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AGUAN VALLEY RURAL ELECTRIFICATION REPORT

National Rural Electric Cooperative Association

Central American Rural Electrification Support Program

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AGUAN VALLEY

RURAL ELECTRIFICATION REPORT

NRECA/CARES

NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION
CENTRAL AMERICAN RURAL ELECTRIFICATION SUPPORT PROGRAM

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ABBREVIATIONS AND ACRONYMS

B/C - benefit-cost ratio
C - commercial activity
CARES - Central American Rural Electrification Support Program
DAM - Demand Assessment and Site Selection Methodology
ENEE - Empresa Nacional de Energía Eléctrica (the national electric company of Honduras)
Ha - hectares (one hectare = 2.5 acres)
I - industry or agro-industry
IRR - internal rate of return
km - kilometer
kVA - kilovolt-ampere
kWh - kilowatt hour
L - lempira (one lempira = $US5.30)
MW - megawatt
MWh - megawatt hours
NPC - net present cost
NPV - net present value
NRECA - National Rural Electric Cooperative Association
PUE - productive use(s) of electricity
R_a - ratio of interdependence through purchases from productive activities (measure of backward linkage)
R_b - ratio of interdependence through purchases from productive uses of electricity (measure of forward linkage)
R_c - ratio of interdependence through sales (measure of forward linkage)
S - service activity
USAID - United States Agency for International Development

EXECUTIVE SUMMARY

The Aguán Valley rural electrification project is an infrastructure project designed to transmit electricity from the new El Cajón hydroelectric station to 25,000 customers in 240 small villages, farms, and farm cooperative clusters in the fertile Aguán River Valley of Honduras, and along the coast between La Ceiba and Balfate. Before the project was initiated, the entire area was without electrical service. The project consisted of upgrading capacity at the La Ceiba transmission substation; installing 1980 km of transmission line from La Ceiba into the Valley; constructing three distribution substations; and installing 470 km of primary line, 185 km of secondary line, and 6325 kVA of distribution transformers in villages and homes.

The main purpose of the project was to establish an electrical system that would help improve the quality of life in the Aguán Valley through improved nutrition, medical care, education, and the economic development that would result from increased productive activity. Although the project was not specifically designed to promote productive activity, increased productivity was an anticipated benefit of electrification. The project's impact was, in fact, analyzed according to the concept of productive use of electricity, which is defined as any use of electricity that improves the financial status of the end user and/or provides stimulus for economic development.

This study based its financial, economic, linkage, and social impact evaluations on the estimated costs and benefits of productive uses of electricity in commercial, industrial, and residential activities. This approach allowed for the analysis of how electrification is linked to other aspects of development. The analysis used an innovative computer model called Demand Assessment and Site Selection Methodology (DAM), originally developed by NRECA/CARES to aid in selecting sites for rural electrification. DAM was used in this study to measure the increase in productive uses that resulted from electrification, and also to provide alternate scenarios for improving the project's financial performance.

The alternate financial scenarios were constructed as part of the financial and economic evaluation of the project (Section 2). This evaluation found that although the economic NPV of the project was an impressive US$46.7, the financial NPV was a disappointing US$(21.6) million, with rising kWh sales resulting in constantly increasing losses for the state utility, ENEE. The alternate scenarios demonstrated that by making some difficult but necessary adjustments such as doubling the tariff, reducing system losses from 25 to 15 percent, and cutting operating expenses in half, the Aguán Valley project could become financially self-supporting in 10 years. The

authors believe that financial self-sufficiency is essential, for this and other rural electrification projects, so that governments do not suffer damaging financial losses in the course of using rural electrification to further their social and economic development objectives.

The evaluation of growth linkages (Section 3) was based on the hypothesis that rural electrification contributes to local economic development not only by stimulating productive use activities in newly electrified areas, but also by stimulating additional productive activities in other sectors in the Aguán. The key concepts used in this evaluation were backward linkages (impacts resulting from increased demand for raw materials, capital goods, or services), and forward linkages (impacts resulting from the increased supply of products and services to other activities or sectors). Data for the evaluations were collected through field surveys of electrified and nonelectrified communities, and through questionnaires administered to owners or managers of electrified activities or industries. A related concept, consumption linkages (demand for housing, local services, and durables as a result of increased employment, income, and marketed surplus) was not used in the evaluation because of lack of data on income expenditure patterns.

The backward and forward linkages from productive use activities were calculated using three "interdependence ratios." The Ratio of Interdependence through Purchases from Productive Activities (R_a) measured backward linkage by estimating the share of productive uses output that came from purchasing other local productive activities, both electrified and nonelectrified. The Ratio of Interdependence through Purchases from Productive Uses of Electricity (R_b) measured the backward linkage of productive uses of electricity only to other productive uses of electricity. And the Ratio of Interdependence through Sales (R_c) measured forward linkage by estimating the proportion of electrified productive use activity output that is sold for other local productive use activities, both electrified and nonelectrified.

This analysis of growth linkages showed that the level of productive activities in the electrified area was high compared to that of adjacent nonelectrified communities. The analysis also demonstrated, however, that the high level of productivity was the result not of electrification alone, but of electrification in combination with other infrastructure and institutional programs in the Aguán, including agrarian reform, credits to agricultural cooperatives, road paving between major towns, increased access of business to formal credit sources, and projects for potable water, health, and education. The analysis indicated that site selection for future electrification projects should include an assessment of other infrastructure development projects, and that preference should be given to sites where development programs are underway or will be implemented concurrently with electrification. The particularly high degree of linkage found between processing industries and other economic activities indicated that preference should also be given

to sites located near processing industries, since these industries have the greatest potential to spread the benefits of electrification beyond the direct beneficiaries of the project.

The evaluation of the project's social impacts (Section 4) was concerned with the effect of electrification on households and on communities. The evaluation was based on interviews with residents and community leaders in 26 newly electrified villages and towns. The interviews confirmed the findings of previous studies that better income, nutrition, and education, as well as smaller family size, are correlated with electrification. The evaluation was particularly concerned with the impact of electrification on women. The surveys revealed that on the household level, refrigeration was the appliance that made the most difference in quality of life; not only did it make possible better nutrition and health care, from the cold storage of perishable food and vaccines, but it also enabled women to sell food and cold drinks out of their homes, and thereby increase their incomes. Although women benefitted somewhat from released time from other electric appliances such as irons and corn mills, the survey indicated that they had few options for using this released time. The study recommends that productive activities for women be introduced concurrent with the electrification process.

In general, the survey found that the greatest impacts of electrification for both women and men resulted not from appliances but from access to the electronic media, which exposed them to news, religious, health, and international programs; and from electric lighting, which extended the hours for reading and productive work and increased nighttime security. On the community level, electrification freed children from nonelectrified productive work and enabled them to go to school. The survey found enrollment almost equally divided between girls (49 percent) and boys (51 percent). Other social benefits included nighttime lighting of community halls for community meetings.

The study concluded that the overall impact of the Aguán Valley rural electrification project was positive, and that the economic impacts of similar projects can be enhanced by considering productive use programs as an integral part of project design. Also, to avoid financial problems in future projects, the impact of tariffs, system losses, and operating and maintenance practices should be quantified and addressed before projects are implemented. Methodologies should be designed and tested to ascertain rural consumers' willingness to pay for electricity in relation to other goods and services.

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AGUAN VALLEY
RURAL ELECTRIFICATION REPORT

1. INTRODUCTION AND METHODOLOGY

Under the Central American Rural Electrification Support Program (CARES), funded by USAID, NRECA is pursuing a range of activities requiring expertise in centralized and decentralized power programs in Central America, and in the related areas of generation technology, demand-side issues, utility management and efficiency, institutional development, and finance. The purpose of these programs is to improve the supply, reliability, and impact of electric energy in developing countries; and to promote the development of sustainable rural electricity distribution and use.

In 1978, USAID/Honduras signed a project paper to help finance a rural electrification project in the Aguán Valley, near the north coast of Honduras. The Aguán Valley is a large and productive agricultural region. It has more than 200,000 hectares of fertile land crossed by several year-round small rivers and streams, all of which flow into the Aguán River. Principal crops in the valley are bananas, corn, rice, sugarcane, African palm, citrus fruits, and vegetables. The valley also provides rich pasture for cattle.

Before this project was initiated, the entire Aguán Valley was without electrical service; La Ceiba was the community nearest to grid power. When Honduras expanded its generating capacity by 275 MW by opening the El Cajón hydroelectric station in 1982, the Aguán Valley rural electrification project was able to use this new power station as a complement to its regional rural electrification effort.

The Aguán Valley rural electrification project was designed to serve 25,000 customers in 240 small villages, farms, and farm cooperative clusters in the area of the Aguán River valley and along the coast between La Ceiba and Balfate. It was designed as an infrastructure project and did not specifically promote productive uses of electricity; although productive uses were anticipated benefits.

The project created the infrastructure to transmit electrical energy from the new El Cajón hydroelectric station to the Aguán Valley. The project upgraded capacity at the La Ceiba transmission substation and installed 1980 km of transmission line from La Ceiba into the Valley. Three distribution substations were constructed in the project area; and 470 km of primary line, 185 km of secondary line, and 6325 kVA of distribution transformers were installed in villages and homes. Project specifications are given in Annex 1.

Private contractors were used to construct the substations and install the lines and transformers; the project included few provisions for training or local participation.

The main purpose of the project was to establish an electrical system that would help improve the quality of life, increase employment opportunities and food production, and thereby increase family income in the Aguán Valley. Other goals were to improve the nutritional and educational status of residents of the Valley and promote the growth of agricultural and industrial activities.

By December of 1982, the project was basically completed; i.e. all substations, transformers, and lines had been installed. Over the next several years, as shown by the records of the national electric utility, ENEE, household and commercial use of electricity in the project area increased, to a total of about 14,000 customers in more than 100 communities as of January 1991. As of that date, customers were distributed as follows: residential 93.2%, commercial 4.9%., Industrial 0.3%, government and municipal 1.6%. Total registered energy consumption was 268 Kwh per month per customer. A list of communities served by the Aguán project is given in Annex 2.

In 1987, NRECA visited each Central American country to complete recommendations for regional rural electrification support program. To help determine the type of support needed to extend the benefits of rural electrification, the USAID/Honduras mission, in 1991, specifically requested the assistance of NRECA/CARES in completing a post-project evaluation of the Aguán Valley project. This study is the result of the evaluation by NRECA/CARES.

NRECA/CARES intends to present the results of this study to USAID, ENEE, donor agencies, and other interested parties. The lessons learned will be shared with others working in the field. Specific recommendations for a support program and follow-up activities will be initiated in cooperation with ENEE upon completion of this report. These recommendations will address such issues as loss control, tariffs, and decentralization.

Background[1]

As recently as a decade ago, rural electrification was perceived almost as a magical force to transform poor areas into highly productive regions. Putting up power lines in poor rural areas was synonymous with providing the necessary infrastructure to quick bring these areas into the 20th century. The assumption underlying the early rural electrification programs was that communication, lighting, increased productivity, increased literacy, reduced birth rates, and many other benefits

[1]This section relies heavily on Barnes, "The Public Policy Controversy over Rural Electrification" in Electric Power for Rural Growth, 1988.

would almost automatically flow from electricity being available in rural areas. Early studies confirmed that rural electrification could act as a catalyst for both social and economic--especially agricultural--development. Studies in Colombia in 1972 and in the Philippines in 1976 for example, found that electricity use was associated with higher incomes and education. Also, a USAID-sponsored study in Costa Rica in 1976 concluded that the availability of cheap, reliable, 24-hour electricity was critical to the production and processing activities of dairy, pig, and poultry farms, and that it encouraged the establishment of repair and maintenance facilities. A study in China also found that electricity had an enormous impact on agricultural mechanization.[2]

But this early optimism was clouded by subsequent reports on projects in developing countries which indicated that prospective customers were not adopting electricity at the rate expected, and that the projects were not producing the anticipated rate of economic and social development. Reports such as the USAID-sponsored study in the Philippines in 1983 found that introducing electricity does not automatically stimulate growth, but that growth depends on a number of other factors, including entrepreneurship, the availability of capital and natural resources, the general level of development in the area, and other infrastructure programs.

Studies critical of rural electrification have focused on several issues: (1) the appropriate time for implementing rural electrification projects in a country's development cycle; (2) whether rural electrification projects should have a household or rural productivity emphasis; (3) whether such projects benefit or hurt the rural poor; (4) the capital-intensive nature of investments; (5) whether rural energy needs would be better served by other types of energy projects; (6) whether the resources needed for rural electrification would be better invested in other social and economic development projects.

Although past impact studies have failed, because of poor conceptualization, weak methodologies, or reliance on fragmentary data, to definitively resolve these issues, the preponderance of evidence is that rural electrification can be a powerful force for change, provided it is part of an integrated regional rural development program that includes other social and economic dimensions. The deficiencies in past studies, in fact, has been the lack of analysis of how electrification is linked to other aspects of development. This study is the first to incorporate the innovative methodology known as Demand Assessment and Site Selection Methodology (DAM) to systematically measure the economic impact of electrification in the context of a broader social and economic linkage analysis.

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[2]Timmer, 1975.

Methodology

This report consists of an economic and financial analysis, a linkage analysis, and a social impact analysis. The economic analysis (Section 2) was accomplished using the DAM methodology, a computer model developed by NRECA/CARES. The methodology was originally developed to aid in selecting sites for rural electrification by determining the economic and financial costs and benefits of electrification for individual villages, using such inputs as cost of initial construction, cost of producing electricity, technical and nontechnical losses, and revenues from residential and commercial consumers. This study marks the first time that the DAM model has been used in a post-project evaluation, to calculate the residential and productive end-use economic benefits of electricity. The DAM analysis also provided a series of options that can be implemented now to improve the financial viability of the project. The methodology is explained in detail in Annex 4.

A key concept in this study is productive use of electricity. Productive use is any use of electricity that improves the financial status of the end user and/or provides stimulus for economic development. That is, productive uses of electricity are those activities that stimulate growth. This study bases its economic, financial, linkage, and social impact analyses on the estimated costs and benefits of productive use of electricity in residential, commercial, and industrial activities.

The direct economic and financial benefits of rural electrification, in terms of residential productive uses of electricity, are discussed in Section 2, Financial and Economic Evaluation. The indirect benefits of rural electrification, also in terms of productive uses of electricity, are discussed in Section 3, Linkages to Other Productive Sectors, and in Section 4, Social Impacts.

The linkage analysis (Section 3) was an investigation of first-round linkage effects of specific productive uses of electricity. It was an attempt to expand benefit analysis beyond the direct end-user of electricity, by considering effects not presently quantified in the DAM economic analysis. DAM analyzes the direct impact of electrification on end users. The linkage study attempted to take the benefit analysis one step further, to the association of end-use benefits with economic growth. Although this report does not definitively quantify the impacts of such linkages, it recognizes their interdependence with the specific end uses of electricity.

The social impact study (Section 4) consisted of interviews, surveys, and sampling to document the effects of electricity in two basic areas: home use and community services. Special attention was paid to how home electricity use affected women. Several indicators of socioeconomic status were included to determine whether electrification was benefiting the poor. Questionnaires used in the social impact study are reproduced in Annex 3.

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2. FINANCIAL AND ECONOMIC EVALUATION

Honduras, like other Central American countries, has a policy of subsidizing rural electrification to help develop the country socially and economically. In pursuit of this policy, the government often requires ENEE, the national utility, to operate rural electrification programs that, while they are beneficial to the country, may be financially damaging to the utility itself. Requiring ENEE to subsidize electrification without giving it the authority to set tariffs to cover its costs compromises the utility's autonomy and its financial health. Although in theory the government is willing to compensate ENEE for its losses, the small tax base in the country, and the poorly organized system of tax collection, often means it does not have the money to do so. As a consequence of the government's inability to adequately support its rural electrification policy, ENEE has in the past lost many good engineers and technicians and postponed needed maintenance, which in turn has resulted in equipment breakdowns and poor quality of service.

The purpose of this section is to compare the financial and economic performance of the Aguán Valley rural electrification project and to recommend ways to make the project financially viable so that ENEE can provide service to the region without suffering damaging financial losses. The authors do not take issue with the government's policy of using rural electrification to create economic and social benefits. Rather, they are attempting to show how rural electrification projects can be made financially self-supporting without sacrificing the government's social or economic development objectives.

Methodology

The financial evaluation sought to determine the past and future performance of the project, and to identify ways to improve the project's financial performance. The economic evaluation sought to determine the extent to which rural electrification directly benefits residential consumers, productive use consumers, and the overall economy of the country. The economic benefits of electrification were calculated separately for residential and productive users, employing the methodology explained in detail in Annex 5.

The indirect (nonquantifable) benefits of electrification are discussed in Section 3 and Section 4.

For both the financial and economic analyses, inputs to the DAM model were based on data gathered during a 4-week field period in 1991. All financial data were estimated at the site and adjusted to 1983 US dollars. No taxes were paid on equipment or other significant local materials, and labor costs were included, but not reported separately, under project investment cost. The time frame for the analyses was 30 years (1983 through 2012), based on life-of-project costs and benefits. The 30 years was broken down into three separate periods: (1) historical, using costs and benefits from project completion (1983) to the present (1991); (2) the present (1991); and (3) the future (1992 through 2012). For each time frame, costs and benefits were derived in both financial and economic terms.

Financial Evaluation

For the financial analysis, the costs were defined as those expenses directly incurred by the utility: cost of construction, cost of producing electricity delivered to the system, cost of line operation and maintenance, technical and nontechnical losses, cost of billing and collection, cost of system improvements, service drops and household wiring.

The financial benefits were defined as tariff revenues from residential, commercial, and industrial consumers.

The specific parameters used in the financial analysis were: (1) tariffs (variable each year from 1983 to 2000); (2) cost of electricity (generation plus transmission, variable each year from 1983 to 2000); (3) expected life of major components (30 years); (4) the discount rate (12%); (5) initial construction costs ($20,825,000); (6) cost of service drops and household wiring (an average of $95.83 per customer over the life of the project, with an addition $1.3 million invested in 1987 to finance line extensions to new consumers); (7) line operation and maintenance costs ($24,717 a year from 1983 to 1986, $30,947 a year beginning 1987); (8) other service costs ($0.27 per customer per month for meter reading, billing, and collection); (9) line losses (25%); (10) number of residential consumers (11,048 strictly residential users and 2,937 residential productive users in 1991, with projected saturation rates of 19,750 and 5,250, respectively, in 2000); (11) residential consumption in kWh per month (58 kWh for strictly residential, and an additional 22 kWh for residential productive users, with a total annual growth rate of 5.7%); (12) productive uses of electricity; and (13) projection of productive uses.

The last two parameters, present and projected productive uses of electricity, were also critical to the success of the Aguan Valley project in economic terms. Field investigation identified more than 4,000 separate productive use activities, broken down into 29 categories, as shown in Table 1 and Table 2, below. Projections for future productive use in each category were developed based on estimated population growth, agricultural land limitations, and market constraints as observed by the

NRECA/CARES team. For Table 1, the productive uses in each category was estimated for each year from 1983 through 1991 based on ENEE billing records and field surveys.

TABLE 1: PRODUCTIVE USE CATEGORIES
FOUND IN THE AGUAN VALLEY

CATEGORY	1991 NUMBER	Projection criteria (*)
1. Commercial/Industrial, 0-150	467	a
2. Commercial/Industrial, 151-300	254	a
3. Commercial/Industrial, 301-450	129	a
4. Commercial/Industrial, 451-600	47	a
5. Commercial/Industrial, 601-750	56	a
6. Commercial/Industrial, 751-900	27	a
7. Commercial/Industrial, 901-1050	36	a
8. Hospital	2	a,b
9. Banana plantation, 100 Ha. units	54	c
10. Residential productive uses	2937	b
11. Supermarket	19	b
12. Cooperative	1	c
13. Radio station	3	d
14. Large construction company	2	d
15. Hotel	2	d
16. Smail sawmill	1	d
17. Bank agency	5	b
18. Beauty parlor	2	b
19. Restaurant	2	b
20. Sausage factory	1	b
21. Dairy plant	1	d
22. Palm oil plant	2	c
23. Other industrial/commercial	3	a

24. Large sawmill	1	d
25. Seafood packer	3	c
26. Small construction company	1	d
27. Farm	1	c
28. Non-specified agro-industry	1	c
29. Government offices	3	b
TOTAL	4,064	

a. Observed number of productive uses in 1991, starting dates of particular productive uses and observed growth rates in the period 1983-1991 (commercial/industrial productive uses and others).

b. Residential projections and population growth (residential productive uses, supermarkets, beauty parlors, restaurants).

c. Agricultural land/resource constraints (banana plantations, palm oil plants, seafood packers, farms and agroindustries).

d. Market constraints as observed by NRECA/CARES team.

Economic Evaluation

For the economic analysis of the project, the financial costs, without modification, were input into the DAM model as economic costs. This was because no taxes were paid, investment was valued in 1983 dollars, labor expendures were not reported separately, and there were no unemployment figures available.

Briefly, the economic benefits of residential electrifica-tion were calculated using surveys to gather data under three parameters: (1) the substitution benefit, or savings from using electricity for lighting rather than kerosene or candles (kilolumen/hour per kilolumen hour, electric lighting is 100 times cheaper than candles, for example[3]); (2) consumers' willingness to pay; and (3) the consumer surplus, or what consumers save when paying for all electricity at a certain rate, when some consumers would be willing to pay more for it and all consumers would be willing to pay more for some kWh than for others. See Annex 5.

The economic benefits of productive use were estimated using a methodology analogous to the residential methodology. Sixteen productive uses ranging in consumption from 69 to 367,647 kWh per month were studied in detail to determine their alternate energy costs and likely response to price changes. For each productive process, the team identified the specific kWh consumption for each main component, and asked production managers which components would continue to receive

[3]Based on "A Comparison of Lamps for Domestic Lighting in Developing Countries," World Bank, Industry and Energy Department, June 1988.

electricity from the higher-cost backup generator in the event of a system outage. For 10 cases, the managers reported an average cutback in consumption of 80% in response to the change in cost of electricity.

TABLE 2: BREAKDOWN OF PRODUCTIVE USES BY MAIN CATEGORY, 1991

Productive Use Category	Number of Productive Uses
Residential	2,937
Commercial (under 1,050 kWh/month)	
0 - 150	467
151 - 300	254
301 - 450	129
451 - 600	47
601 - 750	56
751 - 900	27
901 - 1,050	36
	subtotal 1,016
Large productive uses (over 1,051 kWh/month)	111
TOTAL	4,064

In this scenario, substitution benefits were estimated as the difference between what it cost productive users to generate their own electricity and what ENEE charged, times consumption levels when electricity was self-generated. Willingness to pay was estimated as consumption of electricity when it was available from the grid, times ENEE's applicable tariff. Consumer surplus was calculated, as in the residential procedure, by substracting consumption levels associated with backup generators from grid consumption levels, multiplying the result by the difference between grid and backup generator cost, and dividing the product by two.

Because no correlation was found, for any productive use, between the economic benefit per kWh and total kWh consumption, an average economic benefit per kWh consumed could be derived for use in this analysis. That benefit was calculated to be $0.092 per kWh. The lack of correlation was an unexpected result, and seems to be due to the fact that many forces counteract one another. A large productive use many have lower generating costs using backups, but lower elasticity because of better financial status, for example.

