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Energy Strategies for Oil Importing Developing Countries[†]

INTRODUCTION

The two rapid oil price increases during 1973–74 and 1979–80 have left a lasting impact on the entire world. While the economies of all countries, except the oil exporters, have suffered, the most adverse consequences were felt by the group of oil importing developing countries (OIDCs) (see Appendix for a complete list of both low and middle income OIDs).

This paper seeks to identify possible adjustment strategies that the OIDs might adopt in the coming years. Before attempting to do so, two salient points should be recognized. First, the economic adjustments that OIDs had to make in the past were, to a large extent, governed by the global environment because of tight international linkages via trade, borrowing, investment, and aid. Therefore, any analysis of the OIDs' future prospects and policy options must begin with a general understanding of how the world economy coped with the two oil-price shocks, and how external conditions specifically affected the oil importers. Second, energy related problems cannot be meaningfully separated from development issues, especially in the context of the developing countries. Accordingly, potentially useful strategies for energy management and planning are closely linked with successful development policies for management and adjustment of national economies.

The remainder of this paper is structured as follows: the upcoming section seeks to analyze the impact of the past oil crises on the world economy in general, and on the oil importers in particular. Energy and economic development issues in the OIDs are described in the next section. In the final section, future energy options and adjustment strategies that are likely to be successful in the OIDs are discussed.

THE EFFECTS OF PAST OIL PRICE INCREASES

World Economy

During the past decade, international oil prices have risen sharply twice,

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[†]The opinions expressed in this paper are the author's, and do not necessarily reflect the views of the Sri Lanka government or the World Bank.

in 1973–74 and 1979–80 (see Figure 1). Overall real crude oil prices have risen by a factor of six over a ten year period since 1972. The responses of the world economy to the two energy shocks have exhibited similarities as well as differences.¹ In both cases, the economic growth rates of the industrialized and developing countries declined, but the second recession was less precipitous and longer lasting, as shown in Figure 2.

The differences in response may be attributed to the macroeconomic policies adopted by the major industrial powers in each case. During the first crisis, conventional monetary and fiscal expansion policies were adopted to counteract the recessionary effects of high oil import bills. The oil crisis, however, helped to highlight structural rigidities and defects in the western economies which required structural adjustment rather than traditional macroeconomic stabilization policies. Protection of high cost industries and wage rigidities in the struggle to maintain high levels of money income led to wage-price spirals. The resulting persistent inflation, however, eroded real growth, and high interest rates and investment uncertainty deepened the recession. The first oil price increase did, however, result in a move towards energy conservation and substitution away from petroleum, which began to pay off handsomely by the end of the 1970s.

Most of the industrialized countries adopted somewhat different policies after 1979–80, which were based on their experiences during the previous decade. Tight monetary policies controlled inflation, but large fiscal deficits and high short term interest rates discouraged or delayed investment, increased unemployment, and prolonged the recession. Only towards late 1983 was there some promise of a world-wide economic upturn in 1984.

The OIDs continue to be highly vulnerable to developments in the world economy, not only because of high oil import costs, but also due to shrinkage of export markets, official aid flows, access to international credit, and private foreign investments in domestic economies. Each downturn in the industrialized nations had corresponding adverse impacts on the developing countries, although some (especially the newly industrializing far eastern group) were able to cope better than others. Specific mechanisms by which the oil price shocks have affected petroleum importers are analyzed next.²

Balance of Payment Effects

The drastic changes in the price of oil in the 1970s had major financial

1. THE WORLD BANK, WORLD DEVELOPMENT REPORT 1983 (1983).

2. M. MUNASINGHE & G. SCHRAMM, ENERGY ECONOMICS, DEMAND MANAGEMENT AND CONSERVATION POLICY (1983).

and balance-of-payments repercussions on the oil importing countries. Total energy imports as a percent of total merchandise exports in 1960 had amounted to less than 11 percent worldwide. In 1977, energy import costs had increased to between 16 and 40 percent of exports for the low-income, non-oil producing countries; to 24 percent for the middle-income countries; and to 20 percent for the industrialized countries. However, these average percentages hide rates of dependency that are much higher for a number of individual countries. Some of them, such as Jordan, Pakistan, Panama, Syria, and Turkey, spent between 40 and 90 percent of export earnings for oil imports, and the United States and Japan spent about 31 percent and 32 percent, respectively. Given the more than 100 percent oil price increases in 1979-80, these percentages have increased substantially since then, in most cases. Projections made for 1990 for member countries of the Asian Development Bank indicate that energy imports may account for between 55 and 120 percent of export earnings in low-income countries, and between 17 and 50 percent for the middle-income group, in spite of the fact that the projections also foresee a significant substitution of other energy resources for oil.³

