



BANCO NACIONAL DA HABITAÇÃO

RELATIONSHIPS BETWEEN USE AND  
CONSERVATION OF ENERGY AND URBAN STRUCTURE.

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## INTRODUCTION

The topic I have had assigned to me for discussion, as proposed by the organizers of the INTA unquestionably involves aspects of worldwide interest and of most timely nature. The world energy crisis, which has made itself felt most acutely in the field of petroleum production, distribution and consumption from 1973 onwards, has affected with a greater or lesser degree of intensity every country in the world, as has been analysed in numerous studies and been proclaimed in meetings bringing together personalities and nations of the most varied background and orientation.

Besides this, the fast urbanization of populations, occurring in various forms and degrees of intensity all over the world, is recognized nowadays as one of the most serious challenges mankind is having to cope with. The United Nations Conference on Human Settlements, held in Vancouver in 1976, bore out quite clearly this widespread concern.

Yet in proposing a comparative study between developed and developing countries, the organizers of the 4th INTA Conference implicitly recognize the considerable differences in structure and orientation between the two groups of nations, differences which may well lead to different approaches to similar problems on the part of the two different groups of countries. Possible differences in attitudes between the USA papers and the Brazilian papers on the same topic may encounter therein a proper explanation. This paper accordingly deals with the relationships between the energy problem and the urban problem in terms of an



individual view of the integrated treatment given to the social, economic, physical and institutional sectors of the III National Development Plan of Brazil, for 1980/1985 (III PND), considered from the angle of the overall development project of Brazilian society.

We believe that by dealing with the topic in this manner we shall to some extent be circumventing the limitations established by the organizers of the 4th INTA Conference for preparation of this paper. As we see it, those limitations might make it hard to grasp the "relationships between energy use and conservation and urban structure" in Brazil. We feel, however, that we shall thus be making a better contribution to fertile discussion of the topic by Conference participants.

We shall now proceed to give a succinct description of the Brazilian geographic, energy and urban panorama, within which the relationships in question occur. Following that portion of the paper, we shall identify the problems most directly stemming from the said relationships. Finally, we shall briefly bring up the national policies in the field of Brazilian energy and urban development.

## 1. THE BRAZILIAN CONTEXT

### 1.1 The Geographical Panorama

The 8.5 million square kilometers comprising Brazilian territory are composed, to the extent of over sixty percent, of crystalline, crystallo-phyllite or sedimentary plateaux, with only about 3 per cent of the total exceeding 900 meters in altitude. Of the remaining portion, a part consists of plains that could be more correctly described as low-lying plateaux, whose geological

formation resembles that of the Brazilian and Guyana plateaux. There is, finally, a portion consisting of young true alluvionary plains - the Amazon water meadows, the swamplands of Mato Grosso, which form a part of the Paraguay lowlands, and certain coastal formations. Many of the Brazilian "mountain ranges" are more truly mere borders of these plateaux, pierced through at certain intervals to let out the rivers rising at higher altitudes.

The plains contain two major river systems - the Amazon basin and the River Plate basin. These structures, together with one other major basin - that of the São Francisco river - and the Atlantic coast watersheds, comprise one of the major waterway reserves in the world. Associated with the other water sources rising on the plateaux, these hydrographic systems represent vast hydro-electric potential as yet but little utilized by the national economy, though continuously fed by a pattern of rainfall that is generally copious.

The bulk of the land in Brazil receives 1,000 to 2,000 mm of rainfall per year. Amazonia is characterized by extremely high rainfall - over 2,000 mm and up to 4,000 mm a year, or even more. By contrast with that region, much of the North East macro-region which penetrates in the South East macro-region, gets less than 1,000 mm a year, and there are certain limited areas in which the figure is less than 500 mm a year. This is the so-called "Drought Polygon", of melancholic fame for its prolonged dry periods lasting 12, 15 or even more months at a time, causing widespread harm to agriculture and animal husbandry, with the serious social impact that is well known.

Most of Brazil lies in the tropics, with less



than 7% being below the Tropic of Capricorn. This fact, together with other factors, causes average annual temperatures of about 22° C, while in the lower-lying regions of the Northern macroregion the corresponding figure is 24° to 26° C, and 20° to 18° C on the plateaux in the South East and in the South. Upward and downward thermal spreads of 5° C over and above these annual means are the maximum limits, though considerable daily variations in temperature are common in the more central regions, reflecting the influence of the vast continental mass.

