# ENERGY PLANNING IN LATIN AMERICA:
## A Brief Review of Selected Countries

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### INTRODUCTION

Present conditions in the international energy market and the problems they pose for Latin America hardly need emphasis, especially the uncertainty with respect to the availability and price of specific forms like oil. These concerns are, of course, aggravated by the need to respond to the short-term severe dislocations in the energy market, while at the same time taking coherent steps toward long-term solutions of national energy problems. Indeed, how should oil importing countries offset price increases, which exacerbate national deficits and debt service; deal with inflation, which raises the cost of developing indigenous resources; and successfully increase exports, when a number of other countries around the world are pursuing similar export expansion policies? While in broad terms the international energy market imposes a set of constraints upon all Latin America, there is a wide variety of responses among the countries themselves. The oil importing countries (Dominican Republic, Costa Rica, Brazil) face a set of problems different from that of more-or-less self sufficient nations (Argentina, Colombia), which is in turn quite different from the major oil exporter (Venezuela). The needs of each country are, therefore, a combination of the international context and the specific situation within a country, and this is reflected in the nature of their energy planning and policy institutions.

Since there are common elements of government structure between one country and another, we selected a group of prototypical countries as examples of the way in which Latin American nations organize their energy planning and policy activity. From current energy analyses in these countries and their institutional arrangements we generalize to define some directions toward improving energy analysis capability in Latin American nations.



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## ENERGY MANAGEMENT PROBLEMS

To define the nature of management policies in the energy sector, we take a brief look at current patterns of energy use in Latin America. Brazil, of course, is a large importer of petroleum; Argentina is more or less self-sufficient in oil; Peru is an importer but has a smaller economy; and Central American and Caribbean countries are by-and-large importers, but are small consumers. While imports have been on the rise, the posted crude oil prices increased from about $3 a barrel in 1972 to $12 a barrel in 1977, and above $30 recently, so the aggregate import bill has increased from 700 million dollars to 10 billion dollars in a short time. While this aggregate behavior of oil imports and pricing is often taken to define the energy problem, there are a number of other concerns within Latin American countries which are of comparable significance.

Noncommercial fuels (wood, bagasse, agricultural wastes) make major contributions to energy use in many countries, particularly among rural dwellers. However, with the growth of population, severe pressure has been exerted on the sources of supply. In many regions wood has become a scarce fuel due to commercial sales. Rapid urbanization has raised the demand for commercial fuels, particularly oil for transportation and the expanded use of electricity, though the level of service to many urban dwellers remains minimal. Rural electric grid expansion has been an expensive and difficult approach to meeting energy needs in rural areas and alternatives must be found. Industries have often relied upon residual oil as a boiler fuel. The substitution of other fuels may soon become a necessity; however, substantial capital investment is required to permit such substitutions. Energy management has come to mean, in addition to coping with oil imports, formulating a rational approach to the development of domestic energy resources. Broadly, the concern of policy now is to preserve economic growth and to maintain development programs to meet human needs in a world in which energy is no longer a cheap input.

Patterns of energy use and their relation to economic activity in selected countries are shown in the table. Sixty-five percent or more of total energy consumption is supplied by commercial fuels, the balance being provided by noncommercial fuels. The share of oil is usually large, typically accounting for 60 to 95 percent of commercial fuels. In large part, this reflects the high dependence on oil in the transportation sector (often accounting for 30 to 40 percent of total oil consumption). Oil imports as a percentage of export earnings are more than 30 percent for some heavily importing countries. This reflects their reliance on oil as a fuel for both the transportation and industrial sectors, and the recent effect of world price increases.

Because the transportation and industrial sectors in most coun-

tries rely so heavily upon oil products for their fuel needs, there is a correlation between industrial development and petroleum use. For countries with as varied economic structure as those in the table, which were selected for discussion of energy planning and management issues, gross domestic product does not correlate well with energy utilization. However, larger per capita contribution of the industrial sector to gross domestic product is associated with increased per capita utilization of oil in industrial and transport sectors. Industrialization in Latin America, as well as other parts of the world, has followed a more or less traditional path. Industrialization has meant energy-intensive industry development, energy-intensive goods production, and transport based, for example, on truck freight and energy-intensive modes of passenger transportation, auto rather than bus. Recently, there has been sufficient change in the world energy situation to call into question this model of development. It seems appropriate to ask whether economic growth and development, in the sense that it is intended to provide for human needs at higher standards of living, can be met with less reliance upon imported resources, and to what extent less energy-intensive paths of development might prove successful.

There is no doubt that the crisis in all of the oil-importing developing countries arises out of such factors as the severe imbalance of payments caused by the precipitous rises in oil prices, the growing shortages of noncommercial fuels, and the lack of capital for investment in indigenous energy resources. Yet, in identifying the context for energy planning in developing countries, it is important to distinguish between the lower-income, predominantly primary export countries like the Dominican Republic and Costa Rica and the larger, more industrialized developing countries like Brazil and Argentina.

## BRAZIL[1]

Brazil is an example of the larger nations in Latin America which have combined patterns of rapid industrialization and urbanization over the last decade. Brazilian energy management issues center on the need to control relatively high per capita consumption of commercial energy and the rapid increase in oil import costs. The balance of payments is increasingly difficult to maintain and threatens to slow the expansion of economic activity.

Brazil is well endowed with energy resources. Coal and oil shale deposits are found in the south. Domestic oil production meets half of the country's demand, though large finds in the exploration program are not expected. Rivers with hydro potential abound and many of the larger sites have been developed. Primary energy consumption in Brazil was estimated at $4973 \times 10^{15}$ joules in 1978. Petroleum (almost all im-

ported) supplied 43 percent of primary energy, coal 4 percent, hydropower 26 percent, and noncommercial fuels (predominantly firewood) the remaining 27 percent. Per capita energy consumption is expected to increase from $42 \times 10^9$ joules in 1978 by 4 percent per year while population growth itself is projected at only 2.5 percent annually.