These increased foreign exchange requirements for oil imports were a major contributor to a significant deterioration in the balance of payments of many of the oil importing countries. As a result, their external debt load increased sharply. This is particularly true for developing countries. Since much of their oil expenditure has to be financed through foreign exchange borrowings, rather than increased exports, the accumulation of debt and declining international credit-worthiness of many importing developing countries are major unresolved issues. The special problems of the third world are discussed in greater detail later.

Direct Macroeconomic Effects

One of the most important direct effects of the energy price increases in the 1970s was the resulting fall in real incomes of oil importing countries. World oil prices rose by some 350 percent in 1973-74, and by about 140 percent in 1979-80. These increases occurred in response to relatively small reductions in available world supplies, proving that the short-run demand elasticity for oil is low. In both periods, panic buying reinforced the upward pressures on prices, with the result that spot market prices (which account for between 5 to 15 percent of world trade) rose even faster than the announced contractual prices. Given the uneven distribution of oil producing and importing countries, these drastic price rises resulted in major real income transfers from importing to producing

3. T. L. SANKAR & G. SCHRAMM, *ASIAN ENERGY PROBLEMS* (1982).

countries. The consequence was, of course, that real income in the importing countries had to fall.

Assume the share or fraction of energy costs in GNP is ES . Then, in the worst case, where the price-elasticity of energy demand is zero and no energy substitution is possible, a simple and essentially static analysis shows that an increase in energy process of p percent will reduce real national income at most by $[p \times ES / (1 - ES)]$ percent. Assuming a typical value of 0.1 for ES , real income will fall by a maximum of 1.1 percent following a ten percent rise in energy costs, neglecting the dynamic effects of the energy price shock to be discussed later. Thus, if the energy cost share, ES , is small, this will reduce the adverse impact on national income, basically because the economy is less dependent on energy and therefore less vulnerable to the price increase. However, for a given value of ES , the greater the possibilities of substituting other relatively cheaper inputs for energy in various productive activities (i.e., a higher value for price elasticity), the smaller the decline in real national income.

The direct effects will be the same whether the price of imported energy rises or domestic energy sources become more expensive to exploit. Only countries with significant amounts of cheap (and preferably exportable) energy resources will not be adversely affected. It is important to realize the distinction between national income and national output. Thus, if there is little substitution of other inputs such as capital and labor for energy, real output or GNP will be relatively unaffected. But, since more of this product is used to pay for expensive energy, less will be available as wages and profits, i.e., real incomes and the standard of living will decline. Paradoxically, the greater the substitution of other inputs for energy in production, the larger the fall in real GNP, but the smaller the reduction in real national income.

Dynamic Effects

The dynamic effects of an energy price increase occur as the economy seeks to adjust to this sudden shock, encumbered by wage and price rigidities and constraints. The sharper and more unexpected the increase, the more severe the shock. As discussed in the previous section, the increased share of output claimed by energy costs implies reduced incomes for other factors of production such as capital and labor. However, in the post-1973 period various economic agents in the oil importing countries sought to maintain their real incomes by raising wages and prices of other goods. These actions simply boosted money incomes (with little effect on real income) and triggered a spiral of wage-price inflation.

In addition to the inflationary effects mentioned above, the adjustment of the economy will also cause real output to fall. All the well-known adverse effects such as increased unemployment, decreased GNP growth

rate, and general recession, were felt in oil importing countries after the 1973 and 1979–80 oil price increases. In many cases, the tendency of workers to resist decreases in real wage levels and increases in other input costs resulted in reduced profits. This led to layoffs and decreases in output. At the same time, uncertainty regarding prices, interest rates, and profits resulted in reduced investment. Consumer demand also reacted negatively to reduced future real incomes. Thus the world economy went into recession during the period 1973–75, with the uniformity and synchronization of country responses being enhanced by the tight linkage due to large trade and capital flows among them.

