in failure, although participants clam d to have made progress in the sense of gaining deeper insight into each other's points o£ view. Nevertheless, OPEO's position has hardened in the ensuing years, partly because the industrial countries appeared to have nude a reasonably comfortable adjustment to the higher level of prices of 1973-74; j rtly because the problem of recycling funds was overcome without major difficulties; and partly because they saw little possibility of any major concession being nude on the part of the industrial countries who believed that competition and inflation would erode the price of oil over a period of tine. In addition, the absorptive capacity of OPEC Member Countries themselves proved greater than anyone anticipated. Hence that had seethed to be problems requiring an urgent solution turned out to be manageable. OPkx discovered that it had less leverage than it had believed, but also that the industrial North was much tore capable of absorbing large price increases than had been thought.

The second price explosion of 1979-SO has not caused anywhere near the sane degree of alarm as felt in 1973-74, although in absolute terms the increase has been greater and the difficulties of recycling nay not prove to be so easily managed.

J. The Allocation of Supplies

In an increasingly tight nurket, which is the situation generally anticipated for the mid to late 1980s, it seems quite possible that OPEC nay feel constrained to allocate supplies of crude oil internationally if the pricing mechanism does rot by itself clear the market. One of the reasons why *there* should be doubt about the ability of the pricing Mechanism to function is the lack of easily substitutable supplies for crude oil and an absolute need for oil i£ economic growth is to continue. 1b some extent, the doubt stems from the situation engendered in 1979 at the height of the Iranian supply crisis when oust of the industrial nations were fully supplied with crude, mainly at contract or official government prices, wfiile some developing countries had difficulty obtaining sufficient crude supplies or could only obtain sufficient supplies at the spot market price which was well above official government prices (at tines, about twice as high as the Saudi Arabian official government price).

It now appears that OPEC member countries may be embarking on an embryonic system

of supply allocation. As part of its long-term strategy, OPEC has, as mentioned above, agreed that supplies to developing countries at the official government price should be guaranteed by the organization, and that a mechanism should be established in order to implement this recommendation. Thus, supplies to LDCS would take priority over supplies to industrial countries in times of shortage. This means, of course, that any shortfall would have to be administered by reducing the amounts of oil available to one or more industrial countries, presumably through a central coordinating office. As far as is known, no steps have yet been taken to establish such a mechanism. But if the guarantee is to work, then s no such body would have to be in place, before any supply crisis were to arise again or ad hoc measures were hastily worked out.

Along the same lines, the Venezuelan/Mexican agreement (also referred to above) allocates supplies at a certain price to countries of Central America and the Caribbean. The allocation covers domestic requirements of petroleum only and does not include oil required for processing and re-export, nor for international bunkers at certain pints such as the Panama Canal. However, it does involve establishing what domestic requirements are, and this means that some kind of coordinating body must be created to work out the mechanics of the system.

Obviously, allocation of supplies in favors of a given set of consorters is not likely to raise vigorous protest from them, although there is probably room for dispute on the part of those who believe they should receive more. Allocation away from another set of consumers is, bewever, a different matter. As far as is known, there has as yet been no protest, formal or informal, on the part of industrial countries with respect to the implications of allocation in favors of the LOCs at their expense. Presumably such protests will not be long in coming, if and then the threat of an allocation system appears more imminent and more real than at present, because it is a letter which could be interpreted as affecting national security in the consuming countries. If there is general acceptance among industrialized countries that the aggregate global supply cannot be rapidly expanded, then it would seem that there might be mom for exporters and

Importers to discuss the mechanics of supply allocation, at least on an ad hoc basis and for a limited period of time. Some thought should be devoted to tackling this problem before it is too late for anything to be done about it. It scarcely needs saying that, should producer-exporters resort to a supply allocation scheme on a global basis, the scope for serious conflict with the industrial importing countries is almost without limit.

3. INDUSTRIALISED WUNTRIFS

A. Introduction

The strong economic growth of the industrialized countries during the 1950s and 1900s was fuelled by cheap abundant energy. Iritic coal production gave way to low-cost oil, either domestic as in North America or imported as in Western Europe and Japan. Oil production in developed and developing countries and its pricing, shipment, refining, and marketing were controlled by international oil companies which were typically US, British, Dutch, and French. The growth in the international trade and consumption of oil continued at a rapid pace during the two decades. Reliable access to cheap imported oil was scarcely doubted.

This complacency was upset in the 1970s. Industrialized countries now face an era of high-cost oil, whether domestic, as in the North Sea and the frontier and heavy oils of North America, or imported. Production pricing and increasingly destination of oil exports from OXOCs are now controlled by their own national oil corporations. These countries seek further control over downstream operations at hone and abroad. Meanwhile the major oil comln.nies has lost their dominance in the international market and their role as wholesalers to third parties. They are joined in the market by an array of other purchasers, including refiners, traders, and national oil companies of

industrialized countries. The growth in international oil trade has virtually disappeared. So has reliable long-term access to imparted oil.

From the viewpoint of industrialized countries, the decade of the 1980s remains fragile. These countries are faced with essentially three dangers: short-term oil supply disruptions; continued medium-term reliance on oil imports;

And long-term depletion of world oil supplies entailing a delicate if engagement of the transition to new energy sources. The dangers are evident.

Faced with such concerns, the industrialized countries are forced to take into consideration the strategic nature of oil in their economies. Today there is an overriding concern expressed by all the industrialized countries for secure and assured supplies of oil at what they see as reasonable prices. This is part of the current concern over high inflation and unemployment: stagflation. The energy problem, while not the sole cause, is a key component especially with such large outward flows of annoys to pay for oil imports.

Conservation and accelerated development of new and renewable energy sources are cures for the long-term transition. In the short-term the industrialized countries are faced with the need to deal with potential crises before the transition can take place. For oil, such efforts include demand restraint, emergency sharing arrangements, stockpiling, and import target ceilings. a In times of fore acute crises, there have also been favorable responses from the OXlX2s, in the form of short-term production increases.

B. Energy Diversity of the Industrialized Countries

Part and parcel of the concerns o£ industrialized countries is that they have diverse interests. Their energy supplies nay range in source from complete self-sufficiency to utter dependence on imports. These differing degrees of import dependence are true not only for oil but also for other energy forms. This diversity itself can create strains and even divisiveness among industrialized countries themselves.

The United States has a fundamental concern with world strategic relations, above all with the Soviet Union. It is a nation rich in natural resources and yet woefully dependent on imported oil since the 1970s. Its imports represent about one-quarter of international oil trade. This dependence is evidently detrimental to its economic and strategic strength. It has a vital interest in the stability of the Middle Fast, where it has the dilemma of supporting different foreign policies and economic aims: containrcmnt of Soviet designs, support for Israel, and secure long-term access to oil supplies. High-cost oil imports hurt its international financial balance, except to the extent that it can entice back petrodollars at attractive (high) interest rates and can export economic and military goods and services. Oil imports also weaken the US's political and strategic freedom to Nan oeuvre. A creative US energy policy is a top priority concern for all industrialized countries. A solution can only be achieved through the obvious two-pronged policy of improved conservation and accelerated development of energy resources b

Both Canada and Australia are rich in natural resources. Both are federated states where ownership of natural resources is an issue between the federal Government and the provinces or states, and this has far-reaching implications for the formation of energy policies

Canada is energy self-sufficient though it has become a net oil importer. Its production of conventional light and medium Western crude oils is perceived to have reached a plateau, and medium-term prospects are for increasing net oil imports. However, the longer-

term prospects for oil are good, as production from frontier offshore oil, heavy oil, and synthetic oil from tar-sands looks very promising. Moreover, the potential for other energy resources is large, particularly gas as well as coal, hydro, and uranium.

Australia is sitting on a power-house of coal and could become a very large exporter; it is rich in natural gas; and it produces about 70% of its oil consumption. On reliance it is a substantial net energy exporter.

New Zealand has a relatively snail economy, and its energy strength lies in hydroelectricity, gas, and condensate. It imports rag st of its oil but is nuking efforts to reduce this dependency.

South Africa's energy strength lies in coal, and it looks likely to become a large exporter. It has restrained its demand for oil imports for strategic reasons and relies heavily on synthetic oil from coal.

At the other end of the scale is Japan which has very small known domestic energy resources. So it is the world's second largest importer of oil and also a large importer o£ coal and gas. It is accelerating efforts to find indigenous offshore hydrocarbon resources, but a major concern is the issue of jurisdiction over such resources with neighboring countries. It has pursued an active nuclear power program, but that is way behind official laps. Present prospects are that Japan is likely to remain dependent on large oil imports, which it will have to finance through its strong export sector. With the demise of the third party oil market, Japan has perforce reshaped its oil import conduit in 1979 from reliance on spot oil companies to Japanese trading companies. Japan meanwhile has entered into the high-priced spot oil market. To alleviate its worst anxieties about its dependence on oil in an uncertain future, Japan has adopted policies of building significant oil stocks.

To diminish its energy dependence on a relatively few Middle Eastern countries, Japan is pursuing enlaces of diversifying its oil impart sources (i.e., Indonesia and PR China) and substituting imports of other energy forms from a range of countries. It has created the Japan National Oil Corporation (JNE) to strengthen oil and gas exploration efforts abroad and has encouraged private Japanese interests to do likewise.

Countries within Western Europe are not Endogenous in economic, social, or cultural structure. Some countries such as FR Germany, Sweden, and Switzerland have high per capita income, and others such as Turkey and Yugoslavia have much lower ones and for some purposes are grouped with the developing countries. Economic wealth is also concentrated. Just four countries (France, FR Germany, Italy, and the United Kingdom) account for two-thirds of GNP in Western Europe and indeed 28% of that in all OEC7 countries.

From an energy viewpoint there is an utter diversity of sufficiency in energy resourceswithin Western Europe. Seven countries are highly import-dependent, importing over three-quarters of their energy supplies: Belgium, Denmark, Greece, Ireland, Italy, Luxembourg, and Portugal. Another eight import rare than half their supplies: they include the two large economies France and FR Germany as well as Austria, Spain, Turkey, and the hydro countries Finland, Sweden, and Switzerland. This g•oup includes some of the strongest economies and one of the weakest *(Turkey)*. There are just two Tore countries which import nore than one-quarter of their supplies: Iceland (strong in domestic hydro and geothermal energy) and Yugoslavia (strong in domestic lignite, hydro, and sore oil and gas). There are also significant differences in capital stock and energy end-use between these countries. Nevertheless, Western European countries have handed together politically, economically, and for defence through a number of international organisations.

On$_e$ Western European country imports less than one quarter of its total requirements: the United Kinden, which is self-sufficient in energy other than hydrocarbons and is heading rapidly for self-sufficiency in oil and gas (though it imposts North Sea gas from Norway). Finally two countries are net energy exporters: Netherlands and above all Norway. Both

show concern to extend the life of their hydrocarbon reserves. The Dutch gas fields are retire and could decline in output, and exports are being phased out. Rotterdam is also the Euro port and key port of entry to the energy infrastructure o£ Europe. Norway has just opened offshore areas north of 6V for exploration; this is an untouched, technologically difficult frontier region of unknown prospects, for which fingers are crossed in hope.

All Western European countries have a fundamental interest in reducing their vulnerability to supply disruptions. They are seeking ways of reducing their dependence through increased energy conservation and production. Britain and Norway are now consolidating their successes in finding and developing oil and gas in the North Sea. European efforts are now gearing up for offshore exploration in frontier areas such as north of 62', west of the Shetland Islands, and the Western approaches, and are continuing in the Mediterranean Sea. On shore prospects do not look likely to yield significant bonanzas. All new fields reduce import dependence for the successful nations, but this leaves open the policy issue of how far these successes directly benefit other Western European countries in terms of secure long-term access. There has been great debate how far North Sea oil policies should be determined on national or regional criteria.

Meanwhile, West European countries are seeking to develop other energy sources. But there are serious constraints of a political, social, and environmental nature to accelerated development of conventional energy sources. It is not easy to reverse decisions o£ the 1960s and reopen or start new coalmines in countries which have dismantled their coal industry. There are physical and environmental barriers to further substitution expansion of new hydro sites. Some governments have pursued the nuclear power option but are encountering much public opposition.

C. Institutional Efforts to Coordinate Industrialized Countries' Energy policies

i. OECD

Industrialized countries quite early on made an effort to deal in a concerted manner with energy policy. Shortly after World War II, the OEEC (OECD's predecessor) set up a system o£ emergency-sharing for coal allocation. Efforts were also use within OECD prior to 1973 to set up a system for emergency oil allocation and energy policy coordination.

ii. EEC

The EEC's first organization was the European Coal and Steel Community (ECSC), and since the EST's inception the EEC has worked towards a common energy policy. The European Commission, however, does not seek to have everything in the energy sector regulated on a centralized Swiss at the ~immunity level. The largest part o£ the Community's energy strategy can only take place on a national level. Thus the Commission aims at coordinating and supplementing efforts o£ national governments with Community-wide measures d

iii. IEA

The Arab oil embargo and the jump in international oil prices in 1973-74 led to the Washington energy Conference in February 1974, and the creation in November 1974 of the International Energy Agency (TEA). This is an autonomous body within the OECD, established to implement the International Energy Program. Its membership has risen and now comprises 21 out o£ the 24 DECD members.{ IEA countries account for Some 93% of developed countries' energy consumption and 60% of the world's consumption. The IEA has the roles of i) promoting energy conservation and the enhanced development of secure energy supplies and ii) ensuring the adequate distribution of oil supplies in an emergency.

Basic elements o£ LEA members' cooperation on an International Energy Program include:

a. cooperation to reduce excessive dependence on oil through energy conservation, development of alternative energy sources, and energy I)&D;

b. an information system on the international oil market and consultation with oil commies;

c. cooperation with oil-producing and other oil-consuming countries, with a view to developing a stable international energy trade as well as rational management and use of world energy resources in the interests of all countries; and

d. a plan to prey re against risk of major disruption of oil supplies and to share available oil in event of emergency.

It has established a useful oil market information scheme and over 40 cooperative RD&D projects covering conservation, coal technology, nuclear and fusion power, hydrogen production, and renewable energy sources (including solar, geothermal, biomass, ocean, and wind).

TEA also functions as a consultative organ with a clear mandate on substantive energy issues. Such work has led to a process of understanding and cooperation on an area of* Australia, Austria, Belgium, Canada, Denmark, FR Germany, Greece, Ireland, Italy, pan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States. The otter three DECD countries are Finland, France, and Iceland, while Yugoslavia has associate status.

Concern to industrialized countries. It is a process by Which countries can bring public pressure to hear on each other on energy policy, following guidelines outlined in treaty obligations. Willie France is not a member o£ IEA, it receives its information and has an input by way of the EEC and OECD.

D. <u>The Second Oil Shock, 1979-80</u>

After the first shock of international oil price increases of 1973-74, most industrialized countries were lulled into complacency by the subsequent erosion in real oil prices and more comfortable oil market to 1978. It took the second oil shock of 1979-80 to awaken the consciousness of decision-makers in these countries to the pressing nature of energy-related issues, particularly oil.

It is true that governments of these countries as a whole were in general agreement in the mid-19705 on the likelihood of ever-increasing difficulties in obtaining energy supplies from the mid-1980s onwards. This was reflected in the LEA Governing Board's communiqué in October 1977: the world, it said, is confronted with the serious risk that in the 19805 it will not have enough oil or other energy available "at reasonable prices" unless present energy policies are strengthened. Such dangers, it felt, could lead to severe world economic, social, and political repercussions. It said that member countries must help reduce this risk by strong and sustained policy to make effective use of energy resources, while emphasizing less delectable energy sources; that member countries should act promptly on energy policies; and that their policy response should he concerted. At that 1977 meeting, the Governing Board first introduced a target ceiling on IEA oil imports. Import ceilings were also set up within the EEC.

But the international oil market turned slack in 1978. The expressions of concern for the energy future by industrialized countries' governments in 1977 gave way to a sense of relief.

In contrast to this slackening, the supply and demand balance in early 1979 was precarious. The Iranian oil disruption broke up the complacency of industrialized countries and heralded

the arrival of the supply constraints of the 19805.

It brought home the message to industrialized countries of their alarming dependence on increasingly uncertain oil supplies. It highlighted the difference between a crisis o£ supply and one of rapid real price increases.

In 1979 other (ZDGS increased output towards capacity to help ease the crisis. Meanwhile, oil consumption and stockbuilding in industrialized countries grew apace. That spring IEA countries agreed to reduce demand on world markets by 58 from anticipated "pre-Iran' levels. This action was matched by similar agreement by *EEC* countries (i.e., including France). At the Tokyo summit of the Seven and the EEC summit in June 1979, the participating countries reaffirmed these actions by agreeing i) to oil import targets for individual countries, and ii) to discourage trading on the oil spot market which was overheating.

Both IEA countries and the Seven summit countries also agreed to a set of principles on energy pricing, conservation, development o£ coal trade, expansion of nuclear capacity, RD&D, and the development of alternative sources of energy. IEA countries agreed to a yearly review of their progress in achieving long- term aims and commitments

Despite all these measures aimed at concerted action, there was strong competition for oil. International nil prices surged during 1979, pushed upwards by both the momentum and uncertainty of the Iranian situation and by panic buying. Oil companies and traders bought heavily on the spot market at prices approaching $40 per barrel (i.e., several dollars above official export prices) in an effort to replace oil previously available through traditional supply channels. FR Germany, Japan, and Switzerland were able to buy oil with their strong currencies. Transactions at spot price grew rapidly to become 25-30% of international oil trade, as opposed to the 3-5% previously characteristic of the spot market. Meanwhile, the differentiation between long-term and spot deals became increasingly blurred in oil supply contracts.

The US imposed a $5 entitlement program in May 1979 to entice ln.ck Caribbean oil *which* they believed was being diverted from them to the more profitable Rotterdam market.

Competition thus led to a doubling of oil prices during 1979. This contributed to tower economic growth and higher inflation and unemployment, while it added no new oil to the market. It only highlighted the weaknesses of the industrialized countries to deal with rapid real price increases, for which no policy or emergency mechanism existed.[t]

E. Impact of Oil Price Increases on Industrialized Countries' Economies, 1979-80

The rise in international oil prices during 1979-80 contributed adversely to the overall level of prices, balance-payments, and economic activity in the industrialized (and other oil-importing) countries. The OECD ministerial communiqué of June 1980 suggested the likelihood that by end-1981 "the direct and indirect effects of the oil price rise will be to pull real income in the OECD area down $400 billion, nnre than 5%, below what it would otherwise have been. They will also push inflation up by several percentage points and swing the balance of-payments to a deficit of about $75 billion in 1980 compared to a $10 billion surplus in 1978. For the developing countries, added to the depressing effects of the oil price increase, there will be the impact of the slowdown in the OECD economies which constitute their principal markets. "g

i. Inflation

Taking into account price increases of oil produced outside the OXDCs, the IMF estimates that the direct impact on the general level of prices in oil-importing countries from 1978 to 1980 might be about 43,%.h This pass-through could take about a year to be completed. In addition, there are indirect (secondary) effects of the oil price increases. These include (a) price increases which result from higher wage demands subsequent to higher retail oil prices and (b) price decreases for non-oil goods which my jnssibly result from lower economic activity induced by the oil price increases. Moreover, prices of energy products other than oil have typically risen parallel to those o£ oil.

Hence, the total impact on the overall level of prices is considerably greater than the direct impact of oil import prices themselves. Inflation in oil-importing countries is passed on in prices of exports of goods and services to developing countries including OXDCs. Inflation in industrialized countries hurts everyone; this pleases no one and creates conflict in North. South of North-South trade.

At the OECD ministerial needing in June 1980, it was noted that priority will be given to containing the current surge of inflation "which has resulted vainly from the external shock of higher oil prices." It would be a serious error to relax tight dromedary and fiscal policies until the current surge in inflation has demonstrably been brought under control and the consequences of higher oil prices are fully absorbed.

At that needing the OECD Secretary-General stated that "the policies we shall have to follow to cope with our inflation and energy problems are bound to mice life rare difficult for the developing countries.... We must be concerned lest the required adjustments tax the fragile economic, social, and political systems of these countries beyond the breaking point. Paradoxically, action to mitigate the impact of slowed OEeD growth on developing countries is nore difficult, in the current circumstances, but it is *very* much in our own economic--and wider political--interests to th all we can to lighten the load on the developing countries." The immediate policy priorities are clear, he continued:

- We must keep our markets open. We must be ready if need be to strengthen the financial system to cope with the expanded financing needs of the developing countries.
- We must increase our aid, particularly to the poorer developing countries.

ii. Reduced Economic Growth

The rise in oil prices from 1978 to 1980 has raised the export earnings of OPEC countries by about US $170 billion. Of that amount, the IMF estimates that the industrialized countries would absorb something like $155 billion." This diversion of industrialized countries' purchasing power into oil imports will be deflationary on their real economic activity. As a rough guide to the size of the direct deflationary impact, the increase in their current

Account deficits (goods, services, and private transfers) during this period will to about $8O-85 billion. To this should be added the short-term deflationary effect o£ domestic oil price increases. Together, they are estimated by the IMF to represent a direct impact of about 2% of GM' in oil-importing countries. In addition, there are short-run multiplier effects of a deflationary nature. However, for some countries this estimate nay be too high, to the extent that they use funds recycled by OXDCs to international markets.

Globally the oil-importers' deficits are the counterpart of the surpluses of the capital-surplus oil-

exporters. Although each oil-importing country has powerful reasons for wanting to extend exports and restrain imports, they cannot all succeed simultaneously while the oil surpluses persist. The attempt to do so through uncoordinated do Septic deflationary Policies will slow world economic growth even gore. Because of their weight in the world economy, the World Bank advocates that industrialized countries should maintain growth to the extent that this is compatible with addressing problems of inflation, recognizing that this involves large deficits.'

There is a great disproportion between different groups of countries, in as much as industrialized countries have great ability to consume oil, while not all OXixs have the ability to buy a balancing value of goods and services. The additional flow of saving to the OXBOs that cannot be used domestically in the immediate future must be recycled efficiently, w as to offset the decrease in saving and to sustain investment in the rest of the world. The net short-run impact will be deflationary for the world as a whole and more 9J for the oil-importing countries. In the longer-run, adjustment of investment spending will occur, and exports of goods and services to Oxalis will take place. Both effects will reduce the initial deflationary effect of the oil price increases.

Oil-importing countries must tackle problems of adjustment annng themselves, caused by their differing dewndence on oil imports and their differing ability to attract foreign capital. Adjustment to oil price increases worsens the tendency to stagflation in industrialised countries. Workers resist a reduction in real income by demanding inflationary wage increases. Government attempts to rroderate inflation through nonetary restraint nay lead to recession, as real interest rates are forced up and investment falls.

Global economic adjustment in the 1980s is generally expected to prove fore difficult than during 1974-78. First, as noted by the World Bank, capital surpluses of rag (ZX's could stay at a high level for longer than in 1974-78, because a) Toxics nay pursue fore conservative development programs and hence expand imports less rapidly than previously and b) the real price of oil is widely thought likely to rise. Second, the prospects for capital flows are less favorable. Third, the industrialized countries face more serious difficulties than during the mid-1970s. No quick economic recovery can !~ expected. Governments have decided that inflation must (fltK down before rapid growth nay be resumed, and that deflationary measures must be pursued. Productivity has slowed sharply for reasons including incomplete adjustment to higher energy costs, sluggish investment, and a mismatch of skills in the labour nurket, which cannot be rectified easily.

iii. Current Account Deficits

A sustained recovery of the world economy from the slowdown expected during the next few years will in the World Bank's view depend largely on policies pursued in three areas of international concern: energy, trade, and capital flows. It notes that all economies will have to adapt to higher energy prices. The long-ten outlook is uncertain, but a prudent energy policy should assume that real energy prices will rise for the foreseeable future. What happens to prices will be determined by trends in energy conservation and production. It also cotangents that frost industrialized countries will run current account deficits in 1980. How they respond to these deficits will largely determine the climate for world trade. If they all simultaneously attempt to restrain implants while boosting exports, shrinking markets for each others' exports will defeat their purpose, and world trade and output will suffer, as happened in acute form in the 1930s. Avoiding an excessive slowdown in world trade and output in the early 1980s requires that industrialized countries run larger deficits, and for longer.

OEQI ministers agreed in June 1980 that "member countries, as a group, will have to accept a large but diminishing current account deficit, corresponding to their share of the counterpart of the OPEC surpluses, for same tip to come. All countries will have to pursue policies designed to reduce inflation and to promote structural adaptation to *higher* energy prices. Those countries which have no difficulty in external financing

should refrain from taking policy measures specifically aimed at reducing current account deficits."

The present size of current account balances and the prospect for their continuation raises imlnrtant issues for global financing. In the IMF's view, the main financial problem could 6e the recycling of funds from the major financial markets to the smaller industrial countries as well as OIDCs. *Much* of this recycling has been done through nediumterm loans by commercial banks. This worked well in the past but could be constrained in the future. While the current account balances of major industrial countries *nay* not be a source of concern for recycling, the smaller industrial countries may need m make a prompt start to a medium-term adjustment of their economic structure, in order to finance their current account deficits. Industrialized countries have a large combined deficit which is expected m remain large for a number of years. Attempts by any one country to cut its deficit can only increase the deficit of other countries.

F. Recent Energy~ Strategies of Industrialized Countries

In May 1980 EEC's European Council) passed a resolution on Energy Illicit Objectives for 1990, while in June 1980 first the OECD ministerial meeting and then the Seven agreed on sore comparable energy policy objectives. The comparability is not surprising, given that four of the Seven are EEC members and, except for France, all are lEA members. Moreover, all EEC and TEA countries are members of OECD.

i. Energy Pricing Ibices

Raving said that "the oil price increases in 1979-80 are severely damaging the world economy" and stressed "the serious damage that round be done by further large and sudden oil price increases," the OECD meeting in June 1980 and the

preceding meetings of the EEC and IEA stressed reliance on the price mechanism. The EEC said that consumer energy prices should "reflect" the world nurket, taking account of longer-term trends, and that one determinant should be the cost of replacing and developing energy resources. The Seven stated that domestic prices for oil should "take into account" representative world prices.

Energy pricing Filicides in industrialized countries are complex problems. Oil-imp rtirg industrialized countries are almost all pledged to using the price mechanism as [art o£ their energy policies. But such a tool, as with taxes, tariffs, and quotas, is linked to a range of domestic policies. At least one Western government has fallen due to this issue. Indeed, s>rte believe that taxes and use of the price mechanism are detrimental to the fight against inflation. Yet there can be little doubt that energy prices which reflect the long-run replacement costs o£ oil would be extremely useful in solving the energy problem.

ii. Official Stockpiling

Industrialized countries have stockpiled crude oil and products, often as part o£ treaty obligations which set legal minima. Official stocks are *seen* as a buffer from crisis. But, as ~.id earlier, rapid stock build can help force up prices. Indeed it may lead to undue confrontation when *seen* as a political lever. Given the strategic nature of such stocks, *they* would presumably be rarely run-down. The stock build places an upward pressure on the market, however inevitable it tray be. Panic buying *try* oil importers can hit international trade in time of crisis. Equally severe are the similar pressures on oil supplies from consuner stockbuilding, such as the towing up of gas tanks.

Concerted and constructive stork management policies are central to both good crisis management and good relations with ORBCS. For example, IEA and EEC governments in 1Tecember 1960 advocated that oil supply deficiencies resulting from the Iran-Iraq conflict should be fret by drawing down stocks rather than buying in an overheated spot market.

It should be added that stocks ~ta.y not solve the further problem of product imbalances. This occurs *when*

refiners lack flexibility to procure their desired slate of crude oils, whose yield would match the market pattern for refined products. This leads to gluts of some products and deficits of others, with consequent storage problems.

iii. Emergency Oil-Sharing Arrangements

Stocks form part o£ mechanisms under the auspices of the OECD, EEC, and SEA for the emergency allocation of oil. The TEA mechanism, for example, provides for triggering the allocation of oil on the basis of consumption patterns, drastic production, and other factors, if supply should fall below 7% of a set norm. Demand restraint and stock drawdown are elements in the allocation system. Such an allocation would be quite serious in tents of both cause and effect.

The 1979 oil disruption indicated the need for measures to be worked out for shortfalls less than the 7% level. The EEC terms such a state of affairs a sub-crisis. Like the LEA, it has begun to outline both voluntary and mandatory allocation measures for such sub-crisis. In May 1980, the TEA ~t up yardsticks and ceilings both to manage structural change to new energy sources and to deal at short notice with a deterioration in the oil market, i.e., sub crises of supply. Such reassures are designed to permit monitoring and quick action.

iv. Oil Import Ceilings

Some constructive steps were taken by the IEA Governing Board in December 1979, which agreed to establish specific oil import targets for individual countries for 1980, tightened import goals for 1985, and agreed to rigorous tnnitoring. Lt also agreed to develop an equitable system of adjustment of targets if the oil market tightens up, and to continue coordinating their stockbuilding programs to avoid putting undue pressure on world oil supplies.

The LEA and EEC agreed secretly to examine possible means for bringing fore stability into oil markets, including a registration system for all international oil traders and a code of conduct for behavior in oil trading, which would be enacted in times of erratic oil target behavior.

The LEA countries' overall ceiling was set for 1980 at 24.5 con b/d (or 23.1 nun b/d excluding bunkers) and for 1985 at 26.2 con b/d (or 24.6 nm b/d excluding bunkers), compared with estimated imports of 24.0 con b/d in 1979. The target for 1980 was easily net, given the decline in oil consumption. The target for 1985 looks achievable, provided that oil

consumption in flavor industrialized countries continues the decline of 1979-80. But the target is also too high, as future oil import availability to industrialized countries could be reduced by import demands of OIDCS and Eastern Europe and by possible export policies of (ZWs.

At the IEA ministerial fleeting in May 1980, flamers saw potential for substantially under-shooting the 1985 target, by 4 con b/d in the Secretariat's view, a view noted in June 1980 at the Venice summit fleeting of the Seven. Members agreed to continue efforts to reduce oil inwards beyond 1985.

v. Increased Energy Efficiency and Accelerated Non-oil Supplies

In mid-1980, the EEC and the Seven separately agreed on the need for improved energy conservation and accelerated supply and the use of energy other than oil. The Seven estimated their potential at 15-20 con b/d i.e. during the decade.

Both EEC and the Seven expected that oil would be reduced by 1990 to 40% of total primary energy consumption. The Seven expected that their collective oil consumption would be significantly below present levels so as to permit a balance between supply and demand at tolerable prices. They also envisaged that the energy coefficient could be reduced by 1990 to 0.6, while the EEC's guideline is 0.7 or less; the difference flay reflect the greater mom for energy wing in North America.

