PN-AAT-489

41526

RURAL ELECTRIFICATION IN COLOMBIA

Eduardo Velez

with

Carlos Becerra
Alberto Carrasquilla
Instituto SER de Investigacion

A Report to the

U.S. Agency for International Development

under Cooperative Agreement No. AID/OSAN-CA-0179

Center for Energy Policy Research
RESOURCES FOR THE FUTURE
1755 Massachusetts Avenue, N.W.
Washington, D.C. 20036

March 1983

Acknowledgment

The research for this study was funded under Cooperative Agreement No. AID/DSAN-CA-0179 established between Resources for the Future and the U.S. Agency for International Development, Office of Energy (Director, Alan B. Jacobs). Pamela L. Baldwin is the A.I.D. Project Officer for this Cooperative Agreement. The research staff at RFF is headed by William Ramsay, Project Officer and Principal Investigator, and Joy Dunkerley, Co-Principal Investigator.

Michael Coda of the Center for Energy Policy Research staff verified this report; it was translated by Linda Walker and edited by Douglas Barnes and Linda Walker.

The views expressed in this paper are those of the author and should not be interpreted as representing the views of either A.I.D. or Resources for the Future.

Contents

		Page
PROLOGUE		vii
Chapter 1	GENERAL INTRODUCTION AND RESEARCH METHODOLOGY	1
Chapter 2	ECONOMIC AND SOCIAL CHARACTERISTICS OF HOUSEHOLDS IN ELECTRIFIED AND NONELECTRIFIED AREAS	17
Chapter 3	ELECTRICAL POWER IN BUSINESS AND AGRICULTURAL PRODUCTION	49
Chapter 4	USES AND SUBSTITUTION OF ENERGY IN THE HOME	58
Chapter 5	THE USE OF TIME	69
Chapter 6	CONSUMPTION AND COST OF ELECTRIC POWER	77
Chapter 7	ANALYSIS OF THE OPINIONS OF COMMUNITY LEADERS ON ELECTRIFICATION	81
Chapter 8	CONCLUSION AND POLICY IMPLICATIONS	86
REFERENCES		90
APPENDIX A		92

Prologue

The purpose of this study is basically twofold. It tries to meet the need for information on the demand for and uses of electrical energy in rural areas of Colombia, and secondly, it attempts to generate a base of information for a more in-depth study on the socioeoconomic impact of rural electrification on families and the community. With these two interrelated goals in mind, the report clarifies the consequences of electrification, identifies its advantages and disadvantages, and makes some recommendations regarding mandatory aspects of its implementation.

Studies conducted in developing countries have resulted in conflicting conclusions, some supporting and others criticizing efforts to electrify rural areas. Such variance in the results is chiefly due to consideration of factors such as costs, the beneficiaries, the economic development induced, etc.

In this project, we have combined two complementary methodologies (being aware of the limitations noted in the section on methodology to follow) to try to clarify the specific case of rural electrification in Colombia. This complementary methodology, and some considerations on the use of time as a unique aspect of the quality of life which has seldom been studied, will, we hope, produce better information with which to advance policy development in Colombia.*[1]

It is hoped that in the 1980s and 1990s there will be greater improvement in the conditions in rural areas; at least the objective of current rural development plans is to meet the basic necessities of rural families. One of the mechanisms proposed to meet this objective is to provide access to rural electrification in such a way that families may begin participating in the development process of the country, contributing to as well as benefiting from it. This study provides a sufficient basis for us to conclude, in principle, whether the hypothesis that electrification helps improve the quality of life of rural families is correct. Our efforts, then, focus on developing this last theme.

---

[1]*Due to the complexity of the themes addresses and methodological limitations, one must be particularly careful in making generalizations from the work analyzed here.

Chapter 1

GENERAL INTRODUCTION AND RESEARCH METHODOLOGY

As has been the case for an increasing number of developing countries over the past few years, Colombia has displayed a particular preoccupation with rural electrification policies. The most recent socioeconomic development program states:

> Attention to the rural sector will be improved substantially with the initiation of the Regional Rural Electrification Plan....Outlays will go from 13 percent in 1978 to 27 percent in 1982 (DNP, 1980).[1]

Within this general framework are many more implicit objectives for policy development related to rural electrification.

Socioeconomic problems in the rural areas of Colombia are very typical of underdeveloped areas. A substantial portion of the population have poor diets, housing, work conditions, education, and, in general, quality of life. Rural electrification is perceived as a very powerful instrument for meeting these basic needs. The degree to which it is a pertinent and plausible instrument depends in large part on its social and economic viability. On the one hand, its financial viability depends on the relationship between the strictly financial costs and benefits it produces; and on the other hand, it depends on the widespread social benefits that, it is hoped, will be produced.

In this study we will attempt to establish an analytical approach for evaluating the socioeconomic impact of rural electrification. We are seeking to identify the distinct objective elements in the relationship between rural electrification and such variables as agricultural

---

[1]That is, from 200,000 connections to 414,000.

development, occupation, commerce and manufacturing, transportation and means of communication, migration, etc. We are not seeking to evaluate the impact of a specific rural electrification program but rather to evaluate the impact of rural electrification on a cross-sectional sample of areas with different histories of electrical energy service. In this introductory chapter, we first examine the structure of the electric utilities in Colombia in order to provide a background for the later chapters on social and economic impacts. Then, in a second section of this chapter, the methods and research design of the study will be detailed.

Part 1: The Electrical Sector of Colombia

This study takes place in the context of a national energy system. Electrical utilities in Colombia are a public service administered through state industrial and commercial companies. Thirty-one companies exist in Colombia, all relatively autonomous. Two other entities--the Colombian Institute for Electrical Energy (ICEL) and CORELCA--also exist, which coordinate the activities of several companies, and which are funded through the national budget. The Electrical Interconnection (Interconexion Electric S.A., ISA), made up of several companies, is in charge of large investment projects in the sector.

The organizations charged with providing electrical service in Colombia are:

<u>ICEL and Its Affiliate Utilities</u>
The Colombian Institute for Electrical Energy (ICEL) does not have its own generating facilities or consumers. It owns the majority of stocks in its affiliates, which cover the major portion of the country with the exception of the Atlantic Coast, the Valley, and the zones served by EEEB and EPM.

<u>CORELCA and its affiliate utilities</u>
CORELCA covers the Altantic Coast. Its administration resembles that of ICEL since CORELCA owns the majority of stock in its affiliates. However, it does have its own generating plant which sells in block to the utilities. The future development of generating capacity in the Atlantic Coast region belongs to CORELCA (or is shared with ISA).

CVC and CHIDRAL
Together with some municipal utilities that are principally distributors (EmCali, EmCartago), they cover "the Valley System." CVC has the majority of stock in CHIDRAL, which operates some generating plants and subtransmission stations.

EEEB and EPM
EEEB and EPM are the two major municipal utilities in the sector and serve Bogota and Medellin respectively.

ISA
ISA is an association whose functioning bodies include EEEB, EPM, CVC, ICEL, and CORELCA. It controls planning activities for electricity generation and transmission at the national level. It has generating plants, owns the interconnecting lines between the systems and sells energy in blocks to its members.

The general sectoral policies are determined by the National Council for Economic and Social Policy (CONPES) with the participation of the National Department of Planning and the Ministry of Mines and Energy. These organizations are charged with the study and presentation of sectoral investment plans. Generating and transmission plans are carried out by ISA, directly or in conjunction with its members. Subtransmission and distribution plans are developed and executed by the regional organizations.

The electrical sector in Colombia is not self-financing. For many years, the country has committed major portions of the national budget to finance part of the sector's investments. The remaining part of such investments is financed with loans (generally foreign) with some participation of the utility companies involved. These, in turn, must later assume the service on the debt contracted. The profits of the companies come from the sale of power, and operations and the corresponding portion of the amortization for their participation in the investment programs must be financed with those profits.

Power users are classified as residential, commercial, industrial, official, and others, including in the last category some special users and many small cases of free energy use. The 1980 national consumption (2.9 million MWh) was distributed as follows:

-	Residential:	45.8%
-	Commercial:	11.9%
-	Industrial:	28.9%
-	Official:	9.1%
-	Others:	4.3%
		100.0%

Based on ICEL data, only 22 percent of residential energy or about 9.6 percent of total energy is consumed by users of less than 300 kWh on average per month, a category which includes more than 50 percent of residential users. Independent studies indicate that a high correlation exists between consumption of electrical energy and family income. This information, although incomplete, nevertheless is sufficient to generate a rate scheme which would produce sufficient funds to expand service and at the same time have the desired distributive effect for political viability.

Electrical Rates

Electrical rates in Colombia are regulated and controlled by the National Board of Tariffs, a body attached to the National Planning Department. The average rate collected from each type of user is different based on several criteria. Commercial and industrial users, according the the National Board of Tariffs, should have one rate. Nevertheless, the rate structure that the board "inherited" had an average commercial tariff much higher than the average industrial rate. The board has been increasing the industrial rate faster than that for commercial users with the objective of equalizing these tariffs in the future.

The commercial tariff is a single tariff, while the industrial tariff has two parts: a fixed rate for connecting that is measured as a fixed monthly cost by kilowatt installed capacity, and a fixed rate for consumption that varies with the kilowatt hours actually consumed. This latter tariff may be fixed, in the case of some businesses, or it can be doubled for the remaining businesses that have a tariff for peak periods and another for the rest of the day.

Residential use has a multiple rate which increases with the customer's monthly consumption and which seeks to subsidize small customers, tax large users, and results in an average residential tariff equal to or slightly higher than the average cost of distribution and

transmission services. National residential consumption in 1980 was distributed in the following way, according to the highest monthly consumption by customers:

-	up to 100 kWh	5.3%
-	up to 200 kWh	11.6%
-	up to 300 kWh	14.2%
-	up to 500 kWh	26.5%
-	up to 1,000 kWh	23.3%
-	more than 1,000 kWh	19.1%
		100.0%

The rates are adjusted to the national inflationary cycle through an automatic monthly increase (averaging 2.3 percent monthly; a maximum of 2.5 percent monthly).

Rural Tariffs

Rural electricity consumption is basically for lighting and corresponds to residential use. The cost of providing energy per unit of consumption is higher in rural than in urban areas. Nevertheless, the residential rate structure is the same for rural and urban sectors. Owing to this fact, the rural users in effect receive a subsidy due to the following combination of factors:

1. Average rural residential consumption is less than the average residential consumption of all customers. The tariff level that is paid, therefore, is lower than the average.

2. When all customers pay an average tariff, and since the rural delivery costs are higher than in the urban areas, urban customers are subsidizing the rural ones.

3. When residential use is subsidized by other customers, rural customers benefit.

4. When all customers are subsidized, given that part of the sectoral investment is financed with funds from the national budget, the rural customer benefits equally.

While the national budget makes large contributions to the electrical sector, directly to some groups and indirectly through subsidized fuel

prices to the thermal power centers that produce hydrocarbons and gas, it is difficult to compute these subsidies among the different utilities. It could be assumed that each company recoups its costs. That requires a unique tariff structure for each region of the country, with large variations between regions and between urban and rural tariffs, given the equally great differences in transmission and distribution costs. As such, each specific subsidy could be measured by comparing the "ideal" subsidy with the real one; and if consumption were known, it would be possible to calculate the amounts of subsidies received by each region and by different user groups.

Obviously, different types of subsidies exist for each user group. Also, if tariff levels are observed over several years, variations can be observed in the type of subsidies for different users over time. As an example, using energy sales for a given year (at constant 1979 prices) of the utilities in the grid system compared with those of the Atlantic Coast, and assuming a marginal cost on the order of $2/kWh (in 1980 pesos), the customers in the interconnected companies in 1977 received a subsidy of 46.4 percent of the total. That resulted in a subsidy of $2.981 million in residential consumption that year to residential users; the majority of the subsidy went to Bogota, Medellin, and Cali. So, in many places the tariff is not raised to a level sufficient to cover the debt service, and the continued contributions of the national government are justified as a necessity for these regions.

As was mentioned earlier, electricity consumption levels have a high correlation to household income. Nevertheless, at present there is not enough information to translate subsidies for consumers to socioeconomic groups. However, if the correlation is positive, a progressive tariff structure like that of the Valley tends to produce a distribution of subsidies (or eventually crossed subsidies) in the proper direction. It should be noted once again that rural users probably use much less energy than urban users, and transmission and distribution costs are much higher. Therefore, in general the subsidy for rural users are much greater than for those in urban areas.

This general background on the utilities of Colombia provides a framework for the remainder of the chapter and the report. In general, rural electrification is receiving a greater subsidy than electricity for

urban users. Therefore, the impact of rural electrification for rural areas is crucial for the jusification of the Colombian rural electrification program. If the benefits prove not to be substantial, then it would be difficult to justify the extensive subsidies. Part 2 of this chapter details the methodology utilized to investigate the social and economic impact of rural electrification. Extreme care was taken to insure that the sample design and the questionnaires were appropriate for answering the important questions surrounding the social and economic impacts of rural electrification.

Part 2: Methodological Design

The Approach

This empirical investigation of rural electrification is based on two conceptually different units of analysis: communities and households. As the present study was assumed from the beginning to be highly exploratory in nature, we focus on establishing the empirical bases for determining the fundamental relationships between social and economic variables and rural electrification. As we focused the investigation on both communities and households, the sample was designed using the principle of complementary units of analysis. Information was collected for rural communities and for households, and a basic analytic model has been developed to identify important trends and fundamental characteristics in the data collected. In order to control for biases resulting from an overconcentration of cases in homogeneous sampling units, the sample varies in terms of (1) socioeconomic, cultural and geographic/environmental characteristics, and (2) the history of electrification. Thus, the region-based part of the statistical sample accounts for the variations in socioeconomic and geographical characteristics, while communities were selected according to their length of electrification using secondary information from the municipalities and from the electrical utilities.

Before we turn to the criteria for selecting communities and households for the study, we will briefly review several studies which have attempted to classify regional characteristics in Colombia. These regional classifications are important for stratifying the sample of the study.

Regional Studies of Colombia

The Colombian population had grown from approximately 17 and a half million in 1964 to about 23 million in 1973, and 26,900,000 in 1981 (DANE, 1968; DANE, 1981; and Banguero, 1981). Although the rural population has declined over this period, it still is estimated to be around 37 percent (see DANE, 1981; and Banguero, 1981). Numerous efforts have been made in the last ten to fifteen years to develop regional population groupings for Colombia based on traditional political/administrative classifications. The political/administrative division in Colombia consists of essentially two types of units: the departments and the national territories.

The total eastern zone of Colombia, which is very sparsely populated and lacks an infrastructure, is classified as "national territory." The western zone, mountainous and diversified, consists of the twenty-three political/administrative units called departments. Politically, a 'department' is much less autonomous than the U.S. 'state;' also the number of departments has varied significantly in the last thirty years in response to political pressures and socioeconomic events.

It is commonly accepted that this division is not sufficient for analyzing the diverse characteristics of the nation; therefore, other efforts have been necessary to more adequately classify distinct national zones. These attempts to classify regions are in large part not homogeneous in their methodologies because their purposes have varied. But it is possible, nevertheless, to synthesize the most important results of these studies, and to attempt to identify the most appropriate sample for the present study.

In 1969, Fornaguera and Guhl made an effort to classify 50 percent of the Colombian land and 98 percent of the population based on the assumption that demographic growth patterns could be used to analyze regional development. Direct relationships were found between areas of population growth and the regional focal points of development. An urban center, according to Fornaguera and Guhl, is the nucleus for a human and economic conglomerate. They formulated six regional groupings, each of which is based on a population center: Barranquilla, Medellin, the Caldense Region, Cali, Bogota, and Bucaramanga.

In 1976, the DNP developed the first nodal model using goods and services as the basis for its classification scheme. Two dimensions were

identified: direction and magnitude. These generated three levels of analysis: the nodal centers, the influence areas of the centers, and the regions (DNP, 1976), where regions were based on areas of influence. Eight zones were obtained:

- the Northwest Regions (Choco, Antioquia, and Cordoba);
- the East (Santander, North Santander, and Boyaca);
- Old Caldas (Quindio, Risaralda, and Caldas);
- the Southwest (Valle, Cauca, and Narino);
- the Western Central Region (Tolima, Huila);
- Old Bolivar (Sucre and Bolivar);
- the Northeast (Guajira, Cesar, Magdalena, and Atlantic);
- the Central Region (Cundimarca and Meta).

Fajardo (1978) criticizes the previous concepts as well as those of OPSA (1975, 1976). His work begins with the concept of mode of agricultural production as the basis for classification. He identifies four large regions: the Caribbean Coast, the Pacific Coast, the Andean Region, and the Orinoco and Amazon basins. Fajardo then adopts a typology based on the historical demographic process and on different modes of agricultural production, focusing in on four large regions:

- Mechanized agriculture: Valledupar, Aguchica, Zipaquira, Ubate
- Mechanized coffee growing: Manizales
- Large-scale livestock raising: Chiriguana, El Banco, Sincelejo, Ibague, Ubate
- Traditional agriculture: Tuguerres, Popoyan, Valle de Tenza, Sota, Malaga, Sumapaz

Three common zones are identified: the Atlantic Zone characterized by commercial agriculture and large scale livestock raising; the Old Caldas coffee-growing region; and the Cundimarca and Boyaca zone characterized by traditional agriculture. Anticquia, the Santanderes, the National Territories, and the southeast region are excluded from this analysis.