Future Trends

These immediate, macroeconomic effects of the income transfers from oil importers to oil exporters are diminishing, however, as price-induced substitutions of other energy resources and conservation measures take hold. In the long-run, the higher oil prices lead to a decline in the use of oil, even though it is not clear at this point in time if world consumption rates will fall in absolute terms or only relative to rates that would have prevailed at lower prices. In the industrialized world, oil consumption in 1980 had actually declined relative to 1978, the year of peak consumption. In the developing countries, however, oil consumption is likely to rise further in order to support the essential process of economic development and growth, and to switch over from traditional to commercial, energy-dependent, modern methods of production.

Oil-substitution, itself, generally requires higher initial investment to provide the same level of service that would have been obtained with the use of oil. This substitution process is costly. Although the average costs of electric energy will be lower for atomic or coal-fired alternatives than for oil, over the life expectancies of the respective plants, the problem is that higher initial capital investments are needed per unit of output. To bring about such substitution requires a significant increase in the amount of investment relative to the amount of useful output produced. Higher savings and lower consumption rates are needed to finance these shifts in the capital/output ratios of energy-producing and energy-consuming equipment and facilities. But these increases in capital requirements put a major strain on world capital markets and are a contributing factor to the higher real costs of capital in recent years. These increased capital costs have placed a heavy burden on the already capital-short, oil-importing, developing countries. They also have reduced the economic advantage of oil-substitution.

Because there is less time for dynamic adjustment, sudden increases in the world oil price are more detrimental to the economies of oil importers than a gradual price rise. While there is general agreement that

oil prices will continue to rise (because oil is a depleting resource), the rate of increase is less certain. Recent estimates range between zero and three percent per year, on average, over the next two decades. Greater conservation efforts by oil importers will help to limit world oil price increases, whereas unforeseen supply disruptions in oil producing areas could lead to sharp price rises.

There will also have to be considerable adjustment in the oil refining sectors of many countries. As more refining capacity comes on-stream in the OPEC countries during the 1980s, many less efficient refineries in other countries will have to be phased out. Also, as heavier crudes that yield relatively more of the heavier refinery fractions predominate over lighter crudes in the future, and demand for fuel oil drops relative to the lighter products, refineries will have to adapt, e.g., by installing cracking facilities. This renders obsolete most of the existing distillation-only refining capacity, and puts a premium on high-cost, cracking facilities that are in short supply.

OIL IMPORTING DEVELOPING COUNTRY (OIDC) ISSUES

The problems encountered by the oil importing developing countries require special analysis because these nations are the least well equipped to deal with the increases in petroleum prices. Most of the oil importing developing countries, such as Brazil and Korea, financed their increased energy import bills by external borrowings following the 1973 oil price increase. This was necessary because they were unable to boost exports sufficiently to balance their foreign trade. A few, like Taiwan, sought to cut back sharply on their domestic demand for oil. On the whole, the OIDCs succeeded in cushioning their economies from the oil price shock, and posted a 4.5 percent growth rate of real GNP, while the Organization for Economic Cooperation and Development (OECD) countries were deep in recession. However, the increasing debt service burden of the OIDCs makes it unlikely that continued foreign financing of energy needs can be sustained indefinitely into the future. Between 1970 and 1979, their debt service as percentage of GNP increased from 1.2 to 2.7 percent for low income countries, and from 1.5 to 2.2 percent for middle income countries. The future looks even bleaker for a number of them. For 12 major energy importing Asian countries, the Asian Development Bank predicts that energy imports as a percent of GNP will amount to almost 15 percent by 1990, as against a range of 3 to 7¹/₂ percent in 1978.⁴

The more detailed pattern of foreign exchange borrowings by OIDCs shows that there was a sharp increase in borrowing after the 1973 oil price increase, which gradually decreased up to 1978, only to rise again

4. *Id.*

following the volatility of international oil markets during 1979–80. Many of these loans were obtained from private commercial banks, and therefore not under concessionary terms usually provided by international aid agencies. These rapid increases in short term borrowings have increased the debt service burden of several countries to dangerous levels. For example, by 1985, the more industrialized, middle income OIDs are projected to spend about 29 percent of their export earnings to meet interest and amortization payments on their foreign debt.⁵

Increased borrowing immediately after a sudden oil price increase is generally in the interest of the OIDs. An economy is usually most rigid in the short run, with few possibilities for energy substitution in production and consumption. Therefore it makes sense to borrow more heavily in the initial period following the oil price increase, assuming that energy substitution and conservation programs will provide greater flexibility in later years. However, it is clear that the ability to withstand repeated energy shocks will be diminished if the magnitude and frequency of these price increases is too great to permit economies to adjust to new equilibria and to allow debt service ratios to fall to acceptable levels. While the demand for foreign loans may not be very sensitive to the cost of borrowing (i.e., interest rates and terms of repayment), the supply of funds, especially from the commercial banks, will depend critically on credit worthiness. Already, preliminary results indicate that the OIDs were not able to cushion their economies from the effects of the most recent oil price shocks as well as they did in the post-1973 period.