Results

The analyses revealed inconsistencies between the financial and economic impacts of the Aguán Valley project. The project's negative financial impact, mainly affecting ENEE, occurred alongside substantial economic benefits to both residential and productive use consumers. The base scenario using the DAM model yielded a financial NPV of -$21.6 million, with a benefit/cost ratio of 0.46; but an economic NPV of $46.7 million, with a b/c of 2.17, as shown in Table 3.

TABLE 3: AGUAN VALLEY FINANCIAL-ECONOMIC ANALYSIS:
Results under the "base" scenario

	FINANCIAL	ECONOMIC
Net Present Value ($)	-21,599,305	46,696,393
Benefit/Cost Ratio (b/c)	0.46	2.17
Internal Rate of Return		27.31

The team determined that because it has been nine years since the project began, there is little hope of recovering past financial losses. However, in an effort to find ways to improve the project's future financial peformance, the team undertook several sensitivity analyses using variables that could affect the Net Present Value and the benefit/cost ratio--increasing tariffs by 100%, increasing sales by 100%, deducting USAID contribution from total cost, reducing losses from 25% to 15%, and cutting operating and maintenance expenses in half. As shown in Table 4 through Table 8, each of these measures had a slight positive effect on the NPV and the benefit/cost ratio, except for increasing sales, which actually caused the financial NPV to worsen under the current cost-consumption-tariff structure. That is to say, increasing sales when each kWh costs the utility more than it earns will only magnify the negative impact. Detailed analyses of the base, loss reduction, increased tariff scenarios are presented in Annex 6.

TABLE 4: AGUAN VALLEY FINANCIAL ANALYSIS:
Results of increasing tariffs 100% over 1983

Net Present Value ($)	-15,773,925
Benefit/Cost Ratio	0.61
Internal Rate of Return	4.35

TABLE 5: AGUAN VALLEY FINANCIAL ANALYSIS:
Results of increasing global sales by 100%

Net Present Value ($)	-$22,426,817
Benefit/Cost Ratio	0.51
Internal Rate of Return	

TABLE 6: AGUAN VALLEY FINANCIAL ANALYSIS:
Results of deducting USAID contribution from total cost

Net Present Value ($)	-10,099,305
Benefit/Cost Ratio	0.65
Internal Rate of Return	

TABLE 7: AGUAN VALLEY FINANCIAL ANALYSIS:
Results of reducing losses from 25% to 15%

Net Present Value ($)	-19,605,840
Benefit/Cost Ratio	0.49
Internal Rate of Return	-4.26

TABLE 8: AGUAN VALLEY FINANCIAL ANALYSIS:
Results of cutting operation and maintenance expenses in half

Net Present Value ($)	-21,484,127
Benefit/Cost Ratio	0.46
Internal Rate of Return	

Recommendations

As a result of these analyses, the team determined that several actions can be undertaken to improve the project's financial outlook. If past losses are written off, the following actions will improve future cash flow:

· reducing losses from 25% to 15% (a reduction of 67%) will provide a positive cash flow after Year 10 (Annex 6);

· increasing tariffs by 100% over 1983 levels (or 97% over projected 1993 levels) will also provide a slightly positive cash flow after Year 10 (Annex 7);

· reducing operating and maintenance costs will improve cash flow slightly, but will never, by itself, create a positive cash flow.

Taken together, these measures can result in a positive cash flow after ten years, which will then enable the utility to support increased consumption and economic growth.

3. GROWTH LINKAGES FROM PRODUCTIVE USES OF ELECTRICITY IN THE AGUAN VALLEY

Evaluations of rural electrification have traditionally been concerned with five types of impacts: economic costs and benefits; growth of local employment; increase in local income; growth of productive uses of electricity in commerce, industries, and services; and growth of agricultural output. An additional set of impacts, however, has rarely been considered. These are the backward and forward growth linkages resulting from productive use transactions. Backward linkage is the benefit realized when a productive use results in increased demand (i.e. increased purchases from other sectors). Forward linkage is the benefit realized when a productive use results in increased supply (i.e. increased sales to other sectors).

The only previous study to address the issue of growth linkages from rural electrification was done for USAID in 1979.[4] That study focused on the backward and forward linkages stemming from electrification projects, and suggested that there is substantial potential to maximize the linkages from such projects if attempts are made to locally procure equipment and materials.

The present study differs from the 1979 study in that it is concerned with linkages derived specifically from productive uses. This section complements the DAM economic benefit/cost analysis in Section 2 by using a field-tested methodology to identify and evaluate local backward and forward linkages resulting from productive uses in the Aguán Valley. This section also assesses how productive uses have stimulated additional economic activities in the region. The same methodology is also used for determining agricultural linkages, as discussed below.

The hypothesis put forward is that rural electrification contributes to local economic development not only by stimulating productive use activities in newly electrified areas, but also by stimulating the development of additional productive activities in other sectors through linkage effects. For the purposes of this study, linkages from productive uses are defined as productive activities, both electrified (other productive uses) and nonelectrified. Since the evaluation is limited to economic activities in the Aguán, linkages affecting other regions are not considered.

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[4]Judith Tendler, "Rural Electrification: Linkages and Justifications," for USAID, 1979.

Methodology

In order to develop a methodology to measure growth linkage from productive uses of electricity, the authors adapted the framework developed to measure agricultural growth linkages to the case of rural electrification.[5] The agricultural linkage framework was considered appropriate for this study because the literature on the impacts of agricultural growth is extensive and is applicable to the general economic conditions in rural areas.

The key concepts derived from the agricultural methodology were backward linkages (demand for fertilizers, irrigation equipment, repair services, in the case of agriculture), forward linkages (milling, food processing), and consumption linkages (demand for housing, local services, and durables as a result of increased income from agricultural activities). Backward and forward linkages are also classified under this framework as production linkages, and consumption linkages are also classified as expenditure linkages.

In developing a parallel conceptual framework for analyzing the linkages from productive uses of electricity, the authors adhered to the agricultural methodology of disaggregating growth linkages from productive uses into backward, forward, and consumption linkages. Backward linkages from productive activities were defined in this study as impacts that resulted from increased demand for raw materials, capital goods, or services. For example, a dairy processing plant's demand for milk can stimulate dairy farming or small-scale milking; a sawmill's demand for trees can stimulate tree harvesting; a bakery's demand for wheat can stimulate farming.

Forward linkages from productive use activities were defined in this study as impacts resulting from the increased supply of products and services to other activities or sectors. For example, a dairy farm can stimulate milk collection and distribution; an electrically-powered sawmill can produce enough lumber to stimulate building and carpentry; other productive activities can provide jobs and stimulate selling.

Consumption linkages from productive use activities were defined as the demand for housing, local services, and durables that resulted from increased employment, income, and marketed surplus. Because of lack of data on income expenditure patterns, consumption linkages were not analyzed in this study.

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[5]The conceptual framework of growth linkages was developed by Albert Hirschman in The Strategy of Economic Development, 1988. The framework concentrated initially on linkages derived from manufacturing, to which Hirschman attributed a superior ability to stimulate new activities. From that conceptual framework, John Mellor derived the methodology for analyzing growth linkages from agriculture.

In appraising the backward and forward linkages from productive use activities, the authors used three "interdependence ratios" as rough estimates of potential linkage effects. These interdependence ratios, ranging from 0 to 100%, measure the extent to which productive use activities interlock with other productive activities in the Aguán Valley, both electrified and nonelectrified. The ratios are:

· The Ratio of Interdependence through Purchases from Productive Activities (R_a), which measures backward linkage. It estimates the proportion of productive uses output (defined as the average value of monthly sales) that represents purchases from other local productive activities, both electrified and nonelectrified. For example, if a dairy industry purchases 40% of its output from small, nonelectrified local milk producers and 20% from a local electrified milk carton industry, the R_a is 60. This figure represents the proportion of the dairy industry output that is purchased from other local productive activities.

· The Ratio of Interdependence through Purchases from Productive Uses of Electricity (R_b), which also measures backward linkage, but differs from the R_a ratio in that it measures the extent to which productive uses of electricity interlock only with other productive uses of electricity, rather than with both electrified and nonelectrified activities. For example, in the case of the dairy industry presented above, the R_b is 20, representing only purchases made from the electrified milk carton industry.

· The Ratio of Interdependence through Sales (R_c), which measures forward linkage. It estimates the proportion of electrified productive use activity output that is not used for final consumption, i.e. that is sold to other local productive use activities, both electrified and nonelectrified. For example, if the dairy industry sold 10% of its output to a cheese processing industry and 90% to final consumers, its R_c would be 10.

In these calculations, R_a and R_c represent the stimulus that productive uses of electricity conveys to the local economy through backward (R_a) and forward (R_c) linkage effects. R_b indicates the backward linkage only to other productive uses of electricity, not to nonelectrified activities, and represents only the extent to which electrified productive activities stimulate the growth of other electrified activities. Since the purpose of this study is to assess the impact of productive uses of electricity on the entire local economy, R_b will not be considered here.

For R_a and R_c, the intensity of the stimulus to the economy is equal to the interdependence ratio. On a scale of 0 to 100, the stimulus from a backward or forward linkage is considered low when the value of R_a or R_c is 33 or less; it is moderate when the value is greater than 33 but less than 66, and the high when the value is 66 or more.

High R_a and R_c values indicate that electrification is a significant stimulus to local economic growth. By contrast, electrified productive uses with values of less than 33 impart minimal stimulus to the local economy. Low R_a and R_b values indicate that electrified productive use activities purchase low quantities of their inputs locally; similarly, such activities with low R_c values sell output either directly to final consumers or to customers outside of the Aguán. Low R_a and R_c values indicate that electrification has benefitted only electrified productive use activities but has not stimulated additional economic activities through demand or supply links.

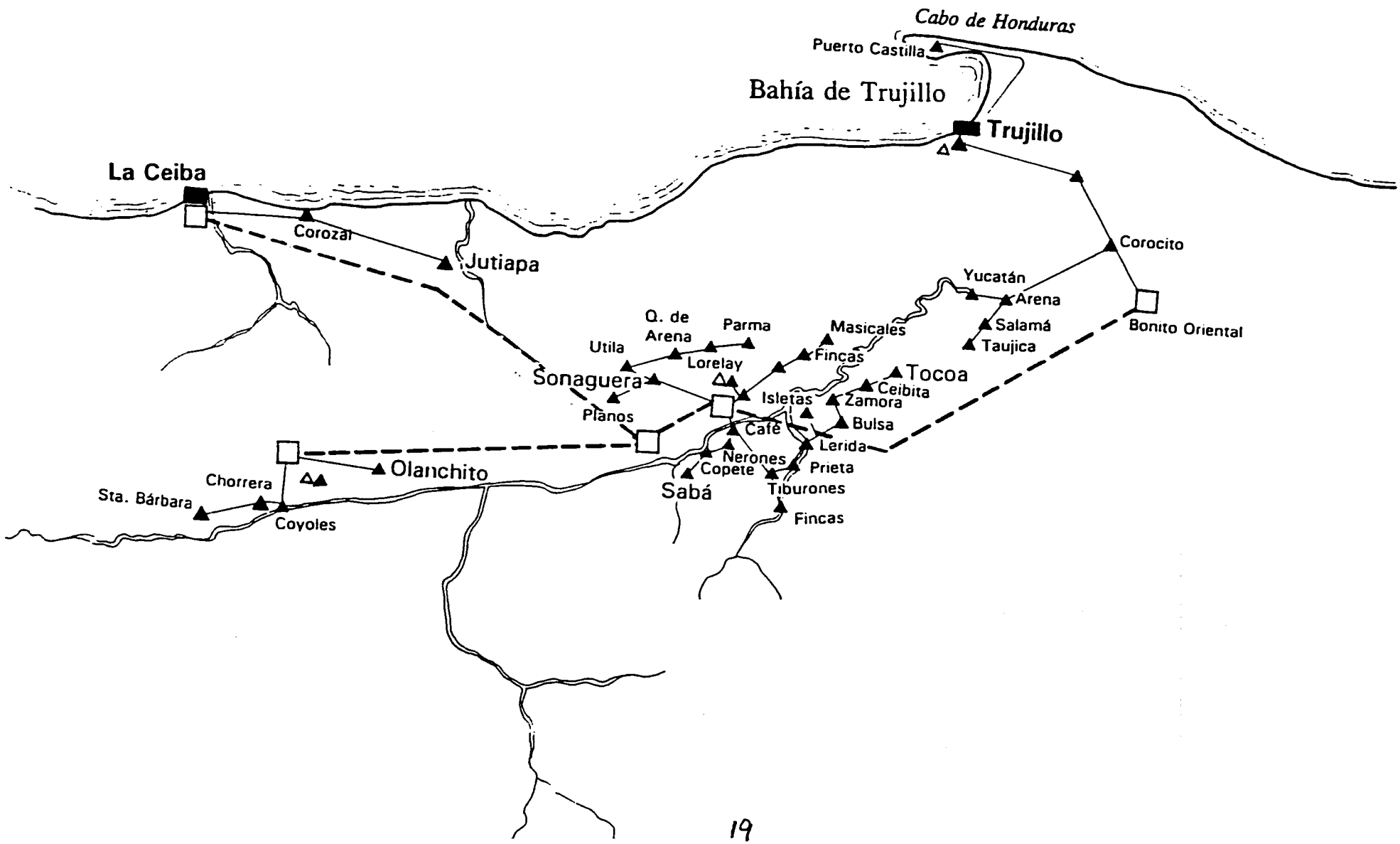
The data used to derive the interdependence ratios were collected through field surveys of electrified and nonelectrified communities, and through questionnaires administered to owners or managers of electrified activities or industries. The field work took place in five relatively distinct agro-ecological zones: (1) the coastal zone, which included towns on or near the Atlantic coast east of La Ceiba; (2) the desert zone, located around Coyoles and characterized by arid conditions with low agricultural production and some cattle raising; (3) the citrus, basic grains, and palm oil plantations zone, located along the road from Ceiba to Tocoa and Sonaguera; (4) the banana plantations zone, located in Isletas, close to Tocoa, and in Coyoles Central close to Olanchito; and (5) the basic grains and cattle production zone, with small and large independent farmers and some cooperatives located along the road between Tocoa and Trujillo. The sample selection is explained in detail in Annex 7; the questionnaires are reproduced in Annex 8; and the agro-ecological zones of the Aguán Valley are shown below in Figure 1.

Results

The study identified 42 types of productive uses of electricity in selected towns and villages. The initial visit to the field revealed the existence of numerous small industries and commercial and service activities, and of a few large productive use activities such as oil processing, banana cultivation and packing, and milk collection.

Analysis of questionnaires on electricity consumption revealed that small businesses (beauty parlors, ice cream shops, tailor shops) and industries (carpentry shops, cement block manufacturing) consume 1000 kWh a month or less; while large industries (sawmills, metal factories), agro-industries (banana production and packing), and large-scale commercial activities (supermarkets, hotels, health clinics, fishing) consume more than 1000 kWh a month. The distribution of large and small productive use activities in 5 larger towns in the Aguán is shown in Table 9; the distribution of such activities in 14 smaller towns is shown in Annex 9.

Figure 1: ENNE'S ELECTRICITY SUBSYSTEMS IN THE AGUAN VALLEY



Of the small-scale productive use activities (items 1 to 25 in Table 9), about 66% are services and commercial activities (i.e. shops), and 34% are small industries or processing activities (i.e. woodworking or cheesemaking). Of the large-scale activities (items 26 to 33 in Table 9), 90% are export and processing activities, and 10% consists of basic warehousing for such grains as rice, beans, and maize.

TABLE 9: TYPICAL PRODUCTIVE USES OF ELECTRICITY IDENTIFIED IN 5 LARGER ELECTRIFIED COMMUNITIES

PRODUCTIVE USE	TOCOA	TRUJILLO	OLANCHITO	SONAGUERA	SAVA
1. FOOD AND BEVERAGES BUSINESS	58	82	37	8	8
2. ICE CREAM SHOPS	3	2	3	3	3
3. GAS STATION	8	2	2	2	1
4. WOOD WORKS	5	4	16	3	9
5. SMALL MISC. BUSINESS	92	52	70	20	21
6. LARGE BUSINESSES	31	21	28	10	11
7. TAILOR SHOP (LARGE)	18	7	11	1	5
8. TAILOR SHOP (SMALL)	7	7	3	3	5
9. WELDING SHOP	2	2	7	4	0
10.AUTO AND MOTOR REPAIR	35	7	29	12	15
11.BICYCLE REPAIR	6	1	2	2	4
12.TIRE REPAIR	5	1	3	2	3
13.POOL HALL	14	5	14	6	6
14.GENERAL STORES (PULPERIAS)	155	50	123	60	46
15.LEATHER WORKS	8	2	2	0	2
16.BAKERIES	3	3	2	2	3
17.CORN MILL	12	2	7	10	6
18.BUTCHER SHOP	28	2	19	9	9

19.CASSAVA PROCESSING	0	0	0	0	0
20.CHEESE PROCESSING	0	2	2	2	1
21.REFRIG. & ELECTRONICS REPAIR	13	9	6	2	2
22.SOFT DRINKS AND BEVERAGE WAREHOUSE	3	2	2	2	0
23.HARDWARE STORE	6	3	4	2	2
24.CEMENT BLOCK MANUFACTURING	8	2	2	4	5
25.WOOD INDUSTRY	6	7	3	1	12
26.WOOD & METAL FACTORY	0	2	2	0	0
27.CATTLE RANCH	0	7	7	0	0
28.MILK PRODUCTION FARM	N.A.	4	2	N.A.	0
29.MILK COLLECTION CENTER	1	0	3	0	0
30.FISHING & PACKING INDUSTRY	0	3	0	0	0
31.OIL PROCESSING INDUSTRY	3	0	0	0	0
32.BASIC GRAIN WAREHOUSE	3	2	2	2	2
33.BANANA PRODUCTION & PACKING	9	0	14	0	0

By contrast, the study found only four types of productive activities in nonelectrified communities: small general stores (*pulperías*) that use gas refrigerators, corn mills powered with diesel motors, tailor and seamstress shops that use manual sewing machines, and carpentry shops that use manual equipment.

Regarding the impact of electrification on the development of electrified productive use activities, the research indicated that 81% of the small productive use activities and 71% of the large activities were initiated after the electrification project began. The evidence suggested, however, that this local economic growth was not the result of the electrification project by itself, but of the project in combination with infrastructure and institutional programs that began in the Aguán Valley in 1976, seven years before electricity became available. Those programs included agrarian reform; colonization; agricultural credits to cooperative groups; road paving between

major towns; increased access of businesses to formal credit sources; and projects for potable water, health, and education. Owners and managers of productive activities who were interviewed for this study said that in addition to the availability of electricity, the growth of productive use was also due to increased (and dependable) household incomes resulting from agrarian reforms, and to the availability of credit. Thirty-eight percent of these owners and managers said that the growth of their productive use activities was due in part to their having received loans from private banks or development agencies.

In order to measure the backward and forward linkages of electrified productive use activities, the study divided the activities into three economic categories: export industries, processing industries, and commercial and service activities. The categories and linkages of identified activities are shown in Annex 10. On the basis of surveys and field work, the study determined that the processing industries have the highest number of backward and forward linkages (80% backward linkage, 33% forward linkage), the commercial and service activities have the next highest (61% backward, 13% forward), and the export industries have the fewest (50% backward, 0% forward). These figures indicate that in all categories, more productive use activities contribute to the economy by purchasing inputs from local suppliers than by selling output to other local productive activities; this is because most outputs are sold to final consumers, or, in the case of exports, are sold overseas.

The intensity of individual activities, in terms of their R_a, R_b, and R_c ratios, is shown in Table 10. The letter C in the table indicates a commercial activity, I indicates an industry or agro-industry, and S indicates a service activity. R_b is shown for purposes of comparison.

TABLE 10: RATIOS OF INTERDEPENDENCE THROUGH PURCHASES AND THROUGH SALES OF PRODUCTIVE USES OF ELECTRICITY

PRODUCTIVE USE	R_a (a\)	R_b (b\)	R_c (c\)
1. RICE WAREHOUSE (C)	86	86	80
2. LUMBER YARD (I)	58	53	60
3. FURNITURE MAKING (LARGE) (I)	55	55	0
4. WOOD INDUSTRY (I)	0	0	60
5. WOOD & METAL FACTORY (I)	5	5	0
6. CATTLE RANCH (I)	20	20	45
7. MILK PRODUCTION FARM (I)	20	20	89
8. MILK COLLECTION CENTER (S)	53	0	0

9. FISHING & PACKING INDUSTRY (I)	0	0	0
10.OIL PROCESSING INDUSTRY (I)	31	0	2
11.BASIC GRAIN WAREHOUSE (C)	93	0	0 (1)
12.BANANA PRODUCTION & PACKING (I)	N.A.	N.A.	0 (2)
13.SAWMILL (I)	6	6	55
14.AGRICULTURAL MACHINERY REPAIR (S)	0	0	60
15.GAS STATION (S)	0	0	0 (1)
16.CEMENT BLOCK MANUFACTURING (I)	68	52	0 (1)
17.TAILOR SHOP (SMALL) (I)	19	19	0
18.TAILOR SHOP (LARGE) (I)	0	0	0
19.CHEESE FACTORY (I)	76	0	0
20.AGRICULTURAL STORES (C)	0	0	0 (1)
21.BUTCHER SHOP (C)	56	0	0
22.LEATHER WORKS (I)	0	0	0
23.CORN MILL (S)	1	1	0
24.FURNITURE MAKING (SMALL) (I)	64	64	0
25.FOOD & BEVERAGE BUSINESS (S)	64	54	0
26.HARDWARE STORES (C)	0	0	0 (1)
27.BAKERIES (I)	50	45	0 (1)
28.AUTO & MOTOR REPAIR (S)	18.5	18.5	0 (1)
29.BICYCLE PARTS BUSINESS (S)	0	0	0 (1)
30.WELDING SHOP (S)	0	0	0
31.BICYCLE REPAIR (S)	79	79	0
32.SOFT DRINKS & BEERS WAREHOUSE (C)	0	0	100

33.TIRE REPAIR (S)	19	19	0
34.PRIVATE HEALTH CLINIC (S)	0	0	0
35.CASSAVA PROCESSING (I)	38	0	0
36.REFRIGERATION REPAIR (S)	37	37	0
37.SMALL MISCELLANEOUS BUSINESS (C)	19	19	0 (3)
38.CARPENTRY SHOPS (I)	60	60	0
39.GENERAL STORES (PULPERIAS) (C)	44	44	0
40.POOL HALL (S)	54	54	0
41.LARGE BUSINESSES (C)	0	0	0 (1,4)
42.ICE CREAM SHOPS (C)	37	0	0

a\ Ratio of Purchases from local productive activities to total output.(%)
b\ Ratio of Purchases from PUEs to total output.(%)
c\ Ratio of Sales to local productive activities to total Output.(%)

(1) Although these PUEs sell output to other electrified and non-electrified productive activities, owners and managers of these PUEs could not distinguish between sales to other productive activities and sales to final consumers.

(2) Personnel working for the Standard Fruit Company was reluctant to provide the team with detailed information regarding total output, prices, inputs for production, and quantities purchased. What the team was able to find is that 70 percent of the Standard Fruit Co. inputs are bought outside the region; 50 percent is imported from the U.S. and 20 percent is bought in other regions of Honduras.

(3) Miscellaneous Business include xeroxing, film developing, and private mailing businesses, movie houses, beauty parlors, and jewelry and shoe stores.

(4) Large businesses include drugstores, health clinics, hotels and supermarkets.