The Regions Considered in this Study

This study uses Fajardo's three large regions for selecting samples because the zones he defined have common characteristics internally and are quite different from one another in terms of the most important regional characteristics (see OPSA, 1975; and Fajardo, 1978). The three zones

selected were: the North Coast, the coffee-growing region, and the Cundi-Boyacense region (see map 1-1). These three distinct regions represent large scale farming, coffee growing, and traditional agriculture, and each has its own socioeconomic, cultural, and social characteristics.

Zone 1, the North Coast, includes the departments of Cordoba, Sucre, Bolivar, Magdalena, and Cesar. According to the 1973 Census, the population of the zone was 4,606,000, with a population density well below the national average of 36.98 per department (see IDER, 1978). The coastal region is agricultural in character, particularly as refers to large landholdings, intensive cattle farming, and modern agricultural production. However, significant socioeconomic differences exist throughout the region and it has a relatively low standard of living. These characteristics differentiate this region from the rest of the country, and for that reason it was selected for the study.

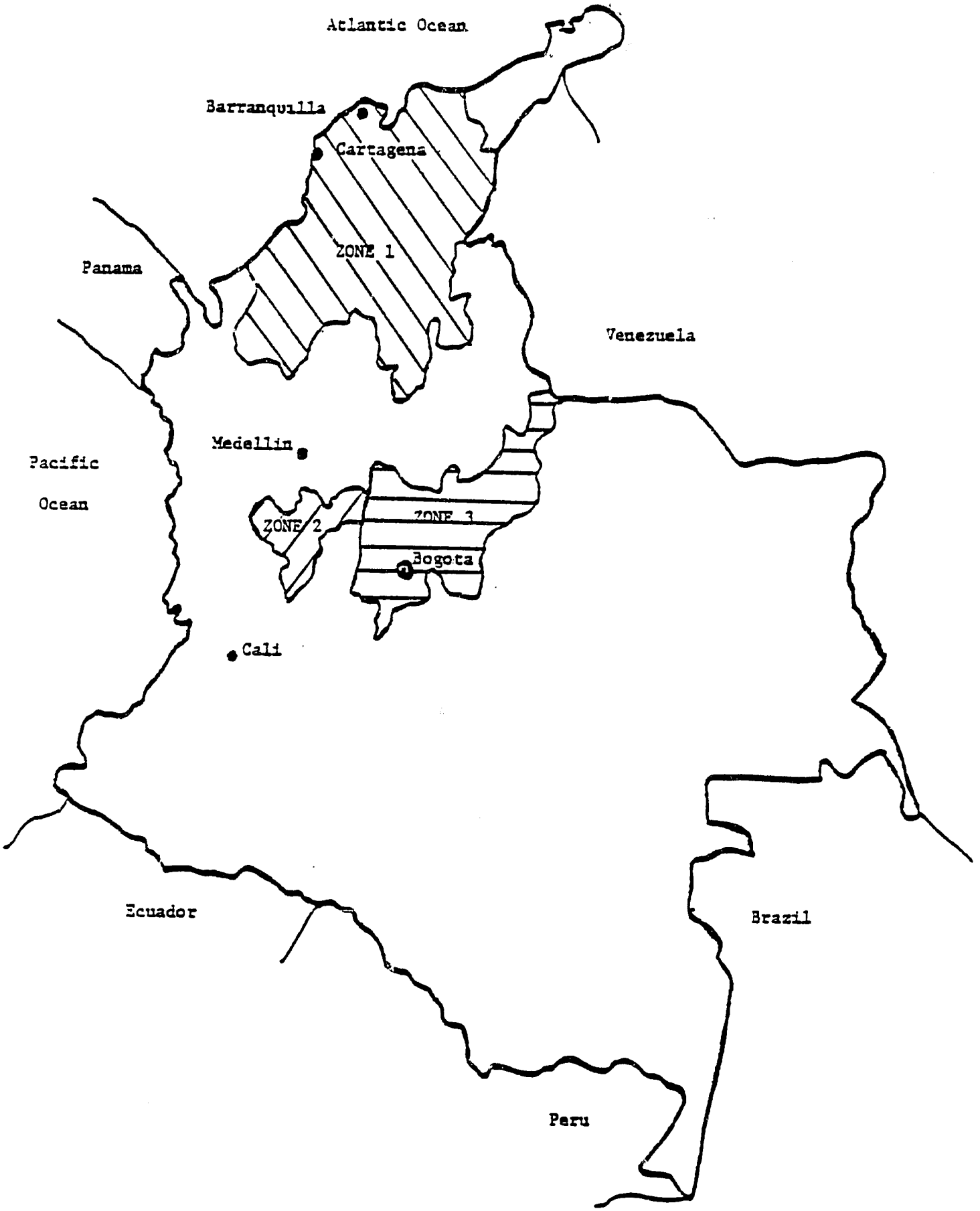
Zone 2 is the coffee-growing region. It has a population of 1,098,000 (1973 Census), and a population density slightly higher than the national average. Coffee is Colombia's main export and, therefore, its main source of foreign exchange. This makes the coffee-growing region of old Caldas (the departments of Caldas, Quindio, and Risalda) unique. The National Federation of Coffee Growers (Federacion Nacional de Cafeteros) is the principal developer of regional investments in education, health, and other development areas. The region has the highest standard of living in the country.

Zone 3 is located in the geographic center of Colombia. It is a mountainous region with a population of 2,131,875 in 1973, and is characterized by a relatively traditional "minifundio" or small scale agricultural economy. This area has a standard of living comparable to the national average and a relatively high level of social equity.

Sample Selection

Method for Stratifying the Municipalities

The information for this study was collected at the municipal rather than the community or village level. The sample includes municipalities which are predominantly rural, meaning those that have a higher percentage of rural than urban population. This was done in order to most accurately



Map 1-1. Political-Administrative Regions of Colombia Studied.

approximate the desired population. The number of rural municipalities nationally is 706.

The following variables were included: proportion of urban dwellings connected to water lines, urban dwellings connected to sewer lines, urban dwellings connected to electrical lines; monthly per capita income, and literacy. While the first three variables refer to urban zones of the municipalities, they can be used as a substitute for coverage by public services at the municipal level. The last two variables refer to levels in the total municipality.

Factor analysis was used to test whether the regions differ using these variables and to discriminate between the municipalities in each region by socioeconomic level. This generated a normalized index made up of the variables mentioned above which produced a relative value for the socioeconomic level of each municipality and thus classified or formed an hierarchy of the municipalities.

Initially it appeared that income was not a unique indicator of socioeconomic development. When tested using factor analysis, it was found that all the variables together do act as a general indicator, although income is particularly weak.

The normalized scale identified the municipalities with the highest and lowest socioeconomic levels. Based on the scale, socioeconomic conditions proved best in the coffee-growing zone, followed by the Cundi-Boyacense zone, and then the North Coast zone. However, high, medium and low socioeconomic levels also exist within each zone. In the North Coast zone it was impossible to select municipalities with socioeconomic levels comparable to the national average, but within the zone we could internally differentiate between better and worse municipalities. Similarly, in the coffee-growing zone, it was impossible to select municipalities with a low socioeconomic level, although within each zone we could differentiate between municipalities with higher or lower socioeconomic levels.

The sample was thus constructed based on both the rating scale just described and year of introduction of electrical service into the municipality. In total, twenty-six municipalities were selected in the three regions.

Sample Selection: Communities

Twenty communities were selected in each region. In terms of size, the communities selected are quite diverse, ranging from 15 to 5,000 dwellings. The average number of dwellings is 525.5 with a standard deviation of 909. Table 1-1 summarizes the distribution of the communities selected, showing the socioeconomic level and when they were electrified. One can see that there is an acceptable distribution, although it was difficult to avoid a concentration of communities with more than 15 years of electrical service. The average length of electrical service is 16.6 years with a standard deviation of 11.3 years.

Table 1-1. Distribution of the Communities According to Socioeconomic Level and Year of Electrification.

Socioeconomic level	Year of electrification				
	Without electricity	1975-1980	1966-1974	1965 and before	Total
Level 1[a]	3	3	4	5	15
Level 2	4	-	2	9	15
Level 3	5	2	3	5	15
Level 4	4	3	4	4	15
Total	15	8	13	23	60

[a]This is the highest level.

Some concentration exists in the long-term electrified category, but the wide distribution by year of electrification and by socioeconomic level satisfies the needs of this study. The wide variation in the sample allows us to capture relationships and characteristics typical of the different certain cells.

Sample Selection: Households

The second unit of analysis, the household, is used to study the effect of rural electrification on the standard of living in general and on the use of time, the physical quality of the house, employment and income structure, uses of energy, and other social and economic variables. Analysis at the household level rather than the village level is more attractive from an analytical viewpoint, because such a sample provides

more information on the relationship between rural electrification and the quality of life. As this approach has not been used in Colombia, the results provide useful information for policy makers regarding the benefits of rural electrification. In total, 631 households in three regions were investigated:

North Coast	231 households	(36.6%)
Cundi-Boyacense	199 households	(31.5%)
Coffee growing	201 households	(31.9%)

In each of the localities selected, a variable number (close to 12) of households were randomly chosen to fill preestablished quotas covering occupational characteristics of households, including farmers (owners), agricultural workers, service-related employees, businessmen (store owners), and government employees thereby covering a range of families with different lifestyles and theoretically different energy-related needs in each locality, whether electrified or nonelectrified.

The occupational characteristics of the head of household interviewed is summarized as follows:

Farm owners	159 cases	(25.9%)
Agricultural workers	156 cases	(24.8%)
Service-related employees	122 cases	(19.4%)
Government employees	29 cases	(4.6%)
Businessmen	57 cases	(9.1%)
Domestic workers	67 cases	(10.6%)
Professionals	8 cases	(1.3%)
Others	26 cases	(4.1%)

There was no occupation listed for two cases.

These quotas assure inclusion of families with particular characteristics which might otherwise not be included. A probabilistic random sample will not get, for example, a number of businessmen large enough to compare with service-related employees because statistically they are so few that in a random sample they will be limited to their proportion in the universe.

Design of the Data Collection Instruments

Two questionnaires were designed, one for households and one for communities. The questionnaires reflect the basic interest of the investigation on the impact of rural electrification on economic, demographic, and education-related variables. Each questionnaire contained approximately 100 questions.

The questionnaire for households consisted of 12 sections:

1. Identification of the locality
2. Data on the respondent
3. Data on the dwelling
4. Data on the head of household
5. Data on the household
6. Electrified dwellings
7. Nonelectrified dwellings
8. Customs and behavior
9. Energy use and interfuel substitution
10. Income
11. Businesses, shop or factory
12. Agricultural development (including livestock)

The questionnaire for communities consisted of two integrated parts:

A. Characteristics of the locality
B. Opinions of the leaders

The community questionnaire was given to leaders of the locality. The first part consists of seven sections:

1. Identification of the locality
2. Services, infrastructure, communication
3. Migration
4. Community services
5. Special activities
6. Participation
7. Production - employment

The second part consists of four sections:

1. Identification of the leaders
2. General opinions of the leaders
3. Opinions of the leaders of electrified communities
4. Opinions of the leaders of nonelectrified communities

Prior to the pilot survey itself, several panels of community leaders were formed to review in more depth certain aspects relevant to the theme of the investigation. In the same way, a number of in-depth interviews were made that helped give a more concrete form to the instruments used in the pilot surveys and therefore to the instruments finally used. The trial surveys took place in the North Coast and in the Cundi-Boyacense regions.

Chapter 2 presents a descriptive analysis of the data collected in the survey, developing a profile of the areas studied within the context of the availability of electrification and population density. The relationships between these two variables and the number of households per dwelling, household size, certain household socioeconomic characteristics, the use of public services, health, migration, communications, and participation in community life are established. Chapter 3 then addresses the issue of the impact of electrification on business, economic, and agricultural development. Chapter 4 presents an analysis of the principal characteristics of energy use and policies for replacing traditional energy sources with electricity in the home. The extent to which electrification has modified household habits and use of leisure time is discussed in chapter 5, followed by an analysis of regional energy consumption, costs, and the extent and quality of rural electrical service. Chapter 7 presents the results of the opinion survey of community leaders on expectations for rural electrification. In the last chapter, the authors draw some conclusions concerning the role of electrification in Colombian social and economic development.

Chapter 2

ECONOMIC AND SOCIAL CHARACTERISTICS OF HOUSEHOLDS IN ELECTRIFIED AND NONELECTRIFIED AREAS

This chapter presents a descriptive analysis of several variables which the authors have identified to define the general socioeconomic environment in the electrified as well as nonelectrified areas considered in this sample. The objective of this chapter is to develop a profile of the areas under study by describing their characteristics while controlling for two variables. The variables controlled for are, first, availability of electricity--the focus of the study--and, second, the crucial element of population density, classified as nucleated and dispersed.

The three zones surveyed in this study conform to the basic demographic patterns typical of Colombia. In Colombia, the basic demographic and political unit is the "municipio," somewhat similar to the American county, which has one main administrative center and one or more minor settlements called veredas, corregimientos, and inspecciones de policia. The term "nuclear" principally refers to the principal municipal centers, but also includes minor settlements with a concentration of dwellings or high population density. The term "dispersed" refers to villages that are outside the main administrative center and with a very low population density. This distinction bears no relationship to the rural-urban scheme of classification; rather, as indicated, the sample is based entirely upon rural municipalities (municipios).

One of the structural characteristics of a society is the way people accomodate their life styles to a given environment. Depending on the social and productive relationships, groupings vary according to specific types of population clusters or scattering of people. Rural electrification projects in Latin America either adapt to the existing demographic patterns or induce new patterns. Those patterns have cost implications which have to be considered in the administration of rural electrification

projects. In general, connection will be less costly in a nuclear than in a dispersed community, other elements being constant. The high costs of electrification require that certain density levels (measured as a function of the number of users per kilometer of grid) exist before projects are initiated, as they are feasible only when potential users can pay for the services.

Once projects are initiated, population densities in a region may change. The process of demographic change may generate an increasing congestion which reaches major proportions as the level of urbanization increases.

This study examines the possible relationships between type of community--electrified or nonelectrified and nuclear or dispersed--and some general characteristics. Among these relationships we consider are demographic, economic, and social interrelationships, such as indicators of crowding, patterns of migration, access to public services, and occupations and income levels.

Occupation and Income

Probably the two most relevant variables for describing the economic characteristics of the heads of household and their families in the community are occupation and income. The occupational structure, expressed as occupational positions, establishes a relationship to production around which labor and the level and grade of qualifications of the labor force are organized. Income represents the availability of goods and services necessary for social and physical reproduction. Income should reflect the different levels of productivity and the relative position of communities in the study.

As in all traditional agrarian societies, the social relationships of production are basically determined by ownership of land used for direct production. Nevertheless, direct ownership is declining as wage-earning labor increases, a product of the modernization of agriculture that tends to separate the small producer from the means of production (land). The growth in a migratory work force for harvesting commercial products is a consequence of this process.

The trends in the figures in table 2-1 indicate that there is a scale in the economics and social profile of the heads of household. At the most developed extreme would be the electrified nucleated centers, which typically are the advanced communities in the coastal, central regions and to some extent the coffee growing region. At the opposite extreme would be the nonelectrified dispersed communities, which characterizes many of the communities in the central, traditional agricultural regions. In these areas the common form of land tenure is traditional farmers owning their own land. In between the extremes would be the electrified dispersed towns, which is typical of the coffee growing area. In these communities there is a mix of large plantations and salaried agricultural workers. Similarly, in the nonelectrified nuclear communities, which are found mostly in the central region, the typical worker is a wage earner. These community and regional distinctions should be kept in mind when examining the subsequent tables.

Survey results indicate that the communities selected for study are in the process of moving from primarily small rural land ownership toward wage-earning production. As can be seen in table 2-1, 46 percent of the heads of household are land owners, 27 percent are hired workers, and 10 percent are otherwise employed. Before turning to other substantive results, we should explain that the percentages in the cells in this and subsequent tables represent the percentage of persons with a particular characteristic <u>for that individual cell</u>. Thus, for table 2-1, the 46 percent landowners refers to the percent of landowners of total heads of household in the total sample. For the figures under owners, the 51 percent represents the percent of landowners for <u>only</u> the electrified nucleated community sample. Likewise in the nonelectrified dispersed community, which is typical of traditional agricultural regions, as expected the percent of landowners is quite high at 69 percent. The proportion of owners is very similar in electrifed and nonelectrified communities, but there are fairly significant differences between the different types of regions. In the tables which follow, the percent figures for the individual cells is for the percent for only that cell. Thus, comparisons can be easily made between the different types of communities.

Table 2-1. Proportion of Heads of Household in Different Occupational Categories by Availability of Electricity and Type of Population (percent)

	Electrified	Nonelectrified	Total
		Owners (46%)	
Nucleated	51	29	43
Dispersed	38	69	51
		Employed (10%)	
Nucleated	17	6	13
Dispersed	9	2	6
		Agricultural workers (27%)	
Nucleated	18	45	27
Dispersed	32	22	28

Source: Present study.