This accounts for a certain variety of hot, humid, tropical climates dominating the major part of Brazil, with hot semi-arid conditions prevailing in the North East macro-region ("Drought Polygon"), and tropical altitude climate occurring on the plateaux located roughly between 15° S latitude and the Tropic of Capricorn. At the latitudes below that Tropic, in the Southern macro-region, the climate is sub-tropical with hot summer weather or even sub-tropical with fresh summers, tending to become temperate in certain limited areas.

Under these climatic conditions there is no need to instal heating systems in buildings. To the contrary, the use of air conditioning is a practice that is spreading, especially at the demand of the more affluent population brackets.

The vegetal cover of Brazil's territory varies greatly from region to region, from the dense Amazonian Equatorial forest (Hyloëia) with predominance of large trees, passing through savannah on the plateaux, with trees and shrubs, down to ordinary prairie land as on the pampas in the Southern macro region, with grasses predominating. Some technicians are of the opinion that some small desert areas

are in course of formation in the "Drought Polygon" of the North East, though that opinion is contested by others who feel those same areas are displaying recomposition of caatinga (scrub) vegetation in areas that have been left fallow of farming and pastureland activities.

Hence practically the whole of Brazil is suitable for the exercise of farming and forestry. Together with the intensive sunlight received due to the country's latitude, the country's biomass resources comprise an enormous reserve of renewable sources of energy that could amply provide for the requirements of national development.

#### 1.2 - The Energy Panorama

Per capita consumption of Energy has been taken as an indicator of the degree of development of the various countries, and, within individual countries, of the regions themselves. The progress of the nations has been conditioned by the availability of energy sources or the ability to import the latter.

As regards electric energy in particular, data for 1979 show the following facts:

- . mean world energy consumption exceeds 1,000 kWh/ /head/yr.;
- . France greatly exceeds 3,000;
- . Japan is approaching 5,000;
- . The USA stands at about 10,000;
- . Canada has already passed the 11,000 mark;
- . Brazil shows a figure of 1,000 kWh/per person/per year, hence is right at the world average level.

Brazil's energy balance sheet for 1977 was as shown in the following table:



Energy Consumption of Sectors: Brazil, 1977  
(in ton equivalents of petroleum /1,000 TEP/)

<u>Energy or Fuel Involved</u>	<u>Self- Consump- tion</u>	<u>Prim- ary</u>	<u>Second ary</u>	<u>Ter- tiary</u>	<u>Government and public authorities</u>	<u>Resid- ential</u>	<u>TOTAL</u>
Electric energy	569	276	14,363	3,071	2,588	4,925	25,792
Fossil coal	8	-	3,499	-	-	-	3,507
Petrol- eum and Shale oil	1,483	386	11,589	25,554	1,004	1,307	41,313
Natural gas	185	-	320	-	-	-	505
Alcohol	-	-	-	537	-	-	537
Wood and Charcoal	-	3,245	2,723	143	9	14,765	20,885
Sugar- cane bag asse	-	99	4,036	-	-	-	4,405
Vegetal residues and by- products	-	-	180	-	-	-	180
Total by sectors	2,235	4,006	36,980	29,305	3,601	20,997	97,124

Source: National Energy Balance Sheet, 1978, Ministry of Mining and Energy.

Brazilian energy reserves as of December 1979 were as indicated in the following tabulation:



Energy Reserves  
Brazil, December, 1979

Kind	Reserve/potential
(\$)	
Petroleum	198,000 thousand meters <sup>3</sup>
Natural gas	45,082 million meters <sup>3</sup>
Shale (\$\$)	514,000 thousand meters <sup>3</sup>
Fossil coal	21,166 million tons
Water power	213,000 GW (gigawatts)
Uranium	215,000 tons U <sub>3</sub> O <sub>8</sub>

(\$ ) Measured, recoverable reserves

(\$\$) Measured reserves

Source: Ministry of Mining & Energy

It is of the utmost importance to follow up the evolution of the measured, recoverable reserves, especially those of petroleum and natural gas. Their upward or downward variations indicate whether or not new finds are offsetting the amounts being taken out.

As regards water power, too, it is important to realize that installed hydro-electric power capacity is equivalent to only 10.3% of the country's available potential.

Brazilian reserves of shale are amongst the two largest world supplies of this energy sources.

And in view of Brazil's size and the prevailing weather conditions, there is vast potential for

obtaining energy from biomasses (sugar-cane, cassava, wood, etc.); the very high levels of sunshine received over most of the country afford outstanding possibilities for use of solar energy, as well.