As shown in Table 10, the study found that the values for R_a and R_c of the electrified productive use activities in the sample were generally low, particularly for commercial and service activities. This was not surprising, since studies have shown that low ratios of interdependence are typical for commercial and service activities even in developed countries. The ratios for the processing industries were higher, which indicates that processing industries are the vehicle through which electrification can have the greatest impact on economic growth in the Aguán.

Recommendations

This study yielded two findings that have important implications for the selection of sites for electrification. The first finding is that the level of productive

activities in the electrified area is very high compared with surrounding nonelectrified communities; and that these activities are the result of a number of factors of change, of which electricity appears to be a key element. This finding leads to the recommendation that site selection should include an assessment of existing and planned infrastructure development projects, and that preference should be given to sites where development programs are underway or will be implemented concurrently with electrification. This finding strongly suggests that infrastructure projects that lack an electrification component will be less successful than those that include electrification.

The second finding is that the growth linkage impact of productive activities is strongest in processing industries and weakest in export industries. This finding leads to the recommendation that processing industries should be targeted for promotional activities, and that preference should be given to sites where processing industries have developed or have the potential to develop, in order to spread the impact of rural electrification beyond the direct beneficiaries of the project.

4. SOCIAL IMPACTS

In addition to the economic and linkage analyses, the NRECA/CARES study was concerned with the social impacts of electrification on two levels: in the home and on community services. Because a number of previous studies have suggested that women are the main beneficiaries of household electrification, this study paid special attention to determining the extent of that impact. And because some previous studies have had conflicting conclusions about whether electrification helps the poor or subsidizes the rich, this study also included several indicators of socioeconomic status to help determine whether electrification was benefitting the poor.

Methodology

Questionnaires and a sampling plan for the social impact analysis were designed after a visit to the Aguán region and interviews with USAID/Honduras officials in March 1991. Questionnaires were then field tested in eastern Guatemala, which socioeconomically resembles Honduras, in April and May 1991. Field work in the Aguán Valley was performed in June 1991.

A two-stage cluster sample was taken of households electrified under the project. In the first stage, 26 newly electrified communities or neighborhoods throughout the Aguán Valley were randomly selected, using ENEE's customer lists from its 4 subsystems: La Ceiba, Tocoa, Trujillo, and Olanchito. The sample was taken from the 14,000 residential and business customers who had been electrified for at least a year. Initial interviews had indicated that there was not much variation among the towns, so the random sample was assumed to be representative. A list of the communities sampled and the number of interviews conducted in each community appears in Annex 11.

Next, within the 26 communities, the team conducted interviews using short questionnaires in a total of 291 randomly chosen households; of those, 287 interviews produced complete information. Also during this stage, community leaders were questioned about community services linked to the use of electricity. As a point of general (not statistical) comparison, 41 interviews using a similar questionnaire were conducted in 4 nonelectrified communities of similar size and population, and the community leaders in those towns were also interviewed about community services.

The questionnaires used in these surveys are reproduced in Annex 3, and tabulations of the open-ended questions are given in Annex 4.

The interview team consisted of six men and six women, plus a woman as supervisor and another as principal investigator. The gender of both interviewer and respondent were coded. The interviewers were either graduates or final-year students at CURLA, the Ceiba branch of the National University. They were all native to the area or familiar with it through long residence.

For the household study, the team tried wherever possible to interview the woman in charge of the household, although if she were unavailable, another adult member of the household or an adolescent was interviewed. Of the 287 completed interviews, 224 were with women and 63 were with men.

The household questionnaires were designed to create a user profile and to answer questions about the impacts of electricity in the home. Questions concerned the costs of using electric lights and appliances, the types of residential productive uses, the amount of time or effort saved on routine household tasks, the uses of released time from household or business tasks (especially whether released time enabled school-age children to actually go to school), the uses of evening hours with electric lighting, and the impacts of radio and television.

For the community surveys, community leaders were asked about services such as potable water, health posts, education, and community halls which might use electricity. They were also asked about the economic base of the community, its businesses, and population size. To measure growth, they were asked the number of new houses constructed in the past year. Interviewers also visited schools and health clinics, and, wherever possible, spoke with teachers, teachers' aides, health professionals, presidents of *patronatos*, and municipal officials in urban concentrations.

Data from the questionnaires were analyzed by the Guatemalan firm of DataPro; SPSS/PC+ was used to generate frequency distributions and cross tabs.

Results

The tabulation of data from the questionnaires revealed no differences in responses due to gender (either the gender of the interviewer or the respondent), except that male respondents were less able to answer questions about time spent on household tasks.

The user profile that emerged for electrified households showed that households ranged in size from 1 to 19 people, with an average of 6 people including 3.1 children. The head of household averaged 4.8 years of education (the national

average is 2.5 years), with 8.8% having graduated from high school. Occupations of heads of households, even in urban areas, were primarily related to agriculture. Women identified themselves as the head of household in 8.4% of the sample. The average annual per capita income for electrified communities was $249.89 (the national average is $203.59). All but 3.8% of the houses were of "formal" construction (cement block, finished adobe, or brick), with an average of 4 rooms, and with 83.6% of the houses owned by the occupant.

By contrast, the user profile for nonelectrified households revealed an average household size of 7 people with 3.7 children; an average education level of 2.7 years; an annual per capita income of $167.19; and smaller, less well-constructed houses with an average of 2.7 rooms, 98% of which were owned by the occupant.

Based on the differences in these profiles, the study seemed to confirm the conclusions of previous studies that income and education rise and fertility falls as one moves along a modernization sequence, i.e. from rural nonelectrified to rural electrified to urban electrified households. However, no direct causal relationship was established between electrification and a decline in fertility, which most likely is a secondary effect of increased income and education, as well as other factors.

The study also indicated that for each community, the social impacts of electric lighting and electronic media (radio and television) in the home were more pronounced that the impacts of electric appliances. While refrigerators (in an average of 51% of electrified homes), irons (66%), and electric mills for grinding corn seemed to make houswork easier for women, the surveys showed that women with such appliances did not spend significantly less time on household tasks, and so had little released time for other activities. Refrigeration did seem to contribute to improving nutrition by enabling the household to store cooked food, meat, fish, eggs, and vegetables. Refrigerators also contributed to household income for 27% of those who owned them by enabling the owner to sell flavored ices or cold soft drinks. Of those who sold food and drinks out of their homes, about 70% said they considered the activity to be a business. That is, in terms of the study, 70% of households with refrigerators operated them for a productive use. By contrast, only 0.6% of irons and 0.6% of electric sewing machines in electrified households were operated for productive use.

In regard to home use of electric lighting and electronic media, the survey showed that lighting (in 100% of electrified homes) made a significant difference in the quality of life by increasing security and extending the hours for productive work, education, reading, and visiting with friends. In homes with radio (77%) and television (47%), however, the time spent visiting with friends decreased slightly for women, even as it increased slightly for men. For electrified homes with radio, 97% of the respondents said they had heard health messages; and 82% regularly listened to news, 79% to music, 31% to sports, 18% to religious programs, 14% to soap operas, 12%

to educational programs, and 5% to agricultural information. By contrast, people in nonelectrified households using battery-powered radios listened to significantly more religion (36%), sports (44%), soap operas (20%), and educational programs (24%). Listening in other categories did not vary significantly.

Television owners showed a different program preference, with a signficantly fewer watching news (39%) and religious programs (4%), and significantly more (81%) watching soap operas. The impact of television seemed to be that it brought viewers into contact with an international culture; many, for example, said they watched English-language films, comedies, and action programs. More than half the households that had television were connected to a satellite receptor. By contrast, radio brought listeners into contact only with national and local programming. The study did not analyze the impacts of exposing television viewers to international culture, but such exposure is assumed to contribute to the general effects of education and modernization.

In regard to community uses of electricity, the study found that the strongest impacts were on the quality of education. Honduras provides primary education to 97% of its school-age children, including those in the project area. In general, the benefits of electricity were distributed evenly among the school-age population, with each primary school using about 25 kWh a month. All primary schools had lighting, and some also used electricity for fans, or for cassette players to play music or folklore stories or for special events. Enrollment was almost equally divided between boys (51 percent) and girls (49 percent).

The impact of electrification on educating the adult population was even more significant. The study found that electrified communities often had public secondary schools, both academic and technical; private trade schools, such as sewing and secretarial; and night schools, ranging from basic literacy training to complete secondary education. Secondary and vocational institutions were concentrated in or near larger communities, but even tiny hamlets had night schools. Electrified communities also had kindergartens, and many used school facilities to run *comedores infantiles* (feeding programs for children).

In regard to the health benefits of electrification, the study found that the 26 electrified towns had a total of 10 health posts, while the 4 nonelectrified towns surveyed had a total of one health post. Eight of the electrified clinics had refrigeration, enabling healthcare workers to store vaccines; and 7 had sterilization facilities.

Other social benefits of electrification included nighttime lighting of community halls for community meetings.

Recommendations

In view of the significant positive impact of household and community electrification on the quality of health, education, security, infant care, and the productivity of women in rural areas, one recommendation is that future projects should emphasize the importance of social impacts as well as productive uses as a measure of project success. Enhancement of the quality of life, including released time for women, better nutrition and access to vaccines made possible by refrigeration, and exposure to international culture through electronic media, also correlate, as do productive activities, with the trend toward modernization. Such impacts can be considered infrastructure improvements that continue to take place after site selection.

Another recommendation is to introduce productive activities to women concurrent with the electrification process, to give women options for using their released time for increased productivity or education.

5. CONCLUSIONS AND LESSONS LEARNED

The Aguán Valley project demonstrates that the economic impact of rural electrification is significant, and that it can be maximized by promoting productive uses of electricity. The sooner productive use activities enter the benefit stream, the more they will contribute to the success of the project. Productive use programs therefore should be considered as an integral part of project design.

As the Aguán Valley project is currently organized, it shows dismal financial results but substantial economic benefits to both residential and productive use consumers. Although the economic NPV is US$46.7 million, the financial NPV is US$(21.6) million, with rising kWh sales resulting in constantly increasing losses for ENEE. Section 2, the financial and economic evaluation of the project, identifies the causes of the financial problems as inappropriately low tariffs, system losses, and excessive operating and maintenance costs. The alternate scenarios discussed in Section 2 show that tariffs must be increased on the order of 100 percent, and that system losses and management costs must be reduced, for the project to have a positive cash flow in, at the soonest, 10 years. Even though financial viability is not the primary goal of rural electrification projects, improving the project's financial return is considered critical to its long-term success.

To avoid financial problems in future rural electrification projects, the impact of tariffs, system losses, and operating and maintenance practices should be quantified and addressed before projects are implemented and imposed on debt-ridden national utilities. Methodologies should be designed and tested to ascertain rural consumers' willingness and ability to pay for electricity in relation to other goods and services. Other questions to consider are whether there should be differential tariffs for each electrification project, depending on its financial benefit/cost situation; and whether utilities should subsidize certain categories of consumers. The cost of future projects can be reduced by including household wiring in initial project design; this will also increase the financial return by maximizing initial sales.

Productive uses of electricity not only benefit the direct end users (via increased productivity and/or lower cost of production as measured by DAM), but also serve as a catalyst for secondary activities. The interdependence of productive uses and secondary activities is strongest in production activities, with processing industries based on local raw materials and destined for local consumption having the greatest impact on local economies. Local production activities should therefore be promoted in rural electrification projects.

Seventy to 80 percent of the productive activities in the Aguán Valley were initiated after the electrification project was completed. Although it is not possible to conclude that electrification is the sole cause of significantly increased productive activity, it appears that electrification is a critical component of development, and therefore should be coordinated with other development efforts.

The social impact of rural electrification is positive, although perceived benefits often are not quantifiable. Electrification contributes to increased productivity, household income, and education; improved nutrition and health care; better security; and the general level of enlightenment and sophistication, particularly from access to electronic media, which brings families into contact with news, religious, health, educational, sports, and foreign language programs.

In economic and human terms, the Aguán Valley rural electrification project has been a success. In retrospect, the economic, financial, linkage, and social impacts could have been increased in the ways described in this document. Designers of future rural electrification projects should closely evaluate the Aguán experience and incorporate the lessons learned into their efforts.

ANNEXES

ANNEX 1. PROJECT SPECIFICATIONS

1) Physical Transmission and distribution plant constructed with project funds.

Transmission: 180 Kms of 138 Kv line as follows

La Ceiba - Reguleto	71 Kms.
Reguleto - Isleta - Bonito Oriental	56 Kms.
Reguleto - Coyoles Central	53 Kms.

Main substations:

La Ceiba substation modifications for Jutiapa 34.5 Kv. line.
Reguleto 138 Kv switching substation.
Isleta substation: 138/34.5 Kv, 6.25 MVA, 4 feeders.
Bonito Oriental Substation: 138/34.5 KV, 12.5 MVA, 4 feeders.
Coyoles Central substation: 138/34.5 KV, 12.5 MVA, 4 feeders.

Distribution: 470 Kms of primary lines 34.5/19.9 KV as follows.

3 phases	300 Kms.
2 phases	70 Kms.
1 phase	100 Kms.

185 Kms of secondary lines 120/240 volts.

6325 KVA in distribution 34.5 - 19.9 KV/120-240 transformers as follows:

205 X 15 KVA.
60 X 25 KVA.
35 X 50 KVA.

Household wiring was deleted from the original construction plan, and internal wiring materials were sold, to get funds for the Jutiapa-Belfate Line.

2) Construction costs of the original Project.

According to the last available "updated financial plan", as of May 1984, the overall figures are:

	AID	ENEE	US$ TOTAL
Transmission line (138 KV)	4930921.86	979930.-	5910851.86
Substations (five)	1950448.18	1380977.-	3331425.18
Distributions System	4618629.96	2593744.-	7212373.96
Storage, Offices and Training facilities		92000.-	92000.00
Training Program		99146.-	99146.00
Engineering and administration		3000955.-	3000955.00
Interests during construction		790000.-	790000.00
Maintenance equipment		388000.-	388000.00
Total cost	11500000	= 9325000.-	20825000.00

The main contractors for principal items were:

Transmission line	Richards & Associates
Substations	CELNÌCSA
Distribution System	Koonts - Wagner Electric Co.
Design	Reyes - Harza.

3) <u>Additions to the original Project</u>

a) Line extensions

There is no information, neither in Tegucigalpa, nor in La Ceiba ENEE'S files, concerning line extensions over the backbone project. The only way to establish the number, extension and characteristics of line additions, is by field work along the total network.
Distribution engineering in La Ceiba offices, estimate a growth of 25% over its original lenght for the Aguan Valley system.

b) From available information in the Commercial Department in La Ceiba, the Table of Customers per Year from 1985 to January 1991, was obtained.

1985	7826	(Dec)
1986	8914	(Dec)
1987	10005	(Nov)
1988	10839	(Oct)
1989	11751	(Jul)
1991	13985	(Jan)

c) Household wiring costs:

From project estimates for 1982, the internal wiring costs, including labor, was:

Minimal: 1 lamp plus 2 outlets, 120/240 volts L. 117.84
Medium : 1 lamp plus 4 outlets, 120/240 volts L. 190.00

Prices for 1991, for a medium size installation are: L. 200.00; labor, plus L. 400.00, for electrical materials. Total L. 600.00

d) Costs per Km for distribution lines.

There are not actualized costs for distribution line construction, because of lack of materials in ENEE'S warehouses since 1989. The last available official prices are from July, 1986. Prices for 1991 are estimated costs from contractors.

	1986	1991 *
Primary line, 30, 34.5KV, 1/0 cable and #2 neutral	L.15215.23/Km.	L. 68000/Km.
Primary line, 20, 34.5KV, 1/0 cable and #2 neutral	L.13184.08/Km.	L. 46000/Km.
Primary line, 20, 34.5KV, 1/0 cable and #2 neutral	L. 8518.81/Km.	L. 22000/Km.
Secondary line 3 wires 1/0, 240/120 volts. Including 30'poles, 2X25KVA transformers and 14 lamps.	L.21292.55/Km.	L. 56000/Km.

* Prices include 2 X 25 KVA distribution transformers.

e) All engineering services for additions in distribution lines, including private lines, are given by ENEE'S Construction Division. Private lines, once they are finished, the construction goes to ENEE's control.

4) <u>Operation and Maintenance Costs associated with the Aguan System</u>.

All activities in this area, are involved in a global account for the entire LITORAL ATLANTIC DIVISION.

Data from economical results for 1990 is attached. There is no available information about the system's total kilometers of distribution lines. ENEE'S people are just now thinking about developing a field work to establish the total lenght of the distribution network. Maintenance

engineers estimate that Aguan's system has about 30% of the total lines in La Ceiba system, and, that the actual Aguan's network is 25% bigger than the original one. Using this data it is possible to assume an estimate of maintenance and operation costs.

1990 Average Monthly Costs:

Operation Costs	L. 67,793.-
Maintenance and repair cost	L. 54,537.-
Administration cost	L. 90,031.-
Customers accounts	L. 62,934.-

Estimate of maintenance cost per Km.:

Original Aguan's distribution network lenght	655 Kms.
25% increased network	820 Kms.
If 30% of total Litoral Atlántico System is	820 Kms.
Then total Litoral Atlántico System is about	2730 Kms.
and monthly maintenance cost per Km. is	L 200/Km/month

Estimate of operational cost per customer:

Average monthly cost for La Ceiba System	L. 67793.-
January/91 customer for the complete system	38178.-
Operational cost per customer	L. 1.80/customer
Administration cost per customer	L. 2.40/customer

5) <u>Average Service Cost for the Aguan System</u>.

Using the complete La Ceiba system information, the monthly average with figures of 1990 and customers for January 1991 are:

Meter reading cost	L. 5075.44/month
Billing and collection	L. 24534.18/month
Others (supervision, uncollectable * accounts)	L. 24365.20/month
TOTAL	L. 53974.82/month

January, 1991 Customers 38178

Average monthly service costs per customer are:

Meter reading	L. 0.13
Billing and collection	L. 0.64
Others	L. 0.64
TOTAL	L. 1.41

6) Average Generation costs since Aguan Project completion.

a) It was not possible to get information for generation costs for the 1984 - 1990 period. Projected marginal prices from 1990 to 2000 taken from "Plan Optimo de Expansión" are:

Years	Generation	Transmission	Primary Distribution	Secondary Distribution
1990	0.0414 US$/Kwh	0.0473	0.0593	0.0848
1991	0.0414 "	0.0473	0.0593	0.0832
1992	0.0414 "	0.0473	0.0589	0.0805
1993	0.0414 "	0.0473	0.0579	0.0772
1994	0.0414 "	0.0473	0.0579	0.0760
1995	0.0661 "	0.0733	0.0851	0.1056
1996	0.0661 "	0.0733	0.0847	0.1050
1997	0.0661 "	0.0733	0.0847	0.1049
1998	0.0661 "	0.0733	0.0847	0.1049
1999	0.0661 "	0.0733	0.0847	0.1049
2000	0.0661 "	0.0733	0.0847	0.1049

b) Load Factor for the Aguan System.

From the statistical report of the Planning Division, the average figure for the complete Litoral Atlántico System for 1989 is 64.8%, but for the Aguan Valley System, using meter readings in the substations of Reguleto, Coyoles, Isletas and Bonito Oriental, that were available in the Central Térmica La Ceiba's files, this factor is lower.

For 1989

Yearly Average Peak demand	12.94 Mw
Energy Consumption	55960.00 Mwh
Load Factor	49.4 %

For 1990

Yearly Average Peak demand	13.68 Mw
Energy Consumption	63987.00 Mwh
Load Factor	53.4 %

From 1984 to 1988, meter readings in substations were not taken.

For 1991, the only available data is for January:

Peak demand	14.4 Mw.
Energy Consumption	4590.0 Mwh.
Load Factor	43 %

Maybe the reason for this low load factor, is the lack of meters in big irrigation systems. A load management study will be useful to determine the causes.

7) Projected average costs for generation

From "Plan Optimo de Expansión" in the Economical Planning Department of ENEE. the following information was taken:

Projected Marginal Costs US$/Kwh.

Year	Basic Economic Outlook			
	Generation	Transmission	Distribution H.V.	Distribution L.V.
1990	0.0414 US$/Kwh	0.0473	0.0593	0.0848
1991	0.0414 "	0.0473	0.0593	0.0832
1992	0.0414 "	0.0473	0.0589	0.0805
1993	0.0414 "	0.0473	0.0579	0.0772
1994	0.0414 "	0.0473	0.0579	0.0760
1995	0.0661 "	0.0733	0.0851	0.1056
1996	0.0661 "	0.0733	0.0847	0.1050
1997	0.0661 "	0.0733	0.0847	0.1049
1998	0.0661 "	0.0733	0.0847	0.1049
1999	0.0661 "	0.0733	0.0847	0.1049
2000	0.0661 "	0.0733	0.0847	0.1049

8) Load Losses

There is not enough data for technical calculations, because the neccessary information, comes from updated configurations of the distribution network, that are not available but the electrical design is good enough to keep technical losses no bigger than 5%.

Official figures from ENEE'S Planning Division states a blended average of losses in 19% for 1989, which is the last year tabulated.

Comparing meter readings found at Central Térmica files, from the Isletas, Bonito Oriental and Coyoles Central Substations, and the billings from the Commercial Department at La Ceiba Division, the results are very different.

1989 -	Monthly average readings in substation	5100 Mwh
	Monthly billing average	3200 Mwh
	Average Losses	37%
1990 -	Monthly average readings in substation	5330 Mwh
	Monthly billing average	Not available
1991 -	(January)	
	Energy registered in main substation	5040 Mwh.
	Energy billed	3222
	Losses	36%

Accuracy of readings is not possible to establish, because there is no registration of meter tests, but calculations from readings in substations are more credible than estimates found in official data sheets.

A value of 25% to 26% is conservative for analysis in the DAM program.

9) Quality of design and construction methods used in the original project and new expansions.

Standards used in the original Aguan's project were almost the same than the REA standards. Harza Engineering Co. was the responsible for lines and substations design. The construction's supervision responsibility was with ENEE'S engineers. No modifications to the original design were neccessary. It is almost the same design and building standards nowadays used.

The problems detected in design criteria are three.

1) Cable used for the line from Bonito Oriental to Puerto Castilla is 266 MCM and structures were not reinforced for the extra weight. Several insulator pins were bent.

2) Insulation for lines along the coast have salt deposits problems and insulators shape were not the anti-fog type.

3) The use of triplex type cable allow easy fire expansion along the cable, in short circuit or false contact heat generation.

Construction differences between, the original lines and the additions are because of the lack of standard materials in their warehouses by long periods of time, forcing them to change their standards. ENEE'S engineers are responsible for the design and the construction of new lines and substations. They have enough experience to do it, but not always the necessary equipment to make it easy.

Private electrical lines to be connected to ENEE'S system, are reviewed by ENEE'S engineers before its connection and acceptance.