Both the direct and dynamic effects of higher energy costs discussed earlier will continue to reduce already low real incomes and living standards, decrease output and employment levels, and fuel inflation in the OIDs. Fortunately, in the next decade or so, energy substitution and conservation policies will help to alleviate these problems. However, the third world will still need increasing amounts of energy to sustain its drive for economic growth and industrialization. Thus, according to the World Bank, total commercial energy consumption in oil importing developing countries will increase from 12.4 million barrels a day of oil equivalent in 1980 to 22.8 million barrels by 1990.⁶ Not all of this increase, of course, will be in the form of oil consumption. For example, for 19 Asian countries, oil dependence is projected to decrease from some 78 percent in 1978 to 65 percent by 1990, even though in absolute terms oil consumption in these countries is expected to double.⁷ As oil de-

5. THE WORLD BANK, *THE ENERGY TRANSITION IN DEVELOPING COUNTRIES* (1983).

6. *Id.*

7. U.N. Economic Committee for Asia and the Pacific, 32 *Econ. Bull. for Asia and the Pacific* 46–62 (1981).

pendence declines relative to total GNP, the negative effects of high and rising oil prices will become less significant for income and employment.

As mentioned earlier, energy related investments in developing countries for developing new energy sources and for conservation programs will also be substantial. According to estimates by the World Bank, for example, the energy-related investment needs of the developing countries as a whole are projected to rise from some 34.4 billion U.S. dollars in 1980 to approximately 82.2 billion dollars per year by 1990 (in 1980 U.S. dollars).⁸ This represents an average annual increase of 12.3 percent over the decade.

In summary, solving the energy problems of the third world will be a formidable challenge. In the past, commercial banks have been willing to act as intermediaries by holding loans from OIDs, and issuing their own internationally recognized instruments to finance oil payments and energy related investments. Since this cannot continue indefinitely, greater direct flows of petro-dollars from the oil-surplus countries to the OIDs in the form of concessionary loans for investments, etc. may be required. More aid from both multilateral and bilateral sources, as well as higher levels of private foreign investment, will be required. The developed countries should also be willing to run greater trade deficits than OIDs.

We note that any evolution of international economic relationships will depend on many difficult and unknown political factors. Energy will be only one issue, albeit an important one, to be thrashed out within some broader framework such as the North-South dialogue and the new international economic order (NIEO) discussions. It is very clear, however, that whatever the outcome of international developments, the more efficient use of energy, and demand management and conservation policies pursued within individual countries, as well as more effective exploitation of indigenous energy resources and supply management, will play an important role in reducing the adverse effects of the energy crisis in those countries willing to adopt appropriate policies.

ROLE OF ENERGY PLANNING AND MANAGEMENT

Because of the intimate link between energy and development issues, we will examine the energy planning and management framework as well as the policy instruments available to tackle the OIDs' energy problems, before setting out the strategies to be adopted.⁹

It is generally accepted that the broad rationale underlying modern energy management and planning is to make the best use of available

8. THE WORLD BANK, *supra* note 5.

9. Munasinghe, *Integrated National Energy Planning in Developing Countries*, 4 NAT. RESOURCES F. 359 (1980).

energy resources for promoting economic development, and improving social welfare and the quality of life. Therefore, energy planning is an essential part of the overall management of the national economy, and should be carried out in close coordination with the latter. However, in energy management and planning, the principal emphasis is on the comprehensive and disaggregate analysis of the energy sector with due regard to the main interactions with the rest of the economy, and among the different energy subsectors themselves. The efficient management of government energy-related corporations and, where necessary, the provision of correct investment and price signals to the private sector, are an integral part of successfully implementing national energy policies.