Coal has become a great expectation as a substitute for oil. The IEA in May 1979 followed up its 1978 retort on Steam Coal: prospects to 2000 by establishing its Principles for Action on Coal and setting up the Coal Industry Advisory Hoard, thus beginning efforts to strengthen coal trade and production. These efforts were subsequently endorsed at the Tokyo sunmit of the Seven in June 1979. In early 1980 the World Coal Study (WONL) was published, which advocated

Increases over the next 20 years in world hard coal production o£ 2.5-3 times and in steam coal trade of 10-15 titers 1979 levels. More ambitiously, the Venice summit of the Seven expressed the intention of doubling their coal production and use by 1990, and the IEA ministerial meeting of May 1980 sought recriminations for a similar doubling.

The replacement of oil by coal to any degree requires increased expenditures for infrastructure and coal burning facilities. Industrialised countries envisage the need for the US, Australia, and Canada to build up export capability, while Western Europe and Japan would conversely build up import capability. There are serious constraints to the development of coal (see Chapter I). They include the lack of consensus on environmental issues, for example air pollution and the accumulation of CO_2 emissions in the atrmsphere. It is conceivable that these constraints could rival those for nuclear energy. Despite these constraints, there is likely to be a substantial increase in coal demand and output.

The leaders of the major industrialised countries have supported nuclear energy, as stated at the Venice Summit. Indeed, French energy policy has emphasised nuclear energy as the major thrust of its effort. But the industrialised countries' aspirations have encountered a whole range of serious difficulties, and there has been no slackening of resistance to this form of energy (see Chapter I). For example, even the partial victory of the "yes" side in the March 1980 Swedish referendum has not ended opposition there and only indicated a desire to see nuclear energy be phased out.

Vi. Structural Readjustment

The future economic success of industrialized countries depends largely on how well they manage the energy problem. They are increasingly vulnerable to uncertain supplies of energy. Illustrations are the recent accident at Three Mile Island, the New York blackout, the 1979 Iranian oil disruption, and the 1980 Iran-Iraq conflict. The challenge for the 1980s will be to find effective strategies for dealing with an oil balance, in which explants tram OPEC countries are at best expected to remain constant or could even decline, assuming that the

present structure is here to stay. The real

Issue at stake for industrialized nations is how they avoid destructive competition in the face of a tightening oil market. They have needed to develop pans for equitable burden sharing.

Energy is a ubiquitous factor in the modern economy. This produces problems for the industrialised countries, because energy has for so long been taken for granted as being in sufficient abundance to lx: rmit growth. Now it must be seen as a constraint, at least for the tedium-term. Such an energy-related upheaval has not taken place since the wood shortages o£ the seventeenth century in Europe oEe. Great difficulties remain in convincing large segments of the Imputation that the crisis is real. Successful conservation impends on such a realisation. In a sense, there is need to show that quality of life and reasonable expectations can still be net in a conservation-oriented world. However, there must be a change in sore values. The structural change needed in the industrialised countries is very deep. But these changes are being nude.

Policy solutions in most industrialised countries are perforce turning to increased energy efficiency and to the long-term possibilities for new and renewable energy forms to the extent practicable. I necrosis face three severe political problems in the energy field.

The first is due to the inevitability of elections and resultant promises. The tendency is to attempt to find short-term solutions for long-term problems, in short, palliatives.

The second is the ability of interest groups to receive a hearing, which is a fundamental right in democracies. This creates a political context for energy policy in which various interests tattle on energy issues. The validity of any particular interest group nay or *nay* not be correct, but such activity does complicate the process of energy decision-making.

The third and perhaps most crucial is the difficulty in improving people's understanding of energy-related issues and the need for better practices in energy use (see Qaapter 111.1.B).

Countries with sizeable dependence on energy imports will be concerned to have good relations with exporters, in order to keep continued and uninterrupted long-term access to imported energy at prices they consider reasonable and predictable. Industrialised countries are likely to pursue increasing diversity of energy import sources. They have also typically sought some *degree* o£ control over their destiny by setting up their own national oil companies and researching the merits of direct oil purchases from oil-exporting countries. Finally, nest industrialized countries row show concern for a revived dialogue with OXDCS.

G. North-South Dialogue from Northern Viewpoint

i. Conference on International Economic Cooperation

In 1974 the IEA appeared to most OPEC countries to symbolize the confrontation inherent in the energy crisis. But it was not intended by most IEA participants to be confrontational. For its pert, France's reluctance to I*reticulate reflected its preference to dissociate itself from the apparent confrontation and instead to pursue bilateral arrangements with OPEC countries.

These different perceptions were reinforced by the CIEC conference of 1975-77. That conference, called at France's initiative, ended in qualified failure. One cause was the North's reluctance to deal with all issues of concern to North-South relations. Instead, the North preferred to discuss the issue of prinary concern to itself, energy.'

The final report of the CIEC conference pointed out the areas of agreement and disagreement. Regarding energy, agreement was reached on a few simpler natters:

a. an assessment o£ the availability and supply of commercial energy,

b. a recognition of the depletable nature of oil and gas and the need for transition to renewable sources of energy,

c. the necessity for conservation and increased energy efficiency,

d. the need to develop all forms of energy, and

e. general conclusions and reconmendations for national action and international cooperation in the energy field.

Disagreement was pointed out on the real substantive issues, including:

a. energy prices and OXDCS' purchasing power from energy export earnings,

b. accumulated revenues from oil exports,

c. financial assistance to bridge external payments'

difficulties of oil-importing countries,

d. recommendations on resources within the UN law of the

Sea Conference, and

e. continuing consultations on energy.

ii. **Subsequent Efforts towards Cooperation**

Fortunately, cooperation has begun to replace confrontation. Some real efforts have been made to cooperate on non-political technical subjects.

The 1978 IEA Workshop on Energy IAia in Developing Countries included rurticipation by QKDCS and OIDCs. The IEA has a current RD&D project with Mexico in the field of geothermal energy. The 1979 OECD report on renewable energy technology for developing countries was also an effort to find means of technical cooperation devoid of politics.

The EEC has begun a concerted effort to provide financial and technological assistance to OIDCS. Such efforts were embodied in the Inure II convention of October 1979. It agreed on cooperation between the European Community and 58 African, Caribbean, and Pacific nations on a broad range of issues, including the field of energy. However, this did not include Latin America. In fact, EEC aid in the energy field in absolute terms is second only to the World Bank. In a role political sphere the EEC is renewing efforts for a Euro-Arab dialogue.

At their Venice summit meeting in June 1980, seven major industrialised countries advocated increased financial aid for energy to OIDCs, and an international energy financing

Facility to undertake ft. They asked the World Bank to examine the adequacy of the resources and mechanism now in place for the exploitation, development, and production of conventional and renewable energy sources in OIDCS. This includes the possibility of establishing a new affiliate or facility by twitch it might improve and increase its lending program for energy activities. They asked the World Bank to explore its findings with oil-exporting and industrial countries. The Seven welcomed the Brandt Commission report and undertook to consider its recommendations carefully.

Ii Renewed Interest in North-South Dialogue

There is a growing realisation that a) economic disaster in the industrialised countries and b) the well-being of developing countries both affect the whole world. The North-South dialogue in its several for is an effort to deal amicably with issues of Joint concern to both industrialised countries and developing countries, whether they be oil-importers Or exporters.

In 1980 the (JEDC, EEC, IEA, and the Seven separately called for a constructive consuner-producer dialogue. In recent months a number of industrialised countries have expressed increasing interest in resuming some kind of North-South dialogue. This looks likely to the underlying theme in summit meetings in 1981, including a) the mini-summit of about 25 developed and developing countries planned for October 1981 in Mexico City, and b) the seven industrialised countries' meeting of July 1981 in Ottawa. This is all additional to attempts to launch the UN global negotiations on international economic cooperation for develop it .

There have been nanny difficulties in reaching a consensus even among industrial countries 1n the field of energy, but there has been willingness to overcome them. A North-South dialogue will encounter similar difficulties, but much can be achieved if there is a comparable willingness to solve them as the industrialised countries. The work

* Canada, France, FR Germany, Italy, Japan, United Kingdom, and the United States. All except France are members of IEA.

Already begun on technical cooperation, in areas devoid of political content, presages well for the future.

4. CONVERGENCES AND OJNFLICTS

A. A Review of Interests--National and Global i. The National Energy Interests o£ the OIDCs

To 6e gin with, it is task to the national security of most OIDCs that they have enough oil to meet the needs of their economies. Typically, these neaps a quantity growing at perhaps 6% p.a., to support their rapidly growing modern sectors and in sane cases to nest needs in their traditional sectors that depleting wxdfuels can no longer fill. It is also important that oil imports be reds available on financial terms which will not leave the OIDCs with crushing debt burdens. Most OIDCs are in the midst o£ a transition from traditional fuels to rare modern fuels. At the same tine, they must soon hake a transition from oil to renewable and other rare plentiful sources. Each of them reeds to learn as soon as possible what these successor sources will be, and whether they can shift directly from traditional fuels to those successors without an intervening period of oil use.

ii. **The National Energy Interests of Oil Exporters**

These nations annul like to maximize their earnings from oil explants. It is not clear whether this can be done best by changing prices frequently and in small increments to charge what the market will bear, or by permitting prices to fluctuate wildly as they did in the 1970s.

A second related goal is to protect the value of their export earnings, perhaps by accepting Payment in a form whose value is maintained by large oil importers or the IMF, and perhaps by converting such earnings into investments at hone, in industrialised countries, or in insured investments in the Third World.

A third closely connected goal is to keep control of their oil resources--a control won only recently and hence jealously guarded. This includes control over prices, production rates, and allocation anang consurters.

Fourth, oil exporters need to sake a transition to the post-oil era. This means that their economies must be strong enough to withstand the reduction in earnings Fran oil exports. It also neaps that energy works most be available to take the place of oil for internal use in these countries.

A fifth goal which they have expressed is to expand their internal oil-producing capacity. This will give them greater knowledge about and control over their oil resources.

At least some oil exporters are eager to gain access to markets in industrialised countries for their processed raw materials and manufactured exports. This includes such goods and services as oil shipping, fertilizers, and other petrochemicals.

Several o£ them are concerned that demand from the industrialised countries is forcing them to produce oil at a faster pace than is warranted either by the goal of maximizing oil extraction or by their economic goals. Hence, they support the idea of oil conservation especially in the large

Industrial countries.

Finally, oil-exporting countries and OPFC countries as a group have called for reforms in the international economic order. From time to time experts from oil-exporting countries have suggested that any negotiations on oil must be linked to such reforms.

iii. **The National Energy Interests of Industrialised Countries**

The chief energy concern of the industrialised countries is to have a reliable supply of oil. Some of them hops to achieve this by securing a political commitment from one or nine producers. Others have urged that productive capacity be expanded in their own jurisdictions, or elsewhere in the world.

Another energy goal comm to rtost of these countries is to achieve orderly prices for oil. Orderly prices according to some views have meant cheap prices. But increasingly, the view is heard that orderly prices may mean rising real prices along a trend line that avoids sharp fluctuations.

A third energy goal is to mvke a non-traumnttc transition from oil to renewable and other lore plentiful energy sources.

tv. **The (barn Energy Interests of the World Oxmnuntty**

The first goal shared by all nations is to keep the world economy performing well. To do so requires ~veral successful efforts.

The second goal shared by the community of nations is to Rake the transition from oil to renewable and other more plentiful sources of energy tefore jtysical shortages of oil have inflicted damage on the world economy.

The third common goal is to resolve our common energy problems in ways that protect the world's ecosystems, notably the planet's forests, soils, streams, lakes, oceans, and air.

B. **Converging and Obnflicting Approaches to these National and Global Goals**

Insofar as international actions are concerned, four steps are essential'L

i. to ensure an adequate supply of oil to each nation, ii. to keep the prices of oil orderly,

iii. to keep the trading system open, and

iv. to keep the foreign exchange earnings of capitalsurplus countries recycling throughout the global economy.

In addition, actions by nations (particularly the largest economies) to avoid inflation and recession are critical to the health o£ the world economy.

We will briefly examine each of these four international actions, and identify those approaches to each which are likely to cause conflict, and those where the national interests o£ the several parties are likely to converge.

i. **Ensured Supply of Oil**

In the medium to long-term, the least contentious approach to a reliable supply of oil is to expand world oil production capacity. Judging from the stated pDsition of the several parties, oil-exporting nations *very* much want to expand their capacity; clearly DIDCs would like to do the same; many industrialised countries are providing incentives to their people to cb likewise; and OPEC nations have expressed preliminarily their interest in joining other nations to start a new program to help OIDCs develop their oil and other energy resources. In sum, a nnjor program to expand world oil supply should be relatively non-controversial.

Another approach to energy supply reliability applicable to the OIDCs would be to help finance their oil imports. Even if world oil supply is adequate, a number of Outs nay be threatened with supply shortage for want o£ financing to pay for oil on terms they can afford. There is no great disagreement in principle over the proposition that the world should help OIDCs finance their oil imports. One s>,newhat controversial proposal is that exporters should sell oil to OIDCS at world prices but on long-term credit at low interest rates (much as the US does with food under P.L. 480). Another proposal that has generated nothing but opposition among oil exporters is for them to sell oil to OIDCS at special low prices.

A very controversial approach to supply reliability is the proposal that oil producers agree to an international

covenant that limits their unilateral control over oil products and exports. OPFE countries, long frustrated by having their oil in foreign hands and only recently having won control, are exceptionally sensitive about any proposals which would reduce their unilateral control over their oil.

The method of ensuring supply reliability being followed by the largest industrial oil importers is to rake bilateral arrangements with individual oil exporters. For example, the largest importer, the US, gives particular attention to its bilateral relationships with Saudi Arabia and Mexico. Likewise, Japan and the several European countries rely on bilateral understandings with oil suppliers. There are two defects in such an international system. First, it is not clear that any o£ these bilateral understandings would last in the event o£ a serious shortfall in supply. One can anticipate keen competition in such an event, and it is likely that producers would tend to review their own positions anew, seeking to serve their own self-interest, rather than considering themselves bound in perpetuity by Fast understandings. The second defect is that a system of competing bilateral understandings tends to leave small importers and financially weak countries out of account.

The industrialised country members of the International Energy Agency have also sought to improve their oil supply reliability by agreeing among themselves on an

emergency system of allocating oil in the event of a shortfall. Some industrialised countries have begun a program of stockpiling oil, but this has prompted OPEC nations to threaten retaliation because they do not wish to lose any of the leverage given them by the dependence of oil importers.

Finally, OPEC's Long Range Strategy (which is still under review) suggests that developing countries be given priority over the industrialised countries in the allocation of oil. OPEC officials are giving thought to the mechanics of an allocation system to give effect to this intention.

It is not easy to find a short-run reliable way to correct this patchwork of arrangenents. Even if OPEC were willing to agree to a long-term binding guarantee not deliberately to cut supplies below a stated level, it would require an unusual degree of discipline among its members for the agreed supply level to be net. Nevertheless, because of the importance of reliable supplies o£ oil, the dialogue between oil exporters and importers should not cease to search for acceptable formulae that would help.

The one step which would be effective and probably could be agreed upon is to launch a program to expand oil production capacity in OPEC and non-OPEC countries. This would take several years to bear fruit. Meanwhile, oil importers must live with a degree of uncertainty, a condition that could be improved relatively quickly by conservation efforts.

ii. **Orderly Prices for Oil**

Many experts believe that the level of oil prices is not as important as the sudden, unpredictable, and uneven pace of change. While they accept the need and desirability of continuing increases in real prices, they believe that the inflationary impact could be substantially reduced if these price changes occurred in strap, predictable increments. It must be conceded, however, that a large strand of thought in the governments and pablics of the North believes that the problem is one of absolute levels of oil prices; that the OPEC "cartel "is forcing artificially and unjustifiably high prices. This does appear to be a declining point of view, as the weight of opinion grows that prices are in fact determined by the buyers' competition for available oil and that the official prices set by OPEC countries merely confirm what the market has already determined.

some proposals have been made, which would help gradually to moderate prices and would have a good chance of being accepted. These include proposals a) to cut demand for oil by conserving and by increasing the production of alternatives to oil, and b) to increase oil supplies by stepping up exploration in all prospective countries.

The most controversial proposal is that there should be multilateral negotiations of a price formula which would be binding upon oil exporters. The reaction of these nations to such a proposal is as negative as their reaction to proposals for a negotiated formula for oil supply and for similar reasons: having only recently gained a degree of control over the prices of oil, they do not want to lose it.

OPEC countries are reviewing the merits of introducing a system o£ unilateral orderly increases in oil prices, linking them to the rate of inflation and growth of real GNP in industrialised countries. The formula would constitute a floor price for oil rather than a ceiling or a target. But if the ceiling is the result of competition among buyers (as suggested atove), perhaps the floor price would not to tar from the ceiling.

OPEC has prepared a table indicating the price at which oil would have sold, if the floor price had represented the actual price since 1974.

TABLE II-11: FLOOR FORMULA PRICE 1974-80

YEAR	INDIX (1973:100)	PRICE ($ per barrel)
1974	116.8	10.84
1975	136.5	12.66
1976	143.0	14.80
1977	164.4	15.50
1978	195.5	17.82
1979	223.8	21.19
1980		24.25

Note: Index is the aggregate of inflation, exchange rates and GNP changes. The base is the actual price for 1974; other prices are derived by applying index.

Source: f troleum Intelligence Weekly, May 12, 1980, Suppleri nt.

This clearly shows a much nore orderly price progression than the prices which actually prevailed. The unilateral price formula could be o£ value to world economic stability, if the floor were to approximate the ceiling. Vigorous efforts by all parties to exEand productive capacity of energy and to restrain demand would help ensure that it did.

iii. **An Open Trading System**

If shortages and price gyrations of oil cause recession, unemployment, and foreign exchange crises, sore countries will be tempted to impose restrictions on fmpcrts. This could trigger retaliatory trade barriers that would greatly nugni£y the damage to the world economy. Even without such oil-induced disturbances, trade lBrriers already exist which are especially burdensome to developing countries that do not have economic strength to protect themselves. Quotas are imposed on some imports from developing countries, and e) are tariffs which escalate with the degree of processing or fabricating. This is burdensome to countries which hope to move from expDrting raw nterials to finished or nunufactured goods but find their experts of such goods penalised. Several proposals have been nude, including elimination of tariff escalation, and rebates to developing countries of all revenues collected from tariffs on imports from those countries. Because of rising unemployment, industrialised countries will find it politically difficult to accept proposals which would accelerate the rate at which their workers are displaced by imports. Tariff rebates nay be less controversial, but it would be difficult to ensure that they were not offset by matching cuts in aid programs.

proposals have been nude and ls.rtially adopted which would support the health of the world economy by smothing out price swings of raw materials and ensuring to rome extent that such prices were not too low. These commodity agreements have been difficult to operate, although there is not much opposition to them in principle.

iv. **Money Recycled Efficiently**

Recent rises in oil prices together with sustained denund will mean that total costs of oil traded internationally in 1980 will come to about $290 billion. This is more money than oil exporters can spend in the short run. Thus, surplus foreign exchange in 1980 (before official transfers) in the hands of major oil exporters is estimated by the IMF at about $115 billion. This is mostly in the hands of half a dozen capital-surplus exporters: Saudi Arabia, Kuwait, Qatar, UAE, Iraq, and Libya. The corresponding deficits are basically in the industrial countries ($52 billion), some minor OXI7Cs ($6.5 billion), and OID s ($62 billion). Unless these surpluses are moved quickly into use, the result will he economically depressing, like a giant tax suddenly imposed without notching expenditures. Recycling can take place when the surplus dollars are borrowed by persons or institutions that invest them, ¢ when the owner of the surpluses invests them directly. Over tine, the surplus countries' denend for imports will also reduce the surplus, but this does not help in the short-run. Much o£ the surplus will be recycled routinely by fire tanks where it is deposited. They lend it to investors, especially in the industrialised countries. But a large Iart of the deficit is to the OIBCS. Unless a proportionately large share of the surpluses is recycled to the *Owes,* the tax-like depressing effect would hit them and be radiated to the rest of the world. But Ianks may to reaching the limits to which they can rrudently lend to such countries, and in many cases those countries have never established credit in the industrialised countries' rroney markets.

A number of ideas have been evolving to deal with the recycling problem. To begin with, the industrialised countries could greatly expand the r,overo nt of funds to creditworthy Third World nations, by establishing a facility to rediscount debts of such countries held by the tanking system of industrialised countries.

For years, ideas have Lien discussed involving World Bank participation in a program to guarantee against default the Iwnds of Third World countries which are placed directly on the public bond markets of Northern countries. Proposals are also being discussed to expand the IME"s activities in deficit countries. Each of these three general approaches would be of most use to countries which can afford to Iay commercial rates. Except for the tMF, these s:wrces would be available only to countries which have established credit ratings in international money markets.

At least two kinds of proposals vrould b useful to countries without established credit and without ability to pay camnercial rates. One would be for an established institution such as the World Bank Cr SME' to crake loans with very low interest rates and long repayment periods to such countries. 'the F1md a *Bank* might borrow the money for those loans directly from the surplus countries. Another approach is represented by the OPEC staff proposal to expand the OPEC Special Fund into an international aid agency with capitalisation of $20 billion. These are only a few of the navy ideas that have been suggested for recycling funds. The main job will, of course, continue to be cbne by the private tanking

system. None of these ideas is particularly controversial. But it is by no reaps certain that any satisfactory program to recycle funds will be approved, because the self-interest of the economic powers in recycling money is not widely perceived outside the ranks of nunetary specialists.

C. The Goal of Making a Transition to More Plentiful Energy Sources

The entire world shares the problem that oil and gas will one day be depleted. It therefore shares the goal of making a transition to renewable and other more plentiful sources of energy before oil and gas supplies fall short. Four actions can help in this transition: i) to conserve energy, ii) to find fore oil in order to allow 'rare time for the transition, iii) to find, invent, develop, and deploy alternative energy aMirces, and iv) to adjust the price of oil and other energy forms relative to one another. In addition to these four worldwide actions, OPEC nations *have* a special problem of preparing their economies for the loss of revenues in the Inst-petroleum era. These five topics are discussed in the following paragraphs. in OPEC countries; ...and the lifting of trade barriers on non-oil exports from oil-producing countries" (PIW, May 12, 1980, Supplement).

Rational pricing is critical in every step of the transition from oil and gas to successor energy sources. If prices are too low, the less accessible deposits of oil and gas will not be sought or, if found, they will not be exploited. Secondary and tertiary production will not be pursued. Heavy oil will be left underground. In short, the right price is important to finding rrore oil. It plays an equally important role in the conservation of oil_ In navy cases it cost *money* to save energy (insulation, new machinery, etc.). An investor (e.g., a horeowner or a businessman) typ'cally will calculate how much money he will save annually by investing in energy efficiency; and he will rake the investment i£ it will pay off in a short period but not if it takes many years. If the price of energy is high, the annual savings are greater; and so it nay ply to make an investment which would not he warranted when energy prices are lower. Virtually the same calculations are at play Women entrepreneurs consider investments which would replace oil. I£ a solar hot-water heater is paid for in five years by saving natural gas, some nay regard it as a good investment, but not if it takes 15 years. The investment decision ray depend on the price of natural gas.

Pricing is likewise important to OPEC countries' effort to prepare for the decline o£ oil. So long as gasoline sells for $0.12 a gallon, it is likely that their economies will quickly become deeply dependent on petroleum, raking it that much harder for them to make the transition.

I). The Goal of Preserving Earth's Ecosystems

Certain of the world's ecosystems ray be threatened by the energy choices node by nations, businesses, and individuals. Forests and other ground cover are threatened in some places by the demand for woodfuels. Deforestation and devegetation in turn may lead to soil erosion, reduced watertables, downstream siltation, flooding, and desertification. The construction of large dams for hydroelectric power destroys river valleys and in some cases nay bring waterborne diseases to a region. Nuclear plants ray lead to ocean dumping of low-level radioactive wastes, which are a threat of unknown proportions to ocean life. They involve a) threats of

nuclear accidents which *nay retake* an area uninhabitable for long periods, and b) the problem of how and where to dispose permanently of spent fuels. Finally, decisions to trove to a coal economy or to synthetic liquid fuels made from coal or shale bring the likelihood of an increase in the earth's COL, together with a possible warming trend which could cause great dislocations on earth.

Although the issue of the earth's life systems is clearly important to all nations, it has not generated as runny proposals or as much intense diplomatic interest as issues of oil price and supply or of a New International Economic Order. There would probably not be much

controversy generated by proposals to protect and renew forests, to safeguard the oceans against radioactive dumping, or to study carefully the impact of building large dams. Clearly fore infornation is needed on the problem of CO_2 and nuclear spent fuel disposal before international action can be seriously discussed. But these are energy-related issues that rtey profoundly affect all of us or our descendants. There is strong convergence of interest in protecting the earth's ecosystems.

E. Maximising OPEC's Economic Gains

Each of the lore pressing demands of the oilimporting and industrialised countries has been dealt with in the three preceding sections. But the oil exporters have a strong interest which has not been covered: namely to maximise their economic gains. They wish to optimise their oil revenues. They wish to protect the value of these revenues. Probably nost important of all, they wish to keep control of their oil resources.

i. **To Optimise OPEC Revenues**

Much (lore study is needed to answer the question how OPEC countries' earnings can be maximized. How far could they cut production and raise prices without causing economic damage which would harm their own earnings? Clearly the health of oil-importing countries' economies is important to them. How can prices rise, without bringing substitutes into play and harming OPEC earnings? We cannot answer these questions; but interestingly, if the OPEC long Range Strategy Report's index had been applied from 19 OPEC countries The actual price rather than the floor price), Would have earned a cumulative $1,306 billion compared to the $1,218 billion they actually earned an increase of $88 billion (Table fI-12).

TABLE II-12: OPEC OIL PRODUC110N AND REVS UE

Year	Production (million b/d)	Actual Price ($/bbl)	Revenue ($ billion)	Price ($/bbl)	Revenue ($ billion)
1973	30.9	3.39	38.2	3.39	38.2
1974	30.7	11.28	126.4	10.84	124.8
1975	27.0	11.02	108.6	12.66	166.3
1976	30.7	11.77	132.3	14.80	175.4
1977	31.0	12.88	145.7	15.50	193.8
1978	29.8	12.93	140.6	17.82	237.4
1979	30.7	18.64	208.9	21.19	248.6
1980	28.0	31.00	317.7	24.26	
		1C7fAl.	1,218.4		1,306.0
		Difference		87.6	

Source: US Department o£ Energy, for product 12 an1980 for price; P1W, Special Supplement, May index prices.

The irony is that this formula nay also has been better for oil-importing nations. Although the annual cost of oil would have been greater by about $11 billion, we believe that this would have been more than offset by two factors: I) the oil price in 1980 might have been an indexed DH$24gh6 Rather than a sting teed $31 and ii) the price has been predictable, smooth, and orderly. There might not Necessarily have been any large increases in real prices, followed by declines and sudden steep rises. Fewer disturbances would have been caused to the global economy. Perhaps the formula ray offer part of the answer to the apparent conflict between OPEC countries' desire to optimize earnings and o s Importing countries' desire for orderly pricing. Not resolve the conflict between OPEC countries' desire to keep unilateral control over their oil and gas and oil importers' desire for assured supply.

Ii. **To Protect OPEC Revenues**

The second step in optimizing OPEC countries' economic welfare is to protect the value of their earnings. One o£ the forces which has discouraged capital-surplus

exporters from producing lore oil has been the fact that oil in the ground (appreciating in value) is a better investment than money (depreciating in value). It is asking too much of these exporters that they should sell more oil than necessary to cover their import needs and to hold the balance in money, unless the value of these funds can be protected.

One approach to protecting their value is to make it easy for OPEC countries to invest surplus funds in profitable ventures in industrialized countries. Some OPEC countries have shown interest in investing downstream, e.g., in shipping, refining, and distributing oil. This would also give capital-surplus countries a stake in keeping a reliable flow of oil to oil-importing countries and thereby keeping their own investment earnings healthy, a clear convergence of interests.

A second approach is to encourage OPEC countries to invest in Outs, where sore of the highest-paying investments are to be found. The problem is that such investments nay be risky. Reasons include less-developed economic infrastructure, immature money markets, unknown consumer demands, and sometimes uncertain government policies towards foreign investors. Hence OPEC countries nay are unwilling to invest in Orifices, unless means are found of sharing these special risks with other countries or international institutions, again a clear convergence.

OPEC countries are eager to put their surplus earnings into investments at home, including fertilizer plants, petrochemicals, oil refineries, and manufacturing plants. To the extent that such investments are in industries which already have unused productive capacity and therefore displace plants in the North or in Odes, there will be contention. This kind of problem needs to be worked out on case-by-case tasks.

Another idea for protecting surplus earnings is to pay them in bonds or other securities whose dollar value increases with the decline in the purchasing power o£ the dollar. A somewhat related proposal is that they be paid in SDRS. The SDR is valued according to a formula which includes the 16 leading currencies (five leading currencies as from 1981). Since a decline in value of any one of these currencies tends to be offset by corresponding gains in others among the 16 currencies, the SDR is unusually stable in value. Moreover, there is less risk that any sovereign government might freeze an OX DC's account, because the SDRS would be held on deposit with the IMF. This approach would also have the effect of strengthening the Imp's role in world Inking. None of these ideas generally provoke any great opposition in principle.

Of course, even with all these proposals OPEC earnings would not be completely without risk. Insecurity is to sore extent unavoidable not only for oil exporters but also for oil importers. The best one can tope for is to reduce it and rake it inures manageable through international cooperation.

Iii**. <u>To Retain OPEC Control</u>**

The third related objective of OPEC countries is to keep control over production and pricing of oil and gas. As noted above, they are especially ~nosedive on this point, because of long history o£ foreign control. They do not regard the issue of control over oil price and volume as negotiable in any eventual dialogue with oil importers.

It was suggested above that the indexed price formula (if an actual price target rather than a floor) could help resolve the price impasse, as it would be better for all parties than what has happened. The problem is whether it will approximate the actual price.

So long as there is no major interruption in oil supply and there are efforts by major oil importers to restrain demand, there is good prospect that the floor formula will become the actual price formula because the floor price will be continually revised upwards and may press against what the rocket will bear. But if major cut-offs do occur and demand outstrips supply, then the actual price is likely to

Exceed the formula price. This will be hard to prevent, even if there were a global negotiated and "binding" obligation upon OPEC nations to restrain prices. The spot market might simply become active, and the amount of oil Roving at official prices (which might indeed not exceed negotiated prices) would decline. It is *very* difficult to prevent any nation or entrepreneur (oil importers as well as exporters) from charging what a hungry market will bear.

Regarding control over production levels, OPEC countries' desire to control their own resources is in conflict with oil importers' desire for an assured supply. The Brandt Commission has suggested that "oil exporting countries... assure levels of production and agree not to reduce supplies arbitrarily or suddenly..." We believe that such an agreement is plausible if it is notched by such a commitment by oil importers to nest sons of the demands of OPEC countries discussed above.