The highest percentage of landowners is found in nonelectrified communities and within this category there are more owners in nonelectrified dispersed communities, a fact consistent with the occupational structure of those localities and with the local, "minifundio" system of landholding. In nucleated electrified areas, official and private institutions produce a demand for office workers, resulting in the higher rate of employees in these localities (17 percent).

In electrified dispersed communities, the ratio of owners to workers is about one and in nonelectrified nucleated areas salaried employment begins to predominate as a result of the large concentrations of a migratory labor force settled in small centers on the Atlantic Coast.

In conclusion, the results of the information collected seem to be that in the rural environments studied, occupations are a function of the different forms and relationships to production, which in turn depend on different types of population. The availability of electricity and the associated socioeconomic and quality of life benefits of electricity are determined by both the demographics and the productivity of the inhabitants.

With respect to family income, the figures indicate in general that the higher average levels are in the electrified nucleated communities (see table 2-2). In the populated centers, average family income is 40 percent higher than for sparsely populated areas and is 60 percent higher in electrified than in nonelectrified areas. If we use average family income as an approximate indicator of quality of life, then electrified nucleated centers, where urban-type activities predominate, and electrified dispersed areas, where owners and wage-earners coexist would be relatively better off since the average family income is higher than the average income for all communities studied (8,556 pesos). On the other hand, nonelectrified areas with lower than average family income would be at a disadvantage, particularly those where work is primarily carried out on the workers' own parcels of land--work characterized by low skills and one person doing all the production tasks. From the figures provided above, this situation seems to indicate that the mobility of the agricultural work force is highly correlated with difference in income.

Table 2-2. Average Family Income by Type of Population and Availability of Electricity (pesos)

	Electrified	Nonelectrified	Total
Nucleated	9,992	6,421	8,660
Dispersed	10,300	5,143	5,368
Total	10,096	5,985	8,556

Source: Present study.

Given the characteristics of the sample, it should be noted that differences in average income are significant as an indicator of income distribution trends in the areas studied and that absolute income is not relevant. In addition, average family income is based only on monetary income and the monetary equivalents of self-consumed output are not imputed, which might if included result in higher yields for the nonelectrified dispersed populations who have low average monetary incomes precisely because production for their own use is not quantified as income.

Education Level of the Population

One of the principal goals of the national social plan is to give the entire country at least a minimum education; therefore free primary school education has been made mandatory. We have analyzed what could be called the state of education of the population in the zones studied. For this purpose we use the following indicators: first, school terms completed by grade level of the head of household, and second, the participation of the head of household in vocational programs.

The different education levels of the population were determined by establishing the proportion of heads of household in this study who have not attended school (see table 2-3). The figures indicate that in this respect one in every three heads could be considered illiterate. Comparing these results with the national literacy rate, we find that illiteracy in the sample group is exactly the same as the national average (28 percent).

Table 2-3. Proportion of Heads of Household by Education Level, Type of Population, and Availability of Electricity (percent)

	Electrified	Nonelectrified
	No education	
Nucleated	21	51
Dispersed	19	31
	Primary education	
Nucleated		
Complete	22	10
Incomplete	38	39
Dispersed		
Complete	14	12
Incomplete	59	54
	Secondary or above education	
Nucleated	19	1
Dispersed	9	3

Source: Present study.

Illiteracy varies with the availability of electricity; only one in five persons in electrified areas has not attended primary school. In non-electrified nucleated communities, one out of two heads never attended school, and in dispersed communities one out of three had not. In small nonelectrified centers on the Atlantic Coast the educational level was lower, while the sparsely populated areas with electricity in the coffee-growing areas have literacy rates comparable to the nucleated centers.

With respect to primary education, the results are similar. A greater proportion of the heads in electrified nucleated communities have completed fifth grade than in electrified dispersed populations. These differences are accentuated when the instructional levels within the primary grades are analyzed. A much higher number of inhabitants (22 percent) in the electrified nucleated centers have completed the first five terms of primary school, than for the dispersed areas (14 percent) and nonelectrified areas (11 percent).

At the other extreme are the persons who have gone beyond primary school. Electrified nucleated centers have the highest number of persons with a secondary education (nearly 20 percent). In the other communities, the number of persons with some secondary or vocational education is less. Basic to the different levels of instruction are the availability of lighting, the type of agricultural production, and lastly its location in the general distribution of services and the national level.

Another approach to characterizing education in the communities studied is the incidence of non-formal education or skill abilities. The figures in table 2-4 show the same basic trends as with formal education. Although the proportion of persons who have taken vocational courses is, in

Table 2-4. Proportion of Persons with Vocational Courses by Type of Community and Availability of Electricity (percent)

	Electrified	Nonelectrified
Nucleated	14	2
Dispersed	10	10

Source: Present study.

general, small, the figure for nonelectrified nucleated populations is particularly low. For the rest of the communities, the proportions are very similar and therefore significant differences do not exist by type of community or availability of electrical service.

Levels of Information

We have analyzed the levels of information and participation of the community using indicators such as the frequency of newspaper reading and involvement in social groups and/or political institutions. We believe that a lack of information and/or participation is a barrier to development and therefore have explored the relationship between these two characteristics and the structure of the community.

This will allow us to visualize the impact of electric power on particularly important conditions. The following analysis assumes that greater levels of information and community participation might well produce improvements in the real quality of life by allowing people to organize, better identify their needs, and consequently to more effectively demand satisfaction of those needs.

Levels of Information

Access to information and communication services is analyzed at two levels: first, by exploring the degree to which households read newspapers, and, secondly, by examining the availability of telephone services in households. In two out of five homes, household heads read or bought newspapers. This proportion is considerably larger in electrified communities, but smaller (only one out of four homes) in nonelectrified areas. In nucleated areas, the proportion of heads who do read or buy papers is larger than in dispersed areas. These facts show that relationships between newspaper readership, and the availability of electricity seems to be quite strong: the proportion of newspaper readers is highest in electrified communities (52 percent) and lowest in nonelectrified dispersed areas (23 percent), as can be seen in table 2-5.

For newspaper reading, the survey response shows that 34 percent of readers in electrified nucleated centers read the papers once a week

Table 2-5. Proportion of Households In Which Members Buy or Read Periodicals

	Electrified	Nonelectrified	Total
Nucleated	56	20	43
Dispersed	45	28	38
Total	52	23	41

Source: Present study.

(Sundays), and that 13 percent read them once a month. In electrified dispersed communities, these figures are inverted: 20 percent read papers monthly and 16 percent on Sundays.

We should caution that the indices on buying and reading papers seem high if one considers the distance many readers are from newspaper distribution points, the literacy rates, and incomes. Nevertheless, returning to our previous point, it is concluded that electrified towns with nuclear populations would be in a better position in terms of the index of newspaper reading and therefore will have higher levels of quality of life among the communities studied.

The relationship between the electrical service level in the community and accessibility of telephone communications is also noteworthy. There is a positive correlation between electrification and availability of telephone communication in the community ($r = .34$), indicating that both the levels and perhaps the structures of information improve with the existence of electric power. The availability of transportation--another factor intimately related to the levels of information and participation--is also higher in electrified communities. Given these relationships, electrification may offer improved communications for rural communities.

Mobility of the Population

General Mobility Characteristics

An analysis of the migration process (immigration and outmigration) that occurs in each of the areas studied helps us to visualize the mobility patterns of the population and the ways in which electricity could either accentuate or diminish the process.

The figures in table 2-6 show that for all the communities studied, disregarding the type of population, nearly half of the heads of household have lived their entire lives in their current place of residence. This proportion holds for both nucleated and dispersed communities.

On the other hand, in nonelectrified areas, the poportion of heads of household who have lived in the same place their entire lives is greater than in electrified areas. This phenomenon is accentuated in the dispersed nonelectrified communities where 63 percent of the heads of household have lived their entire lives at their current place of residence. In table 2-6, it can be seen that the highest rate of immigration is found in dispersed electrified areas, where 28 percent of the heads of household have lived eight years or less in the area and nearly half (43 percent) are native to the area.

Table 2-6. Percent of Heads of Household Who Have Lived in Current Place of Residence for Entire Lives, by Type of Community and Availability of Power
(percent)

	Electrified	Nonelectrified	Total
Nucleated	52	49	51
Dispersed	43	63	52
Total	49	55	51

Source: Present study.

In nonelectrified nucleated areas a greater proportion of heads of household have immigrated than in electrified nucleated areas. But this difference does not seem significant given that the proportion of heads of household in nucleated areas for each of the two cases is very close to the proportion for all communities.

The greater immigration rates are in dispersed electrified areas, which probably have modern agriculture (coffee, cotton, and so on). Once electrified, these areas no doubt are highly attractive to dispersed populations which do not have electrical service. Reinforcing this pattern (see table 2-7), in communities which have nonelectrified dispersed populations, there is a high rate of outmigration; about 42 percent of the

Table 2-7. Percentage of Homes that Have Lost Population in the Last Five Years, by Type of Community and Availability of Electricity

	Electrified	Nonelectrified	Total
Nucleated	36	21	31
Dispersed	33	42	37
Total	35	30	33

Source: Present study.

homes have experienced outmigration of one or more members to other localities in the last 5 years. In very general terms, we can conclude that these areas are losing their populations, thus maintaining a negative migration balance. More people are elaving than arriving.

The figures in tables 2-7, 2-8, and 2-9 indicate that the communities studied are characterized as losing population, that is, they gain fewer migrants than they lose. In the groups studied, this phenomenon is very accentuated in the nonelectrified dispersed communities (see table 2-8).

Table 2-8. Proportion of Heads of Household with Five or Fewer Years of Residency

	Electrified	Nonelectrified
Nucleated	9.7	9.5
Dispersed	21.8	7.0

Source: Present study.

But variables such as type of population and availability of electricity do not seem to be the key to explaining the general trends of population mobility in our sample. The totals in table 2-9 are quite similar, averaging about 21. The negative migratory balances are significantly less, as was said earlier, in nonelectrified nucleated communities and in electrified dispersed areas. As will be seen, structural variables, such

Table 2-9. Migratory Patterns by Type of Community[1] and Availability of Electricity

	Electrified	Nonelectrified	Total
Nucleated	-26.3	-11.5	-21.1
Dispersed	-12.2	-35.0	-21.3
Total	-20.9	-21.6	

Source: Present study.

as the relation of production, seem to intervene in the mobility and migration of the population. Electricity seems to benefit these areas where better conditions such as economic productivity act to attract populations, but if these conditions exist in the nonelectrified nucleated areas they may well result in similar patterns of mobility.

Reasons for Population Mobility

For the communities in this study the reasons for migration seem to follow the national trends. An increase in commercial agriculture, which needs a large labor force with a concentration in the ownership of agricultural property, has resulted in a different level of migration and new population densities, including the recent settlements indicative of the "urbanization" of rural areas. In a thirty-nine-year period (1938-1977), the number of small cities (10-20,000 inhabitants) has tripled and population centers of 20-50,000 inhabitants have quadrupled (see table 2-10).

This phenomenon is supported by various social and economic analyses. From an urban reference point, many of these studies conclude that most of the migrants are attracted by the network of services, comforts of the urban environment, facilities in dwellings and social networks. Recent studies (Santamaria, 1980) have found that people tend to move primarily for economic reasons; that is, that people move within a complex network of social and economic relations and many of these relations are decaying or

[1]We measured it through a migratory balance that is equal to the proportion of heads of household with five or less years of residency minus the proportion of households that contain members who have migrated in the last five years, so the unit of comparison is the household.

Table 2-10. Population Centers by Year

Number of inhabitants	Population centers 1938	1951	1964	1973
10,000-20,000	18	25	56	61
20,000-50,000	10	18	22	43

Source: Departamento Administrativo Nacional de Estadistica (DANE), CENSO Nacional de Poblacion, 1935, 1951, 1964, and 1973.

evolving into more advanced forms (see Shanin, 1980). Almost two-thirds of immigrants have abandoned their birthplace looking for higher wages, better jobs, or the possibility of owning their land. For outmigrants, economic factors are also important to their decision to move their place of residence.

The exception to this pattern is seen in electrified nucleated villages. Here, economic reasons for migrating carry less weight than in other communities (see table 2-11) and therefore the pattern seems to vary from the general tendency. Rather, education is more important in decisions to migrate. Thus, the combination of type of settlement and availability of electricity seems to produce some motivational characteristics that distinguish this type of community from the others.

A particularly significant finding is that a large proportion of immigrants moved to electrified dispersed areas primarily for economic reasons. This confirms the existence of a group of workers and agricultural laborers whose relocation is a function of harvests and production on commercial farms. A fifth of the immigrants move for family reasons into nonelectrified dispersed regions.

The Availability of Public Services in The Study Areas

The availability and coverage of water and sewer services are good indicators of the social characteristics of the areas selected for this study. An analysis of the availability of these services as a function of the electricity variable allows us to determine the quality of life of the people in the observed population. Thus, with respect to the relative

Table 2-11. Primary Reasons for Mobility of Immigrant and Emigrant Populations (percent)

	Outmigrants (leaving)	Immigrants (arriving)
	Economic reasons (work, income)	
Electrified	45	n.a.
Nucleated	36	63
Dispersed	66	81
Nonelectrified	63	n.a.
Nucleated	67	62
Dispersed	62	60
Total	51	n.a.
	Education	
Electrified	32	n.a.
Nucleated	41	4.2
Dispersed	12	0
Nonelectrified	19	n.a.
Nucleated	26	9.5
Dispersed	15	--
Total	27	n.a.
	Family reasons	
Electrified	17	n.a.
Nucleated	17.6	32.0
Dispersed	14.6	7.9
Nonelectrified	15	n.a.
Nucleated	7.4	23.8
Dispersed	19.5	20.0
Total	16	n.a.

Source: Present study.

quality of life of the inhabitants, the high level areas would be those which have the basic public services and those with electric services available over the same time period. The supposition is that public services as a whole represent a series of social policies with which state

representatives can bring about improvements in the quality of life of the population.

In the electrified areas studied, 74 percent of the inhabitants have public water service while only 26 percent have water service in nonelectrified areas, as can be seen in table 2-12.

Table 2-12. Availability of Water Line in Electrified and Nonelectrified Areas
(percent)

	Electrified areas	Nonelectrified areas
Have a water system	74	26
Do not have a water system	26	74
Total	100	100

Source: Present study.

The majority of the population with water service are found in nucleated electrified areas. In nonelectrified nucleated areas, less than half the inhabitants have water service. In the sparsely populated areas with electrical service, the proportion of households with water service is 5 times greater than that observed in the sparsely populated nonelectrified areas. On the other hand, water service is 1.4 times greater in electrified nucleated centers than in dispersed electrified areas, and 2.17 times greater than in nonelectrified nucleated areas (see table 2-13).

Table 2-13. Water Service
(percent)

	With water service	Without water service
Electrified areas		
Nucleated	81.9	18.1
Dispersed	58.3	41.7
Nonelectrified areas		
Nucleated	37.5	62.4
Dispersed	11.1	88.9

Source: Present study.

The previous figures indicate the existence of a polarity with respect to the availability of water services. At one end of the spectrum are the nucleated electrified towns with a high index of services, and on the other are the nonelectrified sparsely populated areas with a low index of services. Taking into account the fact that the level of water service in nucleated areas is roughly double that in sparsely populated areas, 67 percent to 39 percent respectively, and that at the same time the indices are even greater in electrified areas compared with nonelectrified areas, it can be concluded that electrification brings with it changes in the availability of water service.

The same kind of process has been witnessed in the rural areas of Paraguay (see Becerra, 1981). In rural areas lacking water service, once the electricity grids are installed, water lines follow, and in areas where there already were water lines, the extension of electricity to the region generated greater water coverage.

For sanitary services, the situation is quite similar. In electrified areas, 63 percent of the inhabitants use septic tanks or sewer hookups; in nonelectrified areas the opposite occurs: 73 percent of the inhabitants do not use any services of this type (see table 2-14).

Reviewing the figures for type of sanitary service as a function of different types of population settlements, there is a similar yet more accentuated pattern than is encountered in the analysis of water services.

Table 2-14. Sanitary Services According to the Availability of Electric Power (percent)

Type of service	Electrified areas	Nonelectrified areas
None	15	73
Latrine	6	11
Basin	15	11
Septic tank	28	4
Sewer line	35	1
Total	100	100

Note: Totals may not add due to rounding.

Source: Present study.

In electrified nucleated areas, 73 percent of households have septic tanks or sewer line connections. In sparsely populated areas, this percentage drops to 46 percent. In nonelectrified areas, whether dispersed or nucleated, the proportion is only 5 percent.

It can be concluded that in nonelectrified areas, regardless of the type of population settlements, significant number of households lack adequate sanitary services. This situation indicates that the development of better sanitary services is closely associated with the availability of electricity. The extension of sanitary and electrical services also may occur more quickly for nucleated populations, because of the high costs for constructing the physical infrastructure to provide services to sparsely populated areas.