In a strictly technical sense, the best strategy might be to seek the least costly method of meeting future energy requirements. However, energy planning also includes a variety of other and often conflicting objectives, such as reducing dependence on foreign sources, supplying basic energy needs of the poor, reducing the trade and foreign exchange deficits, priority development of special regions or sectors of the economy, raising sufficient revenue to finance energy sector development (at least partially), ensuring continuity of supply, maintaining price stability, preserving the environment, and so on.

In general, energy planning requires analysis at the following three hierarchical levels in relation to fundamental national objectives: (1) links between the energy sector and the rest of the economy; (2) interactions between different subsectors within the energy sector; and (3) activities in each individual energy subsector. The steps involved in the planning procedure usually include energy supply and demand analyses and forecasting, energy balancing, policy formation, and impact analysis, to meet short, mid, and long-range goals. Implementation of the results of this analysis could be considered within the framework of a formal national energy master plan (EMP), or a more decentralized policy package that relies on voluntary responses of private energy producers and consumers to market prices. This will generally require the coordinated use of a number of interrelated policy tools such as: (1) physical controls and legislation; (2) technical methods (including research and development); (3) direct investments or investment inducing policies; (4) education and propaganda; and (5) pricing.

Energy planning may be carried out initially at a relatively simple level, but, as data and analytical capabilities improve, more sophisticated techniques, including computer modeling, may be used. The institutional structure could also be rationalized by setting up a central energy authority or ministry of energy, whose principal focus should be on energy planning and policy-making. Some central guidance and coordination of the many policy tools, energy supplying institutions, and consuming sectors is

necessary even in countries in which energy supply activities are dominated by the private sector. The influence of government actions in the various energy subsectors is quite pervasive in all countries. Regardless of the degree of centralization of planning functions, the execution of policy and day-to-day operations would remain the responsibility of government institutions or private firms, such as electric utilities or petroleum corporations, that already exist.

Policy Instruments

The policy tools available for energy planning and management include pricing, physical controls, technical methods (including research and development), and education and promotion.¹⁰ Since these tools are inter-related, their use should be well coordinated. Price is most effective in the mid and long-term. In terms of economic efficiency, price indicates the consumer's willingness-to-pay and use-value of energy to the supplier, while, to the consumers, it signals the present and future opportunity costs of supply based on various energy sources.

Physical controls are most effective in the short-run when there are unforeseen shortages of energy. All methods of physically limiting consumption are included in this category (for example, load shedding and retating power cuts in the electricity subsector, and reducing the supply of petrol or banning the use of cars during some periods). Technical means include, on the supply side, the cheapest means of producing a given form of energy, the best fuel mix, research and development of substitute fuels such as wood-alcohol for petrol, and on the demand side, introducing higher efficiency energy conversion devices such as better wood burning stoves, etc. Education and promotion include, on the supply side, efforts to make people aware of external diseconomies such as pollution, and supportive of reafforestation schemes to preserve the environment; and on the demand side, public education for energy conservation.

Pricing and investment decisions should be closely related. Energy supply systems (for example, electricity generation, transmission and distribution, oil and gas wells and pipelines, coal mines, forests), usually require large capital investments with long lead and life times. Once the investment decision is made (usually on the basis of the conventional least cost method of meeting demand by subsector, with due regard for interfuel substitution possibilities), there is a lock-in effect with respect to supply. Therefore, prices should be related to the long-term planning horizon. On the demand side, energy conversion devices (e.g., cars, gas

10. Munasinghe, *Third World Energy Policies: Demand Management and Conservation*, ENERGY POLICY 4 (March 1983).

cookers, electric appliances, machines, etc.) are expensive relative to average income and have relatively long lifetimes, thus limiting the ability of consumers to respond to changes in relative fuel prices in the short run.

FUTURE ENERGY OPTIONS AND ADJUSTMENT STRATEGIES

Global Scenario

The energy prospects of the developing countries, and the OIDs in particular, depend on supply-demand projections based on the likely evolution of the world economy. For the period 1985–95, the expected average annual growth rate of real gross domestic product (GDP) of the developing countries and the industrialized countries would be 5.5 and 3.7 percent, respectively.¹¹ In the former group, the middle income countries are estimated to grow most rapidly at 5.7 percent, while the low income Asian countries, with an average growth rate of 4.9 percent, are expected to do better than their African counterparts having growth rates averaging only 3.3 percent. Global oil consumption is predicted to increase by only about one percent per year, up to 1995, while the real oil price is projected to grow at 1.6 percent. Although short-term fluctuations in energy markets (especially oil) will remain unpredictable, the above assumptions are reasonable long-run trends, given that oil prices must eventually approach the costs of potential replacements such as synthetic fuels. In particular, short-term declines in world petroleum prices should not lull the OIDs into a grossly false sense of security.