ANNEX 2: LIST OF COMMUNITIES COVERED BY THE AGUAN ELECTRIFICATION PROJECT

Agalteca
Agua Amarilla
Agua Caliente
Aldea Coyoles
Arenal
Balfate
Barrancho Chele
Barranco
Boca de mame
Caballeria
Calpules
Campo Calpules
Campo Balsamo
Campo Capulin
Campo Copete
Campo El Caulote
Campo El Chorro
Campo Guanacaste
Campo Limones 4
Campo Limones 6
Campo Nerones
Campo Nuevo
Campo Oscuro
Campo Palo Verde
Campo Vally
Carrioles
Cayo Sierra
Ceibita (Saba)
Ceibita (Tocoa)
Chacalapa
Chapagua
Chiripa
Chorrera
Churrusquera
Colonia Aguan
Colonia y Cooperativa Chiripa
Concepcion
Cooperativa Colon
Cooperativa Dos Bocas
Cooperativa El Esfuerzo
Cooperativa Honduras Aguan
Cooperativa Lempira
Cooperativa Los Laureles
Cooperativa Luz del Valle
Cooperativa 9 de Agosto
Cooperativa Salama
Cooperativa Suyapa
Cooperativa 21 de Noviembre
Corocito
Corozal
Cuaca Viejo
Curva de Isletas
El Achiote
El Antigual
El Cacao
El Cafe
El Carbonal
El Carril
El Guapinol
El Juncal
El Nance
El Ocote
El Olvido
El Peru
El Sinai
Elixir
Faust
Ilanga
Isleta Central
Jerico
Jutiapa
La Esperanza
La Polla
Lanza
Lerida
Lorelay
Los Amarillos
Los Planes
Mendez
Monte Abajo
Nombre de Jesus
Nueva Armenia
Olanchito
Paguales
Palmichal
Potrerillos
Prieta
Puerto Castilla
Puerto Escondido
Quebrada de Arena
Rigores
Rio de Piedra
Rosario
Sabana de San Carlos
Salama
Salitran
Sambo Creek
San Carlos
San Francisco
San Jeronimo
San Jose
San Lorenzo
Santa Barbara
Santa Fe
Santa Rosa de Aguán
Sava
Sonaguera
Tarros
Taujica
Tecualtuste
Teguajal
Teguajinal
Tejeras
Tiburones
Tocoa
Trojas
Trovador
Trujillo
Tumbador
Utila
Zamora

ANNEX 3: QUESTIONNAIRES USED IN THE SOCIAL IMPACT STUDY

COMUNIDAD RURAL ELECTRIFICADA - IMPACTO RESIDENCIAL

:stamos haciendo una serie de estudios que servirán para evaluar los beneficio
le la utilización de la electricidad en áreas rurales de Honduras. L
:: boración que nos brinde servirá para planificar el mejoramiento del servici
·lectrico en este país. Los resultados serán confidenciales. Se apunta su nombr
·olo por si fuera necesario chequear la información con Ud.

1. Nombre del entrevistado	ENTREVIS	m=1 f=2
2. Cuantas personas viven en esta casa? Empezemos con los **adultos**:	ADULTOS	_____
	ADULTOH Hombres___	ADULTOM Mujeres___
De los niños de edad escolar: Cuántos **niños** varones hay entre la edad de 6 y 16 años? Cuántos de estos asisten a la escuela?		NIÑOS _____ ESCRINOS _____
Cuántas **niñas** hay entre la edad de 6 y 16 años? Cuántas de estas asisten a la escuela?		NIÑAS _____ ESCRINAS _____
Cuántos ninos hay que tengan 5 años de edad o menos?		MENORES _____
3. Cuántos ambientes hay en la vivienda?		CUARTOS _____
4. La casa es propia? 1=si 4=parte de una finca 2=aquilada 5=parte de cooperativa 3=cedida 6=otra		TENCASA _____
5, Cuánto paga de renta? [o cobraría si fuera aquilada]		RENTCASA _____
6. Desde hace cuánto tiempo tiene luz (años)?		TLUZ _____
7. Cuántas bombillas (focos) tiene en la casa De cuántos vatios son? F25___ de 25, F40___ de 40 F60 ____de 60, F75___ de 75, F100___ de 100 o mas.		FOCOS _____
8. Cuánto cuestan (*confirmarlo en las tiendas*)? CF25____L(25V) CF40___L(40V) CF50 ___L(50/60V) DF75____L(75V) CF100___L(100V) ___L___V.		
9. Cuántos tubos fluorescentes (candelas de neon) tiene para usar en la casa propiamente? De cuántos vatios son? T20____ de 20 V, T40____ de 40V		TUBOS _____
10 Cuánto cuestan? (*confirmarlo en las tiendas*) CT20_____L(20V) CT40____L(40V)		

11. Tiene radio? RADIO ___ si(1) no(2) [->15]

12. Cuántas horas escucharon al radio ayer? HRADIO _____
Lo usa conectado o con pilas? Horas al dia conectado_____ HRADIOC
Horas al dia con pilas_____ HRADIOP

13. Qué tipo de programas escucha mas? (ordenar- 1,2...)) SI=1 NO=2

música_____	RMUSICA	educación____	REDUCA	inf.ag._____	RINFAG
novelas_____	RNOVELA	religión_____	RRELIG	noticias_____	RNOTICIA
deportes_____	RDEPORTE	_____	ROTRO	_____	

14. Ha escuchado un mensaje de salud en el radio? si(1) no(2)
(Por ejemplo, de vacunización) RMSALUD

15. Tiene television? TV si(1) no(2) [->21]

16. Cuántas horas mirarón uds. la televisión ayer? _____
HORASTV

7. Está conectada a un sistema de cable? si(1) no(2)
CONCABLE

18. Cuánto cuesta la conexión? _____
CCONEXC

19. Cuánto es la mensualidad del cable? _____
CMENSC

20. Qué tipo de programas miran Uds. mas? (indicar orden) SI=1 NO=2

novelas_____	TVNOVELA	comedias_____	TVCOMED	información_____	TVINFO
deportes_____	TVDEPORT	noticias_____	TVNOTI	religión_____	TVRELIG
educación____	TVEDUCA	infantiles____	TVINFANT	peliculas_____	TVPELIC
acción/espionaje_____	TVACCION	otros_____	TVOTRO		

21. Tiene refrigeradora? REFRIG si(1) no(2)

22. Qué tipo de comida guarda en la refrigeradora? SI=1 NO=2

leche_____		huevos_____		carne_____	
pollo_____		pescado____		fruta_____	
verdura____		frescos____		cerveza____	
helados____		pan/tortilla___	PAN	comida cocida___	COMCOCI
otro_____	REFOTRO	_____		_____	

23. Qué combustible usa Ud. para cocinar? (1..6) COMBUS1_____

I.

leña___	1	3 kerosina___		5 gas propano_____	
gas ____	2	4 eletricdad___		6 otro_____	

II. COMBUS2 _____

leña___	kerosina___	gas propano_____
gas ____	eletrcidad___	otro_____

24. Qué otros aparatos eléctricos tiene? SI=1 NO=2

__plancha
__liquadora
__tostadora
__aspiradora
__maquina overlock
__bomba agua BOMAGUA
__cocina 1 quemador
__otro_____ APOTRO

__ventilador
__batidora
__cafetera
__reloj
__tejedora
__electroducha
__cocina 2 quemadores
_____

__~~tostadora~~
__estufa con horno
__maquina coser
__secadora pelo
__lavadora de ropa
__calentador agua
__aire acondicionador
_____

25. Le voy a hacer algunas preguntas en cuanto a sus tareas domésticas, a Ud. ó a sus hijos. Por favor digame cuántas horas diarias le lleva hacerle a Ud. o otros miembros de su familia, y quien las hace.

buscar/traer leña LEÑ

_____horas de la mujer HM
_____horas del hombre HH
_____horas de los niños HÑO
_____horas de las niñas HÑA

traer agua

_____horas de la mujer AGUHM
_____horas del hombre AGUHH
_____horas de los niños AGUHÑO
_____horas de las niñas AGUHÑA

planchar PLR

_____horas de la mujer PLHM
_____horas del hombre PLHH
_____horas de los niños PLHÑO
_____horas de las niñas PLHÑA

moler MOL

_____horas de la mujer MOLHM
_____horas del hombre MOLHH
_____horas de los niños MOLHÑO
_____horas de las niñas MOLHÑA

preparar comida COM

_____horas de la mujer COMHM
_____horas del hombre COMHM
_____horas de los niños COMHÑO
_____horas de las niñas COMHÑA

limpieza LIM

_____horas de la mujer LIMHM
_____horas del hombre LIMHH
_____horas de los niños LIMHÑO
_____horas de las niñas LIMHÑA

cuidar niños

_____horas de la mujer
_____horas del hombre
_____horas de los niños
_____horas de las niñas

lavar LAV

_____horas de la mujer LAVHM
_____horas del hombre LAVHH
_____horas de los niños LAVHÑO
_____horas de las niñas LAVHÑA

26. Cuántas horas por dia pasa Ud. o alguna otra persona de la casa comprando comida? HCOMPRA _____

27. Cuántas veces compra Ud. comida en la semana? VCOMPRA _____

29. Si Ud. usa luz eléctrica durante el día, qué hace? Cuántas horas pasa en la actividad?

DIAOFDOM oficios domésticos___ horas
DIALEE leer___ horas
DIAUSOP uso productivo___ horas
DIAOTRO _____ ___ horas

30. Si tiene ratos libres durante el día, qué hace Ud.? Más o menos cuantas horas al día?

LIBAMIG	amigos	___	horas
LIBTV	ver televisión	___	horas
LIBRADIO	escuchar radio	___	horas
LIBLEE	leer	___	horas
LIBUSCP	uso productivo_____	___	horas
LIBOTRO	otro _____	___	horas

31. Qué hace su familia de noche entre semana? Más o menos por cuántas horas? Quien hace cada actividad?

TV

_____horas de la mujer	TVHM	_____horas de la mujer	AMIHM
_____horas del hombre	TVHH	_____horas del hombre	AMIHH
_____horas de los niños	TVHÑO	_____horas de los niños	AMIHÑO
_____horas de las niñas	TVHÑA	_____horas de las niñas	AMIHÑA

Amigos

Leer/estudiar

_____horas de la mujer	LEEHM	_____horas de la mujer	USOHM
_____horas del hombre	LEEHH	_____horas del hombre	USOHH
_____horas de los niños	LEEHÑO	_____horas de los niños	USOHÑO
_____horas de las niñas	LEEHÑA	_____horas de las niñas	USOHÑA

Uso Productivo

Officios Domesticos

_____horas de la mujer	OFIHM	_____horas de la mujer	OTRHM
_____horas del hombre	OFIHH	_____horas del hombre	OTRHH
_____horas de los niños	OFIHÑO	_____horas de los niños	OTRHÑO
_____horas de las niñas	OFIHÑA	_____horas de las niñas	OTRHÑA

Otro_____

A qué horas se acostubran Uds. acostarse? _____ HACOSTAR

32. Durante los ultimos 5 años, ha tenido Ud. o algún familiar un accidente serio con kerosina, electricidad, gas propano, o fuego de la cocina? (quemadura o choque eléctrico que requirió atención médica) Si sí, cuantos?

kerosina	_____	ACCK	electricidad	_____	ACCE
gas propano	_____	ACCGP	fuego de la cocina?	_____	ACCF
ninguna	_____	ACCNIN			

33. Si tiennen algún negocio qua use electricidad en su casa, o pegado a la casa, cuál es (o son)?

	[1] NEGOCAS1	[2] MEGOCAS2
01 tienda sin refrig.		
02 tienda con refrig.		
03 sastreria/costureria/tejidos		
prepara comida para vender		
04 lavar/planchar ropa		
05 molino de maiz		
07 restaurante/comedor/cafeteria/bar		
08 salon belleza/barberia		
09 carpinteria/ebanisteria		
10 taller de reparación de aparatos electricos		
11 taller de reparación de maquinaria, equipo		
12 pinchazos		
13 clinica medica o dental		
14 carniceria o polleria		
15 venta de articulos varios		
16 venta de articulos agrícolas		
17 otro _____		

34. Qué produce (producto principal o representativo)? _____

35. En dónde compra su materia prima - Comunidad, Aguan, Honduras/de Hombre o Mujer? (apuntar en orden mencionado)

MPC ____Comunidad)	____ MPCH hombre	____ MPCM mujer	____ MPCA ambos	____ MPCN no sabe dueño
MPA ____Aguan)	____ MPAH hombre	____ MPAM mujer	____ MPAA ambos	____ MPAN no sabe dueño
MPH ____Honduras)	____ MPHH hombre	____ MPHM mujer	____ MPHA ambos	____ MPHN no sabe dueño
MPI ____Importada			SI=1	NO=2

36. Hace cuánto que empezó a trabajarlo(s) con electricidad (años)? _____
TTRABE

37. Qué aparatos (y cuántos) utiliza en el negocio? _____

38. Cuanto vende actualmente (producto principal/día[1], semana[7]/mes[30])? A qué precio?

VALOR LEM _____ DIASVENT _____

_____ por _____ a _____L

39. Dónde vende estos productos (en orden)

VC ____Comunidad)	____ VCH hombre	____ VCM mujer	____ VCA ambos	____ VCN no sabe dueño
VA ____Aguan)	____ VAH hombre	____ VAM mujer	____ VAA ambos	____ VAN no sabe dueño
VH ____Honduras)	____ VHH hombre	____ VHM mujer	____ VHA ambos	____ VHN no sabe dueño
VE ____Exportada			SI=1	NO=2

40. Cuantos empleados trabajan en su negocio? Son hombres o mujeres? Qué sueldo devengan?

1. m f L_____ EMPS1 EMPL1.
2. m f L_____ EMPS2 EMPL2.
3. m f L_____ EMPS3 EMPL3.
4. m f L_____ EMPS4 EMPL4.

M=1
F=2

41. Cuántos familiares trabajan en el negocio? Son adultos o niños, hombres o mujers? Les paga sueldo?

Adultos

1. m f L_____ EMPA1 EMPAL1
2. m f L_____ EMPA2 EMPAL2
3. m f L_____ EMPA3 EMPAL3
4. m f L_____ EMPA4 EMPAL4

Niños

1. m f L_____ EMPN1 EMPNE1
2. m f L_____ EMPN2 EMPNE2
3. m f L_____ EMPN3 EMPNE3
4. m f L_____ EMPN4 EMPNE4

42. Me permite ver su último recibo de la luz? _____KWH _____L
RECKWH RECLEMP

43. De que trabaja el (o la) jefe de la casa? (occupación) (grupo)
OCUPA OCGRUPO

I. 1
00 desocupados (ninguno, estudiante)
01 oficios domésticos no remunerados
II. 2
02 peón agícola
03 peón no agrícola
04 trabajdores en oficios domésticos remunerados
05 trabajadores en industrias caseras
III. 3
06 pequeños agricultores (4 manzanas o menos)
07 pequeños comerciantes
08 obreros calificados
09 obreros especializados independientes (dueños)
10 empleados de comercio, servicio y gobiernos (no de oficina)
11 Empleados de oficina y profesionales a nivel medio
IV. 4
12 medianos agricultores (5-30 manzanas)
13 medianos comerciantes
14 empleados ejecutivas y profesional de nivel universitario independiente
15 grandes comerciantes e industias
16 grandes agricultores y ganaderos

97 otro
98 jubilado
99 no sabe/no contesta

44. (si no es jefe de la casa) EDUCENTR
Qué grado completó Ud. en la escuela? _____

45. Qué grado completó el jefe de la casa? EDUCJEFE _____

46. Para tener idea de quienes se estan beneficiando de la electricidad, le voy a pedir que ubique su ingreso familiar mensual dentro de unos rangos. (Incluir ingresos de todos que viven en la casa y remisas de otros que no viven en la casa)

INGTOTAL _____(1..5)

Si ingresos totales son:

1. menos de L299_____?
2. mas de L300 _____?
3. mas de L600 _____?
4. mas de L750 _____?
5. mas de L1000 _____?
9. no sabe/no conteste

Y cuántas personas dependen de este ingreso? _____ DEPEND _____

47. Finalmente, nos gusteria saber que piensa usted de las ventajas y desventajas de tener electricidad en su communidad.

_____

_____

_____

_____

_____

_____

COMMUNIDAD RURAL N0-ELECTRIFICADA

:stamos haciendo una serie de estudios que servirán para evaluar el uso de varic
formas de energia en áreas rurales de Honduras. La colaboración que nos brind
; virá para planificar futuros proyectos. Los resultados serán confidenciales
;c apunta su nombre solo para si fuera necesario chequear la información con ud.

1. Nombre del entrevistado **ENTREVIS** m=1 f=2

2. Cuántas personas viven en esta casa? **ADULTOS** _____
Empezemos con los **adultos**:

ADULTOH Hombres___ **ADULTOM** Mujeres___

De los niños de edad escolar:
Cuántos **niños** varones hay entre la edad de 6 y 16 años? **NIÑOS** _____
Cuántos de estos asisten a la escuela? **ESCNIÑOS** _____

Cuántas **niñas** hay entre la edad de 6 y 16 años? **NIÑAS** _____
Cuántas de estas asisten a la escuela? **ESCNIÑAS** _____

Cuántos ninos hay que tengan 5 años de edad o menos? **MENORES 5** _____

3. Cuántos ambientes hay en la vivienda? **CUARTOS** _____

4. La casa es propia? **TENCASA** _____
1=si 4=parte de una finca
2=aquilada 5=parte de cooperativa
3=cedida 6=otra

5. Cuánto paga de renta? (o cobraría si fuera alquilada) _____ **RENTCASA**

6. Cuál es la principal forma de illuminación que utilize? _____ **TIPOILUM**
1= candil casero 4=Coleman
2=candil comprado 5=candelas
3=quinqué 6=otra

7. De qué horas a qué horas la utiliza? **HRSILUM** _____ (no. horas)
_____ a_____

8. Cuánto consume? _____ _____ la _____ **CANTCONS**
BOTELLAS/SEMANA (no.) (botellas, galones) (mes, semana)

9. Cuál es el precio? (confirmar en las tiendas) _____L por _____ **COSTCONS**

10. Qué otros gastos le ocasiona su forma principal de iluminación?
(mechas etc) _____

11. Qué otra forma de iluminación tiene? _____ **TIPOILUM**

1 candil casero 2 candil comprado 3 quinqué
4 Coleman 5 candelas 6 otra

12. De qué horas a qué horas la utiliza? HRSILUM
_____ a_____ (no. horas)

13. Cuánto consume? _____ _____ la _____ CANTCONS
(no.) (botells, galones) (mes, semana)

Cuál es el precio? (confirmar en las tiendas) _____L por CANTOCONS _____

15. Qué otros gastos le ocasiona esta forma de iluminación? _____
(mechas etc)

16. Tiene radio? si(1) RADIO no(2) (->20)

17. Cuántas horas escucharon al radio ayer HRADIO _____?

18. Qué tipo de programa escucha?

música_____ RMUSICA
novelas_____ RNOVELA
deportes_____ RDEPORTE
educación_____ REDUCA
religión_____ RRELIG
_____
inf.ag._____ RINFAG
noticias_____ RNOTICIA
_____

19. Ha escuchado un mensaje de salud en el radio? RMSALUD si(1) no(2)

20. Tiene refrigeradora? REFRIG si(1) no(2)

21 Qué tipo es? 1 kerosina 2 gas
_____ 3 solar 4 biogas TIPO REFR _____

22. Qué tipo de comida guarda en la refrigeradora? SI=1 NO=2

leche_____ huevos_____ carne_____
pollo_____ pescado_____ fruta_____
verdura_____ frescos_____ cerveza_____
helados_____ pan/tort.____ comida cocida____
otro_____ _____ _____
REFOTRO

23. Qué combustible usa Ud. para cocinar? (1..6)

I.
leña___ kerosina___ COMBUS1_____
gas ____ otro_____ gas propano_____

II.
leña___ kerosina___ COMBUS2_____
gas ____ otro_____ gas propano_____

24. Qué otros aparatos tiene? (ejemplo, televisor de bateria, maqina de coser)

SI=1 NO=2

__plancha
__reloj
__maquina coser
__bomba agua
__calentador agua
__otro_____
APOTRO

25. Le voy a hacer algunas preguntas en cuanto a sus tareas domésticas, a Ud. ó a sus hijos. Por favor digame cuántas horas diarias le lleva hacerle a Ud. o otros miembros de su familia, y quien las hace.

buscar/traer leña

___horas de la mujer LEÑHM
_____horas del hombre LEÑHH
_____horas de los niños LEÑHNO
_____horas de las niñas LEÑHNA

traer agua

_____horas de la mujer AGUHM
_____horas del hombre AGUHH
_____horas de los niños AGUHNO
_____horas de las niñas AGUHNA

planchar

_____horas de la mujer PLNHM
_____horas del hombre PLNHH
_____horas de los niños PLNHNO
_____horas de las niñas PLNHNA

moler

_____horas de la mujer MOLHM
_____horas del hombre MOLHH
_____horas de los niños MOLHNO
_____horas de las niñas MOLHNA

preparar comida

_____horas de la mujer COMHM
_____horas del hombre COMHH
_____horas de los niños COMHNO
_____horas de las niñas COMHNA

limpieza

_____horas de la mujer COMHM
_____horas del hombre COMHH
_____horas de los niños COMHNO
_____horas de las niñas COMHNA

cuidar niños

_____horas de la mujer
_____horas del hombre
_____horas de los niños
_____horas de las niñas

lavar

_____horas de la mujer LAVHM
_____horas del hombre LAVHH
_____horas de los niños LAVHNO
_____horas de las niñas LAVHNA

26. Cuántas horas al dia pasa Ud. o alguna otra persona de la casa comprando comida? HCOMPRA ____

27. Cuántas veces compra Ud. comida en la semana? VCOMPRA _____

28. Si tiene ratos libres durante el día, qué hace Ud.? Más o menos cuántas horas al día?

LIBAMIG amigo(a) ____horas
LIBRADIO escuchar radio ___ horas
LIBLEER leer ___ horas
LIBUSOP uso productivo ___ horas
LIBOTRO otro _____ _____ ___ horas

29. Qué hace su familia de noche entre semana? Más o menos por cuántas horas? Quien hace cada actividad?

TV

_____horas de la mujer **TVHM**
_____horas del hombre **TVHH**
_____horas de los niños **TVHNO**
_____horas de las niñas **TVHNA**

Amigos

_____horas de la mujer **AMIHM**
_____horas del hombre **AMIHH**
_____horas de los niños **AMIHNO**
_____horas de las niñas **AMIHNA**

Leer/estudiar

_____horas de la mujer **LEEHM**
_____horas del hombre **LEEHH**
_____horas de los niños **LEEHNO**
_____horas de las niñas **LEEHNA**

Uso Productivo

_____horas de la mujer **USOHM**
_____horas del hombre **USOHH**
_____horas de los niños **USOHNO**
_____horas de las niñas **USOHNA**

Officios Domesticos

_____horas de la mujer **OFIHM**
_____horas del hombre **OFIHH**
_____horas de los niños **OFIHNO**
_____horas de las niñas **OFIHNA**

Otro_____

_____horas de la mujer **OTRHM**
_____horas del hombre **OTRHH**
_____horas de los niños **OTRHNO**
_____horas de las niñas **OTRHNA**

A qué horas se acostubran Uds. acostarse? _____ **HACOSTAR**

30. Durante los ultimos 5 años, ha tenido Ud. o algún familiar un accidente serio con kerosina, electricidad, gas propano, o fuego de la cocina? (quemadura o choque eléctrico que requirió atención médica) Si sí, cuantos?

kerosina _____ **ACCK**
gas propano _____ **ACCGP**
ninguna_____ **ACCNIN**

electricidad _____ **ACCE**
fuego de la cocina? **ACCF** _____

31. Si tiennen algún negocio en su casa, o pegado a la casa, cuál es (o son)?

(1) **NEGOCAS1** (2) **NEGOCAS2**

01 tienda sin refrig.
02 tienda con refrig.
03 sastreria/costureria/tejidos
04 prepara comida para vender
05 lavar/planchar ropa
06 molino de maiz
07 restaurante/comedor/cafeteria/bar
08 salon belleza/barberia
09 carpinteria/ebanisteria
10 taller de reparación de aparatos electricos
11 taller de reparación de maquinaria, equipo
12 pinchazos
13 clinica medica o dental
14 carniceria o polleria
15 venta de articulos varios
venta de articulos agrícolas

