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RURAL ELECTRIFICATION - EXPERIENCE IN LATIN AMERICA

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## 1. Introduction

In recent years, the Latin American countries are bestowing increasing attention on rural electrification as an instrument of economic and social development of agricultural regions. In order to stimulate exchange of information and experience in this field, seminars have been organized in collaboration with the Economic Commission for Latin America. The first one of this kind was held in Buenos Aires, Argentina in 1964, the second in Santiago, Chile in 1967, the third in Mexico in 1969 and the fourth in Belo Horizonte in 1971. At the last Conference, the countries agreed to set up an organization in charge, among other things, of collecting and disseminating data on the subject, which are still scarce, and to arrange for periodical seminars.

## 2. Progress in rural electrification

Table 1, compiled from the available scanty statistics gives an idea of the progress of rural electrification achieved in some of the countries of the region. The table also illustrates the lack of uniform criteria for its measurement, as some countries adopt rural population, others agricultural holdings or farms and still others rural clusters of population for expressing the same.

Also, the definition of rural areas varies from country to country, while the Comisión Federal de Electricidad, Mexico defines <sup>1/</sup> rural zones as those which have a population up to 10,000 and where economic activities of the primary type predominate and where investments public or private are low, other countries such as Argentina, Colombia, Chile and Venezuela consider centres of population with less than 2,000 inhabitants as rural. The government of Brazil defined <sup>2/</sup> rural electrification as supply of electrical energy to rural areas having less than 2,500 inhabitants and located outside the urban, suburban and municipal limits, with economic activities dedicated to agriculture and livestock breeding and where no other industries with a demand greater than 45 kVA exist.

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<sup>1/</sup> Report of the third Latin American Conference on Rural Electrification (Mexico City, 21-26 April 1969).

<sup>2/</sup> Decree Nº 62655 of 3 May 1968.

Table 1

## LATIN AMERICA: PROGRESS IN RURAL ELECTRIFICATION IN SOME COUNTRIES

| Country                 | Population<br>in thousands<br>(1970) | Rural population                 |                         | Farms               |                              | Rural centres <sup>b/</sup> |                              | Remarks   |
|-------------------------|--------------------------------------|----------------------------------|-------------------------|---------------------|------------------------------|-----------------------------|------------------------------|---|
|                         |                                      | In<br>thousands<br><sup>a/</sup> | Per cent<br>electrified | Total <sup>Nº</sup> | Per cent<br>elec-<br>trified | Total <sup>Nº</sup>         | Per cent<br>elec-<br>trified |   |
| Argentina               | 24 352                               | 7 500                            |                         | 500 000             | 7                            | ...                         | ...                          |   |
| Bolivia                 | 4 658                                | 3 000                            | Less than 1             | ...                 | ...                          | ...                         | ...                          |   |
| Brazil                  | 93 244                               | 48 820                           |                         | 400 000             | 1                            | ...                         | ...                          |   |
| Chile                   | 9 780                                | 2 790                            | 37                      | ...                 | ...                          | ...                         | ...                          |   |
| Colombia                | 22 160                               | 10 890                           | 36 <sup>a/</sup>        | 1 200 000           | 37                           | 4 405                       | 28                           |   |
| Costa Rica              | 1 798                                | 1 120                            | ...                     | ...                 | ...                          | 2 500                       | 75                           |   |
| Cuba                    | 8 341                                | 3 220                            | 58                      | ...                 | ...                          | ...                         | ...                          |   |
| Ecuador                 | 6 028                                | 3 610                            | 22                      | ...                 | ...                          | ...                         | ...                          |   |
| El Salvador             | 3 441                                | 2 310                            | 14                      | ...                 | ...                          | ...                         | ...                          |   |
| Guatemala               | 5 179                                | 3 270                            | 2.3                     | ...                 | ...                          | ...                         | ...                          |   |
| Mexico                  | 50 718                               | 18 630                           | 45                      | ...                 | ...                          | ...                         | ...                          |   |
| Nicaragua               | 2 021                                | 1 260                            | 31                      | ...                 | ...                          | ...                         | ...                          | } Target to be realized by<br>1972 with works in progress |
| Peru                    | 13 586                               | 7 240                            | 10                      | ...                 | ...                          | ...                         | ...                          |   |
| Uruguay                 | 2 889                                | 460                              | 70                      | 157 400             | 40                           | ...                         | ...                          |   |
| Venezuela <sup>d/</sup> | 9 686                                | 2 813                            | 31                      | ...                 | ...                          | 23 076                      | 8                            | Figures for 1968  |

Source: Figures collected in ECLA from various sources.

<sup>a/</sup> Figures rounded to last digit.

<sup>b/</sup> Rural centres with population less than 2 000.

