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FOREWORD

The absence of energy development plans up to now has been a reflection of the dependence that our countries and the world in general have had on petroleum.

On the basis of this affirmation during the last two years OLADE has undertaken the elaboration of a methodology for the constuction of energy balances, which due to its adaptability is suitable for developing national, subregion and regional energy balances for Latin America.

Even though the energy balances are just one of the instruments for energy planning, they are the fundamental tool for decision-makers, with a view to generating the information and developing the activities that in the medium range, will permit the formulation of the necessary national energy plans.

From the work developed in this area, OLADE can present for the first time an analysis of the regional energy problem also including two important sub-regions, Central America and the Andean Area. On the basis of this, one can observe the real consumption structure of those areas and especially the importance of firewood in the energy supply, a situation which has always been underestimated.

This is particularly notable in the domestic sector where firewood and charcoal consumption surpasses 50% of the total. This is a direct result of the income of those marginal sectors which depend more and more on these resources to satisfy their energy needs. This has reduced the availability of these reserves and has led to greater levels of deforestation and other ecologically damaging affects.

In addition, energy demand projections were elaborated according to economic growth criteria; and these provided an idea of the challenge which our countries must face in order to reach the desired social and economic levels.

It should be mentioned that the Regional Programa of Energy Balances has had to develop this first phase very quickly and, the data from some of the countries was not available until the end of September. For this reason, the analyses presented herewith are preliminary and obviously can be improved, atask which is currently underway.

Finally, the Permanent Secretariat of OLADE would like to take this opportunity to recognize the work of the group of Latin American experts brought together to make the organization's goals a reality as illustrated by this publication.

GUSTAVO RODRIGUEZ ELIZARRARAS

Organización Latinoamericana de Energía

ENERGY BALANCES AS AN INSTRUMENT OF PLANNING

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1. INTRODUCCION

Integral energy planning is a relatively new phenomenon, the product of increasing interactions within the energy sector. The evidence of a progressively more accentuated interdependence among the various sub-sectors, the need for conservation, and the sometimes complex substitution mechanisms have, among other factors, given rise to a focus on energy planning problems from the perspective of integral criteria, exceeding those found in sub-sector planning schemes.

Energy Planning in Latin America has its origins in the electricity sector, and it is valid to affirm that for many people even now "energy" means electric energy, despite the fact that the latter represents, at most only 20% of the total consumption.

With respect to hydrocarbons, the activities in this energy area have presented great variations in development programs; it is the case of the netly oil-exporting countries where the production rate is conditioned by the world demand which is controlled by the large transnationals and oriented toward basically satisfying the oil needs of the industrialized countries. With the revaluation of this fuel, all the countries have initiated programs that permit the oil to be supplied within a scheme of integral energy planning. Coal, despite being a traditional resource in Europe and the United States, needed to be "rediscovered" in our region when the oil prices demonstrated to the world that this product was finite. With this, coal became a new alternative for Latin America. Firewood and other non-commercial fuels, aside from being the only energy forms that allow the substistence of large parts of the population, have not aroused the interest of planners who in general are more concerned with analyzing how to finance and equip electrical production wihout paying attention to the consumption and production patterns of the misnamed "non-commercial" forms.

Many professionals linked to energy planning still believe, even today, that firewood is something which belongs to the past; and they are surprised to learn that this product accounts for 40-70% of the primary energy balance in many countries, as can be demonstrated on the basis of recent surveys. There has been no historical experience with the new sources of energy, but there is a growing interest in their future development. They are viewed as a kind of "salvation" for humanity in the face of rapidly depleting traditional reserves.

By simply adding together the problems enumerated above, one does not obtain the true nature of their interrelationship, nor define the great diversity of alternatives which are opened up to a given country or region. The awareness of this fact led OLADE to work with a more global analytical concept, on the basic of which more solid elements could be provided for decision-making.

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Energy balances have arisen, then, as the first stage of a global focus; and their aim is to indicate the current situation, broken down into primary energy, transformation, secondary energy, useful consumption, etc. A first contribution of this instrument, which already justifies its existence, lies in building a system of consistently reliable information. It is well known that the best formulations have faults when they are fed by poor data. However, there is not always an awareness that the required information does not necessarily exist before the need for it to be used, and thus its creation should be conceived of and handled within an integral perspective of the problem.

2. HISTORICAL ANALYSIS

With a uniform series of energy balances, it is possible to carry out an historical analysis, serving as a quantitative stage on the basis of which retrospective analyses can be undertaken and invaluable indicators can be contributed to current evaluations.

The analysis of trends in the different elements composing the balances reflects the dynamics of the overall historical series: which elements are expanding, which are declining, how these series compare with the equivalents of other countries, and what advantages or drawbacks are foreseen for the future if these trends are maintained.

The analysis of these structures by products and by sectors provides a picture of the historical dynamics of substitution. First of all, for Latin American it is interesting to learn the relationship among the residential, transportation, and industrial sectors, at the levels of final consumption, useful consumption, and utilization losses. An in-depth examination of the losses in each sector indicates the efficiency of energy use and provides insight into energy rationalization, thereby permitting the optimization of production and use. This efficiency analysis is one of the most important aspects of the study of an energy system. Although it is difficult, it constitutes a necessary orientation since it is the only way to adequately ilustrate the substitution and conservation of demand.

The next step in the historical analysis attempts to link the absolute and relative energy magnitudes with appropriate socio-economic variables, for the purpose of determing inter-related parameters (consumption per unit of sectorial aggregate value elasticities in price, consumption, product/consumption, etc,; process unit consumption and equipment utilization, energy consumption coefficients, among others). The examination and critical selection of these parameters is very useful with the procedure for selecting analytical variables for the global energy magnitudes with a view to demand projections. It is particularly interesting to know the relationships among final energy, usefud energy by sectors and the socio-economic indicators, finding the way to link secondary energy products and final primary products with such indicators. The novelty introduced by the use of energy balances at this stage of the analysis is the fact that functions closer to the consumer and to the mode of consumption, are being dealt with.

This historical analysis of the supply begins with the transformation sector, with the examination of equipment technology and transformation efficiencies. Historically experience in this field has been restricted to the electricity sector and sometimes to that of liquid hydrocarbons; but it should be extended to include all the transformation centers, including those corresponding to non-commercial energy. The supply picture is completed by the primary and secondary energy production structure and the relationship of the latter with the level of resource utilization, the examination of the transportation losses, the energy sector's own consumption, and unulized energy.

Thus, an historical analysis puts the planner face to face with the reality of the phenomena which have been produced in the past and teaches him to discern the relationships and trends which have governed them. The didactic consequences of this

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process are unquestionably formative elements in line with the fundamentals of global planning, which is conceived of as an emminently practical activity. This process permits the detection of bottlenecks by differentiating between the principal and the secondary, in order to prepare the model construction stage.

It is quite commonplace in the developing countries to have attempts to adapt an unknown reality to a known formulation, imitating models from industrialized countries and thus using an inappropriate focus since the model should arise from the reality and not vice versa.

3. DEMAND MODELS

The energy demand, just as that for any other economic good, should be estimated by a model which interrelates different variables; and for that, there are three elements available: theoretical statistics, econometrics, and historical analysis. The first provides the techniques and the latter two contribute to the art of using this technique so as to obtain better resutls. Even so, this result always be tentative; and the important aspect of a demand model does not lie so much in its capacity to be "correct" as in its ability to forecast alternatives by discerning the pehnomena using appropriate variables. It should be kept in mind that the reality will always be unique, while the projection of this reality can be quite broad. The classical concept of projections by means of diverse, alternative means is common both to the sub-sector focus and to the global perspective; and in both cases, a good model will be that which can provide a high probability of demand for a good, where certain given factors come together in the variables of the mode.

So, the novelty introduced by global analysis does not lie in the statistical and econometric techniques that are applied, but rather in the different way of interpreting the explainable and explicit variables. Ideally, an attempt is made to take as an explicit variable the number of useful calories consumed by a sector, independently from the secondary product or the primary source of origin. This function proves more stable than that corresponding to a given product and less sensitive to variations in the econometric parameters; and it is fairly independent of the substitution phenomena (from a theoretical point of view, it depends on technology and the mode of use).

In practice, if no balance is available at the level of useful energy, the demand for useful calories should be derived from the number of final calories; and it is preferable to adopt efficiency measures for the use of the different products, which, although not precise, will better represent the demand than if they were not taken into account. For instance, it must be reflected somehow that the gasoline used in transportation has an efficiency value of some 15%, the electricity in mechanical movement yields around 80%. In other words, although the tendency should be to conceive and project demand by uses (heat, steam mechanical movement, lighting, etc.), many times it is sufficient to consider final energy by sectors (residential transportation industrial, etc.) and analyze it for each one of the intervening products.

On the basis of the useful energy or final energy demand, affected by the average utilization coefficients, one should proceed to the final primary and secondary energy demand. At this point, different paths are opened up, depending on each particular problem and on the knowledge that exists with respect to the consumption patterns of the diverse sectors. From another point of view, it can be affirmed that this is the moment at which econometrics should turn to common sense, since to determine the demand by sectors requires the consideration of substitution policies and mechanisms and the efficient use of energy. This phenomenon cannot generally be detected by purely econometric models, although the component of the relative substituting and substituted product prices should be present for the analysis. However, it is very doubtful that the statistical method can capture the cross elasticity by taking as an

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explicit variable the price of the substitute. Even in the case of capturing it, with what validity could that figure be used in the future when even the elasticity itself is many times of doubtful utility in the projections?

In sum, it can be said that if the phenomena that affect the demand by products are numerous, those which affect the global demand by sectors are fewer; and therefore, these magnitudes are more stable. For this same reason, they act as valuable elements of control and consistency for the demand by products, which if taken independently to be added later, will most probably be overly unequal while others will remain too negligible; and a well-known statistical fact such as the inactivity of non-linear functions will distort the proportions and cause inconsistencies.

Thus, insofar as the modeling of demand, it can be said that the function of an energy balance is first of all to contribute the informational basis on global magnitudes and then, on the basis of the historical analysis of the various parameters participating in the model, to detect the logic of the substitution and conservation of the past, in order to correctly propose new policies for the future. Econometrics in the modeling of demand can be quite useful if it is given the place it deserve, i.e., that of a tool which should be in perfect shape in order to use it to carry out a sound formulation of models but it cannot be the model. It should not be forgotten that the global analysis actually arises from the impossibility of sub-sector models to anticipate the susbstitution mechanisms in the demand through pure econometrics.

4. MODELS TO FORECAST FUTURE ENERGY SUPPLY

In this field, one must be careful since an exaggerated insistence on a global focus can lead to a dead end. Experience with models during the last 20 years has demonstrated that the only global supply models which have lasted have been linear programming ones. Nevertheless, developing countries should bear in mind that the advanced countries have adopted that type of global linear models (such as the MARKAL or BROOKHAVEN) after having completed the sub - sectorial planning stage, I. e., after having mastered the programming of non-linear tools. In elaborating supply models, the global focus used on the demand side must shift to an evaluation of each consumption sector. Just what does this mean? First, that the sub-sector focus and partial optimization criterion in supply planning should not be discarted but rather perfected. The electricity sector and those of hydrocarbons, gas, and coal should be planned with specific instruments; because the problems are not linear and the simplification introduced by making them so is excessive.

Where then does the focus on supply modeling come in? Several points must be considered. The historical analysis demand modeling should be capable of predicting the bottlenecks of a country or region in the supply sector, thus detecting the areas which deserve more attention. This means that is useful to deal with each particular country instead of obliging it to conform to a general pre-established formula. Another important point is the institucional reconnaissance related to the different sub-sectors their planning needs ant the instruments they have avilable. One path open to global supply modeling thus paradoxically arises from the strenghtening of sub-sector modeling; but this is not sufficient: it has to be recognized that there is also a level of global decision-making, generally, governmental planning organizations, which need suitable decision-making tools without necessarily having to run all the subsector models each time. This is a very important point, and no one answer will be valid for all cases; for this will depend on the nature of the energy and institutional problems of each country. The modeling tools in this case are of two kinds: optimization models which will always be linear and will be fed with data originating in the optimal solution of the sub-sector models and, on the other hand, strategy

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simulation models, where various sub-optimal alternatives are simulated and evaluated, where these originate in sub-sector models. Some will enable and facilitate the evaluation of certain policies feasible for adaptation. At the moment of the definitive quatification of an adopted policy, the sub-sector models again affect the detailed fit of solutions.

This varied procedure in supply modeling proves much more economical with the use of computers and once again accomplishes a didactic purpose by presenting the planners with real problems: many times a simple manual calculation done with sound criteria avoids many hours of work and, moreover provides much better results. The main aspect to be conveyed by supply modeling —be this done with mathematical models or not— deals with the fact that is must permit the central planning organizations to do a socio-economic cost and benefit analysis for the adoption of given policies in resource development. How much must be invested in oil exploration as compared to development of an ethanol program or to gas pipelines to transport gas to industries, thereby increasing the refineries conversion capacity or to other alternatives such as the implementation of more efficient firewood use in rural cooking the introduction of coal briguettes, etc. There are only some of the examples whose costs and benefits should be evaluated prior to decision-making.

Obviously, to start this work, it is necessary to have either knowledge about each energy source's potential for being integrated into the supply, or else working hypotheses about the alternatives to the supply composition. In conclusion, it should be stated that the supply model is a combination of sectorial criteria and that the corresponding models, when available, should be auxiliary to the calculations. Finally, it must be recognized that this area of energy planning should be done more according to the availability of additional information and other elements.

5. PROJECTION OF ENERGY BALANCES

It is useful to present the results of the various supply and demand options in the form of energy balances for all the physical magnitudes, adding socio-economic, environmental and other results, in order to obtain a global picture of where the energy system is headed, starting from the present consumption. Using the projected balances, the relationship between supply, transformation, and demand can be visualized; and the alternatives can be simulated to analyze the effects of these changes. The presentation in the form of a balance helps to evaluate the policies adopted while revealing inconsistencies in the projections. The act of making the projections consistent is of undeniable value; since, however well-formed the models are, one can never be sure that all of the complex phenomena that determine the proposals are being taken into account.

Here again, the didactic nature of this procedure and its great contribution to the education of the planners should be emphasized. This procedure of approximation is the opposite of the "black-box" model, in which planners are only in contact with the input and output, but never with the internal functioning based on the computer "hardware" which does not take account the real value of the irreplaceable manual work that is required to attain an acceptable objective.

In conclusion, it should be emphasized that this style of "black box" work implies an inevitable dependency, which OLADE, through its "Regional Program of Energy Balances" has begun to overcome for the benefit of Latin America and the Third World, by providing the countries with the necessary criteria for policy decision-making in the most strategic sector of the present social economic structure.

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ANALYSIS OF THE LATIN AMERICAN ENERGY BALANCE

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I. INTRODUCTION

On the basis of the energy balances of the individual countries, it has been possible to construct a consolidated regional balance for 1978.[1] It should be noted that this balance has been elaborated by totalling the figures from the national ones; this means that the imports and exports reflect the total importation and exportation of all the countries as a whole, without differentiating among intra-regional and extra-regional flows.

This instrument is the culmination of the first phase of OLADE's program, and it is worthwhile to visualize their use and contributions through the comments which follow.

Without doubt, numerous studies and analyses could be carried out, and surely many will. In this regard the program has accomplished one of its principal goals, that of supplying the region's professionals with an information tool of great value, now that Latin America —due to, it growing complexity and relative development within the context of the Third World— needs, deserves and is capable of having an adequate quantitative basis for studies.

[1] It was not possible to construct a series of consolidated energy balances, due to the fact that a complete series of national balances was not available for other years. (See Table 1.)

The historical analysis of energy balances for a country, group of countries or the region is a fundamental stage in preparing the basis for global planning. This chapter does not attempt to present all the possibilities but rather only preliminary concepts, on the way to a comparative examination of the energy sectors in the different countries. The program's broad range of possibilities is its outstanding feature. In effect, if Latin America has been capable of completing the energy balances of its countries, based solely on its own human resources, it can be assumed that it is capable of undertaking rational resource planning in a world that is more and more interdependant and complex. Consequently, several examples are presented herein, in order to illustrate the current situation by comparing the regional consolidated energy balance not only with national balances but also with economic and social parameters. This analysis is of a static nature since there is still no series of consolidated balances, which would be indispensable in determining trends.

II. **Primary Energy**

Table 2/ Ilustrates primary production by sources for 1978. The outstanding conclusion is that for all the sources there are always 3 countries that together produce more than 75% of the total.

For coal, three countries (Colombia, Brazil and Mexico) produce 85%, but this source represents only 1.9% of the total primary production even though the reserves are considerable.

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TABLE 1

ENERGY BALANCES
EXITING SERIES

	AÑOS DISPON.	70	71	72	73	74	75	76	77	78	79	80
ARGENTINA	5	*		*		*		*		*		
BARBADOS												
BOLIVIA	10	*	*	*	*	*	*	*	*	*	*	
BRAZIL	5							*	*	*	*	*
COLOMBIA	10	*	*	*	*	*	*	*	*	*	*	
COSTA RICA	10	*	*	*	*	*	*	*	*	*	*	
CUBA												
CHILE	5	*		*		*		*		*		
ECUADOR	5	*		*		*		*		*		
EL SALVADOR	10	*	*	*	*	*	*	*	*	*	*	
GRENADA	6						*	*	*	*	*	*
GUATEMALA	10	*	*	*	*	*	*	*	*	*	*	
GUYANA												
HAITI	10		*	*	*	*	*	*	*	*	*	*
HONDURAS	6	*		*		*		*		*	*	
JAMAICA	4								*	*	*	*
MEXICO	5	*					*			*	*	*
NICARAGUA	6	*		*		*		*		*		*
PANAMA	9	*	*	*	*	*	*	*	*	*		
PARAGUAY												
PERU	10	*	*	*	*	*	*	*	*	*	*	
DOMINICAN REPUBLIC	8				*	*	*	*	*	*	*	*
SANTA LUCIA												
SURINAME	7	*		*		*		*		*	*	*
TRINIDAD AND TOBAGO	5	*		*	*			*			*	
URUGUAY	6	*		*		*		*		*		*
VENEZUELA	6	*		*		*		*		*	*	
ANDEAN REGION	5	*		*		*		*		*		
CENTRAL AMERICA	5	*		*		*		*		*		
CARIBBEAN	2							*			*	
SOUTHEASTERN REGION	5	*		*		*		*		*		
LATIN AMERICA	1									*		

TABLE 2

LATIN AMERICAN
PRIMARY ENERGY PRODUCTION - 1978
TOE x 10^3 (%)

CARBON MINERAL COAL	**América Latina** 8 182 (100) (1.9)	**COLOMBIA** 3204 (39.1)	**BRAZIL** 2033 (24.8)	**MEXICO** 1750 (21.4)	**OTHERS** 1195 (14.6)
FIREWOOD	56639 (100) (13.3)	**BRAZIL** 26521 (46.8)	**MEXICO** 11954 (21.1)	**COLOMBIA** 2948 (5.2)	**OTHERS** 15216 (26.9)
OTHER PLANT, ANIMAL FUELS	17010 (100) (4.0)	**BRAZIL** 12244 (72)	**ARGENTINA** 1095 (6.4)	**PERU** 662 (3.9)	**OTHERS** 3009 (17.7)
CRUDE OIL	252286 (100) (59.2)	**VENEZUELA** 116660 (45.2)	**MEXICO** 1/ 66 288 (26.3)	**ARGENTINA** 23236 (9.0)	**OTHERS** 46102 (18.3)
GAS	70469 (100) (16.5)	**MEXICO** 1/ 30000 (42.6)	**VENEZUELA** 16857 (23.9)	**ARGENTINA** 9598 (13.6)	**OTHERS** 14014 (20)
HIDROENERGY	20356 (100) (4.8)	**BRAZIL** 9932 (48.8)	**MEXICO** 4658 (22.9)	**COLOMBIA** 1390 (6.8)	**OTHERS** 4376 (21.5)
GEOENERGY	560 (100)	**EL SALVADOR** 387 (69.1)	**MEXICO** 173 (30.9)		
FISSION FUELS	691 (100)	**ARGENTINA** 691 (100%)			
TOTAL Estimated	**42.193 (100)**				

Firewood, accounts for 13.3% of the total, 73.1% which is concentrated in Brazil, Mexico and Colombia. Brazil with 46.8% and Mexico with 21.1% have the largest rural population in Latin America and it can be said that, in general, firewood consumption is proportional al to rural population.

In Brazil, bagasse (4% of the total) accounts for 72% which makes this country the major regional sugar producer and also the major bagasse consumer. It is followed, although with much lower proportions by Argentina and Peru, and among the there they cover 82.3% of the total.

Petroleum represents 59.2% of the primary production, and Venezuela and Mexico concentrate 71.5%. If Argentina is included, the total reaches 80.5%. Even though this last country is the third largest

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TABLE 3

LATIN AMERICAN ENERGY IMPORTS - 1978

CRUDE OIL AND DERIVATIVES	**Latin America** 78241 (100) (94.3)	**Brazil** 44220 (56.5)	**CHILE** 3897 (5)	**ARGENTINA** 2192 (2.8)	**OTHERS** 32316 (41.3)
COAL AND COKE	**Latin America** 4699 (100) (5.7)	**BRAZIL** 2794 (59.5)	**MEXICO** 693 (14.7)	**ARGENTINA** 611 (13)	**OTHERS** 601 (12.8)
TOTAL	42840 (100)				

ENERGY EXPORTS - 1972

CRUDE AOIL AND DERIVATIVES	**Latin America** 155728 (100)	**VENEZUELA** 92503 (59.4)	**TRINIDAD and TOBAGO** 16940 (10.9)	**ECUADOR** 7615 (4.9)	**MEXICO** 20044 (12.9)
COAL AND COKE	**Latin America** 137 (100)	**COLOMBIA** 113 (82.5)	**OTHERS** 24 (17.5)		

producer, it is not an exporter given its high consumption levels; on the other hand, Ecuador, which is an exporter, is in 4th place with 4.2%.

Gas has a participation of 16.5% of the total primary supply and once again, Mexico, Venezuela and Argentina are the major producers (accounting for 80%). The countries of Mexico and Argentina have particularly a log history of gas consumption both in the residential and insustrial sectors.

Hydroenergy, which is an abundant resource in the region, represents only 4.8% of the primary production. The country with the greatest potential is Brazil, with 48.8%, which along with Mexico and Colombia accounts for 78.5% of the region's potential.

Geothermal and fission fuels, despite having a low porcentage of utilization, could come to have a great importance for some countries.

III **Foreign Trade**

Table 3 shows that 94.3% of the imports a comprised by oil and oil by-products and 5.7% b coal and coke. The country which accounts f most of the imports is Brazil, with 56.5% of the c and 59.5% of the coal. The case of coal is especial noteworthy since even though there are both impo ters and exporters in the region, the exports are i significant despite the vast existing reserves in som countries.

In the exports of oil and oil by-products, fou countries —Venezuela, Trinidad, Ecuador and Mex co— cover 88.1% of the total and even though th region as a whole exports twice as much as it im ports, the situation by country is quite uneven sinc there are few exporters and many importers.

With regard to electricity, the lack of region inter-connections mean there is minimal exchang

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TABLE 4

LATIN AMERICAN
TOTAL FINAL CONSUMPTION - 1978

FINAL ENERGY CONSUMPTION	Latin America 237,033	BRAZIL 80,936 (34.1)	MEXICO 57086 (24.1)	ARGENTINA 25,263 (10.6)	OTHERS 73,748 (31.1)
ELECTRICITY	20,136	8,000 (39.7)	3,876 (19.2)	2,402 (11.9)	5,858 (29.1)
FINAL NON-ENERGY CONSUMPTION	16 579	6,687 (40.3)	2,716 (16.4)	3,233 (19.5)	3,943 (23.8)

IV **Final Consumption**

In Table 3 three sub-headings of consumption are indicated: electricity, final total energy consumption, and non-energy consumption. It should be noted that in general the region's three largest countries (Brazil, Mexico and Argentina) consume approximately 70% of the total. Electricity accounts for 8.6% of the final energy consumption, which demonstrates the low level of electrification that exists in the region.