Where petroleum is concerned, however, Brazilian reserves are affording production far below the rate of consumption. Hence in terms of consumption of primary energy, external dependency is of the order of 40%, almost entirely in the form of imports of crude oil (with a small percentage corresponding to fossil coal imports).

Thus on a medium and long-term basis, difficulties in supply of energy will arise far more from high costs than from any absolute limitations in terms of availability of energy sources. Coverage of the demand for energy will undoubtedly more and more call for enormous manpower and financial resources, but will not dispense with an increasing degree of rationalization. It is within this necessary rationalization that measures aimed at the conservation of energy reside.

### 1.3 - The Urban Panorama

The Brazilian population is estimated at about 124.1 million inhabitants at the present time, with 79.1 million (63.7%) in the towns and cities. Aggregate population is increasing at high rates (2.8 to 2.9% per year during the 1960/1970 intercensus period), whereas the urban population is rising at even higher rates (between 4.1 and 4.2% per year over the same period). The difference arises from internal rural to urban migration, inasmuch as the rural population, even though maintaining high rates of vegetative growth, remains almost stationary. The following table shows the evolution of urban population from 1940,



with projections through the year 2,000.

Brazil: Evolution in Urban Population (§)

Year	Total Population (A)	Urban Population (B)	Urbanization (B/A) %
1940	41,236	12,880	31.2
1950	51,944	18,783	36.2
1960	70,992	32,005	45.1
1970	94,506	52,905	56.0
1980	124,116	79,113	63.7
1990	159,974	108,468	67.8
2000	202,269	142,573	70.5

(figures in thousands)

Source: Population from 1940 to 1970,  
IBGE population census data;

Projections from 1980 to 2000,  
IBGE estimates

(§) It should be noted that the national population census is scheduled to be held this year and may substantially alter the projections in the above table. Another important observation concerns the definition of the urban population, which is taken as the population residing in towns and cities and townships as legally defined, whatever the particular volume may be.

As regards distribution of population throughout the national territory, it is to be observed that extensive areas in Amazonia and the Center West are still sparsely occupied, although important pioneering fronts have

been opened up in the past 25 years, as in the case of Brasília, set up in the center of the Brazilian hinterland plateau.

Historic circumstances have led to the concentration of most of Brazil's population in a narrow belt of territory running along the Eastern coastline, where the major cities are located, comprising a network as yet imperfectly integrated.

The Brazilian urban network is dominated by a primary nucleus composed of the Metropolitan Regions of São Paulo and Rio de Janeiro, located in the South East macro-region, the former having an estimated 12.4 million inhabitants and the latter 9.8 million.

A secondary nucleus, covering the North East macro-region, consists of the metropolitan regions of Recife and Salvador, the former with an estimated 2.6 million and the latter with 1.7 million.

The Metropolitan Regions, nine in all, are defined in the laws of the country and jointly account for some 28 per cent of the total Brazilian population. The following table gives the populations of the Brazilian metropolitan regions in 1980. Estimated Population of Nine Metropolitan Regions in 1980 (1,000).

<u>Metropolitan Region</u>	<u>Population</u>
Belém	975
Fortaleza	1,677
Recife	2,587
Salvador	1,710
Belo Horizonte	2,547
Rio de Janeiro	9,813



São Paulo	12,412
Curitiba	1,251
Porto Alegre	2,200

Source: BNH

Moreover, the combined populations of the aforesaid Metropolitan Regions comprise about 45% of the aggregate urban population. At the other extreme, about 41% of the urban population lives in towns with less than 50 thousand inhabitants, which is tantamount to saying that only a small proportion of the urban population lives in mid-sized towns.

As regards their internal structure, the Brazilian urban areas, especially those of the Metropolitan Regions, are markedly divided up into historic nuclei concentrating substantial tertiary activities, traditional industries, and housing for the medium and upper income bracket sectors, and peripheral areas, containing the more modern industries, some market gardening activities, and especially housing for the lower income bracket and even needy populations.

The nuclei contrast with the periphery in terms of their physical and social aspects, in given of the higher density of construction and population. They display city planning and architectural standards comparable with those of the more highly developed countries. This is the case of the central areas and more affluent suburbs of São Paulo and Rio de Janeiro.

The peripheries of the urban areas, on the other hand, are more sparsely occupied, affording levels of infra-structure and services a good deal inferior to those

of the nuclei. It is common to find them totally lacking in drinking water networks, sewerage facilities, and personal and property security coverage, amongst other urban services.