<sup>c/</sup> Derived from statistics in the paper "La electrificación rural en Colombia - Estado actual y perspectivas futuras" by Eduardo Barrera G. (IV CLER).

<sup>d/</sup> From "Información Estadística de la Industria Eléctrica" by C.A. Administración y Fomento Eléctrico, Venezuela (1969).

Because of these differences in approach and lack of precise data, the percentages mentioned in table 1, may be taken as indicative of the order of magnitude. Costa Rica has provided electricity to 75 per cent of its rural population centres, Colombia to 28 per cent and Venezuela 8 per cent. In regard to the proportion of rural population served with electricity, Uruguay has covered 70 per cent, Cuba 58 per cent and Mexico 45 per cent, the other countries in the region registering lesser percentages. Uruguay, Colombia, Argentina and Brazil have electrified 40, 37, 7 and 1 per cent of their agricultural farms respectively. In comparison, most countries of Europe have almost completely electrified their rural regions.

### 3. Importance of agriculture

As may be seen from table 2, in 50 per cent of the countries in Latin America, 50 to 82 per cent of the population live in rural areas and agriculture accounts only for 18 to 46 per cent of the gross National Product. It has been estimated <sup>3/</sup> for the year 1965, that the average product per man employed in agriculture in Latin America was 470 dollars only as against 1,750 dollars in the industrial group including construction and mines.

Table 3, shows that in 10 out of the 24 countries listed, exports of agricultural products constitute more than 73 per cent of their total exports. These data reveal that agriculture has a dominant role in the economy of the countries in the region. It provides the livelihood for a considerable proportion of the inhabitants and earns a major part of the foreign exchange; nevertheless, the income levels of the farmers are low compared to the urban workers.

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<sup>3/</sup> Raúl Prebisch, Change and Development: Latin America's Great Task (Washington, Inter-American Development Bank, 1970), p. 34.

Table 2

LATIN AMERICA: GROSS DOMESTIC PRODUCT, RURAL POPULATION AND  
INVESTMENT IN ELECTRIC POWER SECTOR

| Country                       | Average gross domestic product 1965-1969 (millions of dollars at 1960 prices) | Share of agriculture in gross domestic product (percentages) | Rural population <sup>a/</sup> (percentages) | Annual investment in electric power sector <sup>b/</sup> (percentage of gross domestic product) | Total production of electric energy, 1970 (GWh) |
|-------------------------------|---|--|--|---|---|
| Argentina                     | 19 804  | 15.5   | 30.1   | 0.45  | 22 184  |
| Bolivia                       | 796   | 24.4   | 64.5   | 1.02  | 792   |
| Brazil                        | 26 560  | 19.8   | 52.1   | 1.08 <sup>a/</sup>  | 46 200  |
| Chile                         | 5 328   | 10.3   | 28.9   | 0.58  | 7 551   |
| Colombia                      | 6 876   | 30.6   | 45.6   | 0.87  | 9 000   |
| Costa Rica                    | 779   | 23.9   | 63.4   | 0.95  | 1 022   |
| Cuba                          | ...   | ...  | 38.8   | ...   | 6 100   |
| Dominican Republic            | 775   | 26.0   | 66.4   | 1.15  | 920   |
| Ecuador                       | 1 535   | 31.7   | 61.1   | 0.55  | 905   |
| El Salvador                   | 968   | 25.2   | 67.7   | 0.89  | 660   |
| Guatemala                     | 1 527   | 27.0   | 64.8   | 0.35  | 651   |
| Guyana                        | ...   | ...  | ...  | ...   | 320   |
| Haiti                         | 434   | 46.1   | 82.4   | 0.10  | 130   |
| Honduras                      | 527   | 40.0   | 71.0   | 0.34  | 325   |
| Jamaica                       | ...   | ...  | ...  | ...   | 1 413   |
| Mexico                        | 28 112  | 12.8   | 36.7   | 0.40  | 28 900  |
| Nicaragua                     | 626   | 29.6   | 60.7   | 1.04  | 560   |
| Panama (excluding Canal Zone) | 763   | 21.0   | 51.8   | 0.89  | 1 408   |
| Peru                          | 4 664   | 18.1   | 53.3   | 1.17  | 5 353   |
| Surinam                       | ...   | ...  | ...  | ...   | 1 500   |
| Trinidad and Tobago           | ...   | ...  | ...  | ...   | 1 228   |
| Uruguay                       | 1 850   | 21.1   | 16.5   | 0.87  | 2 138   |
| Venezuela                     | 7 019   | 7.8  | 29.8   | 1.18 <sup>d/</sup>  | 12 794  |

<sup>a/</sup> These percentages may differ slightly from the figures in table 1 because they were obtained from different sources.

<sup>b/</sup> Estimates.

