REVISTA ENERGETICA

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Latin American Energy Organization

JANUARY - FEBRUARY 1982

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PUBLICATION OF THE LATIN AMERICAN ENERGY ORGANIZATION

REVISTA ENERGETICA
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PERIODICAL FOR DISSEMINATION

The new stage of action for the Permanent Secretariat of OLADE, especially with the approval and prompt implementation of the Latin American Energy Cooperation Program (PLACE), will also be reflected in this bimonthly publication, which as of this issue will no longer be known as the Energy Bulletin, but rather the Revista Energética de OLADE; and the English version of this energy review will be published under its Spanish title.

EDITORIAL

The framework of Latin American cooperation has progressively been acquiring characteristic features. The specialized organisms created since the last decade have been strengthening their field of action within their own specific areas, without losing sight of the interplay of their activities in the integral context of regional economic development.

In this regard, it is OLADE's task to promote solidarity of action among the Member States in order to preserve and develop the energy resources and capacity of these countries, as one factor in regional integration; and our institution has undergone an ever greater process of consolidation given that the Latin American energy problems have been affected more by political variables which have increased the external oil supply and its prices.

Aware that the regional energy problems cannot be solved in isolation, the Second Extraordinary Meeting of Ministers of OLADE (held in Lima, Peru, during March 6 - 7, 1981) approved the elaboration of the Latin American Energy Cooperation Program (PLACE) and, through Decision MME/D/077, instructed the Committee of Ministers to take the measures necessary for its prompt approval.

This Committee of Ministers —presided by Mr. Carlos Rodado Noriega, Minister of Energy and Mines of Colombia, and composed of Dr. César Cals de Oliveira, Minister of Mines and Energy of Brazil; Mr. Fernando Altmann Ortiz, Minister of Energy and Mines of Costa Rica; Mr. Hubert O' Jack, Minister of Energy and Natural Resources of Guyana; Mr. José Andrés Oteyza, Secretary of Patrimony and Industrial Development of Mexico; and Dr. Humberto Calderón Berti, Minister of Energy and Mines of Venezuela— aware of the responsibility entrusted to them, decided to provide the Permanent Secretariat with the guidelines and financial resources required for the preparation to the PLACE, so that the project could obtain the participation of recognized experts and institutions from the energy sector of the Member States, in order to produce a document that would reflect the technical, economic, and political will of the Latin American community.

The effort was not in vain, for the PLACE was indeed approved by the Twelfth Meeting of Ministers, which took place in Santo Domingo, The Dominican Republic, during November 13 - 14, 1981. This Program constitutes the political instrument on the basis of which priorities will be established for harmonious, coherent energy development; for financial cooperation; and for an assured oil supply —all to be framed within on-going integrationist activities in a South-South context.

In this Energy Review, OLADE presents a summary of the work that provided support for the elaboration of the PLACE, including work done by regional experts and contributions made by the official groups which collaborated with the Permanent Secretariat but which cannot be listed here due to a lack of space.

The aforesaid makes manifest the characteristics of the new style of cooperation to which we referred at the beginning of this editorial. To the degree that the program's implementation becomes a reality, it will supply the means to increase the region's technological capacity in terms of human resources and goods and services, thereby making it possible for energy development to directly strengthen the Latin American economy.

Finally, in closing, I would like to express how pleased I am that my first editorial as Executive Secretary has the purpose of presenting aspects of precisely that fundamental subject around which the work of this Permanent Secretariat will revolve during my administration.

ULISES RAMIREZ OLMOS

XII/D/086

THE TWELFTH MEETING OF MINISTERS

CONSIDERING

1. Decision EMM/D/077, of the Second Extraordinary Meeting of Ministers, regarding the formulation of the Latin American Energy Cooperation Program (PLACE), in accordance with the objectives and guidelines of the Lima Agreement and the Pronouncement of San Jose;

2. The report of the Committee of Ministers of the Twelfth Meeting of Ministers, as well as OLADE Document N° 15, related to the Latin American Energy Cooperation Program; and

3. The urgent need of Latin American countries to expand and diversify their energy supply, rationalize their production and consumption, and attain a growing integration between the production and use of energy,

DECIDES

1. To accept the Latin American Energy Cooperation Program (PLACE), and

2. To request the Permanent Secretariat to take the necessary steps for the immediate implementation of the Program.

November 13 - 14, 1981
Santo Domingo, The Dominican Republic.

THE PLENARY SESSION OF THE ANDEAN PARLIAMENT

C O N S I D E R I N G :

1. That the technological development of the subregion is subject to our energy capacity and its adequate utilization and

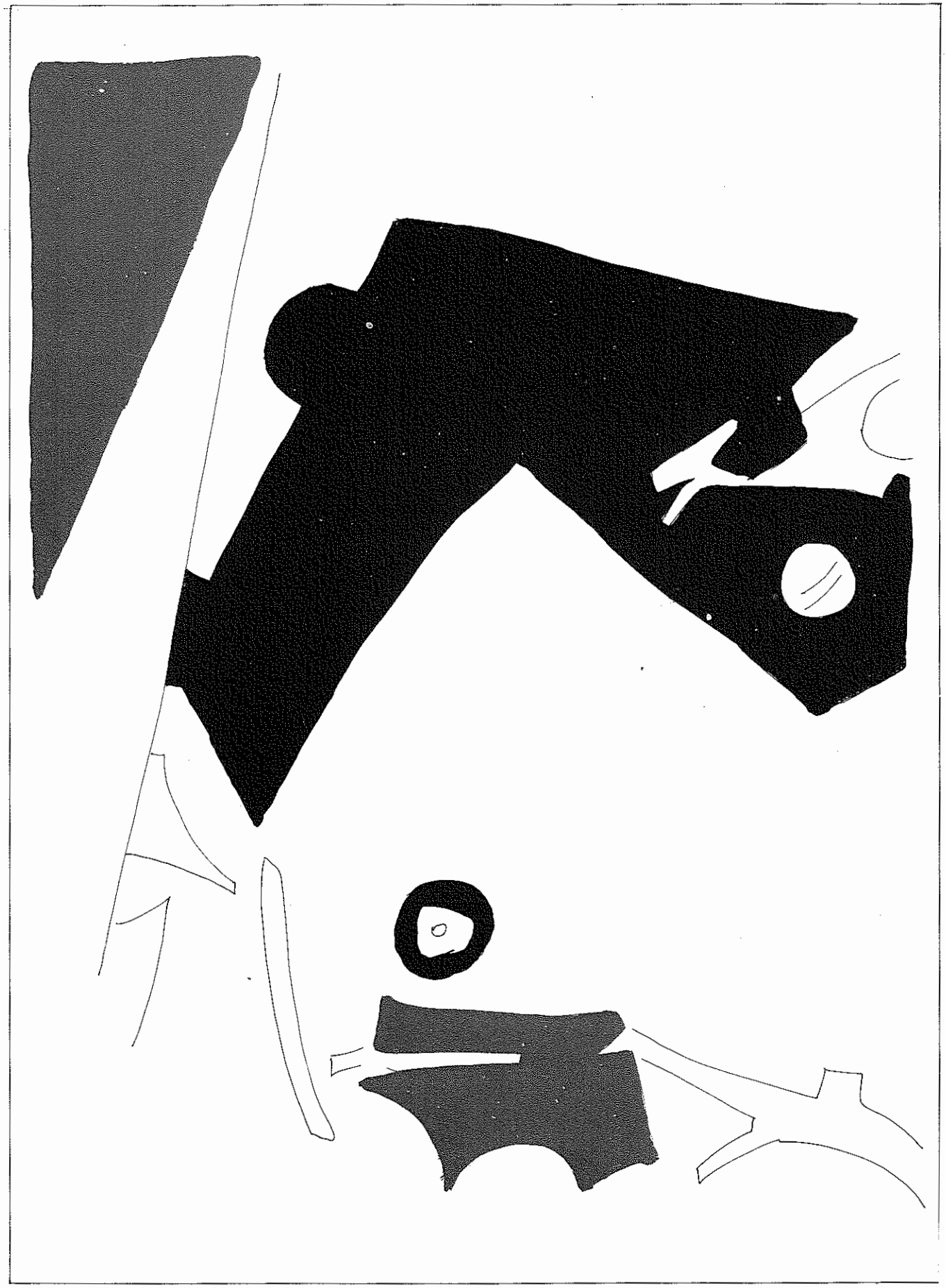
2. That the Latin American Energy Organization (OLADE) has elaborated a Latin American Energy Cooperation Program, which has been ratified by all the countries of the subregion,

R E S O L V E S :

1. To exhort the legislatures and governments of the member countries of the Cartagena Agreement to promote the Latin American Energy Cooperation Program and

2. To recommend especially the implementation of the political decision to establish a financial mechanism administered by OLADE, as a fundamental support for this Program.

Quito, December 18, 1980.



PERSPECTIVES OF THE P.L.A.C.E.

JAIME MONCAYO GARCIA

The Latin American Energy Cooperation Program (PLACE) constitutes a great challenge to the Latin American countries' capacity for action and to their decision to be protagonists in the orientation of their own destiny.

This is a particularly difficult and conflictive era, in which the law of the survival of the fittest prevails and in which obstacles have become greater for the development of our countries, both because of external factors originating in the current, unjust structure of world power and because of internal structural problems that encourage the concentration of wealth and opportunities, making it more difficult to create just, democratic, and independent societies. Nonetheless, the outlook for the future is optimistic when one considers that if we Latin Americans put aside our differences, we are capable of undertaking imaginative cooperation programs, giving renewed vigor to the principle of solidarity and joining forces to cope with the energy problems which undoubtedly figure among the most crucial ones confronting humanity now and in the future.

Even if important modifications are introduced in the current development models, it is unquestionable that the Latin American energy requirements will constantly increase since they are directly linked to economic growth, which is a vital factor in development. A growth rate similar to the historical one of nearly 6% annually, along-side a demographic increase of almost 3%, implies the doubling of energy consumption every ten years. Through the more rational use of resources, this magnitude can sustain a higher economic growth rate, which would be more desirable.

Therefore, guaranteeing the availability of sufficient energy has come to constitute one of the fundamental challenges for the countries of the region. This cannot be accomplished by merely continuing with old behaviors, by increasing the dependency on foreign capital and on the transnational companies, nor by hoping to obtain more resources from the sale of exports and thus permitting the importation of the energy required.

Neither is it socially nor politically acceptable to propose the freezing or reduction of energy consumption since that would mean consolidating and heightening the marginality and poverty of large national majorities.

It is imperative, then, to look to the natural, human, technical, and financial resources available in the Latin American countries, as a basis for energy policies.

This evident necessity has great political implications which are, in turn, the key to the success or failure of OLADE and of its most recent instrument, the PLACE.

In this regard, it is satisfying to note that the areas of cooperation in which it is proposed to implement the PLACE have been the object of careful selection, and they respond not only to priority needs but to viable purposes as well, without overestimating or exhausting the possibilities, only to be disappointed later by the wide gap between concept and action.

The planning and formulation of energy policies; the identification, development, and rationalization of the use of the energy resources; technological cooperation and the training of human resources; the promotion of a regional energy supply; and the necessary information, advising, and financial cooperation constitute areas that can make a contribution of fundamental importance to each and every one of the Latin American countries, in order to aid in solving their respective energy problems. The priorities will

be different for each one, a reflection of the different situations and levels that exist among them. This will oblige carefully balanced, dynamic programs to be carried out, contemplating with sufficient political will the interests of the countries individually and as a whole.

Without going into an in-depth analysis of each of the areas of cooperation, it is worth singling out that a change in attitude and behavior is imperative for the success of the Program.

There is an urgent need to diversify the energy sources and to reduce the growing dependency on oil. This will require substantially greater, more efficient efforts at prospecting for resources than in the past, gearing all of the available regional capacity in this direction, systematically and intensively, on the basis of the principles of solidarity and cooperation, without paternalism nor apparently philanthropic aid, in the search for an equitable distribution of benefits.

This will call for a change in attitude and an increasingly greater use of the regional capacity through various forms of associations and operations, to intensify the prospecting, exploration, and utilization of energy resources, in accordance with the physical availabilities of each country.

These fields have traditionally been controlled by the transnational companies of the industrialized countries, which have basically dedicated themselves to the development of abundant, easily accessible resources, in order to generate large surpluses and profits destined to their own countries.

The development of relatively modest resources, dedicated primarily to the satisfaction of internal needs, has not interested them. This policy is going to become even more accentuated in the future, given the imperative need to obtain increasingly larger flows of energy such as those of the more advanced countries.

Under these circumstances, the use of the regional capacity does not constitute a commercial preference but rather an urgent necessity that requires the adoption of equitable mechanisms and standards facilitating Latin American energy development while generating suitable profits for those who provide the necessary services, with the aid of financial facilities and duly shared risks.

This new attitude would at the same time contribute to technical and commercial development in the region and would create new lines of trade and financial relations; these will be fundamental in coping with the difficult prospects for the world markets. It can be particularly important for the less-developed countries and those with fewer resources, and more attractive for the more advanced countries of the region. A confluence of interests is then produced, coinciding with a stage in which unified efforts is one of the few ways to increase individual negotiating capacity and to generate one's own, independent solutions to the energy problem.

Will we be able to accomplish these changes in time? Can they occur without reproducing on a regional scale the phenomenon of the survival of the strongest or the schemes of domination that our peoples desire to transform? The answer to these questions requires the moral commitment of Latin America to create a new international order. Let's be optimistic. The approval of the PLACE offers new opportunities to Latin Americans, and it sets a good example for other developing countries.

THE P.L.A.C.E. AND LATIN AMERICAN COOPERATION

GUILLERMO MALDONADO LINCE

The most recent Meeting of Ministers of OLADE was held in Santo Domingo, the capital of the Dominican Republic, where the Latin American Energy Cooperation Program (PLACE) was approved. This program is geared to failitating the transition of the Latin American countries towards a new stage of energy production and consumption based on regional cooperation in this area which is so crucial for human destiny.

For more than two decades, Latin America has tried out many ways to strengthen regional cooperation. This is evident in the institutional structure that has been created at the level of both the public and private sectors. The objectives of all these entities are unquestionable. Public opinion has continously attested to the expressions of political backing that the governments have offered to the various entities and processes. There have never been any valid arguments to object to the efforts of cooperation and integration in our region.

Nevertheless, mutual cooperation has delayed in becoming a common tool to accomplish the objectives of national and regional development. The last three or four years have witnessed a process of relative deterioration in the validity of cooperation among our countries as one of the most viable means of strengthening our position in the international context so as to have an active participation in a worldwide reordering, which is occurring, like it or not.