Oil imports provided 23 percent of total energy needs in 1976. This rose to 40 percent of total energy in 1978, a 10 percent annual growth rate, to support a rapidly growing economy. By 1987, oil imports are expected to decline to 30 percent of the country's consumption, but with the expansion of energy demand itself the import quantity will be the same as today, 330 million barrels annually. At present prices, imported oil costs Brazil $US 8 billion. Consequently, a major energy planning issue is the design of domestic oil product pricing, energy efficiency programs, and fuel substitution technology to reduce the need for imported oil. Present plans call for coal and hydropower to offset the growth of oil imports. However, this must be accomplished without substantial detrimental effect in an economy with 7 percent annual per capita GNP growth.

Petroleum consumption is predominantly in industrial and transportation sectors, which represent 36 percent and 38 percent, respectively, of national energy consumption. Fuel oil use increased at an annual rate of 11 percent over the past decade and diesel fuel at 12 percent, reflecting industrialization including heavy use of truck transportation (rail facilities are few and in bad repair). Also, a pricing policy subsidizes diesel fuel so that while diesel consumption rises rapidly, gasoline use has increased at a more modest 7 percent per year. Alcohol (from cane) provides about 1 percent of transport fuel needs, but does result in a 20 percent/80 percent alcohol-gasoline mix at gas stations throughout many parts of the country.

Electricity production in 1978 was 107,000 GWH, 26 percent of national energy consumption. Hydropower is almost the exclusive source of electricity, with less than a few percent of electrical energy supplied by thermal generation. Electricity production has increased 12 percent per year over the last decade, and the projected growth is 9 percent annually for the coming decade. Per capita consumption is currently 935 kWh but will grow to 1600 kWh per capita in 1985. Only 15 percent of electrical energy is utilized in the residential sector. While expansion of the number of customers in service and their household use may increase, electricity needs will be dependent more upon commercial service and industrial growth, particularly the extent to which electricity can substitute for energy now provided by oil products.

Noncommercial fuels are an important energy resource in Brazil. Of 107 million tons of firewood consumed, 80 percent was directly utilized by rural and urban households. The remaining 20 percent of wood

| | *Industrial* | *Balanced Economy* | | *Primary Exporter* | *Agriculture* |
|---|---|---|---|---|---|
| | *Brazil* | *Colombia* | *Peru* | *Jamaica* | *Costa Rica* |
| Population | | | | | |
| Mid–1977 Total (million) | 116 | 25 | 16 | 2 | 2 |
| 1975 % Urbanized | 48 | 66 | 63 | 46 | 41 |
| Distribution of GDP (%) | | | | | |
| Agriculture | 12 | 26 | 16 | 9 | 21 |
| Industry | 37 | 29 | 31 | 37 | 25 |
| Services | 51 | 45 | 53 | 54 | 54 |
| 1977 (US$) Per Capita GNP | 1360 | 720 | 840 | 1150 | 1240 |
| $10^9$j Per Capita Energy Consumption (Commercial) | 21 | 20 | 18 | 56 | 14 |
| $10^9$j Energy Consumption Per $ GDP | 2 | 3 | 2 | 4 | 1 |
| Energy Imports as % of Mdse. Export Earning | 43 | 2 | – | 34 | 14 |
| Export as % of GDP | 8 | 16 | 17 | 32 | 33 |

All indicators are for 1976 unless otherwise noted.

| | *Industrial* | *Balanced Economy* | | *Primary Exporter* | *Agriculture* |
|---|---|---|---|---|---|
| | *Brazil* | *Colombia* | *Peru* | *Jamaica* | *Costa Rica* |
| *Energy Consumption* | | | | | |
| Total | 3364 | 651 | 482 | 113 | 38 |
| Commercial | | | | | |
| Total | 2427 | 422 | 313 | 108 | 29 |
| % | 66 | 65 | 65 | 95 | 77 |
| From Imported Oil | 77 | – | 34 | 55 | 81 |
| *Of Total Commercial Energy Consumption (%)* | | | | | |
| By Fuel | | | | | |
| Coal | 4 | 19 | 4 | – | – |
| Oil | 81 | 60 | 83 | 95 | 82 |
| Gas | 2 | 9 | 7 | – | – |
| Electricity | 14 | 12 | 7 | 5 | 18 |
| By Sector | | | | | |
| Industry | 36 | 8 | 38 | 2 | 14 |
| Transportation | 38 | 31 | 38 | 16 | 31 |
| Other | 26 | 61 | 24 | 82 | 56 |
| *Share of Total Power Generation (%)* | | | | | |
| Industry | 7 | 11 | 43 | 41 | 3 |
| Hydropower | 86 | 59 | 43 | 4 | 86 |
| Thermal | 7 | 30 | 14 | 55 | 11 |

*Sources*: See "Notes"

All energy indicators are in the unit $10^{15}$ joules unless otherwise noted.

fuel was consumed in industrial and commercial activity. In addition, 23 million tons of bagasse was burned as fuel in the cane industry. Of this bagasse, about 6 percent was utilized for thermoelectric generation. The amount of wood consumed remained relatively constant over the past decade and is expected to decline slowly. Bagasse, on the other hand, is utilized as the fuel for distilleries and could double over the decade if government policy continues to favor widespread use of alcohol in transportation.

The major energy management priority in Brazil is one of finding means to exploit quickly indigenous resources in an attempt to continue the rush toward a modern economy. Heavy investment in oil exploration has produced some finds, and domestic production has increased. Hydropower development continues at a rapid rate. In the near term, energy planning issues focus on industrial energy conservation and to some extent, on developing a better basis for a rational energy pricing policy.

Pricing in the energy sector has been a difficult problem in recent years. In the mid-70s, gasoline prices were permitted to rise with oil import costs. However, diesel fuel and residual oils (industrial boiler fuels) remained subsidized. By the late 70s, costly imported oil sold at average prices below other domestic resources. Steam coal (per unit of energy) cost twice as much as fuel oil. However, indigenous coal resources are viewed as a substitute for oil use in industry. To stimulate a transition to coal, ministries, industry associations, and coal producers have established a cooperative agreement to expand coal production, distribution, and utilization. This agreement includes yet another set of subsidies, which will be instituted to balance oil-coal fuel price differentials.