<sup>c/</sup> 1.9 in 1970.

<sup>d/</sup> 0.9 in 1970.

Table 3  
 LATIN AMERICA: TOTAL EXPORTS AND AGRICULTURAL PRODUCTS  
 (Average for the period 1964-1968)

| Country             | Total exports<br>(millions of<br>dollars) | Agricultural<br>exports<br>(millions of<br>dollars) | Agricultural<br>exports as a<br>percentage<br>of total<br>exports |
|---------------------|---|---|---|
| Argentina           | 14 659                                    | 13 331  | 90.9  |
| Bolivia             | 1 407                                     | 65  | 4.6   |
| Brazil              | 16 604                                    | 13 198  | 79.5  |
| Chile               | 7 742                                     | 536   | 6.9   |
| Colombia            | 5 264                                     | 4 072   | 77.4  |
| Costa Rica          | 1 354                                     | 1 112   | 82.1  |
| Cuba                | ...                                       | ...   | ...   |
| Dominican Republic  | 1 523                                     | 1 356   | 89.0  |
| Ecuador             | 1 783                                     | 1 673   | 93.8  |
| El Salvador         | 1 951                                     | 1 439   | 73.8  |
| Guatemala           | 2 010                                     | 1 539   | 79.3  |
| Guyana              | ...                                       | ...   | ...   |
| Haiti               | ...                                       | ...   | ...   |
| Honduras            | 1 296                                     | 1 018   | 78.5  |
| Jamaica             | 2 209                                     | 889   | 40.2  |
| Mexico              | 11 220                                    | 6 003   | 53.5  |
| Nicaragua           | 1 405                                     | 1 216   | 86.5  |
| Panama              | 826                                       | 523   | 63.3  |
| Paraguay            | ...                                       | ...   | ...   |
| Peru                | 7 130                                     | 3 688   | 51.7  |
| Surinam             | 804                                       | 73  | 9.1   |
| Trinidad and Tobago | 4 281                                     | 387   | 9.0   |
| Uruguay             | ...                                       | ...   | ...   |
| Venezuela           | 29 561                                    | 345   | 1.2   |
| <u>Total a/</u>     | <u>113 022</u>                            | <u>52 517</u>                                       | <u>46.5</u>   |

Source: FAO, Trade Yearbook, 1969.

a/ Excluding Cuba, Guyana, Haiti, Paraguay and Uruguay, for want of data.

/In this

In this context, rural electrification has special social and economic significance in the region. By providing the amenities of life in rural areas such as electric light, radio, television, domestic appliances, etc., it can ameliorate the living conditions of the farm workers and stem the tide of exodus to urban areas; and at the same time by supplying energy for irrigation water pumps, agro-industries, cold storage plants, improved appliances in agriculture and livestock operation, etc., offer opportunities of employment and better productivity.

But experience shows that the progress in this regard is slow in many countries owing to the magnitude and nature of the problems that have to be faced.

#### 4. Existing level of electric power development

One of the factors which militates against spread of rural electrification is the low level of power development in the countries of the region. Table 4 gives, besides other data, the installed capacity per inhabitant and per square kilometer of the territory for the Latin American countries and corresponding figures for United States of America, Japan and France. The former countries have only a fraction of the capacity per inhabitant and per square kilometer compared to the latter highly industrialized countries. These figures show the enormous leeway to be made up in power development as a whole in the countries of the region and the vastness of the areas to be covered by electrical network.

The power supply industry is capital intensive and the growth in electrical energy production in Latin American countries is generally twice as great as that of the gross domestic product.



Table 4  
LATIN AMERICA: OUTPUT AND INSTALLED CAPACITY <sup>a/</sup> OF  
ELECTRIC POWER PLANTS, 1970

(Public utility and self-supplying plants)