TABLE 5

COMPARISON OF RESERVES AND GROSS INTERNAL SUPPLY

	Gross Internal Supply (TOE x 10^3)	Reserves (TOE x 10^6)
Coal and Coke	12,898 (4.9)	3,332 (10.2)
Oil and Oil	175,259(66.3)	9,923 (30.3)
By - products	54,831(20.7)	4,023 (12.)2/
Hydroenergy	20,155(7.6)	13,900 (42.)
Geothermics	431(0.2)	
Uranium	691(0.3)	1,475 (4.5)
	264,265(100)	**32,705 (100)**

2/ Theoretical hydro power equivalent.

In the final non-energy consumption both, lubricants and asphalts and the raw materials for petochemicals figure in the final nonenergy consumption and it can also be observed that 7.6% is concentrated in the three largest countries of the region.

V Comparison Between Consumption by Sources and Reserves

For the sake of analysis, it is best to refer to the gross internal supply, which focuses on the energy consumption fromt he aspect closest to the primary source. Also, the hydroelectric reserves have been divided by three so that they will be consistent with the theoretical criteria of evaluation of this energy source in the balance.

The data in Table 4 clearly demostrate that hydroenergy, the most abundant resource with 42.5% of the total, only covers 7.6% of the gross domestic supply. The same occurs on a smaller scale with coal (10.2% of reserves, 4.8% of the supply) and aranium (4.5% of the reserves, 0.3% of the supply). On the other hand, petroleum which represents 30.3% of the reserves, satisfies 66.3% of the supply; and

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TABLE 6

SOCIO-ENERGY INDICATORS

	1971 POPULATION Thousands-INHAB	GDP (10⁶-1970 US.$)	Total Final Consumption TOEx10³	Electricity Consumption GWH	Total Percapita Consumption TOE/INHAB	Percapita Electricity GWH/INHAB x 10³	Percapita Income US.$ INHAB
ARGENTINA	26 389	34 691.9	28 496	27 930.2	1.08	1.06	1 314.6
BOLIVIA	5 286	1 944.4	1 622	1 325.6	0.31	0.25	367.8
BRAZIL	116 393	85 494.3	87 623	98 360.5	0.75	0.85	734.5
COLOMBIA	24 922	18 155.7	13 399	14 348.8	0.54	0.58	728.5
COSTA RICA	2 154	1 853.9	1 403	1697.7	0.65	0.79	860,7
CHILE	10 857	9 204.6	7 155	8 755.8	0.66	0.81	847.8
ECUADOR	7 461	3 998.2	3 633	2 174.4	0.49	0.29	535.9
EL SALVADOR	4 397	2 083.0	2 279	1 267.4	0.52	0.29	473.7
GRENADA	120		18.2	19.4	0.15	0.16	
GUATEMALA	6 622	3 505.4	3 247	1 337.2	0.49	0.20	529.4
HAITI	4 833	698.6	1 633	174.4	0.34	0.04	144.5
HONDURAS	3 439	1 005.0	1 658	627.9	0.48	0.18	292.2
JAMAICA	2 106		2 713	1 127.9	1.29	0.54	
MEXICO	66 944	66 287.6	59 802	45 069.8	0.89	0.67	990.2
NICARAGUA	2 393	1 064.2	1 329	965.1	0.56	0.40	444.7
PANAMA	1 825	1 623.3	1 136	1 290.7	0.62	0.71	889.5
PERU	16 836	10 361.5	9 274	7 732.6	0.55	0.46	615.4
DOMINICAN REP.	5 125	2 689.1	2 832	1 686.0		0.33	524.7
SURINAME			567.4	1 572.1			
TRINIDAD AND TOBAGO	1 132		1 768	1 418.6	1.56	1.25	
URUGUAY	2 852	3 052.9	2 138	2 511.6	0.75	0.88	1 070.4
VENEZUELA	13 155	19 273.9	19 792	18 093.0	1.50	1.38	1 465.1

DATA CORRESPONDING TO 1979

natural gas with 12.4% of the reserves, has a 20% participation in the supply.

VI Relation between Energy and Demographic and Economic Growth.

This stage of the analysis is very rich since it permits the cross analysis of the energy, demographic and economic data from the various countries. In this way, it forms a valuable contribution to national planning by using new analytical tools such as mixed indicators that are applicable from one country to another. Therefore, it is a new dimension in the field of planning models which has unforessen possibilities.

This section represents only the beginning of this procedure designed to provide a preliminary insight as to the possibilities that comparative analyses open up fro planners.

Table 5 presents data on consumption, population and gross products as well as some especially elaborated mixed indicators.

Table 6 presents, as an illustration, the study for 1978 of the statistical relationship between total per capita final consumption and per capita income for the majority of the countries of the region. Towards that ened, a lineae model has been shown as well as an exponential one. The first observation arising from these models is the existence of an apparent relationship between the two indicators which slightly favors the exponential model. This latter could be expressed by saying that the per capita consumption grows at 0.1% when the per capita income increases. This relationship between countries serves as a method for forecasting elasticity, since when the gross domestic product of a country grows excessively, it can be assumed that the gross energy produced will also vary, moving along the curve which represents the per capita consumer incomes of all the countries. In this way, an additional modeling element is available that should not otherwise exist within the boundaries of a single country.

This method is a great step forward for planning the programs of OLADE; it does not mean the estableshment of a global energy plan for the region according to the plans of the individual countries, but rather it gives the countries an intra-regional modeling tool which can serve as a common bases for the formulation of the activities for the organization's planning programs in the future.

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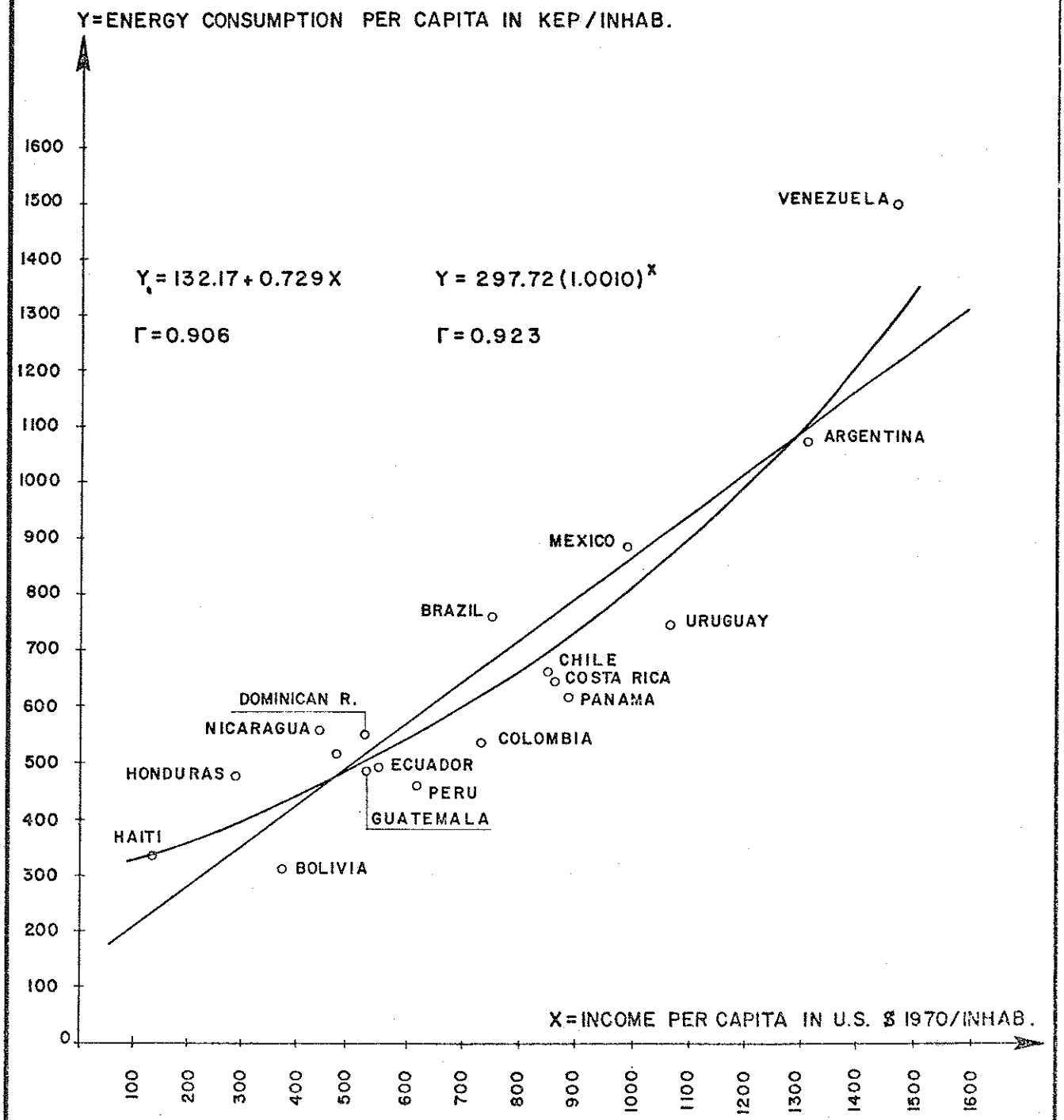
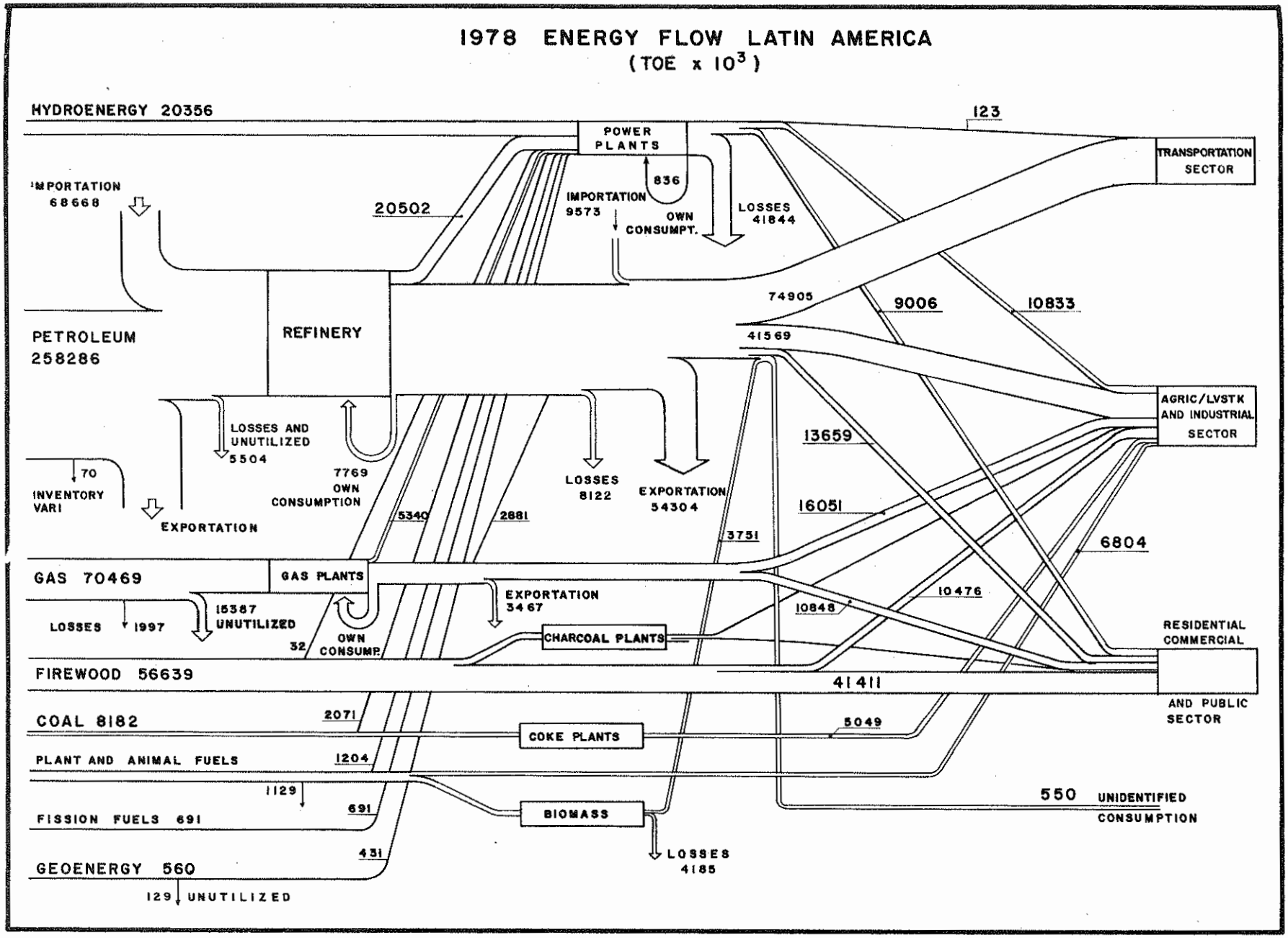
TABLE 7

RELATION BETWEEN ENERGY CONSUMPTION AND INCOME PER CAPITA



1978 ENERGY FLOW LATIN AMERICA
(TOE x 10^3)



CONSOLIDATED ENERGY BALANCE

UNITS: TOE x 10^3 — YEAR: 1978

LATIN AMERICA - REGIONAL BALANCE

INCLUDING: ARGENTINA-BOLIVIA-BRAZIL-COLOMBIA-COSTA RICA-CHILE-ECUADOR-EL SALVADOR-GRENADA-GUATEMALA-HAITI-HONDURAS-JAMAICA-MEXICO-NICARAGUA PANAMA-PERU-DOMINICAN R.-SURINAME-TRINIDAD AND TOBAGO[L4] URUGUAY-VENEZUELA.

PLACE: QUITO DATE: 3/X/81

			PRIMARY ENERGY										SECONDARY ENERGY											
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
			Coal	Firewood	Other Plant Animal Fuels	Crude Oil	Free Natural Gas	Associated Gas	Hydroenergy [L3]	Geoenergy	Fission Fuel	TOTAL PRIMARY ENERGY	Coke	Charcoal	Liquified Gas	Gasolines / Naphthas	Kerosene and Turbo Fuel	Diesel and Gas Oil	Heavy Fuels	Other Energy Fuels	Non-Energy Products	Gas	Electricity	TOTAL SECON. ENERGY	TOTAL
ENERGY SECTOR	SUPPLY	1. Production	6182	53639	17010	252283	26025	44444	20336	560	691	426193													426193
		2. Importation [L1]	5785			81038	2016					88839	914		831	1675	285	1538	4517	1	726		36	10523	99362
		3. Inventory Variation	111			-70			-6			35	218		-35	-5	15	-267	2200	-308	238			2056	2071
		4. TOTAL SUPPLY [L1]	12078	53639	17010	333251	28041	44444	20330	560	691	515067	1132		796	1670	300	1251	6717	-307	964		36	12555	527622
		5. Exportation [L1]	-97			-100224	-645	-1622				-102588	-40	-1	-1200	-4402	-1977	-4552	-42199	-487	-651		-57	-55602	-158190
		6. Unutilized	-175		-406	-655	-3724	-11083	-195	-129		-16547								-11		-622		-633	-17180
		7. GROSS INTERNAL SUPPLY	11806	53639	16604	232372	23672	31739	20135	431	691	381182	1092	-1	-404	-2732	-1677	-3317	-35182	-805	313	-622	-21	-43676	337486
	TRANSFORMATION CENTERS	8. TOTAL TRANSFORMATION	-9154	-8154	-7248	-217463	-21034	-15329	-20095	-431	-691	-328902	4608	3577	8948	48256	12633	41832	73291	2828	8772	27032	24447	256562	-47340
		8.1. Coke Plants, Furnaces	-7074									-7074	4608	-87						-112	436	655		5500	-1574
		8.2. Coal Plants	-9	-8105								-8114		3934										3934	-4180
		8.3. Biomass			-6122							-6122								1937				1937	-4185
		8.4. Refineries				-217424	-973					-218397			4880	46542	12802	46183	89119	1017	7576	3218		211337	-7060
		8.5. Gas Plants					-20061	-15554				-35615			4066	1724		170			760	28499		35219	-396
		8.6. Public Service Power Plants	-1846	-32		-39		-3047	-15679	-431	-691	-25765					-139	-4079	-14238			-4548	22875	-129	-25894
		8.7. Self-Use Power Plants	-225	-17	-1126			-1028	-419			-2815						-442	-1590	-14		-792	1572	-1265	-4081
		9. Energy Sector's Own Consump	-47		-1129	-117	-142	-4568				-6003	-113		-278	-524	-116	-902	-5558	-252	-59	-11441	-836	-20179	-26182
		10. Losses(Transp. Distri. Storage)	-68			-4819	-1925	-72	-31			-6915	-74	-285	-107	-180	-124	-347	-228	-39	-144	-407	-3019	-4954	-11869
		11. ADJUSTMENTS	-257	2	-80	2474		-21	-26			2092	-117	-2	-111	-552	-170	-197	176	-14	1375	-529	-116	-257	1835
FINAL CONSUMPTION		12. TOTAL FINAL CONSUMPTION	2280	45487	8147	80	571	6959				63434	5396	3589	8046	44278	10576	37049	32099	1718	10257	14033	20455	187496	250930
		12.1. Final Non-Energy Consumption			1038		303	1510				2911	347	7	165	2147	8			275	10257	462		13668	16579
		12.2. Final Energy Consumption	2280	45487	7109	80	268	5359				60523	5049	3582	7881	42131	10568	37049	32099	1443		13571	20455	173828	234351
		12.2.1 Residential, Commercial, Public	181	40045	245			625				41096		1356	7317	410	3627	1129	1176			2906	9005	26657	67753
		12.2.2 Transportation	84									84			21	41531	5005	34653	2751	1265			123	75048	75132
		12.2.3 Agricultural / Livestock		3329	342							3671		2	20	20	1039	4222	247				493	6043	9714
		12.2.4 Industrial [L2]	2015	4931	6462	80	268	4734				18490	5049	2214	447	137	896	6947	27896	165		10582	10833	65166	83656
		12.2.5 Unidentified Consumption		182								182			76	33	1	398	29	13		83		633	815
		GROSS SECONDARY ENERGY PRODUCTION											4608	3964	8946	48256	12802	43353	89119	2334	9772	32372	24447	282503	

TRANSFORMATION LOSSES

Observations:

OTHERS:

(L1): CORRESPONDS TO THE SUM OF THE IMPORTS/EXPORTS OF THE COUNTRIES OF THE REGION, WITHOUT CONSIDERING THEIR ORIGIN. THIS ENTAILS SOME DOUBLE ACCOUNTING DUE TO INTRA-REGIONAL FLOWS. THE PROBLEM CAN BE ELIMINATED BY CONSOLIDATING THE GROSS INTERNAL SUPPLY.

(L2): COKE: MOST OF THIS COKE IS FED INTO FURNACES (IT MUST BE RECYCLED DURING TRANSFORMATION); HOWEVER, DUE TO A LACK OF INFORMATION, IT HAS PREFERABLY BEEN CONSIDERED AS FINAL CONSUMPTION IN INDUSTRY.

(L3): HYDROENERGY HAS BEEN EVALUATED WITH A THEORICAL EQUIVALENT. (L4): DATA FOR TRINIDAD AND TOBAGO REFER TO 1979.

ANALYSIS OF CENTRAL AMERICAN ENERGY BALANCES

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1. INTRODUCCION

Central America is the geographical sub-region of Latin America that extends between Mexico and Colombia and that is comprised of Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica and Panama. With a territorial extension of 507,462 square kilometers and a population close to 22 million inhabitants, these countries, aside from having a similar historical origin, demonstrate a certain homogeneity with respect to energy resources and economy.

The sub-region experienced a moderate economic growth during 1960-1979, with an annual per capita GDP growth rate of 2.5%, despite the elevated demographic growth rate (2.9% annually) during the period. The Central American population is primarily rural (60.5%) and the agricultura/livestock sector hass been the most important in the economies of these countries. However, during the last decades, an industrialization process has been initiated within the framework of the Central American Common Market.

Central America showed a deficit of US. $ 1.41 billion for 1978 in its balance of trade, produced principally by the imports of raw materials for industry and the oil bill which rose to US.$ 585 million that year. The Central American sub-region almost completely lacks hydrocarbons and in 1978 imported more than 99% of its oil consumption.

These countries are characterized by a low total per capita energy consumption (0.53 TOE/inhab), which is equivalent to half of the Latin America consumption. However, there are considerable diferences among the countries, since Costa Rica has a total consumption of 1.04 TOE/inhab. while Guatemala, Honduras, El Salvador and Nicaragua consume only half of this figure. Panama is in an intermediate position with a total per capita consumption of 0.82 TOE/inhab. At the same time, there is an large participation by firewood and other biomass fuels, which in 1978 represented 54% of the total. In terms of per capita consumption, the value for firewood and biomass was 0.34 TOE/inhab.

The participation of Central America within the Latin America context is small, given that the sub-region's population is 6.2% of the total while its energy consumption is only 3.3%.

Hydroenergy, biomass and geoenergy are the principal energy resources of the area. Lees than 5% of the hydroenergy potential has less developed in all of the countries except El Salvador where close to 30% has been utilized. It is estimated that there is a considerable geoenergy potential, although there is no inventory for this resource. Biomass and firewood in particular constitute a very important resource for the rural and marginal urban populations. Aside from the accelerated deforestation in the region, there exists a considerable biomass potential.

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Herein, a detailed analysis of the energy production and consumption structures is presented for Central America, based on the consolidated energy balances for the sub-region, which were elaborated from the national balances for the years 1970-1979.

2. Analysis and Evaluation

a. Primary Energy Supply

In 1970 oil imports constituted 50% of the primary energy supply, followed by biomass with 44% and hydroenergy with 6%. The proportions were maintained relatively constant until 1974, when with the oil price increases the imports were reduced by more than 50%. In 1978, they represented 30% of the primary energy supply, while biomass increased its participation to 61% and hydroenergy decreased to 4.3%.

Aside from the fact that all the Central American countries are characterized by a considerable firewood production and an almost total absence of petroleum, there are significant differences between them. Table 1 shows the percentages of participation for each source in the regional primary energy supply.

TABLE Nº 1

THE 1979 PRIMARY ENERGY SUPPLY
(PERCENTAGES)

COUNTRY	Hydroenergy	Biomass	Petroleum	Geoenergy	Total Primary Energy Supply (TOE x 10^3)
Costa Rica	18.6	48.5	32.8		1,230
El Salvador	4.5	56.8	24.7	14.4	2,830
Guatemala	0.8	70.3	28.7		3,046
Honduras	4.5	67.3	28.2		1,741
Nicaragua (1)	5.1	53.9	41.0		1,320
Panama	2.6	14.7	82.6		2,883

TABLE Nº 2

THE 1979 SECONDARY ENERGY SUPPLY
(PERCENTAGES)

COUNTRY	Diesel	Gasoline	Heavy Fuels		Electricity	Total Secondary* Energy Supply (TOE x 10^3)
Costa Rica	40.7	17.6	5.8	17.7	18.2	944
El Salvador	30.6	20.8	6.8	24.4	17.3	790
Guatemala	30.8	21.8	7.8	30.9	8.8	1462
Honduras	17.8	11.0	40.5	18.7	12.0	625
Nicargua	22.4	5.1	29.4	30.9	12.2	664
Panamá	13.4	6.4	25.5	49.3	5.4	2484.9

* Including National Production + imports ± variations of inventary.

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The very low participation of hydroenergy is notable; except for Costa Rica, it does not surpass 5.1% of the primary energy supply. In Guatemala, El Salvador, Honduras, and Nicaragua, biomass represents more than half of the primary energy supply. It should be noted that geoenergy has had high growth rate in El Salvador, where in the five years since the installation of its first geothermal station, it has come to represent 14.4% of the total.