Brazil is typical of many Latin American countries in its assignment of technical and resource planning in the energy field to the Ministério das Minas y Energia; the economic aspects of energy are considered in the Instituto de Planejamento Econômico y Social (IPEA), a quasi-governmental institute associated with the Secretária de Planejamento da Presidencia da República. In theory, resource development issues, technology development, conservation, fuel switching potential, etc. are considered within the Ministry and their cost and contribution to the national energy scene assessed. IPEA considers the integration of energy sector plans, both their financial feasibility as well as their economic impact. However, the link between the two agencies is not a strong one, aside from many individual contacts. Also, the "state enterprises," or national holding companies, are relatively strong organizations in their own right. PETROBRAS, ELECTROBRAS, and NUCLEBRAS are nominally under the jurisdiction of the Ministry, but in reality function as

separate agencies. Consequently, oil exploration, production, and distribution activities lie, for the most part, outside direct control of the Ministry. Energy analysis within the enterprises tends to focus more upon their own economic viability and upon the way in which alternative fuels, packages of tax credits, or other elements of energy strategy may have an impact on their business operations.

Energy sector planning is coordinated in Brazil at two points. The first is a Comissão Balanço de Energia Nacional (COBEN), which is basically intended as an *analysis* unit. There are about ten people in each of the state enterprises, the ministries, and IPEA who are cooperating members of COBEN. In addition, there is a small staff coordinated by the Secretária de Ciência Tecnologia in the Ministry which is responsible for integration of the activities of the separate groups. The energy *policy* group is the Conselho Superior de Energia, made up of the heads of the several state enterprises, divisions in the Ministry, and several other agencies. This is a high-level group, with no staff support other than the individual staff members that each participant in the Conselho Superior uses for his own work. It is this council, for example, that decides upon pricing policy, tax structure in the energy field, and other major policy questions.

As yet, there has been no comprehensive national energy assessment in Brazil. COBEN has prepared an energy balance report, but this is largely a compendium of forecasts for the production and utilization of individual fuels prepared separately by the various national agencies. There is no document that specifies in detail the trade-off among fuels, or that examines in detail the relative costs of different fuel-use scenarios. The Ministry does rely upon some outside groups for analysis support. For example, at the Universidade Federal do Rio de Janeiro is the Coordinação dos Programas de Pos-Graduação Engenharia (COPPE), which includes a group of engineers and economists interested in energy analysis. A recent report by COPPE for the Ministry does project several alternative fuel strategies for the future and begins to look at the energy balance and economic implications of such strategies. IPEA/Rio de Janeiro does have an energy analysis unit, a group of half a dozen professionals focusing on the economic impacts of alternative energy policy. This group has worked with Delfim in his recent policy moves, and is attempting to develop integrated energy planning and policy methodology. The Instituto de Pesquisas Econômicas in São Paulo is linked to energy planning activities for the state of São Paulo; to CESP, the state electricity utility company; as well as to the Ministry. These and other university and research institutes play an important supporting role in many governmental activities, not only in the energy field. Because government bureaucracy is relatively small, and there is, in addi-

tion, some movement in and out of government by the staff of these institutions, they might be expected to continue to play a large role in energy analysis.

The structure for implementation of energy policy in Brazil is poorly defined. On the one hand, broad energy decisions in areas of pricing, taxes, investment, and other aspects of national economic policy for the energy sector lie within the jurisdiction of a strong central government. Yet, many of the important decisions are controlled by the state enterprises. For example, electric rate structures would be implemented through the individual companies, oil field development through PETROBRAS, etc. However, the situation here can become confused. ELECTROBRAS, for example, is a national holding company, and the state-owned electric utilities have considerable freedom. For example, CESP develops its own expansion plan and is considering purchase of the local gas utility and construction of coal gasification facilities, among other future alternatives. The utilities are thus free to pursue expansion as energy companies across a broad range of energy resources. The alcohol program in Brazil, on the other hand, has its planning and implementation focused in a single agency. This tangled web of institutional arrangements for implementing various aspects of energy policy, from resource development to pricing, is typical of most countries and need not pose serious barriers to coherent energy sector development. Far more serious is the lack of integrated energy planning.

## COSTA RICA[2]

Costa Rica provides a good example of the problems of energy planning and management in the small country case. Its institutional arrangements, as well as its energy problems, are typical. The economic life of the country centers on agriculture and a dependency on agricultural exports. Economic stability is closely tied to its external equilibrium. Recent experience has demonstrated a national vulnerability to fluctuations in international commodity prices, especially the price of coffee. The country is well endowed with energy resources and has a large untapped potential for hydroelectricity. There are also substantial reserves of coal and petroleum; however, their commercial value is not known. Forest resources are large but have been depleted at a very rapid rate in the past twenty-five years.

Energy resource consumption in 1978 was estimated to be $781 \times 10^{15}$ joules. Petroleum (all of it imported) accounted for 46 percent of this, with hydroelectricity accounting for 27 percent. Noncommercial energy resources (wood, agricultural wastes, and bagasse) accounted for the remaining 27 percent.

Given the preponderance of imported oil in its current pattern of

consumption, amounting to 5.9 million barrels in 1978, and expected to grow at an annual rate of approximately 4 to 6.5 percent (depending upon assumptions about growth), petroleum consumption is expected to reach an annual level ranging from 12 to 19 million barrels in the year 2000. There is a high priority attached to energy policy measures both to improve the efficiency of energy use in the modern sector and to promote the use of indigenous resources, but the scope, as well as the scale, of effort required by such policies is complicated by the current pattern of consumption and the sources of anticipated growth in demand.

The vast bulk of oil consumption (57 percent of the total) currently arises in the transportation sector. Thermal electricity generation accounts for a significant 16 percent of current oil consumption, followed by industrial demand for oil which accounts for 23 percent of the total, with the remainder accounted for by residential and governmental uses. The demand for diesel fuels in transportation has grown at a particularly rapid 15 percent annually. Much of this growth is accounted for by the rapid growth in demand for truck transportation. The demand for gasoline in private automobile transportation has grown at a modest 4 to 6 percent annually. Furthermore, while most residential energy demands have been satisfied by electricity and fuel wood, there has been a rapid growth in the demand for LPG, which has grown in recent years at an annual rate of approximately 17 percent.

It has been estimated that 80 percent of all households in Costa Rica have access to electricity. Residential electricity use accounted for approximately 49 percent of the total 1839 GWH of electricity generated in 1978. Industry accounted for about 33 percent of electricity demands in 1978, while commercial and government demands accounted for the remaining 22 percent. While residential demand is unlikely to grow much more rapidly than population growth, industrial and commercial requirements will combine to lead demand upward at an approximate annual rate of 7 percent. Thus, electric demand in the next decade is likely to grow at an annual rate of 9 to 10 percent. About 90 percent of current electric generation is hydroelectric.