| Country                     | Population<br>(thousands<br>of<br>inhabitants) | Area<br>(thousands<br>of km <sup>2</sup> ) | Installed<br>capacity<br>(MW) | Output<br>(GWh) | Installed<br>capacity per<br>inhabitant<br>(Watts/<br>inhabitant) | Installed<br>capacity<br>per km <sup>2</sup><br>(kW/km <sup>2</sup> ) |
|-----------------------------|--|--|-------------------------------|-----------------|---|---|
| Argentina                   | 24 352   | 2 777                                      | 6 550                         | 22 184          | 269   | 2.96  |
| Bolivia                     | 4 658  | 1 099                                      | 268                           | 792             | 58  | 0.24  |
| Brazil                      | 93 244   | 8 512                                      | 11 190                        | 46 200          | 120   | 1.31  |
| Chile                       | 9 780  | 757  | 2 143                         | 7 551           | 219   | 2.83  |
| Colombia                    | 22 160   | 1 139                                      | 2 300                         | 9 000           | 104   | 2.02  |
| Costa Rica                  | 1 798  | 51   | 230                           | 1 022           | 128   | 4.51  |
| Cuba                        | 8 943  | 115  | (1 700)                       | 6 100           | 204   | 1.48  |
| Dominican Republic          | 4 348  | 49   | 307                           | 920             | 71  | 6.27  |
| Ecuador                     | 6 028  | 284  | 300                           | 905             | 50  | 1.06  |
| El Salvador                 | 3 441  | 21   | 210                           | 660             | 61  | 10.00   |
| Guatemala                   | 5 179  | 109  | 210                           | 651             | 41  | 1.93  |
| Guyana                      | 757  | 215  | 130                           | 320             | 172   | 0.60  |
| Haiti                       | 5 229  | 28   | 40                            | 130             | 8   | 1.43  |
| Honduras                    | 2 583  | 11.2                                       | 110                           | 325             | 113   | 0.98  |
| Jamaica                     | 1 810  | 11   | 430                           | 1 413           | 234   | 39.09   |
| Mexico                      | 50 718   | 1 973                                      | 7 400                         | 28 900          | 146   | 3.75  |
| Nicaragua                   | 2 021  | 130  | 161                           | 560             | 80  | 1.24  |
| Panama                      | 1 406  | 76   | 326                           | 1 408           | 232   | 4.29  |
| Paraguay                    | 2 419  | 407  | 155                           | 209             | 64  | 0.38  |
| Peru                        | 13 586   | 1 235                                      | 1 686                         | 5 353           | 124   | 1.31  |
| Surinam                     | 411  | 163  | 252                           | 1 500           | 613   | 1.55  |
| Trinidad and Tobago         | 1 129  | 5  | 333                           | 1 228           | 295   | 66.60   |
| Uruguay                     | 2 889  | 187  | 530                           | 2 138           | 183   | 2.83  |
| Venezuela                   | 10 755   | 912  | 2 980                         | 12 794          | 277   | 3.27  |
| <u>Latin America</u>        | <u>279 072</u>                                 | <u>20 417</u>                              | <u>39 941</u>                 | <u>152 263</u>  | <u>143</u>  | <u>1.96</u>   |
| United States <sup>b/</sup> | 201 152  | 9 363                                      | 309 432                       | 1 432 999       | 1 538   | 33.04   |
| Japan <sup>b/</sup>         | 101 080  | 370  | 53 187                        | 261 807         | 526   | 143.74  |
| France <sup>b/</sup>        | 49 920   | 547  | 31 992                        | 117 925         | 641   | 58.48   |

a/ Preliminary figures or estimates.

b/ Figures for 1968, obtained from the statistics of the Union of Producers and Distributors of Electrical Energy.

/The experience

The experience in most countries of the world is that, in order to sustain normal economic growth, annual investments in the electricity sector should be of the order of 6 to 9 per cent of the total investments or 1 to 1.5 per cent of the gross domestic product. Table 2 gives approximate corresponding percentages for Latin American countries, which with few exceptions, register lower figures. It is obvious that only a small fraction of the available capital may be channelled to rural electrification. In Mexico, for example, where intensive effort is being made to electrify rural regions, the investment in rural electrification during the years 1966-1970 was in the range of 9 to 17 per cent of the total in electricity supply industry, the average for the years being 13 per cent.<sup>4/</sup> Finance is therefore, the chief obstacle for widespread electrification of rural areas.

The low level of power development in the Latin American countries signifies, in addition, except in a few countries, paucity of transmission networks and lack of interconnexion between power systems, which in many cases operate in isolation. The generation per kW of installed capacity, which is related to the integrated use of the electrical facilities, was 3,812 kWh (1970) in Latin America as a whole, as against 4,630 kWh in the United States of America and 4,920 kWh in Japan (1968).<sup>5/</sup> Unless there is a wide network of transmission and distribution lines, many rural areas cannot be brought within the economic orbit of electricity supply. The countries in the region are recently showing greater awareness of this aspect, and considerable headway is being made in Brazil, Colombia, Mexico and Venezuela to mention only the more important ones.

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4/ Raúl H. Rosado A., "Electrificación rural sin cooperación de particulares", presented at the fourth Latin American Conference on Rural Electrification in 1971.

5/ Statistics of the Union of Producers and Distributors of Electric Energy, 1968.

## 5. Economic aspects and institutions

The highly dispersed character of the rural land holdings and population centres, often far away from electrified areas and networks calls for large investments for constructing the necessary power stations, transmission and distribution lines and substations for supplying them with electricity. The standards of living of farm workers which in many cases hardly surpass subsistence levels and their low economic capacity militate against investment in electric appliances and maximum use of the available energy. Land tenure systems in some places have also had unfavourable impact in this regard.