B. Secondary Energy Supply

In the secondary energy supply, the participation of the products has experienced great variations.

The region in 1970 was an exporter of heavy fuels (57%), diesel and gas-oil (17%), gasoline (7%), and kerosene (5%), but has become a net importer of those same products in the following proportions: heavy fuels 4%; diesel and gas-oil 14%, gasoline 7% and kerosene 1%. This is due principally to the fact that the sub-region drastically reduced its crude oil imports in the period 1970-78, going from 6183 TOE x 10^3 in 1970 to 3082 TOE x 10^3 in 1978. The countries have reduced the oil available for refining in favor of directly importing derivatives.

The differences in the structure of the secondary energy supply can be seen in Table 2.

It can be appreciated from table 2 that diesel has become the most important product in the secondary energy supply, with a participation of almost 40% in Honduras and Costa Rica. With the exception of Panama and Nicaragua, where diesel and heavy fuels have a similar participation, diesel dominates the supply in all the countries. It should be noted that the oil derivatives represent very high proportions of the secondary energy supply, reaching 72% in Costa Rica, 70.6% in El Salvador, 81.5% in Guatemala, 73,4% in Honduras, 44.3% in Nicaragua, and 74.9% in Panama.

c. Final Energy Consumption by Sectors and Products.

During 1970-1978, the commercial energy consumption (which excludes biomass) grew at an average annual rate of 5%, passing from 28% of the total in 1970 to 35% in 1978. Biomass consumption also grew during the period, but at a much lower rate (1.6%).

In the distribution of the 1978 final energy consumption, the residential, commercial and public sector had the greatest participation, with 55.7% of the total, followed by the industrial sector with 23% and transportation with 18.7%; however, the greatest commercial energy consumption corresponded to transportation.

Within the residential, commercial and public sector, firewood had the highest participation, with 88% in 1978. Electricity had a participation of only 5% in this sector. Industrial consumption was distributed among firewood, heavy fuels, plant fuels, electricity and others. In the transportation sector, gasoline represented 48%, followed by diesel oil with 44%. The greatest cumulative annual growth rate corresponded to diesel with 8.6%, reflecting a clear substitution policy of gasoline by diesel. There is substantial variation in the sectorial distribution of consumption in Central America, as can be appreciated in Chart 3.

From the chart, two groups can be identified within the region: In El Salvador, Honduras, Guatemala and Nicaragua, consumption was dominated by the residential, commercial and public sector, with a 50% participation. On the other hand, in Costa Rica and Panama the residential, commercial and public sector consumed less than 40%, while transportation reached 30%. This was due, as has already been mentioned, to the variation in the predominace of firewood.

The figure shows in graphic form the energy flow in Central America for 1978 and presents a picture of the production and consumption apparatus for the sub-region. The salient characteristics observed include the high participation of firewood and oil

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TABLE Nº 3

THE 1979 FINAL ENERGY CONSUMPTION BY SECTORS (PERCENTAGES)

	Residential, Commercial, and Public	Transportation	Industrially	Total Consumption TOE x 10^3
Costa Rica	39.4	32.9	27.4	1,407
El Salvador	64.3	16.4	17.4	2,307
Guatemala	53.3	17.6	29.0	3,312
Honduras	64.8	12.5	21.1	1,731
Nicaragua	38.2	29.7	32.0	1,125

imports and the low participation of hydroenergy, the principal resource of the region.

d. Analysis of Foreign Trade

For both the primary and secondary energy supply, the proportion is 70% national production and 30% imports. The crude oil imports have decreased in the total supply given the reduction in exports from countries like Panama that refined for exportation. However, the oil bill will continue to increase because of the lack of regional resources to substitute for the hydrocarbons. The oil imports now represent an unbearable burden for the sub-region and, together with the service on the foreign debt, they constitute the principal causes of the serious deficits in the balance of payments effecting the Central America countries.

In some cases, these two areas are equivalent to more than 70% of the national exports, which demonstrates how grave the situation is for small countries that lack hydrocarbons.

If, to these factors are added those caused by the social and political instability of the region, and the economic in balances caused by the disbanding of the Central American Common Market, the outlook for the region is problematic.

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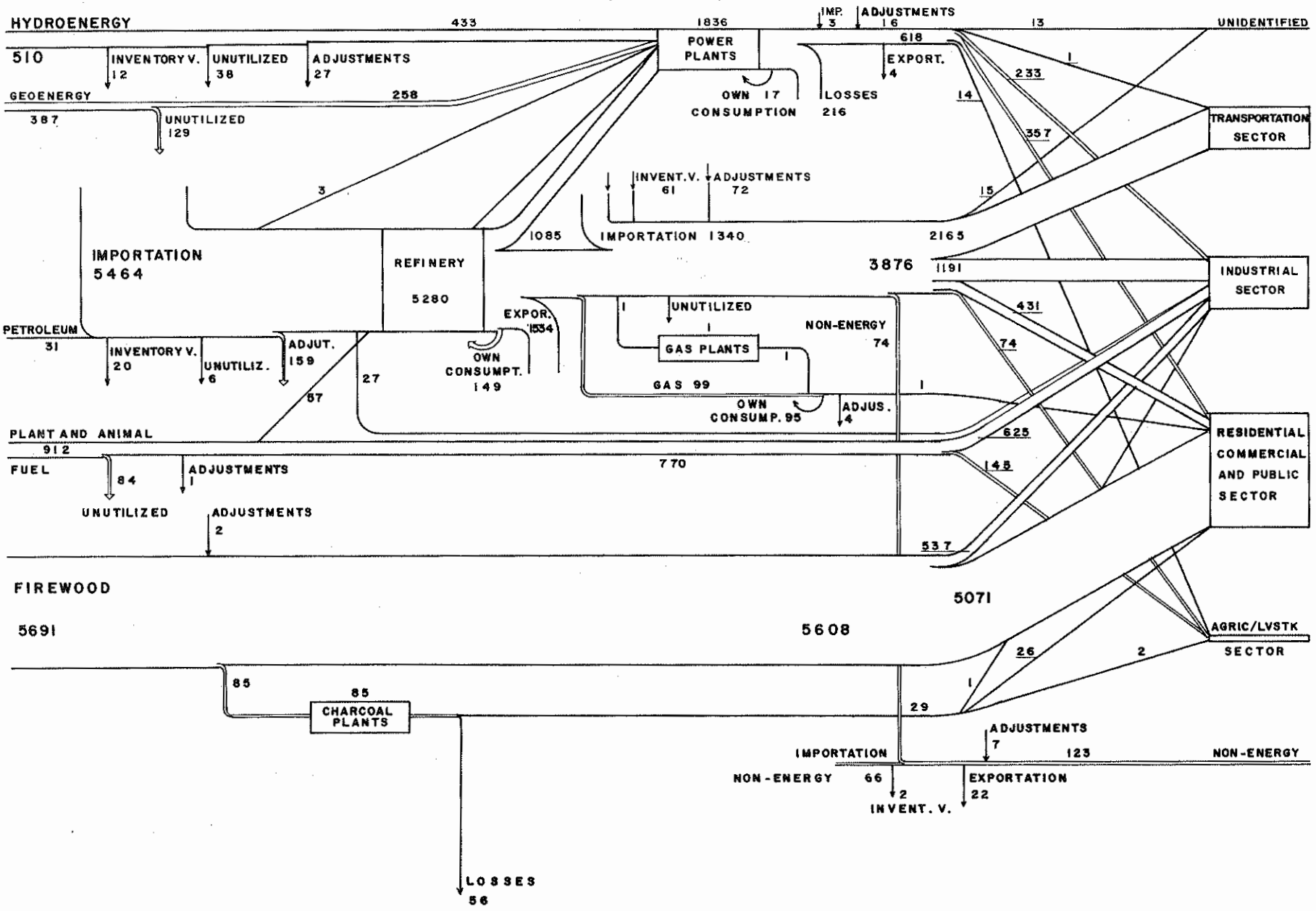
1978 ENERGY FLOW CENTRAL AMERICA

(TOE x 10^3)



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UNITS: TOE x 10^3 — CONSOLIDATED ENERGY BALANCE — YEAR: 1970

COUNTRY: CENTRAL AMERICA
MINISTRY:
ELABORATED BY: OLADE
PLACE: QUITO DATE: 13/VIII/81

			PRIMARY ENERGY										SECONDARY ENERGY												
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
			Coal	Firewood	Other Plant Animal Fuels	Crude Oil	Free Natural Gas	Associated Gas	Hydroenergy	Geoenergy	Fission Fuel	TOTAL PRIMARY ENERGY	Coke	Charcoal	Liquified Gas	Gasolines / Naphthas	Kerosene and Turbo Fuel	Diesel and Gas Oil	Heavy Fuels	Other Energy Fuels	Non-Energy Products	Gas	Electricity	TOTAL SECON. ENERGY	TOTAL
ENERGY SECTOR — SUPPLY	1.	Production		4948	466				756			6170													6170
	2.	Importation	1			6183						6184			27	110	56	168	208		80		1	650	6834
	3.	Inventory Variation				-51			6			-45			2	13	13	-45	187		7			177	132
	4.	TOTAL SUPPLY	1	4948	466	6132			762			12309			29	123	69	123	395		87		1	827	13136
	5.	Exportation													-3	-336	-231	-739	-2157		-54		-7	-3527	-3527
	6.	Unutilized			-49	-1			-176			-226								-1				-1	-227
	7.	GROSS INTERNAL SUPPLY	1	4948	417	6131			586			12083			26	-213	-162	-616	-1762	-1	33		-6	-2701	9382
ENERGY SECTOR — TRANSFORMATION CENTERS	8.	TOTAL TRANSFORMATION		-81	-25	-6130			-230			-6466		37	42	911	559	1293	2306	15	48	155	360	5726	-740
	8.1.	Coke Plants, Furnaces																							
	8.2.	Coal Plants		-81								-81		26										26	-55
	8.3.	Biomass																							
	8.4.	Refineries				-6130						-6130		11	42	913	559	1486	2739	15	48	147		5960	-170
	8.5.	Gas Plants														-2			-16			8		-10	-10
	8.6.	Public Service Power Plants							-226			-226						-119	-403				324	-198	-424
	8.7.	Self-Use Power Plants			-25				-4			-29						-74	-14				36	-52	-81
	9.	Energy Sector's Own Consump.																-6	-99	-14		-145	-10	-274	-274
	10.	Losses(Transp. Distri. Storage)																					-36	-36	-36
	11.	ADJUSTMENTS				-1			-356			-357		-12	8	64	-140	15	-14		-10	-2	5	-86	-443
FINAL CONSUMPTION	12.	TOTAL FINAL CONSUMPTION	1	4867	392							5260		25	76	762	257	686	431		71	8	313	2629	7889
	12.1.	Final Non-Energy Consumption																			71			71	71
	12.2.	Final Energy Consumption	1	4867	392							5260		25	76	762	257	686	431			8	313	2558	7818
	12.2.1	Residential, Commercial, Public		4378								4378		24	66	18	145	29	20			8	177	487	4865
	12.2.2	Transportation														720	88	418	8				1	1235	1235
	12.2.3	Agricultural / Livestock			86							86		1		9	1	37	13				7	68	154
	12.2.4	Industrial	1	489	306							796			10	14	23	195	388				120	750	1548
	12.2.5	Unidentified Consumption														1		7	2				8	18	18

TRANSFORMATION LOSSES

Observations:

GROSS SECONDARY ENERGY PRODUCTION		37	42	913	559	1486	2739	15	48	155	360	6354

OTHERS:

28

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UNITS: TOE x 10^3 — CONSOLIDATED ENERGY BALANCE — YEAR: 1974

COUNTRY: CENTRAL AMERICA
MINISTRY:
ELABORATED BY: OLADE
PLACE: QUITO DATE: 13/VIII/81

			PRIMARY ENERGY										SECONDARY ENERGY												
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
			Coal	Firewood	Other Plant Animal Fuels	Crude Oil	Free Natural Gas	Associated Gas	Hydroenergy	Geoenergy	Fission Fuel	TOTAL PRIMARY ENERGY	Coke	Charcoal	Liquified Gas	Gasolines / Naphthas	Kerosene and Turbo Fuel	Diesel and Gas Oil	Heavy Fuels	Other Energy Fuels	Non-Energy Products	Gas	Electricity	TOTAL SECON. ENERGY	TOTAL
ENERGY SECTOR — SUPPLY	1.	Production		5330	678				429			6437													6437
	2.	Importation	4			6747						6751			37	76	26	105	263		76		2	585	7336
	3.	Inventory Variation				20			7			27			-5	-23	-2	-44	-4		-6			-84	-57
	4.	TOTAL SUPPLY	4	5330	678	6767			436			13215			32	53	24	61	259		70		2	501	13716
	5.	Exportation													-3	-184	-104	-366	-1969		-30		-2	-2658	-2658
	6.	Unutilized			-66	-4			-97			-167													-167
	7.	GROSS INTERNAL SUPPLY	4	5330	612	6763			339			13048			29	-131	-80	-305	-1710		40			-2157	10891
TRANSFORMATION CENTERS	8.	TOTAL TRANSFORMATION		-81	-44	-6766			-305			-7196		28	91	1056	489	1449	2408	1	62	139	517	6240	-956
	8.1.	Coke Plants, Furnaces																							
	8.2.	Coal Plants		-81								-81		28										28	-53
	8.3.	Biomass																							
	8.4.	Refineries				-6766						-6766			91	1058	489	1667	3098	1	62	132		6598	-168
	8.5.	Gas Plants														-2			-12			7		-7	-7
	8.6.	Public Service Power Plants							-301			-301						-147	-666				480	-333	-634
	8.7.	Self-Use Power Plants			-44				-4			-48						-71	-12				37	-46	-94
	9.	Energy Sector's Own Consump.																-9	-136	-9		-132	-14	-300	-300
	10.	Losses(Transp. Distri. Storage)																					-57	-57	-57
	11.	ADJUSTMENTS		1	1	3			-34			-29			-2	30	-145	-133	-2	8	-14	-2	-3	-263	-292
FINAL CONSUMPTION	12.	TOTAL FINAL CONSUMPTION	4	5250	569							5823		28	118	955	264	1002	560		88	5	443	3463	9286
	12.1.	Final Non-Energy Consumption																			88			88	88
	12.2.	Final Energy Consumption	4	5250	569							5823		28	118	955	264	1002	560			5	443	3375	9198
	12.2.1	Residential, Commercial, Public		4709								4709		25	96	22	140	30	18			5	245	581	5290
	12.2.2	Transportation														906	100	644	7				1	1658	1658
	12.2.3	Agricultural / Livestock			100							100		2	2	8	4	51	18				11	96	196
	12.2.4	Industrial	4	541	469							1014		1	20	17	20	269	517				174	1018	2032
	12.2.5	Unidentified Consumption														2		8					12	22	22

TRANSFORMATION LOSSES

Observations:

GROSS SECONDARY ENERGY PRODUCTION														
	28	91	1056	489	1667	3098	1	62	139	517	7150			

OTHERS:

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UNITS: TOE x 10^3 — CONSOLIDATED ENERGY BALANCE — YEAR: 1978

COUNTRY: CENTRAL AMERICA
MINISTRY:
ELABORATED BY: OLADE
PLACE: QUITO DATE: 13/VIII/81

			PRIMARY ENERGY										SECONDARY ENERGY												
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
			Coal	Firewood	Other Plant Animal Fuels	Crude Oil	Free Natural Gas	Associated Gas	Hydroenergy	Geoenergy	Fission Fuel	TOTAL PRIMARY ENERGY	Coke	Charcoal	Liquified Gas	Gasolines / Naphthas	Kerosene and Turbo Fuel	Diesel and Gas Oil	Heavy Fuels	Other Energy Fuels	Non-Energy Products	Gas	Electricity	TOTAL SECON. ENERGY	TOTAL
ENERGY SECTOR — SUPPLY	1.	Production		5691	912	31		3	510	387		7534													7534
	2.	Importation				5464						5464			78	317	44	675	226		66		3	1409	6873
	3.	Inventory Variation				-20			-12			-32			-7	17	-3	-13	67		-2			59	27
	4.	TOTAL SUPPLY		5691	912	5475		3	498	387		12966			71	334	41	662	293		64		3	1468	14434
	5.	Exportation													-7	-75	-153	-372	-927		-22		-4	-1560	-1560
	6.	Unutilized			-84	-6		-3	-38	-129		-260								-1				-1	-261
	7.	GROSS INTERNAL SUPPLY		5691	828	5469			460	258		12706			64	259	-112	290	-634	-1	42		-1	-93	12613
TRANSFORMATION CENTERS	8.	TOTAL TRANSFORMATION		-85	-57	-5283			-433	-258		-6116		29	97	932	424	1218	1397	19	74	100	701	4991	-1125
	8.1.	Coke Plants, Furnaces																							
	8.2.	Coal Plants		-85								-85		29										29	-56
	8.3.	Biomass																							
	8.4.	Refineries				-5280						-5280			97	933	424	1574	2126	19	74	99		5346	66
	8.5.	Gas Plants														-1						1			
	8.6.	Public Service Power Plants				-3			-429	-258		-690						-317	-717				669	-365	-1055
	8.7.	Self-Use Power Plants			-57				-4			-61						-39	-12				32	-19	-80
	9.	Energy Sector's Own Consump.													-1			-7	-123	-18		-95	-17	-261	-261
	10.	Losses(Transp. Distri. Storage)																					-81	-81	-81
	11.	ADJUSTMENTS		2	-1	-159			-27			-185			-2	9	3	20	42		7	-4	16	91	-94
FINAL CONSUMPTION	12.	TOTAL FINAL CONSUMPTION		5606	770	27						6405		29	158	1200	315	1521	682		123	1	818	4647	11052
	12.1.	Final Non-Energy Consumption																			123			123	123
	12.2.	Final Energy Consumption		5606	770	27						6405		29	158	1200	315	1521	682			1	618	4524	10929
	12.2.1	Residential, Commercial, Public		5071								5071		25	137	29	156	87	22			1	357	815	5886
	12.2.2	Transportation														1142	126	884	13				1	2166	2166
	12.2.3	Agricultural / Livestock			145							145		2	1	10		58	5				14	90	235
	12.2.4	Industrial		537	625	27						1189		1	20	18	33	480	640				233	1425	2614
	12.2.5	Unidentified Consumption														1		12	2				13	28	28
		GROSS SECONDARY ENERGY PRODUCTION												29	97	933	424	1574	2126	19	74	100	701	6077	

TRANSFORMATION LOSSES

Observations:

OTHERS:

ANALYSIS OF THE ANDEAN REGION ENERGY BALANCE

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I. INTRODUCTION

As part of the Regional Program of Energy Balances of the Latin American Energy Organization (OLADE), a general analysis of the behavior and trends of the principal parameters for the Andean area energy balance is presented here.

For that purpose, the countries have been grouped, according to geographical criteria, rather than to economic one on integration models such as the "Andean Group". Thus, the sub-region includes Bolivia, Colombia, Chile, Ecuador, Peru and Venezuela. It covers an area of 5,443,232 square kilometers and its population of an estimated ..... 78,457,000 inhabitants in 1978, has 2.5% annual growth rate. In 1979, 68.9% of the population was urban and in 1978 the per capita GDP was US.$ 1,184 with a growth rate for the period 1960/79 of 4.2%.

Even though the Andean region has a significant energy resources potential to back-up its growth and development, there exists an uneveness in the distribution of the commercial energy sources.

Venezuela, and to a lesser degree Ecuador, have important oil reserves while other countries such as Colombia and Chile, although lacking in this resource, have the greatest coal reserves not only in the sub-region but in all of Latin America.

In addition, Bolivia and Peru, which currently are self-sufficient in energy resources, have considerable natural gas and hydrocarbon resources.

The fact that the sub-region participated with a total of 45% of the 1978 total primary energy supply of Latin America, demostrates not only its current regional importance in the energy field, but also its potential as an energy supplier in the future. The following figures show the primary energy production within the region for the year in question:

	% ,Region/Total
Oil	57
Coal	50
Hydroenergy	20
Gas	41

With respect to energy consumption, in 1978 the region registered 22% of the total for Latin America while Brazil, Mexico and Argentina together, accounted for 70%.

Consumption is distributed by sectors as follows:

Transportation	35.6%
Industrial	33.8%
Residential, Commercial, Public	28.5%
Agricultural/Livestock, Mining	1.7%

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2. CHARACTERISTICS OF PRIMARY ENERGY PRODUCTION

The region can be considered privileged in terms of its energy resource potential within Latin America. It has 46% of the coal reserve, 43% of the hydroelectric potential, 37% of the natural gas reserves, and 30% of the petroleum. In addition, it has great prospects in other energy resources such as uranium, geothermal, biomass, etc., which have not been quantified in a systematic way and which at present are just in the exploration at evaluation phase.

TABLE Nº 1

PERCENTAGE STRUCTURE OF THE PRIMARY ENERGY PRODUCTION BY SOURCES IN THE ANDEAN SUBREGION

Sources	1970	1974	1978
Oil	81.6	78.6	75.4
Gas	13.1	14.5	15.3
Firewood	3.0	3.4	4.3
Coal	1.1	1.4	2.1
Others*	1.2	2.1	2.9
	100.0	100.0	100.0
TOTAL (TOE x 10^3)	264.757	237.203	191.457

In the Andean region, the energy supply by sources, shows a great dependence on oil and natural gas, given that in 1978 approximately 90.7% of the need was met by these resources. However, as can be seen in Table 1, a slight decrease in the dependence on petroleum and a gradual increase in the other sources is taking place.

* Including Hydroenergy and others fuels.

It should be emphasized that the decrease in the primary energy production of the region during the last decade is due both to the drastic reduction in oil production, particulary that of Venezuela, which declined by almost 35% during the period, as well as to the downward trend of this resource in countries such as Colombia, Bolivia and Chile. However, compared with the energy production in the rest of Latin America, this sub-region had a participation of 43% of the total in 1978.

It is also important to mention the progressive participation in energy production of sources with large development potential such as hydroenergy, coal and natural gas.

3. FOREIGN TRADE OF PRIMARY ENERGY

As has been noted herein, within the energy context of Latin America, this sub-region is a large exporter, especially in the areas of oil and gas. This phenomenon is explained by the presence of countries such as Venezuela and Ecuador whose economies depend almost entirelly on oil trade. For the inmediate future (1982), coal is expected to have an important participation due mainly to the initiation in the Cerrejón mine in Colombia.

The energy foreign trade of the Andean region in the 1970's presents the following characteristics:

	1970	1974	1978
		TOE x 10^3	
Exports	133,102	104,792	75,963
Imports	4,226	7,687	5,165

A decrease in the exports can be predicted as a consequence of the great reduction in the Venezuelan oil production previously mentioned.

4. CHARACTERISTICS OF SECONDARY ENERGY PRODUCTION

Table 2 shows the secondary energy supply by

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TABLE Nº 2

PERCENTAGE STRCTURE OF THE SECONDARY ENERGY PRODUCTION IN THE ANDEAN SUBREGION (TOE x 10^3)

Products	1970	%	1974	%	1978	%
Gasoline + naphtas	12.919	14.4	14.291	15.3	14.560	16.9
Kerosene + turbo fuels	6.049	6.7	4.405	4.7	4.632	5.4
Diesel & Gas	9.064	10.0	8.820	9.5	10.717	12.4
Heavy Fuels	50.261	56.2	51.773	55.5	39.968	46.8
Gas	3.904	4.4	3.980	4.3	5.246	5.9
Liquified Gas	1.925	2.2	3.077	3.3	2.856	3.2
Electricity	2.952	3.3	4.152	4.4	5.548	6.4
Coke	225		409		371	
Charcoal	146	0.7	132	0.8	128	0.7
Other Fuels	145		299		155	
Non-Energy Products	1.834	2.1	1.989	2.2	1.900	2.3
TOTAL	**89.424**		**93.327**		**86.081**	

products for the Andean area, where more than 60% of the total production corresponds to fuels and other petroleum derivatives, particulary gasoline and fuel-oil. It should be noted that the tendency of gasoline and diesel consumption to grow is due to the greater needs of the transportation sector in all the countries.