20 otro_____

32. Qué produce (producto principal o representativo)?

33. En dónde compra su materia prima - Comunidad, Aguan, Honduras/de Hombre o Mujer? (apuntar en orden mencionado)

MPC ___Comunidad)	MPCH ____ hombre	MPCM ____mujer	MPCA ____ambos	MPCN ____no sabe dueño
MPA ____Aguan)	MPAH ____ hombre	MPAM ____mujer	MPAA ____ambos	MPAN ____no sabe dueño
MPH ____Honduras)	MPHH ____ hombre	MPHM ____mujer	MPHA ____ambos	MPAN ____no sabe dueño
MPI ____Importada			SI=1	NO=2

34. Qué aparatos (y cuántos) utiliza en el negocio?_____

35. Cuánto vende actualmente (producto principal/día, semana/mes)? A qué precio?

_____ por _____ a _____L
VALORLEM DIASVENT

36. Dónde vende estos productos (en orden)

VC ___Comunidad)	VCH ____ hombre	VCM ____mujer	VCA ____ambos	VCN ____no sabe dueño
VA ____Aguan)	VAH ____ hombre	VAM ____mujer	VAA ____ambos	VAN ____no sabe dueño
___Honduras)	VHH ____ hombre	VHM ____mujer	VHA ____ambos	VHN ____no sabe dueño
VE ____Exportada			SI=1	NO=2

37. Cuántos empleados trabajan en su negocio? Son hombres o mujeres? Qué sueldo devengan?

1. EMPS1 m f L EMPL1
2. EMPS2 m f L EMPL2
3. EMPS3 m f L EMPL3
4. EMPS4 m f L EMPL4

M=1 F=2

38. Cuántos familiares trabajan en el negocio? Son adultos o niños, hombres o mujers? Les paga sueldo?

Adultos

1. EMPA1 m f L EMPAL1
2. EMPA2 m f L EMPAL2
3. EMPA3 m f L EMPAL3
4. EMPA4 m f L EMPAL4

Niños

1. EMPN1 m f L EMPNL1
2. EMPN2 m f L EMPNL2
3. EMPN3 m f L EMPNL3
4. EMPN4 m f L EMPNL4

39. De que trabaja el (o la) jefe de la casa?

	(ocupación) OCUPA	(grupo) OCGRUPO
I.		
00 desocupados (ninguno, estudiante)		
01 oficios domésticos no remunerados		
II.		
02 peón agícola		
03 peón no agrícola		
04 trabajdores en oficios domésticos remunerados		
05 trabajadores en industrias caseras		
III.		
06 pequeños agricultores (4 manzanas o menos)		
07 pequeños comerciantes		
08 obreros calificados		
09 obreros especializados independientes (dueños)		
10 empleados de comercio, servicio y gobiernos (no de oficina)		
11 Empleados de oficina y profesionales a nivel medio		
IV.		
12 medianos agricultores (5-30 manzanas)		
13 medianos comerciantes		
14 empleados ejecutivas y profesional de nivel universitario independiente		
15 grandes comerciantes e industias		
16 grandes agricultores y ganaderos		
98. jubilado		
99 no sabe/no contesta		

(si no es jefe de la casa)

4 Qué grado completó Ud. en la escuela? EDUCENTV _____

41. Qué grado completó el jefe de la casa? EDUCJEFE _____

42. Para tener idea de quienes reciben o no el beneficio de la electricidad, le voy a pedir que ubique su ingreso familiar mensual dentro dentro de unos rangos. (Incluir ingresos de todos que viven en la casa y remisas de otros que no viven en la casa)

Sus ingresos totales son:

1. menos de L299_____?
2. mas de L300 _____?
3. mas de L600 _____?
4. mas de L750 _____?
5. mas de L1000 _____?
9. no sabe/no conteste

INGTOTAL_____

Y cuántas personas dependen de este ingreso? _____ DEPEND

43. Finalmente, nos gusteria saber que piensa usted de las ventajas y desventajas de tener electricidad en su communidad.

BEST AVAILABLE DOCUMENT

COMUNIDAD ELECTRIFICADA - LIDERES

Distancia a la carretera pavimentada_____KM

1. Nombre de la comunidad_____ municipio_____

2. Nombre y cargo del contacto_____

_____

3. Actividades económicas más importantes en la comunidad

_____

_____

4. Población de la comunidad [Estimación del contacto].

SERVICIOS COMUNITARIOS

5. Hay un puesto de salud? si no
[-> 11]

[Si es necesario,
entrevistarse con la promotora. Nombre_____

Cargo_____

6. Cuándo esta abierto?_____días _____horas

7. Tiene servicio de emergencia? si no.

8. Cuál es la principal forma de iluminación?_____

9. Cuenta con refrigeradora? no si -> De qué tipo?_____

10. Tiene aparato para esterilizar instrumentos? no si -> De qué tipo?_____

11. Hay escuela en la comunidad? si no
[Si es necesario [-> 22]
entrevistarse con la maestra] Nombre_____

Cargo_____

12. Hasta qué grado llega?_____

13. Cuantos niños y niñas estan matriculados? _____niños _____niñas

14. Escuchan programas educactivos por radio? [por ejemplo, "La Familia de los Numeros"] si no

15. Qué tipo de energia usa el radio de la escuela? ___se enchufa ____pilas [cuántas?]

16. Tienen clases para adultos? no si
[-> 22]

17. Cuántos adultos estan matriculados? _____hombres _____mujeres

18. De qué hora a qué hora hay clases?_____

19. Usa luz electrica? si no
[-> 22]

20. De qué tipo y cuantos? ____candelas de neon de ____vatios
____focos de ____vatios

21. Usa otros aparatos electricos en las classes? no
(radio, grabadora, etc) si _____

22. Hay servicio de agua potable? si no
[-> 24]

23. Si usa bomba, qué tipo es? _____diesel _____electrico

24. Cuántas iglesias o templos hay en la comunidad? _____

25. De éstos, cuántos cuentan con electricidad?_____

26. Que apararatos eléctricos usan?

iglesia 1	iglesia 2	iglesia 3	iglesia 4
__luces	__luces	__luces	__luces
__altoparlante	__altoparlante	__altoparlante	__altoparlante
__grabadora	__grabadora	__grabadora	__grabadora
__instrumento	__instrumento	__instrumento	__instrumento
__otro	__otro	__otro	__otro

27. Hay un salón de reuniones comunitario? si no
[-> 30]

28. Usa luz electrica? si no
[-> 30]

29. De que tipo? ____candelas de neon de ____vatios
y cuantos? ____focos de ____vatios

30. Qué tipo de actividades productivas hay en esta comunidad? Cuantos?

___tiendas con refrig.	___costurerías/sastre.	_____
tienda sin refrig.	aserraderos	_____
___molino (diesel)	___carpinterías	_____
___riego	_____	_____

32. Cuántas casas nuevas se construyeron el año pasado? _____

33. Tiene Ud. algún otro comentario qué hacer?

_____

_____

_____

COMUNIDAD NO-ELECTRIFICADA - LIDERES

Distancia a la carretera pavimentada_____KM

1. Nombre de la comunidad_____ municipio_____

2. Nombre y cargo del contacto_____

_____

3. Actividades económicas más importantes en la comunidad

_____ _____

_____ _____

4. Población de la comunidad [Estimación del contacto].

SERVICIOS COMUNITARIOS

5. Hay un puesto de salud? si no
[-> 11]

[Si es necesario,
entrevistarse con la promotora. Nombre_____

Cargo_____

6. Cuándo esta abierto?_____días _____horas

7. Tiene servicio de emergencia? si no.

8. Cuál es la principal forma de iluminación?_____

9. Cuenta con refrigeradora? no si -> De qué tipo?_____

10. Cuántos consume? [unidades semana, botellas semana, galones/mes]_____

11. Tiene aparato para esterilizar instrumentos? no si -> De qué tipo?_____

12. Hay escuela en la comunidad? si no
[Si es necesario [-> 22]
entrevistarse con la maestra] Nombre_____

Cargo_____

13. Hasta qué grado llega?_____

14. Cuantos niños y niñas estan matriculados? _____niños _____niñas

15. Escuchan programas educactivos por radio? [por ejemplo, "La Familia de los Numeros"] si no
[-> 17]

16. Cuántas pilas usa por mes el radio? _____

17. Tienen clases para adultos? no si [-> 22]

18. De qué hora a qué hora hay clases?_____

19. Usa luz electrica? si no
[-> 22]

20. De qué tipo y cuantos? ____candelas de neon de ____vatios
____focos de ____vatios

21. Usa otros aparatos electricos en las classes? no
(radio, grabadora, etc) si _____

22. Hay servicio de agua potable? si no
[-> 24]

23. Si usa bomba, qué tipo es? _____diesel _____electrico

24. Cuántas iglesias o templos hay en la comunidad? _____

25. De éstos, cuántos cuentan con electricidad?_____

26. Que apararatos eléctricos usan?

iglesia 1	iglesia 2	iglesia 3	iglesia 4
__luces	__luces	__luces	__luces
__altoparlante	__altoparlante	__altoparlante	__altoparlante
__grabadora	__grabadora	__grabadora	__grabadora
__instrumento	__instrumento	__instrumento	__instrumento
__otro	__otro	__otro	__otro

27. Hay un salón de reuniones comunitario? si no
[-> 30]

28. Usa luz electrica? si no
[-> 30]

29. De que tipo? ____candelas de neon de ____vatios
y cuantos? ____focos de ____vatios

30. Qué tipo de actividades productivas hay en esta comunidad? Cuantos?

___tiendas con refrig.	___costurerías/sastre.	_____
tienda sin refrig	aserraderos	_____
___molino (diesel)	___carpinterías	_____
___riego	_____	_____

32. Cuántas casas nuevas se construyeron el año pasado? _____

33. Tiene Ud. algún otro comentario qué hacer?

_____

_____

ANNEX 4: TABULATION OF OPEN-ENDED QUESTIONS IN THE SOCIAL IMPACTS QUESTIONNAIRES

A. FOR ELECTRIFIED COMMUNITIES

Question #

13. Other radio programs - 0

14. Other TV programs - 0

27. Other food stored in refrigerator:
    cheese or butter - 6
    water - 3
    juice - 1
    ham - 1

28. Other electric appliance:
    cassette player - 15
    stereo or sound system - 5
    freezer - 5 (this may overlap with #37)
    stove - 2
    video recorder - 2
    electric pot -1

29. Other use of electric lights during day to use a dark storage room

30. Use of free time during the day
    rest or sleep - 68
    family activities - 7
    church - 5
    outdoor entertainment - 2 (soccer, river)
    handicrafts - 2

31. Other family activities last night
    religious services - 23
    family interaction - 22
    listen to radio - 2
    outdoor chores - 2
    movies - 1
    "rest" - 1

33. Other business using electricity - 0

34. Other electric appliances used in business
    refrigerator or freezer - 21 (within this category 4 used more than 1, and 1 used 6)
    specific mention of lights - 8
    sound system - 2
    iron - 2
    sewing machine - 2

fan - 1
electric mill - 1
hair dryer - 1
blender - 1

47. Volunteered comments on advantages and disadvantages of electrification - 287 interviews, although not all commented.

Total number of comments (572) includes multiple comments by some respondents.

ADVANTAGES - 452 (79% of the comments)

Lighting
general advantage of having light - 57
security - 33
longer day for work or other activities - 13
light to go out at night - 6
total for Lighting - 109

Electric Appliances
electric appliances in general - 43
appliances specifically mentioned
refrigerators or freezers in general - 13
ice or cold drinks - 2
food preservation - 13
total for refrigerators or freezers - 28
electric iron - 9
television - 8
radio - 8
corn mill - 2
fan - 2
blender - 1
hotplate or stove - 1
cassette player -1
total for all appliances - 146

Efficiency: rapidity, benefit to the household - 9
(related to the above)

General improvement in community: prettier, more comfortable, more lively - 51

Community Development - 36

Promote or Facilitate Businesses (own or in general) - 35

Price advantage - 28

Information, knowledge - 6

Entertainment - 19

More services or activities -10

Health - 2

Communications - 1

DISADVANTAGES

Charge for service
price too expensive - 32
meter reading ("recibos alterados"), bill doesn't correspond to usage - 33

Service
blackouts - 31
this included complaints about food spoilage
appliances burn out because of surges or blackouts - 12
attitude of ENEE employees - 4 (this may be related to the recent strike)

Short circuits - 3

Public Lighting
inadequate - 1
poorly maintained - 1

Possibility of Accidents - 1

Benefits accrue to those with businesses - 1- cited as a disadvantage by one person, while another noted that his business prospered because his neighbors did not have electricity and bought cold drinks at his store.

Electricity facilitates a cantina - 1

B. NONELECTRIFIED COMMUNITIES

10. Other costs of light - matches @ L.25 box, wicks 2 L2 month

18. Other radio programs -
comedy 1

22. Other food stored in refrigerator

28. Use of free time during the day
rest or sleep - 14
handicrafts - 1

agriculture - 1
get fuelwood - 1

29. Other family activities last night
religious services - 7
family interaction - 8

30. Accidents - 1 house burned down, 1 child drank kerosene, 1 burned himself with hot water, and 1 burned himself with an iron

43. Volunteered comments on advantages and disadvantages of electrification. There were 41 interviews, although all did not comment. Total number of comments (63) reflects multiple comments by some respondents.

ADVANTAGES - 55

Lighting
general advantage of having light - 11
security - 4
total for lighting - 15

Electric Appliances
electric appliances in general - 9
appliances specifically mentioned:
refrigerators or freezers in general - 2
corn mill - 1 (as a business)
total for all appliances - 12

efficiency, rapidity, benefit the household - 1

General improvement in community: prettier, more comfortable, more lively - 2

Community Development - 6

Promote or Facilitate Businesses - actual or potential- 10

Health - 1 (will bring health post)

Price differential - 8

DISADVANTAGES - 8

Price - too expensive, won't be able to afford, only benefits the rich (1) - 8

ANNEX 5: METHODOLOGY FOR ESTIMATING THE RESIDENTIAL AND PRODUCTIVE END USE ECONOMIC BENEFITS OF RURAL ELECTRIFICATION

This annex outlines the methodological approach used for estimating the residential and productive end-use economic benefits of the Aguán Valley project, using the methdology known as the Demand Assessment Model (DAM). Other rural electrification projects are used as case studies.

RESIDENTIAL BENEFITS: YEAR 1

Definitions

For year one, residential benefits are calculated on the basis of substituting electricity for current energy sources used in residential lighting and computing a total "willingness to pay" for electricity as a measure of benefits obtained by residential consumers.

Substitution benefits are calculated as savings in energy costs of an equivalent amount of kilolumen-hours/month produced using electricity instead of the alternate fuel (see area B in Graph 1) plus a measure of the "consumer surplus," arising from the concept that if lighting services were available at prices between those of the alternate fuel and the electric tariff there would be consumers willing to pay those prices and consume intermediate quantities of kilolumen-hours/month (see area D in Graph 1). The final component of consumers' total "willingness to pay" for electricity (areas A + C1 in Graph 1) is calculated as the electric tariff applied to projected kWh consumption.

The curve "Dem(k)" represents the non-electric energy demand function. "A + B" is the current total cost for basic quantity of light in kilolumen-hours/month "Q(0)" at a set price "P(k)" in $/kilolulmen-hour. Substituting electricity for an equivalent lighting level would cost "A," yielding cost savings of "B."

Since electricity demand is not represented by the same curve as the alternate fuel function (users will more than replace current energy demand), an electricity demand function "Dem(e)" is defined. At a price of electricity "P(e)" the quantity demanded will be "Q(1)" kilolulmen-hours/month for a total expenditure of "A + C1." This expenditure is the consumer tariff for the newly provided electric service.

The consumer surplus is estimated by the triangle "D," assuming the existence of a "Demand for Lighting Services" function passing through points X and Y.

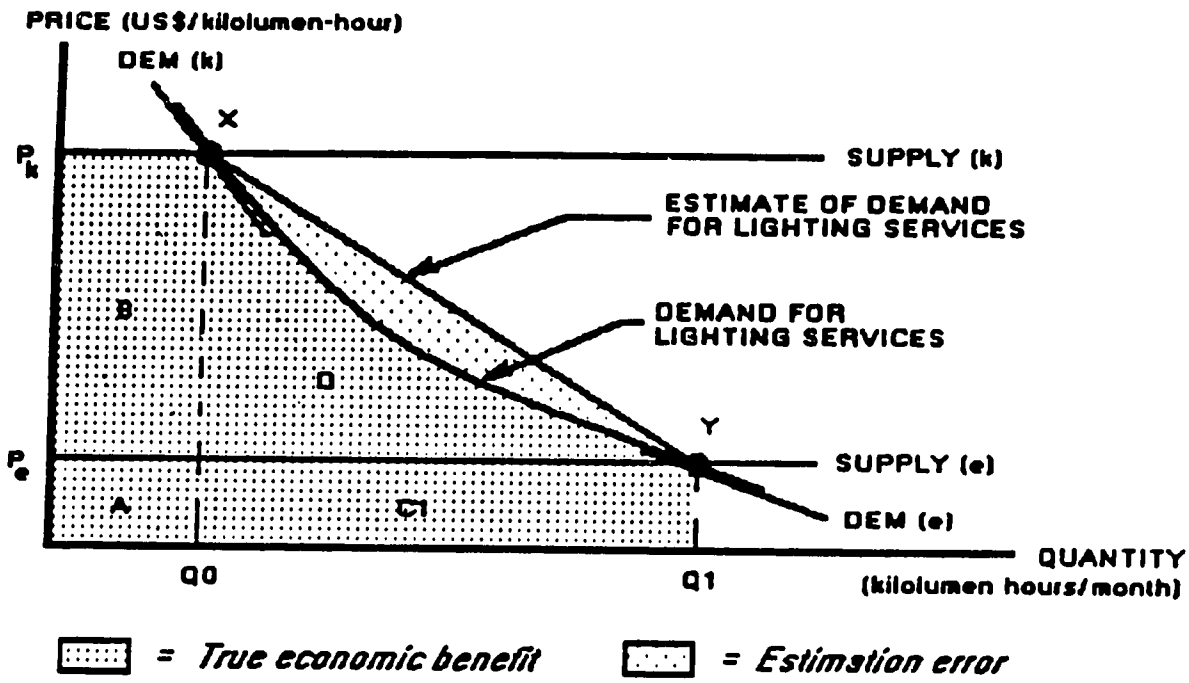
<u>Formulation</u>
Let:

P(k	=	Average price of alternate fuel per unit of lighting ($/kilolumen.hour)
P(e)	=	Average price of electricity per unit of lighting ($kilolumen.hour)
Dem(k)	=	Demand for alternate fuel lighting services, measuring changes in the quantity of kilolulmen-hours/month as a response to changes in the price of a kilolumen-hour using the alternate fuel.
Dem(e)	=	Demand function for electricity's lighting services, measuring changes in the quantity of kilolumen-hours/month as a response to changes in the price of a kilolumen-hour using electricity. When electricity is introduced, people generally consume more kilolumen-hours/month and pay lower prices per kilolumen-hour than was previously the case using alternate fuels. A new demand curve for electricity is defined to the right of the demand for lighting using the alternative fuel. A "demand for lighting services" curve passing through points X and Y is also postulated.
A + B	=	Current cost of lighting using alternate energy source for lighting level Q(0).
A	=	Cost of electricity to replace same lighting level.
B	=	Savings when replacing alternate energy source with electricity for equal lighting level, Q(0).
A + C1	=	Total cost of electricity for lighting in year 1, i.e. tariff payments for quantity Q(1).
D	=	Estimate of consumer surplus
	=	[Pk - Pe) * (Q1 - Q0)]/2

hence:

Residential Benefit = A + B + C1 + D

GRAPH 1


PRICE (US$/kilolumen-hour)
DEM (k)
X
P_k
SUPPLY (k)
ESTIMATE OF DEMAND FOR LIGHTING SERVICES
B
DEMAND FOR LIGHTING SERVICES
D
Y
P_e
SUPPLY (e)
A
C1
DEM (e)
QUANTITY (kilolumen hours/month)
Q0
Q1
= True economic benefit
= Estimation error

How To

The present cost of alternate fuel for current lighting levels can be determined in the target area based on field surveys. Equivalent, or replacement, cost with electricity "B" can be calculated for lighting using conversion tables (see "A Comparison of Lamps for Domestic Lighting in Developing Countries," World Bank Energy Series Paper No. 6 - van der Plas, Graff, 1988).

The projected level of energy use is typically estimated using (a) utility billing information from electrified communities with similar characteristics and (b) applicable tariffs. Questioning prospective consumers regarding intended energy use is also an option.

Application (CASE 1)

Electricity, kerosene, LPG and candle consumption for lighting in the Yungas region of Bolivia was obtained through field surveys. This information is presented in Table 1.

Table 1 - ENERGY CONSUMPTION FOR DOMESTIC LIGHTING SERVICES, EQUIVALENT KILOLUMEN.HOURS/MONTH, MONTHLY EXPENDITURES AND PRICE PER KILOLUMEN-HOUR USING ELECTRICITY, KEROSENE, LPG AND CANDLES IN THE YUNGAS REGION OF BOLIVIA

Energy Source	Share of Pre-electric Lighting	Energy Consumption Units/Month	Equivalent KLm-Hr/Mo	Monthly Expenditure US$/Month	Price US$/KLm-Hr
1. Candles	30%	1.8 kg	3.54	6.08	1.71
2. Kerosene	50%	11.1 kg	13.87	6.08	0.44
3. LPG	20%	7.3 kg	96.75	1.91	0.02
4. Electricity	0%	15.0 kWh	75.00	2.35	0.03
5. Weighted Average of 1-3		--	27.35	5.25	0.19

Notes: 1. Equivalent consumption in KLm-Hr was obtained from the World Bank Industry and Energy Department, "A Comparison of Lamps for Domestic Lighting in Developing Countries: (June 1988), p. 12.

2. The butane equivalent was used for LPG.

3. A weight of 0.058 Kg/candle was estimated.

4. Based on field surveys, it was assumed that domestic lighting in the Asunta Valley of Bolivia is currently based on kerosene 50% of the times, on LPG 20% and on candles 30%. These proportions are used to estimate the weighted average.

Based on these figures, energy cost savings is:

B = (0.19 US$/KLm-Hr - 0.03 US$/kLm-Hr) * 27.35 KLm-Hr/Month = 4.38 US$/Month

The consumer surplus is:

$$D = \frac{(75.00 \text{ KLm-Hr/Month} - 27.35 \text{ KLm-Hr/Month}) * 0.16 \text{ US\$/KLm-Hr}}{2} = 3.81 \text{ US\$/Month}$$

And the tariff payment is: = A + C1 = 2.35 US$/month

For a total economic benefit of 10.54 US$/month.

Since the DAM model calculates A + C1, only B + D, or US$ 8.19 are entered as average residential economic benefits for year 1.

The results are only slightly sensitive to the findings of the field survey of pre-electrification lighting services demand, as well as to the assumptions of fuel switching behavior. For example, suppose instead that the newly-electrified households were formerly using candles, kerosene and LPG in the ratio 10%, 60%, 30% respectively. Then the weighted average monthly consumption figure would be 37.70 KLm-Hr and the weighted average price, US$ 0.13/KLm-Hr.