If some of the recent events are examined in more detail, it can be seen that there have been political factors which have conspired —and which still conspire— against Latin American cooperation and integration. Theses rejected in the past have again become fashionable. The magic of the market as a unique factor in the designation of resources and in the solution of social problems is found alongside an externally more open regional market. Countries whose industrialization processes had maintained high protective tariff rates until recent years have now generously lowered these to levels below those of the industrialized countries, with unfortunate consequences for the industrial process, for the generation of employment, and for income distribution.

The programming of "key" industrial sectors of our countries by one group of them has also been the target of harsh criticism. Extra-governmental and extra-regional mechanisms have mobilized themselves vigorously to create obstacles to the implementation of this vital instrument, as in the case of Andean integration, for example. It is perfectly acceptable to look beyond a process of import substitution, even at a sub-regional level, and to consider the need to export, to grow beyond the limits of the sub-region itself. However, it is not acceptable to question the multilateral decision of several countries to promote the industrialization process, with the pretext of leaving all the market forces open to free play.

In August 1980, the so-called New Treaty of Montevideo took force, creating the Latin American Integration Association (ALADI), which substituted after two decades, the Latin American Free Trade Association (LAFTA). The multi-lateral trade relations on which the LAFTA was based was replaced by a tolerable bi-lateralism. A Free Trade Zone could not be created. After the drastic tariff reductions in some countries of the region and the downfall of the international monetary system, the commercial preferences lost much of their significance. The sad part, from several standpoints, was the fact that the validity of commercial cooperation among our countries was questioned without taking into account the future potential of such cooperation nor the fact that given the wave of protectionism that arose in the developed world, the Latin American market absorbed a good deal of what could not be placed on the markets of those countries.

The Latin American Economic System (SELA), whose founding document was signed in October 1976, attempts to strengthen Latin American cooperation and integration through the use of a variety of means, in order to promote the efficient use of our resources, to increase the negotiating power of the region with other countries or groups of countries, and to strengthen our voice and participation in international forums and organizations. Nevertheless, the historical process of the SELA has demonstrated that it is difficult to obtain a consensus in order to undertake vigorous, trascendental actions. SELA has had to cope with the passive view of some of the countries which are its members but not protagonists of its activities.

These few examples illustrate the fact that there has been a relative deterioration in regional cooperation as a valid instrument for the solution of the problems of our peoples, as is to be expected with the quite varied characteristics of geography, history, and culture. That is why the approval of the PLACE in Santo Domingo is an event of special political importance.

It is known all too well that "energy" and "food" figure among the most serious problems now confronting humanity and those to be faced during the upcoming years and even during the first part of the next century.

Someone from the academic community of the United States questioned the development possibilities of Latin America. He based his arguments on the fact that in order to attain the levels of development and social justice sought, all that is left for us to do is to utilize forty to fifty times the energy used by the industrialized countries to foster their rapid post - World War II growth. According to the argument, this will affect the possibilities for accumulating the capital required to enter on the industrialization stage. It is not only true that energy is now more expensive but is is also necessary to find new sources of renewable energy while rationalizing production and consumption. In no case can the solution be a lower energy consumption for Latin America, since our levels are below those prevailing in more advanced societies. The necessary amounts of energy must be consumed in order to achieve the goals and aspirations of our peoples; but, without doubt, a complex, costly, and difficult stage must be traversed in terms of energy and its indisputable ties to lifestyles, growth goals, and social aspirations.

The PLACE is an instrument for these transcendental purposes. A new international entity has not been created. In approving the PLACE, the member countries of OLADE have made it a mechanism apt for attaining the objectives of the organization - and, even more important, they have provided the program with seed capital originating in their own national resources. This makes manifest their willingness to cooperate and their recognition of the need to cooperate and of the fact that cooperation is not merely someting to talk about or a gratuitous act. Cooperation has a cost, and the Latin American countries have acknowledged that fact by approving a financial mechanism for the program.

In the midst of the prevailing situation and the prospects for the world economy, at least until the end of this decade, the approval of the PLACE marks a very special point in regional cooperation.

The Permanent Secretariat of OLADE and its Member States will be responsible for implementing the program during the coming years; and technology, financial resources, and political decision seem to be the key factors in the success that will crown the efforts begun in Santo Domingo.

ENERGY AND DEVELOPMENT

Synthesis of the Report prepared for the Latin American Energy Cooperation Program (OLADE) by

Dr. Alberto Méndez Arocha
OLADE Consultant

HISTORICAL TIES

Close ties have been established between a community's energy consumption and its degree of development, since the beginning of human history. In this regard, it has been affirmed that "the amount and type of energy used conditions Man's way of life in material terms and establishes certain foreseeable limits for what he is able to accomplish and for the way in which Society is to be organized..." 1/ Nevertheless, it should be pointed out that energy development, in turn, depends on society's degree of development and on its productive efforts.

Throughout history, "energy revolutions" have taken place, and these have modified the relationship between energy and economy. 2/ Without doubt, the most notable ones have been agriculture and the domestication of animals, which permitted the reproduction of "natural energy converters": plants and animals.

Later came the Industrial Revolution of the nineteeth century and the invention of machines driven by fossil fuels (coal, gas, and oil). This permitted the great expansion of recent times; and this type of industrialization in the Western economies was adopted by Latin America first on the basis of coal and then, more markedly on the basis of hydrocarbons.

Thus, the energy history of humanity has been the rise and fall of different forms of energy, in accordance with the technological and economic availabilities of each era. At present, we are living through the decline of the "oil era", a period of transition towards the utilization of new sources of energy.

As a result of the current structural ties between energy and development, Latin America has followed the patterns derived from the oil dependent way of life and industrialization which we have tried to copy and which, directly or indirectly, have been imposed upon us. This has led to commercial, industrial, and residential consumption schemes in the urban areas of the region, which have imitated the life-styles of the developed countries. Such dependency on hydrocarbons has been especially marked in the transportation sector.

Although there is a quantitative relationship between energy and development, expressed by the correlation between the GDP and energy consumption, it should not be assumed on that basis that the "anticipated energy supply" can, in and of itself, constitute a factor to promote development. To the contrary, it is generally accepted that "a relative abundance of energy in its different forms will not play a transforming role if it is not accompanied by other conditions, of a political and economic nature... 3/

In other words, the energy problem taken by itself provides an incomplete picture. Economic development is much more important than energy development, and the latter cannot exist except as a result of the former. Energy is no more than a derived demand, not an economic driving force, **per**

1/ COTTRELL, Fred. Energía y Sociedad. Buenos Aires 1958

2/ VARAGNAC, A. La Conquete des énergies. Paris 1972.

3/ See UNDP/UNEP/OLADE. Energy alternatives in Latin America. Study of capacities for utilization of non-conventional energy sources. OLADE, Quito, 1980, p. 345.

se, The prime movers of the economy are capital, work and technology.

As stated by Allen 4/ increases in the work and capital inputs and increased productivity historically have been the primary factors in economic development.

In the new contexts, however, the price of energy has been viewed as a "brake" i.e., it limits the importation capacity of the countries of the region. Previously, food and capital goods had traditionally constituted the limiting factors insofar as the use of income.

Even though energy as an input is not strictly a development factor in productive activities, it must be kept in mind that in terms of the capital goods industry it can have a great impact on the region's economic development, including multi-national projects based on suitable cooperation between the participating countries.

In Latin America, this is the case of the manufacture of heavy electric and mechanical equipment, of capital goods for the oil industry, and of equipment for non-conventional forms of energy. However, in these other projects, the incorporation of energy into national production depends on the availability of other equally important factors: capital and manpower.

As a result, there are no energy prospects except those derived from economic prospects —and the economic prospects for the Third World including Latin America, are not good. In other words, if the present **status quo** remains unchanged, we will become progressively poorer and the industrialized countries richer. This situation will not be tolerable in many countries, especially due to the increasingly dramatic situation of their foreign debts.

4/ Allen E. L. **Energy and Economic Growth in the United States** The MIT Press 1979.

The most important thing for Latin America is to have a system of international and regional economic relations which will permit its development. As is well-known, the current economic system greatly hinders regional progress. It would be of little value to have a magnificent program of regional energy cooperation without changes in the direction of a New International Economic Order.

It is within this context that the Latin American Energy Cooperation Program (PLACE) was formulated: energy cooperation, yes, but ensuring that our economies will survive in order to be able to comply with the energy cooperation plans. In other words, the PLACE is framed within a program of reforms in the current system of international economic relations; and it should serve as back-up for the circumstances and necessary reforms in the unequal systems that persist in the world's monetary, commercial, technological, economic, and financial realms.

Energy cooperation can undoubtedly contribute to reducing the difficulties of the economic system; and while we do not wish to exaggerate our stress on the macroeconomic problem, we do want to make one thing perfectly clear: our problems in the areas of housing, health, food and energy are not going to be resolved only by isolated efforts in those areas. All of these problems are derived from one single source: our poverty and the impossibility of our development in a world dominated by the industrialized countries. If there is no New International Economic Order, we will not have sufficient income to satisfy the needs of our populations; but if such an Order is consolidated, we will be able to undertake programs for the construction of homes and hospitals, we will be able to eliminate infant malnutrition, we will be able to import oil and wheat-each country in line with its national priorities.

GENERATING SECTOR OF PRODUCT AND INCOME IN THE ECONOMY

If energy is above all an input into production, then its effects on that production will be related to

its availability. Nevertheless, for some Latin American countries, energy is a product and even an export. Thus, a dichotomy is established between the countries of the region, as energy importers or exporters. For the former, energy is only an input in the national production of goods and services (measured by the GDP). For the latter, energy is also an export; and as in most developing countries, it is an export which is the major contributor to the country's income.

Thus, energy will affect production and income in two ways: as an input, when it is lacking or when its cost is a factor that affects economic progress (positively or negatively, as the case may be) and as a development factor in the formation of a capital goods industry to supply the various energy programs.

CRITICAL SECTOR IN THE BALANCE OF PAYMENTS

The fact that energy is known as the "critical sector" in the Latin American balance of payments arises from the fact that it is one of the accounts which has advanced most rapidly in recent years, further aggravating a situation which was already extremely critical.

The balance-of-payments problem in the developing countries can basically be explained by the weakness of their export sector. Their exports are unstable, constituted primarily by low-priced raw materials, while the manufactured goods that they import from the industrialized countries have increasingly higher prices.

Although the Latin American balance of payments has had a chronic deficit in its current account, the situation has become accentuated of late by increased prices for food, capital goods, and fuels. This has led to a serious debt for many countries and to difficult situations in those economies with limited access to the international money market.

In speaking of the Latin American balance-of-payments problem, aside from the oil bill (an average 20%), the impact of imported heavy equipment, most of which comes from industrialized countries, must also be kept in mind. At any rate, the chronic problem derived from weak exports must be taken into account. It is within this global context that a permanent solution should be sought for this situation where all the ills of the current international economic relations converge.

It is interesting to note that larger national debts are not exclusive to the oil-importing countries; rather, as always, they are a generalized problem among the Latin American and Third World countries.

Thus, a balance-of-payments cooperation policy should be designed for Latin America, whereby the energy factor would be considered within the framework of regional economic cooperation, preferably within a scheme to coordinate and compensate the various common interests of the countries of the region.

In terms of the balance of payments, the following actions prove beneficial.

— The substitution of imported equipment used by the energy industries, based on further development of the national and regional technological capacity.

— The substitution of fuel imports, based on the strengthening of the use of local resources, whenever possible.

— The promotion of "industrializing" energy industries.

The balance-of-payments picture would not be complete if we did not include its negative consequence: an increasingly higher foreign debt for the regional economies. This situation could even lead to bankruptcy for some Latin American countries.

CRITICAL FACTOR IN INFLATION

In the era of the 1973 oil price readjustments, the international press agencies launched a campaign to blame hydrocarbons for the world inflation which was experiencing accelerated rates during that period. This timely scapegoat was undoubtedly one element in the inflationary process, but only one of various.

Most authors 5/ coincide in attributing recent inflation (post-1972) to a set of factors mainly related to a lack of convertilibility in the most important international currency and to the resulting increase in international liquidity.

The years 1972-75 were quite unusual from several standpoints, any one of which would have been sufficient to cause a higher rate of inflation:

— The effects of the turbulent evolution of salaries in the developed countries during 1969-70, including accentuated disurbances in different categories of wages and salaries, along with pressure for higher margins of profit.

— The consequences of great alterations in exchange rates, at the end of 1971 and again in 1973.

— The incredible coincidence of strong recoveries in the United States and the rest of the industrial world, in 1972-73; and

— The exceptionally large external increases in world market prices for food and oil products, in 1973.

On the basis of these comments and the review of several studies on inflation, it can be concluded that there was a series of factors which worked together to dynamize price. One of these factors was the price of imports, where energy is not the most important element (capital goods is the most demanding).

INPUT IN PRODUCTIVE ACTIVITIES

It has been accurately stated that energy is "the blood of the economy"; for the physical definition of energy , "the capacity to do work", energy is the basis of the activation and movement of all the devices whose use is fundamental to economic operations in the domestic, commercial, and industrial sectors.

Consequently, energy is not extremely valuable to the economy, it is vital. Its absence causes great losses. Moreover, from the point of view of energy's participation in production costs, its value is much greater than its cost.

In the oil-importing countries of the region, where the costs of domestic energy are higher, the problem of input availability arises. In such cases, the saying "the most expensive kind of energy is the one that doesn't exist" holds true – especially in those sectors (transportation, agriculture, some industries, etc.) where the existing machines cannot be run on substitute fuels, as in the case of the internal combustion engines used in tractors, trucks, etc.

Under such conditions, a supply shortage can create serious bottlenecks in economic activities, modes of operation, and lifestyles, which then have to be adopted to new conditions.