A sligth increase is also observed for electricity, motivated in part by the expansion of the large urban centers and the interest in developing the significant hydroenergy potential of the region.

There is a downward trend in the total secondary energy production due in part to the reduction in the regional oil supply and also to the process of substitution by gas in several countries such as Colombia and Venezuela, which are using the availability of this resource for electricity generation as well as for industry.

5. FINAL ENERGY CONSUMPTION

The Andean sub-region's final energy consumption (Table 3) represented 22% of the Latin American total in 1978 and during the period 1970 - 78/79 registered an average annual growth rate of 6.5% greater than that for the domestic product which for the same period was 4.8%. This implies that, if this consumption growth rate continues, the energy needs would be doubled every 12 years. However, countries like Venezuela have duplicated their total energy demand in less than 10 years, and, although to a lesser degree, others such as Colombia, Ecuador and Bolivia have greatly increased their consumption.

On the other hand, energy consumption in Peru and Chile has had a relatively moderate growth, and Chile even registered a slight decrease in 1978.

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TABLE Nº 3

FINAL ENERGY CONSUMPTION OF THE ANDEAN REGION BY COUNTRIES

Countries	1970	1974	1978
Bolivia	874	1 103	1 622
Colombia	9 784	11 772	13 399
Chile	6 885	7 177	7 155
Ecuador	2 125	2 543	3 633
Peru	7 862	8 861	9 274
Venezuela	8 689	13 297	19 812
TOTAL	**36 192**	**44 753**	**54 895**

6. FINAL ENERGY CONSUMPTION BY SECTORS

From the characteristics of the sectorial energy consumption in the sub-region (Tables 4 and 5), it can be seen that the three principal activities (industrial, transportation and the residential, commercial and public sector) have maintained equal proportions during the period 1970 - 79.

However, the greated relative growth of the transportation sector should be noted. This has caused, especially since 1974, an even greater demand for oil and its derivates.

It should also be mentioned that the residential sector, although it has an important participation in consumption, showed a slight decrease in 1978, with a participation of 29%. This is in contrast to the year 1970 when it was the greatest consumer of energy in the region (35%).

TABLE Nº 4

1978 FINAL ENERGY CONSUMPTION BY SECTORS AND COUNTRIES OF THE ANDEAN SUBREGION (TOE x 10^3)

Countries	Residential, Comercial Public	Transport	Indust.	Others
Bolivia	435	721	304	44
Colombia	4.460	3.933	4.380	406
Chile	2.173	2.163	2.819	—
Ecuador	1.264	1.514	582	175
Peru	4.096	1.993	2.531	388
Venezuela	2.319	8.072	6.852	40
TOTAL	**14.747**	**18.396**	**17.468**	**1.053**

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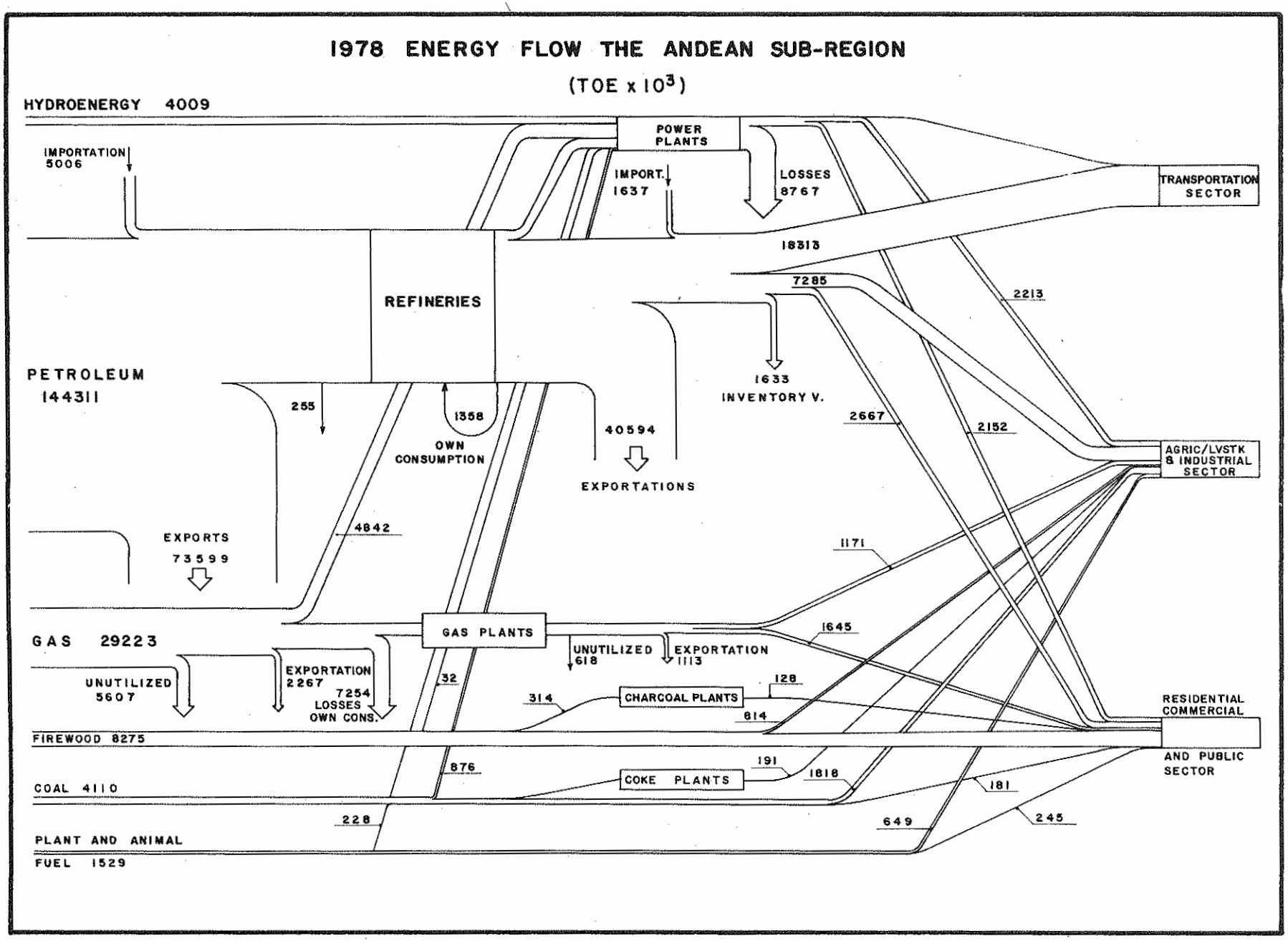
1978 ENERGY FLOW THE ANDEAN SUB-REGION
(TOE x 10³)
HYDROENERGY 4009
IMPORTATION 5006
POWER PLANTS
IMPORT. 1637
LOSSES 8767
TRANSPORTATION SECTOR
18313
REFINERIES
7285
2213
PETROLEUM 144311
255
1358
OWN CONSUMPTION
40594
EXPORTATIONS
1633
INVENTORY V.
2667
2152
AGRIC/LVSTK & INDUSTRIAL SECTOR
EXPORTS 73599
4842
1171
GAS 29223
GAS PLANTS
UNUTILIZED 618
EXPORTATION 1113
1645
UNUTILIZED 5607
EXPORTATION 2267
7254 LOSSES OWN CONS.
32
314
CHARCOAL PLANTS
128
814
RESIDENTIAL COMMERCIAL AND PUBLIC SECTOR
FIREWOOD 8275
876
191
1818
181
COKE PLANTS
COAL 4110
228
649
245
PLANT AND ANIMAL FUEL 1529

TABLE Nº 5

STRUCTURE OF THE FINAL ENERGY CONSUMPTION BY SECTORS THE ANDEAN REGION

Sector	1970	%	1974	%	1978	%
Residencial, Comercial and Public	12.203	34.5	13.595	31.3	14.747	28.5
Transportation	10.684	30.9	14.038	32.4	18.396	35.6
Industrial	11.030	31.7	14.670	33.8	17.468	33.9
Others	1.042	2.9	1.078	2.5	1.053	2.0
TOTAL	**34.959**		**43.381**		**51.663**	

The slow growth of industry, as measured by energy consumption, is notable since in 1978 its participation was only 34% and in 1970 it was 32%.

With respect to the final energy consumption by sectors and countries, Venezuela presents the highest transportation participation with 44% of the total, with a 1978 gasoline consumption of about 47% of the regional total.

In Other countries, such as Ecuador, Colombia and Peru, although this sector has a relative importance and weight in the consumption its participation is distributed propotionately among the three sectors. This can be seen in the table 4.

7. CONCLUSIONS

From this brief analysis and evaluation of the Energy Balance for the Andean sub-region, the following points can be made:

1. The sub-region as a whole can be considered self-sufficient, however, two countries, Colombia and Chile, are net importers of energy. Whether or not Peru, Ecuador and Bolivia can remain self-sufficient depends to a great extent on the success they have in their exploration programs.
2. In the last decade, the decrease in the primary energy production has been especially important and is due basically to the reduction in the Venezuelan oil production.
3. The prospects for a more intensive utilization of these energy sources which are relatively abundant in the region, such as coal and hydroenergy, open the way for the rational and integral use of the available resources.
4. The high participation of petroleum in the foreing trade of the region is significant.
5. The high dependency on oil is a consequence of the marked growth of the transportation sector in this sub-region among other factors.
6. In energy terms, the industrial sector has remained practically at a standstill during the last decade.
7. The sub-region constitutes an important energy resources potential in Latin America.

Organización Latinoamericana de Energía

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UNITS: TOE x 10³ — CONSOLIDATED ENERGY BALANCE — YEAR: 1970

COUNTRY: ANDEAN REGION
MINISTRY:
ELABORATED BY: OLADE
PLACE: QUITO DATE: 13/VII/81

			PRIMARY ENERGY										SECONDARY ENERGY												
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
			Coal	Firewood	Other Plant Animal Fuels	Crude Oil	Free Natural Gas	Associated Gas	Hydroenergy	Geoenergy	Fission Fuel	TOTAL PRIMARY ENERGY	Coke	Charcoal	Liquified Gas	Gasolines / Naphthas	Kerosene and Turbo Fuel	Diesel and Gas Oil	Heavy Fuels	Other Energy Fuels	Non-Energy Products	Gas	Electricity	TOTAL SECON. ENERGY	TOTAL
ENERGY SECTOR — SUPPLY	1.	Production	2786	8046	1165	216081	2620	31971	2058			264757													264757
	2.	Importation	216	3		4007						4226	313		110	200	68	78	1070		85			1924	6150
	3.	Inventory Variation	-1			466			-1			464	-56		16	64	-8	339	-1920	-5	-11	-29	-72	-1682	-1218
	4.	TOTAL SUPPLY	3001	8049	1165	220554	2620	31971	2087			269447	257		126	264	60	417	-850	-5	74	-29	-72	242	269689
	5.	Exportation	-5			-133097						-133102	-2		-737	-4282	-3368	-5526	-43751		-963			-58629	-191731
	6.	Unutilized	-91		-112	-368		-19153	-97			-19821										-471		-471	-20292
	7.	GROSS INTERNAL SUPPLY	2905	8049	1053	87089	2620	12818	1990			116524	255		-611	-4018	-3308	-5109	-44601	-5	-889	-500	-72	-58858	57666
ENERGY SECTOR — TRANSFORMATION CENTERS	8.	TOTAL TRANSFORMATION	-1467	-381	-166	-86830	-798	-6469	-1990			-98101	255	146	1925	12919	6044	8436	49012	145	1834	3638	2952	87307	-10794
	8.1.	Coke Plants, Furnaces	-809									-809	255									28		283	-526
	8.2.	Coal Plants	-8	-357								-365		146										146	-219
	8.3.	Biomass																							
	8.4.	Refineries				-86828	-798					-87626			701	11940	6049	9064	50261	145	1747	1845		81752	-5874
	8.5.	Gas Plants						-4157				-4157			1224	979					1	2031		4235	78
	8.6.	Public Service Power Plants	-506	-24	-80	-2		-1678	-1965			-4255					-5	-510	-1127			-113	2656	901	-3354
	8.7.	Self-Use Power Plants	-144		-86			-634	-25			-889						-118	-121		86	-153	296	-10	-899
	9.	Energy Sector's Own Consump.				-425		-4303				-4728	-134		-141	-167	-36	-105	-687	-139	-25	-2015	-258	-3707	-8435
	10.	Losses(Transp. Distri. Storage)	-16				-1822					-1838				-9	-2	-13	-1		-18	-380	-284	-707	-2545
	11.	ADJUSTMENTS	207			261		-7				461	6		-372	-241	-21	66	308	1	6	85	2	-160	301
FINAL CONSUMPTION	12.	TOTAL FINAL CONSUMPTION	1629	7668	887	95		2039				12318	382	146	801	8484	2677	3275	4032	2	908	828	2340	23875	36193
	12.1.	Final Non-Energy Consumption			67			32				99	227								908			1135	1234
	12.2.	Final Energy Consumption	1629	7668	820	95		2007				12219	155	146	801	8484	2677	3275	4032	2		828	2340	22740	34959
	12.2.1	Residential, Commercial, Public	230	7105	236			383				7954		143	770	189	1825	222	94			79	927	4249	12203
	12.2.2	Transportation	172									172				8183	504	1308	439	1			17	10512	10684
	12.2.3	Agricultural / Livestock			282							282				13	6	404	193				61	677	959
	12.2.4	Industrial	1227	563	302	95		1624				3811	155	3	31	96	28	1338	3304	1		749	1280	7219	11030
	12.2.5	Unidentified Consumption														3		27	2				55	83	83
TRANSFORMATION LOSSES																									
		GROSS SECONDARY ENERGY PRODUCTION											423	146	1890	13008	6049	9064	50354	145	1834	3904	2952	89879	

Observations:

OTHERS:

olade

UNITS: TOE × 10³ — CONSOLIDATED ENERGY BALANCE — YEAR: 1974

COUNTRY: ANDEAN REGION

MINISTRY: OLADE

ELABORATED BY: OLADE

PLACE: QUITO DATE: 13/VII/81

			PRIMARY ENERGY										SECONDARY ENERGY												
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
			Coal	Firewood	Other Plant Animal Fuels	Crude Oil	Free Natural Gas	Associated Gas	Hydroenergy	Geoenergy	Fission Fuel	TOTAL PRIMARY ENERGY	Coke	Charcoal	Liquified Gas	Gasolines / Naphthas	Kerosene and Turbo Fuel	Diesel and Gas Oil	Heavy Fuels	Other Energy Fuels	Non-Energy Products	Gas	Electricity	TOTAL SECON. ENERGY	TOTAL
ENERGY SECTOR	SUPPLY	1. Production	3412	8086	1393	186429	4439	30002	3442			237203													237203
		2. Importation	210			7477						7687	314		50	170	80	73	375		85		2	1149	8836
		3. Inventory Variation	-34			-749			11			-772	-21		45	-180	-62	70	-1350	-16	-621	-44	-82	-1702	-2474
		4. TOTAL SUPPLY	3588	8086	1393	193157	4439	30002	3453			244118	293		95	-10	18	143	-975	-16	23	-44	-80	-553	243565
		5. Exportation	-2			-103209		-1581				-104792	-23		-1657	-3541	-1222	-3393	-44838		-785			-55459	-160251
		6. Unutilized	-97		-151	-611		-12754	-531			-14144										-456		-456	-14600
		7. GROSS INTERNAL SUPPLY	3489	8086	1242	89337	4439	15667	2922			125182	270		-1562	-3551	-1204	-3250	-45813	-16	-762	-500	-80	-56468	68714
	TRANSFORMATION CENTERS	8. TOTAL TRANSFORMATION	-1454	-339	-195	-88307	-1671	-7405	-2922			-103293	211	132	3011	14220	4390	7859	49818	299	1989	3388	4152	89469	-12824
		8.1. Coke Plants, Furnaces	-800									-800	211									41		252	-548
		8.2. Coal Plants	-7	-322								-329		132										132	-197
		8.3. Biomass																							
		8.4. Refineries				-88294	-923					-89207			833	13153	4405	8820	51681	299	1883	1618		82692	-6515
		8.5. Gas Plants					-748	-4615				-5363			2178	1067					4	2321		5570	207
		8.6. Public Service Power Plants	-477	-17	-93	-23		-1805	-2901			-5316					-15	-797	-1659			-344	3820	1005	-4311
		8.7. Self-Use Power Plants	-170		-102			-985	-21			-1278						-164	-204		102	-248	332	-182	-1460
		9. Energy Sector's Own Consump.				-433		-3763				-4196	-135		-182	-143	-21	-135	-723	-281	-16	-2079	-283	-3998	-8194
		10. Losses(Transp. Distri. Storage)	-23				-2768					-2791			-11	-9	-1		-2		-22		-433	-478	-3269
		11. ADJUSTMENTS	-68			-447		18				-497	2		-77	2	-42	31	866		-120	164	-31	823	326
FINAL CONSUMPTION		12. TOTAL FINAL CONSUMPTION	1944	7747	1047	150		4517				15405	348	132	1179	10519	3122	4505	4146	2	1069	973	3353	29348	44753
		12.1. Final Non-Energy Consumption			85			67				152	151								1069			1220	1372
		12.2. Final Energy Consumption	1944	7747	962	150		4450				15253	197	132	1179	10519	3122	4505	4146	2		973	3353	28128	43381
		12.2.1 Residential, Commercial, Public	195	7104	241			515				8055		128	1136	296	1930	213	184			191	1462	5540	13595
		12.2.2 Transportation	116									116				10115	309	2342	639	1			17	13223	14039
		12.2.3 Agricultural / Livestock			347							347				13	8	435	101				71	628	975
		12.2.4 Industrial	1633	643	347	150		3935				6708	137	4	43	92	378	1433	3202	1		782	1740	7910	14370
		12.2.5 Unidentified Consumption														3		16	21				53	103	103

TRANSFORMATION LOSSES

Observations:

GROSS SECONDARY ENERGY PRODUCTION: 409 132 3077 14291 4408 8320 51773 299 1989 3330 4152 93327

OTHERS:

olade

UNITS: TOE x 10^3 — CONSOLIDATED ENERGY BALANCE — YEAR: 1978

COUNTRY: ANDEAN REGION

MINISTRY:

ELABORATED BY: OLADE

PLACE: QUITO DATE: 13/VII/81

			PRIMARY ENERGY										SECONDARY ENERGY												
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
			Coal	Firewood	Other Plant Animal Fuels	Crude Oil	Free Natural Gas	Associated Gas	Hydroenergy	Geoenergy	Fission Fuel	TOTAL PRIMARY ENERGY	Coke	Charcoal	Liquified Gas	Gasolines / Naphthas	Kerosene and Turbo Fuel	Diesel and Gas Oil	Heavy Fuels	Other Energy Fuels	Non-Energy Products	Gas	Electricity	TOTAL SECON. ENERGY	TOTAL
ENERGY SECTOR	SUPPLY	1. Production	4110	8275	1529	144311	5295	23928	4009			191457													191457
		2. Importation	159			5006						5165	507		9	1134	127	199	66		102		2	2146	7311
		3. Inventory Variation	45			-50			-1			-6	23		9	-61	-15	72	1670	-7	-1	-34	-96	1560	1554
		4. TOTAL SUPPLY	4314	8275	1529	149267	5295	23928	4008			196616	530		18	1073	112	271	1736	-7	101	-34	-94	3706	200322
		5. Exportation	-97			-73599	-645	-1622				-75963	-36		-1113	-1795	-864	-2362	-34101		-359			-40630	-116593
		6. Unutilized	-150		-193	-205		-5607	-129			-6284										-618		-618	-6902
		7. GROSS INTERNAL SUPPLY	4067	8275	1336	75463	4650	16699	3879			114369	494		-1095	-722	-752	-2091	-32365	-7	-258	-652	-94	-37542	76827
	TRANSFORMATION CENTERS	8. TOTAL TRANSFORMATION	-1580	-346	-228	-76965	-2725	-7628	-3860			-93352	159	128	2800	14474	4493	9126	38007	155	1900	4017	5548	80807	-12545
		8.1. Coke Plants, Furnaces	-695									-695	159									35		194	-501
		8.2. Coal Plants	-9	-314								-323		128										128	-195
		8.3. Biomass																							
		8.4. Refineries				-76929	-973					-77902			1039	13653	4632	10717	39804	155	1704	1834		73638	-4264
		8.5. Gas Plants					-1752	-4015				-5767			1761	821					46	3377		6005	238
		8.6. Public Service Power Plants	-701	-32	-78	-36		-2585	-3858			-7290					-139	-1412	-1642			-939	5206	1074	-6216
		8.7. Self-Use Power Plants	-175		-150			-1028	-22			-1370						-179	-255		150	-290	342	-232	-1607
		9. Energy Sector's Own Consump.				-90		-3138				-3228	-113		-63	-116	-24	-199	-790	-139	-19	-2124	-305	-3892	-7120
		10. Losses(Transp. Distri. Storage)	-32				-1925					-1957			-4	-4	-1		-1		-31		-639	-680	-2637
		11. ADJUSTMENTS	-391			1645		-21	1			1234	-2		-173	-280	-79	-284	-113		-62	110	-1	-884	350
FINAL CONSUMPTION		12. TOTAL FINAL CONSUMPTION	2064	7929	1108	53		5912				17066	538	128	1465	13352	3637	6552	4738	9	1530	1351	4509	37809	54875
		12.1. Final Non-Energy Consumption			214			1121				1335	347								1530			1877	3212
		12.2. Final Energy Consumption	2064	7929	894	53		4791				15731	191	128	1465	13352	3637	6552	4738	9		1351	4509	35932	51663
		12.2.1 Residential, Commercial, Public	181	7115	245			625				8166		117	1414	300	2009	242	116			231	2152	6581	14747
		12.2.2 Transportation	65									65				12978	1205	2465	664	1			18	18331	18396
		12.2.3 Agricultural / Livestock			191							191				9	3	523	99				78	712	903
		12.2.4 Industrial	1818	814	458	53		4166				7309	191	11	51	64	420	2300	3859	8		1120	2135	10519	17468
		12.2.5 Unidentified Consumption														1		22					126	149	149

TRANSFORMATION LOSSES

Observations:

GROSS SECONDARY ENERGY PRODUCTION | 371 128 2866 13360 4632 10717 39968 155 1900 5046 5548 86081

OTHERS

STRUCTURE OF ENERGY CONSUMPTION IN LATIN AMERICA

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1. INTRODUCCION

In the present article, the energy consumption structure for Latin America is analyzed based on:

a. The 1978 consolidated regional balance, which was obtained from the balances of twenty-two countries from the region;

b. The balances of six subregions, the product of the zoning of the countries; and,

c. The individual balances of the countries for various years from the 1970's.

These were elaborated in a uniform manner following the OLADE methodology and with a common unit of measure, tons of oil equivalent-TOE.

Within the total energy consumption the balances consider the following uses: consumption by the residential, commercial and public; industrial; transportation; and agricultura livestock sectors; as well as transformation centers; transportation, distribution, and storage losses; unidentified consumption, and adjustments.

Using this scheme, a consumption analysis is presented for Latin America and its sub-regions. Within the principal sectors, (industrial, transportation, and residential, commercial and public), the consumption is broken down by products.

2. Analysis

2.1 Destination of the Gross Internal Supply 1/ Latin America - 1978.

TABLE 1

DESTINATION	GIS TOE x 10^3	(%)
Industrial Sector	83.656	24.8
Transportation Sector	75.133	22.3
Residential Commercial and Public	68.033	20.2
Transformation Losses	47.340	14.0
Energy Sector's Own Consumption	26.182	7.8
Agricultural/Livestock Sector	9.704	2.9
Transportation, Distribution and Storage Losses	11.869	3.5
Others 2/	15.559	4.6
TOTAL	**337.486**	**100.0**

1/ GIS = This is the quantity of primary and secondary energy that the country has available for the processes of transformation, distribution and consumption.