In addition, community-level information was analyzed and it was found that nucleated communities tend to be electrified ($r = 0.37$), to have a water system ($r = 0.50$), and to have access to communication systems ($r = 0.22$). We would conclude from these correlations that the pattern is that public services like water systems, roads and electrification, come together at the same time.

Health-Related Aspects

Conditions relating to the health of the population can be analyzed using different indirect factors. This investigation is limited to basic health measured in terms of the quality of water used in the homes for the preparation of food as well as for drinking, and in terms of access to preventive medicine such as vaccinations. Although water quality can be precisely measured technically, within the context of this survey it was interpreted to be the precautions that the population takes to eliminate contamination to prevent gastrointestinal illnesses or other risks of infection common to the areas studied. This estimation of minimal measures taken to protect the health of the population makes sense, since adequately treated water is scarce in these areas which generally rely on rivers, brooks, or rainwater for domestic water supplies.

As can be noted in table 2-15, in 56 percent of the homes studied water is in some way treated for daily use; in electrified communities the percentage of homes where water is treated for domestic consumption is

Table 2-15. Proportion of Homes that Treat Water and the Proportion of Homes Without Water Service (percent)

	Electrified		Nonelectrified		Total	
	Water treatment	No water supply	Water treatment	No water supply	Water treatment	No water supply
Nucleated	57	18	27	63	46	33
Dispersed	87	42	53	89	74	62
Total	67	35	33	74	56	44

Source: Present study.

double that in nonelectrified localities. A similar pattern occurs in sparsely populated areas where water is filtered or boiled for domestic consumption. It could be assumed that in localities lacking water supply systems, inhabitants would try to improve the water they use, but in fact they do not seem to treat their water. In electrified communities, where the water system is more extensive, there is a greater proportion of homes where water is treated. In nonelectrified communities where the access to a water system is low, water treatment is even lower in proportion than for areas without access to a water system. Given these characteristics, the population with electricity is more likely to live under better health conditions, at least with respect to water supply, than people without electricity if both groups lack a water supply system.

Electrified communities will also have better sanitary conditions, especially if they are nucleated. With respect to domestic water quality, condition are worse in nonelectrified communities which are nucleated. An important subsequent result is that in sparsely populated areas (primarily in the coffee-growing zone), campaigns to improve sanitary conditions, together with the availability of electricity, result in high indices of quality of life. This effect is seen clearly in the figures in table 2-15. For instance, in electrified ispersed commnities, 87 percent of households treat water while in nonelectrified areas the figure is 53 percent.

In nonelectrified nucleated communities, a third of the population uses filtered water, while another third boils water. Boiling water was also a frequently cited practice in electrified dispersed areas, primarily

due to the impact of the data from the coffee-growing zone where special programs are sponsored by the National Federation of Coffee Growers (Federacion Nacional de Cafetero).

Another important indicator of health is infant vaccination. In each of the areas studied, where there was a concentration of children under 7 years of age, data was requested on how many children had been vaccinated at least once. First, for the whole sample, the proportion of children vaccination is 0.758 (or more than three-fourths), which indicates that vaccination is widely spread. The highest proportion of children vaccinated was found in the central region (0.772) and the lowest percentage was on the coast (0.751).

The distribution in terms of the availability of electricity and the type of population settlement is illustrated in table 2-16.

Table 2-16. Proportion of Children Vaccinated By Availability of Electricity and Type of Population

	Proportion
Nucleated with electricity	.8218
Nucleated without electricity	.7465
Dispersed with electricity	.6838
Dispersed without electricity	.7170

Source: Present study.

The highest proportion is in the electrified nucleated communities and the lowest is in the dispersed electrified communities. Although the differences are not substantial--they differ by only a little more than 10 percent--it is important to note that the situation is more favorable in the electrified regions.

While for the total sample 20.4 percent of the households had no vaccinated children, the percentage rose to 21.5 percent on the coast and dropped to 18.6 percent in the coffee-growing zone. The coastal area has the highest percentage of households in which no children are vaccinated--42.5 percent; while in the coffee-growing zone and the central region the index was 28.8 percent. On the other extreme, in this zone 67.9 percent of the households with children 7 and under had all the children vaccinated,

compared with 71.3 percent in the central region and 66 percent on the coast. Given these results, we can say that the regional criteria does not significantly explain child vaccination patterns. The indices are very similar in all areas.

The relationship of availability of electricity is shown in table 2-17. Once again, the existence of electricity does not substantially change the indicators.

Table 2-17. Vaccinated Children in the Homes by Availability of Electricity (percent)

	With electricity	Without electricity
None vaccinated	18.70	22.96
Not all vaccinated	11.42	11.85
All vaccinated	69.86	65.19
	n = 219	n = 135

Source: Present study.

Another variable of interest is the type of population, which is illustrated in table 2-18. Reviewing this variable, the "none vaccinated" category is higher in dispersed households than in the other categories, which to some degree happens at the expense of the "all vaccinated" category.

In summary, infant vaccination is quite common and, in more than 75 percent of the households with children, at least some of the children have been vaccinated once. Large differences cannot be explained either in terms of the regional data or in terms of the availability of electricity.

Table 2-18. Vaccinated Children in Homes by Type of Population (percent)

	Nucleated	Dispersed
None vaccinated	18.3	24.8
Not all vaccinated	10.1	14.0
All vaccinated	71.2	62.0
	n = 229	n = 129

Source: Present study.

The more reasonable of the two criteria for explaining the difference in vaccination rates appears to be the type of population settlement.

Participation in the Political Process

Confirming a general tendency toward low levels of participation in formal institutions at the national level in both urban and rural areas, participation levels in the communities studied are very low.

Among family participants, distribution (see table 2-19) is as follows: The highest indices of participation for families (22 percent) are in Community Action Councils (Juntas de Accion Comunal) and the lowest

Table 2-19. Levels of Participation in Formal Institutions (percent)

Institutions	Type of population: Nucleated			Dispersed			
	Electrified	Nonelectrified	Average	Electrified	Nonelectrified	Average	Average
Cooperatives	14	2	10	15.0	10	13	11
Political parties	20	12	18	12.8	35	22	19
Community action	16	7	13	26.0	53	37	22
Social/sports clubs	6	2	4	3.0	3	3	4
ANUC, ACPO	1	-	3	1.5	5	3	2

Source: Present study.

are in organizations in the countryside aimed at stimulating agricultural production (ANUC, ACPO). The higher participation in community action councils is due to government efforts to stimulate the contribution of the population in the construction of the public service and transportation infrastructures. The low participation in ACPO and ANUC perhaps may be due to the fact that the communities studied were not representative of government activities with respect to land participation (INCORA) or of private promotional programs advanced by Popular Cultural Action (Accion Cultural Popular, ACPO). A second level of participation is found in political parties (19 percent) and a smaller proportion in production cooperatives (11 percent) common in the coffee-growing zone.

As can be appreciated in table 2-19, participation levels are unequal; first, participation in the community councils is a typically rural phenomenon and reaches its highest level in nonelectrified communities. With this exception, the major index of participation is in community councils in electrified dispersed areas. Secondly, participation in political parties is significant, particularly in nonelectrified dispersed areas. Approximately one-fifth of the households in nucleated communities participate to some degree in political parties and political activity is predominant in electrified nucleated areas. Lastly, and typically in both dispersed and nucleated electrified areas, significant levels of participation in cooperative associations are found.

These data call attention to the fact that the largest participation in the community councils occurs in nonelectrified dispersed areas where we presume that the population is organized to demand essential services. Thus participation in politics is a form of pressure to obtain basic services. In Colombia, political parties, or rather their local leaders, act as channels for making demands on the local and national government.

Household-Demographic Characteristics

Communities with high density (nucleated) and low density (dispersed) were selected to form the sample for this study. In the electrified nucleated communities, 88 percent of the dwelling units contained only one household, while in the nonelectrified nucleated areas, dwelling units with one household reached almost 100 percent. In the sparsely populated areas with electrical service, 91 percent of the dwelling units contained only one household. In nonelectrified dispersed areas, the percent almost reached 100, as can be seen in table 2-20. These figures show that the number of households per dwelling unit is significantly greater in those areas where electricity is available regardless of the density levels of the village. In this section, we examine household size, size of dwelling, indicators of quality of life, and dwelling ownership patterns.

Table 2-20. Households by Type of Population and Availability of Electrical Energy (percent)

	One household	More than 1 household	Total percent	X* average
Electrified nucleated	88.0	12.0	100	1.173
Nonelectrified nucleated	99.3	0.7	100	1.007
Electrified dispersed	91.0	9.0	100	1.124
Nonelectrified dispersed	99.0	1.0	100	1.011

Source: Present study.

*According to the 1973 Population Census--the last taken in Colombia--the average number of households per dwelling place was 1.2 for urban and 1.01 for rural.

Household Size

The average number of persons per household in nucleated areas in the sample is very similar to the average size of households in sparsely populated areas: 5.68 and 5.53 respectively. Statistically, these differences are not significant according to the "t" test for the difference between means. The average number of persons per household in the sample was 5.63, very close to the national average reported in the 1973 population census of 5.7 persons per household.

Under these conditions, it seems that the availability of electricity relates positively to the size of the household, which is larger in electrified areas as can be seen in table 2-21.

These figures reveal that household size is related primarily to the availability of electricity. First, there are the electrified nucleated villages, second the electrified dispersed, and third the nonelectrified. Whether villages are nucleated or dispersed, the average household size tends to be very similar. In general, it can be said that the average size of households in electrified villages is close to the average in the population census for rural areas: about 5.7 persons per household.

Table 2-21. Average Household Size
(persons per household)

	X
Nucleated population	5.68
Electrified	5.86
Nonelectrified	5.37
Dispersed population	5.53
Electrified	5.62
Nonelectrified	5.40
Electrified populations	5.70
Nonelectrified population	5.30

Source: Present study.

Given the increasing outmigration from the Colombian countryside, the reduction of interregional migration and the increase in small towns (see table 2-22), which were characteristic of the 1960s, one might hypothesize that there is an intrarural movement consisting of the relocation of non-electrified dispersed or nucleated area populations to zones which have become attractive because of the availability of electricity. But this phenomenon may also result from the fact that electrification projects tend to be installed in rural areas with greater population density.

Table 2-22. Proportion of the Population in Centers of Up to 30,000 Inhabitants (1951, 1964 and 1973 Censuses)
(percent)

	1951	1964	1973
Population	39	52	59

Source: Departmento Administrativo Nacional de Estadistica (DANE), CENSO Nacional de Poblacion, 1951, 1964, and 1973.

Characteristics of Dwelling Units

The evaluation of the impact of rural electrification on living areas requires an analysis of the area where electricity has its greatest social utility, in the dwelling place. To this end, we have analyzed the

indicators and the physical characteristics of the dwelling place as well as the type of households occupying the dwellings. The analysis of these indicators should allow us to understand the way in which electric power interacts with the dwelling to produce the social atmosphere and conditions that constitute the quality of life.

Size and Use of Space in the Dwelling

The presence or absence of phenomena associated with population density are good indicators of the level of well-being in the population. For the communities under study, the average number of rooms in a dwelling unit is 3.17; in electrified areas, the average is higher, and in nonelectrified areas it is lower (see table 2-23). In nucleated communities that have household electrical service, this average is 3.7 rooms per dwelling, and in the sparsely populated areas the average size is 3.2. In nonelectrified communities, the average is very similar for nucleated and sparsely populated areas at 2.7 and 2.6 respectively.

Table 2-23. Average Size of Dwelling Units According to Type of Population and Availability of Electricity (rooms per dwelling)

	Rooms per dwelling	Bedrooms per dwelling
Electrified		
Nucleated	3.67	2.38
Dispersed	3.18	2.38
Nonelectrified		
Nucleated	2.68	1.62
Dispersed	2.55	1.64

Source: Present study.

At the same time, in electrified communities, the average number of bedrooms per dwelling is higher than that found in nonelectrified communities. In these two types of communities the number or average of bedrooms does not differ significantly for nucleated or dispersed populations, thus residency and use of dwelling units correlates positively with electricity (see the second column in table 2-24).

Table 2-24. Average Number of Persons per Room By Type of Population and Availability of Electricity

	Persons per room	Persons per bedroom
Electrified		
Nucleated	1.59	2.46
Dispersed	1.76	2.36
Nonelectrified		
Nucleated	2.00	3.13
Dispersed	2.11	3.30
Total number of communities	1.77	2.68

Source: Present study.

The low average number of rooms in nonelectrified areas means that there are to 2.00 persons per room in nucleated communities and 2.11 in dispersed communities. One can assume that many persons must share bedrooms when there are greater numbers of persons per bedroom--3.1 per room in nucleated communities and 3.3 in dispersed communities.

In electrified communities, the average numbers of persons per room and per bedroom are lower than the averages for the total Colombian population. Compared with the national average and international standards, these averages (for electrified communities) indicate less crowding and fewer people sharing bedrooms. However, in nonelectrified communities there is relatively more overcrowding.

Generally, in electrified nucleated communities, dwelling units tend to have more space. Homes average 2.5 rooms for common (recreational and social) uses. In nonelectrified communities, the space is more reduced; an average of 1.5 rooms are reserved both for sleeping and for recreation and social activities. The differences in size, use, and type of occupation in the communities studied are covered in table 2-5. The data indicate that congestion in living space is much greater in nonelectrified dwelling units. It would seem that electrification tends to imply that bedrooms would be added to the dwelling unit.

Indicators of Quality of the Dwelling Unit

In an analysis of the existing social characteristics of the areas studied, another important element is the physical quality of the dwelling unit. This study investigates the type of materials used in constructing the floors of the building.

Traditionally in a census or survey, information is collected on materials and quality of the roof, walls, floor, windows, and such, but usually all these individual variables are unnecessary for the study of the quality of the dwelling. Recent studies of "marginal barrios" in small cities in Colombia (see Velez and coauthors, 1981) and studies on life in rural areas and PAN centers (see Duran and coauthors, 1981) have identified through comparative and regression analyses that floor materials alone are sufficient for explaining the different quality levels of dwellings.

In the electrified communities only 5 percent of the dwelling units have earth floors, while the figure is 50 percent for nonelectrified areas. If we realize that the flooring forms part of a qualitative scale of health, hygiene, well-being, and comfort, it is clear that earthen floors would fall at the lowest end of the scale and cement and tile floors at the highest end, with wooden floors in the middle, having a different significance in rural and in larger urban areas. Given these extremes, the quality level of the dwelling units in the nonelectrified communities would be the lowest possible for nearly half of the inhabitants. The figures show that the population of electrified areas have significantly higher levels of quality in housing.

Examining the types of population settlements, we find that the higher level quality of floors (cement and/or tile floors) are found in 63 percent of the nucleated electrified communities, and in only 30 percent of the dispersed electrified populations where wooden floors are predominant see table 2-25). In the dispersed areas, tile and cement floors are probably too expensive to construct given the scarcity of these materials and the cost of transporting them. The majority of dwellings in these areas would principally have earth floors being replaced by wood floors, taking advantage of the local availability of materials.

Almost half of the dwellings located in nonelectrified nucleated communities have cement and/or tile floors, a much higher proportion than is found in nonelectrified dispersed communities (only 27 percent). Thus

dwellings in electrified zones are of higher quality than in nonelectrified zones independent of the type of population, indicating a similar situation found with the so called pattern of services reported previously.

Table 2-25. Flooring Materials in Dwellings in Electrified and Nonelectrified Areas by Type of Population (percent)

Type of towns	Earth	Wood	Cement/tile
Electrified			
Nucleated	7	30	63
Dispersed	3	67	30
Nonelectrified			
Nucleated	50	2	48
Dispersed	45	27	27

Source: Present study.

One might predict that electricity would encourage the replacement of wood for earthen floors and that this process would be typical of sparsely populated communities. In the nucleated communities, electricity would favor the replacement of earthen by wooden floors and to a lesser degree by the construction of cement and tile floors.

The Ownership of Dwellings

We will now analyze the characteristics of the communities studied as a function of existing ownership and tenancy of the dwelling (see table 2-14). In typical rural communities, the existing ownership patterns are essentially based on ownership by self-construction. It is expected that, as a result of rural electrification, changes would occur in the tenancy structure: ownership of dwellings would move toward rental of property. The figures in table 2-26 indicate ownership is the predominant form of dwelling tenancy; but at the same time, a certain trend can be observed with regard to rental properties. Significant levels of rentals are important in electrified communities in sparsely populated areas. These relationships occur in predominantly agricultural production zones, principally in coffee-growing areas where rental units are often exploited. The rental of dwellings would be a derived phenomenon. This explains the low proportion of owners in these types of communities.

Table 2-26. Types of Ownership in Electrified and Nonelectrified Areas by Type of Population (percent)

	Owned	Rented
Electrified	60	31
Nucleated	76	24
Dispersed	56	44
Nonelectrified	86	14
Nucleated	84	16
Dispersed	89	11
Combined average		
Nucleated	79	21
Dispersed	70	30

Source: Present study.

In nucleated electrified communities, a quarter of the households are in rented dwellings. This is explained by the continuous changes in the movement of the population: new groups move in as tenants of electrified dwellings and produce a substantially greater income for the owners. Therefore the availability of electricity changes the base rental rate, enhancing the value of the property.