F. **Prospects for a Negotiated Settlement**

The convergent interests of all parties are powerful indeed. They include such task goals as keeping national and international economies healthy, making a transition from societies based on oil to those relying on different energy sources, protecting the earth's life systems, and satisfying the special demands of oil exporter's s that progress towards the other goals can proceed. The conflicts do appear formidable, although they are fewer and less important to the life and health of the world and its inhabitants. They include the strong desire of OPEC countries to keep control over oil price and production, which is to same extent in conflict with oil importers' desire for certainty of supply and orderly prices. It is conceivable that OPEC countries, having developed a floor price formula, might be willing, in exchange for concession by oil importers, to prescribe a formula for a price ceiling or for a price target where the actual price would fall within the ceiling and floor. We believe it possible that negotiations between Execs and oil-importing countries could develop a formula to provide some insurance to oil importers against capricious supply interruptions. Given the importance of the stake which all nations have in cooperating, it is certainly worth continuing the dialogue in search of agreement.

This chapter discusses global opportunities in several areas, taking into account convergences and conflicts between the Birdies involved. There are opportunities in managing the remaining decades of oil, such as a) finding and developing oil and gas in the OIDCS, Polar Regions, and deep ocean water, and b) conserving oil production and consumption and improving efficiency in energy use. There are opportunities in pressing ahead with the transition from oil to other energy sources and technologies.

). **MANAGIM3 THE REMAINING DECADES OF OIL**

A. Development of Oil and Gas in the Odes

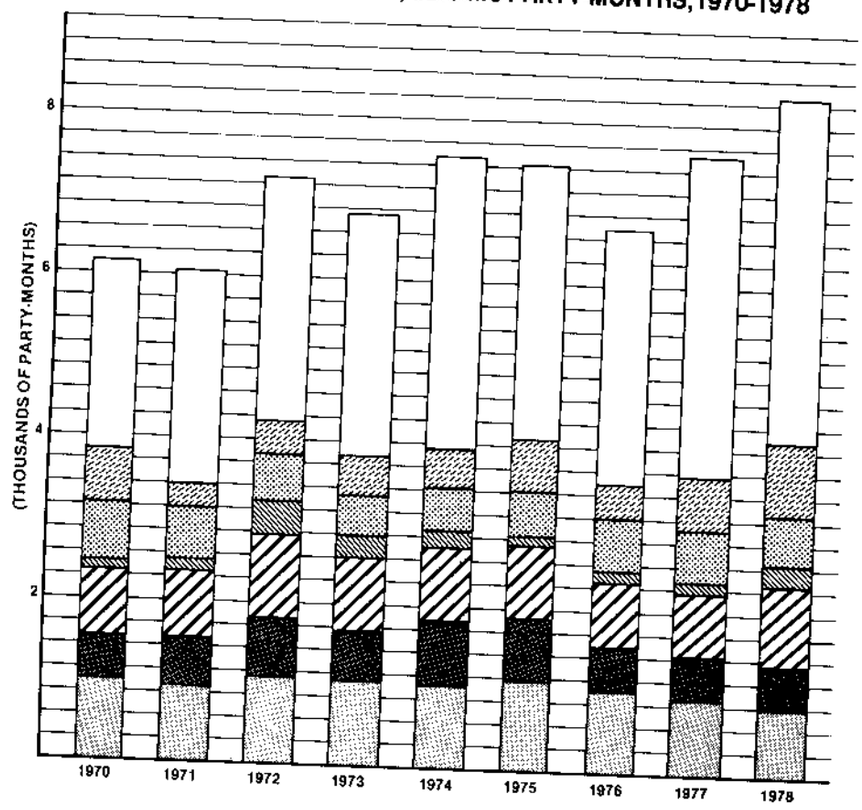
The development of oil and gas resources in Oxides is one of the few areas where there is, in principle at least, a clear convergence of interest between industrialized countries, oil-exporting countries, and the Odes themselves. Indigenous production of oil and gas in the Odes benefits all countries. Industrialized countries stand to gain because additional production in the Odes will take sane of the pressure of errand off limited supplies from exporting countries-a consideration to be weighed in the context of OPEC's guarantee to give priority of supply to other developing countries. The oil-exporting countries stand to gain from the decreased pressure on their depleting reserves and from fewer demands for financial assistance related to oil imports of the Odes. And of course the OIOCS stand to gain enormously from the balance of payments relief that increased production of indigenous energy would bring (oil imports will probably account for 40% of the Odes' merchandise exports this year).

Exploration for oil in developing countries is very far from having responded adequately to the price rises of 1973-74 and 1979-80. There are a number of reasons for this which is set out below, but the salient statistics on the exploratory and development record before

And after the 1973-74 price rises should first be recalled.

The average number of seismic partyynonths in OIDCs (including some c

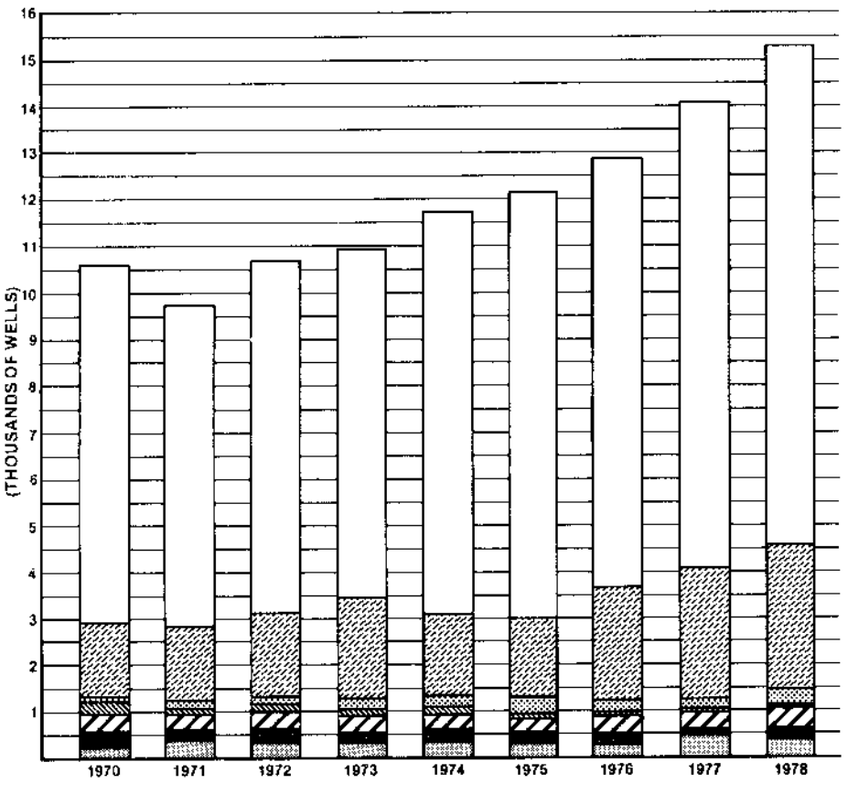
13. DEVELOPED AND DEVELOPING COUNTRIES: GEOPHYSICAL ACTIVITY, SEISMIC PARTY-MONTHS, 1970-1978



UNITED STATES
CANADA
WESTERN EUROPE
OTHER DEVELOPED
OPEC COUNTRIES
NON-OPEC:
OXDCs
OIDCs

Source: AAPG Bulletin, October 1979.

14. DEVELOPED AND DEVELOPING COUNTRIES: NUMBER OF WILDCAT WELLS DRILLED, 1970-1978



Source: AAPG Bulletin, October 1979, and Oil and Gas Journal, Annual December issues, 1970-1976.

To find conventional alternatives such as coal will take private incentives and, in some cases, governnent encouragement. To develop hydro will call for u jor capital inputs. To invent, develop and test non-conventional renewable technologies will take government and private HD&D efforts on a large scale. To nerket these technologies wiL1 take the combined and cooperative efforts o£ governments and private entrepreneurs. To develop and melee available improved traditional energy will call for important investments by public bodies working cooperatively with local institutions and individuals.

Fortunately, there is no opposition in principle to these programs. Major obstacles are governrent budget restraints, lack of trust between investors and public authorities, and imperfect understanding of the comma stake in the success of such programs.

iv. Prejare the Oil Exporters' Economies for the Transition

Oil exporters have needs similar to other countries in terms of expanding oil capacity, conserving oil (waste is apparent in some of these countries), and finding and deploying alternatives to oil. But oil exporters have another special transition problem: their economies have become dependent on earnings from the export of oil and gas. Their import bills for nachines, food, and services have soared. At the end of the oil era they will lose the oil revenues and need other economic activities to take their place, by moaning equivalent revenues or producing import substitutes. Hence one finds on OPEC nations' agenda for negotiation the goal of obtaining "free access to the markets of developed countries for refined products and petrochemicals; access to existing and new advanced technology and know-how needed by OPEC countries for development of their industries; ...the location of energy-intensive industries in areas of natural gas production in OPEC countries; ...and the lifting of trade barriers on non-oil exports from oil-producing countries" (PIW, May 12, 1980, Supplement).

Rational pricing is critical in every step of the transition from oil and gas to successor energy sources. If prices are too low, the less accessible deposits of oil and gas will not be sought or, if found, they will not be exploited. Secondary and tertiary production will not be pursued. Heavy oil will be left underground. In short, the right price is important to finding rare oil. It plays an equally important role in the conservation of oil_ In navy cases it cost *money* to save energy (insulation, new machinery, etc.). An investor (e.g., a homeowner or a businessman) typ'cally will calculate how much money he will save annually by investing in energy efficiency; and he will rake the investment i£ it will pay off in a short period but not if it takes many years. If the price of energy is high, the annual savings are greater; and so it nay ply to make an investment which would not he warranted when energy prices are lower. Virtually the same calculations are at play When entrepreneurs consider investments which would replace oil. I£ a solar hot-water heater is paid for in five years by saving natural gas, some nay regard it as a good investment, but not if it
takes 15 years. The investment decision ray depend on the
price of natural gas.
Pricing is likewise important to OPEC countries' effort to prepare for the decline o£ oil. So long as gasoline sells for $0.12 a gallon, it is likely that their economies will quickly become deeply dependent on petroleum, raking it that much harder for them to make the transition.

I). <u>The Goal of Preserving Earth's Ecosystems</u>

Certain of the world's ecosystems ray be threatened by the energy choices node by nations, businesses, and individuals. Forests and other ground cover are threatened in some places by the demand for wood fuels. Deforestation and desegregation in turn may lead to soil erosion, reduced water tables, downstream salutation, flooding, and desertification. The construction of large dams for hydroelectric power destroys river valleys and in some cases nay brings waterborne diseases to a region. Nuclear plants ray lead to ocean dumping of low-level radioactive wastes, which are a threat of unknown proportions to ocean life. They involve a) threats of

nuclear accidents which *nay retake* an area uninhabitable for long periods, and b) the problem of how and where to dispose permanently of spent fuels. Finally, decisions to trove to a coal economy or to synthetic liquid fuels node from coal or shale bring the likelihood of an increase in the earth's COL, together with a possible warming trend which could cause great dislocations on earth.

Although the issue of the earth's life systems is clearly important to all nations, it has not generated as runny proposals or as much intense diplomatic interest as issues of oil price and supply or of a New International Economic Order. There would probably not be much controversy generated by proposals to protect and renew forests, to safeguard the oceans against radioactive dumping, or to study carefully the impact of building large dams. Clearly fore information is needed on the problem of $\circ_2$ and nuclear spent fuel disposal before international action can be seriously discussed. But these are energy-related issues that rtey profoundly affect all of us or our descendants. There is strong convergence of interest in protecting the earth's Ecosystems.

E. Maximizing OPEC's Economic Gains

Each of the lore pressing demands of the oil importing and industrialized countries has been dealt with in the three preceding sections. But the oil exporters have a strong interest which has not been covered: namely to maximize their economic gains. They wish to optimize their oil revenues. They wish to protect the value of these revenues. Probably nest important of all, they wish to keep
Control of their oil resources.

I. To Optimize OPEC Revenues

Much (lore study is needed to answer the question how OPEC countries' earnings can be maximized. How far could they cut production and raise prices without causing economic damage which would harm their own earnings? Clearly the health of oil-importing countries' economies is important to them. How can prices rise, without bringing substitutes into play and harming OPEC earnings? We cannot answer these questions; but interestingly, if the OPEC long Range

Strategy Report's index had been applied from 19 OPEC countries
the actual price rather than the floor price),
would have earned a cumulative $1,306 billion compared to the $1,218 billion they actually earned an increase of $88 billion (Table fI-12).

TABLE II-12: OPEC OIL PRODUC110N AND REVS UE

Year	Production (million b/d)	Actual Price ($/bbl)	Revenue ($ billion)	Price ($/bbl)	Revenue ($ billion)
1973	30.9	3.39	38.2	3.39	38.2
1974	30.7	11.28	126.4	10.84	124.8
1975	27.0	11.02	108.6	12.66	166.3
1976	30.7	11.77	132.3	14.80	175.4
1977	31.0	12.88	145.7	15.50	193.8
1978	29.8	12.93	140.6	17.82	237.4
1979	30.7	18.64	208.9	21.19	248.6
1980	28.0	31.00	317.7	24.26	
		1C7fAl.	1,218.4		1,306.0
		Difference		87.6	

Source: US Department o£ Energy, for product 12 an 1980 For price; P1W, Special Supplement, May indexed prices.

The irony is that this formula na.y also has been better for oil-importing nations. Although the annual cost of oil would have been greater by about $11 billion, we believe that this would have been more than offset by two factors: i) the oil price in 1980 might have been an indexed dh$24gh6
Rather than an sting teed $31, and ii) the price have been predictable, smooth, and orderly. There might not
Necessarily have been any large increases in real prices, followed by declines and sudden steep rises. Fewer disturbances would have been caused to the global economy. Perhaps the formula ray offer part of the answer to the apparent conflict between OPEC countries' desire to optimize earnings and o s
Importing countries' desire for orderly pricing. Not resolve the conflict between OPEC countries' desire to

keep unilateral control over their oil and gas and oil importers' desire for assured supply.

ii. To Protect OPEC Revenues

The second step in optimizing OPEC countries' economic welfare is to protect the value of their earnings. One o£ the forces which has discouraged capital-surplus exporters from producing lore oil has been the fact that oil in the ground (appreciating in value) is a better investment than money (depreciating in value). It is asking too much of these exporters that they should sell more oil than necessary to cover their import needs and to hold the balance in money, unless the value of these funds can be protected.

One approach to protecting their value is to make it easy for OPEC countries to invest surplus funds in profitable ventures in industrialized countries. Some OPEC countries have shown interest in investing downstream, e.g., in shipping, refining, and distributing oil. This would also give capital-surplus countries a stake in keeping a reliable flow of oil to oil-importing countries and thereby keeping their own investment earnings healthy, a clear convergence of interests.

A second approach is to encourage OPEC countries to invest in Outs, where sore of the highest-paying investments are to be found. The problem is that such investments nay be risky. Reasons include less-developed economic infrastructure, immature money markets, unknown consumer demands, and sometimes uncertain government policies towards foreign investors. Hence OPEC countries nay be unwilling to invest in OIIICs, unless means are found of sharing these special risks with other countries or international institutions, again a clear convergence.

OPEC countries are eager to put their surplus earnings into investments at home, including fertiliser plants, petrochemicals, oil refineries, and manufacturing plants. To the extent that such investments are in industries which already have unused productive capacity and therefore displace plants in the North or in OIDCs, there will be contention. This kind of problem needs to be worked out on a case-by-case tasis.

Another idea for protecting surplus earnings is to pay them in bonds or other securities whose dollar value increases with the decline in the purchasing power o£ the dollar. A somewhat related proposal is that they be paid in SDRS. The SDR is valued according to a formula which includes the 16 leading currencies (five leading currencies as from 1981). Since a decline in value of any one of these currencies tends to be offset by corresponding gains in others among the 16 currencies, the SDR is unusually stable in value. Moreover, there is less risk that any sovereign government might freeze an OX DC's account, because the SDRS would be held on deposit with the IMF. This approach would also have the effect of strengthening the IMP's role in world Inking. None of these ideas generally provoke any great opposition in principle.

O£ course, even with all these proposals OPEC earnings would not be completely without risk. Insecurity is to sore extent unavoidable not only for oil exporters but also for oil importers. The best one can tope for is to reduce it and rake it ilure manageable through international cooperation.

iii. To Retain OPEC Control

The third related objective of OPEC countries is to keep control over production and pricing of oil and gas. As noted above, they are especially ~nsitive on this point, because of long history o£ foreign control. They do not regard the issue of control over oil price and volune as negotiable in any eventual dialogue with oil importers.

It was suggested above that the indexed price formula (if an actual price target rather than a floor) could help resolve the price impasse, as it would be better for all parties than what has happened. The problem is whether it will approximate the actual price.

So long as there is no major interruption in oil supply and there are efforts by major oil importers to restrain demand, there is good prospect that the floor formula will become the actual price formula because the floor price will be continually revised upwards and may press against what the rurket will bear. But if major cut-offs do occur and denand outstrips supply, then the actual price is

likely to

Exceed the formula price. This will be hard to prevent, even if there were a global negotiated and "binding" obligation upon OPEC nations to restrain prices. The spot nurket might simply become active, and the amount of oil Roving at official prices (which might indeed not exceed negotiated prices) would decline. It is *very* difficult to prevent any nation or entrepreneur (oil importers as well as exporters) from charging what a hungry nurket will bear.

Regarding control over production levels, OPEC countries' desire to control their own resources is in conflict with oil importers' desire for an assured supply. The Brandt Commission has suggested that "oil exporting countries... assure levels of production and agree not to reduce supplies arbitrarily or suddenly..." We believe that such an agreement is plausible if it is notched by such a commitment by oil importers to nest sons of the demands of OPEC countries discussed above.

F. Prospects for a Negotiated Settlement

The convergent interests of all parties are powerful indeed. They include such task goals as keeping national and international economies healthy, making a transition from societies based on oil to those relying on different energy sources, protecting the earth's life systems, and satisfying the special demands of oil exporters s that progress towards the other goals can proceed. The conflicts do appear formidable, although they are fewer and less important to the life and health of the world and its inhabitants. They include the strong desire of OPEC countries to keep control over oil price and production, which is to same extent in conflict with oil importers' desire for certainty of supply and orderly prices. It is conceivable that OPEC countries, having developed a floor price formula, might be willing, in exchange for concession by oil importers, to prescribe a formula for a price ceiling or for a price target where the actual price would fall within the ceiling and floor. We believe it possible that negotiations between Execs and oil-importing countries could develop a formula to provide some insurance to oil importers against capricious supply interruptions. Given the importance of the stake which all nations have in cooperating, it is certainly worth continuing the dialogue in search of agreement.

This chapter discusses global opportunities in several areas, taking into account convergences and conflicts between the Birdies involved. There are opportunities in managing the remaining decades of oil, such as a) finding and developing oil and gas in the OIDCS, Polar Regions, and deep ocean water, and b) conserving oil production and consumption and improving efficiency in energy use. There are opportunities in pressing ahead with the transition from oil to other energy sources and technologies.

). MANAGIM3 THE REMAINING DECADES OF OIL

A. Development of Oil and Gas in the OIDCs

The development of oil and gas resources in OIDes is one of the few areas where there is, in principle at least, a clear convergence of interest between industrialised countries, oil-exporting countries, and the OIDCs themselves. Indigenous production of oil and gas in the OIDCs benefits all countries. Industrialised countries stand to gain because additional production in the OIDCs will take sxne of the pressure of der,Rnd off limited supplies from exporting countries-a consideration to be weighed in the context of OPEC's guarantee to give priority of supply to other developing countries. The oil-exporting countries stand to gain from the decreased pressure on their depleting reserves and from fewer demands for financial assistance related to oil imports of the OIDCs. And of course the OIOCS stand to gain enornDusly from the balance of payments relief that increased production of indigenous energy would bring (oil imports will probably account for 40% of the OIDCs' merchandise exports this year).

Exploration for oil in developing countries is very far from having responded adequately to the price rises of 1973-74 and 1979-80. There are a number of reasons for this which are set out below, but the salient statistics on the exploratory and development record before and after the 1973-74 price rises should first be recalled.

The average number of seismic partyynonths in OIDCs (including some countries such as Zaire and Peru which have

oil) actually declined
32 raters of as compared with gaq,ll net expo
ear prod 1976-78' The decrease in
decently 8%y ears s grotto ty was on t to d¢ offsets boon rise each tat in
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and 20% in Latin a12 strut to afire three-Year, average'
in Asian initially lower than n explore
the oratory into retag an
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indicating party,onths in 1910_72 annul
1976-78
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Table III-1 bow
SEISMIC Pithy-MONTHS IN OI1%~ 1970-78a
year

TABi,E III-1: 1~8

Dear)			
197~age number per Y			
OLD		116	92
178		496	39
356		4	g;
Africa	601	1,040	Asia
iatin NERCO'	1,135		5,1
Total		9,958	3,124 cf: US & Canada

Of
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trends dril i g nas [men no re] than absolut[e] and
(wildcat) In [in] 1970
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ase in activity ian in ~ low' numb¢r drilled in [w]ells
fire [rend] on~ephirtYgiftrio the [shows e]xplorato[r]y
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390 in 1978, Table in 1970 and 1978[:]
and the United states. [Jor a]rea
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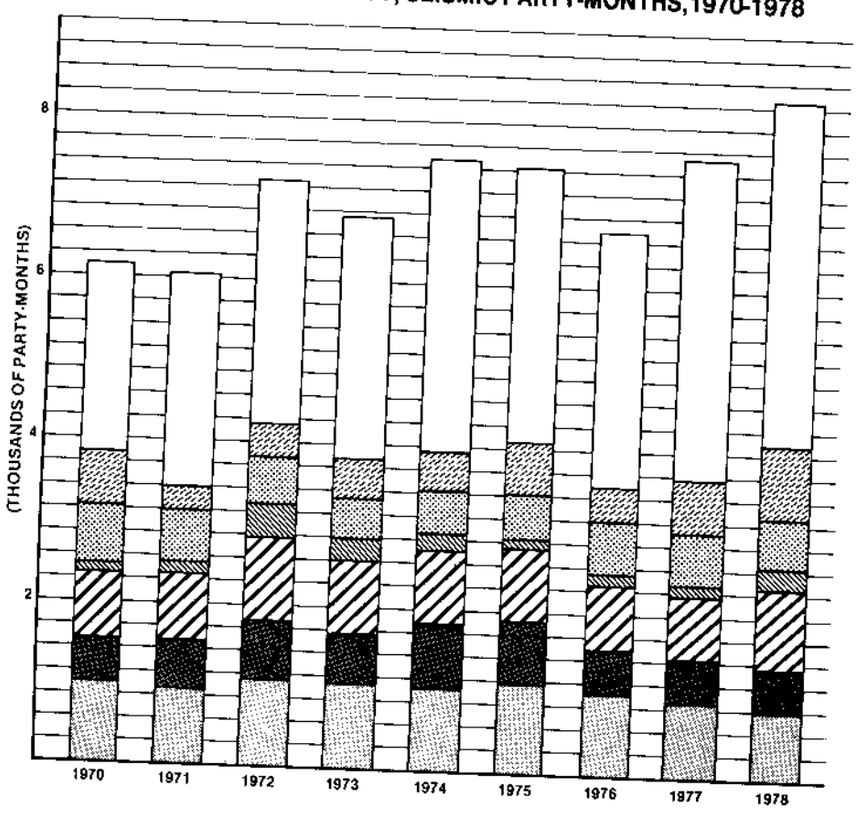
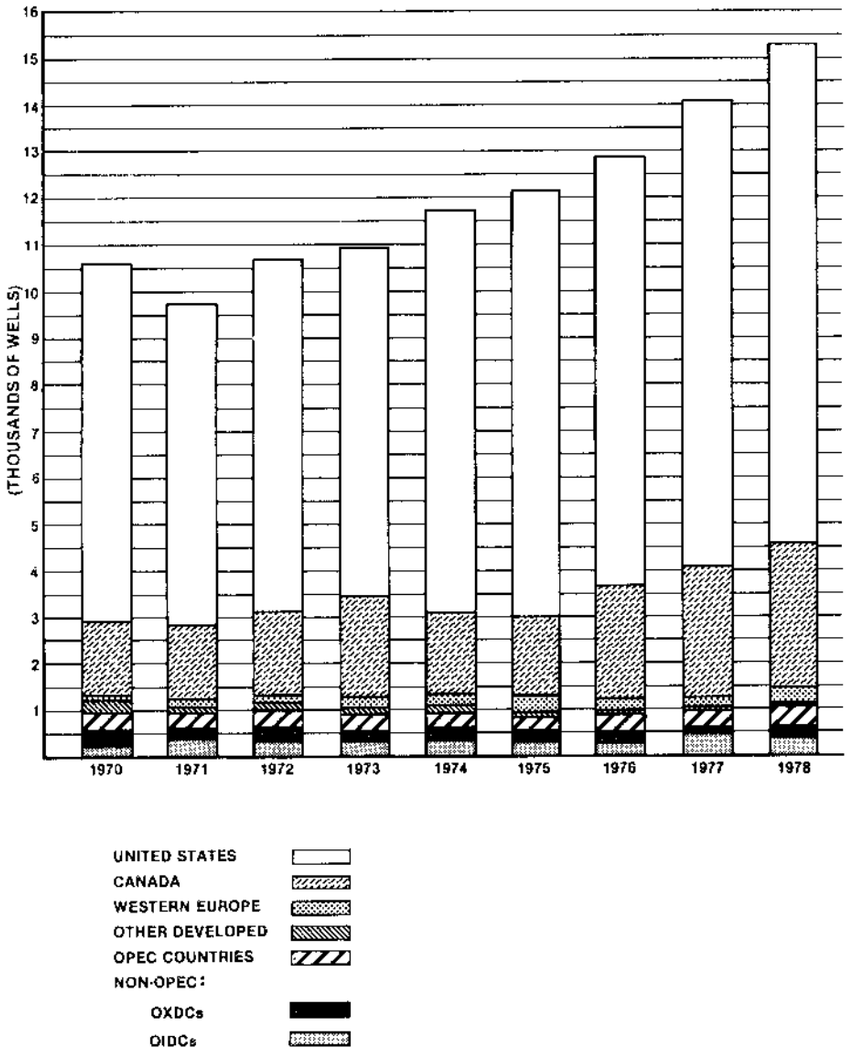
13. DEVELOPED AND DEVELOPING COUNTRIES: GEOPHYSICAL ACTIVITY, SEISMIC PARTY-MONTHS, 1970-1978



Source: AAPG Bulletin, October 1979.

14. DEVELOPED AND DEVELOPING COUNTRIES: NUMBER OF WILDCAT WELLS DRILLED, 1970-1978



Source: AAPG Bulletin, October 1979, and Oil and Gas Journal, Annual December issues, 1970-1976.

TABLE III-2: NUMBER OF FXP1J1 AT0RY WELLS DRILLED IN *OIDCsR*

OIDCS in:	Year 1970	Year 1978	
Africa 53 41 Asia 13 121 Latin MErica		273	228
Total	339	390	
of: US & Canada	9,252	13,821	[R]oil-importing developing countries as of 1979.

The total number of rigs active on both exploratory and develolnent drilling on the other hand has increased fairly rapidly since 1971 (data unavailable for 1970), at a rate of almost 8% per year-but from a very low lsse. As of 1978, they numbered 296 and have continued to rise since then, reaching a total of 328 in June 1980. Table III-3 below shows the comnrison between 1971 and 1978:

TABLE III-3: NUMBER OF RIGS ACTIVE IN OIDCSa

March Ours in:	1971	December 1978	
Africa 9 26 Asia 51 103 Latin America	103	167	
Total	163	296	
cf: US & Canada	926	2,460	[s]oil-importing developing countries as of 1979.

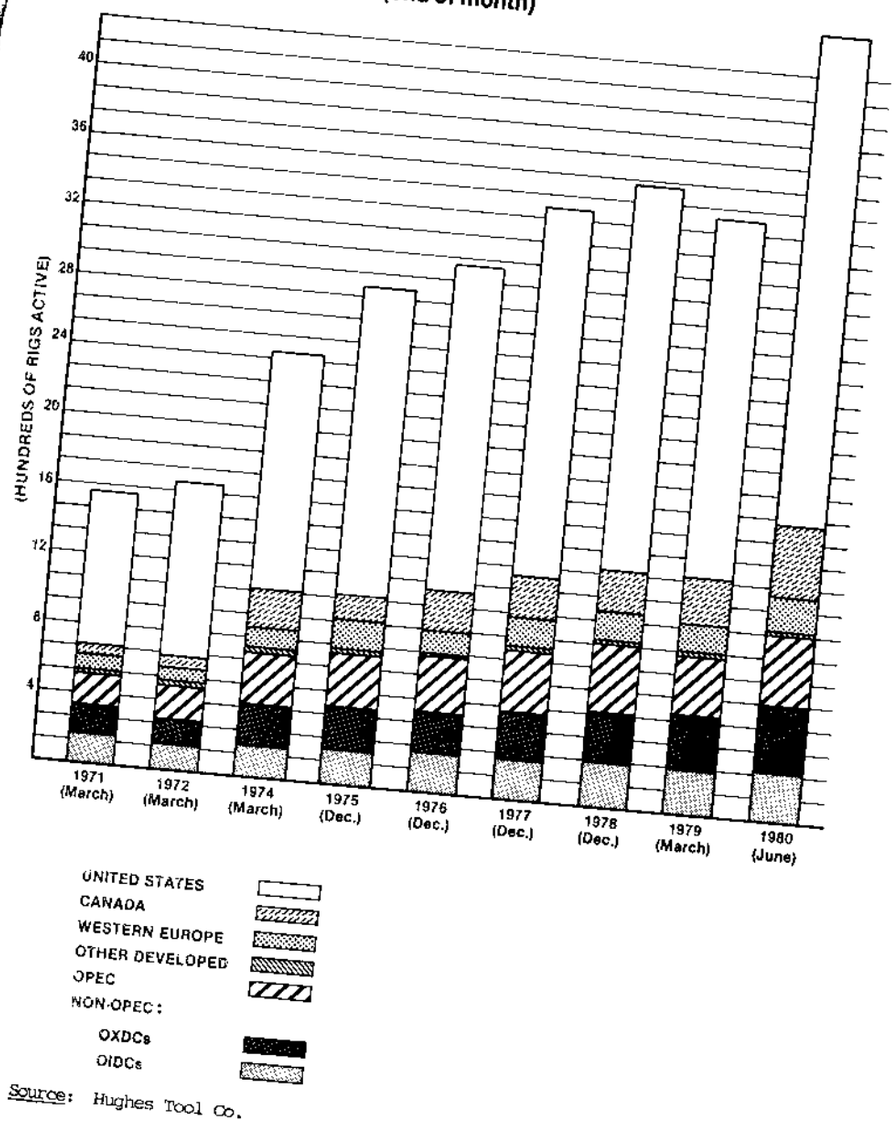
A measure of the inadequacy of the exploratory effort is the minimal result w far obtained. Of the fore than 120

countries which were OIECs in 1979, only eight were producing oil from fields discovered during the eight years 1970-77. Moreover, that production only anounted to 320,000 b/d. In comparison, import requirements of the OIOCs (excluding scuthern Eur)pe) are about 4.5 million b/d. Thus, on the average, discoveries during each of the eight years contributed only 40,000 b/d to total production in 1979. I£ this performance cannot be improved in the future, annual growth of indigenous production will be less than 1% of import requirements, and the gap between production and imports will widen.