2/ INCLUDES: Unidentified and non-energy consumption and adjustments.

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2.2 1978 Destination of the Gross Internal Supply by Sub-Regions.

TABLE 2

	GIS OIB TOE x 10^3	(%)
Latin America	337.486	100
Mexico	88.232	26.1
Central America	12.613	3.7
The Caribbean	14.650	4.3
The Andean Sub-region	76.827	22.8
The Southeastern Region		
*Argentina		11.4
		12.2
*Uruguay		0.8
Brazil	**104.008**	**30.8**

2.3 1978 Final Consumption by Sector for Latin America

TABLE 3

	TOE x 10^3	(%)
Final Energy Consumption	237.351	100.0
Residential, Commercial and Public	68.033	28.7
Transportation	75.133	31.7
Agricultura/Livestock	9.714	4.1
Industrial	83.656	35.2
Unidentified Consumption	815	0.3

2.5 1978 Final Energy Consumption by Products for Latin America

TABLE 5

PRODUCT	TOE x 10^3	(%)
Firewood and Charcoal	52.069	21.9
Gasoline	42.131	17.8
Heavy Fuels	37.049	15.6
Diesel	32.099	13.5
Electricity	20.455	8.6
Gas	13.571	5.7
Kerosene and Turbofuels	10.568	4.5
Liquid Gas	7.881	3.3
Coal and Coke	7.329	3.1
Other Plant and Animal Fuels	7.049	3.0
Natural Gas (associated and free)	5.627	2.4
Other Energy Fuels	1.523	0,6
TOTAL	**237.351**	**100.0**

2.6 1978 Firewood and Charcoal Consumption by Sub-regions

TABLE 6

	TOE x 10^3	(%)
Latin America	52.069	100.0
Mexico	11.954	23.0
Central America	5.637	10.8
The Caribbean	2.245	4.3
The Andean Sub-region	8.057	15.5
The Southeastern Region	941	1.8
Brazil	23.235	44.6

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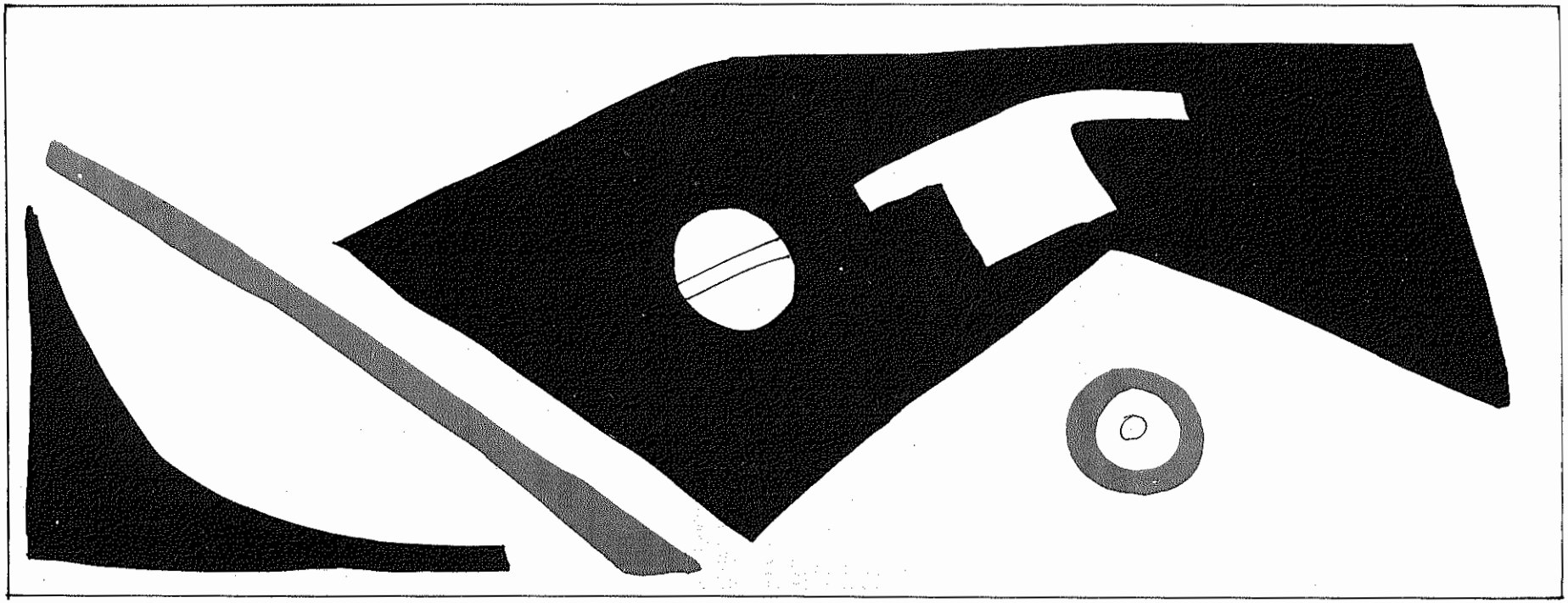
FINAL CONSUMPTION BY SECTORS 1978
TOE x 10^3

SECTOR	MEXICO		CENTRAL AMERICA		CARIBBEAN		The Andean Subregion		The Southeastern Subregion		ARGENTINA		URUGUAY		BRAZIL		AMERICA LATINA	
	TEP x 10^3	%	TEP x 10^3	%	TEP x 10^3	%	TEP x 10^3	%	TEP x 10^3	%	TEP x 10^3	%	TEP x 10^3	%	TEP x 10^3	%	TEP x 10^3	%
Residential	17065	25.1	5886	8.7	2532	3.7	14747	21.7	6976	10.3	6173	9.1	803	1.2	20827	30.6	68033	100.0
Transportation	18610	24.4	2166	2.8	2813	3.7	18396	24.2	10057	13.2	9500	12.5	557	0.7	24111	31.7	76153	100.0
Agricultural	2221	22.9	235	2.4	54	0.6	903	9.3	1078	11.1	1078	11.1			5223	53.8	9714	100.0
Industrial	18848	22.5	2614	3.1	4584	5.5	17468	20.9	8818	10.5	8133	9.7	685	0.8	31324	37.4	83656	100.0
Unidentified	342		28				149		393		379						815	
TOTAL	57086		10929		8956		51663		27322		25263				81395		237351	



2.7 1978 Gasoline Consumption by Sub-regions

TABLE Nº 7

	TOE x 10^3	(%)
Latin America	42.131	
Mexico	11.192	26.6
Central America	1.200	2.8
The Caribbean	1.099	2.6
The Andean Region	13.352	31.7
Venezuela	6.249	14.8
Remaining Countries	7.103	16.9
Southeastern Region	4.871	11.6
*Argentina	4.656	11.1
*Uruguay	215	0.5
Brazil	10.417	24.7

2.9 1978 Electricity Consumption by Sub-regions

TABLE 9

	TOE x 10^3	(%)
Latin America	20.455	100.0
Mexico	3.876	18.9
Central America	618	3.0
The Caribbean Sub-region	375	1.8
The Andean Sub-region	4.509	22.0
The Southeastern Sub-region	2.618	12.8
*Argentina	2.402	11.7
*Uruguay	216	1.1
Brazil	8.459	41.4

2.8 Per Capita Gasoline Consumption in Latin America

TABLE 8

	TOTAL FINAL GASOLINE CONSUMPTION.	PER CAPITA/TEP/HAB. TOE/INHAB
LATIN AMERICA	42.131	
MEXICO	11.192	0,167
CENTRAL AMERICA	1.200	0,058
COSTA RICA	164	0,076
EL SALVADOR	169	0,038
HONDURAS	107	0,031
GUATEMALA	317	0,048
NICARAGUA	185	0,077
PANAMA	258,3	0,142
THE CARIBBEAN	7,96	0,066
HAITI	51	0,011
JAMAICA	220	0,104
DOMINICAN R.	462	0,090
SURINAME	313	0,277
TRINIDAD & TOBAGO 1/	313	0,277
THE ANDEAN SUB-REGION	13.352	
BOLIVIA	407	0,070
COLOMBIA	3.294	0,132
CHILE	1.146	0,106
ECUADOR	1.036	0,139
PERU	1.220	0,072
VENEZUELA	6.249	0,474
THE SOUTHEASTERN SUB-REGION	4.871	0,167
ARGENTINA	4.656	0,176
URUGUAY	215	0,075
BRAZIL	10.417	0.089

1/ Año 1979.

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2.10 1978 Heavy Fuels Consumption by Sub-regions

TABLE 10

	TOE x 10^3	(%)
Latin America	32.099	100
Mexico	6.109	19.0
Central America	682	2.1
Caribbean Sub-region	2.374	7.4
Andean Sub-region	4.738	14.8
Southeastern Sub-region	4.002	12.5
* Argentina	3.573	11.1
* Uruguay	429	1.4
Brazil	14.194	44.2

2.11 1978 Diesel Consumption by Sub-regions

TABLE 11

	TOE x 10^3	(%)
Latin America	37.049	100
Mexico	8.985	24.3
Central America	1.521	4.1
The Caribbean Sub-region	830	2.2
The Andean Sub-region	65.521	17.7
The Southeastern Sub-region	6.099	16.6
* Argentina	5.668	15.4
* Uruguay	431	1.2
Brazil	13.062	35.3

2.12 Structure of the Final Consumption by Sectors and Products in Latin America

TABLE 12

SECTOR	TOE x 10^3	(%)
Industrial	83.656	100.0
* Heavy Fuels	27.896	33.3
* Gas	16.031	19.2
Biomass	13.607	16.3
* Electricity	10.833	12.9
* Coke and Coal	7.064	8.4
* Other Hydrocarbons	8.225	9.8
	75.133	100.0
Transportation	75.133	100.0
* Gasoline	41.531	55.3
* Diesel	24.353	32.4
Kerosene and Heavy Fuels	5.005	6.7
Others	4.246	5.7
Residential, Commercial and Public	68.033	100.0
Firewood and Charcoal	41.411	60.9
* Gas	10.848	15.9
* Electricity	9.006	13.2
* Hydrocarbons	6.342	9.3
* Others	426	0.7

3. CONCLUSIONS

The most important conclusions of the analysis are presented below:

3.1 **Gross Internal Supply**

(Tables 1 and 2)

— In 1978, of the 337,486 TOE x 10^3 AVAILABLE to the region, industry absorbed 24.8%, trans-

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portation 22.3% and the residential, commercial and public sector 20.2%.

— The foregoing was strongly influenced by the very high participation of three countries (brazil 30.8%, Mexico 26.1%, and Argentina 11.4%) in the use of the gross internal supply, which meant only 31.7% of the supply was consumed by the remaining countries.

— The Andean sub-region as a whole had a participation (22.8%) similar to that of Mexico and Brazil.

3.2 **Final Energy Consumption**

(Tables 3 and 4)

— The distribution of the region's final energy consumption (237,351 TOE x 10^3) was similar to that of the gross internal supply; i.e., uniformly between the industrial (35.2%), transportation (31.7%) and residential, commercial and public sector (28.7%).

— Once again, the final energy consumption was concentrated in three countries (Brazil, Mexico and Argentina.)

— In the industrial sector, these countries absorbed 69.6% in the transportation sector 68.6%, and in the residential, commercial and public sector 64.8%.

— The Andean Sub-region, when considered as a whole, was very similar to Mexico and Brazil, with a participation of 20.9% in the industrial sector, 24.2% in the transportation sector, and 21.7% in the residential, commercial and public sector.

3.3 **Final Energy Consumption by Products**

(Tables 5, 6, 7, 8, 9, and 10)

— As surprising as it seems, within the Latin American final energy consumption, firewood and charcoal had the greatest participation; with 21.9%, followed by Gasoline (17.8%) diesel (15.6%), heavy fuels (13.5%), and electricity (8.6%).

— The oil derivatives, considered as a whole, supplied 54.7% of the fuels consumed.

— Brazil was the largest firewood consumer (23.235 TOE x 10^3 equal to 44.6%).

— Mexico was the second largest consumer of firewood, (11.954 TOE x 10^3 equal to 23%).

— In Haiti, firewood and charcoal account for 69.3% of the energy utilized in the total final consumption.

— There were six more countries where biomass exceeded 50% of the final energy consumption: Grenada, Honduras, El Salvador, Guatemala, Nicaragua and the Dominican Republic.

— Mexico was the largest gasoline consumer in Latin America with 26.6%, followed by Brazil (24.7%) and Venezuela (14.8%).

— Venezuela was the largest per capita consumer of gasoline with 0.475 TOE/inhabitant, followed by Trinidad and Tobago with 0.277 TOE/inhab., Argentina with 0.176 TOE/inhab. and Mexico with 0.167 TOE/inhab.

— Brazil consumed 41.4% of the electricity, followed by Mexico (18.9%) and Argentina (11.7%).

— Brazil consumed 44.2% of the heavy fuels, Mexico 19% and Argentina 11.1%.

— Brazil consumed 35.3% of the diesel, Mexico 24.3% and Argentina 15.4%.

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3.4 **Sectorial Consumption by Products**

(Table 11)

— The Latin American industrial sector depended mainly on heavy fuels (33.3%), gasoline (19.2%), **biomass** (16.3%), and electricity (12.9%).

— The transportation sector depended on **oil derivatives** for 94.3% of its consumption (gasoline 55.3%, diesel 32.4%, kerosene and heavy fuels 6.7%).

— The residential sector depended on **firewood and charcoal,** for 60.9% of its consumption, on gas, for 15.9%, on electricity for 13.2% and on hydrocarbons for 9.3%.

— In Brazil, firewood participated with 35% of the residential consumption.

3.5 **General Conclusions**

— Transportation in Latin America was totally dependent on oil.

— The residential sector depended basically on firewood and charcoal.

— The industrial sector was the most heterogeneous with respect to the fuels it utilizes.

— The agricultura/livestock sector had a very low participation in the final energy consumption (4.1), which, among other things indicates the low level of mechanization in Latin American agriculture.

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QUANTITATIVE ANALYSIS OF THE ROLE OF BIOMASS WITHIN ENERGY CONSUMPTION IN LATIN AMERICA

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I. INTRODUCCION

The last decade has been characterized by increased awareness by the international community with respect to biomass importance a principal energy source for the majority of the Third World population. This situation occurs, to varying degrees, in all of the poor countries and has given rise to the fact that firewood and biomass have received growing attention during the last years. The different United Nations agencies, the World Bank and bilateral cooperation organisms have conducted numerous meetings tending to emphasize the importance of these fuels for significant sectors of the world population.

These activities have stressed firewood's role as the principal energy source of the rural and marginal-urban populations, as well as the related problems of land use, deforestation, erosion, and degradation of hydrographic basins.

The majority of the existing studies have been qualitative without precisely quantifying the magnitude and distribution of consumption. For example, it is estimated that firewood and biomass fuels satisfy almost all of the energy needs of more than one third of the world population, and also are the principal energy source of more than 2.500 million human beings[1/].

In Latin America, it is estimated that approximately 50% of the total population depend on firewood and charcoal for their basic cooking needs[2/]. These often cited figures are only broad estimates since there are few empirical studies to support them.

There exist important differences between biomass fuels and other energy sources that make the quantitative analysis of the situation difficult. Firewood utilization in Latin America has characteristics which are peculiar to each sub-region and country, and which make a uniform treatment of the region difficult. Consumption of firewood an other biomass resources are a function of the specific ecosystem, cultural patterns, and other extra-economic factors which contribute to the fact that the level of commercialization of firewood is very different from the other energy sources. In general, biomass fuels are considered "noncommercial' or "marginally commercial" since in many cases there are not well developed markets for them or direct appropriation mechanism predominate. However, the term "non-commercial" is inadequate since it omits the cases in which there is a commercial transaction. An example of the ambiguity existing in this terminology is the case of charcoal which is sold in urban markets with well

1/ Eckholm, Erik, 1975 "The Other Energy Crisis: Firewood," World-watch Paper 1. Worldwatch Institute, Washington D.C., USA.

2/ Final Report of the Regional Technical Meeting on "Firewood and Charcoal: its incorporation to Energy Planning and Policy." ECLA, FAP, OLADE and the Nicaraguan Energy Institute, Managua, Nicaragua, February 1981.

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defined prices, but whose production takes place in artesan units where the firewood that serves as the raw material is apropiated directly. Also, the commercialization of firewood and charcoal has varied patterns among the regional countries.

The economic cycle of biomass fuels can go directly from resource to consumer without passing through the intermediate stage of the market with a well defined supply sector. The lack of this supply sector, that in the case of the hydrocarbons or electricity is the information generating nucleus, explains the lack of statistics for firewood and others.

In addition to these problems, other factors complicate the treatment of biomass within the national energy balances. Firewood utilization, for example, has strong cultural influences that determine the type and units of consumption. These last vary considerably in the region and within the countries. As an example of these traditional measurements, in Costa Rica exists "la carga", in Ecuador "el guango", in El Salvador "el tercio de mujer" and in Peru, "la carga de burro." In addition, it cannot be forgotten that biomass is used together with other low-cost hydrocarbon fuels such as "Kerex" in Ecuador, and "cocinol" in Colombia.

Finally, political factors exist which help to explain the lack of information that characterizes consumption of firewood and other biomass fuels. These energy sources are used almost exclusively by the rural and marginal-urban sectors, composed by the poorest, most underdeveloped and traditional classes. Generally, these are the same classes that receive the least attention by the national governments, and as a consequence their problems almost never are among the government's priorities. Moreover, given the fact that the use of biomass and firewood is generally considered as a sign of "backwardness" or "under-development", many nations prefer not to make known their exact levels of firewood consumption. In certain cases real data on firewood consumption would demonstrate the situation of the rural and marginal-urban populations in sharp contrast with the official data on electrification and national development plans.

All of these factors contribute to the fact that the level of quatitative knowledge on biomass consumption in Latin America is not comparable at the level existing for other energy sources. At the same time, this situation inevitably leads to the fact that in order to estimate biomass consumption, it is necessary to quantify it by meas of direct surveys of the consumers.

Given the heterogenity of the cultural and consumption patterns in Latin America, the surveys should be done in relatively homogenous regions within each country.

OLADE's fundamental purpose was to ensure that in the elaboration of the national energy balance of the Latin American countries, the situation of the rural and marginal-urban areas were treated with the same criteria as the rest of the energy system.

The program of Energy Balances of OLADE, gave advice and financial aid to various countries for the realization of a simplified survey in the rural and marginal-urban areas. By this effort, as well as the work of the Energy Program of the Central American Isthmus (PEICA), it was possible to obtain biomass consumption data for 14 countries in which surveys were conducted. As to the remaining countries, there exist consumption estimates in some cases, while in others no data on biomass and firewood consumption were supplied.

The present work is based fundamentally on the information processed for the above mentioned program that OLADE has published with the title "Energy Balances of Latin America."

This first effort to present a global estimate of the role of biomass within the Latin American energy consumption, will be improved and refined as the countries become aware of the importance of quantify-

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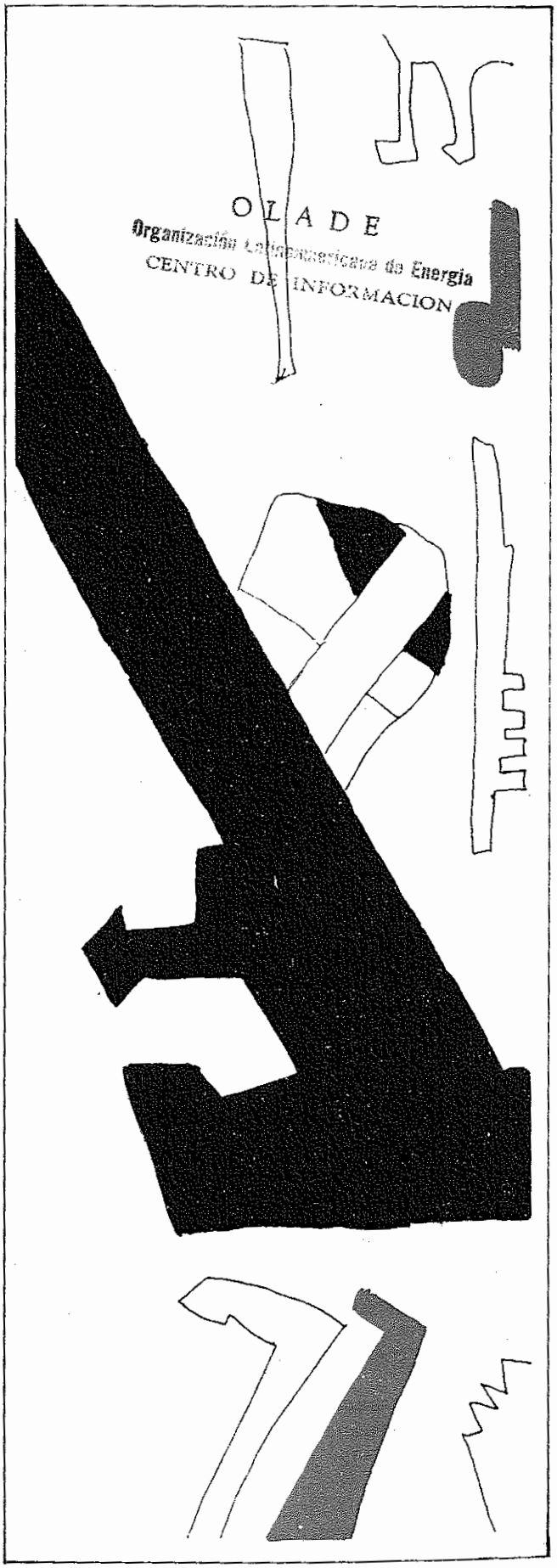

ing this area. Even with the partial results presented herein, it is possible to clearly see the predominant role of biomass in various consumption sectors, throughout the region.

II. RESULTS AND ANALYSIS

As a frame of reference, energy consumption data are presented for the different regions and sectors of the world (Table N° 1) as well as the total biomass consumption for the Latin American countries (Table N° 2).

TABLE N° 1

Energy Consumption in TOE/inhab. (1976)

	TOE/inhab.
Industrialized countries with Market Economies	4.8
Industrialized countries with Centrally Planned Economies	3.9
Total of Industrialized Countries	4.5
Third World Countries	0.5
World Total	1.66

SOURCE: World Energy Conference, 1981.

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TABLE Nº 2

PERCAPITA BIOMASS CONSUMPTION IN LATIN AMERICA (1978)

COUNTRY	Final Energy toe/in hab.	Consumption Firewood toe/in hab.	Biomass Consumption toe/in hab.	Source
México*	1,00	0,17		Estimate
Central América				
Costa Rica	0,66	0,20	0,27	Survey
El Salvador	0,53	0,30	0,34	Survey
Guatemala	0,49	0,27	0,30	Survey
Honduras	0,49	0,30	0,32	Survey
Nicaragua	0,50	0,29	0,29	Survey
Panamá	0,60	0,16	0,21	Survey
The Caribbean				
Grenada	0,15	0,02	0,03	Survey
Haití	0,34	0,24	0,29	Survey
Jamaica*	1,21		0,11	Estimate
Rep. Dominicana	0,58	0,1	0,29	Survey
Surinam	1,44			
Trinidad y Tobago	1,56			
The Andean Region				
Bolivia	0,30	0,03	0,04	
Bolivia	0,30	0,03	0,04	Survey
Colombia	0,53	0,12	0,01	Survey
Chile	0,65	0,12	0,12	Survey
Ecuador	0,47	0,10	0,13	Survey
Perú	0,55	0,15	0,19	Survey
Venezuela	1,56	0,01		Estimate
Southeastern Region				
Argentina*	1,00		0,06	Estimate
Uruguay	0,77	0,18	0,19	Survey
Brasil	0,79	0,17	0,22	Survey

*Firewood and/or biomass consumption data bases on estimates.