5/ See for instance:

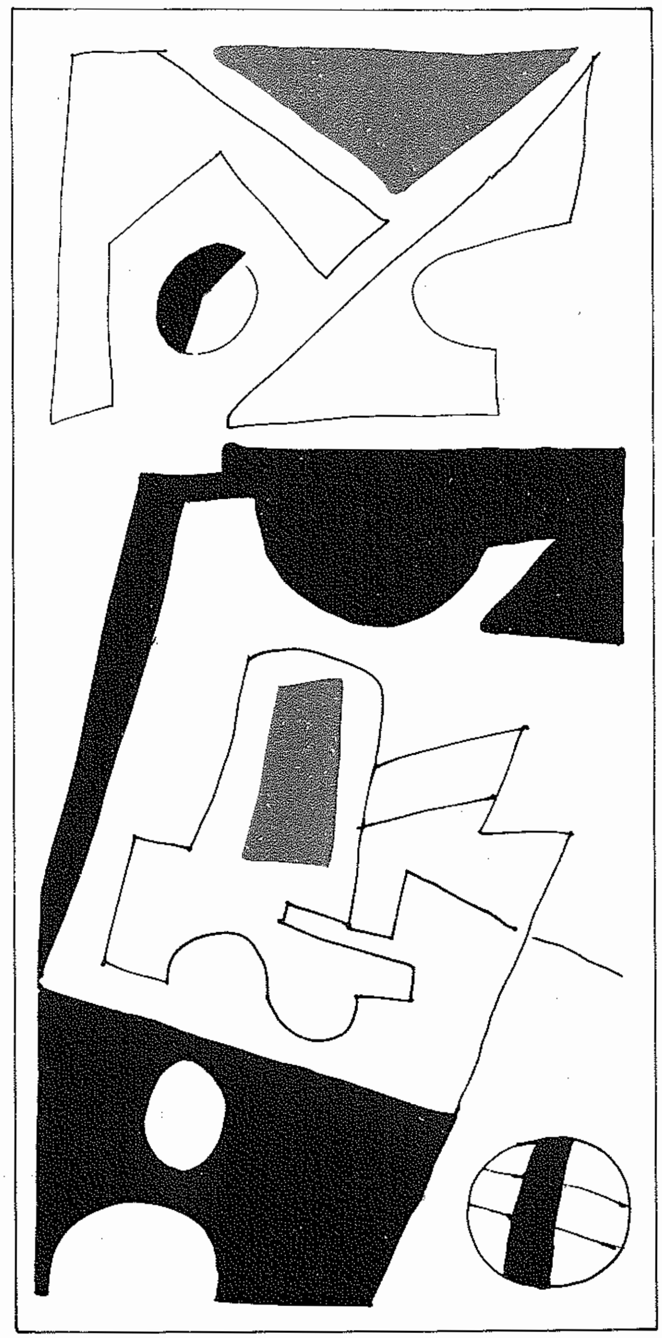
HARTLAND-THUNBERG, Penelope, Ed. **Commissioned Papers on Inflation Recession, Energy and the International Financial Structure.**
The Center for Strategic and International Studies, Washington, DC. 1975. Especially:

JOHNSON, H.G. **Quadrangular prospectives on security, inflation and the world financial structure, 25 ss.** LIN C.Y. and SIDDIQUE, K.M. **Modalidades recientes de la inflación en los paises en desarrollo no exportadores de petróleo.** pp. 28-31. PAZOS, Felipe. **La inflación crónica en America Latina. Rev. Ec. Lat. 56, tl-64.**

The problem which presents itself takes the form of a "transition" to new modes of operation for the economic system so that the energy resources which are being depleted (and which are thus becoming more expensive) can be supplanted by other, more abundant sources.

However, these new "energy mixtures" require the joint effort of political leaders, businessmen, planners, and consumers, in order to modify consumption patterns in the direction of new energy inputs for economic activities, thereby fostering new behaviors for the future.

Finally, in terms of regional cooperation, the possibilities of collaboration with other developing countries should not be underestimated, nor should the support that these programs could receive from the international community, especially in the form of transfer of technology and financing.



THE LATIN AMERICAN ENERGY PROBLEM: A TYPOLOGICAL STUDY

Synthesis of the report prepared for the Latin American Energy Cooperation Program (PLACE) by

Joubert C. Diniz
OLADE Consultant

1. Summary and Conclusions

Despite the fact that Latin America has been seeking solutions to its energy problems for some time now, the results so far have not been very satisfactory.

After the worldwide economic, financial, and political crisis which was unleashed as of 1973 —one of whose most important aspects was the abrupt increase in oil prices— energy difficulties were further accentuated, thus making it even more difficult to find suitable solutions to the energy problems of many of the countries of the region.

Of the twenty-nine Latin American nations included in the present study, only six are net oil exporters: Mexico, Trinidad and Tobago, Venezuela, Ecuador, Peru and Bolivia. All of the others must import all or part of the oil they consume.

Furthermore, Latin America has abundant resources: petroleum, coal, gas, hydroelectricity, geothermal energy and biomass. If these were utilized well, they would permit the energy requirements of the region to be met without recurring to extra-regional imports.

The analyses presented herein define typologies, reflecting the great diversity of physical, demographic and economic conditions, the varying levels of industrial development and the different degrees of the use and development of energy resources in the Latin America countries. While such diversity makes the analysis of the problems more complex, it also makes their solution more viable, to the extent that OLADE's basic objective of integrated regional development is sought and attained.

It is evident that the solutions to the energy problems of Latin America are closely linked to economic, social, and political development. Nevertheless, it is beyond the scope of the present paper to analyze what kind of energy resources development would be harmonious with economic development.

Some of the main conclusions of this typological study are described below:

a) On the basis of physical and political aspects, the Latin American countries can be grouped into six categories:

   — Mexico
   — Central America
   — The Caribbean
   — The Andean Countries
   — Argentina, Uruguay, and Paraguay
   — Brazil

However, within the context of an energy typology, the number of groups or their composition can suffer substantial alternations.

b) A typological analysis of the regional energy problems can contribute to a better knowledge of the available resources, which will provide a basis for projecting sub-regional and regional markets in the most coherent and uniform way and for assessing the alternative solutions in qualitative terms more than quantitative ones.

c) Any study of the regional energy problem is made more difficult by the lack of, or inconsistency in, statistical data on reserves, production, commercialization, and consumption.

d) Another analytical difficulty arises from the fact that the Latin American region is still not sufficiently aware of its energy potential.

e) It is imperative to make a great effort to provide a better knowledge of the regional energy sources, particularly hydropower and coal.

f) The region presents significant variations, not only in terms of primary energy production but also in terms of secondary energy consumption, as a consequence both of the level of development in which the countries find themselves and of the poor use of their energy resources.

g) Three of the conclusions of the present study deserve to be stressed:

— Mexico and Venezuela are large producers and exporters of oil, and they will continue to be for a long time.

— The Central America and Caribbean countries are, in general, large firewood consumers, strongly dependent on the importation of oil by-products for higher-quality utilization.

— Practically all of the countries of the region have an important source of renewable energy in the form of their hydroelectric potential, of which they have developed barely 7%.

h) The following special aspects are also noteworthy:

* Venezuela: This large producer and exporter of oil presents modest industrial development and a vulnerable economy, because it depends primarily on one product: oil, which represents 94% of its total exports.

* Mexico: In addition to being a large producer and exporter of oil, this country presents the most harmonious energy picutre of resource availability, current utilization, and future medium —and long— term prospects.

* Brazil: Due to its physical and demographic dimensions, this country occupies a special position in the Latin American panorama. From the energy perspective, it is notable for its voluminous oil imports, for the diversity of its natural resources, for its singular hydroelectric development and for the relatively advanced stage of development of its capital goods industry. Moreover, it is the only country in the region which has been systematically planning and developing a program to substitute oil with alcohol.

* El Salvador: This country is the major producer of geothermal energy; the Ahuachapán station which began to operate in 1976, produces 25% of the electricity generated in the country.

* Colombia: Relatively speaking, this country has a reasonable equilibrium between its energy problems and the availability and use of its natural resources. It was notable in the last decade for having ceased to be an oil exporter, to become instead a net importer.

* Bolivia: This nation has abundant natural resources and is a gas exporter. Nevertheless, it has had low rates of economic growth and energy use and has maintained an extremely high foreign debt.

i) Sub-regional integration is already a reality in Latin America, as witnessed by: 1) the Energy Cooperation Program for Central American and Caribbean Countries, whereby Mexico and Venezuela provide oil to the countries of these regions under preferential conditions of supply and financing, and 2) the Oil Facility Program of Trinidad and Tobago for the Countries of the Caribbean

Community (CARICOM) for Financing Purchases of Oil, Fertilizers, and Asphalt. Hydroelectric integration is quite significant, for it is undergoing an accelerated development in Southern Latin America, through bilateral agreements between Paraguay, Brazil, Uruguay, and Argentina. Bolivia is also exporting natural gas to Argentina, and Mexico and Central America are working jointly on an electrical transmission system.

2. Energy in Latin America

Among the numerous conclusions to which an analysis of the Latin American energy panorama could lead, the following have a special, direct interest for this paper:

* Latin America is in a privileged position with respect to the rest of the world in terms of its alternative energy sources, which are extensive enough to create regional self-sufficiency.

* Nevertheless, the region as a whole must face serious problems with its energy supply, for three basic reasons:

  — the low level of economic development
  — slight degree of development of its real energy potential, and
  — the lack of greater regional integration.

* The world economic and energy crisis begun in 1973 had a violent impact on Latin America, which, unlike the industrialized countries, had no way to compensate the increased prices of imported petroleum, capital goods, and technology with a proportional increase in the prices of its exports.

* Even for the large oil exporters such as Mexico and Venezuela, the crisis made itself felt due to their poorly diversified economic structures.

* In general, Latin America is an oil exporter; nevertheless, since most of the regional exports are destined to markets in the United States and Europe, the majority of the countries in the region have had to cope with serious oil supply problems since 1973.

  Brazil absorbs 60% of all the oil imported by the region. However, thanks to the availability of other forms of energy, these imports represent only some 30% of its total primary energy while for countries such as Uruguay, Panama, and Jamaica, the imported oil represents between 30 and 80% of the available primary energy.

* The effort made to import oil is clearly reflected in the participation indices for the different countries global exports (Brazil, 40.4%; Uruguay, 37.6%; the Dominican Republic, 35.3%; Jamaica, 34.9%; Guyana, 31.2%; etc.).

* One essential measure which must be imposed in order to solve the region's energy problems is the substitution of imported oil by locally available energy alternatives, together with a greater regional consumption of its exportable oil surpluses.

* Natural gas —a form of energy which plays an important role in the structure of world energy production— has not been exploited and utilized in Latin America in proportion to its availability, or even in proportion to the exploitation of petroleum, with which it is generally associated.

* The scarcity of in-depth knowledge on existing reserves, the reduced consumer market due to the lack of a tradition of natural gas consumption in industry, and the technical problems related to the transportation of gas over long distances constitute the basic causes for the slight importance given to the exploration of Latin American natural gas reserves.

* Bolivia is a special case. It is already exporting free natural gas to Argentina and will soon conclude negotiations to begin exporting to Brazil.

* Coal is a fundamentally important form of energy for the world. It represented nearly 28% of the worldwide primary energy production for 1975, and predictions are that it will maintain that same level of participation until the year 2000 and even until 2030.

* In Latin America, coal accounts for only close to 2% of the total primary energy production.

* Latin America is not aware of the real dimension of its available coal resources. Nevertheless, on the basis of existing information, it is known that said resources are sufficient to justify giving priority to the investigation and exploration of coal as an alternative to oil and a complement to other energy sources.

* Practically all of the continental Latin American countries have great hydroelectric potential, whose resource identification, survey and exploration technology is simple and well-known and whose production costs are many times lower than those of other energy alternatives. Nevertheless, only 7% of the known Latin American potential has been developed.

* As a result, Latin America should attempt to accelerate hydroelectric development, especially since this is a renewable source of energy, widely available in the region.

* The destructive nature of the Latin American extraction of firewood from the forest reserves constitutes one of the region's most serious energy problems. This results in serious ecological damage and only produces a fuel of low efficiency. Its substitution by other forms of energy and improved efficiency in its use are priority measures, particularly in those countries where this type of fuel represents high proportions of the internal primary energy production. (Haiti, with a 95.3% figure, is an extreme case).

* The non-conventional forms of energy such as nuclear, solar, wind and wave energy; biomass; and small hydro power development does not currently have - nor will it have as of the end of this century— a significant participation in the primary energy production of Latin American; this situation is similar to what is occurring in, and what is forecasted for, the world as a whole.

* Nevertheless, for some countries, nuclear energy and geothermics have an important role to play.

In addition, it should be noted that there also exists the possibility of using biomass to substitute oil (gasoline), as in the case of the Brazilian alcohol program.

* In summary, Latin America has to seek solutions to its global energy problems through three fundamental procedures:

a. Compilation of a more complete knowledge of the conventional energy reserves (oil, natural gas, coal, and hydroelectricity);

b. Suitable exploration of these reserves; and

c. Growing regional integration.

Bearing in mind the available energy resources and the levels of consumption that can be reasonably anticipated, these three procedures would allow Latin America to obtain a medium - and long - term energy supply.

3. **Bases for a Typological Study**

General Aspects:

Any analysis of the Latin American energy problems is faced with a series of difficulties:

* A large number of quite diverse countries in

COUNTRY	ECONOMIC PARAMETERS								ENERGY PARAMETERS																COUNTRY
									Primary Energy 1979 - TOE							Secondary Energy				1979 Total Energy Consumption Per-Capita TOE	Reserves - MTOE				Hidroelec. Development Installed Cap. as % Reserves	
									Production							1979 Consumption Structure - %										
	Area (Km2)	POPULATION 1979 1000 INHAB.	POPULATION Rate % 1970-79	GDP 1979 US $ 10^6 (The 1978)	GDP Rate % 1970-79	Participation Manufact. 1979 - %	Relation Foreign Debt & GDP 1978-%	Relation Oil Imports (Exports) & Total Exports %	Petroleum	Natural Gas	Hidroelec.	Firewood	Coal	G-Geothermics O-Other Plant, Animal Fuels	Oil Exports (Imports)	Res. Com. & Public	Transport.	Industrial	Others		Petroleum	Gas	Coal	Hidroelec.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ARGENTINA	2,776,656	26,729	1.3	55,863	2.8	29.9	17.2	11.6													350.9	560.7	81.9	5,233	7.0	ARGENTINA
BAHAMAS	13,935	236	3.6	1,012	.....	.....	5.9	.....	.....	.....	—	.....	—	.....	.....	.....	.....	.....	.....	.....	.....	.....	—	—	—	BAHAMAS
BARBADOS	430	245	0.3	541	.....	11.2	20.6	18.5	.....	.....	—	.....	—	.....	.....	.....	.....	.....	.....	.....	0.1	.....	—	—	—	BARBADOS
BOLIVIA	1,098,581	5,425	2.5	2,709	4.9	15.9	91.2	(5.0)	1,510	4,466 A	312	240	—	0 - 177	P - 27 Gas - 1765	29.5	49.0	18.6	2.9	0.26	16.0	107.0	—	1,293	1.3	BOLIVIA
BRAZIL ⑤	8,511,965	119,636	2.8	186,729	8.9	30.3	22.0	40.4	7,765	1,728	11,126	57,268	2,263	0-13,586	(48,895)	24.8	29.9	38.9	6.4	0.72	186.6	38.2	636.5	15,302	11.3	BRAZIL ⑤
CHILE ⑤	756,629	10,917	1.7	16,851	2.6	24.0	38.2	22.1	1,086	3,543 L	597	1,360	760	.....	(3,729)	30.4	30.2	29.4	—	0.59	57.1	63.7	646.5	562	12.3	CHILE ⑤
COLOMBIA	1,138,338	25,523	2.1	19,569	6.0	18.8	24.0	3.2	5,169	3,144 L + A	1,896	2,989	3,308	0 - 560	(1,241)	34.8	30.8	31.6	3.1	0.52	114.2	152.9	720.3	8,620	2.6	COLOMBIA
COSTA RICA	50,900	2,166	2.8	2,841	5.9	18.0 ⑤	61.6	21.3	—	—	229	456	—	0 - 139	(404)	39.4	32.9	27.4	0.3	0.65				639	4.5	COSTA RICA
CUBA	114,524 ①	9,720 ①	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	—	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	CUBA
ECUADOR ⑥	270,670	7,689	3.3	5,102	7.3	21.7	47.6	(42.0)	10,551	447	76	783	—	0 - 166	5,397	38.7	42.8	16.5	3.0	0.47	157.1	101.9	—	1,580	1.0	ECUADOR ⑥
EL SALVADOR	20,934	4,436	2.9	3,061	4.6	17.5	21.7	10.1	—	—	128	1,401	—	0 - 195 0 - 407	(699)	64.5	18.4	17.4	1.6	0.52	—	—	—	61	28.6	EL SALVADOR
GRENADA ⑥	① 344	① 120	⑨ 0.4	.....	.....	.....	.....	.....	—	—	—	4	—	0 - 0.3	.....	49.0	44.9	4.9	1.3	0.15	.....	.....	—	.....	—	GRENADA ⑤
GUATEMALA	108,889	6,813	2.9	6,967	5.6	15.1	12.0	20.6	79	A 5	23	1,926		0 - 217	(796)	53.3	17.6	29.0	0.2	0.49	2.9	0.3		711	1.0	GUATEMALA
GUYANA	214,970	835	1.7	504	.....	.....	127.9	31.2	—	—	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	—	—	—	862	.....	GUYANA
HAITI ⑥	27,750	4,915	1.7	1,218	3.6	12.3	22.0	23.0	—	—	22	1,728	—	0 - 64	—	79.4	7.3	13.0	0.2	0.04	.....	.....	3.0	.....	.....	HAITI ⑥
HONDURAS	112,088	3,564	3.4	1,948	4.4	15.8	53.6	12.8	—	—	78	1,107	—	0 - 65	(491)	64.8	12.5	21.1	1.5	0.49			11.5	201	3.9	HONDURAS
JAMAICA ⑥	10,962	2,137	1.5	2,787	.....	.....	50.4	34.9	—	—	31	74	—	0 - 175	(1,082)	7.2	18.0	73.0	1.8	1.21	—	—	.....	.....	.....	JAMAICA ⑥
MEXICO ④	1,967,183	64,406	3.6	84,306	6.2	24.9	38.4	(42.5)	80,189	29,483 L + A	5,138	12,384	1,806	G-294	29,046	30.0	35.1	27.5	7.4	0.96	6,283.2	1,643.5	1,049.7	1,814	20.6	MEXICO ④
NICARAGUA ⑤	139,000	2,463	3.1	1,545	0.2	20.0	56.8	.....	—	—	70	613	—	0 - 131	(556)	53.4	19.1	14.6	12.7	0.48			—	211	3.4	NICARAGUA ④
PANAMA ⑤	75,650	1,851	3.1	2,800	5.5	11.9	94.6	.....	—	—	76	295	—	0 - 130	(2,362)	38.2	29.7	32.0	0.1	0.62			—	208	2.1	PANAMA ⑥
PARAGUAY	406,752	2,973	3.3	2,106	7.6	16.3	38.6	41.1	—	—	.....	.....	—	.....	.....	.....	.....	.....	.....	.....			—	1,821	1.3	PARAGUAY
PERU	1,240,219	17,328	2.9	17,194	3.0	21.5	44.4	(19.4)	9,770	A 1,168	720	2,980	30	0-634	2,523	48.6	22.4	27.7	4.3	0.83	92.8	28.0	87.5	4,167	3.1	PERU
DOMINICAN REP. ⑥	48,442	5,275	3.0	4,626	6.2	16.2	23.2	35.3	—	—	89	1,170	—	0-750	(1,835)	34.2	24.8	40.8	0.4	0.80	.....	.....	—	.....	.....	DOMINICAN REP. ⑥
ST. LUCIA									—	—	..... ⑧	.....	—	.....	.....	.....	.....	.....	.....	.....	—	—	—	.....	.....	ST. LUCIA
ST. VINCENT									—	—	..... ⑧	.....	—	.....	.....	.....	.....	.....	.....	.....	—	—	—	.....	.....	ST. VINCENT
SURINAME	163,265 ①	400 ①	0.5	.....	.....	.....	.....	.....	—	—	134	36	—	0 - 46	.....	10.3	20.8	64.7	4.3	1.41	.....	.....	—	19	.....	SURINAME
TRINIDAD-TOBAGO	5,128	1,132	1.1	2,161	.....	.....	22.7	(76.7)	10,884	A 4,277	—	.....	—	0-110	(925)	11.1	38.8	50.1		1.18	100.0	308.8	.....	—	.....	TRINIDAD-TOBAGO
URUGUAY	186,926	2,886	0.9	4,848	2.0	26.7 ④	26.5	37.6			381	542	—	.....	(1,953)	37.5	29.8	32.5	0.5	0.68	—	—	—	503	4.0	URUGUAY
VENEZUELA	998,805	13,587	3.2	32,823	5.3	12.9	23.5	(94.0) ⑤	127,687	A 16,442	1,146	14	39	.....	74,112	12.6	47.6	39.8	0.2	1.40	2,563.3	1,070.4	97.2	2,586	7.4	VENEZUELA
LATIN AMERICA		347,468	2.7		5.7		27.7																	⑥ 44,382	7.2	LATIN AMERICA

SOURCES : ②③⑤⑥⑧ – IDB. Economic and Social Progress in Latin America, 1979 Report.

④⑦ – ECLA, Economic Study of Latin America 1979

⑩ to ㉖ – OLADE. PLACE. CHAPTER III

—— Non-existent data.

..... – Data exist but are not available.

NOTES : ① OLADE, The Hydroelectric Potential

② ECLA, Economic Study of Latin America 1979

③ Includes Mining and Construction

④ Includes Mining

⑤ 1978, Columns 10 - 21

⑥ 1980, Columns 10 - 21

⑦ Includes 269 MTOE in the Caribbean (3.0% development)

⑧ Micro Stations

Ⓐ Associated Natural Gas

Ⓛ Free Natural Gas

Ⓟ Petroleum

Ⓞ OLADE. PLACE, CHP. III

terms of territorial extension, population, level of economic development, availability of energy resources, etc.;

* An accentuated lack of knowledge on the availability of potential resources;

* A lack of, or deficiency in, consistent statistical data;

* An insufficient exchange of information among the countries, coupled with a just-beginning energy integration, even at the bilateral level.

Under such circumstances, the cooperation of countries within sub-regions, or within groups having uniform or similar characteristics, can constitute an analytical instrument leading to a better knowledge of the energy sector, its potential and consumption structure and thereby aiding in the determination of both alternative solutions and the characteristics of the consumer markets and their future prospects.

Chart N° 1 was prepared in order to establish coherent typologies with economic criteria, as a function of primary energy production, secondary energy consumption, and the availability of natural resources. Obviously, other parameters of an economic or energy nature could have been included; but it was thought that for the purposes of this paper, the most essential factor was to make available a set of data permitting coherent and logical cooperation of countries in typological groups.

The Chart permits making observations and reaching broad conclusions; while these fall outside the scope of the present analysis, some of the most pertinent will be described below.

Economic Parameters

The extremes of diversity in the characteristics of the Latin American countries can be clearly identified through a comparison of their area and population. Between Brazil, with an area larger than 8.5 million square kilometers and nearly 120 million inhabitants, and Grenada, with 34.4 square kilometers and 120,000 inhabitants, there is a whole range of intermediate countries. This enormous diversity gives rise to greater difficulties in applying uniform analytical criteria to the energy problem, as well as to disparity in levels of development, and to notable differences in the availability of natural resources. In terms of the technical and economic perspectives and bilateral, sub-regional, or even regional integration, this diversity also creates excellent opportunities for finding and applying appropriate solutions.

The demographic growth rate already presents a slight variation from one country to another, almost always near the average regional value of 2.7% annually during the 1970 - 79 period. The populations of Latin America continue to have a high growth rate, with respect to the rest of the world (see Chart N° 1), which once again reflects the modest level of socio-economic development in the area.

It is interesting to note that Mexico, whose economy is relatively developed, had the highest population growth rate during the period in question while Argentina, equally advanced in regional terms, had one of the lowest.

The demographic growth of Latin America should continue to have high rates for at least one or two decades more; and this makes even more manifest the need to undertake suitable planning for the use of energy resources.

The figures for the Gross Domestic Product reveal the current level of development of the countries in the region, as can be seen in the following chart, which also includes the GDP figures for some of the industrialized countries.

Except for Suriname, which has a high per capita consumption index due to its bauxite, alumina and aluminum industries, which represent a high percentage of the total GDP, in Latin America as a

whole only four countries have a per capita GDP exceeding US$ 1,000: Venezuela, Argentina, Uruguay, and Mexico. In contrast, in 1979 six countries had a per capita GDP below US$ 500. Meanwhile, in the same year, the countries with developed economies had an average per capita GDP greater than US$ 5000; this reflects, quantitatively, how much Latin America still has to develop in order to aspire to socio - economic development patterns similar to those in the more industrialized countries.

Another important aspect related to the GDP is its average rate of evolution for the 1970 - 79 period, indicated in column 6 of Chart N° 1. While Latin America as a whole presented a 5.7% annual GDP growth rate, Brazil, with 8.9%, was the country which grew the most during the period, despite the fact that its gross domestic product was the highest in the region. Moreover, the figures for countries with rates equal to, or less than, 3% reflect serious problems of a political nature during the last decade.

As for the participation of the manufacturing industry within the GDP, the largest percentages are found in Brazil (30.3%) and Argentina (29.9%), followed by Mexico (24.9%) and Chile (24.0%). This index is important for the present study because it provides an idea of the level of development of the capital goods industry, which plays a relevant role in the development of the regional energy potential.

The relationship between a nation's foreign debt and its GDP serves as an indicator of the relative degree of difficulty that these countries must face in terms of the problems involved in the importation of large volumes of oil and oil derivatives or in the importation of technology, specialized labor and the capital goods necessary for the development of their energy resources.

The foreign debt indices of Guyana, Bolivia, and Panama are extremely high, as are those of Honduras, Nicaragua, Costa Rica, and Jamaica -all above 50%.

Another particularly important parameter appears in Column 9 of Chart N°1: the relation between oil imports and a country's global exports or, for the oil-exporting countries between oil exports and the global exports. In general, the former case prevails and the index suggests the level of the efforts that the country must make in exporting its products in order to be able to pay for its energy imports. The case of Brazil should be mentioned, for there the value of the imported oil and oil derivatives represents 40.4% of the total national exports. This explains the emphasis that this country has recently been placing on oil substitution policies, including alcohol and other sources of energy.

Other countries with very high indices are Paraguay, Uruguay, the Dominican Republic, Jamaica and Guyana.

The exportation of oil and its derivatives still accounts for most of Trinidad and Tobago's total income (76.7%), is a primary component in the exports of Mexico (42.5%) and Ecuador (42.0%), and contributes to income in Peru (19.4%) and Bolivia (5.0%). The figures for this last country primarily reflect the natural gas exports to Argentina.

This brief description of the economic parameters represented in Chart N° 1 defines a first typology for the Latin American countries, which can be divided into six groups.

Economic and Geographical Typology

Group I — Mexico
Group II — Central America
Group III — The Caribbean
Group IV — The Andean Countries
Group V — Argentina, Uruguay, and Paraguay
Group VI — Brazil.

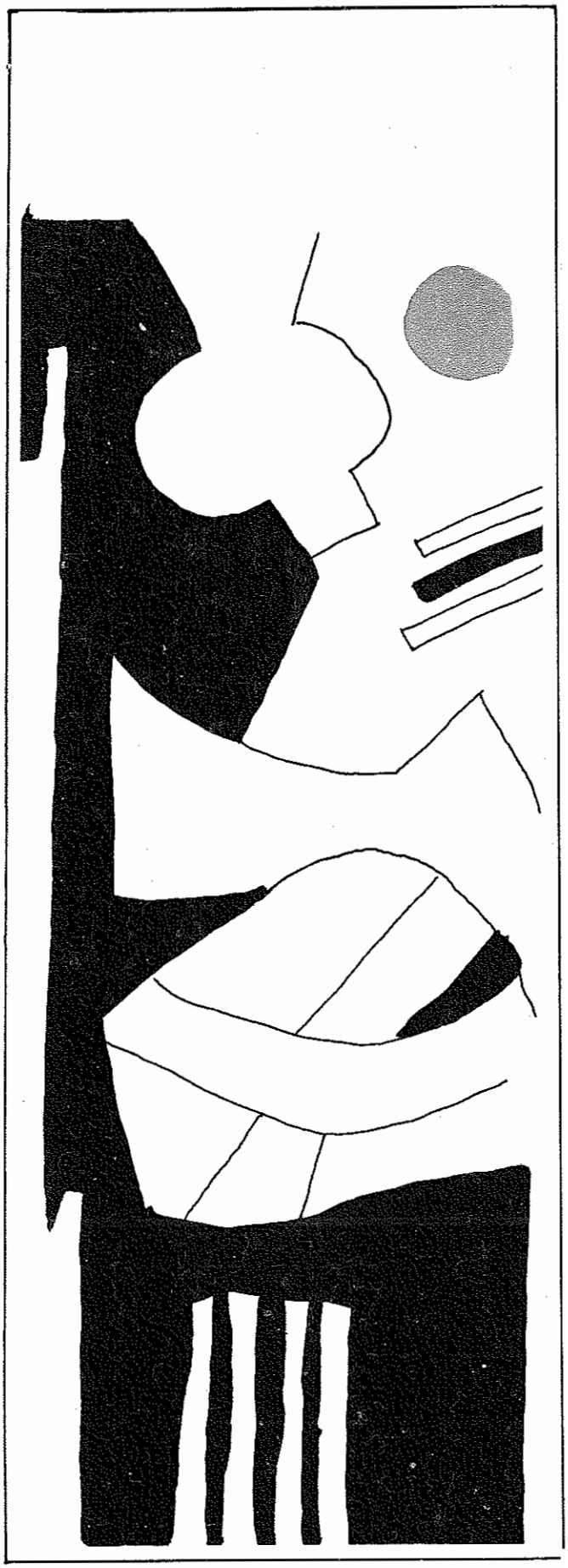
The last section of this paper will present additional considerations with respect to this typology.