Even if one includes countries which have become small net exporters since 1970 (Congo, Cameroon, Tunisia, Zaire), total production in 1979 from 1970-77 discoveries aggregated only 425,000 b/d, or 53,000 b/d each year. If one also includes the handful of success stories Wnich have become net exporters since 1970: Angola, Egypt, Gabon, Malaysia, Oman and Trinidad & Tobago (apart from Mexico which already knew in 1970 that it could develop an export surplus whenever it chose), total production in 1979 from 1970-77 discoveries rises to only 1.3 million b/d, or only 164,000 b/d each year. The data is shown in Table III-4 below.

These results can only be described as wretched. They are very far below the annual increment in oil demand in Ours. Unless great improvements can be made in discovery rates, import requirenents will continue to grow, or demand (and probably economic growth) wilt have to be severely constrained through lack of foreign exchange to pay for the imports.
t
In brief, exploration worldwide in 1978 reached record levels, By far the nDst Fart took place in Cbrth America. A relatively sill amount took place in Olecs. The lion's share was in those of them which produce oil. Exploratory efforts were very ;gall in OII)Cs which do not ' produce oil, no nore than 130 seismic party-months (1.5% of f
[r] Excluding Argentina, for which insufficient data are available.

15. DEVELOPED AND DEVELOPING COUNTRIES: RIGS ACTIVE, 1971-1980 (end of month)



Source: Hughes Tool Co.

TABLE III11:

OIL PRODUCTION IN 1979 FRO& OIDCS OF 1970 AND 1979

OIOCS 1979[a]	OIDCs 197o[b]
No. o£ fields discovered,	83
i	
1970-77	
(thousand b/d)	
Crude production in 1979 from	323 1,309
1970-77 discoveries	40 164
Ditto, average annual increnent	11
16 Average size of field	

aCOuntries which were OIDCS in 1979.

bCOUntries which OIDCs in 1970.

the total for developed and developing countries) end 63 wells (0.4% of the total).

It is possible that lead-timss are so great that it is still too early to judge the response in the exploratory effort to the 1973-74 price increases. For example, major countries--Argentina, Brazil, Chile, and India-have reversed long-standing policies, and have only recently, are only row, bringing in foreign oil companies to assist in exploration. However, the weight of the evidence CEO far (reflected in the statistics above on geophysical exploration and drilling activity) suggests that the response to price increases is rather low, and that there are a nmT which constraints on exploration which cannot retheenornal economic can only be ~.rtiallY overcom=, through through incentive provided by high prices and the expectation of even higher ones to follow. These constraints are examined below.

i %o Gel ogical Wospect The nost intractable constraint of all is, o£ course, when a country has poor geological prospects. But this is notas straightforward a matter as might seem at first sight.

What constitutes a poor geological prospect is a natter o£ judgement. The improvement of geophysical exploratory tech-•s+ques during recent *years* neaps that much of obtainable seismic data is own to reinter many of the areas already exploredPretation and that 'rodern equipment.need tof oil would provide It is Wssible that higher with mentsufficientthe igher rices to take place in theiuC°ntive for this ~instances,norrrslreassess_however, lead-timescourse of events. In sire

with assistance from rxrn o*nia* be substantfallin the establishment private al sources. y shortenedcountriesof privateThis is hecaus;With a ~rime facie sector on of es' priorities, based on prior exploration, nsY Pr'esumpterp°or geology,mnk rather loweii. Bounder Dis utes n a few instances,countries are holdingby disputesExamplesup exploration for beten Indones a Malta and Libya, Greece and T,n.ke hsVietn rboo.blombia and Venezuela. The hi y, ietnam and

from helping to get exploration under high price of oil, far areas, lis likely to aggravate them; and if m these dis~p at all, rt must come atoutside assisanceform of ~edial the political level in theiii. Mom olisation ofAcreageIn a few countries, the governmente thenaxeaer any large *areas* ti s virtuallythedwholeto asingle consortium of, to a sinexplored very slowly, because the This acreage is thenenerall Y willing to devoteconcessioner*mny* isonly relativelyla+rount o£ money each yearit toa 9 iver h'nethe o araP until£ one tibalh e P oration effort re enough tofrom the rr®,incourse of events, r inable to other co concession take

mls.nies (thoughire acreage availugh usually the least attractive)) iv. Gave rr1n t lkDlic and the legal Framework A mm,ber of countries have traditionally bin the particfpstion of foreign oil commiesation and productionhostileAmericanphases of thern the explorcountries in particular,vernstry,reflected in theovernIntincountries' laws, has resulted in F theas he e xclusion o£ foreign private companies from exploration; and exploration and production of oil have been reserved exclusively to the national oil companies. This is true also of some other countries outside Latin M Erica, notably until recently India. But as noted above, there has been a change in policy during the past few years in several o£ the largest developing countries, which are now turning once gore to foreign oil companies for assistance in the exploratory

In other instances, government policy has tended to effort.iscourage exploration by setting conditions which are unacceptable to riany foreign companies, either because of burdensome fiscal terms or because of other factors, such as performance bonds or minimum work programs considered too high by the companies.
Finally, another aspect in which government policy
son times contributes to a slowing-down in exploration for
hydrocarbons is through indecision or simply inability on the part of the

government to implement its policies efficiently. Indecision nay reflect internal differences within the government, mrnetimes as between government qua government and the national oil company. Lack of ability to implement a policy usually stems from inexperience in such ratters as deciding I what type of contractual arrangements are frost suited to the country and its geology, as well as poor judgement of what will attract foreign companies.

v. **lblitical Risk**

Related to government policy is the question of the degree of political risk involved for the foreign oil company. Usually, if the geology is attractive enough, the political risk tends to be highly discounted. But in cases where the geology is moderately attractive or only marginally so, the political risk may be determining in either deterring sDme companies £ran taking any interest whatsoever, or in making those companies which are interested take only minimal exploration commitments. In s me cases, drilling contractors are reluctant to undertake assignments for the oil companies with concessions in certain countries, unless they are insured by the companies against the risk of either having their equipment confiscated, or finding that they cannot get export

permits for it once it has completed the exploration program for which it was committed to the country.

vi. **Industry Structure**

Among the nest important constraints on hydrocarbons exploration in OIDGS is the structure of the international oil industry. Iocal capital and know-how are not available in the OIDCS, and foreign companies must therefore be relied upon.

Historically, companies with an interest in exploring in Third World countries have come nostly from the United States and, to a lesser extent, from Canada and a few European countries. All of them have had and continue to have their nain lsse of operations in their hour countries, either as producers or refiner-o*rketers or both. Their interest in Third World oil has been first and forerost access to cheaper crude oil supplies for their narkets in the industrial countries, and they have practically never had interest in exploration for oil to satisfy the local narkets.

Usually, such local. narkets have been too stall to rank in a company's order of priorities, as it surveys the likely geological prospects around the world and natches up its own resources against them. There have been exceptions, such as Brazil, Argentina, and India. But in the vast najority of Owes the minimum size of geological prospect which attracts the foreign company is generally larger than the whole of the domestic narket. The smaller deposits, which nay satisfy local narkets and be extrenely important to the Third World country itself, are o£ little interest to comlanies big or wall, because opportunities elsewhere are nore attractive in terms of lead-tine, in terms of limited technical and management resources available to a given company, and in terms of the size of the potential reward.

Indeed, in recent years, the balance of alternative opportunity has, if anything, swung against Third World countries as progressive decontrol of crude prices in the US and investment opportunities in Qnada have nade exploration there more attractive than previously, thus drawing away sine of the resources that might otherwise have gone to Third World countries. It seems doubtful if navy Third World countries will ever be in a position to attract companies prepared to
nnunt more than a minor exploratory effort (one or two rigs) in searching for fields whose potential production is not likely to be none than 2-3,000 b/d.
The combination of the factors enumerated above and, in particular, the structure of the industry, present a strong argwrent in favour of stimulating exploration through other means, Whether out of official developrent assistance funds or otherwise. Son, programs are already winder way through the World Bank and the OPEC Fund for International Uevelopren, and proposals for larger programs are being considered.

The World Bank's current program of loans and grants to Third World

countries for energy-related projects anounts to US$13.2 billion through 1985, of which $2.7 billion are to be dedicated to petroleum. The Bank has propased that these sums be doubled and that an energy affiliate be created which would raise much o£ the additional honey required.

OPEC has approved in principle the creation of a joint fund with industrial countries to encourage energy resource developrent and general economic developrent in Third t
World countries. Action on this proposal is likely to be delayed until *the* present conflict between two OPEC numbers,
Iran and Iraq, is resolved. i'
t
A regional project is under way to Central America
and the Caribbean, under which Mexico and Venezuela have ,
agreed to sift loans to nine countries with especially favourable conditions if the loans are used for developing indigen
ous energy resources.

Finally, there are a number of bilateral assistance projects, such as the financing by FR Genrany of eight exploratory wells in Bangladesh, the loan by Algeria of a rig to Tanzania to drill a certain number of wells, and the agreenent by N xico to drill a nwrber of exploratory wells in Costa Rica.
These are encouraging signs that the im[,rtance of the problem is starting to be recognised. But a nMch greater
effort must be rude if OtDC production of oil and gas is to ba significantly *expanded* in the next two decades.

S. **Energy Efficiency and Conservation**

One of the major international theses at this tine is the prospect that energy problems will seriously limit the economic growth of oil-importrng countries, whether developed or developing. There is an overwhelming necessity for a rejor structural readjustaeat to improve efficiencies and conservation in *the* use of energy if *energy* supplies are *going* to be enough in roar countries to support reasonable exFZCtations o£ economic growth.
The largest potential source of energy supplies is the saving which can ba derived from improved efficiency in *energy use. This is* the greatest positive solution for the global energy scene.

The world is faced with the choice of being forced into doing "less with less" or facing up to the challenge of doing "more with less." The phrase "energy conservation" to some (eople has a *negative* connotation of deprivation and cuts in standards of living, which have acted adversely on the iolftical enthusiasm to grapple with the issue of restraining energy demand. The positive approach is the phrase "improved efficiency." There is a broad array of reasures vtnieh can be taken. Sore of them can have a fore effective economic return than investnents in *high-cost* energy supplies. to

the past, they have not excited much attention. But now the signals of price and income constraints as we11*1* as some Dvernrent incentives are beginning to be acted on by intermediate producers and consumers.

The largest absolute savings in energy consumption can and must ke fade in the industrialised countries. Their efforts will have the greatest impact on reducing unsupportable pressures on world oil supplies and on easing the transition to alternative energy sources. But it will be imperative for OthCs to nake similar efforts if their *economic* prospects are not to be jeopardised. Even for the (rQXS, there are *concerns* to stretch out the life of oil reserves not only by pacing their oil production but also by curbing domestic oil consumption through conservation teasures and substi-
ration of other fuels such as gas; these latter steps free oil for export to finance economic development.

i. **Industrialised Countries**

The industrialised countries are highly concerned at the prospect that energy supply constraints may dampen economic growth. The analysis in Chapter I drew attention to the latest expectations that energy supplies available to industrialised countries during the next two decades might expand only slowly (in the order of 1.5-2.0% p.a.). The energy coefficient targets expressed by the IRA, EEC, and the Seven at the nost recent round of summits are probably overgenerous. The EEC is using 0.7 as a minimum in its guidelines for 1990, and the Seven and IEA expect the coefficient to be about 0.6. A central theme is the need to decouple the growth rate o£ energy demand from that of economic activity, if the latter is rot to be lower and energy prices higher than caught.

The long-term prospects for large improvements in energy efficiency could be very promising. This is rot easily quantified. But several recent studies have suggested that energy supplies at today's level or even lower could support reasonable economic growth through the next two or three decades. They include several studies for the United States (WNAES,b Ford/RFF,c Harvard Business School d RFr) and one for the United Kingdom (Leach et alt).

During the 1980s there is every prospect of a highly uncomfortable transition to the subsequent era of increased supplies of alternative energy to imported oil. Any encouraging recovery in economic growth in oil-importing countries could be nipped in the bud by the resultant acceleration in demand for imported oil, sharp increases in its real price, inflation and consequent deflationary government policies, together with the danger of restrictive trade practices. In other words, if there is inadequate

* The ratio expresses the percentage annual change in prinury energy consumption to that in real GDP. It is, of ` course,

a highly rough and ready concept, and analysis has to be in-depth to be useful.
improvement in energy efficiency, there will be an economic downturn as a result of the energy constraint.

This has been part (though only tart) of the story for industrialised countries since 1973. Price increases of imported oil have upset their la lance-of-payments and level of economic activity, even in countries such as the United States where imports do not conprise a large segment of the econ<xgy. Industrialised countries are under great pressure in the short as cell as the long-term to reduce oil imports by increasing efficiency in energy use. This is even true o£ countries with a string export sector such as FR Germany and Japan, and of countries relatively self-sufficient in energy as Britain, Canada, and Norway which will thereby benefit by a slower depletion of domestic resources.

The prerequisite to improved energy efficiency is a realistic adoption by the public of a conservation-oriented society. It has been proven that fore can be done with less, but the Ferceived effects of conservation are as important as the realities. This is the cause of the slow progress on conservation. More incentives are needed. The US and Canada have traditionally had larger houses, larger cars, and in general built nnre spread out cities, in contrast *to* other industrialised countries. To reverse such trends is difficult. There is undoubtedly a formidable obstacle in changing lifestyles and values to orient industrial society to a nore energy efficient value system.

As mentioned in Chapter II, improved efficiency requires an apropriate carry pricing policy. All energy forms should be priced at their long-run aarginal cost, which for most industrialised countries is the cost of imported oil. It is irrelevant that this cost is determined in the international rmrket place. That is the going price of incremental energy. Too often one form of energy or another is subsidised at prices controlled below rtarginal cost; and tense the right price signals to consumers are missing which would have guided them towards more energy-efficient practices or towards alternative energy forms. Retail gasoline prices in North America are still less than half than in other industrialised countries. In a number of countries, natural gas prices and electricity rates still reflect average rather than long-tern
marginal costs, and declining block tariffs are still quite widespread.

If higher energy prices result in unwarranted profits to producers and inequities to low-incare consumers, these problems can be addressed by solutions other than general price subsidies; solutions incluie investment incentives and windfall profits taxes for producers or relief measures for particular groups of conswmers. I£ the price level for energy in oil-importing industrialised countries is below that of imported oil, it is usually unhelpful to restrict the increase in domestic energy prices to a rate lower than domestic inflation; or else real energy prices are just eroding, and the right signals are not reaching the consumer. The lEA's Review of 1978 pointed out that industrial countries are reluctant to allow

energy prices to increase or to impose energy taxes because of the effect on domestic inflation and industrial competitiveness. Yet as the Seven at Venice now point out, market forces should be supplemented where appropriate by effective fiscal incentives and administrative measures. They also point out that energy investment will contribute subn'tantially to economic growth and employment.

There is a multitude of means to improve *energy I* efficiency. They are listed in a number of publications including the annual IEA reviews and also in a recent study by Shell International on "FYiergy Efficiency." An lEA ministerial conference in CCtober 1977 endorsed a series of principles for energy policy and referred to a list of suggested conservation measures. Subsequent meetings of the IEA, EEC "energy" council and the Seven have added new measures and principles. The potential benefits can be high but are herd to quantify. Those listed in the Shell publication are believed able to reduce overall energy per unit of economic activity by roughly 15-30%.

In residential and eomrercial sectors the greatest results are achievable from the integrated design of new buildings and from strengthened building codes. Next come insulation, reduction of draughts, effective incentives for retrofitting programs, minimum energy efficiency standards for appliances, boiler improvements, improved automatic controls for boilers and central heating, goad heat management, waste heat recovery, heat pumps, and double glazing. Other measures include regulatory limits o£ indoor temperatures in summer and winter and of hot water temperatures, individual room thermostats, individual metering of gas, electricity, and hot water, wind screening by trees, solar hot water and solar space heating, switching off unused lights, closing curtains, and district heating from power stations' waste heat (where economically viable).
In the transport sector, measures include incentives for public transport, mess transit systems, and increased use of rail freight. They also comprise smaller cars, minimum fuel efficiency standards, engine improvement, car weight reduction, drag reduction, and use of micro-processes to improve driving. Steps to rationalise production and marketing can eliminate cross-hauling. Other measures include speed limits, car pooling, mini-buses, improved routing, closed town centres, debottlenecking, and reduction of urban sprawl.

In the industrial sector the greatest results come from the integrated design of new processes. Next core effective incentives for *energy-saving* investments, the correct choice of energy type, goad combustion technology, recovery of waste heat for pre-heating and space-heating, insulation, replacing steam by direct-firing techniques, cogeneration of heat and power, heat management, improved nsintenance, improved buildings, manufacture of goods which last longer, and recycling of used materials.

In the energy sector, measures include incentives and regulations for district heating, cogeneration of heat and *power,* greater use of waste heat and waste products, full-cost tariffs for electricity generation, and domestic oil prices at prevailing world market levels.

The measures are evident, but the steps to implement them are slow. Certain "house-keeping" measures can be taken quickly, such as reduced road speeds and reduced use of indoor heating in winter and air-conditioning in summer. Others require capital investment of differing degrees. It takes time for past investment to be replaced. Hence there is the burden of existing infrastructure and the delay in installing new capital stock.

Delivered energy costs are only a .mall Fart of total costs, whether in the residential, conmercial, transport, Cr industrial (other than energy-intensive) sectors. The effect of energy price increases has been diluted in the final delivered cost of economic goods. Inflation has augmented this dilution. The crux o£ thee problem is with final consumers, who account for about half the energy used. Rut these consumers have to make the requisite energy-.saving
investments, and nnst demand a very short pay-back time (say
2-3 years). They will therefore probably not touch good investments which require long-term amrtisation. Governments need to make conservation attractive to individuals by reducing or subsidising the cost of conservation investments or by raising the cost of oil. There is also great potential in mandatory energy labelling; this permits consumers to choose products, taking into account energy costs.

A commonly used indicator of energy intensity is the aggregate ratio of a nation's energy consumption to GDP. The energy/GDP ratio provides a rough-and-ready but useful monitor of progress in conservation for individual co entries or regions, as long as it is measured over a sufficiently long period of years. Some results seem to have been achieved since 1973, Fnrticularly in the last two years. Exxon's "World Energy Outlook" of December 1979 sees evidence that industrialised countries are at last reducing the energy intensity of their economies compared with the 196os, perhaps by 6% in 1978 for the United States and 3% for other industrialised countries.'

Let it be said that the energy/GDP ratio should be used with great care in comparisons of one country's performance with anther's, as it is not a good international measure of economic or energy efficiency.

Regarding economic efficiency, energy is only one input into the total of goods and services which comprise GDP. Lnputs of capital, labour, and materials are much larger. Regarding energy efficiency, the energy consumed in a country relative to its GDP is affected by thee economy's industrial composition. Thus a developed country dependent on energyintensive heavy industry will use more energy than one dependent on agricultm'e.J,k
Nevertheless, international comparisons can to helpful at the sectoral level,

provided they are treated as indicative and qualitative rather than precise and quantitative.

A nation will have a `rare energy-intensive economy than elsewhere when:

i) <u>In the restdentialfeaartercial sector:</u>
a. its housing units are larger,
b, the share of single dwelling units is larger, c. the climate is colder;
ii) **<u>In the transport sector:</u>**
a. fuel and power prices and costs are lower,
b. the passenger-mile volume relative to (lDP is
Larger,
c. the fuel economy of its passenger car fleet is poorer,
d, the share of public transport is lower,
freight-transport votun~u relative to GOP is larger, f. the share of rail,
pipelines, and waterways in
Freight transport is lower;
iii) **<u>Sn the industrial sector:</u>**
a. the share of extraction/manufacturing is greater;
iv) **<u>In the energy sector:</u>**
a. the role o£ electricity is greater, and b. energy supply self-
sufficiency is higher.

Even having allowed for economic structural differences among countries, energy intensities m *differ significantly, particularly between ttorch America and other countries.* The differences are particularly striking in passenger transport and industrial processes. The US consumes about 50% `rare energy relative to GDP than Western Europe or Japan. This higher energy intensity is reflected in almost all sectors, though more in some than in others; the greatest difference is in the transport sector (80%).*
As between

• *It is important to cake international comparisons of GDP using purchasing power parities rather than exchange rates; this has become 2ore practicable through the recent series of studies of the UN International (omparisons Project (Krauts et al.).*
Western Europe and Japan, there is considerable difference in all sectors except transport. Such differences between nations corr~licate efforts to coordinate policy and often confuse public perceptions.

It should come as no surprise that intensity in energy use in North America is by-and-large higher than in other industrial countries. There are *great* differences in energy prices, structure, geography, resources endowment, population, and tastes. However, some o£ these characteris-tics are showing signs of change, through higher energy prices or policy measures (taxes or subsidies) to restrain demand. Shifts towards enhanced fuel economy in cars, improved central heating practices, and use of public transport could reduce the North American/European differential by 15-20%.

There has been a great reduction since 1973 in the growth of energy consumption in industrialised countries. In part, this has been due to slower economic growth and at times recession, augmented by milder winters in some years. At the same time, there are also perceptible improvements in efficiency of energy use. Nevertheless, as noted in the IEA's Review of 1978, the merit of energy conservation continues to be under-estinnted in most countries. There has been too much reliance on infornntion and voluntary action. *Policy* Tmasures have often been held lack by insufficient government funding and staffing and by government perceptions of economic and social constraints. In a few countries, comprehensive conservation prograi are in place, but elsewhere most programs are inadequate. The EEC "energy" council in May 1980 passed a resolution including "Guidelines for a Basic Energy-Saving Programme," which cover fuel efficiencies in all economic sectors.[1]

Strong action has typically not been adopted in contrast to the e-nphasis on accelerated development of energy supplies. The outlook for further substantial improvement is dimmed by failure to press aggressively for new conservation measures. There is *great* cause for concern that energy efficiency nay be improved at too slow a rate in industrialised countries. Much rtore could be done to reduce energy demand without hampering economic growth, although the fear of doing so holds back industrialised countries.

In the residential/conmercial sector, Host industrialised countries have thermal efficiency standards of varying scope. Mandatory and, in some cases, stringent building codes for all new buildings are in place in the Scandinavian countries, FR Germany, and Italy, and are being prepared in Canada. The greatest savings could be obtained from retrofitting existing buildings. The IEA's 1978 Review convents that very strong and comprehensive programs are still limited to three countries (Denmark, the Netherlands, and Sweden). The EEC has initiated community-wide reconnendations and directives on retrofitting and rational use of energy in nonindustrial buildings. In other countries there has been some strengthening of incentive programs. But elsewhere, programs have been accepted lore slowly than hoped. In Host countries, public funds for retrofitting are still very nndest.

The introduction of steps to improve energy use has proven particularly slow in the transport sector. The necessary policy measures are known but are politically and socially not easy to implement. The greatest scope for improvement is in North Pmerica with its historical reliance on large powerful cars for personal transport in spread-out cities. Mandatory fuel efficiency targets have been set there and were strengthened in 1978. Voluntary programs have been announced by Fe Germany, Japan, and the United Kingdom. Most industrialised countries outside North America tax gasoline heavily and vehicles by weight.

But in Host industrialised countries retail prices of gasoline declined in real terms

during the four years to 1978, giving the wrong price signals to the consumers. Since then, real prices have probably ceased eroding and trey even have risen. Gasoline prices remain a politically sensitive issue.

Increased efforts are being made to expanding public transport systems. Their improvement is vital for energy saving. But their quality of service had typically been allowed to deteriorate with the fast expansion in the use of private vehicles, particularly in North Pmerica. But government action still for the Frost part looks half-hearted. There remains huge scope for expanded public transport in nest
Countries.
In the industrial sector there appears to be increasing awareness o£ the financial benefits from improving efficiency. This is Imrticularly evident in energy-inensive industries such as aluminum and steel-making. Son countries
Have adopted voluntary energy-~ving targets for energy inten
sive
and industries, for instance Canada, Greece, Japan, United States. Governs nts have introduced incentives for energy-saving investments in a number of industrialised countries. Nevertheless, the l servRevie iofind18 ryshould
that efforts to pronote energy
be expended, given that this sector is thlargest energenergy consuuser and is expected to show the greatest growth gtion in the next decade.
In the energy sector, efforts are being made to reduce energy losses in electricity generation, transmission,and distribution. Sorte countries have introduced ofincentivesdistrictwaste heat recovery, b)he encourage encourage c production of heat and electricating, and) combined P pricing have been power. leak and seasonal electricity pricing scope for adopted by many countries. But there remains g)'eimprovertent in this sector.

ii. <u>Co1png</u> <u>Countries</u>

There is need £or a big increase in the technical efficiency of energy use in developing countries--using less primary fuels for each unit of useful output. Understsandrably. however, many people in the developing countries the
North) associate conservation with sacrifice and ounlO es
Standard of living. gore People in the develop g c
also believe that the talk o£ energy conservation is notivated
by a Northern desire to hold consumption down in the South, SD that the North will have rmre.
Although it is true that there is much sore waste in the industrialised countries than in the developing countries effort it does not mean that the OIOCS should no the le ever energy
to use energy sore efficiently. In fact,
efficiency is even sore Inwerfinl for developing countries than
the developed nations. 1b begin with, the price and availability of energy being what it is, the poor countries can least afford energy waste.

Second, using energy efficiently does not mean reducing economic growth or giving up pleasant

J183 activities. Energy conservation can be achieve£ecting economic growth and living standards.causethe developing countries are buildingThird, lectures at a rapid *ta.ce,* attentionnew °diffe ce into energy efficiencythennreptheir totaly canlater.Finallenergy billa bigY, conservesinner rather thaenergy will enable lion and increasing efficiency o£sed for otherthe OZ DCS to savedeveloprent activities. resources that candifferentenergy conservationfibm thatinOIrobthe lem in the latter is the industrialised countries to is luxuriousis to a sigseeTheuse of energy andgnificant derelatedGlDCS the problem isenergy intensivetoInefficientone of inefficiency in enIn thecartchoking 9uipment wastesenergy use,waste animal traction; older, wW y pint harnesses and inefficientmOrl outsained rte vehicles waste electricityindustrial layouts waste the lackThe problem is fundaaentalloil and°r skills and capital y O°e of poverty orefficiency, In areasto improveGIDCS to take°f waste these arthe level of a sa°~ of conservation ~as ~spportunities for Z• WAGING THE RANSITION FROM OIL TO OTHER SOURCESA• Accelerated L velo nt of Ener ResourcesHughytem Oil is the ' jortenergy used in to Providing usee heat. j is is no longer low_ min itransported and gare aust newPriced in nternationaltored,and sources of liquid hydrocarbontrade, Norroduce• The old era of low-cheap to dev Oiill increasingly have to toPriced oilPtrapsand chemieserved for premiers g°ne.flportcals,um uses suchasHigher international oil prices have challenges to shape new nationaloil'created urgentrmporting countries, as hasenergy policiesparticularly inthe Aroblem ofin*from*thee°elopingcountriesdeforestationinsecurity of im rhe desire for reliefgovernments toPD ted oil is a Wwerfulare foresem°te domestic enermotive £°rcostly than imported oil an snnplies even if theymore fundarrental is drrostincr thatarenot. Beneasingconstraintslong,

Delectable energy

The pressing needs to find and develop new sources of oil as well as to conserve in its use have been described in Section 1 o£ this chapter. Strenuous efforts will help by providing mire time for the transition to a tanader array of *energy* options.

The next two decades will be faced with an era of transition towards the next generation of energy sources and technologies. *There* is needed to keep energy supply options open *wherever* possible. All planning must allow for Uncertainty. The world needs a diversity of energy sources;

as there is a diversity of *energy* needs and as there are uncertainties surrounding each individual energy source. There is a danger of being locked into short-term palliatives. Hence a wide range of every kind of research and development is needed to retain flexibility of technical options. Moreover, some changes to the energy mix could be nude today with little adjustment to the existing capital stock. But more radical changes will take time to nuke the necessary structural

adjustments to the economy.
Yet, developed and developing countries alike have limited financial, technical, and nanx wer resources to devote to energy. Not *every* energy process can or should be pursued;
each must be economically, socially and environmentally Justifiable.
The range of energy sources is very wide, as was already discussed in Chapter 1. It includes deposits of very *heavy* oil, tar-sands, and shales, as well as oil in lnlar regions or beneath deep water. Then there are enhanced recovery processes to improve the recovery of oil-in-place from existing and new fields beyond that from primary and secondary methods. Discovery of small fields will continue and may accelerate in nuny countries well into the next century; their cumulative impact could be great, and their
support to economies including those of oil-importing developing countries will be significant.
Natural gas is likely to nuke an increasingly large contribution to *world* energy supplies during the next two decades. Its potential looks far greater than had been surmised in earlier years. It has similar advantages to oil, except that it is less easy to store and has less transport
flexibility. Its role is likely to grow up to the limit set by supplies, as it is after all a depleting non-renewable resource.

Coal is plentiful but uninly limited to bulk heat end-uses, particularly electricity generation. Extending its range of applications presents a challenge. There are great opportunities for expansion of its use, but there are also serious economic, financial, and environmental uncertainties surrounding the race of its developnent.

Electricity is versatile in application, easy to use, and can be generated from a variety of sources. The nain ones today are fossil fuels, hydro, and nuclear power. Coal is becoming an increasingly favoured source for new power stations and existing thermal stations. The use of hydroelectricity is expected to continue growing, particularly in Canada and developing countries. Nuclear power has expanded fast. But the future expansion of both coal end nuclear could be constrained by a wide range of concerns in a number of industrialised countries. (See Chapter I.)

In view of the perceived constraints on accelerated developnent of the conventional forms of commercial energy, much lore serious attention is row beginning to be raid to the developnent of oil, gas, and coal supplies from non-conventional sources, as well as to the energy Cinderellas: conservation end renewable energy sources.

Oil-importing countries need to take long-term steps towards a) improved energy use and b) supply alternatives to conventional oil supplies.

The Seven at Venice, the EEC, and the IEA all expect or have set guidelines to

reduce oil as a share in energy consumption from 50-53% to 40% by 1990. Indeed the Seven foresees its collective consumption of oil to be below present levels by 1990 so as to permit a talance between supply and demand. IEA and the Seven sanguinely foresee by 1990 a doubling in the use of coal and an increase in the use o£ nuclear energy. The Seven have specifically said that their potential to increase the supply and use of energy sources other than oil over the next ten years is estimated at the equivalent of 10-20 million b/d o.e. daily. They agreed that no new be. se-load, oil-fired generating capacity should be constructed save in exceptional circumstances, and that their conversion of oil-fired capacity potboiler-other accelerated. Increased efforts are pledged saving investments and oil substitution by all means including j fiscal incentives.