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From the analysis of Tables N° 1 and 2, it can be concluded:

No country in the region surpasses the world average consumption. Only Venezuela, Trinidad and Tobago, Suriname, and Jamaica approach this value. Venezuela, one of the principal energy producing countries of the region has the greatest per capita consumption in Latin America. Trinidad and Tobago, a small oil-producing country occupies second place, while the high consumption of Jamaica and Suriname is explained by the elevated industrial consumption, arising from the aluminum and bauxite processing.

Graph N° 1 shows that there is a good correlation within energy consumption and per capita income for the Latin American countries. The graph shows the data fitted with two types of curves, lineal and potential. There is also a certain grouping of countries with similar characteristics seen from the figure.

Table N° 3 shows the role of biomass within final energy consumption in Latin America for 1978.

Various facts stand out from the analysis of the per capita consumption and income, and the participation of biomass in the final energy consumption: the countries with lower per capita incomes and consumption, in general, present an elevated participation of biomass in the final energy consumption. Haiti, Nicaragua, Honduras, and Guatemala are in this category, while in Bolivia, which has a very low energy consumption, biomass does not surpass 15% of the final energy consumption.

Although there is evidence to sustain the hypothesis that countries with low incomes and energy consumption utilize an elevated proportion of biomass, it is not necessarily true that a high share of biomass within final energy consumption is synonomous with poverty or backwardness. Brazil, Uruguay, Perú, Ecuador, and Costa Rica are characterized by a biomass participation greater than 25% of the final energy consumption, and, they have moderate per capita incomes and energy consumption within the region.

It is also interesting to note that the countries with the largest per capita incomes and energy consumption (Argentina, Venezuela, and Mexico) do not have statistics on biomass consumption. The data presented herein are estimates of each country or of OLADE.

2.2. **Residential, Commercial and Public Sector**

The analysis of Tables N° 4 and 5 shows that aside from purely economic factors there exist geographical and cultural influences on biomass utilization in the sectorial energy consumption for Latin America. Tables N° 4 and 5 present the participation of biomass in the residential, commercial, and public and industrial sectors. In table 4 it can clearly be observed that in Central America, biomass —firewood in particular-represents more than 3/4 of the sectorial consumption in all of the countries and in 3 of them (Guatemala, El Salvador, and Honduras) it approaches or surpasses 90%. The importance of firewood for the rural and marginal-urban sectors of Central America is unquestionable.

A similar phenomena is observed in the Andean sub-region where Colombia, Ecuador, and Peru have biomass participation values of 65% for the residential, commercial, and public sector. These countries have elaborated national surveys for firewood utilization. Bolivia presents a biomass consumption of close to 50% of the total for the sector, Chile has a value of 40.6% and Venezuela has less than 0.5%. This last value was based on estimates.

There is a wide dispersion in the Caribbean with respect to the participation of biomass in the residential, commercial and public sector. Haiti, reports a 98.6% consumption of biomass and in Trinidad and Tobago the figure does not reach 10%. In neither country was there a survey so the figures are estimates. Trinidad and Tobago, being an oil producing country, has petroleum derivative fuels at subsidized prices for use in cooking, which partially explains the low biomass consumption.

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GRAPH No 1

RELATION BETWEEN ENERGY CONSUMPTION AND INCOME PER CAPITA

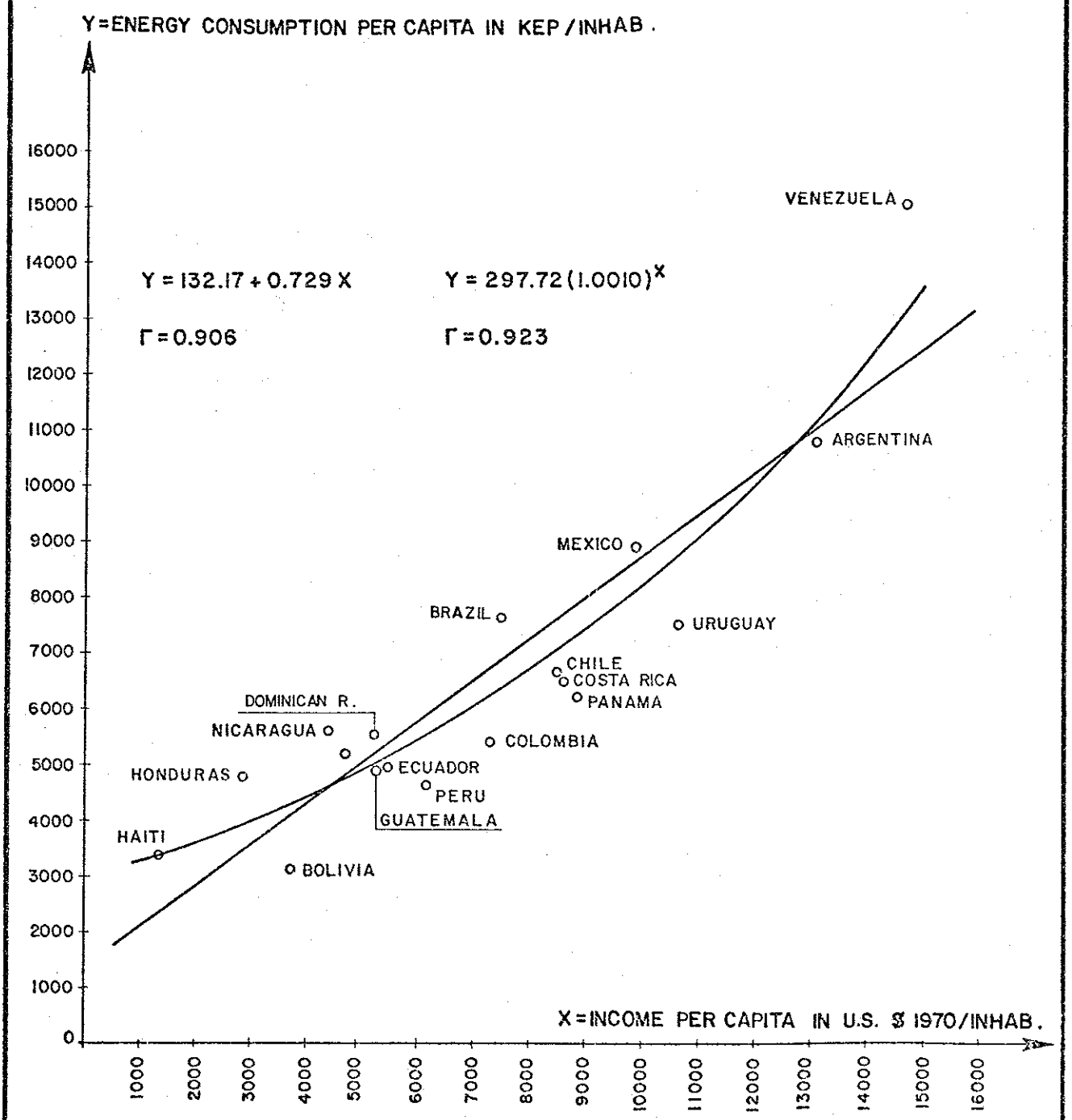

TABLE Nº 3

PARTICIPATION OF BIOMASS IN THE FINAL ENERGY CONSUMPTION (1978)

Country	Firewood		Total Biomass	
	TOE X 10^3	%	TOE x 10^3	%
México	11954	20,9		
Central America				
Costa rica	435	31,5	575	41,6
El Salvador	1359	60,2	1525	67,6
Guatemala	1887	59,1	2054	64,3
Honduras	1068	64,4	1132	68,3
Nicaragua	565	43,0	723	55,1
Panamá	2935	26,2	397,3	35,3
The Caribbean				
Grenada	3	17,6	4,05	22,3
Hití	1126	69,3	1402	86,3
Jamaica*	6	0,2	228	8,5
Dominican Rep.	451	15,7	1501	52,3
Trinidad and Tobago				
The Andean Region				
Bolivia	210	14,0	221	14,7
Colombia	2948	22,4	3220	24,4
Chile	1329	18,6	1329	18,6
Ecuador	783	22,1	969	27,4
Perú	2648	29,4	3199	35,3
Venezuela*	11	0,1	13	0,1
The Southeastern Reg.				
Argentina*	187	0,7	1519	6,1
Uruguay	516,9	25,1	556,3	27,0
Brazil	20676	20,5	26543	32,6

*Firewood and/or biomass consumption data based on estimates.

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TABLE Nº 4

PARTICIPATION OF BIOMASS IN THE CONSUMPTION of the Residential, Commercial and Public Sector

Country	Firewood		Total Biomass	
	TOE x 10^3	%	TOE x 10^3	%
México	11954	70,0	11954	70,5
Central America				
Costa Rica	417	75,0	426	76,6
El Salvador	1330	92,0	1331	92,0
Guatemala	1563	90,4	1563	90,4
Honduras	966	88,4	971	88,9
Nicaragua	508	80,6	518	82,2
Panamá	287	66,8	287,4	66,9
The Caribbean				
Grenada	3,4	37,5	4,05	43,3
Haití	1047	80,9	1276	98,6
Jamaica*	6	3,0	15	8,1
Dominican Rep.	426	39,1	818	79,7
Surinam	30	53,3	29,9	53,5
Trinidad and Tobago				
The Andean Region				
Bolivia	210	48,3	210	48,3
Colombia	2948	66,1	2948	66,1
Chile	882	40,6	882	40,6
Ecuador	783	61,9	783	62,0
Perú	2281	55,7	2641	64,5
Venezuela*	11	0,5	13	0,5
The Southeastern Reg.				
Argentina*			236	3,8
Uruguay	455	56,7	455	56,7
Brazil	13938	48,5	14295	68,6

*Firewood and/or biomass consumption data based on estimates.

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2.3. **Industrial Sector**

With respect to the participation of biomass in the industrial sector, the percentages of the Dominican Republic, Haiti, and Guatemala stand out with consumptions of more than 50% in the industrial sector.

As a sub-region, Central America is characterized by an elevated industrial consumption; Panama and Costa Rica have intermediate consumption levels of 30 and 40% respectively, while El Salvador, Guatemala and Honduras approach or surpass 50%.

In Brazil, the industrial consumption of biomass reaches. 21%.

2.4. **General Considerations in the Consumption**

Tables 3, 4 and 5 quantitatively demonstrate the importance of the biomass and firewood consumption, in general, for the Latin American countries. The data presented are average per capita consumptions and thus omit the large differences existing within the countries and the enormous importance of fuels for the rural and marginal-urban populations. In almost the entire region, biomass represents a very high percentage of the residential, commercial and public sector consumption. Even in countries with a considerable degree of industrialization such as Brazil and Mexico, biomass represents close to 70% of the consumption in this sector.

Central America stands out as the sub-region with the most elevated participation of biomass of the region, both in the residential, commercial and public sector, as well as the industrial sector. Some of the countries of the Andean sub-region such as Colombia, Ecuador and Peru show similar characteristics, although with a lower biomass participation. A similar situation occurs in Brazil.

Finally, it is important to stress the fact that countries which have done surveys show a biomass participation consistently higher than for those countries in which there are only estimates. This points to the possibility that the role of biomass has been underestimated in Latin America. Even in the countries that have conducted surveys on firewood, it is possible that plant and wood residues, and other biomass fuels which are part of the regional energy consumption, have not been included.

2.5. **Evolution of the Production of Biomass for Energy.**

It is not possible to estimate the total biomass production in the region, rather only the portion utilized for energy. The historical series of the energy balances show the evolution of the production of firewood and other plant and animal fuels during the past decade. Graphs N° 2, 3, 4 and 5 present the firewood and other biomass fuel production in thousands of tons for 1970-1980.

Graph 2 shows firewood production in thousands of tons for the small and medium producers (those with production less than 5 million tons annually) while Graph 3 shows the same data for the large producers of the region (Brazil, Colombia, Peru, and Guatemala). It is noteworthy that for a considerable number of countries firewood production has been maintained relatively constant during the decade. Only Ecuador shows a considerable decrease while El Salvador, the Dominican Republic and Haiti showed a growth trend.

Graph 4 shows the plant and animal fuels production for small and medium producers while Graph 5 provides data for the large producers of the region. There are few countries where consumption has stayed relatively constant or decreases slightly; however, in the mejority of the countries there was a considerable increase in consumption of biomass fuels. In addition, various countries show significant fluctuations from one year to another. This is the case with Brazil where an increase of 34% was reported from 1976 to 1977. In Guatemala, consumption was trippled from 1970 to 1976 and fell abruptly after that year.

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TABLE Nº 5

PARTICIPATION OF BIOMASS IN THE INDUSTRIAL SECTOR

Country	Firewood		Total-Biomass	
	TOE x 10^3	%	TOE x 10^3	%
México*				
Central America				
Costa Rica	18,0	4,8	149,0	40,0
El Salvador	29,0	7,3	194,0	48,9
Guatemala	324,0	36,2	491,0	54,9
Honduras	102,0	30,2	161,0	47,7
Nicaragua	57,0	22,7	58,0	23,1
Panamá	6,6	1,8	109,9	30,5
The Caribbean				
Grenada	0,19		0,2	
Hití	79,0	36,2	126,0	57,8
Jamaica*			213,0	10,6
Dominican Rep.	25,0	2,1	683,0	57,3
Surinam	0,2	2,1	3,6	1,0
Trinidad and Tobago				
The Andean Region				
Bolivia			10,7	3,5
Colombia			272,0	6,2
Chile	447,0	15,9	447,0	15,9
Ecuador			186,0	32,0
Perú	367,0	14,5	367,0	14,5
Venezuela*				
The Southeastern Reg.				
Argentina*	5,0		1100,0	
Uruguay	61,9	9,0	101,3	14,5
Brazil	3409,0	8,0	8919,0	21,0

*Firewood and/or biomass consumption data based on estimates.

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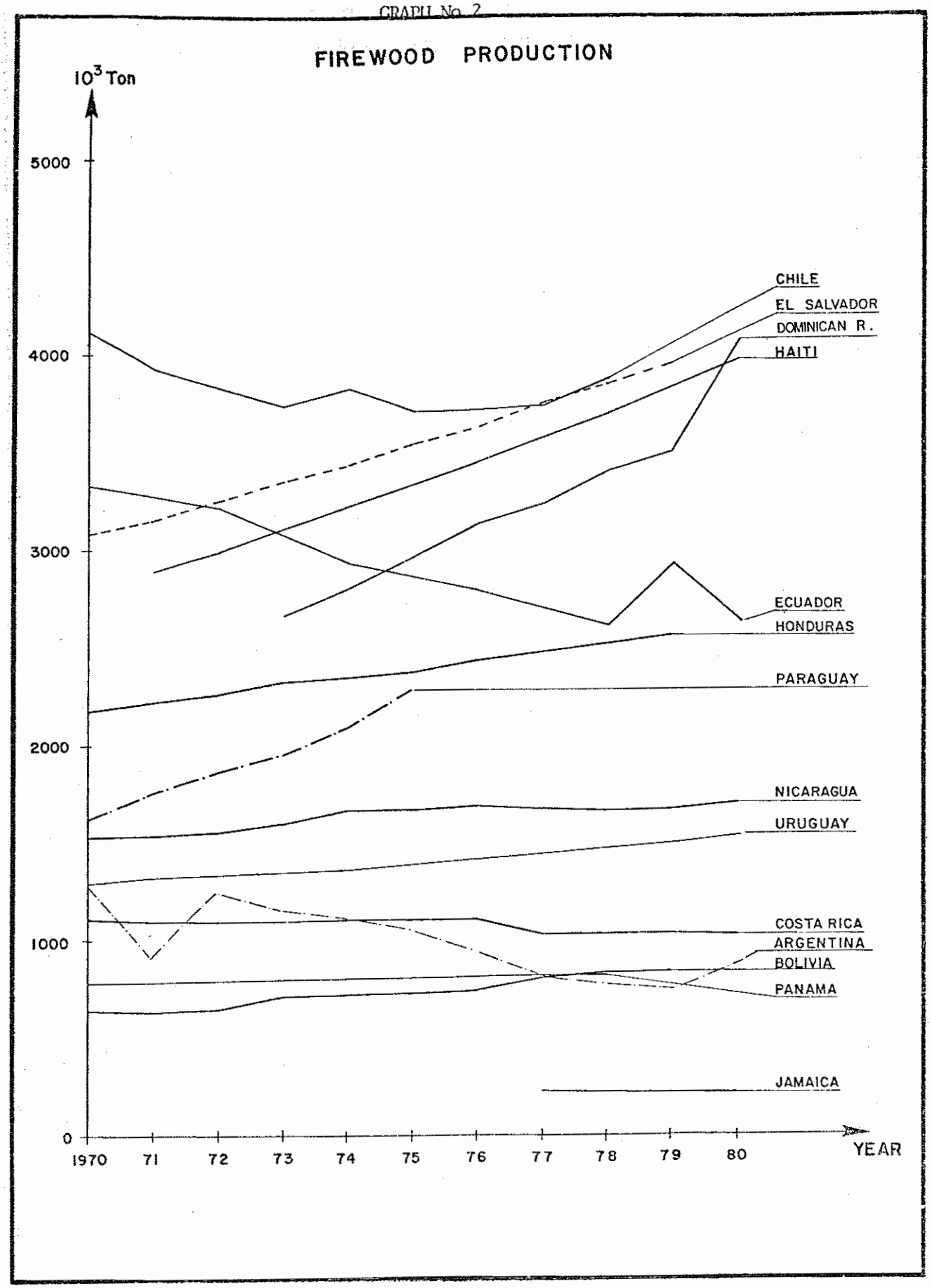
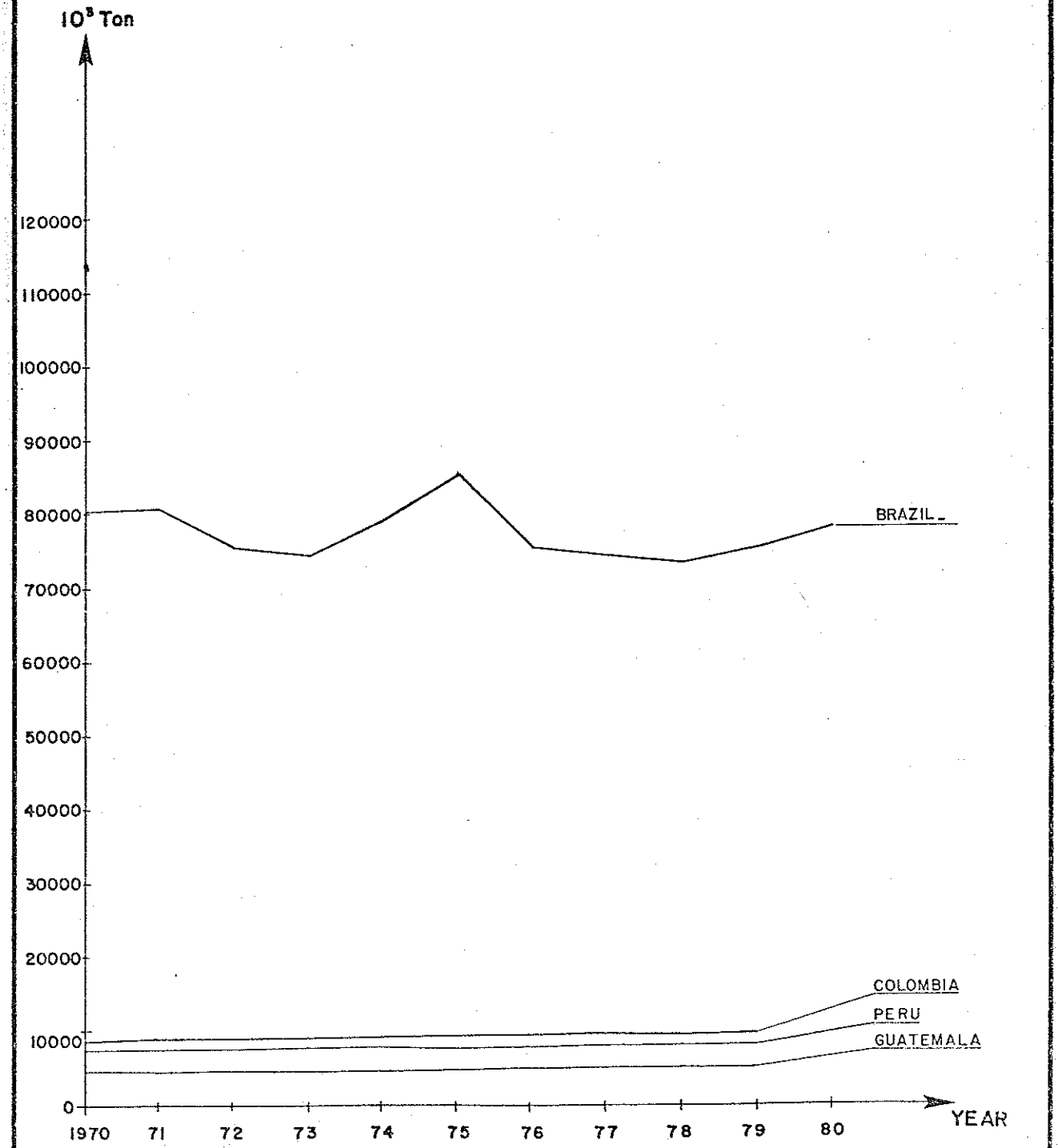
GRAPH No. 2


FIREWOOD PRODUCTION
10^3 Ton
5000
4000
3000
2000
1000
0
1970
71
72
73
74
75
76
77
78
79
80
YEAR
CHILE
EL SALVADOR
DOMINICAN R.
HAITI
ECUADOR
HONDURAS
PARAGUAY
NICARAGUA
URUGUAY
COSTA RICA
ARGENTINA
BOLIVIA
PANAMA
JAMAICA