CHART Nº 2

GROSS DOMESTIC PRODUCT OF LATIN AMERICAN COUNTRIES

COUNTRIES	US$ 10^6 1978	PER CAPITA US$ 1978
Argentina	55.563	2.004
Bahamas	1.012	4.288
Barbados	541	2.207
Bolivia	2.709	499
Brazil	156.729	1.310
Chile	18.551	1.699
Colombia	19.569	767
Costa Rica	2.841	1.311
Dominican Republic	4.626	877
Ecuador	5.102	663
El Salvador	3.061	690
Guatemala	6.967	1.023
Guyana	504	603
Haiti	1.218	247
Honduras	1.948	546
Jamaica	2.787	1.304
Mexico	84.306	1.215
Nicaragua	1.546	628
Panama	2.800	1.489
Paraguay	2.106	708
Peru	17.194	992
Suriname	———	— —
Trinidad and Tobago	2.161	1.904
Uruguay	4.845	1.679
Venezuela	32.823	2.416

SOURCE: For Latin America. IDB. **Economic and Social Progress in Latin America,** 1979 Report.



Primary Energy

Columns 10—16 of Chart N° 1 indicate the production of the main forms of energy, by country, and the oil imports or exports, for the year 1979. From the analysis of these data, it can be concluded that:

1. There is a great lack of statistical information;

2. Fewer than 10 countries have a significant oil production, and Venezuela, and Mexico together account for nearly 70% of the total;

3. Natural gas is produced by the oil-producing countries and Bolivia is the only country with a substantial production of free natural gas;

4. Firewood is produced in all the countries and represents, in some of them, a very high percentage of the total primary energy production;

5. Hydroenergy plays an important role in a few countries such as Argentina, Brazil, Colombia, Chile, and Mexico; however, with the exception of a few Caribbean nations, all the countries of the region have hydroelectric plants in operation;

6. Coal has been explored very little in Latin America. In 1979, it was being produced by Brazil, Colombia, Chile, and Mexico, with minimal production in Venezuela and Peru;

7. Only El Salvador and Mexico are already using geothermal energy;

8. All of the countries make use of "other plant and animal fuels", the category which includes sugar cane (bagasse) and animal wastes, which often represent important sources of energy;

9. Brazil is the only country that has a notable energy production based on biomass (alcohol), which is being developed as a substitute for oil and its derivatives;

10. The importation (exportation) of oil indicated in Column 16 represents a heavy economic burden for most of the importing countries, as can be seen by analyzing the data from Column 9; such a burden demands enormous exportation efforts in order to be able to meet their financial obligations. Moreover, the oil-exporting countries count on this product as a significant factor in their exports;

11. Argentina is the only country with a commercial use of nuclear energy to generate electricity.

Chart N° 3 is presented below, so that the structure of primary energy production can be better appreciated and so that the importance of petroleum can be more easily assessed.

As was affirmed previously, of the nine oil-producing countries in Latin America, only 5 are oil exporters. Chart N° 3 shows that with the exception of these five, all the others depend, to a greater or lesser degree, on imports.

In addition, in the analysis of economic parameters, it was proven how much impact oil has in terms of its percentage equivalent in total exports.

The oil supply's importance for the Latin American countries -whether national production or imports- gives rise to a second typology in which the countries are classified as net exporters or importers, taking into account both the degree of the country's energy dependency on oil imports and its internal flexibility as a function of the availability and exploration of alternative resources. (This typology is also described in the last section of this paper).

Secondary Energy Consumption Structure

Chart N° 1 also provides the percentage values of secondary energy consumption for three sectors: residential, commercial, and public; transportation; industrial and others.

CHART Nº 3

STRUCTURE OF PRIMARY ENERGY PRODUCTION AND PETROLEUM IMPORTS - 1979
(Percentages)

COUNTRY	PETROLEUM		NATURAL GAS	HYDROELECTRICITY	FIREWOOD	COAL	OTHERS
	IMPORTS	PRODUCTION					
Argentina	•••	•••	•••	•••	•••	•••	•••
Bolivia	—	22,5	66,6	4,6	3,6	—	2,6
Brazil	31,3	6,3	1,3	26,6	20,7	1,8	9,7*
Chile	33,6	9,8	31,9	5,4	12,2	7,1	—
Colombia	6,5	32,3	16,5	8,9	15,6	17,3	2,9
Costa Rica	32,8	—	—	18,6	37,2	—	11,3
Cuba	•••	•••	•••	•••	•••	•••	•••
Dominican Republic	42,6	—	—	1,6	37,9	—	17,9
Ecuador	—	87,6	3,7	0,6	6,5	—	1,5
El Salvador	24,7	—	—	4,5	49,5	—	21,3**
Guatemala	26,1	2,6	0,2	0,8	63,2	—	7,1
Guayana	•••	—	—	•••	•••	—	•••
Haiti	—	—	—	1,2	95,3	—	3,5
Honduras	28,2	—	—	4,5	63,6	—	3,7
Hamaica	76,0	—	—	3,3	6,3	—	14,4
Mexico	—	64,5	23,7	2,9	7,6***	1,0	0,3
Nicaragua	41,0	—	—	5,1	44,4	—	9,5
Panama	82,6	—	—	2,6	10,2	—	4,5
Paraguay	•••	—	—	•••	•••	•••	•••
Peru	—	63,9	7,6	4,7	19,4	0,2	4,1
Suriname	•••	—	—	•••	•••	—	•••
Trinidad and Tobago	—	71,3	28,0	—	—	—	0,7
Uruguay	66,2	—	—	13,0	18,6	—	2,1
Venezuela	—	86,7	12,5	0,8	0,0	0,0	—

(*) Includes 7,7% sugar cane
(**) Includes 14,4% of geoenergy
(***) Includes other plant and animal fuels.

It is obvious that in light of Latin America's current level of development and the aforementioned problems, secondary energy consumption (i.e., the final uses of energy) presents significant variations and this can be discerned, at a glance, from Chart Nº 1.

It should be pointed out that the present paper has placed more importance on the evaluation and analysis of available resources and data on effective production than on the characteristics and possibilities of action at the level of final consumption. The programs of energy economy and rationalization are obviously quite important and must be duly considered, with in-depth analyses undertaken on the features of the consumer market for secondary energy, the energy losses, and possibilities for substitution.

A third typology based strictly on the structure of secondary energy consumption is also presented in the last section.

Per Capita Total Consumption

Column 21 of Chart Nº 1 provides the per capita figures for total energy consumption (gross internal supply). The same values have been re-ordered below, from highest to lowest.

CHART Nº 4

TOTAL ENERGY CONSUMPTION, PER CAPITA
Values in TOE

Venezuela	2.18	Peru	0.53
Mexico	1.68	El Salvador	0.52
Trinidad and Tobago	1.18	Honduras	0.52
Brazil	1.14	Colombia	0.51
Jamaica	1.11	Guatemala	0.49
Uruguay	0.68	Nicaragua	0.48
Costa Rica	0.64	Ecuador	0.47
Panama	0.62	Haiti	0.42
Chile	0.59	Bolivia	0.28
Dominican Republic	0.56	Grenada	0.18

As indicated in Chart Nº 1 the values above correspond to 1978, 1979, or 1980, depending on the country.

Nevertheless, this lack of uniformity in the data does not affect the order of magnitude of the respective indices.

Since per capita total energy consumption constitutes a kind of summary index, it was natural for great discrepancies to exist in the values for the different countries in the region. Thus, for example, Jamaica is one of the five countries with an index of above 1.0 TOE despite all the above-mentioned negative indicators for its energy characteristics, because its index reflects the high degree of consumption by the bauxite and alumina industries. Venezuela and Mexico, which are oil-exporting countries where the transportation sector predominates in the structure of secondary energy consumption, have indices which also could reflect energy wastefulness.

Although this index reflects a country's level of development, the chart would demand a more detailed analysis to explain, for instance, the situation of Colombia. At any rate, for the purposes of the present study, it was not thought necessary or useful to define a typology based on per capita total energy consumption, by itself or together with other indices, whenever the groups of associated countries are not satisfactorily similar.

Availability of Energy Resources

The data in Columns 22—26 of Chart Nº 1 demonstrate that Latin America has a wealth of energy resources, even though their distribution by country is quite irregular.

The evaluation of the true dimensions of the Latin American reserves is hindered by a lack of data and by an acknowledged inconsistency in much of the available information. Some important conclusions can nevertheless be reached:

— Mexico and Venezuela together have 89% of the known regional oil reserves. This means, in part, that the true potential of the other countries is unknown -however, oil price increases have given rise to a decided search for new reserves.

— Bolivia is the only country that has already identified significant reserves of free natural gas.

— Nine countries have known coal reserves, notably Mexico, which also has large oil reserves.

— Brazil, Chile, and Colombia have reserves on the same order of magnitude.

— All of the continental countries and some of the Caribbean ones have a hydro power potential. This is indicated in the chart in terms of its thermal equivalency, assuming a lifetime of 50 years for the hydroelectric plants, an average annual use of 5,000 hours (load factor = 0.57), and a 30% efficiency.

Example: if the Bolivian potential is 18,000 MW, the thermal equivalent will be:

$$\frac{18{,}000 \text{ MW} \times 50 \text{ yrs.} \times 5{,}000 \text{ hrs/yr.}}{0.30 \times 11.6 \times \text{MWH/MTOE}} = 1{,}293 \text{ MTOE}$$

— The Brazilian hydroelectric potential represents some 35% of the Latin American total, but this percentage should be reduced in the future, once Brazil has a more accurate inventory of such resources.

— Column 26, which refers to the percentage of installed capacity against known potential, reveals that Latin America only utilized 7.2% of its potential. This value ranges between a maximum of 28.6% for El Salvador, which is not really significant due to its reduced potential, to 1% for Guatemala. The low indices for hydroelectric exploitation in all the countries of the region open the way for an accelerated development of this source of energy, especially now that it is in a favorable position to compete with oil.

To solve the region's energy problem, it is important and imperative to maximize the orderly, rational planning and use of Latin America's abundant energy resources. Thus, a fourth typology was defined as a function of these resources, as seen in the following section.

TYPOLOGIES

The typologies presented herein are derived from the data, considerations, analyses, and conclusions of the previous sections.

Typology Based on Economic and Geographical Parameters

Group I — Mexico

Group II — Central American Countries
* Guatemala
* Honduras
* El Salvador
* Nicaragua
* Costa Rica
* Panama

Group III — Caribbean Countries
* Bahamas
* Cuba
* Jamaica
* Haiti
* Dominican Republic
* St. Lucia
* St. Vincent
* Barbados
* Grenada
* Trinidad and Tobago
* Suriname
* Guyana

Group IV — Andean Group
* Venezuela
* Colombia
* Ecuador
* Peru
* Chile

Group V The Plata Basin
* Argentina
* Paraguay
* Uruguay

Group VI * Brazil

This typology shows a strong geographical influence and for this reason should be viewed with certain reservations as the basis for analyzing the Latin American energy problems. Nevertheless, it can be useful in making consumption projections on a regional basis; and this is sometimes sufficient to solve problems related to the lack of reliable data on the historical evolution of consumption or when, for various reasons, it proves more convenient to avoid individual projections by country.

The use of this typology should be accompanied by special considerations for some countries, for example, Bolivia in the Andean Group and Cuba and the Dominican Republic in the Caribbean.

Typology Based on Oil Dependency

Group I EXPORTERS
* Bolivia
* Ecuador
* Mexico
* Peru
* Trinidad and Tobago
* Venezuela

Group II IMPORTERS WITH SEVERAL DOMESTIC ALTERNATIVES
Sub-group 1 - Argentina
Chile
Colombia
Sub-group 2 - Brazil

Group III IMPORTERS WITH FEW DOMESTIC ALTERNATIVES
* Paraguay
* Uruguay
* Barbados

Group IV IMPORTERS WITH LARGE FIREWOOD CONSUMPTION
Sub-group 1 - Costa Rica
El Salvador
Guatemala
Sub-group 2 - Honduras
Nicaragua
Panama
Sub-group 3 - Caribbean Countries

Typology Based on the Structure of Secondary Energy Consumption

Group I PREDOMINANCE OF THE RESIDENTIAL, COMMERCIAL AND PUBLIC SECTOR (Over 50%)
* Haiti (79.4)
* Honduras (64.8)
* El Salvador (64.5)
* Nicaragua (53.4)
* Guatemala (53.3)

Group II PREDOMINANCE OF THE TRANSPORTATION SECTOR (Over 40%)
* Bolivia (49.0)
* Venezuela (47.5)
* Mexico (43.5)
* Ecuador (42.8)
* Grenada (42.6)

Group III PREDOMINANCE OF THE INDUSTRIAL SECTOR (Over 40-)
* Jamaica (75.2)
* Brazil (43.8)
* Trinidad and Tobago (50.1)

Group IV NO WELL-DEFINED PREDOMINANCE
* Chile
* Colombia
* Costa Rica
* Panama
* Peru
* Dominican Republic
* Uruguay

Typology Based on the Availability of Energy Resources

Group I — OIL PRODUCERS AND EXPORTERS
- Sub-group 1 - Mexico
  Venezuela
  Trinidad and Tobago
- Sub-group 2 - Bolivia
  Ecuador
  Peru

Group II — COUNTRIES HAVING REASONABLY WELL-BALANCED ALTERNATIVE ENERGY SOURCES (P/G/C/H/N)
* Argentina
* Chile
* Colombia

Group III — PREDOMINANCE OF HYDROELECTRICITY
* Brazil
* Paraguay
* Uruguay

Group IV — PREDOMINANCE OF FIREWOOD AND OTHER PLANT AND ANIMAL FUELS
- Sub-group 1 - Guatemala
  Costa Rica
  El Salvador
- Sub-group 2 - Nicaragua
  Honduras
  Panama
- Sub-group 3 - Caribbean Countries

AN ANALYSIS OF THE ENERGY SITUATION IN LATIN AMERICA:

THE AVAILABILITY OF REQUIRED ENERGY TECHNOLOGIES

Jean-Pierre Angelier

INTRODUCTION

The purpose of this paper is to describe and analyze the situation of energy technologies in Latin America, to identify the existing problems, and to propose solutions that could be carried out within the framework of the Latin American Energy Cooperation Program (PLACE), which will be implemented by the Latin American Energy Organization (OLADE), in compliance with a decision by the Twelfth Meeting of Ministers of OLADE held in the Dominican Republic in November 1981.