B. Research, Developrent, and Denonstratfon

Much use can be trade o£ existing technologies. But in the long-run new and better technology must be dev ogee
For energy conservation and supplies. This points fundamntal importance of well-directed rational programs for energy research, development, and demonstration (RD&D).*
The ultimate goal of energy RD&D is to neat the longterm needs for energy and to open technological sclutions to energy problems for incorporation into energy policy. Hence energy policy should provide clear guidelines for RD&D, and it should take better account o£ the supply and conservation options offered by RD&D.

i. Industrialised Countries

Not surprisingly, much o£ the work worldwide on energy RD&D programs is heing done in the industrialised countries, by both governments and the private rector.
Virtually all the industrialised nations, except
France, are mw trembers of the IEA, w tch introduced in 1977 a energy LaD system of annual reviews o£ its member countries energy RD&D
Programs. By 1980 it had published a re[br
Strategy for member countries and three annual reviews of national programs.a,b
The IEA report of 1980 on "Energy LaD: a Strategic View" contains sore significant policy guidelines for its member countries. Its conclusions for RD&D planning are that

* The following paragraphs on energy RD&D in the industrial - used nations draw greatly on publications o£ the IEA, European Community and UN Economic Omission for Europe.
the need for imports of conventional oil will decline during the years to 2020. During the first two decades the decline is vainly due to conservation and existing technologies, while thereafter new technologies for liquid fuels should begin to make a significant contribution. Nevertheless, the rate of decline in oil imp,x is would continue to leave countries vulnerable to

supply disruptions. The contribution of new energy technologies before 2000 may not reduce oil denand enough to avoid supply constraints, unless their introduction is accelerated.

The impact of new technologies for conservation can be as significant as new ones for supply. The report attaches high priority to RDAD efforts for coal and nuclear power. Some new technologies for renewable energy will begin to mice substantial contribution before 2000. But those for non-renewable energy will provide nost energy needs for the balance o£ this century, even if efforts are accelerated to introduce renewable ones.

The conclusion is that the pace should be accelerated to develop and bring new energy technologies to commercial use. A strategic view must be taken of requisite near-term action, taking into account their state of development and potential importance. Some technology will be at the exploratory stage, some at the stage of pilot-scale experiments, some at that of large-scale demonstration, and finally sore ready to be brought into conmercial use. Virtually all energy technologies have environmental impact, and this should be taken into account at all stages of their
Development.

The deployment *of new* technologies can be affected by a wide range of non-technical issues. There is the need for rational pricing signals to assist the proper introduction o£ new technologies as well as conservation. If energy forms such as oil, gas, or even electricity are subsidised at prices below their long-term narginal costs, consumers have little incentive to anus to alternative energy forms which *nay* be lower in cost but are priced to *cover* that cost. Social impacts need to be sell considered. So does the availability of skilled labour, raw materials, infrastructure, land, and
Water.

The TEA annual reviews assess how adequate the scope and character of national programs are in meeting energy needs, and they identify steps to strengthen these programs. All these countries have stated in same form or other their policies or aims for energy RD&D programs. But their statements are often so general that they offer little guidance to the long-term decision making necessary for these programs. Countries need at least to define priorities by technology areas. They should also identify which o£ these priority technologies they would try to develop themselves and
Which they would import.

Is the aggregate level o£ present effort in industrialised countries enough to provide new technologies in time to offset the depletion of conventional resources and the risk of disruption to oil supplies? This looks unlikely at the present pace of development.

The annual reviews illustrate that IEA countries have increased their government support o£ energy RD&D substantially, by 113% in real terms from 1974 to 1978. The United States is dominant; its funding represented half the total in 1978 and grew Tnrticularly strong (by over 200%) during the period. Hence the growth in other IEA countries was much less (45%), and some even spent less in 1978 than in earlier years. The size of the

effort varies greatly from country to country. Population, type of economy, and energy intensity inevitably lead to different efforts.

Official funding of energy RD&D in industrialised countries is dominated by nuclear programs. In 1978 IEA governments devoted 31% of these funds to conventional nuclear fission, 20% to fast Ireeders, and 9% to nuclear fusion.

In contrast, they allocated less than 9% to renewable energy (solar, wind, ocean, biowass, and geothermal). Moreover, the United States accounts for about three-quarters of the renewables effort. There are considerable differences of national view as to the potential of renewable energy technologies. Most of the funds for renewable energy are spent on large-scale applications that will be of little use to rural people who need decentralised energy sources.
The effort devoted to coal technology continues to increase. But in the TEA view these increases are not enough to provide a proper balance of coal RD&D relative to other conventional fuel systems.

By far the greatest government efforts are spent on supply technologies. In 1978 TEA governments allocated only B% of their energy RD&D budgets to conservation. These efforts look woefully small. RD&D financed by private industry is thought to be much greater in this area. bbreover, some official funding of RD&D into energy-related supporting technologies (power conversion and transmission, energy storage, environmental protection and safety, energy systems analysis, and basic energy research) has some impact on conservation improvenxsnt.

Industrially financed RD&D makes an important contribution to national programs. It is much directed towards product improvement. But it includes significant work on technologies for energy conservation, enhanced recovery of hydrocarbons, and some supporting technologies. The TEA reviews comment that RD&D on non-conventional oil deposits still receive less emphasis by governments and industry than their worldwide potential would warrant.

The RD&D results could be greatly increased without corresponding cost increases if there were reliable arrangements *tide* for exchanging information, materials, and personnel, and for pooling research results.
In this regard, it is of interest that in 1979 an International Ehergy Technology Group was created under the auspices of the EEC and OECD/IEA, with participation from 14 industrialised countries. Its purpose was to define priorities by technology areas in the field of new *energy* sources, to examine current and planned projects, and to look for potential areas of international collaboration. The Group came up with four n in conclusions. First, a program of commercialising new technologies is needed. Second, international cooperation is needed in areas where commercialisation is not possible without government support, specificaly coal liquefaction, heavy oils, tar-sands and shale, biortass, high calorific coal gasification, natural gas liquids, and coal combustion. Third, there is need

for government efforts to reduce risk and improve financial incentives. Fourth, there is need to monitor the conmercialisation o£ new energy technologies.
Recently, multilateral programs have been initiated by the UN agencies and international financial institutions to assist developing countries in their efforts to make the transition from oil to other energy sources. The UN Conference on New and Renewable Sources of Energy in 1981 will focus especially on these issues.

Industrialised nations have expressed willingness to assist developing countries bring into use technologies related to renewable energy, as at the Tokyo sunmit meeting of seven major countries. Such initiatives could have great potential.
This is also a two-way street, as some developing countries have been making significant technological breakthroughs, from which industrial countries have much to learn. Examples include Brazil's program to produce liquid fuels from biortass and PR China's production of biogas units to produce gas and fertiliser from animal and vegetable wastes.

ii. <u>Daveloping cbuntries</u>
For the developing countries, alternative energy includes small-scale, decentralised renewable energy, as yell as commercial energy used in the nndern sector such as gas, oil, coal, and large-scale electricity from whatever source. It includes inherently decentralised renewable energy sources (DRE) such as wind, flowing water in small streams, biomass, and sunshine. These energy sources have characteristics that make them especially interesting for Third World countries.

First, they are inherently decentralised to the rural areas where frost Third World people live (except for Latin America where slightly less than half live in rural areas). This is important because the distribution of centrally produced energy (e.g., electricity and diesel fuel) to rural areas has proved to be a problem in many countries. A World Bank report of 1975 estimated that only 4% of the rural people of Africa lived in areas cerved by electricity and the pace of
Extension seemed *very* slow (World Bank, "Rural Electrification," p.ll).

Second, the costs o£ certain technologies to collect and use DE are not expected to rise as rapidly as oil, and the costs of at least one technology (photovoltaics) are expected to decline. In most regions one a a-ore of these renewable sources are likely to he plentiful.

Third, the long-term future of oil does not seem bright and even the short and nedium-term outlook is uncertain. This adds to the interest in technologies that can collect and convert into usable form the generally very ample renewable supply of locally available energy.

Despite these evidences of promise especially *for* application in rerrote areas, renewable energy needs a great deal ore research end site testing before its full rromise becones evident.

The concepts and technologies developed in laboratories need to be tested in actual village sites in order to learn reliably tnw well they work, what they cost in terms of actual village work performed, how well they are accepted, operated, and rt intained by the people and institutions of the villages, and how best they can be introduced into villages. In addition there needs to be a great deal of survey work to learn of the quantity and reliability of various kinds of primary energy present at the village level in the Third World. This would include surveys of the wind regimes at various sites, small stream flow data, insulation, and estirtetes of biorr®ss.

Optimally, research, site testing, and collection of data on local energy availability should be conducted by one or more institutions of each developing country. This calls for financial and technical support fcc those institutions by industrialised countries and international donor agencies.

A growing an)unt of research and developnent of DBE is under way in the laboratories of industrialised and developing countries. 'Ihe fink of the funding for this kind of *work* comes from industrialised countries, and most of the actual laboratory work is done in those same countries. There is an opportunity for mutual benefit if Northern RD&D funds were used to finance certain kinds of [)RE research in the developing countries. In some cases the costs would be lower, while the research results could be equally or fore effective for the Northerners who were to finance the work. There could be an added benefit that Southern RD&D institutions would be strengthened as a result.

There is mom for strengthening existing or creating new international nachinery to deal with this topic. Proposals have been made for an International Energy Institute (Kissinger, UN Seventh Special Session), a "Global Energy Research Centre" (Brandt Conmission Report), a Solar Energy Fund (Overseas Develogrent Nuncil), or a Fund for Renewable Energy Enterprise (thins et al., Foreign Affairs, July 1980). Such a proposed new institution might be a research center, a leader agency knitting together the various renewable energy researchers into a network, a central information bank, a monitor and critic o£ existing research, a fund to finance promising RD&D in the Third World, or a combination of the above and other ingredients.

Beyond research, site testing, and primary energy data collection, there will soon be a need for nechanisms to finance the distribution to Third World villages of the kinds of technologies that are proved in laboratories end site tests to be the nost promising. T_o nany cases the best distribution system nay be private entrepreneurs who see a chance to rake a profit by selling equigrent and providing spare Farts, training, and repair services to keep it functioning. In other cases the distribution system nay need to be governrental. In either case, governnvnt action may be needed to collect information, provide financing, and train people to help technologies rove from laboratories and test sites to widespread
village use.

Offers by industrialised countries to conduct a najor new program of assistance to

Third World countries for DRE could form pert of a package for negotiations of oil and related subjects. This might also be linked to initiatives now under consideration by OPEC end industrialised countries to help OIDCs find and develop indigenous energy resources.

MEEfINC THE ENERGY NEEDS OF DEVELOPING OJUNTRIES

Human nnterial progress is dependent upon the use o£ energy. Without sufficient annunts of energy in usable forms and at affordable prices, there is little prospect for improving the conditions of the rmjority of the people in the world. The inability of the poor to use adequate and efficient energy lends to low productivity and low incomes. And because of their low incomes, the poor cannot afford to use rmre and high quality energy to increase their productivity and they rennin poor. They are in a vicious circle.

In navy countries the oil price increases have nnst seriously affected the poorest segments o£ the sDcieties. For instance, the sudden increases in international oil prices have affected the retail price and availability of kerosene, the commercial fuel nnstly used by the poor. When kerosene became expensive the poor returned to using wood and charcoal, thereby driving the prices of these corn,dities up. Because energy costs take a very high percentage of the p'wr's income, the price increases tend to be very damaging. Furthermore, it was the poor who 'ere the first to be laid off as a result of curtailed industrial activities that followed the oil price increases. Agriculture has also suffered from higher fuel and fertiliser costs creating food shortages and higher food prices that mainly affect the poor. In order to be able to pay for the increasing oil prices, many countries were forced to cut tack on imports of other essential conmdities, thereby lowering their growth rates. The drop in economic growth affected the pnor seriously in countries which seek to alleviate poverty through higher growth.

The consequences of heavy reliance on non-commercial fuels is also negatively affecting the pair. In addition to the price increases for wood and charcoal, the expanding deforestation, devegetation, declining water tables, soil erosion, silting, and flooding are leading the shortages in food supplies with consequences of hunger and famine to the poor. Deforestation also leads to desertification with all its consequences on the ecosystem in general and food and firewood production in particular.

The energy problems of developing countries are so serious and so complex that they cannot be tackled without massive help from the international community. Assistance is needed by the LDCS to overcome energy related constraints to their development efforts.

A. Assistance in Energy Develoynent

The energy problem is basically a global problem. The availability and

price of oil, for instance, affect most every country. It is in the self-interest of every nation to see that as rtany countries as possible find and develop oil, develop substitutes for it, and conserve energy. This will prolong the availability of oil, a that the world has time to develop successors to oil. Moreover, the world's ability to find successors to oil depends on the quality and amount of RD&D of new technologies and on the efficiency with which different countries coordinate such work. The Third World's participation in RD&D projects and the strengthening of its RD&D capabilities will contribute to this global effort. Further ere, our planet's energy problem, if not well rtanaged, may lead to counting ecological damage. It is in the interest o£ every nation to prevent such dartage.

The developing world stands in need of help, and the international community can render timely and essential assistance for energy developrent in the Third World. In the following paragraphs we will point out some of the types of actions that donors can undertake.

B. A Basic Energy Assesanent

To begin with, sound policies depend on a good grasp of the relevant facts about resource availability and demand, consumption pattern, developrent strategy, technological capability, etc. In other words, good energy planning begins with a comprehensive and detailed energy assessment.

The easiest and least valuable way to conduct an assessment is for aid-giving agencies to send technicians who prepare the assessment and turn it over to the host country. A harder way but one that is incomparably n re valuable is for host country technicians to prepare the assessment with the help of experts from the industrialised countries. Beyond the clear developmental value of developing host country assessment skills, confidence, and pride, an additional reason for
favouring this approach follows from the tact that any assessment begins to obsolesce the day it is written. To be relevant, an assessment must be continually updated and re-evaluated as resource estimates, prices, development plans, and technologies change. Since aid donors cannot supply permanent assessment teams the best course is to help the host country develop the institutional ability to make its own continuing assessment.

A number of energy assessments have been undertaken under various aid programs. A common failing of such assessments has been that they have ignored or treated inadequately the non-commercial and especially the rural energy scene. Above all, they have not dealt adequately with the tranount Third World energy problem, that of fuelwa d. The Third World institutions that will make future energy assessments should be adequately equipped to treat these neglected areas.

A good assessment of present and prospective energy supply and demand is only the starting point for energy policy planning. The developing countries need institutions and experts who can evaluate these facts, identify

alternative courses of action, weigh them, and choose among them. This is a task that is too intimately connected with internal political, social, and economic factors to be performed by outsiders. But outsiders can advise, and they can help train a corps of technicians who can supply the analysis needed.

Before undertaking the project demand for energy in the future, one needs a reasonably accurate estimate of current demand and consumption patterns. With respect to modern sectors of developing countries, where energy is distributed in a formal market, there is some information, although it is markedly less complete and reliable than comparable data in the industrialised countries. But for the traditional energy sector--mostly rural areas lot including urban slums as well--the picture in the Third World is quite different. There is virtually no quantitative information on traditional energy consumption, since most such energy is used directly by the gatherer of the fuel or owner o£ the animal and never enters into a formal market place; hence, the concept of demand is not very applicable. The first need is to learn something about current energy use in the traditional areas. But even i£ complete and reliable information on the present use of energy were available, there would be special problems in neking projections in the Third World for several reasons. To begin with, there is the problem of predicting the pace o£ economic growth, a problem that is similar to but greater in intensity than that faced in industrialised countries. This is because econanic growth in developing countries which produce primary goods fluctuates even note than in industrialised countries.

Even pore of a problem is presented by another variable, the development strategy chosen try the developing country. For example, a national decision to emphasise import-substituting or labour-intensive exporting industries will call for different kinds and amounts of energy than a commitment to agriculture and rural development. Moreover, the pace of population growth and the rate o£ migration to urban areas are also variables that pose prbblens. The rate of decline in available traditional fuels and the rate at which people substitute modern energy sources for traditional fuels also complicate assessnent efforts. While virtually nothing precise is known about the speed of this substitution, the direction is generally clear: it nearly always takes the form of oil. One final complication in projecting is that so little is known about the potential for conserving energy in the Third World. It is possible that a concerted effort to improve efficiency of energy use could yield greater results in the short run than any equivalent effort at producing nore energy.

All o£ these complications suggest two courses of action. First, countries must have their own capabilities to make projections, because projections must be constantly updated. The reason for this is that several of the variables discussed above are volatile and must be reassessed frequently. If a donor country were to send a team in to nuke a projection of denand, that projection would begin to become outdated as soon as it was

completed. To be sure, some outside help will be needed in navy cases and that suggests our second course of action: the outside assistance should come from those who--in addition to knowing energy--are steeped in those developnental variables that nuke projecting so complicated in the Third World. A person whose entire experience has been in making energy demand projections in industrialised countries would have to acquire a great deal o£ knowledge about developing countries before he would be of much use in making a projection in a developing country.

C. **Exploring and Producing Oil and Gas**

One of the promising methods of alleviating the energy problem in the medium-term is to help develop indigenous energy resources in the OWes. Oil and gas exploration and development offer excellent opportunities for foreign assistance in the energy field. Some geologists claim that more than 40% of the world's prospective oil reserves is in these countries. Yet, only about 5% of the world's investment (excluding centrally planned economies) in petroleum exploration--virtually all of which is private investment--now takes place in the ron-OPEC developing countries. The industrialised countries can, therefore, encourage the exploration and development of oil in the OIDes. Because rent' private companies, for various reasons, have shown reluctance to invest in oil exploration in many of these countries, their governments can encourage them to undertake the investment. This could be done by such measures as guaranteeing the investment, giving tax breaks, and providing soft loans. In situations where the foreign companies are rot attracted to invest at the initial stages, international institutions can help the tnst countries to take all or part of the risk of exploration.

Because technological capacity is one of the things that the OIDCs lack, there is a need for the industrialised world to help in the development and application of various technologies. In the exploration for petroleum, one area in which the developed countries can help is in undertaking the very important geological and geophysical surveys. The survey information is *very* valuable in negotiations between governments and the companies that might be interested to invest. Both sides will have a better knowledge of the pmspecis and probable commercial value o£ any oil and gas that nay be found. Accurate knowledge of what they have to offer will also strengthen the bargaining position of the countries concerned.

An important task in this area is meeting the urgent need of these countries to train their nationals as engineers, geologists, and others capable of performing geological and geophysical surveys and interpreting results. Once commercial scale reserves are found, training is needed for engineers and chemists able to produce and refine oil, and oil economists and lawyers able to produce the analysis on which a sound development policy can he tried. Such training and institution building activities should be included annng the highest priorities of bilateral and multilateral aid programs.

OPEC countries could also help in the effort to develop the oil reserves of the OIDCS'. OPEC can help the developing countries by advising them on how to get the best possible deals from the oil companies, by providing finance for initial surveys and exploratory drilling, by giving them advice on contractual natters, and by cooperating with other international institutions, like the Strld Bank, which promote the exploration and development of oil in the LDCs. OPEC can also enter into joint ventures in co-financing oil development with oil companies and/or developing country governments.

D, **Developing Substitutes for Oil**

In the long run, developing nnre plentiful substitutes for oil in developing countries will lee nnre important than finding or conserving oil. Energy sources like coal and hydroelectricity where they exist could be utilised fore extensively. Other renewable energy sources could also be developed.

Although coal is vastly more abundant than oil and gas, its development in the OID s faces a number of rerious problems, including lack of data on the resource base, heavy infrastructural and other requirements, and serious environmental hazards. Assistance from bilateral and multilateral agencies could help developing countries melee surveys, train personnel to undertake basic tasks such as preparing the technical and economic analysis to determine whether and if so how to develop their coal supplies, and help secure the financing required to do so.

With over 60% of the world's major hydroelectric potential located in the developing world, hydroelectric develolment will continue to have a significant future role. Because conventional hydroelectric projects are typically very
large, they face knth capital availability constraints and the p'oblem of concentration of demand for their large power output. Although the number of large hydropower projects *cannot* be *expected* to increase *very* rapidly, such plants will be an important electric power alternative, especially to oil-powered *therrrel* power plants. This warrants increased aid in preparing project plans to seek financing as well as larger capital resources for loans to worthy projects.

An even less exploited potential for water *power* lies in the nwny possibilities for medium-sized and even small installations. This is especially relevant, given the lredominantly rural distribution of Bust developing countries' populations. Aid roams can provide funds for preparing feasibility studies of hydrosites, identify suitable locations, and finance dams and power installations.

The Bust prevalent form of energy now used in most developing countries is renewable energy. Even for the world as a whole, renewable sources in old and new forms will eventually become the dominant energy sources. The

research and developnent of snail-scale renewable energy technologies need much greater attention and funding. An effort of great value in assessing the real worth of renewable energy resources could be a special international cooperative program for RD&D on DRE that could substitute for and eventually succeed sane uses of oil. The technology would, of course, be available for application anywhere in the world, but the justification for such a lrogram should acknowledge that the ~.rliest and perhaps most frequent application of the resulting technology probably would be in the Third World.

A related area of mutually beneficial cooperation on new and renewable energy resources is the testing and dennnstration of renewable energy equipnent on the farms and in villages, mrket towns, and urban slues of the developing countries. Such tests and denonstrations are essential steps in the evolution of DRE technology. Because nsny of the LDC do not have the financial resources, the technological knowhow and the institutional capabilities to undertake such activities, assistance fran donor agencies is highly valuable.

Aid agencies can also help in the dissemination of information and distribution of new technologies. As the intended beneficiaries are vainly the poor, rural dwellers of these countries, the development of efficient distribution methods is highly crucial. Aid agencies can he helpful in the marketing and distribution process in a number of ways.

First, they lc1p the country to gather the facts on local needs, preferences, and primary energy availability. Surveys will be needed of such conditions as available local stream flow, sunshine, wind, and organic materials in order to determine what DRE devices might be usable in a Iarticular locality. The aid input might take the form of funds and advisors to help indigenous institutions to conduct the survey.

Second, aid programs could help build or strengthen essential institutions, such as extension services, smell credit services, and marketing facilities. Aid programs could also help finance imports o£ DEE equipment and provide local currency for smell credit programs. In all cases, great effort should be made to strengthen the institutions of the LIXS capable of performing research on and developmnt of new technologies or adapting industrialised countries' technologies to meet their own needs.

E. **Afforestation**

The declining availability of traditional fuels is one of the critical energy problems facing the developing world. Not only is firewood a very important fuel ajurce, becoming more scarce and expensive, but the side effects of deforestation on food production and the environment carry with them high economic costs. The burning of animal dung and crop

wastes is resulting in the loss of soil nutrients and **declining** food and wood production. Finding alternative sources of energy, therefore, will not only alleviate the energy problem but also help increase food production and contribute towards the checking of desertification. If the conditions of rural energy are neglected and ignored the result could he serious ecological problems with far reaching implication of global dimensions.

Assistance is required for programs of afforestation, fuelweod plots, improved stoves, and better charcoal kilns.
Aid agencies can provide funds, technical advice, technicians, and volunteers to help with forestry programs. They can help find and develop substitutes for Iireunod. They can also help develop better and efficient stoves, find ways of efficient charcoal production, and undertake research try develop and test new varieties of fast growing wood and perhaps other bionwss forms of fuel.

F. **Energy Conservation**

Although energy waste in the developing countries is not as great as in the industrial nations, there is the need to Conserve. The problem is generally one of a lack of skills and capital to improve the level of efficiency. While the poor can least afford to consorts energy wastefully, they can also least afford the cash investment that is needed to rtake energy productivity rope efficient. Aid agencies can contribute to energy conservation. For example, they can sponsor studies of energy losses inherent in current practices, finance and undertake surveys of plant layout and equipment, finance the developrent of rope efficient a uiprent, and train nations in all aspects of conservation.

To a great extent, the developing countries h_{ave} weathered the increases in oil prices in the 1970s and the resulting recession better than *was feared.* In spite of all the problems, the LDCs, by and large, have been successful in avoiding disasters a far. They *have* been able to adjust *rrore* easily than anticipated. But many experts rbubt that they can in future continue to adjust as easily and avoid economic damage.

In the long run, the developing countries will have to rake fundamental structural adjustments to the energy problems. Governments will have to reassess their developrent strategies, people will have to change their consumption patterns, and changes will have to be made in the economic structure. In addition to increasing the cbrrestic production of energy and finding alternative *energy* sources, these countries will have to restructure their export and import sectors, adopt more energy efficient patterns of developrent, and be nnre self-reliant. Each country will have to make a clear and thorough analysis of its problems and priorities and chart out its long-term adjustment programs accordingly.
However, since such structural adjustments are difficult and costly to make, there is an urgent need for massive international assistance. The international community should provide help not only for the sake of the

OIDCs, but because it is in the self-interest of every nation to do w.

4. IMPROVED INTERNATIONAL COOPERATION ON ENERGY

Such topics as food, health, communications, and environment are given careful and systematic attention at the international level by one or tore international bodies. Some experts in the energy field have urged that a special international organisation he created to do the sate for energy. Whether additional machinery is needed is not a suitable subject for this framework report. However, it nay he helpful to identify the kinds of problems in the field of energy that are not adequately manageable at the national level but need attention at the international level, either by existing or possibly by new Indies.

A. A Forum for Southern Views on Energy

The industrialised countries of the North have found it useful to consult with one another frequently on the subject of energy. There are consulting and cooperative arrangements on oil supply, on Rll&D on new technologies, on conservation, and, of course, on nuclear power (often involving only the nuclear nations). The South is excluded from most of these arrangements. OIDCs need to he included in a world-wide forum where they nay express their views on subjects like energy waste in the North, the management of oil pricing systems, nuclear rules imposed by the JAM or unilaterally by the nuclear power countries, and the global allocation of energy RD&D funds.

R. Third World Oil Supply Security

One o£ the important functions of the IEA is to raintamn a contingency plan for dealing with politically caused oil supply shortages. Under that plan, members undertake to restrain consumption, build contingency stocks, and share continued oil flows in case of a shortfall. There is no such plan for the oil importing developing countries. An international agency could he asked to establish such a plan or at
least to mnitor the IEA plan to ensure that, in the event of a crisis, it thes not harm the interests of these countries.

C. World Ihergy Balance Sheet

In the field of world food supply, it has been very useful for the FAO to wrt out and publish, frail tine to time, a talanw sheet on world food. A similar service in the international energy field would be useful. Such a service would assemble known data on current and potential energy supply, demand, costs, investnent levels, technologies, and national and sub-national needs. It would prepare analytical think pieces on such topics as international energy balances and merging energy problems for the guidance of the nations o£ the world.

D. Finance For Renewable Energy rvelopment Within the Third

World

Just as there is an agency (IAEA) to promote nuclear *energy,* so there might be a special international solar (or renewable) energy assistance program. Essentially, it would support fact gathering, site testing of DRE equipment, training, and institution building; and it would finance or subsidise the distribution of the mrre promising DBE equipment based on site test results and other data.

E. Exchange of Infornation on RD&D Results for DRE Technologies
The existing network of researchers on international food issues might serve as a nodal for the world of DRE research. Already, our contacts with researchers in nany Third World countries nuke clear their feeling of isolation and their need for a systematic neaps of keeping up with the work of other researchers. One task for international energy na.chinery nay be to establish and nonitor such an information exchange mechanism.

CRAFTER IV: A FRAMEWORK FOR ENERGY IK)LICIES IN OIL IMloRTING DEVELOPING CONUNTRIES

In this chapter we examine the main energy supply options for OIDCS in the medium term, i.e., during the next 10-15 years. These include oil, gas, coal, nuclear, hydro and geothermal power.

In Section 1 supply options for external energy are considered. The main conclusion is that trade in oil will decline in importance but will or my be partly substituted by coal, gas, and electricity. In particular, there trey be increasing exchanges o£ gas and electricity among bordering countries or entire regions.

In Section 2 supply options for domestic energy are reviewed in light of what is known or inferred regarding OIDCS' energy potential. The ruin conclusion is that with adequate policies rrost OIDCS, particularly those which are medivir sized or larger, could become much mre self-sufficient and in some cases exporters of energy. This is because they contain within their territories energy resources which are significant for their medium-term needs. An analysis is nude source by source.
In Section 3 an attempt is nude to project *low* the situation of energy dependency could change over the next 10-15 years. OII s are grouped by degree of energy selfsufficiency now and in the future. At the sa.zp time, a second type of classification is attempted in terms of the ruin kinds of external assistance which these countries nuy need to overtone their problems. These are divided into: i) technical assistance from official institutions, ii) financial assistance from official institutions, iii) foreign private investment and know-how, and iv) financial assistance from private banks.

1. EXTERNAL SUPPLY OPTIONS
A. Oil

During 1950-73 the bulk of new energy supplies for the non-communist world, particularly Western Europe, Japan, and the OIPCs, was provided by rapidly growing oil production from a small group of aclXs, members o£ OPEC.

Oil was abundant, convenient, and required relatively low investments for its production, transport, processing, end use. Furthermore, it was sold at a price lower than that o£ coal, becoming a significant factor in the unprecedentedly rapid economic expansion which Europe, Japan, and many Third World countries experienced during the period. However, this was at the risk of becoming simultaneously excessively dependent on oil and on imports for the energy needs o£ their economies.

Since the Middle hat war of 1973 and nore ro since **the** Iranian revolution of 1979, a fundamental change has taken place. Briefly, this change consists in the adoption by OPEC n tubers of very determined conservation policies. These are aimed at lengthening the life of their oil resources and increasing their value to the level of eventual substitutes (e.g., synthetics). The rationale for these policies has been discussed elsewhere. It must be accepted that it is basically sound from their viewpoint. Moreover, it is also in the longer-term interest of the oil consumers. This is because the transition to a ron-oil era is unavoidable, needs several decades to be accomplished, and could he more painful if it did not start with enough time for carrying out the search and implenentation of acceptable alternatives.

Because of the new policies of aCliCS, oil importers have no effective choice and must accept the following constraints:

i) There will be little or no increase in oil supplies from OPEC sDurces. In fact, there nsy he a gradual decrease.

ii) External oil supplies will stay at a high price. This price is likely to increase even further, until substitutes gay he sufficiently available to satisfy the world's additional energy needs, in particular those of developing nations.

iii) Oil supplies and prices will rmst probably be subject to violent but hopefully short-term fluctuations.
This will result from likely but unpredictable o1itical, social, and technical accidents, due to the intrinsic vulnerabilities of the supply system.

Chapter I indicated that international trade in other energy sources is likely to increase. S im of these sources will be significant to OINCS and should be kept in mind Mien analysing energy options.