Summary

This chapter presents a descriptive analysis of the behavior at the household level of a vector of dependent variables which we consider important in explaining the relative well-being of the population studied. Implicit functions were established for these variables in terms of the availability of electric power and, secondly, in terms of the specific type of population settlement. The information revealed that the criterion variables were relevant in establishing differences in the variables observed. As a summary, we present the major findings in the following paragraphs.

1. Income. Part of the households derive their incomes from some form of property. Among them, a majority are found in the nuclear electrified areas. Family incomes are also higher in electrified than in nonelectrified areas and in nuclear as compared to dispersed population settlements, although the differentials are not highly significant for the latter.

2. Education Levels. Differences among the types of areas follow the same basic trends as for income, but are much stronger.

3. Access to Sources of Information and Communication. Electrified and nuclear areas were found to have greater access to sources of information and communication.

4. Migration. In general, areas surveyed show negative migration balances, and no difference was found by community characteristics.

5. Access to Public Services. Electrified areas were found to have greater access to public services and communication than nonelectrified areas, as do nucleated areas over dispersed populated areas.

6. Health-Related Aspects. A more favorable trend exists in the electrified nuclear communities as compared to all others. Also, independent of the electricity availability, nucleated areas are somewhat better off than those sparsely populated.

7. Participation in Political, Social and Community Action Groups. Participation is somewhat more significant in electrified and nuclear settlements as compared with nonelectrified and dispersed areas.

8. Demographic Variables. Average family size was found to be larger in nonelectrified than in electrified population settlements and that within electrified areas the number of dwellings with only one household is somewhat larger. Electrified and nucleated communities tend to be more crowded, possibly as a result of the larger size observed in those communities.

9. Quality of Dwellings. In general, electrified and nucleated communities tend to be built out of higher quality ocnstruction materials.

The information presented above was analyzed using a standard linear regression technique, whose basic indicators are presented in table 2-27. The dependent variables in the first column were considered in terms of the

electricity and the type of population settlement variables in a very simple linear model of the form:

$$Y_i = A_o + A_1X_1 + A_2X_2$$

Where:

Y_i = the selected dependent variable under consideration
X_1 = type of population settlement (2 = nuclear; 1 = dispersed)
X_2 = community electrification variable (2 = electrified; 1 = nonelectrified).

Through these models, we can detect the real importance of electricity, independent of density. Electrification, in fact, proved significant in the explanation of ten (out of thirteen) variables while type of population settlement was significant in only four of the thirteen cases. These results show that electricity is an important factor, as compared to type of settlement, in the conformation of the various structural indicators studied above.

A second aspect which is of interest is the sign for each coefficient in each regression considered. While for the type of settlement variable only the land property shows a negative relationship, for the electrification variable the family size and the persons per bedroom variables are also negative. This confirms the statements developed above concerning the way in which electrification and population settlement relate to general socioeconomic and demographic indicators.

We also used income in the same regression model but it was not significantly predicted, although positive sign regression coefficients were found, indicating the electrification induces income generation or vice versa.

Village electrification proved less significant than household electrification in alternative models specifying three independent variables. This leads one to think that household, not village, electrification is the more relevant explanatory variable in the context of this study.

Table 2-27. Standardized and Non-standardized Regression Coefficients R^2 and F for Selected Variables on Electrification and Type of Settlement

	Type of settlement		Electrification			
Dependent variables	b1[a]	B1[b]	b2[c]	B2[d]	F	R^2
Persons per bedroom	.349 (.486)[e]	.063	-1.157 (0.49)	-0.28*	5.073*	.072
Households in dwelling	.13 (0.054)	.21*	.10 (.055)	.16*	6.96*	.096
Family size	.513 (.54)	.085	-.363 (.0557)	-0.059	.51	.007
Water service	.376 (0.06)	.37*	.49 (0.06)	.48*	61.64*	.485
Number of rooms	.85 (.23)	.29*	.86 (.24)	.28*	18.15*	.21
Number of bedrooms	0.99 (0.17)	.047	.83 (0.18)	.387*	12.79*	.16
Flooring material	.04 (.146)	.02	1.04 (0.149)	.53*	27.66*	.29
Vaccinated children	.045 (.072)	.05	.112 (.0743)	.13*	1.7	.026
Land properties	-0.5030 (.261)	-.17	.641 (.266)	.21*	3.69	.05
Newspaper reading	.103 (.212)	.04	.717 (0.217)	.28*	6.66*	.09
Heads: Level of schooling	2.34 (1.21)	.16*	3.13 (1.24)	.21*	7.06*	.09
Sewerage	.185 (0.030)	.21*	.330 (0.099)	.38*	80.8*	.207
Sanitary service	.599	.17*	2.106	.63*	253.601*	.45

Source: Present study.

*Significant at .05 level.

[a]b1 = Non-standardized regression coefficient for type of settlement variable.

[b]B1 = Standardied regression coefficient for type of settlement variable.

[c]b2 = Non-standardized regressiona coefficient for electrification variable.

[d]B2 = Standardized regressional coefficient for electrification variable.

[e]Equals standard errors in parenthesis.

Chapter 3

ELECTRICAL POWER IN BUSINESS AND AGRICULTURAL PRODUCTION

Introduction

In order to establish what relationships might exist between electrification and economic development and opportunities to increase the general well-being, we explored the types of businesses, shops, and modes of production in the family units studied to characterize them and eventually to speculate on the impact of electricity on those businesses and shops.

First, we outline the characteristics of the businesses, shops, and so on, and then we present the structure of agricultural production.

Shops, Industry, Businesses

A relatively high percentage (21.6 percent) of the households sampled owned some type of business or shop. The majority of these (48.4 percent) are stores selling the usual goods; cigarettes, sodas, beer, bread, cooking oil, food in general, kerosine, and the like. The next significant percentage is specialty shops that we have separately categorized because they tend to sell only one product such as baked goods, soda or ice, work clothes, and so forth. Another 3.8 percent are artisan industries, which represent a much lower percentage than the other types of shops mentioned. Repair shops represent 2.8 percent. Finally, several different types of businesses have been grouped (15.2 percent) which do not represent a very well-defined category. These include small family-owned coal mines and very small scale family-owned food markets, among others.

Businesses averaged 6.6 years in operation, with a mode of only one year. One-fourth of the businesses have existed for at least one year and 52.2 percent have existed for three years. Nevertheless, nearly 20 percent

of the businesses have been in operation for more than 10 years, indicating that there is a great variation in survival rates and little stability.

Energy Use

The most common source of power used by businesses is electricity (75.2 percent). Another 5.8 percent use other fuels, and 16.8 percent use no fuel.

Based on just this information, it might be concluded that electricity is vitally important to creating businesses, shops, and other commercial establishments. But before making this conclusion, we feel it is necessary to examine general additional factors. We first examine the relationship between time of electrification and the existence of a business; second, we assess the benefits of electrification; third, we analyze the limitations of a business that does not have electricity; and, fourth, we study possibilities for improving a business that does not have electricity.

In table 3-1 we see that the longer a community has been electrified the more likely it is that one can find businesses in the community. The information produces an X^2 equal to 27.4 which is significant at a level of 0.0001 and with a contingency coefficient of 0.208. These statistical results indicate that, in general, there is a relationship between years of electrification and the existence of businesses, supporting our previous

Table 3-1. Households with Businesses by Year of Community Electrification

Year of community electrification	Number of households in the community	
	Without business	With business
Not electrified	168	22
Recent (between 2 and 5 years)	75	15
Intermediate (between 6 and 10 years)	61	27
Old (more than 10 years)	161	72

Source: Present study.

conclusion concerning the role of electricity in business development. Nevertheless, the relationship could be spurious because of the socio-economic development pattern of the region, so we need to further confirm this conclusion.

To understand the role of electricity in developing businesses, the second level of information examined is the benefit obtained from actually using electricity in business. To explore this point, we consider those businesses which were electrified after they were established, that is, those which have had the opportunitiy to evaluate whether the availability of electricity has had some benefits. Table 3-2 presents information related to four indicators of the benefits of electricity in commercial development.

Table 3-2. Percentage of Businesses that Have Perceived Some or No Improvement Since Introduction of Electricity, Using Four Evaluative Indicators of Benefits of Electric Power

Indicator	Benefit	
	No improvement	Some improvement
Increase in sales	55	45
Use of new equipment	63	37
Sale or production of new products	81	19
General improvement of business	54	46

Source: Present study.

In general, nearly 45 percent of the businesses improved their sales and used new equipment because they had electricity. A smaller percentage, one of every five businesses, found they could sell or make new products. The table can be summarized using the fourth indicator which presents the perception of the general improvement of business due to electrical service and we conclude that having electricity in business is positive since 46 percent of the businesses experienced an improvement with electricity.

The third aspect related to the usefulness of electricity in developing businesses in rural areas involved the workforce and problems which would occur if electricity were eliminated. Table 3-3 presents results concerning the processes that would have to be eliminated if the business did not have electricity.

The large majority report that their business would have problems if they did not have electricity. A substantial percentage, 23 percent, would have to eliminate refrigeration. (Recall that a large number of the businesses are stores selling foodstuffs, sodas, or ice that require

Table 3-3. Problems that Would Occur if There Was No Rural Electrification (percent)

Problems	Percent
None	33
Refrigeration would be eliminated	23
Work shifts would be reduced	29
The basic process would be eliminated	3
Other	11

Source: Present study.

refrigeration.) Almost a third of the persons indicated that they would have to eliminate work time. A much smaller percentage would have to eliminate their basic production process; specifically, tailoring shops would have to eliminate the use of electric sewing machines. Another 11 percent saw other effects of eliminating electricity.

The fourth and last aspect which we considered relevant to an analysis of the complementarity of business development and electricity is the expectations of business proprietors concerning improvements they could make if they had electricity. Table 3-4 presents the information on these potential improvements in their order of importance. As noted in the first column, the greatest benefit expected is lighting. The other is refrigeration required to conserve food or drinks, but this is a smaller proportion, since only 9.7 percent chose refrigeration as their first choice of benefits resulting from electrification. But this category was selected by 47.6 percent of those interviewed as the second benefit resulting from electrification. Other selections were use of motors, machinery, and so on. Lastly, many owners could not identify a specific benefit but did feel that they would benefit from electrification. This represented a significant percentage, 19.4 percent and 28.6 percent, in the category "other unspecified benefits."

Complementing this idea of expectations of benefits, we tried to specify two particular benefits; first, if the owners thought that having electricity would improve their economic picture and second, if they could make or sell things that they otherwise could not. The results were that, first, 71.4 percent of the owners without electricity felt that they would improve economically if they electrified, and second, 67.9 percent felt

Table 3-4. Aspects of Business that Could Be Improved If Electrified (percentages appear in the order of importance)

	Order of importance	
	1	2
Lighting	54.8	0.0
Refrigeration	9.7	47.6
Motors	6.5	9.5
Ovens/stoves	6.5	0.0
Heaters	0.0	0.0
Fans	0.0	14.3
Machines	3.2	0.0
Other unspecified benefits	19.4	28.6

Source: Present study.

that they could manufacture or sell things they now could not without electricity. The large majority thought they could sell things which require refrigeration. We would caution that these findings are based on the twenty businesses that did not have electricity, which is a rather small sample.

Summarizing, we see that there does exist a relationship between electric power and business development, not only by introducing more businesses where they have had electricity, but because there is a certain consensus among owners who have had an opportunity to use electricity in their businesses. Also, those who have not had this opportunity agree that benefits do accrue to business from electrification. That is, the economic benefits include the creation of businesses, and changes which occur in existing businesses. Further, those businesses without electricity expect that electricity would improve their economic opportunity.

Agricultural Development

The effects of electrification on the agricultural sector are examined from two perspectives: the actual and the expected use of electric power.

Data on actual use were obtained from those agricultural units linked to the households studied which reported using electric power. Type and degree of power usage was requested and is described in this subsection. For nonelectrified households, data on expected uses of electric power in

agricultural units were requested and reference is made to the types of eventual use proposed.

Almost half, or 46.5 percent, of the households studied have access to land for agriculture. The size of these properties is relatively small, a mode of 0.60 hectares, a median of 1.47 hectares, and a mean of 4.74 hectares. This large average size is due to a few farms which are quite large. The standard deviation is 10.07 hectares.

Land tenancy patterns indicate that most families are owners. As will be seen in the next chapter, more than 80 percent of the farm families own the land they cultivate or work. There is a small percentage (7.1 percent) of families that have access to land through co-ownership[1] and the rest farm rented land or, in a few cases, loaned land.

The majority of farmers use traditional varieties of seeds (87.3 percent) and do not have access to credit (63.7 percent). Nevertheless, a significant proportion have access to modern farm processes, not only because some use improved seeds, but because 78.8 percent have received technical assistance in the past year (the past two harvests). This frequency is higher than the national average primarily because of the efforts of the National Federation of Coffee Growers in the coffee-growing zone.

Energy Use

The large majority of total farms (89.8 percent) use electric power in their production systems. When specifying type of use, the low level of electricity use is corroborated in each stage associated with production. Electricity use in pumps (irrigation), motors, mills, driers, and lighting were surveyed. The number of producers using electricity in each of these activities appears in table 3-5. The figures are so low that only 1 percent of the farms use electric power for irrigation and mills, while almost 2 percent use it for drying and lighting. The most common use is motors, but only 8 percent of farmers use electric motors. Among all the electricity users in the agricultural sector, two-thirds said they have had to suspend

---

[1]Method through which a land owner forms an association with another person. The former capitalizes the project and the latter partner works the land and they share the earnings.

Table 3-5. Number of Producers[a] Who Use Electricity for Specific Uses

Uses	Number	Percent
Pumps	3	1
Motors	24	8
Mills	3	1
Driers	5	2
Illumination[b]	6	2

Source: Present study.

[a]The majority of these producers are in the coffee-growing zone.

[b]Illumination is different from house lighting. This refers to lighting for security, drying rooms, and such.

some activity if electrical service is interrupted, revealing a high dependence on electricity. This should be viewed cautiously, however, since on the one hand there are very few producers who use electricity, and on the other hand, the work they would suspend is almost exclusively related to coffee cultivation.

The second aspect considered important in identifying the impact of electricity on agricultural development activities is the expectations of non-users concerning the potential benefits of electrification. Table 3-6 presents the information obtained. First, the majority (64.9 percent) do not believe they could mechanize using electricity. The major benefit mentioned is processing and finishing of agricultural products, particularly coffee. Other activities mentioned by the producers include irrigation, and, on a smaller scale, adaptation of machinery, mills, and others. In summary, a significant group felt benefits would accrue through electrification.

By contrast, when we presented specific possibilities to farmers, 23.5 percent felt they could improve harvesting, 35 percent felt they would be able to use improved techniques and machinery, 17.1 percent thought they would be able to introduce new crops, and 32 percent felt that they could introduce a product treatment stage; but the most likely benefit to be introduced was thought to be lighting, as almost 70 percent of the owners would light their houses. Table 3-6 presents the anticipated benefits to be obtained if farmers had access to electric power.

When specifying the five areas of anticipated benefits due to electricity use, we see that improvements in production may result from introducing new technologies but, above all, electricity provides greater reliability. There seems to be a common belief among producers that lighting and electricity are the same concept. This may result from the fact that agricultural units are closely linked to households, and respondents tend to view them as a single unit. Domestic benefits would thus be placed in a more preferential place on the scale.

Table 3-6. Improvements that Could Be Made with Electric Power (percent)

Improvements	Percent
Better harvests	23.5
New techniques	35.1
New products	17.1
New processes	31.8
Lighting	69.2

Source: Present study.

Summary: Electric Power in Agricultural Production and Businesses

There is no relationship between electric energy and the existence of agricultural plots, and thus it would not be prudent to expect, at least in the short run, that the amount of land linked with households that is under cultivation would increase as a result of electrifying these households.

In discriminating land ownership, three variables were significant: family income, length of residency of the head of household in the community, and his education level. As mentioned, electrification had no relationship to land ownership.

The relationship between electrification and productivity was also not significant, showing that in rural Colombia, electrification does not have the expected impact of increasing productivity. The correlation, though positive, is not statistically different from zero. There are several explanations. In general, we are talking about very small plots where levels of production are very low and where size in itself in a constraint.

Second, in general, we are talking about peasants with very low if any investment capacity, and few persons in our sample were able to install pumps, motors, or mill driers which can be important in increasing productivity.

On the other hand, the existence of business could be partially explained by electrification. A discriminant analysis not reported here showed that electrification was the most important variable in explaining access to a business, family income and the education level of the head of household were also relevant. We have observed how many of the businesses depended on refrigeration for their activities, and how some depended on electricity to use some machines. One possible causal relationship could be that electricity does induce development or increase businesses in rural areas in Colombia. It is very difficult to argue that income has a direct causal relationship. We believe that income does encourage the creation of businesses and these in turn help improve income. In summary, education and income have an independent effect, although less significant than electric power, on defining whether families will have businesses or not, if dependency can be directly established.

Chapter 4

USES OF ENERGY IN THE HOME

Introduction

In this chapter the principal characteristics of energy use and policies for replacing traditional energy sources with electricity in the home are analyzed.