An analysis of the technologies used in the energy sector is a very important part of the present undertaking, since the characteristics of the sectorial operations primarily rest on the availability of, and expertise in, appropriate technologies. Thus, energy reserves are measured according to the technical and economic feasibility of the known production technologies. For example, an oil field only becomes part of a country's reserves if its depth, size, location, sub-surface geological characteristics, and the quality of its product will allow it to be exploited at an acceptable cost. Therefore, a technological innovation can modify the volume of a country's reserves. Energy balances are based on conversion coefficients and equivalencies among forms of energy; these correspond to the use of certain technologies and certain energy production, transformation, and consumption processes. Thus, the generation of electricity on the basis of a fuel used in a turbine-alternator system can have an effective conversion performance, depending on the technologies employed and the conditions under which they are used. For this reason, conversion factors vary from country to country and from region to region. The conversion factor for Latin American countries is 0.086 TOE/MWh, while the average in Europe is 0.082 TOE/MWh.[1/]

Broadly speaking, the efficiency of a country or region's energy production and consumption is estimated in accordance with: 1) the relationship between available energy and final energy. These two factors, in turn, depend on the most commonly used technologies. One illustration of this can be appreciated in a chart on regional energy efficiency[2/], where it can be seen, for example, that efficiency in cooking varies between 5% and 60%, according to the technology and type of energy used.

These examples seek to demonstrate that the energy technologies available for use in a given country or region determine in large part the structure of the energy sector as a whole. While they represent short-term restrictions, they are not medium - and long - term ones; and thus they become variables on the basis of which decision-makers can act with respect to a country or region's energy sector. As a result, a critical review of the energy technologies available in Latin America is a necessary step in acquiring a better knowledge of the regional energy situation, in order to define and resolve existing problems.

Before embarking on such a review, however, it is useful to define the term "technology". Technology

1/ See OLADE. **OLADE Methodology for the Elaboration of Energy Balances.** OLADE Document Series: N° 8, Quito, 1980; and CPDP, **Statisques Petrolieres et Energétiques.** Paris, 1980.

2/ PLACE, Chart III-3, "Regional Energy Efficiency."

is a set of knowledge needed to produce goods or services. This knowledge materializes in the form of the capital goods required for such production. Two technological characteristics should be underscored: first, the fact that if a technology corresponds to the knowledge of a well-known physical or chemical process, then this technology will never be globally optimal, but rather only at a certain point in time, within a given economic setting. This is illustrated in the following example: electricity is thought to be the most efficient way to heat water, since the useful energy in that process is equal to 90% of the available energy. Nevertheless, this efficiency does not only exist in the technology of water heating but also in the conditions for generating, transporting, and distributing electricity and for using hot water, as well as in the thermal qualities required to supply this element. In other words, the global efficiency of an energy technology does not only depend on its own characteristics but, essentially, on the energy system within which it is used.

Thus, the technology of heating water on the basis of firewood could be more effective than the method described previously, whenever it were better adapted to the energy system in question. This relative nature of technological efficiency should be kept in mind, especially by energy policy-makers.

The second important feature of energy technologies refers to the degree of expertise in the field. This not only refers to the knowledge of a physical - chemical process permitting goods or services to be produced; it also includes the capacity to manufacture capital goods and the capacity to make use of these. Scientific knowledge on, and the manufacture and utilization of, capital goods are all vital elements in technological expertise.

Now that technology has been defined, stressing the relative nature of its efficiency and the elements involved in mastering it, it remains to analyze the situation of energy technologies in Latin America; to reflect on the reason for this situation; and, finally, to identify the region's specific needs and OLADE's possible contribution in that regard.

1. Analysis of the Situation of Energy Technologies in Latin America.

An analysis consists of three stages: first, a description of the subject to be studied; second, an assessment of the situation; and third, an explanation of the phenomena involved. This analytical formula has been applied to the subject of this paper, with the first stage broken down into two focuses: the origin of the technologies and the level of expertise both in the countries that generate them and in those that acquire them.

1.1 Origin of the energy technologies available in Latin America.

The industrial and commercial energy sector was born in Latin America at the turn of the century, with capital and companies from North America and Europe which imposed their technologies when developing oil industries (basically for exportation purposes) and power plants (for the concentrated markets of the large cities). The total technological dependency that had existed at the beginning of the century was gradually reduced, primarily through laws nationalizing the foreign oil companies (in Mexico and Brazil in 1938, in Cuba in 1960, in Peru in 1968, in Ecuador and Argentina in 1974, and in Venezuela in 1975) and through the purchase of foreign power companies and the formation of national ones. Thus began the process of Latin American control over the exploitation of its imported capital goods.

In some countries of the region, a process of research and development was begun on certain specific points, by state energy enterprises or research institutes. This process was extended by the creation of regional organizations such as the ARPEL (Latin American Association for State Oil Reciprocal Assistance), CIER (Commission for Regional Electrical Integration) and by the establishment of research centers. Important advances have been made in:

CHART 1 - EXAMPLES OF ENERGY EQUIPMENT IMPORTED BY LATIN AMERICA IN 1977 (10^6 US$ FOB)

TYPE OF EQUIPMENT	SUPPLIER							
	U.S.A.	JAPAN	W. GERMANY	U.K.	FRANCE	ITALY	SWITZ	TOTAL
Steam engines	68.	161.	47.9	10.7	7.0	9.9	1.9	343.6
Internal combustion engines other than airplane motors	281.4	65.8	63.6	96.6	14.2	30.4	16.9	657.8
Gas turbines	27.1	29.9	17.4	13.3	2.0	—	—	91.5
Nuclear Reactors	5.3	—	12.4	—	—	—	—	21.1
Electric generators	515.9	211.1	121.7	53.1	95.7	45.4	44.1	1 301.5
Electric distribution equipment	56.7	34.9	11.5	15.1	15.4	2.7	0.7	160.7
								2 576.2

Source: United Nations. **Bulletin de Statistiques du Commerce Electriques, 1977.** New York, 1979.

CHART 2 - PRINCIPAL WORLD ENERGY ENTERPRISES

OIL EQUIPMENT AND TECHNICAL SERVICES (1976)

COMPANIES	TOTAL VAL. (10^6 US$)
Baker International	553
Lausser Industries	2 232
Halliburton	4 866
Hugues Tools	383
Schlumberger	1.810
Smith International	308

*P = Petroleum
G = Natural gas
N = Nuclear
Q = Chemical
C = Coal

TECHNICAL SERVICE FIRMS IN THE ENERGY SECTOR (1976)

Kellog EU	PGNQC
Lummus EU	PGNQC
Stone § Webster EU	PGNQC
Lurgi AL	PGNQC
Fluor EU	PGQ
Foster Wheeler EU	PGNQC
Creusot Loire FR	PGNC
Badger EU	PGQ
Snam Progetti IT	PGNQC
Technip FR	PG

PRINCIPAL ELECTRIC EQUIPMENT COMPANIES (1976)

General Electric	USA
ITT	USA
Siemens	FRG
Hitachi	Japan
Westinghouse	USA
AEG	FRG
Shibaura	Japan
General Electric	UK
Thompson-Brandt	FR
Brown Boveri	Switz.
CGE	FR
Schneider	FR
Mitsubishi Electric	Japan

SOURCE: ECLA. **Energy Supply to the Developing Countries.** New York, 1980.

1) the promotion of research and development activities in the energy sector and 2) the training of personnel capable of mastering the technologies used.

Many of these technologies are well-known in the region, some have been adapted; but, nevertheless, a weak point arises in terms of the national or regional production of capital goods for the energy sector. With the exception of a few countries (Mexico, Brazil, and Argentina), the region imports almost all of the equipment required for the development of its energy sector. The suppliers of such equipment and technology are concentrated in a few countries and transnational companies, and energy technologies are imported along with the imported capital goods.

In conclusion, almost all of the energy technologies available in Latin America are imported from the developed countries (with the exception of Mexico, Brazil, and Argentina; Brazil even exports negligible amounts of energy equipment to other countries in the region). Thus, little equipment is generated within the region, and little is adapted to the technical and economic reality of Latin America.

1.2 Regional expertise in energy technologies

The origin of the energy technologies used in Latin America explains in large part the degree of regional expertise in the areas of energy exploration, production, and conversion.[3/]

The energy exploration technologies are generally not very complex, as in the cases of geology and seismology, which reveal the composition and formation of the sub-surface and which aid in locating minerals, fuels,and geothermal fields; and drilling and soundings necessary for hydrocarbon and coal exploration already have a higher degree of complexity, especially off-shore drilling. While, it can be said that the Latin American countries as a whole are familiar with the exploration technologies, which permit the regional energy resources to be estimated, to date, few of the countries have a sound knowledge of their sub-surface and energy reserves (i.e., the portion of the energy resources that it is economically feasible to exploit). Exploration is usually left to foreign companies, which accept the contracts that they think most convenient. This explains the importance of the oil in Latin America, which lies not in the fact that it is the regions's most abundant resource (because it is not) but rather in the fact that it has been pursued by the large international oil companies.

This lack of exploration expertise can be explained —or at least is usually justified— by the fact that these operations are costly and risk-laden. Thus, it would not be wise for a developing country to spend an important part of its small capital on these operations; it would be more reasonable to leave them to the large oil companies which are accustomed to taking such risks. This line of reasoning makes sesnse for a small country, but not for a large country or for a group of countries which could share the risk and costs involved in exploration, while favoring national or regional interests rather than the interests of the large transnational companies. This affirmation can be illustrated well by the Mexican experience, where between 1938 and 1966 PEMEX spent 600 million dollars on exploration and discovered nearly 1 billion tons of crude oil. If they had left the oil exploration work to foreign oil companies, they would have paid out 10 billion dollars, i.e., 17 times more.[4/] Another example of the logic of carrying out the exploration work appears in one of OLADE's studies on coal[5/]: for an area of 50 Km^2., the preliminary geological reconnaissance and detailed geological survey in the areas of interests only costs an average of 615,000 dollars. Later, if there is strong evidence of coal deposits, the drilling program to evaluate the mineral reserves would only ascend to an average of 1,864,000 dollars for an area of 50 Km^2., with work as far as 500 meters deep.

3/ See UNCTAD **Energy Supply to the Developing Countries.** United Nations, New York, 1980.

In conclusion, if all but a few Latin American countries have not mastered the energy exploration technologies, it is not because these operations are very complex but rather because they are expensive and risky; and consequently, the countries have not made an attempt to undertake them at the national level but have left them to specialized foreign firms.

At the level of energy production, the degree of technological complexity varies according to the type of energy and the type of operation. On-shore well drilling is relatively simple, off-shore drilling is more complex. Well completion is complicated in the areas of oil, gas, and geothermal energy. The hydrocarbon exploitation technologies and the enrichment and manufacture of nuclear fuels are also highly complex. In other cases, technology is not very complicated, e.g., the civil engineering and construction of piping, valves and turbines for hydro power plants. Nevertheless with the exception of certain countries such as Mexico, Brazil, and Argentina, most of the energy technologies used are imported; and the decision of which energy to produce, and how, is left up to foreign companies. Once again, the production plans correspond in part to the latter's interests, which seldom correspond to the interests of the countries to which the energy source belongs. Most of the countries of the region have state oil, power and, sometimes, coal companies; and these often control the exploitation of imported capital goods. However, national manufacturers of production goods are lacking; and therefore, there is still little expertise in the energy production technologies. This situation can be explanied by the amount of power that a handful of transnational companies have by virtue of their dominion over the technologies that they prefer to sell or rent rather than transfer.

At the level of energy conversion, the degree of technological complexity is usually low; such is the case of crude oil distillation, and the manufacturing of turbines, alternators, and transformers for power plants or of water heaters, solar pumps, photovoltaic are the manufacture of lubricants, the processes of cells, biogas plants and charcoal plants. The exceptions reformation and cracking of crude oil, the liquefaction of gas, the manufacture of gas turbines and nuclear power plants. Nonetheless, in general, even when a technical procedure is well-known, the Latin American countries import a good deal of the energy conversion devices they require. This is due to several reasons, including the almost immediate availability of energy machines on the international market and the difficulty of developing a market for capital goods in the energy sector when the national market is relatively closed. Nevertheless, certain Latin American countries have developed such industry; and despite the fact that they still import many of the capital goods required by their energy sector, they are already exporting certain types of generators; this is the case of Mexico, Brazil, Argentina, and to a lesser extent, Venezuela.

Thus, for the three levels of energy technology, the Latin American countries depend to a great extent on the developed countries, or more precisely, on a small group of transnational companies which control the energy technologies. The power of these firms rests on several factors: their mastery of the technology (i.e., not only expertise in the techniques but also their capacity to manufacture the machinery), the large amounts of their available capital, and their reputation. Compared to these companies, the Latin American countries are characterized by a fairly good knowledge of the techniques; but given their needs, they have only slightly developed their capital goods sector. They are also characterized by a relative lack of capital which could be invested in the energy sector and by the urgency in undertaking any energy production project, i.e. by a lack of longterm energy planning. Thus, as a whole, despite the important differences and exceptions, Latin America finds itself in the group of countries which must purchase energy technology. Few are the cases of reproduction, imitation, or adaptation of imported technologies, and rarer still the cases of the creation of one's own energy technologies.

CHART 3 · PRINCIPAL PUBLIC ENTERPRISES IN THE LATIN AMERICAN ENERGY SECTOR

COUNTRY	OIL/GAS	ELECTRICITY	COAL
Mexico	Petróleos Mexicanos	Comisión Federal de Electricidad	
Costa Rica	Refinadora Costarricense de Petróleo	Instituto Costarricense de Electricidad	
El Salvador		Comisión Ejecutiva Hidroeléctrica del Río Lempa	
Guatemala	Comisión de Petróleo	Empresa Eléctrica de Guatemala	
Honduras		Instituto Nacional de Electricidad Empresa Nacional de Energía Eléctrica	
Nicaragua		Empresa Nacional de Luz y Fuerza	
Panama		Instituto de Recursos Hidráulicos y Eléctricos	
Cuba	Instituto Cubano del Petróleo	Ministerio de Electricidad	
Bahamas	Oil Refining and Transshipment	Bahamas Electricity Corporation	
Jamaica	Petroleum Corp. of Jamaica	Jamaica Public Service Corp.	
Bolivia	Yacimientos Petrolíferos Fiscales Bolivianos	Comp. Boliviana de Energía Eléc. Anelectrica	Anelec
Colombia	Empresa Colombiana de Petróleo	Instituto Colombiano de Energía Eléctrica	Carbones de Colombia
Chile	Empresa Nacional del Petróleo	Empresa Nacional de Electricidad	Empresa Nacional del Carbón
Ecuador	Corporación Estatal Petrolera Ecuatoriana —CEPE—	Instituto Ecuatoriano de Electrificación —INECEL—	
Peru	Petróleos del Perú	El. del Perú/Electrolima	Minero Perú
Venezuela	Petróleos de Venezuela	Cadafe/Edelca/Enelven	
Argentina	YPF/Gas del Estado	Segba/Agua y En. Hidronorte	Y. Carboníferos Fiscales
Uruguay	Adm. Nac. de Comb. Alcohol y Portland	Usinas de Transmisión Eléctrica	
Brazil	Petróleos del Brasil	Electricidad del Brasil	

1.3 Disparities between resources and needs

In addition to the questions of origin, mastery, and transfer of energy technologies, the problem of appropriateness presents itself, in terms of the technologies acquired and the physical and economic reality of Latin America. Previously, it was noted that the relative nature of the technologies aided in resolving a technical problem industrially, within the context of a specific economic focus. The energy technologies purchased by the Latin American countries were elaborated for the developed economies and form part of what could be termed their energy systems.