Rural electricity supplies are consequently characterized by low consumption and low load factor of energy use. The direct returns on power supply investments for these areas are low at least in the first few years of operation. In some cases, the returns may not even be sufficient to cover the operation and maintenance charges. On the other hand, high tariffs for electrical energy will deter energy consumption and defeat the basic objectives of electrification.

The private electricity supply undertakings with few exceptions, with their natural outlook on direct returns and profits rarely extended the supply to the less profitable rural areas. In most countries of Latin America, rural electrification is now being fomented and executed through government support. In fact, the need to bestow attention on electrification of the less favoured areas stimulated to some extent the progressive increase in the participation of the State Governments in the electricity supply industry as a whole, in order to set off partly the losses in rural supplies by earning adequate surpluses from urban and industrial consumers. The general pattern of approach has been to encourage creation of rural electric co-operatives in promising areas and thus eliminate the profit motive in the marketing of electrical energy.

In general, creation of rural electric cooperatives is sponsored and assisted by the existing public sector organizations in the electricity industry such as Empresa Nacional de Electricidad (ENDESA) in Chile,

Instituto Ecuatoriano de Electrificación (INECEL) in Ecuador, Empresa Nacional de Electricidad (ENDE) in Bolivia, Instituto Costarricense de Electricidad (ICE) in Costa Rica, Empresa Nacional de Luz y Fuerza (ENALUF) in Nicaragua, etc. The Sixteen co-operatives now operating in Chile have organized themselves into a Federación Nacional de Cooperativas Eléctricas (FENACOPEL) for joint action in the matter. Recently, the Government of Chile has set up a "Comisión de Electrificación Rural" charged with the task of reassessing the progress and outlining a national policy.

In Brazil, Electrificação Rural de Minas Gerais (ERMIG) was set up as a subsidiary of Centrais Elétricas de Minas Gerais (CEMIG) to be in exclusive charge of attending to rural electrification in this state and to the creation of electric co-operatives. In the other states of Brazil, state organizations in charge of the electricity supply industry also attend to the electrification of rural areas and creation of co-operatives.

In Peru, División de Electrificación Rural (DELRU) was established under the Dirección de Electricidad and was entrusted with the responsibility of preparing national plans of rural electrification, their execution and promoting the formation of co-operatives with the collaboration of Instituto Nacional de Cooperativas. Also, Servicios Eléctricos Nacionales (SEN) is in charge of constructing, operating and maintaining the power plants and distribution lines in many rural areas. Recently, the setting up of a single organization "ELECTROPERU" and changes in the institutional structure are under consideration of the Government.

In Bolivia, besides ENDE, the Instituto Nacional de Electrificación Rural (INER) working under the Ministerio de Energía e Hidrocarburos is directly concerned with the task of rural electrification. In the Department of Santa Cruz, the Cooperativa Rural Eléctrica (CRE) attends not only to the supply of electricity to the town of Santa Cruz but also to other rural centres in its vicinity and to other zones.

/In Mexico,

In Mexico, "Juntas Estatales de Electrificación" in which the Comisión Federal de Electricidad (CFE), the State Governments and consumers participate, have been set up, one for each state, and attend to the programmes of rural electrification and organization of co-operatives. Fifty per cent of the investment is met by CFE and the balance jointly by the State Government and consumers.

In Colombia various regional public sector electricity undertakings were promoting electrification of rural zones partly with the financial assistance of Federación de Cafeteros. Recently, the Instituto Colombiano de Energía Eléctrica (ICEL), besides its other tasks of preparing, co-ordinating and financing national plans for power development, has been given charge of administering the "Fondo Nacional Financiero de Electrificación Rural" and providing technical assistance to rural plans.

In Argentina, 721 electrical co-operatives including 65 in course of formation by the end of 1969, are attending to rural extensions in addition to supplying electricity to many urban centres. They have joined together to form the "Federación Argentina de Cooperativas de Electricidad Ltda.". In addition, a few "consorcios" exist whereby the prospective consumers group together, prepare a project and execute the same either with their own funds or loans from government organizations. New consumers who desire to be connected pay a fixed amount depending on the distance from the supply line and probable consumption. Subsequently, the maintenance and operation of the supply may be transferred to a co-operative. By this procedure, individual rural farms desiring electrical energy may obtain connections without waiting for the formation of a co-operative.

In Venezuela, the first three rural co-operatives were set up in 1965, two in the Western region and one in the Eastern part with the support of C.A. de Administración y Fomento Eléctrico (CADAFE) and Instituto Estatal Financiero para el Desarrollo Comunal (FUNDACOMUN). More are being organized.