Uses observed include appliances and equipment used in the home. Substitution is studied at two levels: first, changes produced by having electric power; and, second, possible changes in homes that are not electrified, focusing on the current energy sources used when the survey was conducted and anticipating the effect of eventual electrification.

Energy Uses in the Home

To analyze energy use and substitution patterns in the context of domestic appliances, this chapter was designed to focus on the problem within the format of the questionnaire used in the survey. The study centered on the following appliances: iron, radio, television, refrigerator, blender, sewing machine, fan, lights, electric generator, motorized pump, and stove. Table 4-1 shows the percentages of homes that in fact use these items.

The most commonly used appliance, which is used in almost all homes, is lighting. The appliance next in importance is the stove.[2] These items are the two principal indicators of the basic needs met in the home. Next in order of importance are the radio (a well-established custom in rural

---

[2]Homes that do not have a stove generally cook on small outside fireplaces using wood. These fireplaces are movable and are not assigned any specific location.

Table 4-1. Appliance Use in the Home (percent)

Appliances/Equipment	Percent
Lamps (lighting)	94.8
Stove	90.6
Radio	78.8
Iron	73.1
Television	39.0
Blender	32.2
Sewing machine	26.1
Refrigerator (ice box)	19.0
Fan	7.1
Motorized pump	1.7
Generator	0.8

Source: Present study.

Colombia for many years) and the iron, also documented in comparable areas in Paraguay (see Becerra, 1981). More than one-third of homes own a television and one in three has a blender. These two items are significant because of their relatively high predominance and because of their functions. Since they are not considered necessities, they therefore may act as indicators of quality of life. The sewing machine can also be considered in this group, having a significantly high rating--more than one in every four homes.

The next two items, refrigerator and fan, have to be considered with some caution since some communities visited are located in mountainous areas where it is sufficiently cool and these items are not needed; therefore we believe that there is a correlation between geographic location and use of these items which affects the data and limits their usefulness as indicators of quality of life.

Lastly, and with a very low frequency, are motorized pumps and electric generators, 1.7 percent and 0.8 percent respectively.

It is useful to examine the type of energy used by each item to understand the role electricity plays in determining whether homes have these items. Table 4-2 presents the energy type used by each of these appliances/equipment. According to the table, electric energy is highly correlated with households that possess goods considered here as relevant in measuring quality of life. We see that blenders and fans depend

Table 4-2. Type of Power Used[a]
(percent)

Appliances	Gas	Diesel	Kerosine	Gasoline	Batteries	Candles	Charcoal	Coal	Manual	Central grid electricity
Lighting			20	2		14				65
Stove	8		12	7			41	17		16
Radio					65					35
Iron							23	7		70
Television					2					98
Blender										100
Sewing machine									81	19
Freezer	3									97
Fan										100
Motorized pump[b]		8		46				8		39
Generator[b]		50		25						25

Source: Present study.

[a]These figures are rounded to whole numbers.

[b]Only a small number of households have sewing machines, motorized pumps, and generators in dwellings.

exclusively on electricity as televisions and refrigerators do almost completely. Electric energy is of course used for lighting and irons in homes, and is also utilized extensively for radios, motorized pumps, and generators.[3] Only for stoves and sewing machines does it lack much importance. Electricity is also unique in that it appears in all 11 types of uses considered while gasoline, the second most frequent energy source, is only used in four of these cases.

Last is the question of ownership prior to electrification, which leads us to conclude that the use of televisions, blenders, fans, and air conditioners is exclusively dependent on electricity. This is consistent with the previous table. Therefore, electrification undoubtedly improves the quality of life by allowing families to have access to items that represent improved well-being. This is confirmed when information on the cost and advantages of electricity are analyzed.

The analysis of table 4-3 indicates that despite the fact that electricity is not inexpensive, it has more advantages than the energy sources which it replaces. With the exception of use for radios, the majority surveyed thought that electrification was more expensive than the energy source it replaced, but 80-96 percent of homes thought that electric power was more advantageous than the source previously used.

Table 4-3. Cost and Relative Advantage of Access to Electric Power for Some Household Uses (percent)

	Lower cost	More advantageous
Lighting	40	91
Stove	18	83
Radio	50.7	80
Iron	28.8	96
Sewing machine	11	80

Source: Present study.

[3]Note that only a small percentage of homes have motorized pumps and generators.

Among the most common uses of electricity is cooking. However, there is a certain inflexibility among persons who continue to use wood, coal, and kerosine. A better explanation might be that electric power is relatively more expensive and that there is an additional cost of buying the electric stove. Also, in rural areas wood and coal continue to be relatively inexpensive. The sewing machine is another item where the impact of electricity has not been dramatic. Nevertheless, we see that about one in five sewing machines uses electric power.

Energy used in family-operated businesses is examined to complete this section on patterns of energy use in the home. About 21.6 percent of families indicated that they had a business and nearly 46.5 percent had land under cultivation, indicating (and this is reflected in the household sample) that the number of homes with businesses and/or land under cultivation allows us to describe energy use in rural businesses and farms.

Almost 90 percent of those in cultivation and agricultural activities reported that they use electric power for selected agricultural work. Nevertheless, it is practically impossible to tell if the specific uses reported represent actual productive utilization. Only 8 percent of those interviewed reported using electric energy in motors; nearly 2 percent used electricity in driers--in the coffee-growing zone--and a little more than 1 percent used it in pumps and mills. Therefore, according to these results, electricity is used primarily in lighting.

Energy Substitution

As we indicated in the introduction to this chapter, we have analyzed energy substitution at two levels. First, we assume that use of appliances that were present before access to electricity and that are now still used signifies that electricity is replacing some other source of energy. Second, those homes that have appliances and operate them using alternative energy sources, could use electric power, thereby implying substitution potential.

In table 4-4 we see that, depending on the type of use, there are various energy sources replaced by electric power in these regions. The first column of table 4-4 represents the percent of homes that now have an electrified appliance and who had an equivalent nonelectrified appliance

before electrification. For lighting, primarily candles and kerosine are replaced. For the stove and oven coal, primarily kerosine and charcoal are replaced. For the radio, batteries are replaced; for the iron, coal and some biomass are replaced. Lastly, electrification of the sewing machine replaces human energy. Electric power therefore principally replaces coal, candles, batteries, biomass, and kerosine. For substitution potential, the pattern would be practically the same as that described above. Among the fuels that can be replaced are coal, kerosine, gas, and biomass, but primarily coal and kerosine.

Table 4-4. Uses Maintained from Before Electrification and Replaced Fuels (percent)

Percent of homes currently with appliance that had it before electrification		Fuel replaced: Fuel 1		Fuel 2		Fuel 3	
Lighting	80	Candles	78	Kerosine	21	Others	1
Stove	95	Charcoal	48	Kerosine	35	Coal	8
Radio	67	Batteries	100				
Iron	76	Coal	86	Charcoal	8	Others	5
Sewing machine	29	Human energy	100				

Source: Present study.

Electric Energy and Introduction of Domestic Goods

The impact of electric power on the level of home life is measured in large part by the effect that electrification has on the introduction of domestic goods into the home. The most pertinent results of a statistical survey are presented here within this framework; the level of introduction of various appliances was studied in relation to the existence of electric power in the dwelling, controlling for several variables considered relevant.

An additive scale was constructed as a function of the presence of appliances studied in this chapter and a linear model was tested to see how

energy, independent of the other relevant variables, influences the acquisition of those appliances, which in turn act as an indicator of the level of well-being in the home.

The results obtained are presented in table 4-5. The availability of electric power is in fact the most relevant factor for explaining the accessibility and use of these appliances and subsequently for a high quality of life. Education is next in importance. Third and having a relatively small effect compared with electric power and education is family income. The other variables in the model--age and time of residency of the head of household--do not seem to have any independent effect on quality of life. Lastly, the model explains a high degree of variance in the scale.

Table 4-5. Non-standardized and Standardized Coefficients, R^2 and F

Explanatory variable	Uses	
	Non-standardized coefficients	Standardized coefficients
Existence of electric power	2.005	.505*
Total income	.000028	.136*
Age of head of household	.0079	.055
Education of head of household	.061	.248*
Time at residence of head of household	.089	.057
Constant	8.72	
R^2	.456	
F (5,524)	88.11*	

Source: Present study.

*Significant at 0.01 percent.

Also note that the same variables were used to examine access to services or individual basic appliances like stoves or lighting.[4] As can be expected, the model produced very low levels of significance, and explained only 4 percent of the variance. The existence of electric power had hardly any effect at all. Almost everyone has both a stove and lighting.

To formulate a conclusion regarding the impact of rural electricity on each of the appliances studied, we present below some more firm results based on a discriminant analysis, in order to answer the question of the principal determinants for adopting domestic appliances. Table 4-6 contains the F statistics for the same five independent variables used in the regression models for each type of use.

The most significant result in a majority of cases is the variable measuring the availability of electricity. Thus, the existence of each one of the appliances in the home is closely tied to the existence of electricity. A second important factor is the educational background of the head of household, which like electricity is a significant discriminating factor for each appliance, and in particular for radios. Contrary to expectations, total family income is not a significant discriminating factor. It only discriminates relatively well for access to radio and sewing machines. In the same way, neither length of residence of the head of household nor number of persons in the dwelling were significant discriminating factors.

To summarize, the data analyzed definitely point out the importance of electric power in the introduction of appliances in rural homes in rural Colombia. It is more relevant than family income, which in the literature is considered to be the most important factor. Without disregarding the fact that many of the appliances considered (such as televisions and fans) require electric power, the importance of electric power should be emphasized. We also wish to mention that not all the effects of electricity are independent of education and income. In a path analysis, it can be corroborated that part of the effect of electricity comes principally through education but also income. Figure 4-1 summarizes the tabular analysis where the direct and indirect effects of education, income

---

[4]The scale included any form of stoves and lighting. Its values are 0, 1, and 2.

Table 4-6. Discriminant Analysis of Appliances Versus Electricity and Other Variables
(F value and level of significance are reported)

Article[a]	Independent variable				
	Time of residency of the head of the community	Education level of the head of the household	Number of persons in the dwelling	Existence of electricity	Income
Iron (1,625)[a]	1.250 (.2639)	39.3 (0.00)	2.003 (.1574)	142.5 (0.00)	6.567 (.0106)
Radio	.0082 (.92)	45.9 (0.00)	.83 (.36)	43.5 (0.00)	8.86 (0.003)
Sewing machine	.93 (.3329)	26.8 (0.00)	4.72 (.03)	37.22 (0.00)	11.25 (.001)
Television	.34 (.558)	76.06 (0.00)	9.173 (.0026)	331.1 (0.00)	.9757 (.3236)
Air conditioner	.3421 (.5589)	50.35 (0.00)	.21 (.64)	84.39 (0.00)	3.014 (.0831)
Stove	.0049 (.94)	4.83 (.028)	.0017 (.96)	3.58 (.05)	.09 (.763)
Lighting	8.58 (.0035)	.89 (.3451)	1.387 (0.239)	25.84 (0.00)	.643 (.423)
Fan	.3483 (.55)	20.16 (0.00)	14.83 (.0002)	20.58 (0.00)	2.78 (.09)

Source: Present study.

[a]The numbers in parentheses are the respective degrees of freedom of the numerator and denominator.

and electric power on the quality of life are appraised in terms of the use of domestic appliances.

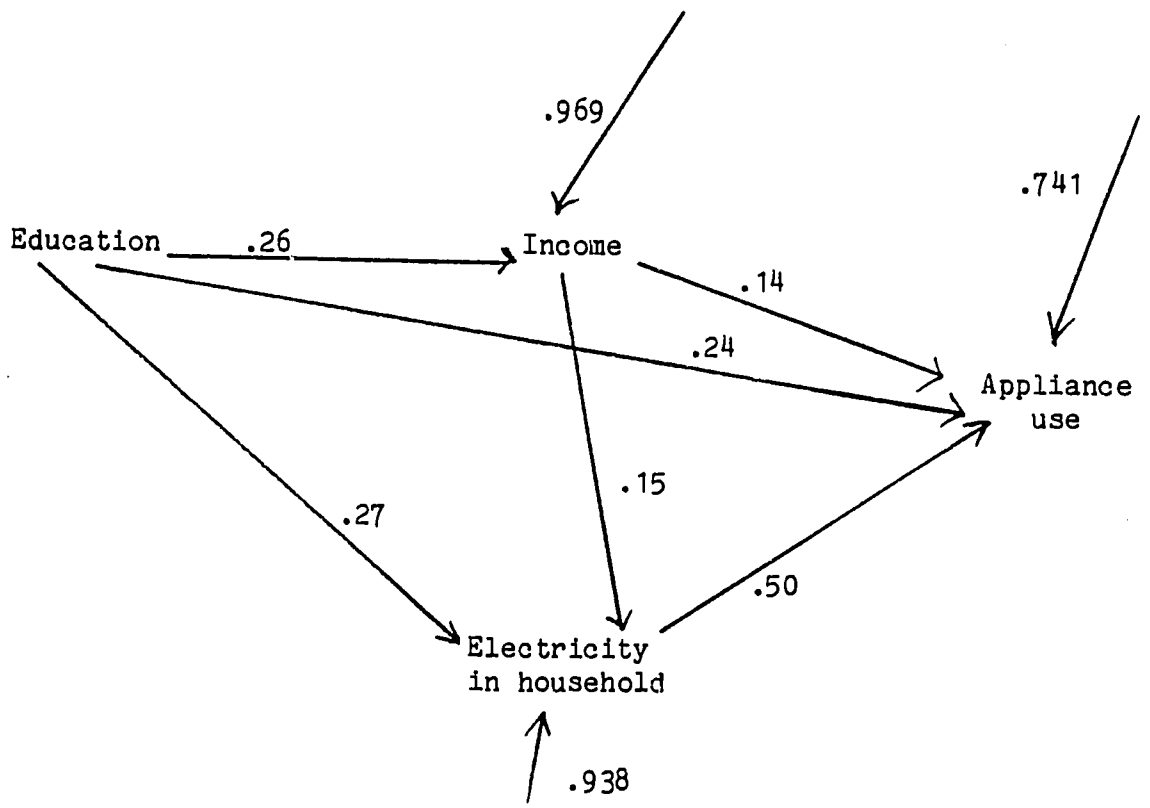


Figure 4-1. Path Analysis Explaining Use of Domestic Appliances

Source: Present study.

Chapter 5

THE USE OF TIME

Introduction

Electricity may have an impact from the perspective of both extending availability of light and providing long term patterns of electrical use in the home. Greater availability translates into a lengthening of the daily routine that was limited without electrical service. The possibility of using additional hours of light for a combination of recreational, organized and productive activities might constitute one of the most important benefits of electrification projects. This part of the study focuses on how electrification has modified customary habits and after-work activities in the evening hours. With this in mind, we have compared data collected from both electrified and nonelectrified homes on selected style of life variables.

Changes of Sleeping Habits

We have assumed that there is natural light for approximately 14 hours per day in the dry season, and for the purposes of this study it is used as the maximum time available for activities. The survey results indicate that heads of household and their wives are busy an average of approximately 15 hours per day, while children between 7 and 12 years of age are busy an average of 14 hours per day. Change in the time at which people go to bed as a result of electrification is greater for children than for adults; while 53 percent of children in electrified areas stay up longer than 14 hours, this is true for only 35 percent of children in nonelectrified areas. Although the average day for heads of household habitually is much longer than 14 hours, this is more true in electrified areas than in nonelectrified.

While 74 percent of the heads of household in electrified homes indicate that they go to bed after an average day of more than 14 hours,

Previous Page Blank

the proportion drops to 63 percent in nonelectrified areas. If we compare these two proportions for adults with the proportions for children, it is clear that children have prolonged their daily schedule more as a result of electrification. For housewives, it appears that the impact of electrification is not as appreciable, as the data do not indicate changes in the number of hours devoted to daily activities. In both electrified and nonelectrified areas, 70 percent of the women indicated that their daily routine lasted about 14 hours. In nonelectrified areas, seven out of ten women keep long daily schedules, which is closely associated with domestic work and frequently with work outside the home typical of the localities studied. In this case, the benefits of electricity result more from the use of electrical household appliances that facilitate and alleviate domestic work. The figures supporting this analysis appear in table 5-1.

Table 5-1. Hours of Activity per Day by Heads of Household, Housewives, and Children 7-12 Years Old in Electrified and Nonelectrified Homes (percent)

	Heads of household		Women		Children (7-12)	
	Electrified	Nonelectrified	Electrified	Nonelectrified	Electrified	Nonelectrified
Up to 14 hours	26	37	30	30	37	65
More than 14 hrs	74	63	70	70	53	35
Total	100	100	100	100	100	100

Source: Present study.

Without distinguishing between the occupants of households, the data (see table 5-2) indicate that after electrification residents go to bed earlier than before in only 3 percent of the homes, 39.6 percent go to bed at the same time as before, and 57.4 percent indicate that with electricity they go to bed later than was customary.

Table 5-2. Changes in Bed-time Hours in Electrified Homes, Heads of Household

	Percent
Go to bed earlier	3.0
Go to bed at the same hour	39.6
Go to bed later	57.4
Total	100.0

Source: Present study.