An energy system can be defined as the rational group of energy sources available in a given geographical framework, at a given moment, together with the energy and industrial enterprises that produce, transform and distribute this energy; the technologies and machinery that permit these operations to be carried out; and the needs to be satisfied. The energy systems of the developed countries are characterized by the greater availability of certain forms of energy (e.g., the oil bought on the international market in large amounts); by the price relationships among the different forms of energy (relatively low price of hydrocarbons); by the price relationships among energy, capital, labor and space (relatively low price of capital); by the level and rate of growth of demand (high level of total and per capita consumption and high growth rate); and by the quality of this demand (assured utilization, uniform conditions of supply at the national level, spatial de-concentration of the supply and demand, thermodynamic level of demand).

An example will be useful to illustrate this. The classic, large-capacity (600 MW) thermoelectric plants based on fuel oil represent the most efficient way to generate electricity thermally, in developed countries where there is an important demand for electricity. Indeed, the yield of these plants is the highest ever found. This is not due, however, to technical prowess but rather to the point reached in a development process where the following elements are notable:

— competition between hydroelectricity and thermoelectricity brought about important technical changes in the thermoelectric plants (higher temperatures and greater turbine speeds), thus increasing the thermal yield - in large part due to the fact that the production of coal, steel, and electromechanical equipment was concentrated in the hands of a small number of industrial and financial groups, unlike the case of hydroelectricity; and

— the continuous growth of demand and its increasingly higher levels permitted scaled utilization, and interconnected networks permitted an assured supply.

All of this encouraged the consumption of electricity at the domestic, industrial, and transportation levels (railroad), in turn permitting scaled uses, a certain levelling out of the load curve, and a better amortization of the investment costs, which resulted in lower prices and greater incentives for an expanded electricity consumption. With the low oil costs as of the 1960's, new technological changes were developed in order to take advantage of the calorific value of fuel oil, which is higher than that of coal. Moreover, the high level of concentration of builders led to preferences for larger rather than smaller constructions, and thus eliminated small builders from the competition. It should also be noted that the increase in size corresponded to the phenomenon of the substitution of capital for labor, which grew out of the needs of the developed capitalist countries, where labor was more and more costly as compared to capital. The larger size was also a way to economize space, which was beginning to be scarcer in the industrialized countries. Thus, it can be said that in an economy such as that of the United States, Europe, or Japan, a 600 - MW thermoelectric plant burning fuel oil is very efficient, given the characteristics of these economies: particularly, electrical interconnections, high levels of electricity consumption, high growth rates for demand high degrees of concentration among electromechanical

builders. Likewise, it can be shown that the large refineries, with a capacity of 300,000—500,000 barrels per day, do not really constitute optimal refining technologies, but rather correspond to the technical and economic features of the oil supply (concentration of the oil producers and builders) and to the structural characteristics of the demand for refined products in the developed countries.

In general, however, for the Latin American countries, such a power plant or such a refinery is not efficient. If the power capacity of an electric plant represents a high proportion of the so-called total power, the electricity supply is not reliable; if the base electricity demand is not very important in comparison to the size of the plant, then the latter will not be able to achieve its theoretical efficiency. Moreover, if the country has energy resources other than oil (the case of almost all the Latin American countries, which have little oil but a good deal of other energy sources, such as hydroelectricity), these resources cannot be developed because the country will prefer to import fuel oil to supply the plant. In a way, not only is a plant being imported but also an energy system, that is, a technology, its inputs (machines and energy), and its products (plant work patterns and energy consumption trends).

If the imported energy system falls within the country's economic framework, the choice is effective; but, generally, this does not happen. Instead, the imported machinery determines both the energy flows required to run the equipment and the energy consumption patterns, independently of the resources and needs of the importing country, and despite the fact that these apparent needs determine the decision to import in the first place. Thus, it should not be surprising that in 1979 the percentage of the hydroelectric potential developed in the Latin American countries was only 7%[6], when at the same time the regional oil imports were creating acute problems (in 1979, the Dominican Republic stressed in an official document that Latin America imports as much oil as it exports, a fact which makes manifest both the region's dependency on the international market and the disparaty between its oil resources and requirements). Neither should it be surprising to learn that in general the efficiency of energy consumption is lower in Latin America than in Europe[7], nor that almost half of the regional population is marginal to the production and consumption of commercial energy, which at an official level represents the part of the energy sector which it is useful to develop; while the energy consumed by the transportation sector accounts for a substantial part of energy consumption.

Thus, it can be seen that the energy technologies available in Latin America are not only a means of providing energy to the economy but they also constitute a factor in determining, to a great extent, 1) the availability of energy resources (due to a lack of appropriate technologies, no attempt is made to develop the other forms of energy) and 2) the energy consumption patterns (since they are commercial, these patterns correspond to the needs expressed by the sectors of the population with the highest incomes and do not correspond to the needs, sometimes even the basic ones, of the majority of the population). The inappropriate technologies also bring with them low levels of efficiency in the utilization of the available energy. This would seem to contradict the reasons for importing these energy systems which are characterized by their inappropriateness for the Latin American energy resources and needs.

II. SOME EXPLANATIONS FOR THE SITUATION OF ENERGY TECHNOLOGIES IN LATIN AMERICA

If the situation of energy technologies in Latin America is viewed from the perspective of their results, i.e., the disparity between the region's energy resources and requirements, it should be asked what the reasons for this situation are. Within these, three are usually pointed out as the main explanations: 1) the comparative level of importation costs and the origin of energy technologies; 2) the lack of capital goods manufacturers for the Latin American energy sector; and 3) the lack of energy planning at the national or regional level.

2.1 Comparative level of technological costs

The comparative level of the costs of importing or generating energy technologies usually explains or justifies the energy technologies imported in the region. The decision to import technologies is based on calculated costs. At first, the costs of importable technologies seem incomparably low. In light of the fact that the markets of the developed countries are the largest in the world, the producers of capital goods for the energy sector can take advantage of the large - scale production of any type of machinery corresponding to the characteristics of the developed countries' energy systems. Once the main investment costs of the manufacture of these goods have been amortized by sales in the markets of the developed countries themselves, they can be sold at an even lower cost in the markets of Third World countries, as shown by the product life cycle theory of Raymon Vernon. However, another type of equipment technology, generated in Latin America, would be something of a prototype and would thus have a much higher cost per unit. The costs of producing such equipment would also be much higher when undertaken in the Latin American countries.

This view of costs belongs to the economic theory of international specialization, and the international division of labor, i.e., the specialization of the developed countries in those forms of production having large aggregate values and of the developing countries in those forms of production having low aggregate values - or in the words of Eduardo Galeano, "some specialize in earning, others in losing."[8/] It is this international division of labor that imposed "competitive" production from the developed countries on the Latin American nations, thus destroying the latter's industry, relegating to them the production of raw materials, and generating unemployment and a total dependency on the countries that purchased their products. In the context of this international division of labor, the gap between the two groups of countries can only widen. For this reason, the Latin American countries have to develop their own energy technologies.

The production of energy technologies proper to Latin America would most certainly be expensive, but it would supply the regional economies through energy systems adapted to the prevailing economic characteristics. Such technologies could permit the development of the exploration and exploitation of the local energy resources instead of increasing the volume of imports. These technologies would have to correspond to an energy consumption level much lower than that of the developed countries, so that the machines could be used efficiently without encouraging useless energy consumption. When the costs of developing and implementing these technologies are compared to the costs of acquiring imported technologies, it can be concluded that when all is said and done, this criterion of costs should not be a determining factor in decision-making. The purchase of foreign technologies corresponds to a drain of the currency and values produced in a country; and it has as a counterpart the low-efficiency operation of these technologies, a fact which is seldom taken into account in the economic calculations.

In addition, the creation of energy technologies proper to the region would permit 1) the part of the patrimony constituted by natural resources to be given its proper value, 2) a domestic market for a national capital goods industry to be created for the energy sector, and 3) energy systems to be established to correspond to the economic characteristics of a given country or region. Although the costs are higher in this last case, one of its fundamental features should be stressed: the costs of assessing the national or regional energy resources and of manufacturing the necessary equipment in part consists of wages which permit, through consumption, the broadening of the national market and an increased voluntary and compulsory savings. In conclusion, these costs correspond in large part to an enriched national or regional reserve, while the importation costs mainly correspond to a decrease in the same. Moreover, such efforts can constitute a prime mover in the economies concerned, whereas importation is a hindrance.

It should also be noted that while energy is indispensable to the workings of an economy, its low cost is not; and any small cost increase cannot have grave consequences when there is national production. (With the exception of Brazil and the southern tip of South America, the price levels for energy in Latin America are currently much lower than those in the rest of the world). In industry in general, the part that energy plays in the total production costs is approximately 5%. This average covers the differences between the 2% figure for most industries, the 20% for the cement or paper industry, and the 40% for the iron and steel industry. Therefore, a higher energy supply cost, due to the implementation of energy technologies proper to the region, would have almost no repercussions for prices on the internal or external market, except for the energy-intensive industries, for which suitable measures could be taken.

A higher energy cost would have an income re - distribution effect. Energy consumption would grow more rapidly than the level of income, so that high levels of income would be more affected than low ones. It can also be considered that a higher energy cost could facilitate the development of local or national sources of energy, conventional or not, whereas the current level of prices would not permit this. Finally, it should be noted that by virtue of the fact that technologies proper to the region would be more efficient than imported ones, energy consumption could be reduced; and although costs could prove to be higher per unit of energy, the global cost of the national or regional energy supply would not be higher.

In conclusion, it is useful to recall that at the end of the last century, Germany developed its own energy systems, based in large part on the use of national lignite reserves and on the hydroelectric equipment for small water falls, and at a time when the medium - sized power plants based on coal were already quite efficient. Nonetheless, the German economy did not suffer from this decision. Despite its being a frequent justification for choosing imported technologies, the criterion of comparative costs (imported vs. national or regional energy technologies) should not be considered a determining - nor even valid - factor in such decisions.

2.2 Lack of local capital goods manufacturers

The second reason which explains the situation of the energy technologies in Latin America is the lack of local manufacturers of capital goods for the energy sector. With the exception of Mexico, Brazil, and Argentina, the Latin American countries import the machinery required by their energy sector, and for that reason, they have not developed their own technologies. Thus, even when technological research has been undertaken, it has not been at the industrial level. This is usually explained by three factors: international competition hinders national production; the national market is too closed; and the capital goods industry is capital-intensive. The manufacturers of capital goods for the energy sector are few (see Chart 2); this high degree of concentration makes it possible for them to dominate the market, creating many barriers to entering these industries[9/], due to the difference in direct equipment costs which have demonstrated that the demand elasticity is quite low in comparison to the prices[10/]. Nevertheless, factors such as brand name and supposed reliability are determining factors, along with the conditions for financing and the availability of replacement parts.

In reality, this question of differential costs for the manufacturing of capital goods in the countries of Latin America and the developed countries is not an explanation for the lack of this industry in the regional countries, for the reasons set forth above.

The relatively closed national market seems to be a better reason to explain the lack of a capital goods industry in the region. This characteristic does not justify the installation of factories for energy equipment, since they could not operate with a high utilization rate. Moreover, since many machines are imported, the internal market is even smaller. It should also be pointed out that in almost all the countries of the region, the specifications of the various energy products are

quite different for historical reasons; thus, it would be difficult for a local manufacturer to embrace them all. Nevertheless, these obstacles can be overcome through regional cooperation, as in the case of the Andean market where each country is specialized in certain kinds of production, permitting investments to be made in facilities that would be economically profitable.

Another explanation for the lack of a capital goods industry for the regional energy sector is a technical-economic feature of these industries: the fact that they are capital-intensive. The lack of capital gives them a high cost in comparison with labor costs; therefore, the long-term investment recovery in capital-intensive industries discourages potential businessmen, and even more so when long-term profit-making is not assured for their investments, since it seems that a well-defined market does not yet exist. Private sector businessmen prefer to invest in the consumer goods industry, where well-defined markets with a well-known growth rate do exist, where the markets are often protected from external competition by tariff barriers. Insofar as capital goods, which constitutue a part of the cost of other industries, the regional markets are largely open to imports so that their prices will be as low as possible.

In sum, it should be specially noted that the lack of capital goods industries in the majority of the countries of the region is not so much the result of economic restrictions as the result of economic policies. In order to develop private investments, the State attempts to minimize production costs, particularly the costs of capital goods; it also tries to assure sufficient profits by limiting the existing markets, i.e., the markets for consumer goods. Thus, most of the latin American countries do not have capital goods industries for the energy sector and they therefore import the machinery which is required. They import energy systems from the developed countries and these are inefficient when transplanted to the countries of the region.

In this context, the experience of the developed countries can aid in determining energy and industrial policies: the arrangements that arose in most of these countries between a public or private enterprise for the construction of the material necessary for the industrial development of the public firms gave rise to and strengthened national manufacturing of capital goods for the energy sector, competitive at the international level. Thus, the world's large energy companies are not the result of the free market play but rather the result of nationalistic industrial policies.

When the Latin American countries decide to implement industrial policies to develop the capital goods industry for the energy sector, it can be seen that, at least in some areas of this sector, there are few barriers to entry. Two examples can illustrate this.