The importance of noncommercial energy sources has already been referred to. Of the 14,863 terajoules of estimated firewood and agricultural wastes consumed in 1978, the largest share (53 percent) went to serve cooking requirements in urban and rural households. Half of rural households are estimated to rely on such fuels for cooking. Noncommercial fuels are also important in industry, which consumed approximately 47 percent of the total firewood and agricultural wastes consumed in 1978.

Energy planning in Costa Rica will have to respond to the need to reduce its reliance on oil, which emerges as the most pressing of its present problems. It is also clear that a policy to control fuel wood use

must be coordinated with demand management measures to control the use of oil, if new difficulties are to be avoided. There is also a need to explore systematically the technical options with Costa Rica's available resource potential. The ability to implement chosen strategies will also require financial and economic assessments and policies that ensure that projects, once undertaken, will be completed.

A rational pricing policy must avoid the pitfalls of Costa Rica's recent experience. In the effort to reduce oil consumption, recent measures raised the price of gasoline (to $2.00/gallon) but left the differential between diesel and gasoline at 100 percent (diesel sells now for $1.00). The net result has been a rapid expansion in diesel demand, without a large overall reduction in crude requirements.

Costa Rica lacks a well-established structure for plan formulation and implementation, but the urgency of its energy problem has prompted taking some initial steps towards integrated energy sector planning. Evidence of this is found in the creation by presidential decree of the Comisión Nacional de Energía in 1979. The commission includes the ministers of public works and transport, agriculture, and economic affairs; the chief executive of the Instituto Costarricense de Electricidad (ICE), the main supplier of electricity in the country; the director of the national oil refinery, Refinador Costarricense de Petroleo (RECOPE); and the director of the national planning office, Oficina de Planificación Nacional y Política Económica (OFIPLAN). The private sector is represented on the commission by nominated delegates from the chambers of industry and commerce, Camara de Industrias and Camara de Comercio.

The National Energy Commission is empowered to take steps leading to the formulation of medium- and long-term energy policy measures, culminating in a national "Plan for Energy Development"; the estimation and exploitation of national energy resources, including new and renewable resources; the controlled growth of rural energy use; the development of medium- and long-term energy demand projections; and the establishment of a national energy information system to be integrated with the existing National Information System. The creation of the National Energy Commission provides a much-needed forum for a systematic discussion of energy options. Its establishment does not, however, represent a sharp break with the past. This will require a national institutional structure to implement plans.

It is often the case in developing countries that the activities of the electric utilities have gone beyond providing reliable electricity supplies from a central grid. They have been the principle source of all energy data and their activities have sometimes included the investigation of fuels other than electricity. Since electric utilities are often publicly owned enterprises, well-endowed with both financial and manpower

resources, it has frequently been possible to justify and expand their activities in the energy sector as a whole. ICE's emerging role fits this pattern. Since its establishment in 1947, it has extended its activities to include the collection of energy data, the projection of energy demand, and the development of domestic resources including nonconventional (e.g., mini-hydro and geothermal) resource exploitation. In August 1979 it conducted a study of nonconventional energy sources including an estimation of the national potential for biomass exploitation. Their inclusion in the National Energy Commission will serve to benefit the implementation of national energy plans. But given the interdependencies inherent in national energy planning, other institutional structures will have to be created.

In the case of Costa Rica, institutional needs in energy planning have more than usual significance. The experience of national planning in general is limited to the activities of OFIPLAN, which has been in existence for a little over ten years. Its past record suggests a relatively ineffective role. Planning has been construed to mean little more than the preparation of broad projections of sectoral trends to provide government with necessary background information for economic policy. OFIPLAN has not had a mandate to develop and implement medium- to long-term plans. In the absence of a national commitment to develop such plans there is no reason to expect that the creation of a National Energy Commission will alter the status of planning in the energy sector, beyond providing policymakers with informed guidelines for action.

## PERU[3]

Among Latin American countries, Peru occupies a middle ground in the spectrum of development with per capita income estimated, in 1977, at approximately $US 748. In 1977, the service sector accounted for 48 percent of GDP, followed by manufacturing and construction, which accounted for 30 percent of GDP, with agriculture contributing 13 percent and mining 8 percent. The significance of agriculture in the economy far outweighs its contribution to national income, providing jobs for 40 percent of the labor force.

Energy policy in Peru is likely to be shaped by the country's dominant economic problems. Agricultural output has been stagnant. Therefore, raising productivity will undoubtedly be an important focus of economic policy in the foreseeable future, especially since food production has lagged behind population growth and placed a serious burden on the balance of payments. The mining sector, while small in terms of aggregate domestic production, has been a key economic sector historically, contributing a large share to Peruvian exports. In 1977, mining accounted for 54 percent of all export earnings. The development of

mineral production is likely to continue as important in future development plans, with focus on downstream mineral processing to increase domestic value added. Among industries, food processing, followed by chemicals production, metal fabrication, and textiles are important subgroups. The expansion of the industrial sector will, undoubtedly, be emphasized in future development policies to lessen the severe problems posed by Peru's external disequilibrium. Among the major economic sectors, growth of the manufacturing industry in the most recent decade has been among the most consistent, the exception being 1977, when Peru's international disequilibrium triggered a severe recession. In the period 1970–76, Peru's economic growth was at an annual rate of approximately 6 percent. In 1977, however, negative growth rates were experienced in most sectors with the exception of mining.

While the most recent indicators suggest a recovery from the experience of declining growth rates, Peru's economic situation is still characterized by high domestic inflation and slow growth in employment. These factors, in combination with population growth, have made severe inroads into per capita real income. In the foreseeable future, Peru's economic policies will continue to be shaped by the large external debt, which burgeoned from $1.6 billion in 1973 to $8.3 billion in 1978, with debt service payments amounting to over 40 percent of foreign exchange earnings. The crisis of 1977–78 was followed by debt rescheduling arrangements that alleviated the immediate crisis. Peru's economic future will continue to be dominated by the structural conditions that have contributed to its adverse external payments situation.