The energy cost savings is then:

B = (0.13 US$/KLm-Hr - 0.03 US$/kLm-Hr) * 37.70 KLm-Hr/Month

= 3.77 US$/Month

The consumer surplus is:

$$D = \frac{(75.00 \text{ KLm-Hr/Month} - 37.70 \text{ KLm-Hr/Month}) * 0.10 \text{ US\$/KLm-Hr}}{2} = 3.73 \text{ US\$/Month}$$

And the tariff payment is: = A + C1 = 2.35 US$/month

For a total economic benefit of 9.85 US$/month, or about 7% lower than under the previous assumptions.

RESIDENTIAL BENEFITS: FUTURE YEARS

Definitions

Future economic benefits from residential uses are estimated as all benefits for year 1 plus increased willingness to pay over the years. In other words, areas "A" + "B" + "D" remain constant while area "C" grows reflecting displacements in the electricity demand curve "Dem(e)" (See Graph 2). Since uses other than lighting will occur, energy use is measured in energy units, such as kilojoules.

The benefit of replacing basic lighting quantity demanded under the alternative fuel with electricity, "B", is attributable to each year of the analysis, since these savings occur each year the residence is electrified. The same applies to the consumer surplus "D", provided in both cases that all energy costs remain constant in real terms over the period of the analysis.

If electric tariffs or any other energy costs are deemed to increase over and above inflation rates in any one year, areas "B" and "D" need to be recalculated and the new figure used in subsequent years.

"D" must also be recalculated if uses other than lighting are taken into account.

Formulation

Let:

P(k)	=	Price of alternate fuel
P(e)	=	Price of electricity
Dem(k)	=	Demand function for alternate fuel
Dem(e)1..n	=	Demand function for electricity in future years
A + B	=	Current cost of alternate energy source for lighting level Q(0)
A	=	Cost of electricity to replace original lighting level
B	=	Savings when replacing alternate energy source with electricity for equal original lighting level, Q(0)
B+C(1)+..C(n)	=	Total cost of electricity in year n for basic lighting and additional uses, i.e. willingness-to-pay for quantity Q(n).
D	=	Estimate of consumer surplus

hence:

Residential benefit in year n = A + B + C(1) + C(2) +..C(n) + D

How To

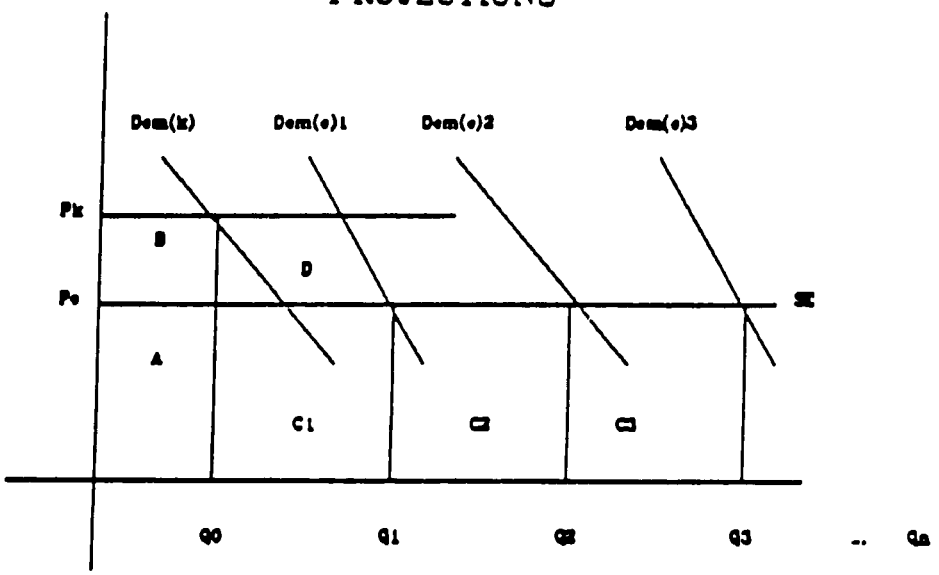
Fuel substitution benefit ("B" + "D") is calculated as defined for year 1 residential benefit. Future years' willingness-to-pay is simply future years' tariff applied to projected kWh consumption (A + C1...n).

Application (CASE 2)

In the Agroyungas prefeasibility study, an estimated "B + D" = US$ 8.19 is entered as residential economic benefit and the model is allowed to calculate tariff times kWh consumption as an estimate of A + C, or willingness to pay, each year.

GRAPH 2

RESIDENTIAL BENEFITS PROJECTIONS



RBn = A + B + C1 ... N, WHERE

C1 ... Cn = DEMAND IN YEARS 1 THROUGH N

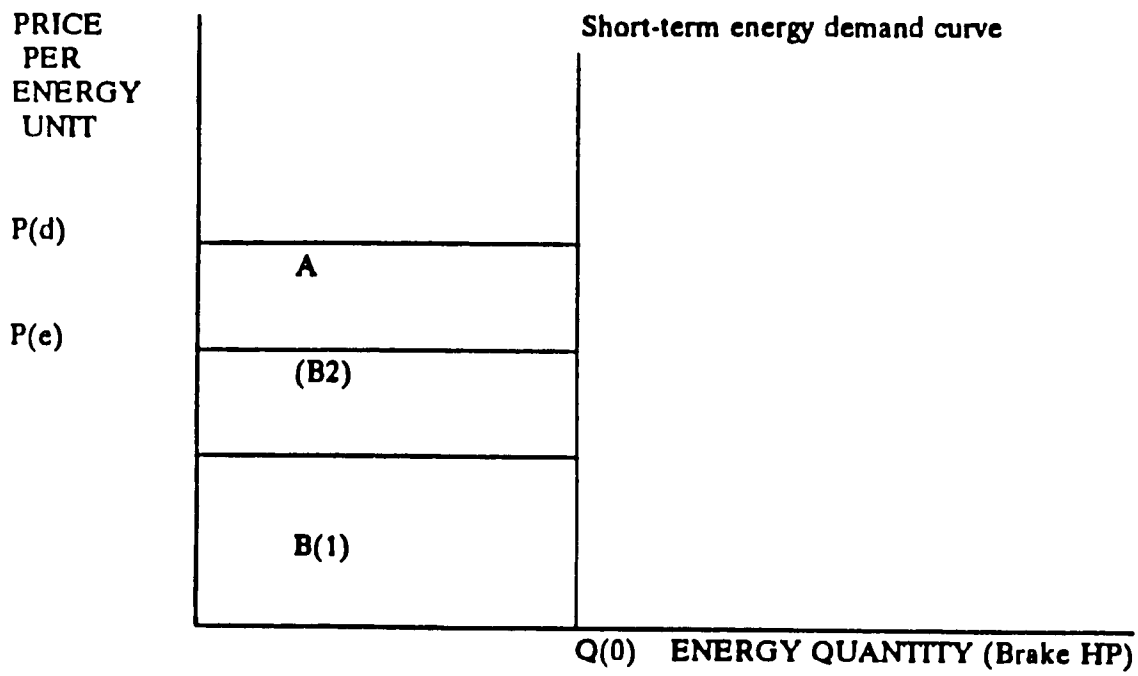
EXISTING PRODUCTIVE USES: ASSUMING NO INCREASE IN TOTAL ENERGY USE

Definitions

Increased entreprise profits attributable to electricity (supply side benefits) are calculated by adding energy cost savings, increased productivity and increased product quality estimated by comparing similar entreprises with and without electricity (Graph 3). Shadow prices and the marginal cost of electricity are to be used for all energy-related costs.

GRAPH 3

I. ENERGY COST REDUCTION



Formulation
Let:

P(d)	=	Price per energy unit (such as kilojoules) using alternate fuel.
P(e)	=	Price per energy unit using electricity
A+B(1)+B(2)	=	Total energy related cost in the activity using an alternate fuel.
B(1)	=	kWh consumption * Long Run Marginal Cost/kWh) plus other supply side costs in the activity using electricity.
B(2)	=	Annualized cost of electrical equipment investment by entrepreneur.
A	=	Energy cost savings, or the difference between current alternate energy cost and total energy-related electric energy cost.
Q(0)	=	Replaced energy demand (Brake HP) for cost comparative purposes. That is, Brake HP for alternate fuel activity is equivalent to Brake HP supplied to the electrified enterprise.

Note: This methodology is applicable only when electric and alternative fuel powered activities are of similar Brake HP sizes. See end of section for How to and Application.

EXISTING PRODUCTIVE USES: ASSUMING NO INCREASE IN TOTAL ENERGY USE

II. PRODUCTIVITY EFFECT

Definitions

Enterprises using electricity often experience increased production per unit of energy used. This is attributed to the "form" value of electricity. Form value is composed of electricity's characteristics above and beyond the sole supply of power and include: instantaneous availability, cleanliness, continuity, noise reduction, electronics and an almost infinite dosification of use levels within available range. These characteristics, not found together in any other energy source, sometimes result in a greater response of output to the same levels of energy use (Graph 4).

Formulation

Let:

0(e)	=	Product output level from the electrified activity at equivalent brake HP input level Q(0)
0(k)	=	Product output level in the alternate fuel activity at equivalent brake HP input level
Q(0)	=	Equal energy input (Brake HP basis) level
P	=	Market price per unit output (assumes no change in market value of product)
C(k)	=	Average cost curve for the alternate fuel activity
C(e)	=	Average cost curve for the electric powered activity
Profit(k)	=	Price - production cost per unit output for alternate fuel activity

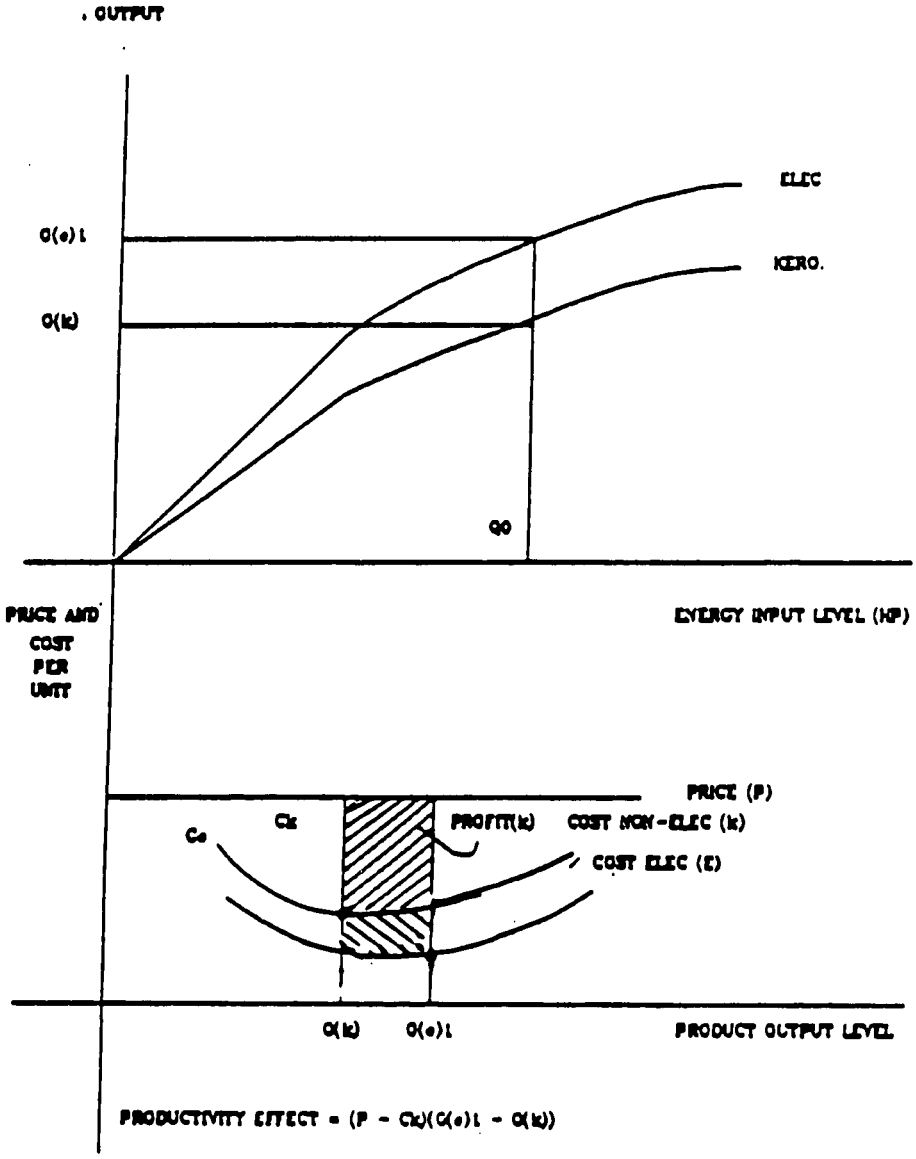
hence:

Productivity benefit = (P - C(k)) * (0(e)1 - 0(k))

Therefore, the average cost curve for the alternative fuel activity instead of the cost curve for the electric powered activity is used in the formula for the productivity benefit. Note that the cost savings of energy are already accounted for by the energy cost reduction calculated.

GRAPH 4

EXISTING PRODUCTIVE USES: PRODUCTIVITY EFFECT



Note: Benefit in lower shaded area accounted for in Graph 3.

EXISTING PRODUCTIVE USES: ASSUMING NO INCREASE IN TOTAL ENERGY USE QUALITY EFFECT

Definitions

For the same reasons mentioned in the preceeding discussion of productivity effects, sometimes electrified enterprises are able to achieve higher quality levels and this may allow them to charge higher prices for their products. Examples from Central America include seamstresses whose embroidered aprons obtained a higher price because consumers were willing to pay more for what they perceived to be the finer work of an electric sewing machine; also, a barber shop whose customers paid higher prices for what they perceived to be the comfort and speed of an electric haircut. Quality effects can be measured via price differences in products of similar electrified and non electrified enterprises (see Graph 5).

Formulation

Let:

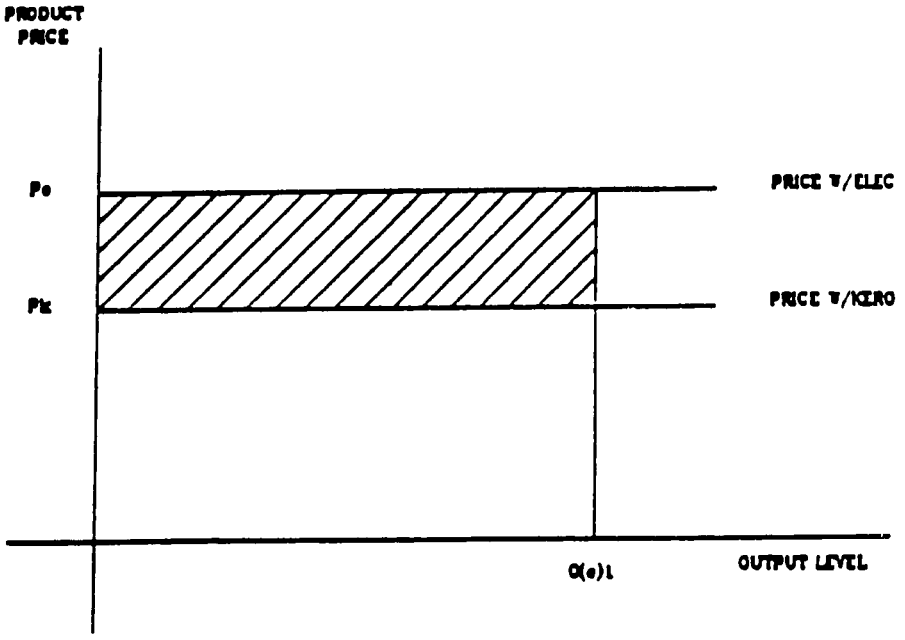
P(e)	=	Product price of electric activity
P(k)	=	Product price of alternate fuel activity
0(e)	=	Total output level of the electrified activity (not necessarily at comparative Brake HP input level)

hence:

Quality benefit	=	(P(e) - P(k) * 0(e)1

GRAPH 5

EXISTING PRODUCTIVE USES: QUALITY EFFECT



QUALITY EFFECT = (Po - Pk) * Q(o)l

EXISTING PRODUCTIVE USES: ASSUMING NEAR EQUIVALENT BRAKE HP ACTIVITIES

The economic benefit of converting existing productive-use enterprises to electricity has been simplified in this analysis to consider only three major impacts: 1) energy cost reduction, 2) productivity effect, and 3) quality effect. The comparison must be based on similarly-sized (in Brake HP terms) electrified and non-electrified activities even though actual energy use and production levels may vary. Shadow prices for energy-related costs and the marginal cost of electricity are to be used in the cost comparison.

This analysis ignores the fact that most young enterprises will increase production levels and corresponding energy use over time. Ways to make benefit estimates more dynamic over time include: a) calculate increased profits per kWh used and vary the number of kWh over time; b) switch to a "demand side" approach to benefit estimation and let willingness to pay reflect increased benefits.

It also assumes a perfectly inelastic demand curve in the short run, as well as no shifts in the demand curve as a result of adopting electricity, i.e. no increased kWh sales.

Note also that only activities of similar Brake HP size should be compared to avoid effects of economies of scale and provide a comparative basis for calculation of benefit.

The entrepreneur is currently spending the amount "A + B(1) + B(2)" on alternate fuel and other energy-related costs in Graph 3. When he switches to electricity, the cost of electric energy "B(1)" will be accounted for by the Model via line extension costs, operation and maintenance costs, marginal cost of generation and transmission (LRMC) and other supply-side costs. Therefore, to correctly calculate the country-wide economic benefit (and avoid counting these costs twice) one must now only take into account B(2), or the annualized cost of electrical equipment investment by entrepreneur.

How To

Pairs of alternate fuel land electric powered activities are identified in the field and basic business cost data including energy use information and output levels are determined. Pairs should be selected based on installed Brake HP capacity regardless of energy use level. Field data collection and processing techniques for the paired comparisons are further described in Villagran and Orozco, "An economic review of electricity in production use activities in rural Guatemala," (Guatemala: NRECA/CARES, 1989).

Application **(CASE 3)**

These benefits were calculated for ten existing productive uses in the Asunta valley, Bolivia using market prices for alternative fuels.

NEW PRODUCTIVE USES: TWO APPROACHES

EXPLANATION

The economic analysis methodology for productive uses of electricity that exist presently and are to be converted to electricity is defined in the previous section titled "Existing Productive Uses." The issue here is how to estimate the economic benefit, if one assumes that a productive-use activity comes about exclusively via the introduction of electricity.

(a) Before the introduction of electricity, the situation is such that the supply and demand curves for the product of the enterprise do not cross (See "S1" and "D" in Graph 6). With electricity, the supply curve shifts to "S2" and intersects the demand curve at a price P1. Profits to the enterprise, depicted by "A," and a consumer surplus, shown as, "B" are created about that point.

To estimate "B," the price elasticity of demand must be known. This would imply an analysis of the productive use activity itself, normally beyond the scope of a rural electrification project. Profits, represented by l"A," can be more easily calculated by surveying enterprises in similar electrified areas. This was not done in the Agroyungas prefeasibility analysis.

The entire profit of the newly created enterprises should be attributed as economic benefit under this approach.

(b) In cases where profit is not measurable, a willingness-to-pay criteria has been used by World Bank staff.

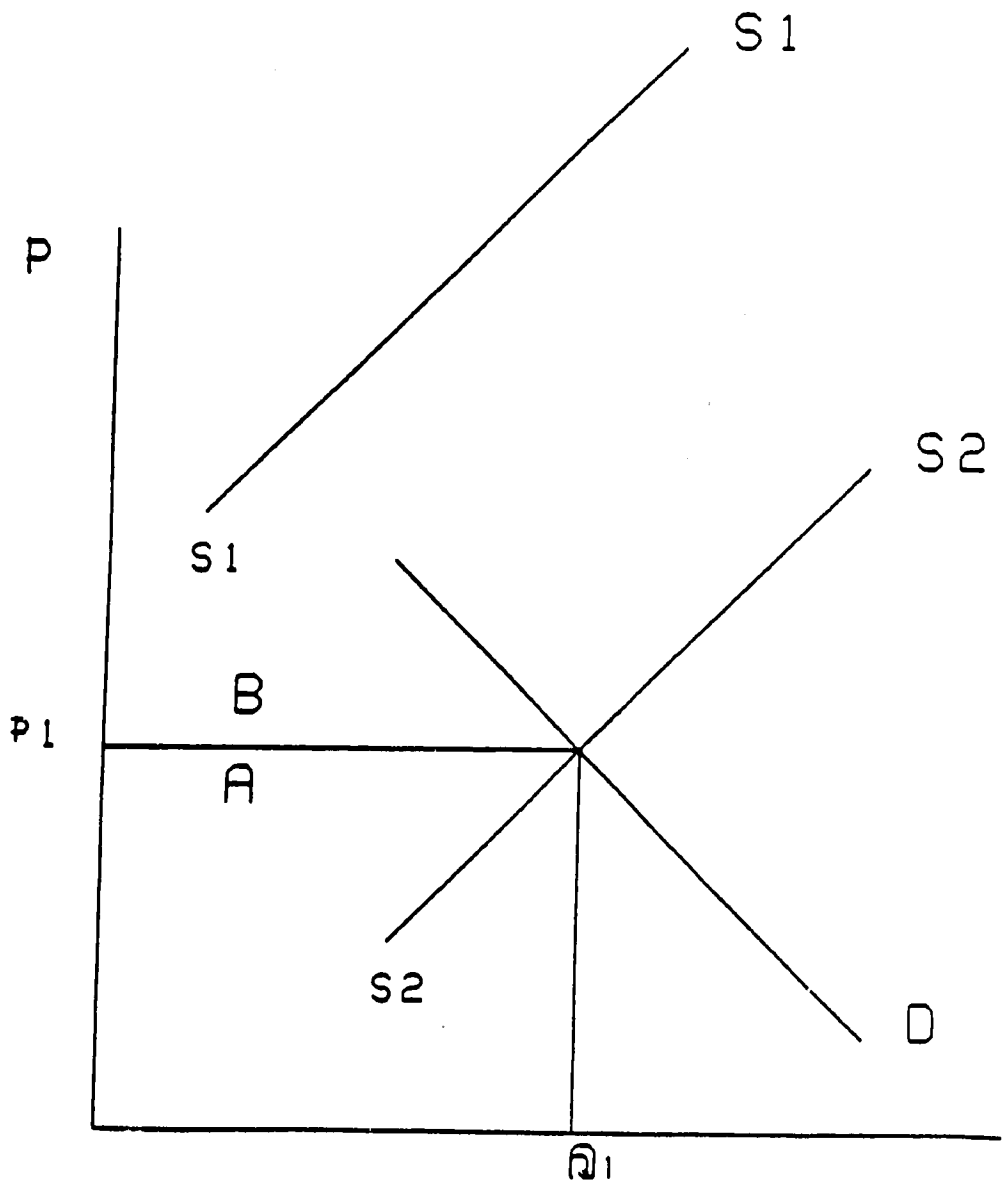
The willingness-to-pay argument in productive uses assumes that an entrepreneur will use electricity up to the point where marginal cost equals marginal benefit and ignores those net benefits accrued before reaching that point. In such cases the economic benefit is simply the total electric energy expense calculated at the market rate (kWh * tariff). This was the approach used in the evaluation of the Asunta valley electrification options.

How to

The production cost stream and resulting sales figures are easily determined for electrified productive use activities in similar areas, using simple field techniques (this covers the profit component, or "A," under alternative i above). Willingness to pay is calculated by applying the tariff to estimated kWh consumption.