In order to develop its petroleum industry, Mexico had to import drilling rigs. When the iron and steel industry decided to manufacture such towers, with aid from the State, they were able to cover an appreciable part of the national market and are now even exporting their products to other countries of the region, such as Ecuador. Another more recent example can be found in the Institute of Electrical Research of Mexico, which invested 300,000 dollars in the acquisition of four machines with an annual production capacity of 10,000 transformers, for the transportation and distribution of electricity. On working with the technology, one realizes that it is not so very complex and that it adapts easily to local market conditions (technical characteristics, buyer specifications). One also realizes that reliability is not necessarily linked to the name of a large North American, European, or Japanese company; and it can be seen that production costs are acceptable. Nevertheless, in this case, the size of the Mexican market was only 5000 transformers, and this makes manifest the need for regional cooperation in order to develop such efforts under better economic conditions. To these two examples many more could be added, demonstrating that when there

exists a political will to develop a capital goods industry for the energy sector of a given country, the barriers do not seem as great. However, it would also appear that regional cooperation is required to develop these activities under competitive production conditions.

2.3 Lack of energy planning

The lack of energy planning at the national level also seems to explain regional dependency in terms of energy technology. Thus, for example, this lack of energy planning was mentioned by almost all of the twenty directors of energy research institutes who met in Cuernavaca at the beginning of October 1981, under the auspices of OLADE, to exchange information on their work and requirements, to decide on joint projects, and to debate the principal problems that limit the development of energy research in the institutions of the region.

More precisely, the following problems were identified.

— Lack of, or deficiency in, the adoption of energy, technological, and industrial policies; insufficient general inter- institutional coherence.

— Deficient planning schemes.

— Institutional and organizational deficiencies at the sectorial level, related to the development or utilization of the results of research on energy technologies.

— Lack of coherence among research activities in terms of energy processes related to those required for the development and production of equipment.

— Deficient schemes for establishing priorities for the execution of projects, considering the scarcity of available resources. Thus, it is necesary for the governments and institutions to make greater efforts to define and establish priorities for the problems to be resolved.

— Lack of continuity and long-term projections for technological development activities.

— Lack of ties with the production sector, a fact which limits the application of research results.

— Lack of a balanced analysis of the development needs in the areas of conventional and non - conventional energy sources, which means that important efforts are left inarticulated and decisions are made with insufficient consideration.[11/]

At first glance, it may seem strange that in most of the countries of the region there are market economies rather than planned economies. The main problem in terms of energy technologies is identified with the lack of planning. This contradiction is only apparent; since research time is long, especially in the energy sector, it cannot be subject to the short-term needs of the market. The future market equilibrium is determined through necessarily centralized planning, which is seen in both countries with a market economy as well as in those with planned economies.

Then, it would seem that the lack of planning becomes a problem when it does not permit sufficient development of research in the field of energy technology, when such research exists but is undertaken independently of the needs expressed by the region or when it does not take place at the industrial level. In reality, few are the countries which have developed technological research in the energy sector, including industrial possibilities. In general, this lack of planning can be explained by the fact that it is impossible for the governments to control basic variables in order to accomplish the objectives of an energy policy. Due to a lack of political decision or political power, the variables of action that permit the long-term planning of energy technology become restrictions characteristic to the external dependency of the regional countries.

In conclusion, this rather superficial analysis of the explanations for the dependent situation of the Latin American countries in terms of energy technology demonstrates that the obstacles to an autonomous

development of energy technologies proper to the region does not seem to be of either a technical or economic nature but rather a political one; in other words, they lie in the lack of political decision or power which would be necessary for 1) the development of research on energy technology and 2) manufacturers of capital goods for the energy sector, based on technologies adapted to the region's resources and needs.

3. SPECIFIC REGIONAL REQUIREMENTS AND THE ROLE OF OLADE

In July 1979, in the Pronouncement of San Jose, the Ministers of OLADE, assembled for the First Extraordinary Meeting of the organization, set forth the problem of energy technology in the region and the importance of finding solutions to modify the current situation.

"It is useful to continue fostering cooperation and the transfer of technology among the countries of the region in a continuous and sustained way for energy matters. Nevertheless, since a good deal of the advances in this area do not originate in these countries, it is necessary to propose, in the appropriate international forums, the formulation of new and specific regulations —less restrictive than the prevailing ones— for the transfer of energy technology coming from the industrialized nations. Given the central importance that the increase in energy supply holds for the entire world, it is in the collective interest to give preferential treatment in this field to the developing countries.

"Because the energy consumption patterns of the countries of the region are determined to a large extent by the machinery and equipment originating in industrialized countries, the rationalization of such patterns depends on the degree to which the region heightens its capacity for technological self-determination within the scope of the economy as a whole. This objective, undoubtedly a long-range one, should always be kept in mind in designing global and sectorial policies, due to its implications for the field of energy."[12/]

Thus, the disparities between the region's energy resources and needs are notable, due to the fact that the available energy technologies are imported from the developed countries and are therefore inappropriate. It should also be noted that it is necessary to modify the present situation through the local generation of technologies adapted to the physical and economic framework of the region.

The possibilities for modifying this situation are presented below, along with the role that OLADE could play in this regard.

3.1 Situation not exclusive to the energy sector.

A simple observation which can be made is that the situation of the energy sector and technologies in Latin America, as described in the foregoing paragraphs, is not a characteristic particular to this sector, but characterizes the Latin American economies as a whole. This situation is one of the results of the economic policies that are most commonly found in the region, and these can be described schematically as follows.

In order to develop private investment, the governments try to reduce production costs in order to increase profits. Therefore, the machines and technologies are imported from the developed countries and they are characterized by their comparatively low costs. In addition, the existing public enterprises function with a financial deficit, equivalent to a subsidy for the private sector, which uses the services of the public enterprises. Moreover, the national production of consumer goods is protected by tariffs so as to reduce international competition and to assure attractive rates of profit for national businessmen. Within this scheme, the products of the energy sector are considered to be a cost which it is necessary to reduce, specifically through the importation of machinery and technology. These observations, which

can seem to be outside the scope the present paper, have an important objective: to demonstrate that the situation of the energy sector is not an isolated factor and thus cannot change if everything else is not changed as well. This complexity does not mean that it is impossible to modify the dependency and inappropriateness of the regional energy technologies; however, these goals are ambitious, long-term ones. Action in this field is characterized by its political nature, i.e., it requires political decision. To be realistic, the activities of OLADE will have to bear all these elements in mind.

3.2 Highly developed research on energy technologies in Latin America

Despite the aforesaid, Latin America has a scientific, technical, and industrial potential that is quite developed in the field of energy technologies.

As for the training of technical and scientific personnel, there are high-level information centers in Latin America, in the universities, in public training institutes, and in centers created by public and private enterprise. There are also systems of scholarships and grants which aid in completing professional or technical training abroad.

In terms of technological research in the energy sector, Latin America has a large number of institutes which undertake specific projects in various areas of energy. It would be too much to list these projects or these institutes. Nevertheless, the main areas of energy research in Latin America, can be broken down as follows; technical research takes place in the following fields: hydrocarbons, coal, nuclear energy, electricity, new and renewable sources of energy, hydro power, small hydro power stations, geothermal energy, solar energy, bioenergy, wind energy, bituminous sands, and the conservation and rational use of energy. In terms of research of an economic nature, the following should be noted: development and transfer of technology, global energy planning, financial energy analysis, energy information and documentation, energy and environment, and capital goods for the energy sector.[13/] This list reflects the fact that the main problems of the Latin American energy sector are already the object of serious investigation (perhaps with the exception of energy in the transportation sector, which was not included); it also demonstrates that the region is attempting to find appropriate local solutions to these problems and that the region has the scientific capacity to do so.

In terms of the manufacture of equipment and materials for the energy sector, it should be noted that there is a quite important production capacity. On the one hand, in countries such as Mexico, Brazil, or Argentina, there are large companies, often public, in the heavy equipment or electromechanical sectors which to a certain extent supply the country's energy sector. In Brazil, this type of enterprise even includes nuclear power plant construction (activities of this kind are usually carried on in the developed countries; Brazil and India are the only exceptions). In addition, throughout the region there are many small private enterprises which often began with the importation of machinery and equipment for the energy sector, which later developed their activities with imported parts and then with the manufacture of such parts, and which are now capable of building several of these machines required by the regional energy sector.[14/]

To the extent that this capacity exists in the fields of training, research, and materials manufacturing for the regional sector, it would seem possible to develop and implement energy technologies adapted to the physical and economic framework of Latin America, despite the political problems that would oppose such activity. Within this context, OLADE can play a role such as that pointed out by the Ministers of the organization in the Pronouncement of San Jose in July 1979 and reaffirmed by those who took part in the Meeting of the Committee of Ministers of OLADE in September 1981, in Acapulco.

3.3 OLADE's possible role in the development of energy technologies proper to the region.

One of the main objectives of the Latin American Energy Organization is to promote the solidarity of

action among the member countries, in the energy sector. Some of the recent results demonstrate that the countries which compose the organization go beyond the good intentions and aspirations represented by the objectives of OLADE. This can be illustrated by two transcendental examples in the area of conventional energy sources. One is the Energy Cooperation Program for Central American and Caribbean Countries, a program which was implemented in August 1980 and in which Mexico and Venezuela have committed themselves to attend the oil consumption of the Central American and Caribbean countries. The other example of OLADE's success in terms of promoting regional solidarity is the multi - national oil protocol signed on October 16, 1981, by PEMEX, PETROBRAS, and PDVSA, wherein these three Latin American state oil companies propose joint objectives in the field of oil exploration.

These two examples demonstrate 1) that the OLADE member countries can overcome political problems opposed to a more autonomous development of the energy sector in the countries of the region and 2) that cooperation among them is the principal way to respond to the current situation of dependency. Thus, it can be affirmed that OLADE is capable of promoting actions for an autonomous development of the regional energy technologies, given the importance of the current energy challenge. It is certain that self-determined technologies are not going to radically modify the economic patterns of the countries of the region; nevertheless, the recognized need to change the current energy systems requires different technologies. Thus OLADE can act on five different levels: macroeconomics, microeconomics, the capital goods industry, energy production, and energy forecasting.

At the macroeconomic level, the role of OLADE is to demonstrate the importance of energy planning to rationalize decisions in this basic economic sector. Planning compatible with market economies is the only way not to waste the regional resources and to learn what the energy requirements are and how to satisfy them through long-term decision-making. Since the lack of planning is the main problem confronting the national energy sectors, so that they can be based on self-determination, to remedy this situation is OLADE's main objective. The organization has to sensitize the governments of the member countries in this regard, and the other levels of OLADE's activities are subject to this primary objective.

At the microeconomic level, the organization should facilitate the exchange of information on the workings of the energy sector firms, with particular stress on the example of the public enterprises. The latter are actually the principal actors in the energy sector; and a good knowledge of their behavior, through the regional exchange of experiences, is imperative in order to be able to control the principal variables for action in the field of energy planning.

At the level of capital goods industry, OLADE can contribute effectively to reducing the problems caused by the closed nature of the individual national markets by promoting cooperation at this level. A better knowledge of the regional energy enterprises will reflect the long-range requirements of the regional market for capital goods in the energy sector. Investment needs can be forecast in terms of production capacity, type of equipment, and financing. Once again, cooperation among the countries of the region is a necessity, in order to base this industry on technologies appropriate for, and proper to, the regional requirements and in order to make it competitive.

At the level of energy production, the role of OLADE is to underscore the characteristics of the energy demand, in order to best satisfy it on the basis of the available energy resources. In other words, the role of OLADE is to contribute to providing the countries of the region with energy systems adapted to the regional energy requirements. In order to achieve this objective, it is extremely important to develop specific programs, corresponding to concrete needs: construction materials, urban transportation, the iron and steel industry, etc. It should be reiterated

that regional cooperation is extremely important, as is the exchange of information on production techniques and the use of energy, in order to be able to construct new energy systems characteristic to the region and based on self-determination and the adaptation of these systems to regional resources and requirements.

Finally, at the level of energy forecasting, the role of OLADE is to foster imagination in order to find long-term solutions to the current energy problems. This level of action is very important, because it is imperative to project the region's energy future, in order to be able to abandon this attitude where it is expected that technological changes will take place in the industrialized countries and that later new technologies will be imported and adapted. This level of projection is imperative in order to achieve an autonomous pattern of development for the energy technologies and to implement in the long run energy systems independent from those of the industrialized countries.

In this way, the role of OLADE can be stated as follows: 1) to develop and implement energy technologies proper to the region, 2) to underscore the importance of energy planning, 3) to promote the implementation of the same in the countries of the region, and 4) to encourage cooperation projects. The challenge is even more important since the role of energy is changing with the so-called "energy crisis"; Latin American industrialization should be based on energy technologies adapted to the region's socio-economic characteristics, as well as on self-determined economic systems. Time is a fundamental variable in this challenge, since the large companies that supply Latin America with inappropriate energy systems are now developing new energy technologies. Thus, it is imperative to meet this challenge before such inappropriate technologies can again be imposed.

4/ See Tanzer, M. **The Political Economy of International Oil and the Underdeveloped Countries.** London, Temple Smith, 1970, pp. 292—298.

5/ OLADE. **Methology for the Exploration and Thermal Use of Coal.** Quito, 1981.

6/ OLADE. **The Hydroelectric Potential: Energy Alternative and Industrial and Financial Challenge for Latin America.** ECLA, 1981.

7/ OLADE. **Latin American Energy Cooperation Program.** Chapter III.3.

8/ Galeano, Eduardo. **Las venas abiertas de América Latina.** México, Siglo XXI (publishers), 1971.

9/ See UNCTAD, op. cit.

10/ See Surrey and Chesshire. **The World Market for Electric Power Equipment.** Bridgton, 1972, 194 pp.

11/ OLADE. **Final Report of the First Seminar for Directors of Energy Research Institutes.** Cuernavaca, October 7, 1981.

12/ OLADE. **The Latin American Energy Juncture and Regional Cooperation.** Quito, 1979.

13/ See, for example, four OLADE studies on this subject:

OLADE/UNDP/UNEP. **Energy Alternatives for Latin America: A Study of the Capacities for Using Non-conventional Sources of Energy.** Mexico and Quito, 1979.

OLADE. **First Inter-agency Meeting on Energy Cooperation in Latin America: Summary Chart of Energy Programs.** Quito, May 1981.

OLADE. **System of Inter-agency Information on Energy: A Summary of the Institutional Profiles.** Quito, September 1981.

OLADE. **Panorama de la Investigación Tecnológica en el Marco del Programa Latinoamericano de Cooperación Energética.** Cuernavaca, October 1981.

14/ Some of these firms are listed in OLADE studies; see, for example: OLADE. Regional Program of Small Hydro Power Stations. **Situation and Perspectives of the Technology and Equipment for Small Hydro Power Stations in Latin America.** Quito, September 1980.