## 6. Approach to rural electrification

In general terms, the first rural areas to be served with electricity are those which encircle urban centers to a radius of 30 to 50 km such as the belts around Buenos Aires and Córdoba in Argentina.

Many of the hydro-electric sites are located far away from urban centers. While harnessing these sites, the rural areas in the vicinity get benefited. The construction of the Pilmaiquén Hydrostation in Chile in 1944 was followed immediately with the setting up of the first "Cooperativa Rural Eléctrica Osorno" in its neighbourhood.

In some countries such as Peru, Ecuador, Panama, Uruguay, etc., in order to serve rural areas, small diesel power stations have been installed in isolated places and in some cases operate for a few hours in the evenings. While the electrical energy available from these is usually of high cost or has to be subsidized in some manner, such nursery schemes are useful in familiarizing the rural inhabitants with the several potential benefits of electricity and initiating them in the technology of its use. But, by and large, this method of bringing electrical energy to rural consumers cannot be adopted extensively, because of its relatively high specific capital and operation costs.

Most of the countries in the region have sought to stimulate rural electrification by extending the network of transmission and distribution lines so that the rural beneficiaries are not loaded with the relatively high capital expenditure on generating capacity. Even in such cases, the areas to be served with electricity are selected with due care to minimize the costs and maximize the benefits. The principal criteria for selection of the rural areas for supply of electricity have been:

- (a) Availability of adequate generating capacity for the projected extensions;
- (b) The density of agricultural holdings and population in the area should be sufficiently high to achieve a density of demand of 10 to 12 kVA per km of rural line in order to make the extension economically viable.

/(c) There

- (c) There must be reasonable prospects of increasing the rural incomes and agricultural production in the area by co-ordinated and concentrated application of various measures. Among these, mention may be made of irrigation facilities, supply of good seeds and fertilizers, opening up of communications and marketing facilities, promotion of literacy, introduction of scientific agricultural practices, expansion of rural credit, encouragement of small scale and cottage industries, etc.
- (d) Prospective consumers must evince interest in the project for electrification, have a tradition and experience in co-operation and defray part of the capital expenditure on the scheme.

Electricity is but one among the many inputs necessary to raise the agricultural production and economic well-being of a region. The agrarian reforms being introduced in some countries have also had a favourable impact in this regard.

As electricity undertakings have only a specific and limited role, in some countries special institutions have been created to promote and accelerate the economic and social development of rural inhabitants. For example, Brazil has set up Instituto Nacional de Colonización y Reforma Agraria (INCRA). Its activities embrace colonization, promotion of co-operatives, rural extension work and development. The Institute finances and implements national plans for rural electrification in collaboration with Grupo Ejecutivo de Electrificación Rural (GEER), through the local electricity supply undertakings.

In Argentina Instituto Nacional de Tecnología Agropecuaria (INTA) has been helping for all-round development of rural regions.

Very often, organizations of this type are faced with difficulties arising out of lack of co-ordination among the different sectoral activities of the government.

The experience in Latin America underlines the necessity to fulfil the following conditions for realizing the economic and social goals:

- (i) To have a global plan or strategy of economic development for the country and outline clearly the regional targets and measures to achieve the same;

/(ii) Co-ordinate

- (ii) Co-ordinate and intensify the diverse sectoral activities for specified regions eliminating conflicts and introduce the technology of electricity to secure optimum results and effective progress.

#### 7. National plans and investments

Rural electrification is being implemented in stages and integrated with the over-all plans for electric power and national or regional economic development as is the case in Argentina, Brazil and Chile.

A three-year national plan of rural electrification (1969-1971) is under way in Argentina <sup>6/</sup> with an estimated investment equivalent to 45.5 million dollars of which 15 million was financed by the Banco Interamericano de Desarrollo (BID); the Banco de la Nación Argentina and Dirección Nacional de Energía y Combustibles provided 7.5 million dollars each and the balance by the consumers.

INCRA in Brazil <sup>7/</sup> is patronizing a 4-year (1971-1974) programme for the country as a whole, involving an outlay of 63.5 million dollars equivalent of which 30.3 million was met by IDB 19 million by INCRA and the balance by the electricity undertakings and co-operatives.

In Chile, the Corporación de Fomento de la Producción (CORFO) obtained <sup>6/</sup> a 3.3 million dollar loan from Agency for International Development (AID), to which was aggregated national contribution of 3.6 million dollars equivalent and completed a five year (1966-1970) programme of rural electrification in the country. A similar nation-wide plan is underway for the years 1970-1973 involving a capital expenditure of 5.0 million dollars equivalent of which 2.54 million dollars are met by a loan from IDB.

Mexico has invested 46.6 million dollars equivalent during 1957-1964 and 120.4 million dollars equivalent for the years 1965-1970 in electrification of rural areas. <sup>8/</sup>

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6/ Loc. cit., ref. 1/, annex 2.