B. Gas

Natural gas *can* be nnved by sea in the form of LCG or by land in

pipelines. Regarding LNG, the high investment costs of liquefaction, transport, regasification, and distribution make this option of little interest to post OIBCs. Only large consumers with no cheaper alternatives could choose this option. They may include Brazil, Korea, and Rep. o£ China (Taiwan), though Brazil in larticular could obtain gas by pipeline from neighbouring countries such as Bolivia and Argentina.

The option of importing gas by pipeline nay be of much greater interest. It is usually p,ssible to purchase the gas at a lower price than oil (both seller and buyer nay lack better viable alternatives), and investments are also considerably lower.

As already noted, situations of this type nay arise between Brazil, Bolivia, and Argentina. They my also arise between Uruguay and Argentina, and between (ntral American countries and Mexico to the north or Colombia to the south. In South Asia it could happen between Pakistan and India, as well as between Bangladesh and India (in both cases India the purchaser). In the Middle Fast, it could happen between Turkey and Iraq or Iran, and between Fgypt, Israel, and Jordan (should peace ever come to that area). In North Africa it could happen between Algeria and Tunisia (taking advantage of the pipeline to Italy). West Africa could eventually be linked by gas pipelines, particularly around Nigeria.

C. Coal

Imports of coal from both industrial (Australia, Canada, South Africa, and US) and developing countries (such
as Botswana, Colombia, and Indonesia) fray be a very attractive option in terms of cost per unit of energy, particularly for power generation and industrial uses (cement, glass, etc.). Security of supply and attractive prices might be obtainable on the basis of long-term contracts. In sons cases, especially for large consumers, it could rake sense for OIDCs to buy coal mines in foreign countries, as sJne European countries are doing in the US. Brazil in fact has tried to have an equity position in Colombian coal developments. Korea and Rep. o£ China could seek the same in such countries as Australia and Indonesia.

Coal trade development in OIDCs will require careful planning, as the infrastructure for unloading, transporting, and burning coal is generally non-existent and costly. In this sense, trade in coal has cone of the characteristics of LNG; noreover, coal has greater flexibility and lower investment.

D. Nuclear Fuels

There are a number of OIDCs (e.g., Argentina, Brazil, India, Korea, Pakistan, Philippines, Rep. of China), which are *or my* become users of nuclear energy in the 1980s. Most of them will need to import nuclear fuel, because they lack either the raw naterial or the enrichnent facilities. The nuclear option is

expensive and technologically complex. At the present tine, it is available and competitive with oil --and in sons instances coal--only for very large power plants, at least 600 MW if not higher. This neaps that only a few, though rope of the largest, developing countries vould be justified, on economic grounds alone, to go for this option.

Contrary to the case in which a country Inssesses gas or coal resources, the availability of domestic uranium resources is not sufficient to justify following the nuclear option. Uranium represents a minor proportion of the cost of nuclear power, and it is sore logical to consider it as a possible source of export revenues (as oil) rather than a source of domestic energy.
Another possibility is to import electric energy from neighbouring countries. In some cases, it *may* be to import other countries' large surpluses which cannot be used locally (e.g., ongoing projects to export from Paraguay to Argentina and Brazil; and pDssibly Nepal to India). In other cases, it may be through better regional planning (e.g., the interconnected system under review by the Central American countries, which allows optional generation and transmission line scheduling).

The conclusions of this section are that:

i) OIIX`s could face very tight supplies o£ foreign oil. They could be competing with the rest of the world (and among themselves) for very limited additional global supplies. Unless they can secure special treatnent from suppliers on a government-to-government basis, the competition will be largely on a market-determined basis, and the stronger buyers will fore likely be favoured. There is serious danger that OIDCS will get relatively less and pay relatively fore than the industrial countries and CPEs.

ii) OIf7Cs should therefore investigate and pursue other less constrained external sources o£ energy, especially coal, gas, nuclear, or hydropower. In particular, gas and electricity from neighbouring countries, brought in by pipeline and transmission lines, may prove quite attractive and equally beneficial to the importer and exporter.

iii) Nevertheless, development o£ dofestic supplies and efficient use of energy are the main options to be pursued. Imported oil, which was in the past and is still the most important scarce for many OIDCS, cannot be expected to support their future energy needs.

This leads us to examine the donestic energy resources of OIDCS and the policies which they *may* adopt to develop them. The issue of energy efficiency and conservation was discussed in Chapter III.

2. Ir*LESTIC SUPPLY OPTIONS

The pre-1973 availability of low-cost oil from external sources provided little incentive for the exploration and exploitation of domestic resources. Generally speaking, npst countries concentrated in the area of hydroelectric generation, which was usually competitive, especially for the supply of

urban and industrial narkets. Coal developnent outside India has been very limited and has nnstly been a carry-over of the era before World War II. As for oil and gas, efforts by the international oil industry were concentrated in a few exceptionally promising areas with a clear potential for exports. In the OIICs, the work was done essentially by national oil companies, in part because of these countries' dissatisfaction with the level of effort and investment which foreign companies appeared able and willing to make at various critical points in time. These foreign companies were, of course, parsuing a global optimisation and moved to countries Witch offered better geological prospects as well as financial terms. This was what happened in some countries of Latin America (e.g., Argentina, Brazil, Cnile) as well as India and Pakistan.

For these reasons, the crisis of 1973 caught OIIKs generally weak and unprepared to face effectively the new situation, in terms of organisation, nanagenent, and technical skills, as well as knowledge of their potential energy resources. Part of this gap could have been covered by international developrent banks and other aid organisations, but these also were initially unequipped in terms of staff and Iolfcy to be very effective. Only in 1977 was the World Bank able to start a proper response in this area, to Ix followed later by others.

In view of these national and official aid weaknesses, it was clear that any quick response to the crisis must turn to external sources for the financial and policy means to secure the necessary skills. These skills are for

* Issues regarding rural non-oomnercial energy in developing countries have been discussed in chapters II & III.

the frost part available only in the industrial world's energy companies, particularly in the areas o£ oil, gas, coal, and nuclear developnent. In trying to secure these skills, OIDCs are competing i) with pressures in industrial countries for increased cbmesttc efforts, ii) with claims and requests of OPIC countries, iii) with other established exporters which have lore negotiating strength and leverage, and iv) aimng themselves-.

Many OIOCS appear to be unaware o£ this situation or unable to cope with it: one for ideological reasons, others because of political divisions and weaknesses, and others because of explicit opposition or more frequently effective toot-dragging by their national oil companies, which would like to maintain their predominant role, no matter what the cost in risks and delays to the country as a whole. Even if most OII7Cs adopt optimal policies a) in the long-term to attain a national implementation capability, and b) in the short- and medium-term to accelerate energy exploration and development, they would still face very serious obstacles, for reasons which are worth repeating:

i) modest development and export prospects relative to OXIX2s,
ii) weak local infrastructure, physical and human, and iii) investors' concern with political instability and non-comaercial risks.

To overcome these obstacles needs enlightened, pragmatic, and stable governnrnt policies. It also requires (until these policies become credible for countries with poor records) the sort o£ de facto international guarantee which can be given by institutions including the World Bank and other development taroks as "third lorries."

It is taking a long tine for these ideas to gain ground in all the parties involved: OIUCs, development institutions, and industry. But there are signs that progress is finally being made.

As for the past period of 1973-78, it is clear that the efforts of industry have been concentrated in the industrialised countries and that, relative to these, the work carried out in the OIIXS is mininie.l.

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Let us now look more specifically at the energy development options o£ OIDCS. In general, with very few exceptions (islands or *very* small countries), OIDCS are endowed with a variety of actual or potential energy sources. This is shown in Table Iv-1, which list countries with oil, gas, coal, and geotherfl l potential. In addition, Table IV-2 gives quantitative information °n their lh drstill tonly p en tial; it shows that most of the P°t ned or unused. A brief but ri rdi detailed discus s u sio o f this key potential is *given* below, development problems.

A. Oil and Gas

Oil and gas are found geologically in sedimentary basins. The imp below shows the approximate area of the world's known sedimentary basins, indicating which of them are currently producing oil and gas. It assures that, if a country has a sedimentary basin in its territory, there is a possibility of finding oil and gas. This assumption, while generally correct, toes rpt held in every case. To come extent, the evaluation of the oil potential of any given area is a subjective judgement by individual petroleum geologists;

Hence the wide diversity of estimates of undiscovered oil and Gas in any particular country.

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TABLE IV-1: CHARACTERISATION OF NON-OPEC DEVELOPING WUNTRIES BASED ON THEIR POPENTIAL ENERGY RESOURCES

Net Oil Exporters	Oil &/or Gas Producers	Iotential Oil and/or Gas Producers
Angola	Afghanistan Benin	Honduras Papua New
Bahrain	Argentina Chad	Ivory Coast Guinea
Bolivia	Bangladesh Costa Rica Jannica	Senegal
Brunei	Barbados Cyprus Jordan	Sierra
Congo	Brazil Lbminican Kenya	*Leone*
Egypt	Bunny Rep. Korea	Sonnhla
Malaysia	Cameroon Eq. Guinea Lebanon	Sri Lanka
Mexico	Chile Ethiopia Liberia	Sudan
Onan	Colombia Fiji Mali	Surinam
Peru	India Cambia Madagascar	Tanzania
Syrian AR	Mbrocco Ghana Mauritania	Togo
Trinidad & Tobago	Pakistan Philippines Guatennla Guinea- Mozambique Volta	Mauritius Upper Tunisia Thailand Bissau Nepal
Uruguay	Zaire Turkey Guinea Rep. Nicaragua	Vietnam
Yugoslavia	Guyana	Niger Yemen, AR
Haiti		Panann Yemen, A)R

Potential Geothermal	Coal- Producers	Indigenous F?mergya Endowed	Resource Deficient
	Cameroon	Argentina	Cyprus
	Chile	Bangladesh	Lbminican Rep.
	Colombia	Botswana	Gambia
	Costa Rica	Brazil	Haiti
	E1 Salvador	Chile	Jamaica
	Ethiopia	Colombia	Jordan
	Guatemrnla	India	Lebanon
	Kenya	Mexico	Mauritius
	Malawi	Madagascar	Singapore
	Nicaragua	Mozambique	Upper Volta Philippines I~ru
	Rep. China	*Rep.* Korea	
	Tanzania	Swaziland	
	Turkey	Turkey	
	Uganda	Vietnam	
	Yemen, AR	Zambia	

Note: [a]proven and probable indigenous commercial energy resources, which are at present comletitive with imported oil, are small relative to conmercial energy demand in these countries.

Source: World Bank Staff Working Paper No. 350, August 1979.

TABLE IV-2: HYDROPOWER CAPACITY IN DEVEIAPILi WUNTRIES

Countries	Gross Capacity			
	Theoretical			Under
(H2biaitY	Operating	Construction	Planned	Unused
	(TJ)			(MW)
Afghanistan	n.a,	N.A.	n.a,	ma.
n.a. Angola	252,002	284	80	300
9,000 Argentina	8,755,279	1,393	4,212	36,323
9,125 Bangladesh	n.a.	80	50	100
1,087 Brazil	2,399,536	15,297	24,225	16,537
44,567 Chile	805,321	1,454	950	6,595
6,781 Wlombia	4,644,004	1,900	1,150	23,350
23,600 Costa Rica	802,807	214	270	1,635
4,881 Egypt	n.a.	2,445	n.a.	2,440
n.a. E1 Salvador	15,120	97	135	940
n.a. Ethiopia	819,876	n.a,	n.a.	1,390
7,602 Ghana	ma.	948	n.a.	140
527 Guatemala	46,008	96	n.a.	1,100
n.a. Honduras	n.a.	69	n.a,	n.a,
n.a. India	777,602	6,750	6,800	56,450
n.a. Ivory Coast	230,402	225	n.a.	555
n.a. Malaysia	ma.	296	348	341
334 Mexico	n.a.	3,885	3,030	17,975
n.a. Mozambique	180,002	90	3,700	2,500
5,000 Pakistan	n.a.	2,173	1,125	n.a.
31,171 Peru	n.a.	1,389	n.a,	n.a,
n.a. Philippines	70,543	641	2,085	ma.
4,778 Rwanda	n.a.	41	n.a.	128
n.a. Spain	557,440	11,355	2,326	8,835
6,808				
Syria	ma.	204	n.a,	n.a,
n.a. Rep. China	105,448	1,365	27	321
n.a. Thailand	244,113	910	780	6,573
13,602 Tunisia	69	29	n.a.	n.a.
25 Turkey	1,570,485	19,577	ma.	n.a.
n.a. Uruguay	n.a.	252	1,890	300
465 Yugoslavia	396,004	4,247	910	9,500
2,300 Zaire	n.a.	597	289	n.a.
32,000				
Zambia	757	910	n.a.	n.a,
n.a.				
Note: acne tera joule (TJ) 2.8 x 10^5 Kwh.				
Source: World Bank Staff Working Paper No. 350, August 1979, based on World Energy Conference data.				
Aid agencies can provide funds, technical advice, technicians, and volunteers to help with forestry programs. They can help find and develop substitutes for Iireunod. They can also help develop better and efficient stoves, find ways of efficient charcoal production, and undertake research try develop and test new varieties of fast growing wood and perhaps other bionwss forms of fuel.				

F. Energy Conservation

Although energy waste in the developing countries is not as great as in the industrial nations, there is the need to Conserve. The problem is generally one of a lack of skills and capital to improve the level of efficiency. While the poor can least afford to consorts energy wastefully, they can also least afford the cash investment that is needed to rtake energy productivity rope

efficient. Aid agencies can contribute to energy conservation. For example, they can sponsor studies of energy losses inherent in current practices, finance and undertake surveys of plant layout and equipment, finance the developrent of rope efficient a uiprent, and train nations in all aspects of conservation.

To a great extent, the developing countries h_{ave} weathered the increases in oil prices in the 1970s and the resulting recession better than *was feared.* In spite of all the problems, the LDCs, by and large, have been successful in avoiding disasters a far. They *have* been able to adjust *rrore* easily than anticipated. But many experts rbubt that they can in future continue to adjust as easily and avoid economic damage.

In the long run, the developing countries will have to rake fundamental structural adjustments to the energy problems. Governments will have to reassess their developrent strategies, people will have to change their consumption patterns, and changes will have to be made in the economic structure. In addition to increasing the cbrrestic production of energy and finding alternative *energy* sources, these countries will have to restructure their export and import sectors, adopt more energy efficient patterns of developrent, and be nnre self-reliant. Each country will have to make a clear and thorough analysis of its problems and priorities and chart out its long-term adjustment programs accordingly.

However, since such structural adjustments are difficult and costly to make, there is an urgent need for massive international assistance. The international community should provide help not only for the sake of the OIDCs, but because it is in the self-interest of every nation to do w.

4. IMPROVED INTERNATIONAL COOPERATION ON ENERGY

Such topics as food, health, communications, and environment are given careful and systematic attention at the international level by one or tore international bodies. Some experts in the energy field have urged that a special international organisation he created to do the sate for energy. Whether additional machinery is needed is not a suitable subject for this framework report. However, it nay he helpful to identify the kinds of problems in the field of energy that are not adequately manageable at the national level but need attention at the international level, either by existing or possibly by new Indies.

A. A Forum for Southern Views on Energy

The industrialised countries of the North have found it useful to consult with one another frequently on the subject of energy. There are consulting and cooperative arrangements on oil supply, on Rll&D on new technologies, on conservation, and, of course, on nuclear power (often involving only the nuclear nations). The South is excluded from most of these arrangements. OIDCs need to he included in a world-wide forum where they nay express their views on subjects like energy waste in the North, the management of oil pricing systems, nuclear rules imposed by the JAM or unilaterally by the nuclear power countries, and the global allocation of energy RD&D funds.

R. Third World Oil Supply Security

One o£ the important functions of the IEA is to raintamn a contingency plan for dealing with politically caused oil supply shortages. Under that plan, members undertake to restrain consumption, build contingency stocks, and share continued oil flows in case of a shortfall. There is no such plan for the oil importing developing countries. An international agency could he asked to establish such a plan or at

least to mnitor the IEA plan to ensure that, in the event of a crisis, it thes not harm the interests of these countries.

C. **World Ihergy Balance Sheet**

In the field of world food supply, it has been very useful for the FAO to wrt out and publish, frail tine to time, a talanw sheet on world food. A similar service in the international energy field would be useful. Such a service would assemble known data on current and potential energy supply, demand, costs, investnent levels, technologies, and national and sub-national needs. It would prepare analytical think pieces on such topics as international energy balances and merging energy problems for the guidance of the nations o£ the world.

D. **Finance For Renewable Energy rvelopment Within the Third World**

Just as there is an agency (IAEA) to promote nuclear *energy,* so there might be a special international solar (or renewable) energy assistance program. Essentially, it would support fact gathering, site testing of DRE equipment, training, and institution building; and it would finance or subsidise the distribution of the mrre promising DBE equipment based on site test results and other data.

E. **Exchange of Infornation on RD&D Results for DRE Technologies**

The existing network of researchers on international food issues might serve as a nodal for the world of DRE research. Already, our contacts with researchers in nany Third World countries nuke clear their feeling of isolation and their need for a systematic neaps of keeping up with the work of other researchers. One task for international energy na.chinery nay be to establish and nonitor such an information exchange mechanism.

CRAFTER IV: A FRAMEWORK FOR ENERGY IK)LICIES IN OIL IMloRTING DEVELOPING CONUNTRIES

In this chapter we examine the main energy supply options for OIDCS in the medium term, i.e., during the next 10-15 years. These include oil, gas, coal, nuclear, hydro and geothermal power.

In Section 1 supply options for external energy are considered. The main conclusion is that trade in oil will decline in importance but will or my be partly substituted by coal, gas, and electricity. In particular, there trey be increasing exchanges o£ gas and electricity among bordering countries or entire regions.

In Section 2 supply options for domestic energy are reviewed in light of what is known or inferred regarding OIDCS' energy potential. The ruin conclusion is that with adequate policies rrost OIDCS, particularly those which are medivir sized or larger, could become much mre self-sufficient and in some cases exporters of energy. This is because they contain within their territories energy resources which are significant for their medium-term needs. An analysis is nude source by source.
In Section 3 an attempt is nude to project *low* the situation of energy dependency could change over the next 10-15 years. OII s are grouped by degree of energy selfsufficiency now and in the future. At the sa.zp time, a second type of classification is attempted in terms of the ruin kinds of external assistance which these countries nuy need to overtone their problems. These are divided into: i) technical assistance from official institutions, ii) financial assistance from official institutions, iii) foreign private investment and know-how, and iv) financial assistance from private banks.

1. EXTERNAL SUPPLY OPTIONS A. Oil

During 1950-73 the bulk of new energy supplies for the non-communist world, particularly Western Europe, Japan,

and the OIPCs, was provided by rapidly growing oil production from a small group of aclXs, members o£ OPEC.

Oil was abundant, convenient, and required relatively low investments for its production, transport, processing, end use. Furthermore, it was sold at a price lower than that o£ coal, becoming a significant factor in the unprecedentedly rapid economic expansion which Europe, Japan, and many Third World countries experienced during the period. However, this was at the risk of becoming simultaneously excessively dependent on oil and on imports for the energy needs o£ their
economies.

Since the Middle hat war of 1973 and nore ro since the Iranian revolution of 1979, a fundamental change has taken place. Briefly, this change consists in the adoption by OPEC n tubers of very determined conservation policies. These are aimed at lengthening the life of their oil resources and increasing their value to the level of eventual substitutes (e.g., synthetics). The rationale for these policies has been discussed elsewhere. It must be accepted that it is basically sound from their viewpoint. Moreover, it is also in the longer-term interest of the oil consumers. This is because the transition to a ron-oil era is unavoidable, needs several decades to be accomplished, and could he more painful if it did not start with enough time for carrying out the search and implenentation of acceptable alternatives.

Because of the new policies of aCliCS, oil importers have no effective choice and must accept the following constraints:

i) There will be little or no increase in oil supplies from OPEC sDurces. In fact, there nsy he a gradual decrease.

ii) External oil supplies will stay at a high price. This price is likely to increase even further, until substitutes gay he sufficiently available to satisfy the world's additional energy needs, in particular those of developing nations.

iii) Oil supplies and prices will rmst probably be subject to violent but hopefully short-term fluctuations.

This will result from likely but unpredictable o1itical, social, and technical accidents, due to the intrinsic vulnerabilities of the supply system.

Chapter I indicated that international trade in other energy sources is likely to increase. S im of these sources will be significant to OINCS and should be kept in mind Mien analysing energy options.

B. Gas

Natural gas *can* be nnved by sea in the form of LCG or by land in pipelines. Regarding LNG, the high investment costs of liquefaction, transport, regasification, and distribution make this option of little interest to post OIBCs. Only large consumers with no cheaper alternatives could choose this option. They may include Brazil, Korea, and Rep. o£ China (Taiwan), though Brazil in larticular could obtain gas by pipeline from neighbouring countries such as Bolivia and Argentina.

The option of importing gas by pipeline nay be of much greater interest. It is usually p,ssible to purchase the gas at a lower price than oil (both seller and buyer nay lack better viable alternatives), and investments are also considerably lower.

As already noted, situations of this type nay arise between Brazil, Bolivia, and Argentina. They my also arise between Uruguay and Argentina, and between (ntral American countries and Mexico to the north or Colombia to the south. In South Asia it could happen between Pakistan and India, as well as between Bangladesh and India (in both cases India the purchaser). In the Middle Fast, it could happen between Turkey and Iraq or Iran, and between Fgypt, Israel, and Jordan (should peace ever come to that area). In North Africa it could happen between Algeria and Tunisia (taking advantage of the pipeline to Italy). West Africa could eventually be linked by gas pipelines, particularly around Nigeria.

C. <u>Coal</u>

Imports of coal from both industrial (Australia, Canada, South Africa, and US) and developing countries (such

as Botswana, Colombia, and Indonesia) fray be a very attractive option in terms of cost per unit of energy, particularly for power generation and industrial uses (cement, glass, etc.). Security of supply and attractive prices might be obtainable on the basis of long-term contracts. In sons cases, especially for large consumers, it could rake sense for OIDCs to buy coal mines in foreign countries, as sJne European countries are doing in the US. Brazil in fact has tried to have an equity position in Colombian coal developments. Korea and Rep. o£ China could seek the same in such countries as Australia and Indonesia.

Coal trade development in OIDCs will require careful planning, as the infrastructure for unloading, transporting, and burning coal is generally non-existent and costly. In this sense, trade in coal has cone of the characteristics of LNG; noreover, coal has greater flexibility and lower investment.

D. Nuclear Fuels

There are a number of OIDCs (e.g., Argentina, Brazil, India, Korea, Pakistan, Philippines, Rep. of China), which are *or my* become users of nuclear energy in the 1980s. Most of them will need to import nuclear fuel, because they lack either the raw naterial or the enrichnent facilities. The nuclear option is expensive and technologically complex. At the present tine, it is available and competitive with oil --and in sons instances coal--only for very large power plants, at least 600 MW if not higher. This neaps that only a few, though rope of the largest, developing countries vould be justified, on economic grounds alone, to go for this option.

Contrary to the case in which a country Inssesses gas or coal resources, the availability of domestic uranium resources is not sufficient to justify following the nuclear option. Uranium represents a minor proportion of the cost of nuclear power, and it is sore logical to consider it as a possible source of export revenues (as oil) rather than a source of domestic energy.

Another possibility is to import electric energy from neighbouring countries. In some cases, it *may* be to import other countries' large surpluses which cannot be used locally (e.g., ongoing projects to export from Paraguay to Argentina and Brazil; and pDssibly Nepal to India). In other cases, it may be through better regional planning (e.g., the interconnected system under review by the Central American countries, which allows optional generation and transmission line scheduling).

The conclusions of this section are that:

i) OIIX`s could face very tight supplies o£ foreign oil. They could be competing with the rest of the world (and among themselves) for very limited additional global supplies. Unless they can secure special treatnent from suppliers on a government-to-government basis, the competition will be largely on a market-determined basis, and the stronger buyers will fore likely be favoured. There is serious danger that OIDCS will get relatively less and pay relatively fore than the industrial countries and CPEs.

ii) OIf7Cs should therefore investigate and pursue other less constrained external sources o£ energy, especially coal, gas, nuclear, or hydropower. In particular, gas and electricity from neighbouring countries, brought in by pipeline and transmission lines, may prove quite attractive and equally beneficial to the importer and exporter.

iii) Nevertheless, development o£ dofestic supplies and efficient use of energy are the main options to be pursued. Imported oil, which was in the past and is still the most important scarce for many OIDCS, cannot be expected to support their future energy needs.

This leads us to examine the donestic energy resources of OIDCS and the policies which they *may* adopt to develop them. The issue of energy efficiency and conservation was discussed in Chapter III.

*2. Ir*LESTIC SUPPLY OPTIONS*

The pre-1973 availability of low-cost oil from external sources provided little incentive for the exploration and exploitation of domestic resources. Generally speaking, npst countries concentrated in the area of hydroelectric generation, which was usually competitive, especially for the supply of urban and industrial narkets. Coal developnent outside India has been very limited and has nnstly been a carry-over of the era before World War II. As for oil and gas, efforts by the international oil industry were concentrated in a few exceptionally promising areas with a clear potential for exports. In the OIICs, the work was done essentially by national oil companies, in part because of these countries' dissatisfaction with the level of effort and investment which foreign companies appeared able and willing to make at various critical points in time. These foreign companies were, of course, parsuing a global optimisation and moved to countries Witch offered better geological prospects as well as financial terms. This was what happened in some countries of Latin America (e.g., Argentina, Brazil, Cnile) as well as India and Pakistan.

For these reasons, the crisis of 1973 caught OIIKs generally weak and unprepared to face effectively the new situation, in terms of organisation, nanagenent, and technical skills, as well as knowledge of their potential energy resources. Part of this gap could have been covered by international developrent banks and other aid organisations, but these also were initially unequipped in terms of staff and Iolfcy to be very effective. Only in 1977 was the World Bank able to start a proper response in this area, to Ix followed later by
others.

In view of these national and official aid weaknesses, it was clear that any quick response to the crisis must turn to external sources for the financial and policy means to secure the necessary skills. These skills are for

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Brunei	Barbados	Cyprus Jordan Sierra
Congo	Brazil	Lbminican Kenya *Leone*
Egypt	Bunny	Rep. Korea Sonnhla
Malaysia	Cameroon	Eq. Guinea Lebanon Sri Lanka
Mexico	Chile	Ethiopia Liberia Sudan
Onan	Colombia	Fiji Mali Surinam
Peru	India	Cambia Madagascar Tanzania
Syrian AR	Mbrocco	Ghana Mauritania Togo
Trinidad & Tobago	Pakistan Philippines Turkey	Guatennla Mauritius Upper Guinea- Mozambique Volta Tunisia Thailand Bissau Nepal Uruguay Zaire Guinea Rep. Nicaragua Vietnam
Yugoslavia		Guyana Niger Yemen, AR
Haiti		Panann Yemen, A)R

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Colombia	Botswana	Gambia
Costa Rica	Brazil	Haiti
E1 Salvador	Chile	Jamaica
Ethiopia	Colombia	Jordan
Guatemrnla	India	Lebanon
Kenya	Mexico	Mauritius
Malawi	Madagascar	Singapore
Nicaragua	Mozambique	Upper Volta Philippines I~ru
Rep. China *Rep.* Korea		
Tanzania	Swaziland	
Turkey	Turkey	
Uganda	Vietnam	
Yemen, AR	Zambia	

Note: [a]proven and probable indigenous commercial energy resources, which

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Costa Rica	802,807	214	270	1,635	4,881
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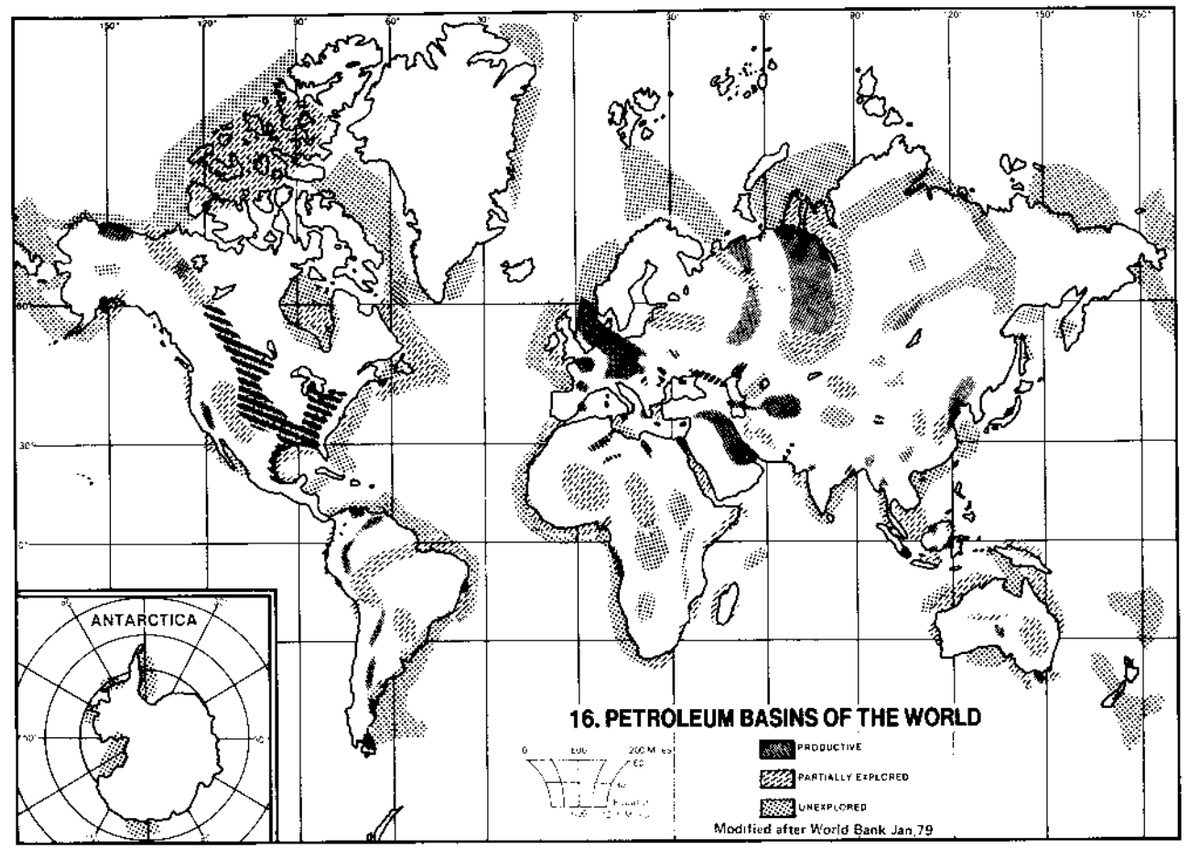
E1 Salvador	15,120	97	135	940	n.a.
Ethiopia	819,876	n.a,	n.a.	1,390	7,602
Ghana	ma.	948	n.a.	140	527
Guatemala	46,008	96	n.a.	1,100	n.a.
Honduras	n.a.	69	n.a,	n.a,	n.a.
India	777,602	6,750	6,800	56,450	n.a.
Ivory Coast	230,402	225	n.a.	555	n.a.
Malaysia	ma.	296	348	341	334
Mexico	n.a.	3,885	3,030	17,975	n.a.
Mozambique	180,002	90	3,700	2,500	5,000
Pakistan	n.a.	2,173	1,125	n.a.	31,171
Peru	n.a.	1,389	n.a,	n.a,	n.a.
Philippines	70,543	641	2,085	ma.	4,778
Rwanda	n.a.	41	n.a.	128	n.a.
Spain	557,440	11,355	2,326	8,835	6,808
Syria	ma.	204	n.a,	n.a,	n.a.
Rep. China	105,448	1,365	27	321	n.a.
Thailand	244,113	910	780	6,573	13,602
Tunisia	69	29	n.a.	n.a.	25
Turkey	1,570,485	19,577	ma.	n.a.	n.a.
Uruguay	n.a.	252	1,890	300	465
Yugoslavia	396,004	4,247	910	9,500	2,300
Zaire	n.a.	597	289	n.a.	32,000
Zambia	757	910	n.a.	n.a,	n.a.