The most recent national energy assessment data for Peru show that between 1965 and 1976, total energy resource consumption grew at an annual rate of about 3 percent to reach 538,000 terajoules in 1976. Per capita consumption ($34 \times 10^9$ joules) was relatively stable in this period.

Noncommercial fuels account for an estimated one-third of total energy consumption. Firewood is the principal component of these fuels and is the only source of energy for about 40 percent of the population. Bagasse is an important fuel for cottage industry and for the sugar industry. Oil is, by far, the most important commercial fuel, accounting for almost three-fourths of total commercial fuels consumed, which have grown at an annual average rate of 5 percent. Transportation and industry accounted for almost three-fourths of the 41 million barrels of oil consumed in 1976 (46 percent and 28 percent, respectively). Oil was also an important fuel for households, where kerosene provides almost three-fourths of urban household cooking needs.

Domestic production of oil in 1976 accounted for two-thirds of oil demands. Peru's presently identified reserves of oil are estimated to be 815 million barrels. Domestic production in 1978 was approximately 59 million barrels. Annual production has already peaked, and it is esti-

mated that currently producing oil fields will be depleted by the year 2000. With adequate exploration and expansion of its measured reserves in this period, however, it has been estimated recently that annual domestic production could expand to a rate of 116 million barrels per year.

Electricity provides a little over 8 percent of commercial energy demands in Peru. Its consumption has grown at an annual rate of 6.5 percent, reaching a total level of 8000 GWH, and an installed capacity of 2,516 megawatts, in 1976. Electroperu, the state-owned utility, is the main supplier of electricity. It owns over one-half the installed capacity; most of this (56 percent) is supplied by Peru's very large usable hydropower (estimated at 58,239 MW). Most publicly supplied electricity is provided through twelve unconnected transmission and distribution grids, to be integrated in the future into three separate grids. Self-generation of power by industrial, mining, and agricultural enterprises is significant; over 40 percent of installed capacity in the country is self-generating and this is largely oil-fired electricity generation.

Most of the current consumption of electricity (58 percent) arises in the industrial sector. Industry is concentrated in the vicinity of Lima, which accounted for about 47 percent of the regional distribution of electricity. The remainder of current demand arises principally in the residential sector (accounting for about 37 percent of the total), the balance being accounted for by agriculture.

In the absence of major policy initiatives, Peru's energy consumption will grow from a current level of $538 \times 10^{15}$ joules to $1318 \times 10^{15}$ joules by the year 2000. Among fuels, oil will remain the most important by far, with growth in this period expected to occur at about 4 to 5 percent each year. According to recent estimates, oil's contribution to total energy consumption by the year 2000 will be approximately 59 percent.

Given the uncertainties of additions to recoverable oil and of exploration, Peru's future rate of oil production is difficult to predict. The continued growth of oil requirements over the next decade will, therefore, require policies that stress fuel substitution strategies and the search for more efficient patterns of fuel use. A likely emphasis will be to increase the use of domestic coal resources, of which much is currently untapped. This task will rely on conventional technologies but will also examine the use of new processes such as coal liquefaction. Renewable resource technologies will also be explored. Currently, a large hydroelectric potential exists, and, even in the absence of a major acceleration in the pace of its exploitation, hydroelectric generation will probably grow in importance, perhaps to a level of approximately $300 \times 10^{15}$ joules, from its present level of about $75 \times 10^{15}$ joules. In addition, Peru has significant geothermal reserves, and there is scope for a more systematic use of its biomass resources. While the country's future options

are considerable, all of these policy efforts will require an integrated approach. Such a view emerges from a realization of the size of the financial effort required. Without exception, all strategies to reduce the country's reliance on oil will require large investments in a period when capital resources will generally be in short supply. In the period 1978–2000, total capital costs for an adequate level of energy supply has been estimated to be approximately 14 billion dollars. Implicit in this calculation is an average annual investment level of $600 million, about one-third the 1978 total for all national investment. The magnitude of the economic task at hand is enormous, given the realities of Peru's historical external disequilibrium. Recent years have seen domestic investment substantially exceeding national savings, deteriorating balance of trade, and growing reliance on external borrowing. Clearly, these factors emphasize that Peru's priorities will necessarily require a very careful and planned approach to solutions if there is any practical hope for realization of policy initiatives.

While its recent economic past seems to have had all the elements of severe economic instability and problematic growth shared by so many other Latin American economies, Peru's institutional structure for planning is atypical. On any comparative scale of evaluation, the country's ability to formulate and implement economic plans must be ranked as among the most advanced in Latin America. In the period after 1968, a well-articulated national planning system (Sistema Nacional de Planificación) emerged capable of formulating medium-term and biennial development plans. The Instituto Nacional de Planificación (INP), the national planning office, has ministerial power among government agencies. It is the central planning agency of government. In addition to overall plan formulation and the monitoring of aggregate and sectoral plans, it produces biennial budgets and oversees the fiscal implementation of all plans. INP is, therefore, an agency with broad planning powers.

National energy plans have been formulated in Peru as part of its national development plans. Since 1970, these have included the quinquennial plan of 1971–75, and the biennial plans of 1971–72, 1975–76, and 1977–78. Sectoral plan formulation and implementation is the responsibility of the Oficina Sectorial de Planificación in the Ministerio de Minas y Energia overseeing the various operational agencies and enterprises of the energy sector.

It is significant that Peru, quite early, gave recognition to the need for *integrated* planning in the energy sector, conducted within the framework of INP. In 1978 a major national energy "assessment" was conducted jointly with the United States Department of Energy. That assessment attempted, for the first time, to explore broad strategic options for the energy sector within the context of Peru's development objectives

and trends. This assessment explored the current structure of Peru's energy demands and its energy resource base, and developed an integrated view of future energy supply and demand patterns. It included an examination of a number of policy options: the greatly expanded use of renewable resources, the increased use of coal and hydropower, as well as the potential for increased efficiency in the use of fuels. It explored the potential for more efficient use of energy in the industry, transportation, residential, and commercial sectors. It also examined the use of traditional biomass fuels and the potential for their increased use. In general, the assessment did not make specific recommendations. However, it concluded that with adequate planning and implementation starting immediately, Peru's energy future would not necessarily be crisis-ridden, in spite of the array of current economic difficulties. It recommended, in addition to the establishment of comprehensive planning, a regional approach to planning issues and a greater stress on coordination and implementation.