Table 1 shows the expected consumption and imports of various forms of commercial energy in the OIDs. Although overall annual energy consumption will grow at five percent, the increase in oil use will be limited to about half this value. A combination of conservation and indigenous energy resource development policies will permit the OIDs to reduce their petroleum imports from 44 to 28 percent of total commercial energy use between 1980 and 1995. Despite these hoped for successes, their net oil imports will increase from 295 million tons of oil equivalent (toe) in 1980 to about 386 million toe by 1995, when oil will still be supplying 39 percent of total commercial energy needs. Total commercial energy imports will rise at an average annual rate of three percent, from 288 million toe to 449 million toe, over the same period.

Meanwhile, biomass accounts for as much of the gross energy requirements of OIDs as commercial fuels. In many countries it is used not only for fuel but also for construction timber, a total use which is several fold greater than the safe sustainable yield from already depleted forest cover. The future consumption of fuelwood will be determined mainly

11. THE WORLD BANK, *supra* note 5.

TABLE 1.
Expected Commercial Energy Consumption and Imports
in the Oil Importing Developing Countries

	Consumption			Imports		
	1980 Million toe	1995 Million toe	1980-95 percent growth per year	1980 Million toe	1995 Million toe	1980-95 percent growth per year
Oil	360	531	2.6	296	386	1.8
Coal	186	442	5.9	- 6	58	—
Natural Gas	26	120	10.7	- 1	5	—
Primary Electricity	98	306	7.9	0	0	0
Total	670	1399	5.0	288	449	3.0

Source: *The Energy Transition in Developing Countries*, The World Bank, Washington, D.C., August 1983, Chapter 1.

by the availability of supply. Unless significant afforestation efforts are undertaken, accessible forest cover will disappear within the next two or three decades, especially in the low-income Asian and African OIDs. In addition to the hardships imposed on the predominantly rural poor in these countries due to the inability to meet basic energy needs, other undesirable effects, including topsoil erosion, declining agricultural productivity, desertification, reservoir siltation, and reduced retention of water in catchment areas, will also manifest themselves.

Broad Energy Options

The principal energy options available to OIDs are: (a) improving the efficiency of both energy supply and consumption for short- and mid-run gains, and (b) increasing the pace of development of indigenous energy resources, and restructuring their economies for longer-run pay-offs.

Energy Efficiency

In most countries, the highest return on investments in the energy sector today may be realized from projects directed at increasing energy efficiency. On the demand side, energy efficiency improvements or conservation and demand management measures should be vigorously pursued by providing energy consumers with the latest technical knowledge, financial incentives through appropriate price signals and taxes or subsidies, and educational and promotional information. While the concept of energy conservation is intuitively appealing in a period of increased costs and

scarcity of energy, the desirability of specific energy conservation policies must be verified by applying specific tests that compare their costs and benefits.

Two purely technical measures of the efficiency of energy use may be derived from the first and second laws of thermodynamics. The principal weakness of these measures is that they focus almost exclusively on the amount of energy used in a particular process and do not take into consideration the necessary inputs of other scarce resources such as capital, labor, and land. Also, the first and second law criteria may not always be consistent.

By contrast, a comprehensive and unambiguous test of specific energy conservation policies is based on the concept of economic efficiency and cost-benefit analysis. Generally, a conservation measure gives rise to cost saving benefits, B , due to a reduced consumption or substitution of energy, and to additional costs, C_1 , of implementing the conservation policy (including hardware costs), and to costs C_2 , representing benefits foregone due to reduced energy consumption. If B exceeds the sum of C_1 and C_2 , the conservation measure is desirable. However, in some cases, increased energy consumption may improve overall economic benefits, e.g., if the actual price of an energy produce is well above its marginal opportunity cost (MOC), this price should be lowered toward MOC, with a consequent increase in demand.