Note: acne tera joule (TJ) 2.8 x 10^5 Kwh.

Source: World Bank Staff Working Paper No. 350, August 1979, based on World Energy Conference data.


ANTARCTICA
16. PETROLEUM BASINS OF THE WORLD
PRODUCTIVE
PARTIALLY EXPLORED
UNEXPLORED
Modified after World Bank Jan.79

ENERGY FOR DEVELOPMENT TABLE IV-3: OIL EXPLORATION DRILLING DENSITY, 1976

Petroleum Prospective	Area	Drilling Iknsity (million sq. (wells per '000 miles) spective area) sq.miles o£ pro
Developed A Developing	30.5	109
Industrialised Countries	9.0	290
of which: OS	(3.1)	(780)
Non-OPEC Dev'g Countries	12.9	7
of which: 0i1-importing	(8.6)	(5)
OPEC Countries	4	20

Note: The relatively low density in OPEC countries is due to the very favourable geological conditions (large individual fields), which cb not apply elsewhere.

Source: Grossling, Window on Oil, 1977.

Table IV-4 lists those non-OPEC countries a) which are considered to have sore possibility o£ finding additional oil and gas reserves, and b) in the case of those where no discoveries have yet been nade, where exploration nay be justified.

Most of the OIDCs which are listed in the first three columns (with prospects fairly good or better) are already producers or should become producers in the near future. This group includes some of the largest, host populated as well as the rmst seriously affected oil-importing countries. Many of them have a long way to go before solving their problems, even

if they have recently improved their policies (e.g., Brazil, Pakistan, Philippines, and Thailand). In roost cases, these countries have adopted a positive attitude to foreign Participation.

TABLE IV-4: DEVELOPING POTENTIAL FOR OIL AND GAS

NUNTRY INC ME GROUPING	(iced to Very (bad		Good	Fairly (iced	Fair	Fbor to Moderate
South Asia						
Low			Banglades Burma India Pakistan		Sri Lanka	Nepal
E. Asia & Pacific						
High		Brunei'				Singapore
Middle: Upper						Hong Kong
Intermediate		Malaysia'			Rep.Koroa	
Lower				Papua N.GUinea		
Low				Philippines a Thailanda		Laos
Euro~. Mid East & N. Africa						
High		Bahrain'	Yugoslavi a		Jordan	
Middle: Upper			Turkey			
Intenrediate		Syria'	Morocco			
		Tunisia'				
Lower		Egypt'				
Low Fast Africa			Afghanist		Yemen AR Yem n PDR	
Middle: Intenrediate						Mauritius
Lower					Mozambiqu	Betswana
Low			Zaire'	Tanzania	Ethiopia Madagasca r	Cwroro Is Kenya Lesotho

((bntinued)

Table IV '_O~~pI ~~Tftlo PGTtT`'TIA~ OIL M'0 GAS OISIXIVERIES
(Col tinved)
poor to
Good Fairly Fair M1bde~ate
V rv <:ood
Good IiO~
OJUNTRY INWMF
GROUPING
West Africa
High
Sao Tame
Middle: Principe Intermediate
Lower go
la Ivory ('grit Fquatorial
Pn
b Giaeroon' Ghan' Guinea
lingo' Benin Togo Senegal
da Central Upper African Rep. Volta
LOW Gambia Guinea Mali Niger
Sierra Icon
Lstin America g Caribbean
Surinam
Middle: Mexico' Argentina Uruguay a
Trinidad k Brazil Uruguay
Tobago' Barter<bs
Guatemala Guyana Janic
b Chile a Paraguay
Internedlate l ru C Dominican Rep. Nicaragua Costa Rica
Pane a
lblivia lbnduras
tnwer
Haiti
Low
Number 10
10

Countries 13 15 30

Awill join the list of oil/gas producers shortly.

Notes', 'Includes non-OPF O%Des.

W ld Bank S Ef W rking Pavxr No' 350, August 1979.

The situation is nore difficult for countries with mly fair or poor prospects. It is in these countries, particularly those with low-income per capita, where good governnent policies and front-end support for exploration by international aid nay be nest critical to get them started. It is ilso in those countries that it is nnst important to investigate a) alternatives to oil and b) if alternatives do not exist, options for economic growth which will minimise energy needs and/or allow foreign exchange to be earned for oil
Imports.

B. Gas

The utilisation of natural gas in a developing country has become economically far more attractive as crude oil prices increase. But it often presents a number of severe problems which call for policy decisions. White natural gas itself is a highly desirable fuel for both domestic and industrial use, it must be transported, in met cases by pipeline. Hence the market needs to be sufficiently large and concentrated, to justify the cost of constructing not only the gas processing plant, but also the pipeline to supply tt.

To provide a narket of adequate size, it is necessary to have a grouping of large fuel consumers such as thermal power generating stations, cement plants, nitrogenous fertiliser plants, and similar energy-intensive plants. While rrany developing countries have such plants, they are rarely grouped in the sane area. In nnst developing countries there is no demand for space heating. It is often necessary to develop the market for natural gas at the wore tine as the transport facility, because an underused pipeline is an uneconomic investment. Further fnvestfent costs are incurred if associated gas is used from oil fields, because this must be collected from dispersed sources of supply, treated, and compressed
Before it is put in the pipeline.

[t] Natural gas can be liquefied by refrigeration and transported in this form, but the cost makes it only feasible at
Present for large exportoriented plants. Liquefaction
Plant for 500 million cubic feet o£ gas per day
$1 billion, and ocean tankers to ship it cost as much
Again.

Furthermore, natural gas competes in ~n eases with
Fuel oil or hydropower for the same narket,
gas development nay actually increase problems intaother find P,mar exS
of the economy. It is, therefore,
plaited natural gas resources in countries which ohaviing difficulty in obtaining foreign exchange to pay solution ports. Frustrating as this HEY be, there is no easy
to the problem at the present time. Nevertheless, developing countries having natural gas reserves should nake a serious
attempt to use them.

For the above reasons, gas development for tbmestic use presents tore similarities with coal or hydroelectric development than with oil. The role of government than foreign investment becomes paramount.
consequently .
financial and technical assistance of development institutions
is very imlbrtant.
Of the oil-importing countries listed bleIV-4, greatest
the ones where domestic gas development Colombia India,
interest are Mgentina, Bangladesh, Chile, Pakistan, Tanzania, and
Thailand.

C. <u>Coal</u>

Coal was the nain fuel of the industrial world until the early 1950s. It has not played this role in OIDC5, because they began for the most Fart to industrialise in the oil era. Knowledge of OIrEs' coal resources is vEry inadequate.
The World Energy conference in 1977 estiteted the
World's economically and technically ahrecoverable nal reserveto be 636 billion metric tons,
loca
Ted in developing countries.
A larger proportion of these reserves may be recoverable in the future
than is estitated at present. Botswana,
Brazil, India, Indonesia, and Swaziland account for tore than 60% of presently recoverable coal reserves in developing
co prospectssupplies,*above*allonconventionalsuggestoil untries. Table IV-5 lists coal reserves in developing
Countries. In tang countries the full extent of coal resour-should ces has never priority yrthose countries where coals is known
Receive high in
to exist.

TABLE IVs: WAL EIESERVFS NIL) R83WRCFS OF

	0Ex2xlcw RESOURCES	acawlCALL? um FnwO1CAU,y RE JVERABLE RESERVES		DFCRRR OF FXPIcATION
		% World Resources		% world Recoverable Reserves	
rorAL	230,3	ss.us	-	1.t3	L
AFRICA	11938	L!!	119	0.56	L-M
Algeria	20			0.15	M
Angola	500	3,500		0.01	1
eeni	100,0	1,820		0.01	
Bctswaoa	00	38.583		0.26	
Bumndi	na.	33.700		0.12	
Egypt	500	1,930		5_05	
Ethiopia	80	10,951		0.08	
Madagascar	n	8,098		0.25	
Malawi	92	B_y9(5		5.30	
Mor	19		0.93	0.22	
eipoe	s		0.02	0.03	
Niger	900	80	-	0.06	
Nigeria	n	£4)		-	
Sierra Leone	180		0.05	--	
~alifl	5000	5		0.12	
Swaziland	,	755	0.07	0.05	
Tanvania	360		0.72	1.27	
Tunisia	73	519	0.02	0.03	
Zaire	228	-		0.07	
Znnbia	7,130	1		0.19	
Zimbabwe	72		0.05	0.02	
AS LA	72		0.55	0.15	
Afghanistan	95		0.09	1.33	

Argentina
Bolivia
Brazil
CTile
Colombia
Costa Rica
Ecuador
(Rateaaha
mndnr
Mexico
Panama
xr$_a$
Venezuela
EUROPE
Ywoslavia

Lbtes's cploration	of	re estimates, sell defined geolcy.
Well established		prc ware *have* been
- Few exploratory		ants.

teeanlllion netrlo tons of coal equivalent.

Source: World RaN[Staff Working Paper No. 350, August 1979.

World coal production in 1977 was 2,774 million tons, equivalent to about half the energy equivalent of oil output. Of this total, 176 million tons were mined in developing
countries.
Ten o£ these, narrely Brazil, Chile, Colombia, Mexico, Pakistan, Republic of China, Republic of Korea, Turkey, Vietnam, and Yugoslavia between them account for 96% o£ coal output in developing countries. Table IV-6 shows actual and forecast coal production in developing countries. It is evident that there is considerable scope for increasing production of coal in developing countries, since 21 o£ them are reported to have deposits of coal.

Coal production costs vary over a wide range. Opencast mining is invariably much cheaper than underground mining. Low-grade coals often cannot be exploited economically except by the open-cast method. Mining costs on a worldwide basis in 1978 averaged $10-15 per ton for open-cast mines, and $20-30 per ton for underground mines. For a good grade of steam coal, this would corns re with a cost of $14-20 per ton of fuel oil equivalent for open-cast coal and $27110 per ton of fuel oil equivalent for coal from underground
Mines.
Exploration for coal is less costly than for oil, tut nevertheless represents a risk outlay. It is carried out by means of geological surveys, assisted by geophysical methods and drilling to prove the thickness, continuity, and grade of the coal away from the outcrop.

Except in the few cases where a potential for competitive coal exports exists (e.g., Rotswana, Colombia and Swaziland), it is unlikely that foreign investment would be interested in playing a role in coal developrrnt. This will have to take place under the direction and with the financing of the OII7CS, for which they will need naximum technical and financial assistance fran development institutions.

Small-scale coal mining for local use does not present many problems. But a large-scale development to support industrial growth presents navy. First and foremast is the cost of developing the mines and the need for infrastructure, such as transport and community facilities for miners and

TABLE IV-6: (DAL PRODOCrION PRospD2rS OF DEVELOPIN:

	itecoverable Reserves		action			Annual Growth Hate	
	(Million	197	19 (Million	19	19	1977 (%	1985-90 (%)
WORLD	636_364	2,773.7	3,661 60	3,861	4,480	4.2	4.4
INDOBTRIAL C(MJNTRIE5	324,341	1134.4	1,265	j746	1,752	3.3	3_35
CPES	246,304	1,463.4	1_`fi2	2,089	'210	4.6	4.5
DEVEIAPIN".,	65,219	175.9	233	304	440.	7.1	7.6
Africa	7`20	5.0	0.3	15.	31.9	14.8	17.1
Algeria	(20)[0]	...	...		...		_
Angola	(500)C						_
Bctswana	3,500	0.2		0.3	5.0	5.2	75.5
Burundi	n. a.			_		_	-
C&r)ero0n	(500)[0]						
ypt	(80)[0]						
Madagascar	(92)[0]		-	1.0	2.0	-	
Malawi	(14)[0]						
Morocco	(96)°	0.6	0.9	1.0	1.1	6.6	1.9
Mozambique	80	0.4	1.0	2.0	3.0	22.3	9.4
Nigeria	90	0.3	0.3	1.0	3.0	10.2	24.6

Swaziland	1,823	0.1	0.5	1.5	5.0	28.6	27.2
Dinzania	(3so)°		e	2.0	3.0	-	8.5
Zaire	(73)[0]	0.1	0.1	0.1	0.1	0.0	0.0
Zambia		0.8	1.3	1.9	2.5	11.4	5.6
Zimbabwe	755	2.5	4.0	4.6	5.2	7.9	2.5
Asia	38,583	136.1	171.5	211.2	288.7	5.7	6.3
Afghanistan	(8s)c	itT2	0.2	os	1.0	14.7	20.1
Bangladesh	519	_					_
Brunei	(1)[0]						
Burn	(280)[0]	_			_		_
China, Rep.	(680)[0]	2.9	4.0		6.0	5.7	4.5
India	33,700	99.7	125.0		190.0	4.0	5.6
Indonesia	1,430	0.2	0.2		12.0	42.2	27.4
Iran	193	0.9	1.0		1.5	6.6	0.0
Korea, Rep.	386	28.3	19.0		25.0	3.1	2.6
Malaysia	(75)[0]				2.0	-	
Pakistan	(1,375)[0]	1.0	1.5		3.0	9.1	8.5
Philippines	(87)[0]	0.3	0.3		4.0	23.3	20.1
Thailand	(78)[0]	0.2	0.5		6.0	13.4	-
Turkey	793	7,4	9,8		16.2	7.3	5.9
Vietnsm	(3,000)[0]	6.0	10.0		20.0	12.1	24.6

(continued)

TABLE IV-6: W L PROWCrION pROSPEcrs OF OEVaDPING WONTRIFS (Wntinued)

	Recovorable[a] Reserves 1977 ('Million tech)	Production (Million tech) 1980	1985	1990	annual Growth Rate 1977-85 (%)	1985-90 (%)
Latin America	10,951	15.0	23.8	39.3	73.8		
Argentina	290	0.5	2.3	3.5	7.5	27.5	16.5
Brazil	8,090	3.5	6.4	10.0	20.0	13.9	14.9
ct.ue	162	1.2	2.0	2.5	7.5	9.6	24.6
Wlombia	443	3.7	5.0	10.0	20.0	13.2	14.9
Ecuador	(22)[0]	-			-		
Haiti	(7)[0]	-		-	0.3		
Honduras	(0.2)[0]	-		-	-		
t~kxico	875	6.0	6.7	8.0	9.3	3.7	3.1
Ebru	105		0.2	0.3	0.4 d		5.0
Venezuela	978	0.1	1.2	5.0	8.8	63.1	12.0
EWro~e							
Yugoslavia	8,465	19.0	23.5	10.2	46.0	9.3	3.8

[a]Data o recoverable reserves are rot available for the following countries. Benin, Ethiopia, Niger, Sierra Leone, 3vrelifl, Tunisia, Laos, Bolivia, Guatentla, and Panana.

[b]tce: nstric tons of coal equivalent

'Figures in parenthesis represent geological resources, since ro reserve data are available.

dann.al growth rate in excess of 50% due to very low 1977 production base:

eontput below 0.1 million tee in 1977.

Source: World Rank Staff workin Pa r lb. 350, August 1979.

their families. Table IV-7 gives some representative costs for coal mine development. Large-scale transport o£ coal is effected for the inst part by rail. Water transport is very suitable for this type o£ traffic, but it is rare in developing countries to find a situation where this is feasible. The cost of building a railroad and handling facilities to transport the coal is *very* high. Therefore, if developing countries propose to

develop coal as an industrial fuel, they should seriously consider setting up industrial development at the coal field, rather than transporting the coal to existing population centres.

Many low-grade coals can be improved in quality by mechanical washing to reduce ash content, and by partial carbonisation to reduce water content, sulphur, and the volatile matter which gives rise to nnst o£ the sr ke from coal burning. Such smokeless fuels can often be compressed into briquettes, which are easier to transport than the original raw coal and which provide a useful fuel for domestic purposes and light industry. In developing countries suffering from shortages of domestic fuel and consequent deforestation, serious consideration should be given to exploiting coal deposits to make n,keless fuel briquettes as a substitute. The briquetting potential of each coal deposit needs to be determined separately, by experiment, a, that an appropriate technical process can he used. Many of the failures reported in this type of project result from lack of proper investigation of the properties of the coal before purchasing the plant.

D. nthetics

There has been much discussion about the production of synthetic liquid fuels from coal, in consequence of the higher prices of refined petroleum products. While coal itself can substitute for fuel oil in most industrial applications, the manufacture of synthetic liquid fuels from coal offers one of the few possibilities of substitution for petroleum fuels in the transport sector, i.e., for gasoline and diesel fuel. The technology is fairly yell known, having been used extensively in Germany during World War II. The only plants operating at present are located in South Africa, although there are a number of pilot plants in the US. The problem is less one of technology, although the plants have had considerable start-up problems, than of cost. It is

_TABLE: WN. PIN)DBCTIOI AND ntal Mine
I7-7'. MINE, INVES1MENT (FAT$ ntal lost
anrsISS
IN SELECTED WAL-

Mining 'Ita:hnology	(bnl 7	Mfotnead Pr iictlon (bst	
mwemPED cu0NTR1		Ecistlng Mine lea Mine (0S$ lct ton-1070)	(IISS trt ton-1878)
A:aaaah a Canada	B c,L B,C,	12- 8-5	20-40 40-50 20-30

	R	B	x-05	x-30	n.a.
		L	35-95	n.a.	
BR	0		m-25	70-	70-85
	0		10-12		3•L-35
	B		8-10		n a
United	L	BC	45-75		70-10
united			20-30		40-55
			5-15		10-35
Pn Uina	0		12-20		25-55
			s Iz		5-10
Caatbnelo		c	x-40		sJ-70
DR	B	L	5-12		15-25
ibtand		5 0	18 25	n	50 430
		L	5-10		1 5-20
Soviet		B	15-25		x44
			5-10		15-20
OIVEIU91 N1		R	40-15	n.n.	50-60
cT:NTRIE S					
Argentina					
Br'a'zil	0/S	B	15-25	*Pb1 8*	x-50
			5-22		
$I_n$dia		B.C	12-25		30-35
		B L	x-22		n a
Indonesia			35-40		n.a.
			10-20	35	x-80
			20-25		35-90
		B.C	15-22	n.a.	45-55
Pakistan		B	20-30		n.a.
P1:11ippln	0	B	8-21	18-	30-70
Thai land				7-	20-35
veneaue a			n.a.	20-	50-55
Yugoslavi		S,B,L	6		2^{5-34}
		S,B,L	11-10	n.a.	to-20
trend: oh Mint		og	lbel~Lc		
IT -	e		A - anthracite		

wane B-bitu[minous]

na. not g coal
available L = lignl

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			-	*E'9*		*OC't*		
		0 5	*Os'CC*	*0"C I*		*0s't*		
E			*OC"CE*	*Oat*		*W't*	*E*	*OL*
	ort							*59-*
90	*/OI*	*OS*	*OZ'BE*	*S*		*SC'I*	~	*py*
03	-		-	*0'6I*		*EL"t*		
E	*n)0*	*oW*	*o06'0C*	*9'LI*		*Os'1*	*tr*	
Eo	*OO*	*O6*	*06'OC*			*O0"I*		
(6'	*05'*	*15'*	*06•6Z*	*0'*	*0E*	*'I Z It*	*Ot*	*0*
Oi'	*OI'*	*O*	*OZ L*	*E"Z*		*00"I*	*aue*	*OS*
v	oro			*0'zt*		*W't*	wa	*09"*
SC 'tF	-		-	*S'C*		*C'it*	*tN Vh 70*	*OZ -9I oo-*
so w	*(EE C*	*cs's z*	*Os'az*	*O"e t*		*s'zt*	*Et mE at7*	
							Ett En	*52- 91*
E	*sl'iz*	*OF*	*00'ZI*	*0'91*		*09'*	*dT*	*OL*
	-	-	-	*S'El*		*Co t 0'tl*	*e=t*	
W E'	*0tO Z*	*0P CE*	*09'IZ*	*0'C I*		*W'I 6'It*	*APE sW tWiH*	*bY` O1*
							Ea	*080 L*
	SE'	*OS'*	*09*	*0'ZI*		*Cot e'*	*aTz*	*SE-*
	OC' LZ	*Or LZ,*	*01St*	*g0' LZ*		*09'0 s'fi*	*PU Eto*	*SB- OL*

	O6' LC	*D C'*	*05'bZ*	*E' ZI*		*CO'I O'ZYS'Z*	*Saa uc*	'V U
	9C	*06· 6E*	*W'W.'*	*O'C Ib'Z t*		*cot 0'zt*	*a x /sp dH*	*OF O2*
	55	orn	*0E'CZ*	*0'ZI*		*CO'z C'ZI*	*nva uu*	*Oy W*
							ss1 E1 5	*Ofr OC*
	L_{nl}		*Asnt*	*Y*		*($) mW1R9*	Y	*(97*
	(um					*BNOIYMJIJIx idS*		
	31I0'iVAI VA HG]					*—*		
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TAELR IV-0: RI3'fdRICAL COAL 77WI)E VALUES FOR SELECTED
(US$ per rtetrn: ton)

Producing Year	W.Ebro1p fob	elf	Japan elf	fo	Poland W.Eliro elf	cif	fob	Canada o	Ja
1972	6-0	20	18	-	22-24	24	-	21	
1973	7-9	18-	20	-	22-25	24	13	-	22
1379	16-	[2]26	33	-	32-20	30		31	
1975	16-	90	39	-	42-57	57	181	48	
1976	1431	45-05		-	3650	59	20-33	-	58

Producing Countries	FR. Cenrnnti			ttwnbique _	_	Soutb A4tca	
1972	W.Nrope fob	cif	Japan elf	ope Japan elf	fob	ro _____	cif
	2'13	3t5	-	17	-	7	19
1073	29-	36-	-		-	29	18
1979	9950	42-	-		-	30-00	
1975	59-	54-	84	97	1.5	2850	43
7976	72	41-70			21	30_32	

P odeeing Countries:	United Kingdan		S vi t Union		United States	
	W. Europe	Japan	W. Europe	Japan	4. Europe	Japan

Year	fob	cif	elf	fo	elf	elf	fob	cif	elf
1972	-	12-35		b	1918		21	23<30	23
1073	-	12-20		-	14-17		23	24-29	30
7'379	-	37-04	-	-	10-32		98	42-53	&7
1075	21-01	9056	-	-	30-58		50	50-73	73
1976	32-06	4953	-	-	32-08		58	48-59	

5

Nate': aValues are calculated on rt tonnage t sis without consideration

Cource: World Sank Staff Working Paper 1b.

reported that, provided the cost o£ coal at the plant is below $10 per ton, it should be possible to produce synthetic automotive fuel from coal at around $40 to $50 per barrel which is already competitive.

The main problems from the viewpoint of developing countries are the nmssive investment cost and complex technology. It takes around $3 billion and a coal input o£ 40,000 tons per day for an output of 4,400 tons of gasoline/ diesel oil per day (37,500 b/d). The process does not require a high quality coal feedstock. But the size of coal reserves needed to support a single plant o£ this capacity (around 500 million tons) and the plant's high cost do limit the number of developing countries which can contemplate the production o£ synthetic automotive fuels from coal, unless future technological improvements can both reduce the plant's cost and improve its conversion efficiency.

E. Hydropower

This is one of the earliest forms of primary energy to be exploited, and simple primitive water-wheels nay still be found in many countries. Because of the rise in oil prices, there has been renewed interest in small hydro plants (micro-hydro and mini-hydro are terms for installations having less than 1 megawatt of installed capacity) for supplying electric generators. M1bdern hydroelectric installations have installed capacities in the range of hundreds or thousands of megawatts. The largest hydro plant in the world is under construction at Itaipu in Brazil and will have an installed capacity o£ 14,000 MW.

ALmst all hydro plants require sane form of civil engineering work for water storage to increase the availability of energy throughout the year. The cost of this work constitutes the largest part of the investment, and the storage must usually be constructed in its entirety before any energy can be generated. Hydro develog~nt is therefore characterised by high initial investment and low running costs. Many hydro installations are dual purpose, providing both power and irrigation water.

Capital costs for hydropower installations vary widely. Including an allowance for transmission and distribution facilities, they range from $850/kilowatt installed for a high-head installation in Nlombia to $2,500/kw for wall installations in Africa. An average cost for developing countries is $1,296/kw of installed generating capacity.

As shown earlier in Table IV-2, the potential for increasing hydropower output in navy developing countries is considerable. For example, Africa is estimated to have 22% of world hydropower resources, but only 2% of this has been developed. One problem is that many sites have a potential far in excess of any local market demand for the energy, ro that the cost per unit of energy delivered becomes prohibitively high. One solution to this problem is to locate energy-intensive industries, such as aluminum smelters, near the hydro site, as was done with the Volta River development scheme in Ghana. Another solution is to arrange to export the power to neighbouring countries where demand is greater, as was done between Uganda and Kenya.

It is unlikely that foreign investment will play a role in hydropower, unless it is linked to a major exportoriented industrial project (e.g., aluminum). Most OIDCS have local power companies with some experience in hydroelectric power. More important, UNDP and the development inks have strong and long experience in this field; they are ready to play a substantial role in providing technical and financial assistance to those OIDCs *which* need it most. In effect, the main policy question now is to shift aid resources from those countries which already have strong local institutions (mainly Latin American & Caribbean and some major Asian countries) to those which have weaker ones (vastly African).

F. Geothermal Energy

Geothermal resources consist of underground aquifers containing superheated water and steam at temperatures up to 250' Celsius, which are exploited by neaps of wells. Superheated water and steam from geothermal sources have been used for electric power generation, tndustrial process heat, and

[t] The hydraulic head is the height of the usefully available column of water above the turbine inlet, which determines water pressure at the turbine.
Space heating. Geothermal tx~t water resources can also he used for domestic space heating and hot water supply.

The geothermal resources o£ endowed countries should be evaluated and developed, because haseload electricity generated from high-temperature geothermal resources is likely to he substantially cheaper than electricity produced from fossil fuels. It is important to note that the exploration and development of high-temperature geothermal resources involve an element of financial risk.

The following developing countries are believed to have geothermal pDtential:

Mexico Venezuela Turkey Yemen A. Guatemala B ospectssupplies,
aboveallonconventionalsuggestoil Olivia Iran Ethiopia
E1 SalvadorChile India Kenya
Nicaragua Argentina Indonesia Tanzania
Rwanda Costa Rica Philippines Cameroon
Burundi St. Lucia Ibminfca Martinique
Guadeloupe Solomon Islands

Geothermal energy requires technologies and equipment similar to oil exploration and development, though less costly because of the shallower depth of the geothermal sources. Hence, in principle it is Inssible to interest foreign investors in this field (e.g., Union Oil in the Philippines). But it is possible and lure realistic to undertake geothermal development under local management (usually that o£ the existing power comjnny), with the assistance of the ON agencies which have pioneered in this field a,d of the development banks.

G. Other Options (Oil shale, tar-sands)

The options discussed above are o£ more immediate interest to OIOCS. But there are other possibilities which should become economically attractive by the late 1980s, once the technology becomes fore proven. In particular, these include the production of oil products from oil shales and tarsands. Developing countries known to have significant oil shale resources are: Brazil, China, Nbrocco, Thailand, and Zaire. Smaller resources have been identified in Burma, Chile, Jordan, Turkey, etc. As for tar-sands (which are al-
ready commercially exploited in Canada), they are known to occur in large annunts in Ghana, Ivory Coast, Madagascar, Rumania, Syria, Venezuela, etc.

The rain tasks which could be usefully initiated in these countries are exploration and measurement of resources, feasibility studies, pilot plants, and testing of alternative technologies (less capital and rrore labour-intensive). Unless exploitation is labour-intensive and wall-scale, the investments required wilt be huge, of the order of 5-10 times those needed to explore and develop conventional oil. At the same time, in oust countries (possibly excepting Venezuela), the scale of production will not allow exports. In this sense it seems that these resources will require financing from development banks in a manner similar to that provided for hydropower.

3. EXTERNAL ASSISTANCE NEEDS

The current energy position of developing countries is summarised in Table IV-10. Taking into account the options reviewed in Sections 2 and 3 above, the following position could be achievable by the late 1980s and early 1990s;

a) Sorre countries have good pcssibilities of becoming oil exporters, including: Argentina and Colombia (currently 0-25% dependent on oil imports to meet their commercial energy reeds), Mozambique and Pakistan (currently 26-50% dependent), and Burma, Cameroon, Chad, Guatemala, Fbnduras, Madagascar, Niger (currently 76-100% dependent).

b) Some countries could significantly decrease their energy imports, including: Chile, Bangladesh (currently 26-50% dependent), Afghanistan, Brazil, Ghana, and Turkey (currently 51-75% dependent), and almost all countries currently 76-100% dependent (except Cyprus, Gambia, Haiti, Lebanon, Mauritania, and Singapore).

c) Some large- and medium-sized countries could approach self-sufficiency, for example: Bangladesh, Brazil, Chile, Ivory (bast, Morocco, Philippines, Sudan, Thailand, Turkey, and Vietnam.