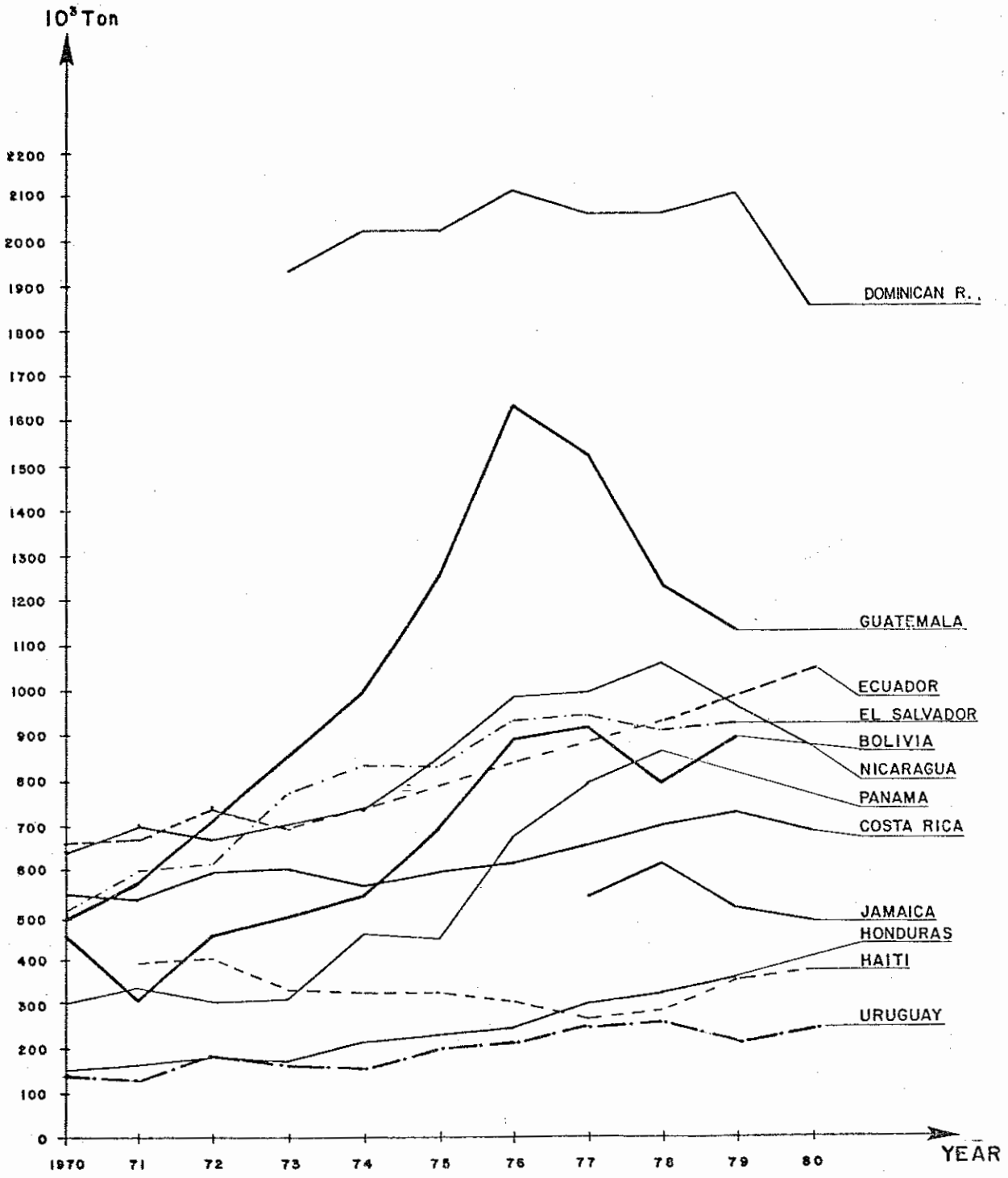
GRAPH No 3

FIREWOOD PRODUCTION



GRAPH No 4

PRODUCTION OF OTHER VEGETABLE AND ANIMAL FUELS



GRAPH No. 5

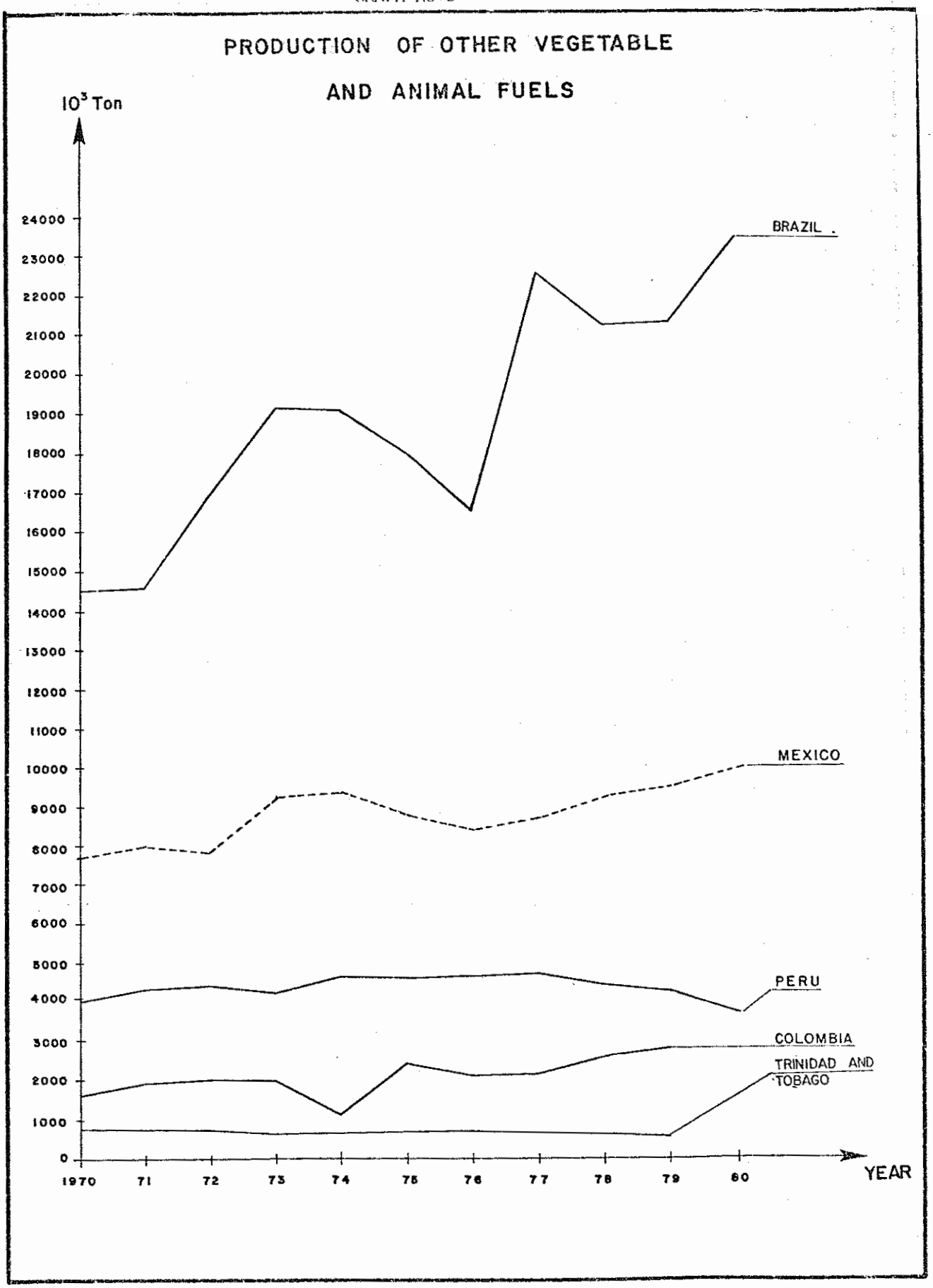

PRODUCTION OF OTHER VEGETABLE
AND ANIMAL FUELS
10³ Ton
24000
23000
22000
21000
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
BRAZIL
MEXICO
PERU
COLOMBIA
TRINIDAD AND TOBAGO
1970
71
72
73
74
75
76
77
78
79
80
YEAR

CHART Nº 6

BIOMASS RESOURCES AND URBAN RESIDUES
(M toe)

REGION	Forest Resources	Resources for 1995				ALCOHOL	TOTAL	Equivalence with other Resources
		Agriculture	Livestock	Agroindustry	Urban			
Central America and Mexico.	14,20	15,90	8,30	9,22	5,73	0,23	53,40	1.602,00
Caribbean Islands Guyana and-Suriname	5,50	3,90	3,20	15,09	0,97	0,40	29,06	871,80
Colombia, Ecuador and Venezuela	8,82	1,50	10,20	3,83	3,04	0.18	27,56	826,80
Bolivia, Chile and Peru.	8,67	2,50	3,30	1,85	1,74	0,09	18,15	544,50
Argentina, Paraguay and Uruguay.	6,99	6,00	13,00	3,55	1,74	0.26	31,54	964,20
Brazil	48,83	19,70	23,60	21,48	7,25	3,28	119,14	3.574,20
Latin American	87,83	49,50	61,60	55,01	20,47	4,43	278,34	8.383,50

n/ According to the criteria of the United Nations for the comparison of renewable resources, it corresponds to the use of resources for 30 years.

SOURCE: UNDP- OLADE "Future requirements of Non- conventional sources of energy in Latin America".

If they are real, these considerable fluctuations in consumption could reflect a significant unused potential as well as the marginally commercial character of the plant and animal fuels. Large increases in consumption from one year to another imply the existence of quantities of available resources when the economic conditions change to favor their utilization. An important example is the bagasse of sugar cane whose growing importance comes from the production of wastes in the sugar cane and alcohol industries. The bagasse could be used in sugar mills for the production of electricity when the economic and institutional conditions facilitate its integrations with the national electrical system.

Space limitations prevent the analysis of each individual country to evaluate the specific chages in each case, and it is not possible to show in detail the level of precision of the information contained in the energy balances with respect to the use of plant and animal fuels. Given the heterogenity and variety of the fuels utilized, it is likely that greater efforts should be realized in order to obtain complete information, especially in the industrial and residential sectors.

Aside from these problems, tables 4 and 5 reflect an upward trend in the biomass consumption throughout the decade, the result of a greater integration of these fuels in the regional energy systems. Given the changing conditions with respect to the prices of hydrocarbons and their substitutes, it is very probable that the trend observed will be maintained in the coming decades, however, the limitations impossed by the need to maintain the ecological balance remain to be considered.

2.6. **Biomass Resources of the Region**

Even though there exists information on biomass resources potential in Latin America, this information has not been generated on the basis of estimates and also is quite scattered, unsystematic and rather unreliable. The data that are presented herein come from a study done by UNDP and OLADE3/ in 1978 The study considered estimates for 1975, 1985 and 1995; and for this paper the values for 1995 are used.

Table N° 6 shows the estimates for biomass resources and urban residues for the year 1995. Since it is a renewable resource, the criteria of the United Nations for these resources was used, which consideres a period of 30 years of use of the renewable resource to compare it with the non-renewable ones.

From the previously study, the following conclusions about the role of biomass within the energy resources of Latin America should be mentioned:

* In Latin America the biomass resources are around 8,000 M TOE* wich corresponds to 12% of its total energy reserves.
* In Mexico and Central America, biomass resources are equivalent to 11% of their total energy reserves.
* In the Caribbean Islands, Guyana and Suriname biomass resources represent 36% of the total energy reserves.
* In Colombia, Ecuador and Venezuela they represent only 4% of the total reserves.
* In Bolivia, Chile and Peru they constitute 7% of the total energy reserves.
* In Argentina, Paraguay and Uruguay they represent 13% of the total energy reserves.
* In Brazil they represent 17% of the total reserves.

These estimates, although preliminary, allow the establishment of an order of magnitude for biomass within the regional resources.

III. **CONCLUSIONS AND RECOMMENDATIONS**

From the analysis done herein, an increasing trend can be observed for the participation of biomass in

3/ UNDP - OLADE, "Future requirements of Non - conventional Energy Sources in Latin America." Instituto de Economía Energética, Bariloche.

* M = Million.

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the energy consumption of Latin America. This situation is the natural product of the increase in rural population of the region, as well as the accelerated growth of the marginal-urban sectors.

At the same time, the incremented fossil fuel prices in the last decade has had two important consequences. Each time more rural and marginal-urban inhabitants are forced to use biomass fuels to satisfy their domestic needs. According to a recent study by the FAO[4/], by the year 2000, aproximately 250 million inhabitants of Latin America will live in zones categorized as deficient for firewood supply. Also, in the industrial sector there is interest in the substitution of firewood by fuels derived from biomass in several areas of the production process, which represents an additional demand. Thus, it is probable that future pressures by these sectors on biomass resources will increase.

It is important to refer to biomass utilization within a perspective that considers the interaction with the environment. The use of biomass for energy is closely tied to the problems of land use, irrational expansion of the agricultural frontier, deforestation and degradation of hydrographic basins. In addition to the complexity of these interrelations, it should be taken into account that in each country the problem is presented in a different manner, given the heterogeniety of ecological, economic and social conditions. The detailed analysis of all the factors that coincide or are affected by the utilization of biomass in Latin America is a complex task, beyond the scope of this paper.

However, it is also not possible to ignore the fact that one of the most serious environmental problems of the region arises from the irrational utilization and systematic destruction of the forest resources. Even though it is true that biomass can be considered a renewable resource, it should not be forgotten that an inappropriate handling of these resources converts them into non-renewable. It is precisely this phenomenon which is taking place in almost the entire region.

In Central America, for example, where biomass plays a more important role than in all the other sub-regions, the level of deforestation has gained alarming proportions reaching critical situations, as in the case of El Salvador which has been virtually deforested. Thirty years ago, Costa Rica, which has a low population density, was covered by forests over more than 2/3 of its territory and today only one third of the country has dense forest. These figures are just isolated examples of a common trend in almost all of the countries of the region, where zones that were previously forests are now ruined.

Also, there exists a related problem of trnscendental importance which is the close relationship between the protection and rational handling of the hydrographic basins, and the regional hydroelectric potential. Hydroenergy represents close to 70% of the total energy reserves (excluding biomass) and constitutes one of the principal energy resources of Latin America. Together with hydroenergy, biomass constitutes one of the cornerstones for planning the transition to renewable sources in which humanity is now inmersed.

Any rational strategy for development and regional energy cooperation, aiming for a planned transition to renewable and indigenous sources of energy, should be based on solid criteria of protection and rational utilization of the environment. Considering the level of environmental deterioration and the lack of mechanisms to carry out the coherent political practices of planning and use of natural resources, the integration of the renewable sources of energy in the long range planning is one of the great challenges for Latin America in the next decade.

4/ FAO, "Technical Panel of Fuelwood and Charcoal. Final Report of the Preparatory Committee for the United Nations Conference on New and Renewable Sources of Energy." 1981.

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Finally, various recommendations are presented aimed at providing an integral treatment of biomass whithin the social-energy and environmental context.

1. The integration of biomass in national and regional energy planning and politics.

The social-energy consideration mentioned above, show clearly the necessity to include the problem of biomass in the rural and marginal-urban areas in national and regional energy planning.

2. There exists a minimum of information necessary for presenting to political levels in order to design a strategy of biomass utilization that is congruent with the resources and needs of the regional countries.

This information, which should be generated on a national level includes:

* Rural energy consumption, including all of the the fuels utilized and their relative participation.

* Origins of the fuels: prunings, private, plantations, primary forests.
* Systems of appropriation and commerce of biomass.

* Cultural consumption patterns.

* Identification and quantification of forest resources and biomass in general within each country.

* Characteristics of current exploitation of forest resources and other biomass fuels.

3. It is possible to introduce and adapt appropriate technologies for the production and consumption of firewood, charcoal, biogas and others. Some of the areas in which considerable progress can be attained are:

* Technologies of rational utilization of forest resorces including species, plantations and cultivation systems that permit a sustained production.

* Production technologies for biomass fuels including charcoal plants, anaerobic digestion, pyrolysis, gasification, and methanol production.

* Efficient firewood combustion technologies for the rural area. In addition to the distribution of efficient stoves now developed, the existing stoves or burners should be improved.

4. It is necessary to study in detail the socio-economic and environment impact of the current trends with regard to deforestation, degradation of hydrographic basins and the relation of these problems with landholding, expansion of the agricultural frontier and biomass use.

* The direct and indirect costs and benefits to the different social classes should be studied.

* The environmental effects should be investigated for the short, medium and long run.

5. The means of communication should be expedited between forest and energy studies, research related to estimates of supply and potential. Specific aspects that need to be studied are:

* High production forest species adaptable to the various conditions of the region.

* Species producing fermentable sugars, including sugar cane and others.

* Species producing hydrocarbons.

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ESTIMATES OF FUTURE ENERGY DEMAND FOR LATIN AMERICA

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I. INTRODUCTION

The aim of this article is to estimate the future energy demand of the region for the period 1981-2000. The initial discussion of the methodology is followed by a presentation and analysis of the results.

II. METHODOLOGY

To estimate the future trajectory of the energy demand is a complex task which requires a detailed analysis of the numerous factors which affect this variable. Without doubt, economic growth, technological processes, prices, and the political situation figure among the important factors to be considered due to their affect on energy demand. Nevertheles, an exhaustive study of the ratio between energy demand and the aforementioned variables —which are important for making econometric estimates by sectors, regions, and sources— falls outside the scope of the present work but will be the object of later investigations by OLADE.

In this first stage, the estimate is concentrated on projections of the total energy demand by countries and sub-regions. The tool which is used for this purpose is the ratio between energy and the gross domestic product (GDP). Since it is impossible to accurately know the future evolution of the regional economies, three possible GDP growth rates are used to establish the probable ranges whitin which the Latin America countries will be moving.

A 3.5% annual growth rate was chosen as the minimum value for both national and regional economic expansion during the next two decades. The second value selected for the projections was 5.7%, the region's historical growth rate during the 1970's. A third value of 7% annually, was chosen because it is the figure used by the regional model of the Economic Commission of Latin America (ECLA).

To establish the correlation between energy consumption and the gross domestic product, the information contained in the energy balances for the countries of the region for the 1970-79 period was used; and GDP values were taken from ECLA studies, at constant 1970 dollars.

As for the function relating energy and ghe GDP, the potential form $Y = AX^B$ was chosen, for the following reaons:

a. The correlation coefficients obtained are mostly above 0.9, and

b. The potential function facilitates the interpretation of (B) as the GDP/energy elasticity.

Once the energy consumption/GDP correlation has been defined, then an estimate can be made of how much energy consumption will increase porcentage-wise in response to a given variation in the GDP, based on knowledge about the energy/GDP elasticity values.

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It should be noted that the elasticities used in the present study reflect the situation of the 1970's. As a consequence, the projections resulting from the use of these do not take into account changes which could occur in the Latin American countries —both in terms of production structures and energy policies— and which would have a decisive effect on the energy/economic ratio.

III. RESULTS

III.1. **General Elasticities**

The demand/GDP relation was estimated for each country and for six sub-regions: Mexico, the Caribbean, Central America, the Andean Region, the Southeastern Regiona, and Brazil (see Table 1).

As mentioned above, the following function was used 1/:

$E = a\ (GDP)^e$, where:

E = final energy consumption, in thousands of TOE

GDP = gross domestic product, in millions of 1970 dollars.

a = constant and

e = elasticity for the final energy consumption/ GDP.

The results show some surprising facts. First, in most of the countries, the energy/GDP elasticity is lower than, or close to 1; and this seems to contradict the assumption that in a country's first phases of development, elasticity is above 1 and that as it grows, elasticity decreases and approaches 1, or even lower values.

In the case of the analysis of the Latin american economies, there are several explanations. First of all, energy consumption includes "non-commercial" sources of energy such as firewood and others which weight heavily in the region's energy balances.

Second, some countries have already gone through the "take-off" stage in the development of industries and other energy intensive sectors. Finally, the effect of the energy price increases has opened the way for a better use of the energy resources.

Another aspect which should be noted is the fact that the information in the energy balances is not uniform, since not all of the countries provided energy data for the year 1970-79. For this reason, when making estimates by sub-regions and comparing the projections until the year 2000 with those for each individual country, in general the energy demand, by subregions is overestimated, this led to the decision to discard the regressions by sub-regions and to work rather, with the results by country.

In the elaboration of projections for the three GDP growth rates, it is assumed that all the countries grow at the same annual rate, be that 3.5, 5.7, or 7.0%. In reality, the countries grow at quite different rates. However, from a global point of view, the three scenarios chosen correspond to low, medium, and high levels of GDP growth; and this permits a broader perspective of the possible Latin American energy demand.

A summary chart is presented below for the statistical analysis elaborated for each country. The table indicates the elasticities obtained for the total final energy consumption, with respect to the GDP. The correlation coefficients derived from the analysis are also presented.

As was mentioned previously, not all of the countries supplied OLADE with a complete series of 1970-79 energy balances. As a result, some elastecities reflect characteristcs peculiar to the period under consideration.

1/ The parameters were estimated by the method of minimum ordinary squares.

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II.2 **Sub-regional Elasticities**

Some clarifications are presented below with respect to the elasticities obtained.

MEXICO

The elasticity, calculated for Mexico (1.33) is high and the fit is very good. The years used to obtain this result were 1970, 1975, 1979, 1980. Mexico has experienced an increase of great mangnitude in the production of energy during recent years, and the elasticity obtained reflects this fact.

CENTRAL AMERICA

All of the countries of this sub-region have elasticies lower than 1 and a good fit, with exception of Panama whose elasticity is 2.08. This value is the highest in Latin America and can be expalined, in principe, by the strategic position of the country and its role as crude oil processer and oil derivative exporter, among other factors.

THE CARIBBEAN

Due to a lack information, only Haiti and the Dominican Republic are included. The high elasticity value for Haiti (1.07) is notable for a country with such a low per capita income and such a high biomass consumption.

THE ANDEAN REGION

All of the countries except Bolivia and Venezuela have elasticities lower than 1. That of Bolivia is 1.55 while that of Venezuela ascends to 1.83, the second highest in the region.

THE SOUTHEASTERN REGION

Argentina's elasticity is close to 1, while that of Uruguay has a notably low figure (0.46), the lowest in Latin America.

BRAZIL

The Brazilian elasticity is 1.02, and the fit obtained is good.

TABLE Nº 1

ENERGY CONSUMPTION/GDP ELASTICITIES FOR LATIN AMERICA

e = ELASTICITY
r = CORRELATION COEFFICIENT

COUNTRY/REGION		
SUB REGION I		
Mexico	e	1.337
	r	0.998
SUB-REGION II		
Costa Rica	e	0.732
	r	0.988
El Salvador	e	0.989
	r	0.989
Guatemala	e	0.656
	r	0.980
Honduras	e	0.819
	r	0.989
Nicaragua	e	0.699
	r	0.830
Panama	e	2.080
	r	0.984
Central America	e	-----
	r	-----
SUB-REGION III		
Haiti	e	1.072
	r	0.996
Dominican Republic	e	0.597
	r	0.955
SUB-REGION IV		
Bolivia	e	1.558
	r	0.992
Colombia	e	0.630
	r	0.998
Chile	e	0.522
	r	0.512
Ecuador	e	0.847
	r	0.970
Peru	e	0.668
	r	0.997
Venezuela	e	1.836
	r	0.997
Andean Región	e	-----
	r	-----
SUB-REGION V		
Argentina	e	0.998
	r	0.984
Uruguay	e	0.461
	r	0.894
Southeastern Region	e	-----
	r	-----
SUB-REGION VI		
Brazil	r	1.021
	r	0.955

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III.3. DEMAND PROJECTIONS

Once the elasticities had been obtained, projections were elaborated for the three GDP growth rates mentioned above (3.5%, 5.7%, 7%).

Table 2 shows the growth rates of Final Energy Consumption as a function of the three GDP growth rates considered.

Tables 3, 4, and 5 indicate the demand projections for the countries.

Table 6 gives the projections for final per capita consumption.

The projections for Latin America and its sub - regions apper in Graphs 1, 2, and 3. The sub-regional projections were obtained by adding together the respective national results.

IV **CONCLUSIONS**

IV.2 **Elasticities**

— In the majority of the countries the energy/GNP elasticity is lower than or close to one, which appears to contradict the theory that in the first stages of development for a country, the elasticity is greater than one. The principal reason for this is that the energy consumption includes "non-commercial" energy sources which because of their very low efficiency, weigh disproportionately in the calculation of the energy/GNP elasticity.

— The great turmoil of two regional countries during the past decade Chile and Nicaragua) are manifested in the study of their elasticities and for this reason these countries present the lowest correlation coefficients.

IV.3 **Demand Projections**

— With a GNP growth rate of 3.5%, the region would have a demand of 581,851 TOEx10X^3 in the year 2000 which is 2.3 times the 1978 final consumption. However, it should be noted that 84% of this demand would be concentrated in Argentina, Brazil, Mexico and Venezuela.

— With a GNP growth rate of 5.7%, the region would have an energy demand of 986,842 TOEx 10^3 in the year 2000 which is 3.8 times the 1978 final consumption. Eighty-six per cent of this demand would be concentrated in Argentina, Brazil, Mexico and Venezuela.

— With a GNP growth rate of 7%, the region's energy demand would be 1,318,175 TOEx10^3 in the year 2000 which is 5.2 times th 1978 final energy consumption. Once again, Argentina, Brazil, Mexico and Venezuela would account for 87% of the demand.

— From the 1978 final consumption (253, 930 TOEx 10^3) which had the following distribution Brazil (34.7%), Mexico (23.6%), Argentina (11.2%), Venezuela (7.8%), the rest of Latin America (22. 7%) the projected situation would be as below:

* For a GNP growth rate of 3.5%; Mexico (30%), Brazil (29.9%), Venezuela (13.8%), Argentina (9.9%) and the rest of Latin America (16.4%).

* For a GNP growth rate of 5.7%; Mexico (31. 8%), Brazil (25.7%), Venezuela (18.8%), Argentina (9.5%) and the rest of Latin America (14.2%).

* For a GNP growth rate of 7.0%: Mexico (32. 4%), Brazil (23.2%), Venezuela (22.1%), Argentina (9.1%) and the rest of Latin America (13.2%).

The explanation for these changes is basically the high elasticities of Mexico (1.33) and Venezuela (1.83) as compared to the other regional countries. (See Table N° 1).