The assessment has added stimulus to the development of a long-term energy plan, with a plan horizon to the year 1990 and perspectives extending to 2000. The plan is oriented to the goal of energy self-sufficiency. Immediate emphasis is placed on the expansion of coal use for electricity, intensified exploration for oil, and demand-management. A set of detailed prefeasibility studies and techno-economic surveys are to be conducted prior to the formulation of investment plans in nonconventional technologies.

Plan implementation has, in the past, been hampered by a set of factors not unusual in the context of most developing countries. These include scarce financial resources and an insufficient organizational and technical capacity among the main implementation bodies, the public enterprises—Petroperu, Electroperu, Mineroperu, Centromin, under the Ministerio de Minas y Energía. They also include the absence of systematic information management. But, with the heightened consciousness of these impediments following the energy assessment of 1978, and with a commitment by government to strengthen the planning process, these impediments are amenable to gradual solution.

## JAMAICA[4]

Jamaica's energy problem is dominated by its virtually complete dependence upon imported oil. Petroleum products account for 90 percent of current energy consumption. Projections for the 1980s suggest the import costs for petroleum will amount to more than $500 million per annum, more than twenty times the annual cost in the early 1970s. At present, oil import cost is already 28 percent of total export earnings. The external debt problem has undergone a severe deterioration in re-

cent years, due in large part to the price increases for oil imports. These factors, coupled with national dependence upon export earnings of bauxite and alumina, create intense pressures for the planned development of the energy sector.

Current per capita energy consumption is among the highest in the developing world, and stands at 50 billion joules per capita. However, energy use is concentrated among a few sectors. Half of all petroleum fuels are consumed in the bauxite-alumina industry and another 18 percent in electric power generation. Energy costs in the bauxite-alumina industry are now nearly half its foreign exchange earnings. Hydropower supplies less than 15 percent of electricity while the remainder is oil-fired generation. Consequently, great significance is attached to energy conservation and to the search for alternative energy resources.

Domestic energy resources in Jamaica are limited, yet promising. The Blue Mountain hydro project should add 65 MW of electric generation capacity by 1985, and other sites remain to be developed. The utilization of reserves of peat is under study. The Jamaica Petroleum Corporation was formed recently to pursue on-shore and off-shore exploration for oil and gas, though the uncertainty of reserves estimates makes difficult any prediction of the results of this effort. Given the location of Jamaica, solar energy is among the potential fuel sources of the future, but the economic viability of solar technology is questionable except in the long term. A recent assessment estimated that aggressive development of these domestic energy resources might reduce by one-third the demand for oil. But, energy conservation is expected to play the largest role in reducing oil consumption in the shortest possible time.

For this reason, energy policy has focused on a series of detailed energy audits aimed at quantifying the potential for energy conservation. This effort has been implemented through a program of energy end-use surveys in the six major demand sectors—household, tourism, industry, trade, agriculture, and transport; the first two have been completed. Each survey includes a detailed inventory of energy conservation practices to improve the basis for projections of future energy requirements. A National Advisory Committee on Energy Conservation assists the Ministry of Mines and Energy in the direction of these programs, which affirms the priority given to energy conservation for control of oil imports.

The organizational efforts to implement these policies began in an energetic fashion. Most energy planning activities are centralized in the Energy Division of the Ministry of Mining and Natural Resources. The Ministry is responsible both for the assessment of energy demands and for the integration of efforts to expand the use of domestic energy re-

sources. The Ministry has, in the past two years, conducted a series of preliminary assessments to evaluate the extent of domestic energy resources and to document the potential for energy conservation. A National Energy Accounting System was established to facilitate the collection, integration, and dissemination of energy information and to serve as the basis for preparation of planning reports for the energy sector in Jamaica. Recent administrative actions in the energy sector include elimination of a variety of price subsidies, restrictions upon the import of private automobiles, and initiation of a low-interest loan program through the Jamaica Central Bank to fund recapitalization in industry for energy efficiency improvements. A National Energy Commission for discussion of broad issues of energy sector policy is also part of the overall energy establishment in Jamaica.

As yet, Jamaica has not developed a comprehensive policy for the management of energy demand and future development of domestic energy resources. But, given the momentum of activity in establishing national energy priorities, it is likely that Jamaica will move rapidly towards integrated energy sector planning in the very near future.

## COLOMBIA[5]

Per capita energy use ($20 \times 10^9$ joules per capita) and the percentage of commercial fuels in total energy consumption (65 percent) in Colombia are virtually the same as for Brazil. However, both the energy situation and the economic structure of Colombia are substantially different. Agricultural export earnings in Colombia are large. This sector is modernized and contributes 26 percent to domestic product. Heavy industry is less prevalent, but substantial light manufacturing is present. The urban fraction is 70 percent, with concomitant heavy energy demand for transportation. In rural areas, substantial numbers of people remain subsistence farmers, outside the commercial economy, and rely upon noncommercial fuels. Economic stability has not been impaired by rising oil prices since Colombia is self-sufficient in oil production. In addition, energy import costs for other fuels total only 2 percent of national export earnings (whereas in Brazil energy import costs, including oil, are 43 percent of export earnings).

Colombia has abundant energy resources. Estimates suggest 70 percent of South American coal lies within Colombia. This coal has very low sulfur and ash; it is premium grade on the world market. In addition, the deposits are in substantial seams near the surface and are found in the northeast coastal region. At present, coal supplies 18 percent of domestic energy requirements, including a third of electricity generation. On-shore and off-shore oil deposits are found in the areas bordering Venezuela. Domestic oil production meets present needs but

may become somewhat deficient toward the middle 80s. Hydropower resources are large; with two-thirds of current electricity generation by hydro, still only 3 percent of potential sites have been developed. A part of the rural improvement program looks to small-scale hydro to supply needs in more remote areas, as well as a more traditional grid expansion to achieve rural electrification. In-country prices for oil products and coal have been modest by world standards, encouraging rapid growth, particularly in gasoline use for private transportation.