TABLE IV-1O: M ENERGY OIL-FY.RM'fIM, CLASSIFICATION OF DEVFX Th(QNINTRIE9n

9 _	0-35%	A4MBEft	_ MtMUEH9	____	ALGERIA
28~LO%	50-75%	76			100%
IRAN	MAIAYSIA				IRAQ
I.IgyA	PERU				QATAR SYB AN SAUDI ARABI GCATRMAIA Para TOBAGO Guy VFNEZGELA
fCUALOR	ANSOLA	'			INCONESIA
INDIA	FIk.LADEBH				
AFPHANISTAN IPnin	AOIdivos				
(Urn					FGYPT
	PAKIS				
TAN	thlawi				Zambia
					Rwanda
					Ctt Verde Is. Nepal
		a,ad So Tam e			i Salvador ~4ne
Ethiopia lbloman 1s.					Cambia 3n,a
GuineaSign					Guinea- Swaz
Lnndwas					lenya I!pPer Volta
M dagascar		920	1180	820	Notes; flIX,untrles
WPWAT					are oil end/or gas pr
1pq (nil lion)					

Table based on UN ', world 17iergyStatisties 1978 and Wield Rank estimates of fuelwaod. Kbpulation data fnm World Ikveloe:ent Peport 1980
Bgxclt ing countries with 1078 per capita GNP above $3)0 and stn¢ countries with Population of lees than 0.5 million.
[''Countries where annual consumption 0f £uelwcd is unlikely to be Noble at miniaun levels through the *year* [20,], without damage to the ecology. thny countries not inoWded will have fuel wood pnoble s in lonal areas.
Source: World Park, *hhergy* in the Developing Lbuntries, August 1980.
d) Some sraller countries could become minor exporters by the end of this period (due to their small energy consumption), for example: Barbados, Guinea, GuineaBissau, Liberia, Mali, Mauritania, Nicaragua, PapuaNew Guinea, Surinam, Tanzania, Yemen A.R., and Yemen P.D.R.

For these changes to take place, massive increases in exploration and developrent effort and finance are needed, as well as a quantum jump in official technical assistance. The type of assistance needed by different countries depends on their experience in energy developrent, the strength of their existing energy and economic institutions and, of course, the strength of their economies vis-a-vis the financing (particularly the risk capital) needed for an accelerated effort for energy development.

In financial terms alone, the World Bank estimates that in the ten years to 1975 the developing countries invested about US$ 12 billion a year (in 1980-$) on average in commercial energy production and transformation, mostly electricity. This represented about 5% of total investment and 1.3% o£ GNP)' In 1980 their energy investment is an estimated US$ 34 billion. Of this amount, investment in OIDCS is an estimated $25 billion. It represents wme 10% of total investment and 2.5% of GNP, clearly indicating the economic adjustment triggered by the 1973 oil crisis.

This trend is expected to continue during the 1980s; energy investments are envisaged to grow by about 10% p.a., twice as fast as GNP. A breakdown by s)urce of OIDCs' energy investment requirements during the 19808 is given in Table IV-11. In brief, the World Bank estirates these requirements at US$450-500 billion (in 1980-$) during the decade, or a yearly average of $37 billion during the first five years and $53 billion during the second. Of these amaunts, investment in electric power (including transmission and distribution) will continue to take about three-quarters. Exploration and development of petroleum is envisaged to grow from $2.6 billion in 1980 to $3.5 billion p.a. during the first five years, and $4.7 billion p.a. during the second.

The financing of such a program will nuke heavy demands on domestic and foreign saving. But OIDCS face even

TABLE IV-11: OIL-TMPORTINO DEVELOPING COmVTRIES: PRINCIPAL IWESTMErT
REQUIRE7AEITTS IN CTMAO RCIAL ENETGY, 1980-90[9]

E tth to		Annual Average_	Mnual Average	Average Growth Rate
Total: 0IIXS	1980	1981x35	19.96-90	1960-90
	29.8	(US$ billion in 1980-$)		(%p.a.)
	18.5			
	8.0			
	9.2	36.7	59.4	10.9
Electric rbwerb	1.2	27.5	39.7	10.7
Thermal	0.1	11.8	15.4	9.1
Nyaro	0.5	13.5	15.1	6.8
Nuclear	2.6	2.1	8.8	30.4
Other	0.5	0.1	0.4	90.3
Pulp	2.1	0.7	1.5	15.8
0ila	1.0	3.5	4.7	8.2
Exploration	0.5	1.0	1.5	11.6
IPVeloptent	0.5	2.5	3.2	4.3
0ase	1.0	1.7	2.7	14.2
Alcohol	34.4	0.9	1.2	12.4
FLelawd		0.6	1.3	13.0
8et1ner1esf		1.8	2.3	11.8
Pote:		54.4		12.3
All Developing				

Notes: abased on World Bark's case 1 Assure that
blncludes cwt of transmission and
capacity regairetans will grow at same rate as in 1973-
cBV d on investments required to develop coal production fran
175 million tee in 1980 to 250 million tee in 1993.
dBaSe1 on vestments required to develop oil production tram
2.0 nn bid in 1980 to 3.6 mm bid in 1990.
used o investments repaired to raise gas prMUCtion

larger oil import bills ($67 billion in 1980 alone)-. By maximising energy production during the decade and by vigorous conservation, it esti,rates that OLDCs could cut their oil import bill in 1990 by $25-30 billion (in 1980-$)b.

For its part, the World Bank had planned to expand its energy lending to $13 billion total (in current-$) during the next five years. Envisaging that this is insufficient, it now proposes to lend an additional $12 billion during *these* five years.

The economic rationale for OIDCs' increased investment in thmestfc energy sjurces is *very* clear: their costs are expected to be much lower than those of imported

energy (Table IV-12).

Despite the significant dimension of the financing problem, it seems to us that the main obstacles to energy development, which might otherwise be achievable in [x-ely physical teams, wilt not be financial. Currently, there is a growing understanding of the global nature of the *energy* crisis. Those OIDCs which adopt realistic energy policies and the minimum managerial and institutional capabilities will have access to those official and private rources of know-how and finance which are necessary to improve their energy position.

It is helpful to classify OIDCs according to the type of external sources of energy develop xnt assistance which will be frost important in the 1980s, as follows:

i. technical assistance from official institutions
- mainly to create an adequate framework for energy development, institutional policy, and basic data;
ii. financial assistance from official institutions
-irainly to complement i) aWve, e.g., surveys, training, and to finance in "last resort" such areas as exploratory drilling, gas, and hydro development in countries where private foreign financing is unlikely to be a viable alternative;

TABLE IV- D EWPEU C\7APARATIVE (L1ST3 OF FHEIGY Fop [DI]

		7ransrort/ Ekrort Costa (u3$ Per tfre1	r ocessing nil equiv. in	t liverea 1980-$) `
I.	15MESTRIC PRWucrloN CWeOil-lowCost	5.W	1.00	0.00
	Nigh Cost	12.00	1.00-	13.00-15.00
	twel Gas - mw cost	0.30	1.05	2.250
	- High Cost	2.20	8.80	11.540
	COel - Low Cost	2.00	2.50	4.50
	- Nigh Oat	5.00-10.00	30.00	15.00
	Imnned Ietrnlein Products (fra$_n$ wresttc Crude			0.40-21.40
	household Eerosenn			11.30 25.40
	Diesel (53/57)		50	5.40-21.00
	Ilean' Fuel Oil			7.20-17.50
	Liquefied I troleoan			10.00-25.00
	Synthetic Fueis			.00_21.00 11
	Gasoline, Diesel frcm (racked Fuel Oile Gasoline Diesel fra			40.00-80.00
	Fxhanol fiat Sugarcane			25.00-45(X)
	A6thannl tnm Natural Gasoline Iran Hetitanol			25.00-45.00 25 00-35 00
	Shale °fig			25.00-35.00

Renewable mergyd	8.00-20.00
Firewod	
tharccal	20W-SO .00
Dung Chkes (India)	5.00-10.00
Solar Neat	50.00-00.00
Oeothenmi Neat	.00-11 .00
Rlectrio rower	44.00-158.00
(at 2.4I-10j per kwh)I'	

(Continued

TABLE IV-12: Dgvaopm CtWP TIVE WSCS OF ENEB3Y FF04 (continua)

	Transport/		4livered Okstb
	(us$ pr barrel oil equiv. In 1900-$)		
Crude oil			
Arabian Light: June 1980	28.W	2.75[1]	
Products train stove (Refined			
Gasoline (MR)			35.50
'69sehold Kerosene			42.60
Diesel (53/57)		)[9,1]	35.50
Heavy Fuel 011			27.20
Refined Products			
Gasoline (90R)	39.35	4.15[1]	43.50
Hcusehola Kerosene	41.50	4.38i	45.ee
Diesel (53/57)	30.50	4.61[1]	44.13
Heavv Fuel Oil	24.20	3.25[1]	27.45
Liquefied WtroIeum Gases			42.50
Liquefied Natural Gas			27.W
Steam Coal	6.W-8.W	3.W-6.W	9.W-14.W

bPotional delivered cast to OIOC countries i coastal locations.
maker rates': clean for white products (diesel and gasoline) and dirty for crude oil and heavy oil.

°Natural gas prices were derived £ma Bank projects and studies in Bangladesh, Pakistan and Thailand.

dp$_s$t delivered to consuners $_{near}$ pint o£ production.

eAssunes production frwn fuel oil refined locally frvn indigenous crude. flhsed on gas prices of U35040-$1.50 per Mot (D3$2.25-$8.50 per barrel o.e.). 8based on Shell and Hechtel estiimtes adjusted for inflation. h!'tat of electricity used in electric heating

devices such as °coking stoves.

firefight rates as i re 11)0-ton 0-con tanker on Persian Gulf - Far Fast route.
Fates: clean for white products (diesel and gasoline) and dirty for crude oil and heavy oil.

Source'. Nbrld Bank, kLergy in the revelopfn¢ countries, August 1980.
A FRAMEWORK FOR ENERGY 1VLICIES 23'9
iii. financial assistance from private tanks
- mainly to creditworthy countries with adequate management and technical capabilities; and iv. foreign investment
- mainly private investment for a package technical, risk capital, and (in some cases) marketing capabilities. This is especially important in areas such as oil development and LNG. It is not aid but profit-oriented and concerned with political as well as commercial risks; ignoring these constraints would be naive.

Foreign investment can be expected to play a leading role only in the following types of country situations:

i. countries with potential for oil exports;
ii. Countries with large potential for gas exports, particularly in the form of LNG to industrial countries;
iii. Countries with medium to large potential for coal exports;
iv. Countries with low-cost energy resources which cannot be exported but can be used industrially to produce exportable goods, e.g., mineral processing; and
v. countries with large domestic markets for energy, where government policies and overall economic outlook allow withdrawal of investment and net revenues in foreign currency.

Official development assistance (ODA) is needed to cover many other country situations. In particular:

i. financial support is needed in almost all cases where domestic energy developments are unlikely to lead to exportable surplus. This includes oats development projects for electric power (a typical area o£ past ODA), coal, geothermal, and gas, as well as oil in countries with modest prospects;
ii. in middle- and high-income countries, ODA financial support should be complemented to the maximum extent by co-financing with private Inns. When possible,
INTRODUCPION

a. Mahbub ul Haq. The Third World and the International Economic Order. Ikvelopi nt Paper 22, Overseas Development Council, Washington, D.C., 1979.

b. Khadija Haq, ed. Dialogue for a New Order. Paragon Press, 1980.

C. UNCLAD. The Enveloping Countries in the World Economy. Paper presented at workshop on "Energy and Development: Increasing Third World Collective Self-Reliance", sponsored by OPEC, OPEC Fund and UNCLAD. Vienna, July 1980.

d. J. Amoeba. A Requiem for the North-South Conference. Foreign Affairs. October 1977.

e. Independent Commission on International ! Vilipend Issues. North-South: A Programmed *for* Survival_ MIT Press. Cambridge, Mass., 1980.

THE GLOBAL ENERGY SCENE

a. World Bank. World Development Report 1980. Washington, D.C. 1980.

b. Workshop on Alternative Energy Strategies (WOES). Energy: Global Prospects, 1985-2000. McGraw-Hill. New York, 1977.

C. Exxon Corporation. World Energy Outlook. New York, 1980.

d. Conservation Commission. World Energy Conference. World Energy Demand to 2020. IPC Science and Technology Press. New York, 1978.

e. IIASA. Energy in a Finite World: _____a Global Energy Systems Analysis. Vienna, January 1981.

f. International Energy Agency. Energy Rejoices and Programmers of LEA Countries: 1979 Review. Paris, 1980.
this Should also be done in creditworthy low-income countries, e.g., India;

iii. a much larger share of CAA should be allocated to predevelopment stages of energy investments, as little help can be expected from private sources; and
iv. COA is needed to overcome non-financial weaknesses, such as policy advice, strengthening of planning and management institutions, and training programs.

In principle, it would be (ensile from the above criteria to prescribe the mix of official and private assistance, which would be individually needed and feasible for each country, type of project, and /Particular timing. In this manner, a program for global energy development could be destined, and the requisite hewn and financial resources could be quantified. Recent efforts by the World dank seem to point in that direction and may provide the basis for a major new international initiative in this field.
1.(continued):

g. US (bngressional Budget Office. The World Oil Market in the 1980s:

_____ Implications for the United States. Washington D.C., May 1980.

h. International %betrays Fund. World Economic Outlook. Washington, D.C., 1980.

i. UNCFAD. Energy and Ocelot nit: Increasing Third World Collective Self-Reliance. Papers at Workshop sponsored by CPEC, OPEC Fund and UNCFAD. Vienna, July 1980.

j. World Bank. Energy in the Developing Countries. Washington, D.C., 1980.

k. OPEC papers. Energy in developing ountries - Present and Future. Vienna, Cbtober 1980.

1. Shell Briefing Service: Fhergy in tile fevoloping Countries. Lnndon, January 1980.

m. OPEC Papers. Mastic Energy Requirements in OPEC Member Countries. Vienna, August 1980.

n. Committee on Nuclear and Alternative Energy Systems (CONAES). Alternative a ergy Denison Futures to 2010. National Academy of Sciences. Washington, D.C., 1979.

o. Committee on Nuclear and Alternative Energy Systems (CONAES). U.S. Energy Supply Prospects to 2010. National Academy of Sciences. Washington, D.C., 1979.

p. Energy in America's Future: The Choices *before* Us. A study by the Staff of the *RFF* National Fiery Strategies Project. Sam H. Scour, Project Director. Resources for the Future. Washington, D.C., 1979.

q. Clergy: The next 20 years. Report by a Study Group sponsored by the Ford Foundation. S.H. Landsbergis, Chain*n. Ballinger. Cartridge, td ass. 1979.

I. (continued):
r. Ait-Laoussine, N. OPEC Oil:_____ Recent Ikvelognents and Problems of Supply. Paper at Second Oxford Energy Seminar. Oxford, September 1980.

S. US C.I.A. The Energy Outlook and its Implications for the USSR and Eastern Europe. Washington, D.C., February 1980.

t. PetroStudtes. Soviet Oil Production Reform of 1980 and It's Biennial. Milne, Sweden 1980.

u. World Coal Study (WO)L). Coal: Bridge to the Future. Ballinger. Cambridge, Mass., 1980.

V. International Energy Agency. Steam Coal: Prospects to 2000. Paris, 1978.

w. President's Mission on Accident at Three Mile Island. The Need for change: the Legacy of TMI. John G. Kerrey, Chairman. Washington, D.C., 1979.

x. International Consultative Group on Nuclear Energy (ICGNE). Papers. Rockefeller Foundation. New York, 1980.

y. International Nuclear Fuel Cycle Evaluation (INFCE). Working Group Reports. International Atomic Energy Agency. Vienna, 1980.

z. UNITAR. "Summary Report of the Conference on Long-Term Energy Resources." Special Issue of Important for the Nurture. Vol. 5, noel. New York, February 1980.

aa. OECD. Renewable Energy Technologies for Developing Countries. Paris, 1979.

Other Relevant Literature

Benard, Andre. World Oil and Cold Reality. Harvard Business Review. Vol. 58, no.6. November-December 1980.

Brown, Win. N. & Hen-inn Kahn. Energy I~rspective for 1980s & 1990s: A Scenario Based on Guardedly Optimistic Assumptions. Hudson Institute. Croton, New York, July 1980. .(continued):

Commission on Energy and raw materials of the French Mlle Plan. Summary of report. Taking over from Oil. Conmissariat General du Plan. Paris, Goober 1980.

Independent (immussion on International F velopment Issues (Brandt (ommission). North-South: A Program for Survival. MIT Press. Cambridge, Mass., 1980.

Interfutures: Facing the Future; Mastering the Probable and Managing the Unpredictable. OBCU. Paris, 1979.

Levy, Walter J. Oil and the Decline o£ the West. Foreign Affairs. Vol. 58, rro. 5. Summer 1980.

National Foreign Assesrimnt Center (CIA). Save Perspectives on Oil Availability for the Non-OPEC LOOS. Washington, O.C., September 1980.

Petro-Canada. International Energy Prospects to 2000-Revisited. Ottawa, July 1979.

Petro-Canada/Petroleos de Venezuela. World Oil Supply Prospects. Ottawa, February 1980.

Petroleum Industry Research Associates. Outlook for World Oil into the 21st Century, with Emphasis on the Period to 1990. Final Report. New York, 1978.

Sewell, John W. et al. The United States and World Developnent. Agenda 1980. Praeger. For the Overseas Ikvelopnent Council. New York, 1980.

Smith, Gerald C. and Rathjens, George W. Nuclear Energy And Con-Proliferation. Trialogue. Winter/spring no.22. F Trilateral Conmission. New York, 1979.

Sorensen, Bent. Renewable Energy. Academic Press. C London, 1980. f i

Stobaugh, R. and D. Yergin. Energy Futures. Report of the Energy Project of the Harvard Business School. Harvard University Press. Hoston, Mass., 1979. f

I. (continued):

Turner, Louis. Oil Wmpanies in the International System. Royal Institute of International Affairs. London, 1978.

US I) j tent of Energy. Energy Supply and Iceman Balance and Financing Requirements in Non-OPEC Developing Nations. February 1979.

II. THE PARTIES INVOLVED

11.1 Oil-Importing [veloping Nuntries

a. Lincoln Gordon. International Energy Arrangements and the Lbveloping Countries. Working Leper for needing of the Ford Foundation Energy/LDC Group. July 1979.

b. Ted Taylor Associates. Energy Profiles of Selected Countries. (Mimeo.) Washington, D.C., 1977.

c. James A. Beaver. U.S. AID Renewable Energy Project. Paper for Senegal 1978, and personal observation and notes from field visits to West African villages.

d. Antonio R. Para. Overview of the Energy Situation in Oil-Importing Developing Bounties. Prelered for OPEC Ministerial Committee on Long-Term Strategy. March 1979.

e. Bernardo Grossing. Window on Oil. The Financial Times Ltd. London, 1977.

f. U.N. World Energy Supplies, 1973-1978. Statistical Papers Series J. No. 22. New York, 1979.

g. World Bank. Rural Electrification. Washington, D.C., October 1975.
h. William Know land and Carol Win ski. Traditional Fuels: Present Data, Past Experience and Risible Strategies. Prepared for U.S. AID. September 1979.
ii.ikCOnunueu)-.

f. This discussion of Africa is adapted from Japes W. Howe and Frances A. Gulick. Fulvous and Other Renewable Energies in Africa: A Progress Fender on the Problem and the Response. CDC. Washington, D.C., January 1980.

j. IAvid French. Firewood in Africa. Prepared for AID/AFR Firewood Workshop. June 1978.

k. Energy in the Develo?Ient of the She: Situation -Perspectives -- Recommendations. CILSS (Club du Sahe1).

1. Raider Person. Forecast Resources o£ Africa: An Approach to International Forest Resource Appraisals, Part II: Regional Analysis. pp. 128-132, 144-145. Royal College of Forestry. Stockholm, 1977. Part I, published in 1975, provides a country-by-country summary analysis of the status of national forests, including details on inventories.

m. As calculated by F. Weber. Wood Lot Estimate Guides. (Sahel.) International Resources Development and Conservation Services. Boise, Idaho, December 1979.

n. Bo Chlsson. Forestry for Rural Cbmnunities: A Case Study from Tiro. Supplementary Special Paper. Ethiopia Forestry and Wildlife Development Authority (FAWDA). Addis Ababa, Ethiopia, 16 October 1978. Presented at the Eighth World Forest Congress. Jakarta, October 1978.

o. See ODC's various Peace Corps case studies.

p. Helen Hughes. Changing *Relative* EYlergy Prices The Balanceof-Payments and Growth in Developing Countries. Paper presented at FJPRI Workshop on Energy and the Developing Nations. Palo Alto, (lifornia, March 1980.

q. World Hank. World Development Report, 1980. Washington, D.C., August 1980.

r. Morgan Guaranty Trust 0. TIC Prospects and Role of the IMF. World Financial Markets. New York, September 1980.
XI.l(continued):
s. Workshop on Alternative Energy Strategies (WAES). Energy: Global Prospects, 1985-2000._____ MWraw-Hill. New York, 1977.

t. IMF Survey. Washington, D.C., January 1980.

U. International M1Ionetary Fund. World Economic Outlook. Washington, D.C., 1980.

v. For example, see Martin M. McLaughlin and staff of Overseas Development Council the United States and World Ikvelopnent Agenda 1979. Praeger. For the Overseas I~velopren council. Washington, D.C., 1979.

w. Middle Fast Economic Survey. Vol. xxiii, No. 19. February 1980.

x. IMF Press Release 80/34. Washington, D.C., April 1980.

y. Independent commission on International Ikveloprent Issues. (Brandt Conmission.) North-South: A Program for Survival. MIT Press. Cambridge, Mass., 1980. Also James H. Howe and staff of Overseas Ikvelopnent (bunch. The U.S. and the Developing World: Agenda _____ for Action, 1974. Praeger. For the Overseas Developrent Council. Washington, D.C., 1974.

z. Jean Louis Waelbroeck. Energy and International Trade Issues. Paper at EPRI Workshop on Energy and the Ieveloping Nations. Palo Alto, California, March 1980.

Other Relevant Literature

Cleveland, Harlan. Ed. Energy Futures of Developing Countries. Aspen Institute for Humanistic Studies. New York, 1980.

Dunkerley, D. et al. Energy Strategies _____ for _____ Developing Nations. Resources for the Future. Washington, 0.C., 1981.

Hoffmann, T. $ Johnson, B. World Energy Triangle: Strategy for Cooperation. Ballinger. Cambridge, Mass., 1981.

11.2. Oil-Exporting Developing Countries Relevant Literature

A1-Chalabi, F. Papers in OPEC Review and OPEC Bulletin. Vienna, 1979-80.

A1-Chalabi, F. OPEC and the International Oil Industry: A Changing Structure. Oxford University Press. Oxford, 1980.

11.3. Industrialised Countries

a. Krapels, Edward N. Oil Crisis Management. Johns Ropkins University Press. Baltinnre, Maryland, 1980.

b. Conant, Melvin A. The Global Imlact of Energy on US Security Intents and Commitments. Paper at Fall-Winter Seminar Series. National Security Affairs Institute. Washington, D.C., December 1979.

c. Canada, National Energy Program, Department of Energy, Mines & Resources.

Ottawa, November 1980.
I
d. Conmission of the European Communities. Energy Fblicy Nmnunication from the Commission to the European Council, 31st March - 1st April 1980). Coin (80) 130 Final. Brussels, 1980.

e. International Energy Agency. Energy Policies and Programs of IEA countries. 1979 Review. DECD. Paris, 1980.

f. Lantzke, Ulf. Energy: A Continuing Trilateral Priority. Trialogue. Winter/spring, no. 22. Trilateral Connission. New York, 1979.

g. Organisation for Economic Cooperation and Development (DECD). Economic Outlook no. 27. Paris, July 1980.

h. International Monetary Fund. World Economic Outlook. Washington, D.C., 1980.

i. World Rank. World Development Relort, 1980. Washington, D.C., 1980.
• 3(continued):

• European Economic Carmunity. "Energy" Council. Community Energy Objectives for 1990 and convergence o£ the policies of the member states. Europe Ibcuments no.1099. May 20, 1980.

Flyer, Trevor A. The End of the Paris Energy Dialogue and the Need for an International Energy Institute. Energy Policy. Vol.6, ro.4. December 1978.

her Relevant Literature
trmtission of the European Communities. Energy O ope$_{ra}$tion with Developing Countries and the Role of the Community. Report from the Commission to the Council. Can (80) % Final. Brussels, 1980.

Cannission of the European Communities. Measures to Mitigate the Effects of Short-Term Oil Supply Problems. (COnmunication from the Cbnnnission to the Council) Can (80) 247 Final. Brussels, 1980.

European (br, munities - European Council. SlnrGary by the Presidency fo the proceedings of the European Council. European Report ro.693. June 14, 1980.

European Economic Community. "Energy" Council. New Lines of Action by the Cannunity in the Field of Energy Saving. Europe Ibcunents no.1099. May 20, 1980.

International Energy Supply: A Perspective from the Industrial World, Working Paper. International Policy Studies. Rockefeller Foundation, March 1978.

Noreng, Oystein. Oil Iblitics in the 1980s: 'Pattern of International Cooperation. New York Council on Foreign Relations, 1978.

Sawhill, John C., Rans W, Maull and Keichi Oshfma. Energy, Managing the Transition. Trilateral Oxrmission Task Force. New York, 1978.
U .3(continued):

AMrt, Ian. Nnmunicating with the Oil-Exporters: The Old Trialogue and the New. Trialogue. Winter/Spring no. 22. Trilateral (bnmission. New York, 1979.

Stobaugh, R. and Yergin, D. Energy Futures. Report of the Energy Project of the Harvard Business School. Harvard University Press. Boston, Mess, 1979.

United Kingdom. Ikpartment of Energy. International Energy Questions. U.K. Dept. of Energy. Energy Commission Paper no. 13.

United Nations Econanic Commission for Europe. New Issues Affecting the Energy Economy of the ECE ReR ion in the Medium and Inng mm. 1978.

III. GLOBAL OPPORTUNITIES

111.1 Managing the Remaining Decades of Oil

a. World Bank. A Program to Accelerate IEtroleum Production in the Developing Countries. Washington, D.C., 1979.

b. Committee on Nuclear and Alternative Energy Systems (WNAES). Alternative Energy Demand Futures to 2010. National Academy of Sciences. Washington, D.C., 1979.

c. Energy: The Next 20 Years. Report by a Study Group sponsored by the Ford Foundation. S.H. Landsberg, Chairman. Ballinger. Cambridge, Mass., 1979.

d. Stobaugh, R. and Yergin, D. Energy Futures. Report of the Energy Project of the Harvard Business School. Harvard University Press. Boston, Mass., 1979.

e. Energy in Pmerica's Future: The Cokes before Us. A Study by staff of the RFF National thergy Strategies Project. Sam H. Schurr, Project Director. Resources for the Future. Washington, D.C., 1979.
III.I (continued):
f. Leach, G. R. et al. A Pnw Energy Strategy for the United Kingdom. International Institute for Pkvelolment and Environment. Inndon, 1979.

g. Beijdorff, A. F. Energy Efficiency. Shell International Petroleum Company. London, 1979.

h. International Energy Agency. Energy fblicies and Programs of IEA Countries. 1979 Review. OECD. Paris, 1980.

i. Exxon Corporation. World Energy Outlook. New York, 1980.

j. Darmstadter, Jcel et al. How Industrial Societies Use Energy; a Comparative Analysis. Johns Ibpkins University Press. For Resources for the Future. Baltimore, Maryland, 1977.

k. International Comparisons o£ Energy Consumption. Proceedings of a Workshop sponsored by Resources for the Future and the Electric Power Research Institute. Joy Dunkerley, Editor. Resources of the Future. Washington, D.C., 1978.

1. European Economic Comnunity. "Energy" Council. New Lines of action by the Conmunity in the Field of Energy Saving. Europe Pbcuments no.1099, May 20, 1980.

Other Relevant Literature

Ehrlich, Everett M. Oil and Gas Prospects in Non-OPEC Less Leveloped Countries. EPRI Workshop on Energy and the Developing Nations. Stanford University. Palo Alto, California, March 1980.

Fallen-Bailey, O.G. and T.A. Byer. Energy Options and Policy Issues in Developing Countries. World Bank Staff Working Paper no. 350. Washington, D.C., August 1979.

Hughart, Cavid. Prospects for Traditional and NonConventional Energy Sources in Developing Countries. World Bank Staff Working Paper no. 346. Washington, D.C., 1979.

I11.1 (continued):

intro-Canada/Petroleos de Venezuela. World Oil Supply Prospects. A Staff Report. February 1980.

Pipes, K. Exploration in Developing Countries. Exxon paper presented at UNITAR Conference. Hbntreal, 1979.

Socolow, Robert H. The Caning Age of Conservation. Annual Review of Energy, 1977. Vol. 2.

Socolow, Robert H. Resource-Efficient High Technology and the Convergence of North and South. Discussion Paper. Symposium on Social Values and Technological

Vedavalli, R. Petroleum and Gas in Non-OPEC Developing Countries 1976-1985. World Rank Staff Working Paper no. 289. Washington, D.C., 1978.

World Sank. Program to Accelerate Petroleum Production in the LYVeloping Countries. Washington, D.C., 1979.

World Bank. Coal L~velopnent Ebtential and Prospects in the Developing Countries. Washington, D.C., 1979.

World Bank. Energy in the tveloping Countries. Washington, D.C., August 1980.

111.2 Managing the Transition from Oil to Other Sources

International Energy Agency. Energy Research, rvelopnent and Damonstration in the TEA Countries: A Strategic View. GE!). Paris, 1980.

International Energy Agency. Energy Tblicies and arrr s of IEA Countries. 1979 *Review.* Paris, 1980.

IV. FRAMEWORK FOR ENERGY POLICIES IN OIDCs

a. McNamara, R. S. World Hank President's Address to the Board of Governors. Washington, D.C., September 1980.
I
V. (continued)

b. World Bank. *Energy* in the Ikveloping Countries. Washington, D.C., August 1980.
o. World Dank. World Oevelopnent Report, 1980. Washington, *D.C.,* 1980.
About the
intro-scam RasrorASts of the Society for International DevelopintThe North-South Roundtable (NSRT), established in 1978 under the auspices of the Society for International Development, is en unofficial, intellectual font which brings together eminent leaders of thought in all walks of life to discuss and debate global developnent issues. Matters of the Roundtable participate in its activities in their personal capacities. *They are* frrm many continents and countries and are united by a shared camatt ant to orderly change in human affairs. The NSRT organizes its deliberations both through its annual sessions and through periodic, smaller sessions on specific global policy themes. Its various sessions are regarded not as unique events in thevselves but as part *of a process of* careful analysis, *wntinuing* debate, and attetipts to reach cullnon understandings in *a very* diverse world--ail contributing to a process of orderly structural change within and enong nations.

The Roundtable's main ongoing projects are:
North-South FTergv Roundtable: An international task force to prepare policy studies on tta future of energy to serve as a basis for continuing dialogue leading to negotiations of *a neu* national

and international frame*work* for dealing with energy issues.
Glcbal Round: A progremre of study and discussion on the global round of North-South negotiations, carrying on fran the report of the Hrandt Cmmission.

North-south Food Roundtable: An international task force to prepare policy studies on world food situation intended to start a process of dialogue on food issues.
The Society for International I velopment is an independent nongovernmental organization whose purposes are to provide a forun for collective reflection and to encourage a mutually educating dialogue on developrent, at all levels. The Society was founded in 1957 and has evolved into several interlocking networks--where individuals and institutions are linked in different ways around a varied range of activities. The President of SID is James Grant and its Secretary General is ibnna Wignaraja. The Society's international headquarters is in Rare.

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