— Taking into account that in 1976 the industrialized countries had a per capita energy consumption of 4.8 TOE/inhab-year, it is interesting to analyze the prediction that has been made for Latin America in the year 2000. The following conclusions can be reached:

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* Although suregional differences exist, they are evened out when the Latin American countries are grouped.

* Great differences exist from country to country for the three GNP growth rates. As an ilustration the most relevant conclusions for the 5.7% growth rate are presented.

* Venezuela would have a per capita consumption of 6.67 TOE/inhab-year, which is comparable to that of the industrialized countries, but very different from other regional countries; it would be 14.4 times the consumption of Nicaragua, 11.9 times that of Guatemala, and 11.7 times that of Haiti.

* Consistent with their high participation in the energy demand, Venezuela, Argentina, Mexico and Brazil have the highest per capita consumptions of the region.

* The projections from country to country are greatly affected by the elasticities obtained in the 1970's decade and thus, Panama shows a per capita consumption (5.07) that can only be explained on the basis of the theoretical inconsistencies of the projection.

IV.3 **General**

The previous analysis demonstrates that the situation foreseen for Latin America in the year 2000, leads to a dangerous and excessive dependency for the majority of the countries and the only viable alternative for solving this is that of regional cooperation and the introduction of substantial changes in the production and consumption of energy.

TABLE 2

TOTAL FINAL ENERGY CONSUMPTION GROWTH RATES

FOR THREE GDP GROWTH RATES

PERIOD: 1978-2000

	GDP GROWTH RATE %		
	3.5	**5.7**	**7.0**
Mexico	5.0	7.7	9.3
Central America	3.3	5.9	7.6
Andean	4.4	7.4	9.3
Southeastern	3.2	5.3	6.6
Brazil	3.1	4.8	5.8
Latin America	3.9	6.4	7.9

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TABLE 3

DEMAND PROJECTIONS

TOTAL FINAL CONSUMPTION
GDP GROWTH RATE: 3.5%
(TOE x 10^3)

COUNTRY OR SUB-REGION	1985	1990	1995	2000
Mexico	87 953.2	110 703.3	139 338.1	175 379.5
Costa Rica	1 647.8	1 868.8	2 119.5	2 403.7
Guatemala	3 809.7	4 264.6	4 773.9	5 343.9
Nicargua	1 233.6	1 391.2	1 568.9	1 769.4
El Salvador	2 752.1	3 262.4	3 867.4	4 584.6
Honduras	2 046.3	2 356.0	2 712.5	3 122.9
Panama	1 869.2	2 763.5	3 823.8	5 469.0
Central America	13 358.7	15 816.5	18 866.0	22 693.5
Haiti	2 083.0	2 504.9	3 012.3	3 622.4
Dominican Republic	3 462.4	3 837.2	4 252.5	4 712.8
Ecuador	4 180.1	4 835.5	5 593.5	6 470.4
Colombia	15 648.6	17 440.4	19 437.4	21 663.0
Chile	8 304.8	9 084.6	9 937.5	10 870.5
Perú	10 915.6	12 244.0	13 734.1	15 405.5
Bolivia	2 245.4	2 935.3	3 837.3	5 016.1
Venezuela	31 305.0	42 928.0	58 886.4	80 722.4
Andean Region	72 599.5	89 467.4	111 406.1	140 147.9
Argentina	34 680.3	41 172.3	48 879.6	58 029.6
Uruguay	2 408.7	2 607.6	2 822.9	3 056.0
Southeastern Region	37 089.0	43 779.9	51 702.5	61 085.6
Brazil	112 715.6	130 320.7	150 675.5	174 209.6
TOTAL Latin America	**329 261.4**	**396 429.9**	**479 253.0**	**581 851.3**

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TABLE 4

DEMAND PROJECTIONS
TOTAL FINAL CONSUMPTION
GDP GROWTH RATE: 5.7%
(TOE x 10^3)

COUNTRY OR SUB-REGION	1985	1990	1995	2000
Mexico	101236.4	146666.5	212483.4	307.835.9
Costa Rica	1807.2	2213.5	2711.2	3320.7
Guatemala	4138.4	4963.4	5952.8	7139.4
Nicaragua	1327.7	1611.5	1956.1	2374.4
El Salvador	3117.9	4101.2	5394.7	7096.0
Honduras	2269.2	2847.6	3573.5	4484.4
Panama	2539.2	4519.9	8045.7	14321.8
Central America	15199.6	20257.1	27634.0	38736.7
Haiti	2331.6	3138.6	4224.9	5687.1
Dominican Republic	3686.9	4351.0	5134.7	6059.5
Ecuador	4735.1	5987.5	7571.1	9573.6
Colombia	16944.1	20178.3	24029.9	28616.5
Chile	8967.9	10363.2	11975.5	13838.7
Peru	11875.2	14289.3	171194.2	20689.7
Bolivia	2733.2	4208.9	6481.3	9980.6
Venezuela	39465.9	65643.1	109183.3	181603.2
Andean Region	84721.4	120670.3	176435.3	264302.3
Argentina	40167.2	52961.2	69830.2	92072.3
Uruguay	2528.4	2873.3	3265.1	3710.4
Southeastern Region	42695.6	55834.5	73095.3	95782.7
Brazil	123174.5	155627.6	196631.2	248438.1
TOTAL Latin America	**373046.0**	**506545.6**	**695638.8**	**966842.3**

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TABLE 5

DEMAND PROJECTIONS
TOTAL FINAL CONSUMPTION
GDP GROWTH RATE: 7%
(TOE x 10^3)

COUNTRY OR SUB-REGION	1978	1985	1990	1995	2000
Mexico	59 802.0	109 859.5	172 716.1	271 536.3	426 896.8
Costa Rica	1 403.0	1 906.9	2 442.4	3 128.3	4 006.8
Guatemala	3 247.0	4 342.3	5 420.9	6 767.4	8 448.4
Nicaragua	1 329.0	1 385.6	1 755.3	2 223.6	2 816.9
El Salvador	2 279.0	3 352.5	4 684.5	6 545.9	9 146.9
Honduras	1 658.0	2 409.7	3 179.2	4 194.4	5 533.9
Panamá	1 136.0	3 033.9	6 132.9	12 397.2	25 060.0
Central America	11 052.0	16 430.9	23 615.2	35 256.8	55 012.9
Haiti	1 633.0	2 489.6	3 578.2	5 142.9	7 391.7
Dominican Republic	2 932.0	3 824.1	4 680.7	5 729.2	7 012.5
Ecuador	3 633.0	5 090.9	6 779.2	9 027.5	12 021.5
Colombia	13 399.0	17 745.7	21 962.9	27 182.2	33 641.9
Chile	7 155.0	9 377.3	11 187.4	13 346.8	15 923.1
Peru	9 274.0	12 471.2	15 631.5	19 592.8	24 557.8
Bolivia	1 622.0	3 063.9	5 189.5	8 789.5	14 887.0
Venezuela	19 792.0	45 153.6	84 020.6	156 343.0	290 918.4
Andean Region	54 875.0	92 902.6	144 771.1	234 281.8	391 949.7
Argentina	28 496.0	43 746.6	61 307.0	85 916.4	120 404.2
Uruguay	2 138.0	2 600.7	3 039.9	3 553.3	4 153.3
Southeastern Region	30 634.0	46 347.3	64 346.9	89 469.7	124 557.5
Brazil	88 082.0	129 693.2	172 535.8	229 531.0	305 354.0
TOTAL Latin America	**249 010.0**	**401 547.2**	**586 244.0**	**870 947.7**	**1 318 175.1**

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TABLE Nº 6

FINAL PER CAPITA CONSUMPTION[1/]
(F P C)

	1985			1990			1995			2000		
	3.5%	5.7%	7.0%	3.5%	5.7%	7.0%	3.5%	5.7%			5.7%	7.0%
Latin America	**0.88**	**1.00**	**1.08**	**0.95**	**1.22**	**1.41**	**1.03**	**1.49**	**1.87**	**1.11**	**1.86**	**2.53**
México	1.11	1.28	1.39	1.23	1.63	1.92	1.37	2.08	2.66	1.52	2.66	3.69
Central America	0.52	0.59	0.64	0.53	0.68	0.80	0.55	0.80	1.03	0.57	0.97	1.38
The Andean Subregion	0.76	0.89	0.98	0.84	1.13	1.36	0.93	1.47	1.96	1.04	1.96	2.90
The Southeastern Subregion	1.18	1.36	1.47	1.32	1.69	1.94	1.48	2.10	2.57	1.67	2.61	3.40
Brasil	0.83	0.91	0.95	0.86	1.03	1.14	0.89	1.17	1.36	0.93	1.33	1.63

1/ Valores in TOE/inhab-year.

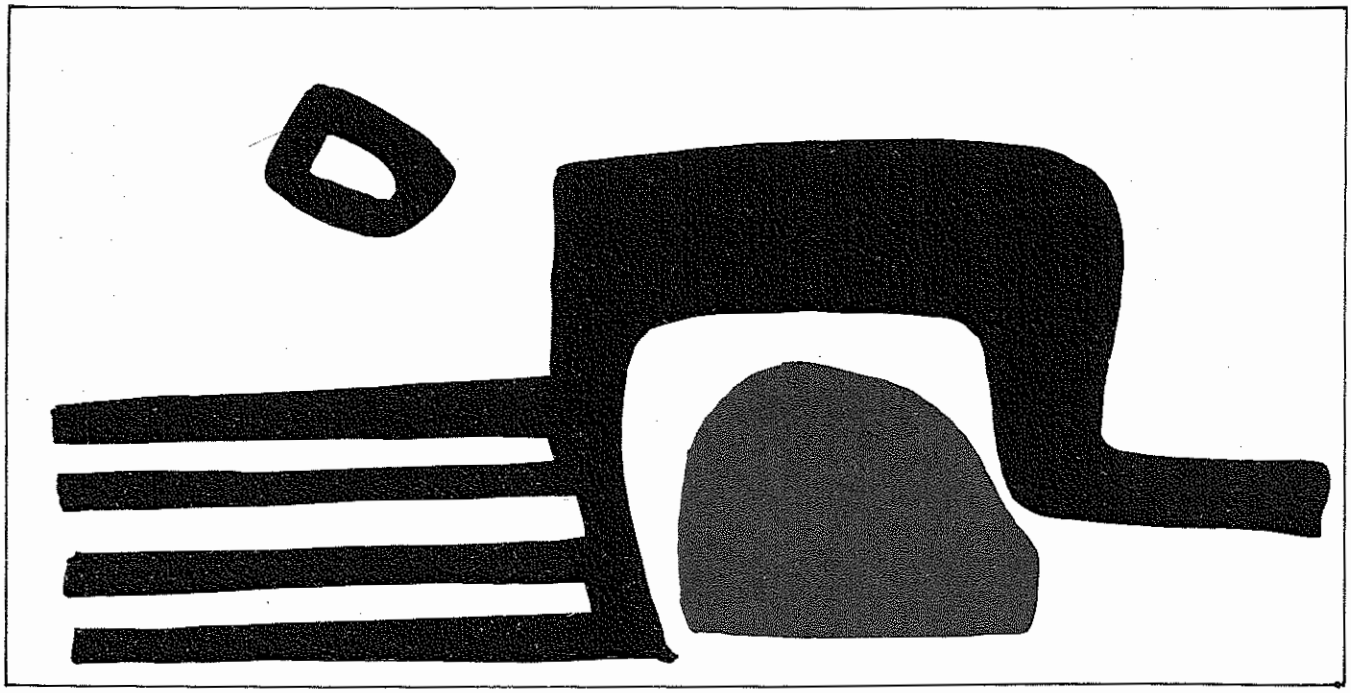

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TABLE Nº 7

DEMAND PROJECTION
FINAL PER CAPITA CONSUMPTION
GDP Growth Rate of 5.7%

Countries and Subregions	Per Capita Consumption to 2000 - 5.7% Growth Rate
Mexico	2.662
Costa Rica	0.983
Guatemala	0.560
Nicaragua	0.461
El Salvador	0.815
Honduras	0.643
Panama	5.073
Central America	5.073
Haiti	0.577
Dominican Republic	0.650
Ecuador	0.656
Colombia	0.753
Chile	0.927
Peru	0.674
Bolivia	1.026
Venezuela	6.675
The Andean Subregion	
Argentina	2.857
Uruguay	1.076
The Southeastern Subregion	
Brazil	1.325

1/ Values in TOE/inhab-year

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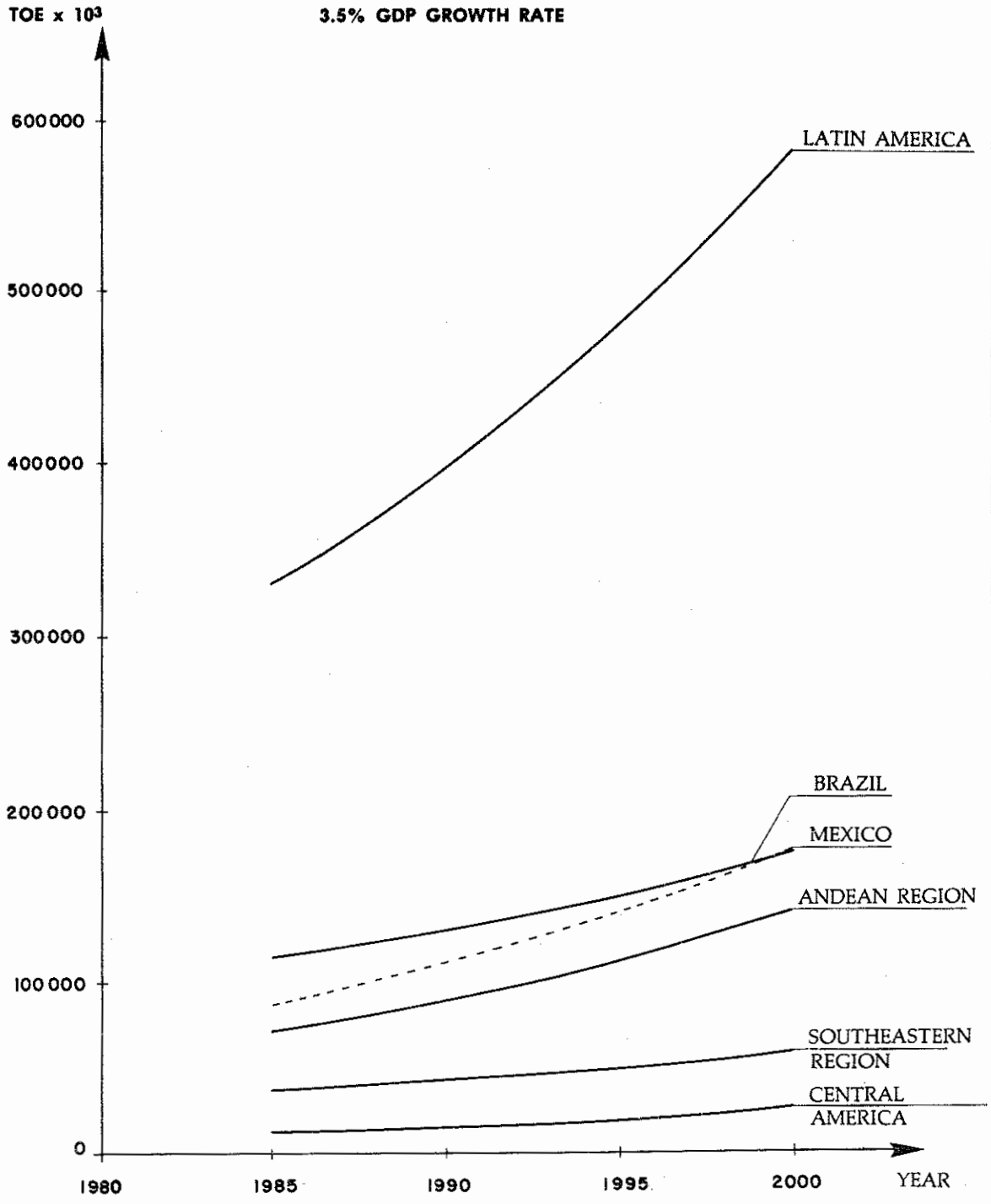
GRAPH 1

DEMAND PROJECTION

TOTAL FINAL CONSUMPTION

3.5% GDP GROWTH RATE



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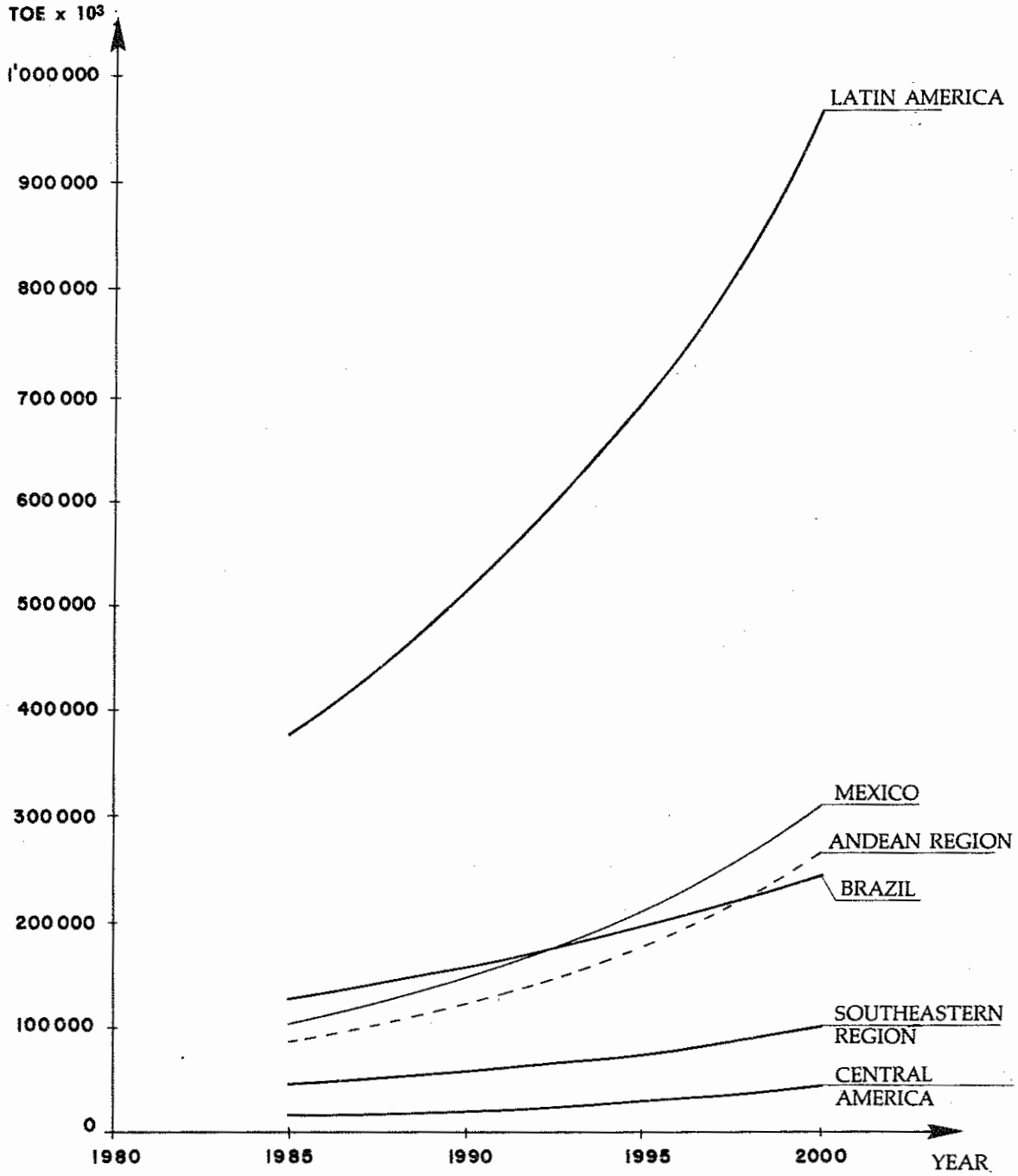
GRAPH 2

DEMAND PROJECTION

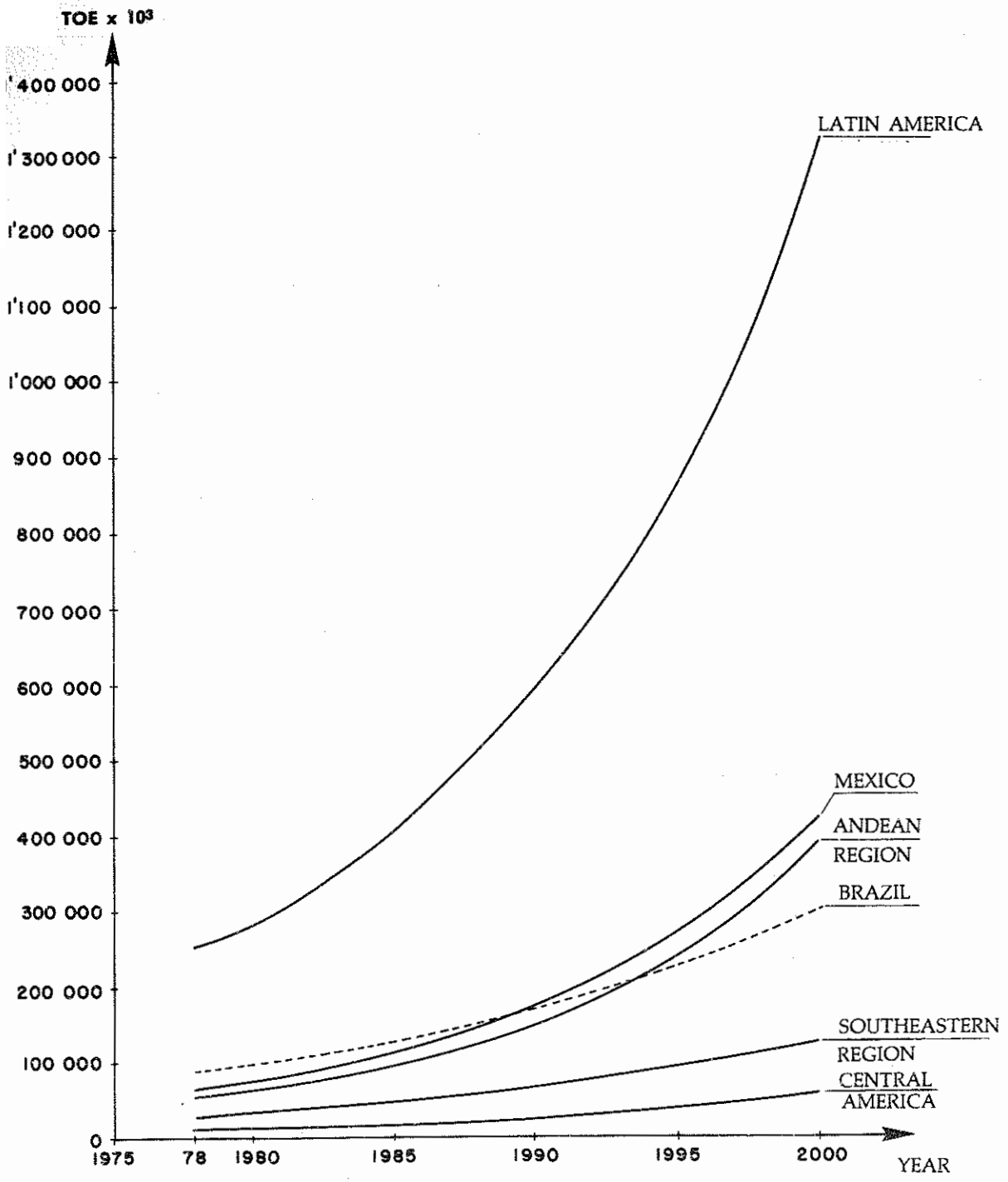
TOTAL FINAL CONSUMPTION

5.7% GDP GROWTH RATE



GRAPH 3

DEMAND PROJECTION
TOTAL FINAL CONSUMPTION
7% GDP GROWTH RATE



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