With further reference to the internal structure of the cities, it is important to draw attention to the matter of how mass transportation services are organized. In the Metropolitan Regions certain factors make for extremely high transportation costs, in terms of strictly financial angles and also in energy, ecological and social aspects.

The first series of these factors refers precisely to the actual structure of use and appropriation of the land area, regarding the segregation of urban functions and social categories and the discrepancy in terms of urban density - with congestion in the nuclei and sparse distribution at the periphery.

The second has to do with shortcomings in the urban infrastructure, especially as regards telecommunications.

Yet another series of factors intervening in the organization of the highway system is concerned with the widespread preference for individual means of transportation, to the detriment of collective transportation.

## 2. PROBLEMS OF DEVELOPMENT

### 2.1 - The Energy Crisis

The economy of the nations dependent on petroleum, especially that of the developing ones, has been undergoing far-reaching changes in behavior stemming from the position



adopted by the petroleum exporting countries subsequent to October 1973.

The embargoes placed on free supply of petroleum, aggravated by the price escalation, have entailed a state of alert towards energy problems in the international community as a whole. There is thus a pressing need for reformulation of the world energy panorama, with particular weight attaching to factors stemming from the international political process, allied to justified fears as to national security in particular.

Thus energy policies have to be handled with due consideration for external and internal conditioning factors, the former being subject to the known exogenous parameters especially as regards the supply and the available technology. Internal factors are connected with the achievement of compatibility of goals of industrial policy, dearth of resources, need for generating jobs, technological shortcomings and institutional implications.

Up to the beginning of the Seventies, the energy question, in general terms, was conducive to adoption of energy consumption patterns concentrated on petroleum. There was predominance of a form of energy both cheap and abundant up to that time. Thus energy policies were concerned, first and foremost, with ensuring the supply of conventional sources of energy, more particularly petroleum, with its strategic implications and the intensive working of the said sources.

That situation has now undergone far-reaching change, since the time when the attitude of the petroleum exporting countries unleashed the most traumatic challenge

to the economy of consumer countries, with vulnerability becoming accentuated above all in the developing nations.

Three decisions by the petroleum exporting countries made this situation even more critical, namely:

- . The prices established by the OPEC were now to be considered as minimum prices, with the addition of overprices being up to the sovereign will of each member state;
- . Supply of petroleum was placed under control, to avoid availabilities exceeding demand from coming into the market; and
- . Prices would be readjusted at three-monthly intervals.

The impact of these exogenous decisions on Brazil's economy was strongly reflected in costs of transportation and industrial products, producing vigorous inflationary pressure.

Based on this situation, attitudes shape up in terms of the quest for alternatives to petroleum through development and optimization of the use of usual or new forms of energy, through scientific and technological development, in addition to measures for conservation of energy.

## 2.2 - The Urban Question

Rural and urban settlements are the main componentes of the structure of geographic space in a country, meaning that the population is distributed throughout the territory in accordance with the distribution of productive activities. The location of such activities is decisively influenced, in turn, by natural, historic or other factors. In countries with a market economy system such as Brazil at



the present time, therefore, the production forces seek out precisely those locations that afford greater advantages, which are forthcoming precisely in the enormous agglomerations which concentrate great masses of population and activity, capital and decision-making power.

In former historic periods, when agricultural activities predominated and in which rural settlements were therefore more important, there was a certain harmony between the rurals and the towns. That harmony was broken down, however, with the increasing importance of industrial activities in the country's economy. The population grew slowly and tended to remain in the same place where it had been born. At present, on the other hand, Brazil is passing through a transitional phase in which the most marked demographic aspects are rapid growth and intensive migration of populations leaving the rural areas and the small towns, heading for larger and larger cities. The regaining of a new demographic balance, that would arise in another stage of development, is not yet possible at current horizons. Increasing urbanization is not, therefore, a phenomenon that occurs without disadjustment and contradictions. Quite to the contrary, it entails a series of problems that have to be faced up to by society as a whole and the authorities in particular, in terms of the impact of its imbalance on global development and, especially, on economic development.

Efforts are made at identifying the various planes on which urban imbalance takes place. Those points of imbalance are first of all identified on a national level, in fast growth of towns and cities and relative stagnation in the rural areas. On another plane, that might be termed regional, it concerns the dimensions and distribution of the nuclei comprising the Brazilian urban network, and finally,