7/ Instituto Nacional de Desenvolvimento Agrario, Estudio de Viabilidade de Electrificação Rural, submitted to the Inter-American Development Bank in July 1968, p. 2 (revised figures).

8/ Annual report 1969-1970, CEE (Mexico).



Honduras and Venezuela have launched rural electrification plans on a national scale, the former a ten year programme and the latter for 1970-1974 involving investments of the order of 11.2 and 64.6 million dollars respectively. Costa Rica has been granted a loan of 3.8 million dollars by IDB for electrification of the Provinces of Guanacaste and Limón. Colombia is preparing a programme for 8.1 million dollars (ICEI-IDB).

#### 8. Social benefits

Reference was made to the social benefits provided by electric light, radio, television and domestic appliances in rural surroundings.

In Colombia, Bolivia, Ecuador and in some other countries, a concerted programme of mass education is being attempted by means of radio and in some cases by television. Night classes are being held using electric illumination. The potential benefits of this campaign to raise rural literacy can hardly be exaggerated. The educated farm worker is likely to adapt himself more rapidly to the new techniques in agriculture and use of labour-saving appliances to increase productivity.

It is known that mechanization in some activities in agriculture such as use of tractors leads to unemployment in the farm. In the context of the high percentage of population living in rural areas in Latin America with low incomes and underemployment, the question may well arise as to what extent mechanization could be introduced without detriment to the employment potential in these regions. The introduction of electrical energy, is however, generally beneficial. Productivity is increased by installation of incubators, farm workshop, lighting, refrigeration, electric pumps for irrigation, hay driers, ventilation in poultry farms, etc., which do not reduce opportunities for employment. On the other hand, the availability of electricity may offer increased scope for profitable employment in small scale and cottage industries.

#### /9. Finance

### 9. Finance and subsidies

The main sources of funds for rural electrification projects in Latin America have been:

- Credit or budget allotment of State, Provincial or Federal Governments;
- Loans from international organizations such as the International Bank for Reconstruction and Development (IBRD), IDB, etc.;
- Loans from foreign countries;
- Surplus funds arising from the operation of electricity undertakings such as profits, depreciation reserves, etc.;
- Contributions by consumers;
- Rural development or Electrification funds created by legislation;
- Banks established for rural or agricultural credit and development.

The terms of the loans granted by international banks vary with the prevailing conditions in the money market. The IDB loan to Brazil had an interest of 6 per cent and called for revaluation of unpaid balances by 6 per cent annually, a redemption period of 17 years with three years of grace. For Argentina, interest charged was 4 per cent annual, with amortization in 26.5 years. These resources together with national funds are then distributed to the agencies executing the rural electrification programmes at slightly higher rates of interest. Many Latin American countries suffer from inflation and grant of loans without adjustment for the yearly devaluation of currency is in fact an indirect subsidy to the programme.

The IDB loan to Costa Rica had an amortization period of 30 years including 4 years of grace and carried 3 1/4 per interest plus commissions.

The 5.5 million dollars loan to Honduras granted by the International Development Association (IDA) was for a 20 year period including 4 years of grace and carried interest of 3/4 per cent per annum. The Empresa Nacional de Energía Eléctrica (ENEE) which is the executing agency, will pay an interest of 7 per cent to the government. The difference 6 1/4 per cent will be credited to the "Fondo de Electrificación Rural" and utilized for electrification of rural areas.

/Colombia has

Colombia has also created a "Fondo Financiero Nacional de Electrificación Rural" which will finance partly the programme of rural electrification.

The Agency for International Development (AID) of the United States of America has been assisting financially many of the Latin American countries with a view to stimulating electrification of the less favoured regions. During the last 10 years the loans granted were as below:<sup>2/</sup>

3.3 million dollars to Colombia (1965); 3.3 million dollars to Costa Rica (1965); 3.3 million dollars to Chile (1965); 1.6 million dollars to Perú (1966); 4.2 million dollars to Ecuador (3.55 million in 1970); 10.2 million dollars to Nicaragua (1968).

These loans carry 0.75 to 2.5 per cent interest with long redemption periods, in some cases 40 years. The loans generally envisage participation of countries' funds for implementation of the projects.

Various institutions exist in the different countries for rendering financial assistance by way of loans to rural electrification projects:

- Argentina - Dirección Nacional de Energía y Combustibles,  
Banco de la Nación Argentina and Banco de la Provincia de Buenos Aires;
- Brazil -- Banco Nacional de Crédito Cooperativo, Consejo Estatal de Agua y Energía Eléctrica; diverse organizations in the federating states;
- Chile - ENDESA, CORFO and Banco del Estado;
- Colombia - ICEL, Federación de Cafeteros;
- Mexico - CFE and State governments;
- Uruguay -- Usinas Eléctricas y Teléfonos del Estado (UTE).