The absence of an oil import requirement has, in large measure, isolated Colombia from many of the economic ills brought on by oil price escalation. Its energy planning and management issues stem more from resource development than demand management. For example, about half of the oil exploration and field development has been carried out by private companies. Oil potential is thought to be large, but exploration has been limited. A new government initiative in exploration will invest $US 3.5 billion for some two hundred holes over the next ten years. Coal development requires large investment, especially in infrastructure for distribution, if it is to become widely used. The relative merits of premium coal for domestic use versus export commodity is a central planning question. Pricing policy to establish patterns of consumption consistent with the economic value of domestic resources is of fundamental concern. For example, electricity is expensive yet large hydro capacity, a low-cost source, remains. Two-tier pricing of gasoline subsidizes its use as a cooking fuel by the urban poor, while commercial production of charcoal is under consideration. Without the economic isolation found in the oil importing developing countries, Colombia still must balance the energy needs of a growing economy with the mix of indigenous resources and investment requirements to realize their use.

The government structure for energy planning and management is more established and integrated than elsewhere. The Departamento Nacional de Planeación includes an energy division on a par with those for the natural resources, communications, and transportation sections. The Ministerio de Minas y Energía maintains a planning division, with a comprehensive national perspective, which reports directly to the vice-minister. The Ministry and national planning department officials seem to have better knowledge of each other's activities than is found elsewhere. Together, these groups have produced studies of coal development strategy, national energy supply-demand balance, and pricing policy. Economic stability and abundant resources permit a less crisis-oriented approach and a longer term view of energy economic planning in Colombia.

## REGIONAL INSTITUTIONS

Recognizing the serious nature of the energy situation in Latin America and shared concerns with continuing economic growth, regional energy planning groups have formed within, or as adjuncts to, existing organizations. The Organización Latinoamericana de Energía (OLADE) was established by Central and South American member states to facilitate the exchange of information and prepare joint energy policies, where appropriate. Funding comes directly from sponsoring governments for a small staff located in Quito. Three program areas have been undertaken: (1) the preparation of energy supply/demand balances and projections for the region, in conjunction with publication of an annual statistical report; (2) a look at alternative energy sources (solar, geothermal, mini-hydro, etc.) and their contribution to regional energy needs; and (3) a proposed study of capital- and energy-intensive industry development. Notably OLADE does *not* touch upon issues such as cooperative oil exploration agreements, joint hydro or other project development, or other aspects of regional planning. While member governments feel the need to explore regional cooperation in energy matters, their restricted mandate for the organization and limited funding emphasize their reluctance to permit regional concerns to assume more than a minor role in pursuing their individual national courses in energy and economic development.

The Caribbean Regional Economic Community (CARICOM) for economic and trade coordination recently established an energy unit at the suggestion of its foreign affairs ministers. The fourteen-country organization maintains headquarters and staff in Georgetown, Guyana, which support regional analysis of issues to be discussed at biannual meetings of the Council of Ministers of Trade. The secretariat of CARICOM will be the focus of regional energy policy. Since most countries are small primary exporters, there is more common ground for cooperation in energy management and a longer history of individual countries working in common through CARICOM on other than energy issues, both of which are expected to facilitate true regional planning. At the same time, individual countries like Jamaica have established their own energy analysis units. Regional research and development on energy technology, industrial conservation, transportation, etc. will be sponsored, in part, through collaboration with the Carribean Development Bank. Whether this multicountry institutional arrangement can create regional energy policy remains to be seen, but the sharing of common energy-related problems would seem to favor this step.

## REQUIREMENTS OF INTEGRATED ENERGY PLANNING

The discussion of energy management problems in a number of specific countries serves to illustrate the complexity and range of planning problems. Generally stated, these can be reduced to a few key issues involving the ability of countries to examine future energy requirements and to take adequate steps to meet these future needs. Some of the concrete issues that such planning efforts must address involve: (1) the ability to make investment analyses for capacity expansion; (2) the adoption of a rational pricing policy for fuels that can lead to a realistic valuation of resources and serve particular fuel consumption objectives; and (3) the provision of necessary long-term direction to demand management without obstructing established developmental objectives.

Such a characterization of planning needs is not unique to the energy sector. However, the importance of establishing a planning structure in the energy sector is made more urgent for two reasons. First, the international oil supply situation impinges most heavily on many developing countries, whose balance-of-payments condition is rapidly deteriorating under the burden of higher oil import costs. Second, almost any response that attempts to develop alternative energy supplies to substitute for imported oil, whether these involve the substitution of hydrocarbons, biomass, or renewable energy resources, requires a minimum of ten to fifteen years to implement. Given the pervasive interdependence of energy and economic development, even the most preliminary steps to develop a planning structure will alleviate future difficulties.

Planning in the energy sector will depend, to a considerable degree, on the ability of countries to undertake a planned pattern of development in general. However, a minimum first step towards energy planning involves the conduct of national energy assessments. Such assessments generally represent a preliminary stage in the formulation of detailed national energy plans. They require that the policy options facing planners be outlined and examined in an *integrated* framework that outlines the range of desirable policies for the future, rather than predicting the future. The process may take the form of schematic scenarios that take into account a range of possible futures over the time scale that is of interest and that explicitly analyze the wide set of programs and policies that may be of interest to decisionmakers. Such policies might include those designed to reduce energy demand in a group of end uses, to improve conversion efficiencies, or to accelerate the use of new technologies and renewable resources, to mention some examples.

The development of a national energy plan must serve to support national economic and social objectives. Therefore, the assessment pro-

cess here must begin with the recognition of these goals and their related impact on population growth, income distribution, patterns of urbanization, and industrial and agricultural change. Such an examination requires relatively extensive information on energy use, demographic patterns, and the structure of economic activity. The assessment process can usefully employ numerous types of modeling exercises to examine these interactions and changes. Many factors other than those that can be easily quantified also must be taken into account if such assessments are to be useful.

The first step of the analytical process is to formulate a scenario of the future evolution of the overall energy system. One such framework that has been found useful in the context of the assessment process is the Reference Energy System (RES) approach, first developed for use in the United States and other developed countries.[6] This approach utilizes a network overview of the national energy system to examine future energy resource requirements in relation to alternative patterns of sectoral demands. It also allows the construction of future scenarios based on alternative assumptions regarding the use of new technologies, fuel substitution possibilities, and the impact of policies such as pricing measures and conservation. Energy assessments based upon this approach have been conducted in Peru, Brazil, and the Dominican Republic. A number of additional countries are soon likely to embark on similar efforts.