In terms of present discounted values, these economic costs and benefits should be evaluated and compared on a life cycle basis. Appropriate shadow prices or measures of the opportunity costs of goods and services must be used to verify whether the given policy will increase economic welfare from a national viewpoint. If so, the same calculation must be repeated using market prices to check whether private individuals will actually find it profitable to adopt these measures. Often, since market prices diverge from opportunity costs, it may be necessary to change taxes, prices, and legislation to promote a desirable conservation policy.

Conservation options in transport, buildings, industry, and electricity supply will now be summarized. The principal purpose of a transportation system is to physically convey people or goods from one location to another. Therefore, any measure that increases the payload in terms of energy used per passenger-mile or ton-mile would help the conservation effort. Important methods of achieving this result include: changing from more to less energy intensive transport models or to cheaper fuels; increasing the technical efficiency of energy use of given modes of transportation; and changes in behaviour and overall systems effects.

In the case of lighting, space heating, and cooling of buildings, three factors affecting the consumption of energy are: behavioral characteristics and attitudes of occupants; the type of energy-using equipment installed;

and architectural design practices and materials used. Keeping living and working space lighted and cool are the chief concerns in the tropics, where most of the developing countries lie. In these areas, the use of air-conditioning is growing rapidly for commercial buildings such as businesses, hotels, etc., and to a lesser extent for residences of upper income urban and expatriate groups whose numbers, fortunately, are small.

Contrary to widespread belief, many industries are unaware of potential decreases in energy use that can be realized quite simply and are extremely cost effective. Because of the concentrated nature of such energy users, governments as well as energy suppliers and utility companies can be particularly effective in legislating improvements, counselling, providing energy audits, and helping consumers carry out technical improvements. Four broad areas for industrial energy conservation are: (a) waste heat recovery and cogeneration, (b) other retrofits and improvements in operation, (c) major changes in manufacturing processes and production methods, and (d) recycling and recovery of waste materials.

Efficiency improvements may also be realized in energy production and distribution. Loss reduction in petroleum refinery operations as well as distribution and retailing activity are areas in which significant gains could be made. In electric power supply, the three principal opportunities for conservation arise in (a) generation, (b) transmission, and (c) distribution. Furthermore, conservation at the end-use stage may also be achieved by two principal methods: improving the technical efficiency of energy-using devices and appliances, or changing the shape and characteristics of the load through demand management and load control techniques.

Energy Resource Development

OIDCs can reduce their oil import bills and overall energy costs substantially by exploiting and developing their indigenous resources more vigorously. The greatest potential for increasing domestic commercial energy production lies in the petroleum, natural gas, coal, hydroelectric, and nuclear energy subsectors.

The development of these resources requires: (a) better national energy planning, policy analysis, and formulation of strategies, (b) accelerated identification, evaluation, exploitation, and marketing of specific energy resources, and (c) improved capability of energy sector institutions to manage and operate such projects. In view of the massive and non-marginal nature of many of these schemes, more pre-investment activity is required to avoid serious misallocations of investments and waste. At the same time, the mobilization of both domestic and foreign financial resources to support the projects themselves requires a major effort by the OIDCs.

For the OIDCs as a whole, the World Bank estimates that almost \$900

billion (in constant 1982 dollars) will be required over the next decade.¹² About one third of these investment requirements will be in foreign exchange. To finance these needs, the low-income OIDs require greater flows of official assistance on concessional terms. Middle-income OIDs will need better access to international capital markets to increase commercial borrowing on the best possible terms, if excessive debt service burdens are to be avoided. At the same time, the remaining two thirds of investment must come from domestic sources. Energy sector institutions, like petroleum companies, coal mining firms, and electric utilities, have to play a vital role in contributing adequately to their own investment needs. In particular, realistic pricing policies for commercial energy must be pursued to preserve and strengthen the financial viability of these energy sector institutions.

Strategies for Specific Energy Subsectors

Oil: Exploration and development of petroleum must be rapidly increased by identifying and promoting acreage suitable for drilling, and on terms sufficiently attractive to international oil companies. At the same time, domestic expertise and the capabilities of national oil companies (where appropriate) must be strengthened, not only to monitor the efforts of multinationals and protect national interests, but also to engage directly in exploration, development, and refining.

Natural Gas: Although the availability of this resource is far more widespread than realized earlier, the lack of an integrated gas development strategy, unavailability of infrastructure, and uncertainty as to future markets, have hindered more rapid development. Because of the very project-specific nature of gas costs and the high costs of transport to markets, greater efforts must be devoted to promotion and market development, pricing, and contractual arrangements for gas use. Domestic institutional capability must be strengthened and more systematic exploration has to be carried out.