The rural electrification projects are thus subsidized indirectly to some extent by granting loans at low rates of interest and long amortization periods. In some countries, importation of equipment for rural electrification is exempt from import duties.

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<sup>2/</sup> Agency for International Development (US AID) - Operations Report data of June 30, 1970, Washington D.C.

## 10. Tariffs

Electricity tariffs are controlled in most of the countries by appropriate government institutions. Existing regulations regarding framing of tariffs are in general applicable to both urban and rural supplies of electrical energy.

In February 1970, however, the Venezuelan government authorized the CADAFE to adopt "Tarifa Residencial Social" for consumers of 15 kWh or less per month, with sale price of about 4.4 cents of U.S. dollar per kWh. For general residential consumption in excess of 15 kWh per month, four types of block tariffs applicable to different regions were authorized, the average rate per kWh varying from 8.5 to 4.5 cents depending on the consumption.

In some countries special rates are offered for water pumping for irrigation. In Brazil, this concession is applicable to areas subject to long droughts. Promotional rates have been adopted in a few regions to augment energy use in off-peak hours and thus improve load factor. In order to stimulate rural consumption, the rural consumers in Brazil are exempt from payment of certain taxes such as Empréstimo Compulsario and are also given a discount of 20 per cent on the bill, conceded by art. 18 of Decree No 62724 of May 17, 1968.

In order to illustrate the wide range of costs that prevail in different areas, some typical figures in cents of U.S. dollar per kWh for sale of electrical energy are given below (1970):

Costa Rica, 2.02; Honduras, 3.51; El Salvador, 2.84 and Nicaragua, 3.25.

In Ecuador, corresponding figures for Santo Domingo de los Colorados and Daule were 3.93 and 4.61 (1968) respectively.

## 11. Evaluation of projects

Some countries such as Brazil, calculate the benefit-cost ratios taking into account, the direct as also the indirect benefits resulting from their implementation. Very often, the major indirect benefit, susceptible of evaluation is the increase in agricultural output as a result of pumping underground water for irrigation.

/Irrigation loads

Irrigation loads in parts of Latin America are contributing to spread of electricity in rural regions. For example, 20 per cent of the 6,000 wells in the province of Mendoza in Argentina had been electrified before 1964, augmenting thereby the production of its several vineyards and resulting in a loading of about 80 kW per km of high tension line.<sup>10/</sup>

In the middle São Francisco region in Brazil, the Companhia de Electricidades de Pernambuco had a load of 1,760 HP of which 172 pumps accounted for 92 per cent of the load - 14.7 kVA/km of low tension line.<sup>11/</sup> In the north and central plateaus of Mexico, large areas are being irrigated with ground water using electric energy for pumping.

## 12. Technical aspects

Approach to rural electrification from the stand point of organization, planning, financial, fiscal and tariff policies was outlined in the above paragraphs. Considerable attention is also being devoted to reduce the capital and operation expenditures of these projects.

Production of electrical energy from hydroelectric schemes, use of single phase high tension supply in preference to three-phase wherever demands may be met by this procedure, use of lower factors of safety in the design of overhead lines with lower clearances to ground in rural areas, use of steel or aluminum conductors in place of copper and use of treated wood poles wherever feasible are some of the many measures being adopted to reduce costs.

Standardization of electrical equipment, and designs, the local manufacture of reinforced concrete, spun or prestressed concrete poles are also being adopted in some countries.

## 13. Load promotion

This is another approach for making rural extensions financially viable by encouraging intensive and widespread use of electricity by consumers. Demonstration farms for introducing scientific agriculture practices and use of modern equipment and demonstration of mechanical devices for small scale industries have been organized in some countries.

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<sup>10/</sup> La Electrificación rural y su utilización en el riego con aguas subterráneas en la provincia de Mendoza - first Latin American Conference on Rural Electrification (16-22 November 1964).

<sup>11/</sup> Genildo Nunes de Souza, Un programa integrado no Medio São Francisco (fourth Seminar on Rural Electrification in Latin America).

Some undertakings offer domestic wiring and appliances on hire-purchase basis as in the case of "Paquete CFE" Mexico.

Once electricity is introduced to rural areas, experience in many regions shows that not only the number of consumers increase year to year, but also the consumption per consumer rises. As an example, the first co-operative established in Chile in 1945 had 65 members with an average consumption per consumer of 5,430 kWh per year; in 1966, it had 847 members and consumption of 10,500 kWh each. <sup>14</sup>

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12/ -- Observations of the President of the Empresa Nacional de Electricidad, S.A., (ENDESA) at the opening meeting of the second Latin American Conference on Rural Electrification.