Willingness to pay was used for those cases where the productive end-use activity involved did not exist in the Asunta valley at the time of the pre-feasibility study, but estimated profits from newly created enterprises can be used in subsequent applications.

GRAPH 6



ANNEX 6: ALTERNATE FINANCIAL SCENARIOS

Scenario A: Base

13/02/92

Project Summary

AGUAN VALLEY projected to 30 years

Productive Uses Scenario : probable

# of consumers	:	3,407
Initial Investment	:	20,825,000
Investment per consumer	:	6,112

	Financial	Economic
N.P.V	-21,599,305	46,696,393
B / C	0.46	2.17
I.R.R	-9[illegible].99	27.31
B / K		3.24

13/02/92 Project Cash Flow Analysis

AGUAN VALLEY projected to 30 years

YEAR	SOURCE OF FUNDS + FINANC. INCOME	AMORTIZATIONS + INTEREST	TOTAL COSTS	CASH BALANCE	CUMMULATIVE CASH FLOW
00	22,109,807	0	20,825,000	1,284,807	1,284,807
01	402,426	0	191,548	210,878	1,495,685
02	612,044	0	423,821	188,223	1,683,908
03	734,045	0	422,205	311,840	1,995,748
04	1,327,265	0	2,680,999	-1,353,734	642,014
05	1,470,564	0	1,433,473	37,091	679,105
06	1,928,697	0	1,803,432	125,265	804,370
07	2,174,028	0	1,997,563	176,465	980,835
08	1,653,479	0	2,281,571	-628,092	352,743
09	1,920,637	0	2,520,191	-599,554	-246,811
10	2,799,959	0	2,741,491	58,468	-188,343
11	3,634,511	0	2,811,173	823,338	634,995
12	3,906,688	0	2,933,721	972,967	1,607,962
13	4,098,787	0	4,589,616	-490,829	1,117,133
14	4,315,440	0	4,778,708	-463,268	653,865
15	4,538,016	0	4,972,987	-434,971	218,894

13/02/92 Project Cash Flow Analysis

AGUAN VALLEY projected to 30 years

YEAR	SOURCE OF FUNDS + FINANC. INCOME	AMORTIZATIONS + INTEREST	TOTAL COSTS	CASH BALANCE	CUMMULATIVE CASH FLOW
16	4,774,515	0	5,179,323	-404,808	-185,914
17	4,871,572	0	5,244,995	-373,423	-559,337
18	4,937,248	0	5,280,254	-343,006	-902,343
19	5,015,507	0	5,346,210	-330,703	-1,233,046
20	5,110,390	0	5,427,770	-317,380	-1,550,426
21	5,205,240	0	5,509,220	-303,980	-1,854,406
22	5,331,945	0	5,623,947	-292,002	-2,146,408
23	5,400,187	0	5,680,489	-280,302	-2,426,710
24	5,496,307	0	5,763,086	-266,779	-2,693,489
25	5,593,802	0	5,846,944	-253,142	-2,946,631
26	5,688,134	0	5,927,959	-239,825	-3,186,456
27	5,774,683	0	6,000,239	-225,556	-3,412,012
28	5,904,185	0	6,113,760	-209,575	-3,621,587
29	5,972,305	0	6,170,397	-198,092	-3,819,679
30	6,072,951	0	6,256,882	-183,931	-4,003,610

Project AGUAN VALLEY 30 Years

13/02/92

ANUAL REPORT SUMMARY

YEAR	CONSUMER	% RES	% P.U	kWh SOLD	% RES	% P.U	kVA DEMAND	% RES	% P.U
01	3407	90.90	9.10	8228472	6.77	93.23	3097.000	100.00	0.000
02	4875	83.30	16.70	9943908	9.80	90.20	4064.000	99.93	0.074
03	5106	74.93	25.07	12067536	9.89	90.11	3829.000	99.92	0.078
04	8777	75.61	24.39	15987840	15.94	84.06	6641.000	99.92	0.075
05	10081	74.45	25.55	20079060	17.04	82.96	7513.000	99.89	0.106
06	11217	74.31	25.69	26246436	16.77	83.23	8343.000	99.90	0.096
07	12405	74.20	25.80	29235132	18.89	81.11	9212.000	99.91	0.087
08	13998	73.93	26.07	33106668	19.88	80.12	10359.000	99.90	0.097
09	15111	73.11	26.89	37639116	20.43	79.57	11061.000	99.88	0.118
10	17077	73.36	26.64	39787308	22.29	77.71	12541.000	99.90	0.104
11	18561	73.42	26.58	41578644	23.60	76.40	13641.000	99.90	0.095
12	20048	73.46	26.54	43472892	24.80	75.20	14743.000	99.89	0.109
13	21531	73.51	26.49	45153672	25.66	74.34	15843.000	99.90	0.101
14	23017	73.54	26.46	47064924	26.76	73.24	16943.000	99.91	0.094
15	24503	73.57	26.43	49033032	27.79	72.21	18042.000	99.91	0.089
16	25991	73.59	26.41	51124344	28.73	71.27	19142.000	99.92	0.084
17	26875	73.49	26.51	52378032	28.96	71.04	19766.000	99.92	0.081
18	26967	73.24	26.76	53529624	29.22	70.78	19768.000	99.91	0.091
19	27061	72.98	27.02	54209592	28.85	71.15	19768.000	99.91	0.091
20	27155	72.73	27.27	55053672	28.84	71.16	19768.000	99.91	0.091
21	27246	72.49	27.51	55899672	28.83	71.17	19768.000	99.91	0.091
22	27349	72.21	27.79	57076032	28.65	71.35	19771.000	99.89	0.106
23	27441	71.97	28.03	57671232	28.36	71.64	19771.000	99.89	0.106
24	27533	71.73	28.27	58526136	28.35	71.65	19771.000	99.89	0.106
25	27629	71.48	28.52	59390016	28.33	71.67	19771.000	99.89	0.106
26	27722	71.24	28.76	60231456	28.33	71.67	19774.000	99.88	0.121
27	27819	70.99	29.01	60975024	27.99	72.01	19774.000	99.88	0.121
28	27915	70.75	29.25	62152020	28.22	71.78	19774.000	99.88	0.121
29	28006	70.52	29.48	62742276	27.95	72.05	19774.000	99.88	0.121
30	28101	70.28	29.72	63633492	27.93	72.07	19774.000	99.88	0.121
*** Total ***				1323217260					

Page No. 1 Project AGUAN VALLEY 30 Years
13/02/92

**** ECONOMIC ANALYSIS ****

YEAR	CONS-TRUCTION COSTS	OPERATION & MAINTENANCE COSTS	GENERATION + LOSSES COSTS	SYSTEM IMPROVEMENT COSTS	TOTAL COSTS	PRESENT VALUE TOTAL COST	ECONOMIC BENEFIT	PRESENT VALUE BENEFIT	B / C BENEFIT COST	NET PRESENT VALUE
00	20825000	0	0	0	20825000	20825000	0	0	0.00	-20825000
01	0	11039	155792	24717	191548	171025	2947697	2631872	15.39	2460847
02	140678	15795	242631	24717	423821	337868	3921976	3126576	9.25	2788708
03	22137	16543	358808	24717	422205	300517	4350488	3096591	10.30	2796074
04	351792	28437	991246	1309524	2680999	1703824	6849062	4352703	2.55	2648879
05	124962	32662	1244902	30947	1433473	813391	8040898	4562622	5.61	3749231
06	108863	36343	1627279	30947	1803432	913675	9204656	4663366	5.10	3749691
07	113846	40192	1812578	30947	1997563	903596	10188726	4608863	5.10	3705267
08	152657	45354	2052613	30947	2281571	921488	10675165	4311520	4.68	3390032
09	106659	48960	2333625	30947	2520191	908806	11732780	4230958	4.66	3322152
10	188402	55329	2466813	30947	2741491	882687	13620150	4385324	4.97	3502637
11	142212	60138	2577876	30947	2811173	808145	15287737	4394059	5.44	3586714
12	142499	64956	2695319	30947	2933721	753013	16375480	4203177	5.58	3450164
13	142116	69760	4346793	30947	4589616	1051822	17380467	3983154	3.79	2931332
14	142403	74575	4530783	30947	4778708	977819	18407487	3766536	3.85	2788717
15	142403	79390	4720247	30947	4972987	908546	19446559	3552813	3.91	2644267
16	142595	84211	4921570	30947	5179323	844860	20506013	3344975	3.96	2500115
	84714	87075	5042259	30947	5244995	763904	21126041	3076889	4.03	2312985
18	8816	87373	5153118	30947	5280254	686642	21288860	2768395	4.03	2081753
19	9008	87678	5218577	30947	5346210	620731	21401884	2484904	4.00	1864173
20	9008	87982	5299833	30947	5427770	562679	21532288	2232183	3.97	1669504
21	8721	88277	5381275	30947	5509220	509931	21663063	2005125	3.93	1495194
22	9870	88611	5494519	30947	5623947	464777	21850457	1805776	3.89	1340999
23	8816	88909	5551817	30947	5680489	419152	21953998	1619941	3.86	1200789
24	8816	89207	5634116	30947	5763086	379684	22086614	1455113	3.83	1075429
25	9200	89518	5717279	30947	5846944	343937	22219612	1307031	3.80	963094
26	8912	89819	5798281	30947	5927959	311341	22349458	1173812	3.77	862471
27	9296	90134	5869862	30947	6000239	281373	22483505	1054332	3.75	772959
28	9200	90445	5983168	30947	6113760	255979	22647754	948245	3.70	692266
29	8721	90739	6039990	30947	6170397	230670	22750266	850479	3.69	619809
30	9104	91047	6125784	30947	6256882	208842	22888875	763983	3.66	555141
*** Total ***										
	23191426	2010498	115388753	2188297	142778974	40065724	497178016	86762117		46696393

I.R.R economic 27.31
B / C economic 2.17
N.P.V economic 46,696,393
B / K economic 3.24

Project AGUAN VALLEY 30 Years

13/02/92

**** FINANCIAL ANALYSIS ****

YEAR	CONS-TRUCTION COSTS	OPERATION & MAINTENANCE COSTS	GENERATION + LOSSES COSTS	SYSTEM IMPROVEMENT COSTS	TOTAL COSTS	PRESENT VALUE TOTAL COST	FINANCIAL BENEFIT	PRESENT VALUE BENEFIT	B / C BENEFIT COST	NET PRESENT VALUE
00	20825000	0	0	0	20825000	20825000	0	0	0.00	-20825000
01	0	11039	155792	24717	191548	171025	402426	359309	2.10	188284
02	140678	15795	242631	24717	423821	337868	612044	487918	1.44	150050
03	22137	16543	358808	24717	422205	300517	734045	522478	1.74	221961
04	351792	28437	991246	1309524	2680999	1703824	1327265	843501	0.50	-860323
05	124962	32662	1244902	30947	1433473	813391	1470564	834437	1.03	21046
06	108863	36343	1627279	30947	1803432	913675	1928697	977138	1.07	63463
07	113846	40192	1812578	30947	1997563	903596	2174028	983421	1.09	79825
08	152657	45354	2052613	30947	2281571	921488	1653479	667813	0.72	-253675
09	106659	48960	2333625	30947	2520191	908806	1920637	692601	0.76	-216205
10	188402	55329	2466813	30947	2741491	882687	2799959	901512	1.02	18825
11	142212	60138	2577876	30947	2811173	808145	3634511	1044835	1.29	236690
12	142499	64956	2695319	30947	2933721	753013	3906688	1002750	1.33	249737
13	142116	69760	4346793	30947	4589616	1051822	4098787	939336	0.89	-112486
14	142403	74575	4530783	30947	4778708	977819	4315440	883024	0.90	-94795
15	142403	79390	4720247	30947	4972987	908546	4538016	829078	0.91	-79468
16	142595	84211	4921570	30947	5179323	844860	4774515	778827	0.92	-66033
17	84714	87075	5042259	30947	5244995	763904	4871572	709516	0.93	-54388
18	8816	87373	5153118	30947	5280254	686642	4937248	642038	0.94	-44604
19	9008	87678	5218577	30947	5346210	620731	5015507	582334	0.94	-38397
20	9008	87982	5299833	30947	5427770	562679	5110390	529778	0.94	-32901
21	8721	88277	5381275	30947	5509220	509931	5205240	481794	0.94	-28137
22	9870	88611	5494519	30947	5623947	464777	5331945	440645	0.95	-24132
23	8816	88909	5551817	30947	5680489	419152	5400187	398469	0.95	-20683
24	8816	89207	5634116	30947	5763086	379684	5496307	362107	0.95	-17577
25	9200	89518	5717279	30947	5846944	343937	5593802	329047	0.96	-14890
26	8912	89819	5798281	30947	5927959	311341	5688134	298746	0.96	-12595
27	9296	90134	5869862	30947	6000239	281373	5774683	270796	0.96	-10577
28	9200	90445	5983168	30947	6113760	255979	5904185	247204	0.97	-8775
29	8721	90739	6039990	30947	6170397	230670	5972305	223264	0.97	-7406
30	9104	91047	6125784	30947	6256882	208842	6072951	202703	0.97	-6139
*** Total ***										
	23191426	2010498	115388753	2188297	142778974	40065724	116665557	18466419		-21599305

I.R.R financial -99.99
B / C financial 0.46
N.P.V financial -21,599,305

Scenario B: Reducing Losses to 15%

Project Assumptions	NRECA	AGUAN: ESCENARIO BASE 16

Project Name: AGUAN VALLEY	Use Foreign Currency in
Term of Analysis (years): 30	Financial Calculation ? Y/N : Y
Discount Rate (%): 12.00	
Productive Use Scenario: P (P/H/L)	Operation & Maintenance Monthly Costs
	- Per km.of primary line: 0.00
Connection Cost per Consumer	- Per km.of secondary line: 0.00

	1st.year	others
SERVICE DROP		
-local currency	0.00	0.00
-foreign currency	0.00	18.87
HOUSEHOLD WIRING		
-local currency	0.00	0.00
-foreign currency	76.96	76.96

Other Monthly Costs	
- Per Consumer :	0.27
Percentage of Connection	
Costs Paid by the User :	80.30
Line Losses (not previously counted)	
- Technical : 15.00 % kWh generated	
- Non-techical: 0.00 % kWh generated	

[M]odify [I]mprovement costs [T]ree of villages [S]ource of funds e[X]it

13/02/92 Project Summary

AGUAN VALLEY projected to 30 years

Productive Uses Scenario : probable

# of consumers : 3,407
Initial Investment : 20,825,000
Investment per consumer: 6,112

	Financial	Economic
N.P.V	-19,605,840	48,689,858
B / C	0.49	2.28
I.R.R	-4.26	27.72
B / K		3.34

13/02/92 Project Cash Flow Analysis

AGUAN VALLEY projected to 30 years

YEAR	SOURCE OF FUNDS + FINANC. INCOME	AMORTIZATIONS + INTEREST	TOTAL COSTS	CASH BALANCE	CUMMULATIVE CASH FLOW
00	22,109,807	0	20,825,000	1,284,807	1,284,807
01	402,426	0	173,220	229,206	1,514,013
02	612,044	0	395,276	216,768	1,730,781
03	734,045	0	379,992	354,053	2,084,834
04	1,327,265	0	2,564,382	-1,237,117	847,717
05	1,470,564	0	1,287,014	183,550	1,031,267
06	1,928,697	0	1,611,987	316,710	1,347,977
07	2,174,028	0	1,784,319	389,709	1,737,686
08	1,653,479	0	2,040,087	-386,608	1,351,078
09	1,920,637	0	2,245,647	-325,010	1,026,068
10	2,799,959	0	2,451,278	348,681	1,374,749
11	3,634,511	0	2,507,893	1,126,618	2,501,367
12	3,906,688	0	2,616,625	1,290,063	3,791,430
13	4,098,787	0	4,078,229	20,558	3,811,988
14	4,315,440	0	4,245,675	69,765	3,881,753
15	4,538,016	0	4,417,663	120,353	4,002,106

13/02/92 Project Cash Flow Analysis

AGUAN VALLEY projected to 30 years

YEAR	SOURCE OF FUNDS + FINANC. INCOME	AMORTIZATIONS + INTEREST	TOTAL COSTS	CASH BALANCE	CUMMULATIVE CASH FLOW
16	4,774,515	0	4,600,315	174,200	4,176,306
17	4,871,572	0	4,651,788	219,784	4,396,090
18	4,937,248	0	4,674,005	263,243	4,659,333
19	5,015,507	0	4,732,260	283,247	4,942,580
20	5,110,390	0	4,804,261	306,129	5,248,709
21	5,205,240	0	4,876,129	329,111	5,577,820
22	5,331,945	0	4,977,533	354,412	5,932,232
23	5,400,187	0	5,027,334	372,853	6,305,085
24	5,496,307	0	5,100,249	396,058	6,701,143
25	5,593,802	0	5,174,323	419,479	7,120,622
26	5,688,134	0	5,245,809	442,325	7,562,947
27	5,774,683	0	5,309,667	465,016	8,027,963
28	5,904,185	0	5,409,858	494,327	8,522,290
29	5,972,305	0	5,459,810	512,495	9,034,785
30	6,072,951	0	5,536,202	536,749	9,571,534

Project AGUAN VALLEY 30 Years

13/02/92

ANUAL REPORT SUMMARY

YEAR	CONSUMER	% RES	% P.U	kWh SOLD	% RES	% P.U	kVA DEMAND	% RES	% P.U
01	3407	90.90	9.10	8228472	6.77	93.23	3097.000	100.00	0.000
02	4875	83.30	16.70	9943908	9.80	90.20	4064.000	99.93	0.074
03	5106	74.93	25.07	12067536	9.89	90.11	3829.000	99.92	0.078
04	8777	75.61	24.39	15987840	15.94	84.06	6641.000	99.92	0.075
05	10081	74.45	25.55	20079060	17.04	82.96	7513.000	99.89	0.106
06	11217	74.31	25.69	26246436	16.77	83.23	8343.000	99.90	0.096
07	12405	74.20	25.80	29235132	18.89	81.11	9212.000	99.91	0.087
08	13998	73.93	26.07	33106668	19.88	80.12	10359.000	99.90	0.097
09	15111	73.11	26.89	37639116	20.43	79.57	11061.000	99.88	0.118
10	17077	73.36	26.64	39787308	22.29	77.71	12541.000	99.90	0.104
11	18561	73.42	26.58	41578644	23.60	76.40	13641.000	99.90	0.095
12	20048	73.46	26.54	43472892	24.80	75.20	14743.000	99.89	0.109
13	21531	73.51	26.49	45153672	25.66	74.34	15843.000	99.90	0.101
14	23017	73.54	26.46	47064924	26.76	73.24	16943.000	99.91	0.094
15	24503	73.57	26.43	49033032	27.79	72.21	18042.000	99.91	0.089
16	25991	73.59	26.41	51124344	28.73	71.27	19142.000	99.92	0.084
17	26875	73.49	26.51	52378032	28.96	71.04	19766.000	99.92	0.081
18	26967	73.24	26.76	53529624	29.22	70.78	19768.000	99.91	0.091
19	27061	72.98	27.02	54209592	28.85	71.15	19768.000	99.91	0.091
20	27155	72.73	27.27	55053672	28.84	71.16	19768.000	99.91	0.091
21	27246	72.49	27.51	55899672	28.83	71.17	19768.000	99.91	0.091
22	27349	72.21	27.79	57076032	28.65	71.35	19771.000	99.89	0.106
23	27441	71.97	28.03	57671232	28.36	71.64	19771.000	99.89	0.106
24	27533	71.73	28.27	58526136	28.35	71.65	19771.000	99.89	0.106
25	27629	71.48	28.52	59390016	28.33	71.67	19771.000	99.89	0.106
26	27722	71.24	28.76	60231456	28.33	71.67	19774.000	99.88	0.121
27	27819	70.99	29.01	60975024	27.99	72.01	19774.000	99.88	0.121
28	27915	70.75	29.25	62152020	28.22	71.78	19774.000	99.88	0.121
29	28006	70.52	29.48	62742276	27.95	72.05	19774.000	99.88	0.121
30	28101	70.28	29.72	63633492	27.93	72.07	19774.000	99.88	0.121
*** Total ***				1323217260					

Project AGUAN VALLEY 30 Years

13/02/92

**** ECONOMIC ANALYSIS ****

YEAR	CONS-TRUCTION COSTS	OPERATION & MAINTENANCE COSTS	GENERATION + LOSSES COSTS	SYSTEM IMPROVEMENT COSTS	TOTAL COSTS	PRESENT VALUE TOTAL COST	ECONOMIC BENEFIT	PRESENT VALUE BENEFIT	B / C BENEFIT COST	NET PRESENT VALUE
00	20825000	0	0	0	20825000	20825000	0	0	0.00	-20825000
01	0	11039	137464	24717	173220	154660	2947697	2631872	17.02	2477212
02	140678	15795	214086	24717	395276	315112	3921976	3126576	9.92	2811464
03	22137	16543	316595	24717	379992	270471	4350488	3096591	11.45	2826120
04	351792	28437	874629	1309524	2564382	1629711	6849062	4352703	2.67	2722992
05	124962	32662	1098443	30947	1287014	730287	8040898	4562622	6.25	3832335
06	108863	36343	1435834	30947	1611987	816683	9204656	4663366	5.71	3846683
07	113846	40192	1599334	30947	1784319	807135	10188726	4608863	5.71	3801728
08	152657	45354	1811129	30947	2040087	823957	10675165	4311520	5.23	3487563
09	106659	48960	2059081	30947	2245647	809803	11732780	4230958	5.22	3421155
10	188402	55329	2176600	30947	2451278	789246	13620150	4385324	5.56	3596078
11	142212	60138	2274596	30947	2507893	720959	15287737	4394859	6.10	3673900
12	142499	64956	2378223	30947	2616625	671622	16375480	4203177	6.26	3531555
13	142116	69760	3835406	30947	4078229	934625	17380467	3983154	4.26	3048529
14	142403	74575	3997750	30947	4245675	868749	18407487	3766536	4.34	2897787
15	142403	79390	4164923	30947	4417663	807091	19446559	3552813	4.40	2745722
16	142595	84211	4342562	30947	4600315	750411	20506013	3344975	4.46	2594564
[illegible]	84714	87075	4449052	30947	4651788	677507	21126041	3076889	4.54	2399382
18	8816	87373	4546869	30947	4674005	607806	21288860	2768395	4.55	2160589
19	9008	87678	4604627	30947	4732260	549447	21401884	2484904	4.52	193545[illegible]
20	9008	87982	4676324	30947	4804261	498042	21532288	2232183	4.48	1734141
21	8721	88277	4748184	30947	4876129	451333	21663063	2005125	4.44	1553792
22	9870	88611	4848105	30947	4977533	411356	21850457	1805776	4.39	1394420
23	8816	88909	4898662	30947	5027334	370957	21953998	1619941	4.37	1248984
24	8816	89207	4971279	30947	5100249	336015	22086614	1455113	4.33	1119098
25	9200	89518	5044658	30947	5174323	304371	22219612	1307031	4.29	1002660
26	8912	89819	5116131	30947	5245809	275514	22349458	1173812	4.26	898298
27	9296	90134	5179290	30947	5309667	248989	22483505	1054332	4.23	805343
28	9200	90445	5279266	30947	5409858	226507	22647754	948245	4.19	721738
29	8721	90739	5329403	30947	5459810	204106	22750266	850479	4.17	646373
30	9104	91047	5405104	30947	5536202	184787	22888875	763983	4.13	579196
*** Total ***										
	23191426	2010498	101813609	2188297	129203830	38072259	497178016	86762117		48689858