Coal: Although coal is a much more abundant resource than oil or gas worldwide, OIDs are not making adequate use of either indigenous deposits or inputs of this resource. Coherent strategies for coal use, better coordination among different coal suppliers (both local producers and importers), between coal suppliers and users, improved infrastructure and management, and more rational pricing policies are required.

Electricity: This subsector will absorb about 60 percent of total investments in commercial energy over the next decade due to its highly capital-intensive nature and relatively high growth rates of demand. Better optimization, especially of distribution networks, and improved demand

12. *Id.*

management and pricing policies are crucial as power systems increase in size and complexity. Particular attention must be paid to identifying and developing hydroelectric resources, based on post-oil crisis relative fuel price changes.

Geothermal: This resource is quite widespread, but lack of data and clear national policy has hindered development. Reconnaissance work, field surveys, and exploratory drilling, as well as market surveys and studies of contractual arrangements between the potential producers and users of geothermal steam, must be given early attention if this situation is to be remedied.

Biomass Fuels: This energy source supplies at least half the gross energy needs of OICs, mainly in rural areas where over 80 percent of the population lives. Serious efforts have to be made in order to avoid severe fuelwood shortages, deforestation, and attendant ills in many of these nations within the next two decades. On the supply side, massive afforestation schemes must be launched. These initiatives need to be supported by the strengthening of local institutions and grass roots infrastructures, the use of low-cost tree planting methods (suited to projects ranging from small community woodlots to large commercial fuelwood plantations), and better integration of fuelwood programs with other rural and agricultural activities. On the demand management side, the promotion of higher efficiency wood stoves, fuel-switching to charcoal, and other policies, should be vigorously pursued. Most importantly, preoccupation with commercial fuels should not be permitted to dominate the biomass subsector and starve it of resources and attention.

New Energy Sources: Systematic efforts are needed to research, adapt, fieldtest, commercialize, and disseminate the new technologies (such as small hydro, solar, and wind energy). However, because of site-specific resource endowments, the economics of these schemes must be proven on a case by case basis. While the viabilities of these technologies have already been demonstrated, their contribution to total national energy needs will be only a few percent, at most. To analyze the usefulness of these technologies in specific significance, local institutional capability must be developed to deal with the monitoring and adapting of new discoveries and technological improvements from abroad, rather than to unnecessarily duplicate or rediscover such advances. In any case, the commercialization and widespread popularization of new energy sources will remain a difficult problem for many years to come.

CONCLUSION

We conclude by noting that the broad energy policy options and specific subsector strategies described above will remain relevant over a reason-

able range of future oil prices. Most OIDs have not yet fully adjusted to the sharp increases in energy prices of the 1970s, and unless there is a dramatic reversal of these prices relative to other goods and services (e.g., back to pre-1973 levels), the policy options and conclusions described in this paper are unlikely to be significantly altered.

APPENDIX: LIST OF OIL IMPORTING DEVELOPING COUNTRIES

1. *Low Income*

Afghanistan, Bangladesh, Benin, Bhutan, Burma, Burundi, Cape Verde, Central African Republic, Chad, Equatorial Guinea, Ethiopia, Fiji, Ghana, Guinea, Guinea-Bissau, Haiti, India, Kampuchea, Democratic Lao PDR, Madagascar, Malawi, Mali, Mozambique, Nepal, Niger, Pakistan, Rwanda, Sao Tome and Principe, Sierra Leone, Somalia, Sri Lanka, Sudan, Tanzania, Togo, Uganda, Upper Volta, Viet Nam, Zaire.

2. *Middle Income*

Argentina, Barbados, Bolivia, Botswana, Brazil, Cameroon, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, El Salvador, Greece, Guatemala, Guyana, Honduras, Hong Kong, Israel, Ivory Coast, Jamaica, Jordan, Kenya, Korea (PDR), Korea (Republic of), Lebanon, Lesotho, Liberia, Mauritania, Mongolia, Morocco, Nicaragua, Panama, Papua New Guinea, Paraguay, Philippines, Portugal, Senegal, Singapore, Thailand, Turkey, Uruguay, Yemen Arab Rep., Yemen PDR, Yugoslavia, Zambia, Zimbabwe.