Thus, the day lengthens significantly for heads of household, wives and children (7 to 12 years old) with the acquisition of electricity. Table 5-3 presents the relevant information. The largest difference is observed among children and the smallest among housewives.

Table 5-3. Hours in an Average Day for Household Members

	Electrified	Nonelectrified	Difference
Head of household	15.22	14.85	22 minutes
Housewife	15.34	15.01	20 minutes
Children (7-12)	14.66	14.21	27 minutes

Source: Present study.

Use of Maximum Time Available

The activity that has been most affected in electrified homes has been the use of television; of those answering, 43 percent of heads of household, 44 percent of housewives, and 54 percent of children spend some time watching television programs. Before electrification, neither husbands nor wives spent much time watching television, although a small percentage of children indicated that they watched battery-operated televisions before electrification at small community centers.

Studying has increased considerably among children, with 72 percent spending some time since electrification reading or studying. Before electrification, only 43 percent of minors spent part of the evening studying. Adults (heads of household and housewives), on the other hand, have reduced their reading habits since electrification. Although before

electrification the overall proportion of homes spending some time reading was small (35 percent), it is now much lower (18 percent). Television sets have replaced reading.

The impact of television is also evident in the decline in the percentage of homes that spend part of the evening visiting family and friends. At present, 3 out of 10 homes report making such visits in the evening, while before electrification 7 out of 10 used the evening for social visits in the neighborhood. This phenomenon is more accentuated among heads of household than among housewives, as can be seen in table 5-4.

Electrification has had an appreciable impact on the domestic work routine. Currently, only 23 percent of children spend part of the evening doing household chores while before electrification the percentage was 46. In other words, electrification has changed housewives' working habits. What they used to do in the evening now is done during the day, and most probably at night they watch television.

Table 5-4. Comparisons of Current and Recalled Activities for Persons in Homes That Have Been Electrified Within the Last Five Years (percent)

	(1) Percent of persons who do activities now as a % of homes electrified in last five years			Persons who did activities before electrification: (2) as a % of persons in homes electrified in last 5 years			Persons who did activities before electrification: (3) as a % of persons who do activity now*		
Activity	Head	Wife	Children	Head	Wife	Children	Head	Wife	Children
Reading	18	16	72	6	8	30	35	47	43
Watching TV	43	44	54	0	1	5	0	0	10
Making visits	29	35	0	19	24	n.a.	68	70	0
Working	22	12	5	13	7	0	56	60	0
Listening to the radio	62	63	0	59	60	n.a.	97	95	0
More time at home	75	86	0	64	69	n.a.	85	81	0
Domestic work	0	57	23	n.a.	36	11	0	65	46

Note: The figures in column 3 are the percentage difference between the persons who did the activity before their household received electricity (column 2) compared to the number who do the activities today (column 1).

Although 6 out of 10 heads of household used to listen to the radio in the evening, this activity has decreased in electrified towns. Previously, all the heads of household used to listen to battery-powered radios; the decline in the listening audience is explained by the increase in television viewing since electrification. A similar phenomenon is observed among housewives.

In the localities studied, the inhabitants have customarily remained at home most evenings, and visiting is infrequent and limited. This is confirmed by the figures in table 5-4. The large majority of heads of household said they remained at home in the evenings. It would seem that electrification results in an even larger percentage of persons at home.

Concerning evening work, a decline occurs for men as well as for women, although among women it is more significant. Currently, only 22 percent of heads of household work evenings, as compared with 56 percent before electrification. Sixty percent of housewives spent part of the evening working, while since electrification the percentage is only 12 percent. The figures in table 5-4 indicate that a small percentage of children work evenings, but it is too small a percentage to be significant; it is mentioned to show that the trend is opposite that of adults.

In nonelectrified homes, to approximate the changes that would occur in evening activities after electrification, those interviewed were asked about their most frequent activities and the activities they anticipated they would engage in if electricity were available. The expectation level in the population is influenced by the effects of imitation and demonstration that are clear in the replies, but indicate the value that people place on the possible availability of electricity in the home. As is the case in electrified homes, the activity that would occupy the largest number of people is watching television in the evenings (71 percent of children, 68 percent of housewives, and 67 percent of heads of household). These figures are in all cases similar to current habits observed in electrified areas.

Reading habits are notoriously poor among heads of household and housewives (10 percent). Nevertheless, 62 percent of children who do not read or study in the evening say they would take up this habit with electrification, as would 24 percent of heads of household and 14 percent of housewives. Assuming that those who now read would continue to do so,

Table 5-5. Current and Future Evening Activities of Heads of Household, Housewives, and Children 7 to 12 without Electrification (percent)

	Percent of people that do activity now			Percent of people that don't do activity now but will in future		
	Head	Wife	Children	Head	Wife	Children
Reading	10	10	43	23	14	62
Watching television	6	5	6	65	67	70
Making visits	39	41	n.a.	15	16	n.a.
Working	19	21	8	28	21	7
Listening to the radio	69	69	n.a.	44	21	n.a.
More time at home	82	86	n.a.	35	45	n.a.
Domestic work	n.a.	49	35	n.a.	50	23

Source: Present study.

[a]Percentages for future activities are with respect to household which had not undertaken the particular activity. For this reason, the numbers in the columns under "future activities" do not equal the totals mentioned in the text.

it could be expected that with electrification, 31 percent of heads of household, 22 percent of housewives, and 78 percent of children would read evenings. With the exception of housewives, these figures indicate that future proportions of readers among heads of household and children would be very similar to those now observed in electrified areas.

Activities such as listening to the radio would increase to a lesser degree. An additional 14 percent of the heads of household report they would listen after electrification, as would 7 percent of housewives. Thus, if the current radio listeners continue to listen , 82 percent of heads of household and 75 percent of housewives would listen to the radio after electrification. These proportions are higher than those now observed in electrified localities.

To a much smaller extent, social activities such as visiting and spending more time at home would increase; 9 percent in the former case and 6 percent in the latter. These anticipated increases are similar for heads of household and housewives.

The proportion of heads of household who now work evenings would reportedly increase 22 percent after electrification. Sixteen percent more

housewives report they would work evenings and 5 percent more children 7-12 years old would undertake productive activities. If persons who now work continue to do so after electrification, 40 percent of heads of household, 37 percent of housewives, and 15 percent of children would work during the evening. It seems that electricity would take on a strong socioeconomic emphasis given that the proportion of heads of household who would work evenings is double those who now work evenings in electrified homes. This emphasis is even observed to a greater measure among housewives and children.

The figures show[1] domestic work would likely increase among housewives (by 24 percent) and children (by 15 percent). According to the figures, once electricity is installed, it is anticipated that evening domestic activity levels would increase to 73 percent among housewives and 49 percent among minors. If we observe in table 5-5 the proportion of homes that develop this activity in electrified dwellings, we see that interviewees in nonelectrified areas overestimate the anticipated time dedicated to domestic work. It is assumed that the large television audience generated and the proportion of time it would use after electrification might attain the levels now observed in electrified communities where the tendency is for evening domestic work by housewives and children to decrease after electrification.

Using homes as the unit of analysis, electricity has allowed approximately 75 percent of them to develop new evening activities that previously couldn't be done without electricity. Evening recreational activities and other entertainment occupy more available time in 30 percent of homes. The increase in additional nondomestic work could be considered a result of electrification (see table 5-6); this is also the case for domestic housework.

Conclusion

To the rural residential community, electrification has meant the availability of more time for basic recreational activities, with an

---

[1]The percentiles used in this analysis correspond to the proportion of heads of household, housewives, or children who now do not do any of the activities under study but would do them after electrification. For this reason, the figures are not the same as in table 5-5.

Table 5-6. Existing Evening Activities in the Home With Electricity Five or Less Years Prior to Electrification

	Percent
Recreation, entertainment	30
Nondomestic household work	10
Domestic housework	19
Others	14
None	28
Total	100

Note: Total does not equal 100 due to rounding.

Source: Present study.

emphasis on television watching. For teenagers and children, the most significant benefit of electrification is that more of them spend some evening hours studying. It has permitted housewives to do evening chores during the day, and has also alleviated some routine domestic work through the use of electric appliances. More members of the family stay at home after electrification.

In nonelectrified homes, the activities most anticipated to be available after electrification are the same as those most frequently pursued in electrified homes. Without exception, with electricity, members of households would spend part of their available time watching television, and children would study in the evening.

Nevertheless, in contrast to what actually happens in electrified households, in nonelectrified homes both heads of household and housewives anticipate doing more productive and domestic work in the evening after electrification. These positive expectations are not fulfilled in reality. The same happens with household businesses. An increase in social activity anticipated with electrification also does not seem to occur, at least in the evening.

In general, the study confirms that both electrification and expectations of its installation result in behavioral changes. On the one hand, the figures show changes in recreational, cultural, and educational activities. On the other hand, there are present changes and expectations of additional income and a decrease in domestic work.

Chapter 6

CONSUMPTION AND COST OF ELECTRIC POWER

Introduction

This chapter briefly presents the following aspects related to consumption and energy costs in selected homes: (1) the regional costs for the electricity user, (2) the regional electric power consumption in households, (3) the regional quality of electric power supply, and (4) the coverage of electric power services.

The Cost Structure of the User

Although a large majority of electrified households obtain electricity from the grid and only a small minority have their own generating systems, information on the cost structure is not homogeneous. First, the period of reference varies to a relatively significant degree between regions (and within them). Second, information on the bills sent out by the electric power companies could not always be obtained.

The analysis in this section is based on two indicators with control factors: first, the reference period, in months, and, second, information obtained from either the electric power companies provided by the interviewees themselves. Although it is not possible to compare the two based on existing data, is is very possible that the the two sources differ in terms of credibility.

Monthly costs for the user differ substantially depending on the origin of the data. When using the data from a meter in the home, costs are much higher, as is noted in table 6-1. This difference is substantial except in the coffee-growing region.

Table 6-1. Cost Structure and Regional Income Distribution in Pesos/Month

	Income	With a meter	Without a meter
Total mean	8556.67	326.44	225.44
Coastal region	7810.63	460.04	395.38
Coffee-growing region	9795.19	187.94	208.02
Central region	8298.22	155.38	68.00

Source: Present study.

This distribution shows that the cost structure does not correspond to the regional income distribution.

In summary, based on the regional framework, the cost to users appears to be higher where the household income is lower.

Regional Cost Structure for Electric Power in Households

Table 6-2 presents the consumption of electric power measured in kWh/month by region.

Average consumption in the coffee-growing zone is notably higher than elsewhere. It is considerably lower in the central region, and is about the same in the Atlantic Coast.

With respect to tariffs, the results are similar to those presented in the introduction. The median tariff for the sample was 2.25 pesos/kWh, 4.01 pesos on the coast, 1.58 pesos in the coffee-growing region, and 1.41 pesos in the central region. This shows that the coast has a much higher cost than the other regions and that a not-insignificant difference exists between the tariff for the central region and the coffee-growing region.

Table 6-2. Consumption Structure
kWh/month (mean)

	kWh/month
Total	152.12
Coastal region	159.81
Coffee-growing region	170.52
Central region	112.33

Source: Present study.

The second interesting result--as expected--is that the highest tariff is in the dispersed rather than nucleated zones. In the former, the tariff (excluding the North Coast zone) is 1.64 pesos as compared with 1.42 pesos for nucleated areas.

Coverage and Quality of Service

As was mentioned in the previous chapter, a total of 60 communities were covered in the sample, 21 of which (or more than 33 percent) are non-electrified. Taking only the 39 electrified communities for the moment, the connection of the system and the quality of service are examined.

Connections

In electrified communities more than 84 percent of the dwellings have electrical service, which is quite high. In communities with a relatively long history of electrification, the percentage of serviced dwellings is higher than in communities which were electrified more recently. This is noted in table 6-3. In communities electrified in 1969 or earlier, 92 percent of the dwellings are electrified, while this drops to 65 percent for communities electrified after 1975.

From a regional perspective, electrified dwellings are concentrated principally in the coffee-growing zone (45 percent). This region has a much higher index of connections than the others, 88.4 percent versus 58.8 percent and 42.6 percent for the central zone and coast, respectively.

Table 6-3. Dwellings Connected by Number of Years the Community Has Been Electrified
(percent)

Year	Connected	Not connected
1969 or earlier	1.7	92.3
1970 - 1974	18.7	81.3
1975 or later	34.4	65.6

Source: Present study.

Quality of Service

To measure quality of service the two indicators used are: continuity of service during the week, and continuity of service during the day. At the aggregate level, there is electrical service in these communities during the majority of the days in 80.8 percent of the dwellings and for only a few days of the week in 19.2 percent. For the electrified sample, 48.3 percent have 24 hour/day service, while 45.2 percent have interrupted service, but both day and night service exists. The remaining 6.5 percent have service only during part of the day.

Regionally, service is most regular in the central region: more than 99 percent of the serviced dwellings have service during most days of the week, while in the other two zones the highest figure is 73 percent. In the central region, 80.7 percent of the dwellings have 24-hour/day electrical service, while only 39.4 percent in the coffee-growing region and 36 percent on the coastal zone have 24-hour/day service. The coastal zone has the most erratic service, with 19 percent of the service in this area being night service. In the coffee-growing region, a high 62 percent have interrupted service.

Although there appears to be higher use of electricity in nucleated communities, the coffee-growing zone has the highest quality of electrical service. This reflects, either singly or in combination, the influence of the National Federation of Coffee Growers in that zone or the proximity of the Central zone in Bogota, and/or hydroelectric electrification projects. In the coastal zone, where energy is thermally produced, there is an obvious higher production cost, but at the same time a lower quality of service.

Chapter 7

ANALYSIS OF THE OPINIONS OF COMMUNITY LEADERS ON ELECTRIFICATION

As a complement to the objective information obtained at the household and community levels, a qualitative-type questionnaire was designed to obtain the opinions of community leaders[1] on the area in general as well as on the actual or anticipated benefits of electrification in the areas.

Opinions of Leaders on Community Development

Each leader interviewed was asked about the actual and potential development of the community. Actual development is understood to be the degree of progress that the community has achieved, in comparison to other communities that the leader is familiar with as well as in terms of the history of the community itself.

In the cases of actual development, the majority of leaders (66.6 percent) indicated that the community was making progress and that it was going through a positive dynamic process. The remaining leaders felt that the group was not moving forward at the present time or with reference to its past.

---

1. The majority of leaders (76.7 percent) are male and older than 36 (66.7 percent). Only 1.7 percent of leaders interviewed are under 25 and the greatest concentration is among the 50 and older group. The average years lived in the community is 31.16 years.

More than half of the leaders (50.8 percent) do not own businesses or farmland in the community. Land is the principal holding of those who do have property.

Lastly, 75 percent of the leaders interviewed have some civic duty in the community and 75 percent are institutional leaders--with bureaucratic duties. The rest are informal leaders of communities interviewed.

It should be noted that no differences were found, among the variables described, between leaders in electrified vs. nonelectrified communities.

Potential community development is viewed as positive; 85 percent of the leaders felt their communities would move forward while only 15 percent saw them stagnating with little possibility of progressing.

One interesting discovery is that there is no significant statistical difference between electrified and nonelectrified communities in progress leaders feel has occurred. Nevertheless, more leaders from electrified communities (69.2 percent vs. 60.0 percent in nonelectrified) feel their communities have moved forward.

In the same way, there also does not seem to be a significant difference between electrified and nonelectrified communities with regard to perception of potential progress. Almost 85 percent of the leaders of both types of communities think that their communities have development potential in the near future.

In summary, we see that electrification is generally perceived as relatively insignificant, since only 10 percent more leaders of electrified than nonelectrified communities perceive progress for their community and there is no significant difference in terms of future progress perceptions; leaders of both types of communities have expectations for progress.

Nevertheless, we believe that to determine the relationship between electrification and progress (improvements, well-being, etc.), it is necessary to also look at the opinions of leaders from a more specific angle, asking them precisely what they feel are the advantages and benefits of electrification. These opinions are presented below using a scheme similar to that used in previous chapters; first, we present the opinions of leaders from electrified communities, and second, those of leaders from nonelectrified communities.

Opinions of Leaders About the Benefits of Rural Electrification: Communities with Electrical Service

When trying to detect whether electrification brings progress to a community, we see that only a small majority of the leaders indicate that electrification has produced some agricultural and commercial benefits, 54.8 percent and 52.4 percent respectively. The impact of electrification on the manufacturing sector is recognized by many fewer leaders, only 31.8 percent.

As a consequence, the majority of leaders (5[illegible].1 percent) indicates that electrification does not create many work opportunities, and some even feel that electrification decreases the availability of sources of work.

It is clear that the leaders have observed that electrification has much less importance in terms of production than in terms of household improvement and for the community in general. Thus 72.7 percent of the leaders feel that there is more security with electrification, 86.4 percent think that there is greater access to recreational activities, and a high percentage think that it offers more opportunities for women to participate.

Lastly, the leaders in general (59.1 percent) feel that the community benefits the most for electrical service: 31.8 percent identified households as the most likely beneficiary, and only 9.1 percent of the leaders of the communities studied think that the business sector is the primary beneficiary.