A major institutional obstacle to be overcome in order to implement such an integrated approach to plan formulation is the absence of adequate technical expertise. For this reason, specialized training in the techniques of energy systems analysis has become the focus of several recent international and local initiatives.

One such effort, conducted with U.S.A.I.D. support, is the Energy Management Training Program at the State University of New York. The program consists of a two-month intensive course on the broad spectrum of analysis skills required for energy analysis in developing countries. Over the last three years, one hundred fifty individuals from ministries, economic offices, and other organizations in fifty developing countries have attended the course. Latin American participation has been significant, including officials from Peru, Colombia, Chile, Brazil, Jamaica, Nicaragua, Mexico, and Haiti, among others. The program includes an introduction to the role of energy in economic development, energy analysis techniques, resource assessment in both fossil and renewable fuel areas, electric capacity planning, pricing policy, demand management, and energy sector investment and finance.

More important, perhaps, are efforts being undertaken within the region itself to establish local energy management and training activities. A discussion of regional needs has been initiated in OLADE. In

addition, Fundación Bariloche, a research institution in Argentina, offers a regional energy sector course. COPPE, at Universidade Federal do Rio de Janeiro, and other Latin American universities are beginning to offer energy planning courses, in addition to their direct participation in the energy studies noted earlier. The expansion of in-country training will continue and offers the best chance of meeting the coming need for large numbers of professionals in the energy field. In many instances, individuals from these university or research institutions (Bariloche, COPPE, etc.) have visited at the State University of New York at Stony Brook or the National Center for the Analysis of Energy Systems at Brookhaven National Laboratory to exchange ideas on energy planning techniques, and vice versa. A one-week intensive introduction to national energy planning and selected energy resources was held in Brazil. These kinds of formal and informal interactions can be expected to increase as Latin American nations more forcefully approach the question of integrated energy sector planning.

There are many additional obstacles to the successful evolution of energy planning and management. The ability to undertake integrated assessments yields only the broad outlines of alternative strategies. A strategy, once selected, must be translated into implementable plans. This second step will generally require detailed analyses of particular energy demand and supply options, leading to the selection of projects; or, in the case of a more indicative approach, to the selection of well-articulated policies for implementation. The successful implementation of plans depends upon careful project preparation involving a range of organization and skill requirements lying beyond the scope of this brief review. Most of the countries surveyed in this paper have all taken preliminary steps to strengthen the organizational infrastructure for energy planning. However, it is too early to judge the success of these efforts, which will depend as much upon the ability of governments to implement as upon their ability to formulate policy.

## A COMMENT

Finally, we must attempt an objective evaluation of the success of energy planning efforts thus far. An overriding element in the success of energy planning is the political strength of the energy analysis group itself. Where such groups have direct access to those agencies and individuals making key decisions on capital investment, foreign borrowing, and other factors of economic planning in their nation, energy planning has taken hold. Secondary to the internal workings of government are questions of data availability and analysis. For much of the decisionmaking related to the energy system, data needed to make rational decisions may require some survey work and other types of data information

gathering, but this is not of such a nature that it would either require extensive periods of time or present an insurmountable barrier to analysis of energy policy. More important is the balance of internal to external interest in energy analysis. The capital-intensive nature of energy system development requires substantial cooperation of the major lending institutions, such as the Inter-American Development Bank. As a result, many countries undertake energy studies primarily to satisfy the needs of international assistance or lending agencies.

Peru is one example where energy planning activities have not been successful. The major incentive to the national energy assessment was the United States Department of Energy joint study, which included most of the funding. However, it might be expected that a country would expose its energy sector only when it anticipated some value in terms of follow-up aid. Such was not the case in Peru. And national integrated energy planning has not really taken hold for several reasons. First, the United States failed to convince Peru that the energy study was a substantive activity and firmly connected with future assistance or lending activities. Second, the study itself did not recommend much beyond what was current policy in such fields as hydropower development. Last, the study was undertaken under the previous government and has been largely ignored by the new regime. Separate planning agencies for oil development and for hydropower development are economically and politically strong and so yield their power to an integrated energy planning activity only with great reluctance. For all these reasons, the Peru energy assessment provides an extensive base of data and information on their energy system, but has resulted in little in the way of either interest in integrated energy planning or project development that might not have occurred otherwise.

Jamaica, on the other hand, is a sharp contrast. Through funds from the Inter-American Development Bank, the United Nations Development Programme, and the Jamaican government, a national energy assessment was carried out. Of course, since the nation is completely dependent upon oil imports and is now experiencing severe balance-of-payment problems because of higher oil prices, it might be expected that the government would be far more interested in energy analysis. An energy analysis group was formed in the Ministry of Mining and Natural Resources and now has individual staff responsible for such areas as industrial energy conservation, household use, transportation, and renewable resource development. The group has organized workshops on various aspects of energy use and conservation. A number of continuing energy resource assessments have been carried out. This year the Energy Division of the Ministry, along with two United States consulting firms, prepared a brief report of energy options for Jamaica and their specific impact, particularly upon oil savings and foreign exchange com-

ponents of capital cost, which are primary issues in the management of balance-of-payment problems. Prime Minister Seaga's personal interest in the issues demonstrates the priority placed by the government of Jamaica upon formulation of a national energy strategy. Whether such efforts can improve Jamaica's energy situation remains to be seen, but the interest and intent to improve the situation is certainly there. The ingredients for successful energy planning are clear—government recognition of the need for energy planning and interest and ability to commit the resources to carry it out. We hope these elements come together in the many Latin American countries that seriously need to undertake energy management.

## NOTES

*Sources for table:* Energy statistics were compiled from *Balanço Energéticos Nacional 1979* (Ministerio das Minas e Energia, Brasil), *Colombia Today* (Colombia Information Service, New York), *Peru/United States Cooperative Energy Assessment* (Brookhaven National Laboratory, New York), *Energy and Public Policy, 1970–1990* (Petroleum Corporation of Jamaica), *Energy and Development in Central America* (Energy/Development International, New York). Economic indicators from P. F. Palmedo et al., "Energy Needs, Uses, and Resources in Developing Countries" (prepared for the United States Agency for International Development by the Policy Analysis Division, Brookhaven National Laboratory, Upton, New York), March 1978.

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