Finally, and to further strengthen the conclusion that electrification does generate benefits, it should be noted that 65.9 percent of the leaders feel that the high costs of electrification are justified given the benefits generated. Nevertheless, a majority (56.8 percent) indicated that not all families can afford electrical service, pointing out the existence of a real constraint. This attitude was explored with the leaders and the difficulties some families have in getting electrical service emerged as one of their chief concerns, because those families could not get access to the benefits which electrification provides.

Opinions of Leaders on the Benefits of Rural Electrification: Nonelectrified Communities

Leaders of nonelectrified communities (53 percent) feel that the principal reason the community does not have electrical service is the lack of action by the central government. If we also include the 11.8 percent who feel that the principal reason for lack of service is the incompetence of politicians, we can conclude that a large majority feel that government (the State) is to blame for the lack of electrical service.

Some leaders (17.6 percent) think that the principal problem is the distance from the community to the grid or nearest power sources, which

inflates the cost of electrification. Other leaders (11.8 percent) criticize the families in their community for apathy and for showing a lack of interest in making the effort necessary to obtain electrical service.

Concerning the expectations of leaders in nonelectrified communities for progress that could be directly attributable to electrification, the majority think that business in general will increase. The benefits of electrification mentioned, in order of importance, are: improvement of the household with more commodities, opportunity to refrigerate food and increased time for study. Others mentioned irrigation systems and development of tourism. But the optimism which characterizes the expectations of the leaders concerning the benefits of electrification are clearest given the 93.3 percent of leaders who think that the community would make progress through electrical service.

The majority feel that it would generate more work (93.3 percent), would improve agricultural activities (68.3 percent), that women would be able to participate more (100 percent), and that it would generate more businesses in the community (78.6 percent).

Conclusions

Based on the information provided by the leaders of electrified and nonelectrified communities, among which there seems to be a strong link with the communities examined, we can say that electrification generates expectations of development that usually are not satisfied.

Table 8-1 compares the opinions of leaders of both types of communities concerning the benefits attained and expected through electrification and notes that there are significant differences.

In general, leaders think that electrification is an important factor in the progress of their communities. Nevertheless, there is a marked difference between the optimistic expectations and what in fact happens in the communities that have been electrified. This finding follows the same patterns found in the households data. The expectations of the nonelectrified households and/or communities are higher than what in fact happens once the households and/or communities are electrified. The changes expected with the advent of electrification are different from the actual changes experienced once a community can be electrified.

Table 7-1. Opinions of Leaders from Electrified and Nonelectrified Communities Concerning the Benefits of Electrification (percent)

	Electrified	Nonelectrified
More work opportunities	42.9	93.3
More agricultural benefits	54.8	68.3
More opportunities for women	54.5	100.0
More business opportunities	42.1*	78.6

Source: Present study.

*Average of the indicators of most progress in commercial and manufacturing activities.

In conclusion, the greatest benefits of electrification seem to be the increase in time and business opportunities and also the satisfaction or fulfillment of what is considered to be a primary need. The access to time produces changes in behavior patterns related more to leisure than to productive activities; the access to business produces an increase or improvement in income structure; and the satisfaction of the need produces a positive general feeling in the households as well as in the communities.

Chapter 8

CONCLUSIONS AND POLICY IMPLICATIONS

POLICY IMPLICATIONS

The increase in the price of energy which occurred over the last ten years has created serious problems for many developing countries. This is especially so in the context of the large amounts of foreign credit which in many instances are necessary to sustain socioeconomic development. Energy use patterns and the efficient selection of different sources of energy to meet specific end uses are major components of energy planning, and consequently it is important to establish a base of information about them to assist policy makers in developing countries as they try to attain the most developmental impact from their energy investments.

The purpose of this study is to examine the role that electric energy plays in rural areas of Colombia, and to clarify those socioeconomic factors that merit consideration in planning and implementing policies for the electrical sector. In this study energy needs and resources are viewed from a holistic perspective, assuming that electric energy has some relationship with both agricultural production and household uses, and that its effects can be documented both at the community level and at the individual household level. Applying these assumptions, the project field research involved both surveys and structured interviews at those levels. (For future studies we would recommend including qualitative case studies.) In fact, in the absence of reliable official information from utilities, researchers and policy makers have to rely on first-hand information from surveys and local villagers to determine socioeconomic impacts.

In most developing countries energy consumption has been growing faster than energy production, more dramatically so in those countries where the industrial energy consumption/industrial production ratio is

increasing. In spite of its energy shortages, Colombia is experiencing an increase in household energy use, particularly in rural areas. The consequences to the electrical sector in countries such as Colombia are that periodic blackouts and power failures are becoming part of the daily experience of most people.

While there is a strong interest among Colombian government officials in the development of energy in rural areas, policies seem to be oriented almost exclusively toward increasing energy production. For instance, there is a significant effort to increase energy production by tapping the hydroelectric resources of the country. But little systematic research has been sponsored to assess the nation's energy needs or the energy uses of the rural population. The policy makers seem to feel that many problems can be solved simply by providing more electricity.

Villagers also consider electric energy as basic to improving their lives. Most nonelectrified households think electrification will increase work opportunities and productivity. However, based on our survey analysis, this does not appear to occur. No significant connection was found between electrification and productivity. This may be because many elements can play a role in the relationship between electricity and improved productivity. Important factors such as access to land, credit, and technology, as well as marketing and transportation infrastructures need to be coordinated in order to increase productivity and work in rural areas. For instance, in the central region of Colombia where small plots are owned and cultivated through traditional procedures, electrification has had a smaller impact than in the coffee region where a higher level of institutional development was present. An important conclusion of this study is that without such coordination of infrastructural inputs, electrification has more of a social than an economic impact.

The competitive posture of centralized electric energy vis-a-vis traditonally used commercial fuels is also an important consideration. Households with access to electrification indicated in this survey that electricity is more convenient to use and cheaper. Increasing prices and/or decreasing availability of such fuels as kerosine for lighting and charcoal and wood for cooking can affect the introduction of a new energy source and energy production plans associated with rural development.

This study goes beyond measuring the relationship between electrification and productivity and economic development. Our analysis also deals with the social impact of rural electrification--the relationship between electrification and the satisfaction of basic human needs. These basic human needs are clearly affected by electrification. Our study shows that electrification increases recreational opportunities, time for children to study, some types of business activities, and accessibility of appliances. But also--and this is quite important--it fulfills the expectations of the rural population for meeting basic human needs.

The low levels of living standards and productivity in rural areas raise a number of general issues to be addressed when considering the most beneficial investment of scarce resources. It necessitates making clear estimates of the costs and benefits of electrification, or how to set tariffs. For Colombia, consideration of the social benefits is particularly important. Rural electrification programs in Colombia must not only consider the economic benefits of rural electrification, but also must take into account its social benefits in developing an investment plan and schedule.

The opportunity to electrify places particular stress on rural households with limited incomes. In some areas the cost of connecting the household to the central grid equals what an average family earns in about four months. While the expectation is that household productivity and therefore income will increase, for some families a connection will imply the privation of other needs like education, health or even food. Expectations rise and for some families the potential for becoming overextended is even more dramatic when you consider the attraction of a television set or other appliances which would represent a substantial proportion of a family budget. If the government decides to expand the electrical coverage, it should create financial mechanisms in order to alleviate the financial burden that new electrical connections carry.

Government promotion of efficient use of electricity at the household and community level in relation to productive tasks might also be a high priority. The possibilities here are for economic growth and an increase in the income of families to satisfy the new material aspirations that may emerge from watching television.

To propose recommendations to government officials is a complex task but we feel that some can be made based on the results of the study.

1. More information should be gathered at the village level in order to ascertain their socioeconomic profile, their needs and their potential for development. To maximize investments in electrification, the local conditions and response to electrification should be the identified in advance of extending electrical services to areas.

2. The study indicates that electrification alone does not necessarily increase productivity. Some other programs involving improved credit, access to land, and market structures should be implemented if productivity increase is expected.

3. Electrification in Colombia seems to have a substantial social impact. Improvements in the quality of life result from appliances, recreation, time availability, security, and even through increasing of domestic work for housewives, etc.

4. We would make an observation concerning the significant increase in television viewership in the regions with electricity. Once electrification is extended to a region and the need for lighting is satisfied, almost everybody desires a television set. This has implications for the low-income families and also we believe it raises expectations that may be difficult to satisfy in the rural areas.

5. Connection costs and tariffs are a concern both for the users and obviously for the government. In the survey we found general dissatisfaction that costs were too high. It is interesting that tariffs are higher in the Northeast where family income tends to be lower. The economic reason for the regional difference in price basically is the production cost. We would recommend a common tariff with a subsidy for lower income families.

These recommendations emphasize the conditions under which electrification can make an important contribution to rural development.

References

Agency for International Development AID). 1980a. Bolivia: Rural Electrification. Project Impact Evaluation Report No. 16 PN-AAH-978. (Washington, D.C.: AID).

_____. 1980b. The Philippines: Rural Electrification. Project Impact Evaluation Report No. 15 PH-AAH-976. (Washington, D.C.: AID).

_____. n.d. Ecuador: Rural Electrification. Projet Impact Evaluation Report No. 21 PN-AAH-976. (Washington, D.C.: AID).

Banguero, Harold. 1981. Estudio Demografico, Economico y Social de la Cuenca Hidrografica del Rio Sinu (Monterrey: CVS).

Becerra, Carlos. 1981. La Electrification Rural en Paraguay (Monterrey: CVS).

DANE. 1968. XIII Censo Nacional de Poblacion Resumen General (Bogota, D.F.).

_____. 1981. XIV Censo Nacional de Poblacion y III de Vivienda, Octubre 1973 (Bogota, D.F.).

Duran, Fabio and coauthors. Analisis Estadistico de la Encuesta de Evaluacion de Impacto del PAN en Cauca (Bogota, D.F.: Instituto SER de Investigacion).

Fajardo, Dario. 1978. "Configuracion Historica de la Estructura Agraria Colombiana. Caracterizacion Actual de sus Experiencia Rurales" Planeacion y Desarrollo January-April.

IDER. 1978. Estudio Regional Integrado Para La Costa Atlantica Colombiana (Bogota, D.F.: IDER) IDER Publication 780003.

International Bank for Reconstruction and Development (IBRD). 1975. Rural Electrification. A World Bank Sector Paper. (Washington, D.C.: IBRD).

Jankowski, John, Jr. 1981. "Industrial Energy Demand and Conservation in Developing Countries." Discussion Paper D-73A. (Washington, D.C.: Resources for the Future).

Ministerio de Mines y Energia (DNP). 1982. Estudio Nacional de Energia Informe Final Preliminar, Resumen. (Bogota, D.F.: Ministry of Mines and Energy).

OPSA. 1975. Propuesta de una Regionalizacion Comun para Todos Los Organos del Sector Agropecuario (Bogota, D.F., Ministry of Agriculture).

Santamaria, Alejandro. 1980. Mercado de Trabajo y Migraciones de Trabajo en Dos Comarcas Colombianas (Bogota, D.F.: Universidad de Los Andes, CEDE).

Shanin, Teodor. 1980. El Advenimiento de los Campesinos: Emigrantes que Trabajan, Campesinos que Viajan, y Marxistas que Escriben (Manchester, England: University of Manchester Department of Sociology).

Suliani, Siwatibau. 1981. Rural Energy in Fiji: A Survey of Domestic Rural Energy Use and Potential (Ottawa: International Development and Research Center).

Velez, Eduardo. 1981. Modelo de Evaluacion de Impacto del Programa IPC, Linea de Bases (Bogota, D.F.: Instituto SER de Investigacion.

APPENDIX A

This appendix examines many of the dependent variables discussed in the report, and an attempt is made to determine if variables other than rural electrification might be important for explaining some of the significant findings of the study. The analysis technique is multiple regression, which establishes the relative important of several independent variables--including electrification--in explaining such dependent variables as family income, the number of persons earning money per family, workers per family, reading materials such as magazines and newspapers, migration, and several others. The independent variables include existence of electric power, type of population in the community, family size, sex of head of household, length of residence of head of household, education level of head of household, type of sanitary services, and region (central, coastal, or coffee growing). The purpose of this exercise is to determine if electrification is related to the various dependent variables <u>even after controlling for other important variables</u>. The findings are presented in table A-1.

In general, the explanatory power of the independent variables in the models is relatively low, with R^2 values going from .059 for migration to .44 for levels of property ownership, and averaging .146. However, although the explanatory values are low, electrification still plays an important role in explaining the dependent variables, even after controlling for the other dependent variables. In table A-1, for ten of twelve models, electric power is statistically significant. This is particularly true for use of leisure time (columns 6-10) and for family members working and family income (columns 1 and 5). The other models where electricity also is significant include those that are a proxy for quality of life, namely frequency of reading newspapers and magazines (column 3), property ownership (column 9), and number of rooms in the household (column 11).

There are no <u>significant</u> relationships between electricty and income, access to work, modern technology, property ownership, or even quality of

life. However, electricity apparently is associated with an increase of leisure time for all members of the household. The relationship between electricity and migration, after controlling for other relevant variables, appears to be negative, although significant. In other words, in households with electricity migration tends to decrease.

Other variables are more important than electricity in some of the regression models. For example, education is significant in explaining income, quality of life-related variables, and in access to agricultural technology. Family size is significant as expected for number of workers and income earners, but also for property owners, where it is by far most significant. Lastly, the geographic zones, which acted as dummy variables, also are significant with respect to leisure time: in the coastal region (with a warmest climate), families and household members tend to have more leisure time during the day. The lowest level of technology is observed in the central zone where "minifundios" or traditional farming is common. This area, which is close to Bogotá, also has higher levels of outmigration. Not surprisingly, the greater job opportunities result in a higher number of household family members which can work.

To summarize, electrification remains significantly associated with many of the dependent variables even after controlling for other important indicators.

Table A-1. Standardized and Non-standardized Regression Coefficients for the Twelve Models to See the Relative Importance of Electric Energy

Independent variables	Dependent variables											
	Number of persons earning money	Number of workers	Reading printed material	Migrants	Income	Time head	Time wife	Time child	Property owner	Time	Number rooms	Tech-niques
	1	2	3	4	5	6	7	8	9	10	11	12
Electric power	.17*	.03	.13*	-.06	.13*	.21*	.19*	.18*	-.16*	.21*	-.13*	.09*
	(.23)	(.05)	(.34)	(-.15)	(2465.6)	(.65)	(.53)	(.17)	(-.66)	(.83)	(.39)	(.16)
Type of community	-.00	-.11*	-.09	.03	.02	.02	.09	-.01	-.008	.04	-.00	.15*
	(-.01)	(-.18)	(-.23)	(.08)	(384)	(.06)	(.25)	(-.04)	(.04)	(.18)	(-.02)	(.27)
Size of family	20*	.19*	.04	-.02	.05	.11*	.15*	.03	.62*	.15*	.08*	-.01
	(.05)	(.05)	(.02)	(-.01)	(181.9)	(.06)	(.07)	(.01)	(.45)	(.10)	(.04)	(-.00)
Sex of head of household	.01	.04	.06	-.05	.06	-.006	-.02	-.10*	.016	-.02	-.00	.01
	(.02)	(.08)	(.17)	(-.18)	(1512)	(-.05)	-.05	(-.32)	(-.08)	(-.11)	(-.02)	(.02)
Time of residence	.09*	-.02	.04	.07	.04	-.046	-.07	-.04	-.09*	-.04	.12*	.03
	(-.00)	(-.00)	(.04)	(.07)	(294.06)	(-.05)	(-.07)	(-.05)	(-.14)	(-.06)	(.14)	(.03)
Education level	-.04	-.08*	.25*	(-.00)	.18*	.09*	.03	.12*	-.030	.08	.16*	.14*
	(-.00)	(-.00)	(.04)	(-.00)	(224.06)	(.017)	(.005)	(.02)	(-.009)	(.02)	(.03)	(.01)
ZCAF	.15*	.24*	.02	.04	-.05	-.35*	-.30*	-.35*	-.09*	-.33	-.11*	-.01
	(.22)	(.39)	(.85)	(.12)	(-.388.5)	(-1.09)	(-.65)	(-.93)	(-.07)	(-1.12)	(-.02)	(-.30)
ZCEN	.12*	-.05	.08	.18*	-.05	-.027*	-.23*	-.35*	-.01	-.27	-.00	-.17*
	(.17)	(-.08)	(.20)	(.51)	(-955.2)	(-.86)	(-.65)	(-.93)	(-.07)	(-1.12)	(-.02)	(-.30)
Sanitary service	-.07	-.11*	.08	.14*	.05	-0.010	.01	.09	-.09*	-.01	.25*	-.01
	(-.03)	(-.05)	(.06)	(.11)	(313.7)	(-.015)	(.001)	(.07)	(-.10)	(-.02)	(.22)	(-.00)
Constant	.342	.5527	.38	.38	-3750.96	14.38	14.39	14.64	2.9	21.62	.94	2.9
R2	.093	.110	.168	.059	.090	.128	.092	.178	.44	.12	.206	.072

Source: Present study.

*Significant coefficients of at least .05 level.