I.R.R economic 27.72

B / C economic 2.28

N.P.V economic 48,689,858

B / K economic 3.34

Project AGUAN VALLEY 30 Years

13/02/92

**** FINANCIAL ANALYSIS ****

YEAR	CONS-TRUCTION COSTS	OPERATION & MAINTENANCE COSTS	GENERATION + LOSSES COSTS	SYSTEM IMPROVEMENT COSTS	TOTAL COSTS	PRESENT VALUE TOTAL COST	FINANCIAL BENEFIT	PRESENT VALUE BENEFIT	B / C BENEFIT COST	NET PRESENT VALUE
00	20825000	0	0	0	20825000	20825000	0	0	0.00	-20825000
01	0	11039	137464	24717	173220	154660	402426	359309	2.32	204649
02	140678	15795	214086	24717	395276	315112	612044	487918	1.55	172806
03	22137	16543	316595	24717	379992	270471	734045	522478	1.93	252007
04	351792	28437	874629	1309524	2564382	1629711	1327265	843501	0.52	-786210
05	124962	32662	1098443	30947	1287014	730287	1470564	834437	1.14	104150
06	108863	36343	1435834	30947	1611987	816683	1928697	977138	1.20	160455
07	113846	40192	1599334	30947	1784319	807135	2174028	983421	1.22	176286
08	152657	45354	1811129	30947	2040087	823957	1653479	667813	0.81	-156144
09	106659	48960	2059081	30947	2245647	809803	1920637	692601	0.86	-117202
10	188402	55329	2176600	30947	2451278	789246	2799959	901512	1.14	112266
11	142212	60138	2274596	30947	2507893	720959	3634511	1044835	1.45	323876
12	142499	64956	2378223	30947	2616625	671622	3906688	1002750	1.49	331128
13	142116	69760	3835406	30947	4078229	934625	4098787	939336	1.01	4711
14	142403	74575	3997750	30947	4245675	868749	4315440	883024	1.02	14275
15	142403	79390	4164923	30947	4417663	807091	4538016	829078	1.03	21987
16	142595	84211	4342562	30947	4600315	750411	4774515	778827	1.04	28416
	84714	87075	4449052	30947	4651788	677507	4871572	709516	1.05	32009
18	8816	87373	4546869	30947	4674005	607806	4937248	642038	1.06	34232
19	9008	87678	4604627	30947	4732260	549447	5015507	582334	1.06	32887
20	9008	87982	4676324	30947	4804261	498042	5110390	529778	1.06	31736
21	8721	88277	4748184	30947	4876129	451333	5205240	481794	1.07	30461
22	9870	88611	4848105	30947	4977533	411356	5331945	440645	1.07	29289
23	8816	88909	4898662	30947	5027334	370957	5400187	398469	1.07	27512
24	8816	89207	4971279	30947	5100249	336015	5496307	362107	1.08	26092
25	9200	89518	5044658	30947	5174323	304371	5593802	329047	1.08	24676
26	8912	89819	5116131	30947	5245809	275514	5688134	298746	1.08	23232
27	9296	90134	5179290	30947	5309667	248989	5774683	270796	1.09	21807
28	9200	90445	5279266	30947	5409858	226507	5904185	247204	1.09	20697
29	8721	90739	5329403	30947	5459810	204106	5972305	223264	1.09	19158
30	9104	91047	5405104	30947	5536202	184787	6072951	202703	1.10	17916
*** Total ***										
	23191426	2010498	101813609	2188297	129203830	38072259	116665557	18466419		-19605840

I.R.R financial -4.26

B / C financial 0.49

N.P.V financial -19,605,840

Scenario C: Increasing Tariffs 100% Over 1983 Level

Record of Projected Real Tariff Increase	NRECA	AGUAN:.ESCENARIO BASE 12

Input annual increase. Cumulative % is calculated

	%increase	% cum.	year	%increase	% cum.		%increase	% cum.
1	0	0	13	30	100	25	0	100
2	0	0	14	0	100	26	0	100
3	11	11	15	0	100	27	0	100
4	0	11	16	0	100	28	0	100
5	0	11	17	0	100	29	0	100
6	0	11	18	0	100	30	0	100
7	0	11	19	0	100	31	0	100
8	-40	-29	20	0	100	32	0	100
9	3	-26	21	0	100	33	0	100
10	32	6	22	0	100	34	0	100
11	32	38	23	0	100	35	0	100
12	32	70	24	0	100	36	0	100

(M)odify e(X)it

13/02/92 Project Summary

AGUAN VALLEY projected to 30 years

Productive Uses Scenario : probable

# of consumers	:	3,407
Initial Investment	:	20,825,000
Investment per consumer	:	6,112

	Financial	Economic
N.P.V	-15,773,925	52,291,622
B / C	0.61	2.31
I.R.R	4.35	27.84
B / K	.	3.51

13/02/92 Project Cash Flow Analysis

AGUAN VALLEY projected to 30 years

YEAR	SOURCE OF FUNDS + FINANC. INCOME	AMORTIZATIONS + INTEREST	TOTAL COSTS	CASH BALANCE	CUMMULATIVE CASH FLOW
00	22,109,807	0	20,825,000	1,284,807	1,284,807
01	402,426	0	191,548	210,878	1,495,685
02	612,044	0	423,821	188,223	1,683,908
03	734,045	0	422,205	311,840	1,995,748
04	1,327,265	0	2,680,999	-1,353,734	642,014
05	1,470,564	0	1,433,473	37,091	679,105
06	1,928,697	0	1,803,432	125,265	804,370
07	2,174,028	0	1,997,563	176,465	980,835
08	1,653,479	0	2,281,571	-628,092	352,743
09	1,920,637	0	2,520,191	-599,554	-246,811
10	2,987,239	0	2,741,491	245,748	-1,063
11	4,031,966	0	2,811,173	1,220,793	1,219,730
12	5,230,969	0	2,933,721	2,297,248	3,516,978
13	6,438,987	0	4,589,616	1,849,371	5,366,349
14	6,782,745	0	4,778,708	2,004,037	7,370,386
15	7,136,042	0	4,972,987	2,163,055	9,533,441

13/02/92 Project Cash Flow Analysis

AGUAN VALLEY projected to 30 years

YEAR	SOURCE OF FUNDS + FINANC. INCOME	AMORTIZATIONS + INTEREST	TOTAL COSTS	CASH BALANCE	CUMMULATIVE CASH FLOW
16	7,511,347	0	5,179,323	2,332,024	11,865,465
17	7,692,703	0	5,244,995	2,447,708	14,313,173
18	7,832,744	0	5,280,254	2,552,490	16,865,663
19	7,956,875	0	5,346,210	2,610,665	19,476,328
20	8,107,482	0	5,427,770	2,679,712	22,156,040
21	8,258,173	0	5,509,220	2,748,953	24,904,993
22	8,458,750	0	5,623,947	2,834,803	27,739,796
23	8,567,568	0	5,680,489	2,887,079	30,626,875
24	8,720,137	0	5,763,086	2,957,051	33,583,926
25	8,874,712	0	5,846,944	3,027,768	36,611,694
26	9,024,581	0	5,927,959	3,096,622	39,708,316
27	9,161,780	0	6,000,239	3,161,541	42,869,857
28	9,367,383	0	6,113,760	3,253,623	46,123,480
29	9,475,736	0	6,170,397	3,305,339	49,428,819
30	9,635,311	0	6,256,882	3,378,429	52,807,248

Project AGUAN VALLEY 30 Years

13/02/92

ANUAL REPORT SUMMARY

YEAR	CONSUMER	% RES	% P.U	kWh SOLD	% RES	% P.U	kVA DEMAND	% RES	% P.U
01	3407	90.90	9.10	8228472	6.77	93.23	3097.000	100.00	0.000
02	4875	83.30	16.70	9943908	9.80	90.20	4064.000	99.93	0.074
03	5106	74.93	25.07	12067536	9.89	90.11	3829.000	99.92	0.078
04	8777	75.61	24.39	15987840	15.94	84.06	6641.000	99.92	0.075
05	10081	74.45	25.55	20079060	17.04	82.96	7513.000	99.89	0.106
06	11217	74.31	25.69	26246436	16.77	83.23	8343.000	99.90	0.096
07	12405	74.20	25.80	29235132	18.89	81.11	9212.000	99.91	0.087
08	13998	73.93	26.07	33106668	19.88	80.12	10359.000	99.90	0.097
09	15111	73.11	26.89	37639116	20.43	79.57	11061.000	99.88	0.118
10	17077	73.36	26.64	39787308	22.29	77.71	12541.000	99.90	0.104
11	18561	73.42	26.58	41578644	23.60	76.40	13641.000	99.90	0.095
12	20048	73.46	26.54	43472892	24.80	75.20	14743.000	99.89	0.109
13	21531	73.51	26.49	45153672	25.66	74.34	15843.000	99.90	0.101
14	23017	73.54	26.46	47064924	26.76	73.24	16943.000	99.91	0.094
15	24503	73.57	26.43	49033032	27.79	72.21	18042.000	99.91	0.089
16	25991	73.59	26.41	51124344	28.73	71.27	19142.000	99.92	0.084
17	26875	73.49	26.51	52378032	28.96	71.04	19766.000	99.92	0.081
18	26967	73.24	26.76	53529624	29.22	70.78	19768.000	99.91	0.091
19	27061	72.98	27.02	54209592	28.85	71.15	19768.000	99.91	0.091
20	27155	72.73	27.27	55053672	28.84	71.16	19768.000	99.91	0.091
21	27246	72.49	27.51	55899672	28.83	71.17	19768.000	99.91	0.091
22	27349	72.21	27.79	57076032	28.65	71.35	19771.000	99.89	0.106
23	27441	71.97	28.03	57671232	28.36	71.64	19771.000	99.89	0.106
24	27533	71.73	28.27	58526136	28.35	71.65	19771.000	99.89	0.106
25	27629	71.48	28.52	59390016	28.33	71.67	19771.000	99.89	0.106
26	27722	71.24	28.76	60231456	28.33	71.67	19774.000	99.88	0.121
27	27819	70.99	29.01	60975024	27.99	72.01	19774.000	99.88	0.121
28	27915	70.75	29.25	62152020	28.22	71.78	19774.000	99.88	0.121
29	28006	70.52	29.48	62742276	27.95	72.05	19774.000	99.88	0.121
30	28101	70.28	29.72	63633492	27.93	72.07	19774.000	99.88	0.121
*** Total ***				1323217260					

Project AGUAN VALLEY 30 Years

13/02/92

**** ECONOMIC ANALYSIS ****

YEAR	CONS-TRUCTION COSTS	OPERATION & MAINTENANCE COSTS	GENERATION + LOSSES COSTS	SYSTEM IMPROVEMENT COSTS	TOTAL COSTS	PRESENT VALUE TOTAL COST	ECONOMIC BENEFIT	PRESENT VALUE BENEFIT	B / C BENEFIT COST	NET PRESENT VALUE
00	20825000	0	0	0	20825000	20825000	0	0	0.00	-20825000
01	0	11039	155792	24717	191548	171025	2947697	2631872	15.39	2460847
02	140678	15795	242631	24717	423821	337868	3921976	3126576	9.25	2788708
03	22137	16543	358808	24717	422205	300517	4350488	3096591	10.30	2796074
04	351792	28437	991246	1309524	2680999	1703824	6849062	4352703	2.55	2648879
05	124962	32662	1244902	30947	1433473	813391	8040898	4562622	5.61	3749231
06	108863	36343	1627279	30947	1803432	913675	9204656	4663366	5.10	3749691
07	113846	40192	1812578	30947	1997563	903596	10188726	4608863	5.10	3705267
08	152657	45354	2052613	30947	2281571	921488	10675165	4311520	4.68	3390032
09	106659	48960	2333625	30947	2520191	908806	11732780	4230958	4.66	3322152
10	188402	55329	2466813	30947	2741491	882687	13803309	4444296	5.03	3561609
11	142212	60138	2577876	30947	2811173	808145	15675289	4506271	5.58	3698126
12	142499	64956	2695319	30947	2933721	753013	17663943	4533894	6.02	3780881
13	142116	69760	4346793	30947	4589616	1051822	19652531	4503853	4.28	3452031
14	142403	74575	4530783	30947	4778708	977819	20796519	4255380	4.35	3277561
15	142403	79390	4720247	30947	4972987	908546	21958414	4011720	4.42	3103174
16	142595	84211	4921570	30947	5179323	844860	23147900	3775924	4.47	2931064
17	84714	87075	5042259	30947	5244995	763904	23844331	3472792	4.55	2708888
18	8816	87373	5153118	30947	5280254	686642	24073618	3130523	4.56	2443881
19	9008	87678	5218577	30947	5346210	620731	24223740	2812540	4.53	2191809
20	9008	87982	5299833	30947	5427770	562679	24401971	2529673	4.50	1966994
21	8721	88277	5381275	30947	5509220	509931	24580690	2275179	4.46	1765248
22	9870	88611	5494519	30947	5623947	454777	24831821	2052164	4.42	1587387
23	8816	88909	5551817	30947	5680489	419152	24968040	1842341	4.40	1423189
24	8816	89207	5634116	30947	5763086	379684	25149209	1656883	4.36	1277199
25	9200	89518	5717279	30947	5846944	343937	25330513	1490025	4.33	1146088
26	8912	89819	5798281	30947	5927959	311341	25508000	1339701	4.30	1028360
27	9296	90134	5869862	30947	6000239	281373	25684799	1204453	4.28	923080
28	9200	90445	5983168	30947	6113760	255979	25915014	1085043	4.24	829064
29	8721	90739	6039990	30947	6170397	230670	26049862	973829	4.22	743159
30	9104	91047	6125784	30947	6256882	208842	26238625	875791	4.19	666949
*** Total ***										
	23191426	2010498	115388753	2188297	142778974	40065724	551409586	92357346		52291622

I.R.R economic 27.84

B / C economic 2.31

N.P.V economic 52,291,622

B / K economic 3.51

Project AGUAN VALLEY 30 Years

13/02/92

**** FINANCIAL ANALYSIS ****

YEAR	CONS-TRUCTION COSTS	OPERATION & MAINTENANCE COSTS	GENERATION + LOSSES COSTS	SYSTEM IMPROVEMENT COSTS	TOTAL COSTS	PRESENT VALUE TOTAL COST	FINANCIAL BENEFIT	PRESENT VALUE BENEFIT	B / C BENEFIT COST	NET PRESENT VALUE
00	20825000	0	0	0	20825000	20825000	0	0	0.00	-20825000
01	0	11039	155792	24717	191548	171025	402426	359309	2.10	188284
02	140678	15795	242631	24717	423821	337868	612044	487918	1.44	150050
03	22137	16543	358808	24717	422205	300517	734045	522478	1.74	221961
04	351792	28437	991246	1309524	2680999	1703824	1327265	843501	0.50	-860323
05	124962	32662	1244902	30947	1433473	813391	1470564	834437	1.03	21046
06	108863	36343	1627279	30947	1803432	913675	1928697	977138	1.07	63463
07	113846	40192	1812578	30947	1997563	903596	2174028	983421	1.09	79825
08	152657	45354	2052613	30947	2281571	921488	1653479	667813	0.72	-253675
09	106659	48960	2333625	30947	2520191	908806	1920637	692601	0.76	-216205
10	188402	55329	2466013	30947	2741491	882687	2987239	961811	1.09	79124
11	142212	60138	2577876	30947	2811173	808145	4031966	1159094	1.43	350949
12	142499	64956	2695319	30947	2933721	753013	5230969	1342660	1.78	589647
13	142116	69760	4346793	30947	4589616	1051822	6438987	1475650	1.40	423828
14	142403	74575	4530783	30947	4778708	977819	6782745	1387884	1.42	410065
15	142403	79390	4720247	30947	4972987	908546	7136042	1303728	1.43	395182
16	142595	84211	4921570	30947	5179323	844860	7511347	1225263	1.45	380403
17	84714	87075	5042259	30947	5244995	763904	7692703	1120398	1.47	356494
18	8816	87373	5153118	30947	5280254	686642	7832744	1018567	1.48	331925
19	9008	87678	5218577	30947	5346210	620731	7956875	923847	1.49	303116
20	9008	87982	5299833	30947	5427770	562679	8107482	840477	1.49	277798
21	8721	88277	5381275	30947	5509220	509931	8258173	764374	1.50	254443
22	9870	88611	5494519	30947	5623947	464777	8458750	699053	1.50	234276
23	8816	88909	5551817	30947	5680489	419152	8567568	632183	1.51	213031
24	8816	89207	5634116	30947	5763086	379684	8720137	574501	1.51	194817
25	9200	89518	5717279	30947	5846944	343937	8874712	522040	1.52	178103
26	8912	89819	5798281	30947	5927959	311341	9024581	473979	1.52	162638
27	9296	90134	5869862	30947	6000239	281373	9161780	429628	1.53	148255
28	9200	90445	5983168	30947	6113760	255979	9367383	392205	1.53	136226
29	8721	90739	6039990	30947	6170397	230670	9475736	354234	1.54	123564
30	9104	91047	6125784	30947	6256882	208842	9635311	321607	1.54	112765
*** Total ***	23191426	2010498	115388753	2188297	142778974	40065724	173476415	24291799		-15773925

I.R.R financial 4.35

B / C financial 0.61

N.P.V financial -15,773,925

ANNEX 7: SAMPLE SELECTION FOR LINKAGES STUDY

The selection of electrified productive uses and of electrified and nonelectrified communities was based on local advice and team member expertise. The study included the broadest possible range of productive use activities and accounted for regional and local variations.

In the preliminary visit to the Aguán, the team observed that the region's towns and villages are highly homogeneous. Most are small rural communities of less than 1000 persons which had similar kinds of productive uses of electricity, such as general stores, carpentry shops, drink vendors, corn mills, and tailor shops. A few larger communities comprise the region's most urban towns. Trujillo, Tocoa, and Olanchito, the largest in the region, have populations over 5000, exhibit a wide variety of electrified productive uses, and are the region's most important commercial and service centers. Tocoa, the self-declared "Capital of the Agrarian Reform," has benefitted from the agrarian reform program started in the 1970s; from palm oil production and processing and banana cultivation and packing; and from its position as a transportation center. Olanchito is an older town well-known for its lumber production and for the quality of its wood works.

The next larger towns are Sava and Sonaguera, with populations between 4,000 and 5000. Electrified productive uses identified in these towns are similar to those found in larger towns but not as numerous or diverse.

Nineteen electrified communities, representing 15 percent of all electrified communities in the Aguán Valley, were selected for study. Regional and local variations were accounted for by using the following selection criteria: (a) at least two communities from each ENEE subsystems, (b) at least two communities from each of the five agro-ecological zones, (c) towns with different population sizes, and (d) towns with different degrees of economic development. The degree of economic development was based on community access to public services (telephone and telegraph, post office, potable water, health facilities, schools), and private services (bank branches, hotels, gas stations, restaurants, transportation, repair services), housing quality, number of paved streets, and distance from a major road. The degrees of economic development were defined as ranging from 1 to 5. The most developed communities (Trujillo, Olanchito, and Tocoa) were given 5 degrees; the least developed (Copete, Tumbador, Cayo Sierra, etc) were given 1.

Based on these selection criteria, and given the homogeneity of communities found in the region, the chosen communities were considered representative of all electrified communities in the Aguán Valley.

The basic criteria for selecting productive uses of electricity was to include different types and sizes of commercial and industrial users of rural electrification throughout the 19 communities. Ninety-one questionnaires were

administered to a total of about 8 percent of the commercial and industrial users in the Aguán.[7]

For purposes of comparison, 6 nonelectrified villages were also visited, and 6 questionnaires administered.[8] The non-electrified villages visited were: Silin and Marañón near Trujillo area, Nueva Armenia near Sava, Cooperative Primero de Mayo and Las Trojas near Olanchito, and Piedras Amarillas close to Ceiba, all with populations of under 1000, and all with an economic development rating of 1.

TABLE 1: ELECTRIFIED COMMUNITIES USED IN LINKAGES STUDY

Town	ENEE system	Agro-ecological Zone	Population Size	Degree of Economic Development
1. Corozal	La Ceiba, S.E.	Coastal	1,074	2
2. Jutiapa	La Ceiba, S.E.	Coastal	1,614	3
3. Copete	Tocoa	Banana	175	1
4. Cayo Sierra	Tocoa	Palm Oil/Citrus/ Basic Grains	620	1
5. El Olvido	Tocoa	Banana	487	1
6. Olanchito	Olanchito	Banana	13,306	5
7. Santa Barbara	Olanchito	Desert	653	1
8. El Nance	Olanchito	Desert	419	1
9. Tacualtuste	Olanchito	Desert	260	1

[7] According to ENEE's consumer lists, the total number of industrial and commercial consumers in the four electric subsystems in the Aguan is 1092. The actual number may be higher, however, because of underreporting. The residential survey found that 21 percent of residential consumption of electricity was, in fact, used for productive purposes.

[8] Information regarding the total number of nonelectrified villages in the Aguán was not available. Therefore it is not possible to indicate what percentage of the total number of nonelectrified villages these are. What can be ascertained is that there are no significant differences among non-electrified villages, and that those visited are representative of the rest.

10. Sinai	Tocoa	Palm Oil/Citrus/ Basic Grains	1,232	2
11. Trujillo	Trujillo	Independent Farmers	5,622	5
12. Tumbador	Trujillo	Independent Farmers	25	1
13. Puerto Castilla	Trujillo	Independent Farmers	1,111	2
14. Taujica	Trujillo	Palm Oil/Citrus/ Basic Grains	908	1
15. Salama	Trujillo	Palm Oil/Citrus/ Basic Grains	1,473	2
16. Tocoa	Tocoa	Palm Oil/Citrus/ Basic Grains	13,500	5
17. Ceibita	Tocoa	Palm Oil/Citrus/ Basic Grains	385	1
18. Sava	Tocoa	Banana	4,974	4
19. Sonaguera	Tocoa	Citrus/ Basic Grains	4,366	4

ANNEX 8: QUESTIONNAIRES USED IN LINKAGES STUDY

No. de Boleta_____Tipo de UP_____Agricola_____No-Agricola

Entrevistador (m/f)_____ Fecha_____

CUESTIONARIO PARA USOS PRODUCTIVOS
DE LA ELECTRICIDAD EN AREAS RURALES Y URBANAS DE HONDURAS

Estamos haciendo una serie de estudios que servirán para evaluar el impacto de la electricidad en el crecimiento economico y del empleo local en áreas rurales de Honduras. La colaboración que nos brinde servirá para planificar el mejoramiento del servicio eléctrico en este país.

I. GENERALES

1. Nombre_____ 2. Comunidad_____

3. Municipio_____ 4. Departamento_____

5. Tipo de empresa o negocio_____6. Propietario(M/F)_____

7. Hace cuánto empezo a trabajar en este negocio?_____

8. Desde cuándo tiene electricidad?_____

9. Cuántos negocios similares a este hay en la comunidad?_____

II. PRODUCCION Y DESTINO

10.1 Productos Principales	10.2 Cantidad	10.3 Precio	10.4 A quien Vende	10.5 Valor

* Importante: indicar C si es cliente de la comunidad, A del Aguan, H de otros lugares de Honduras.

11. Ventas brutas mensuales:
Vendemos aproximadamente_____Lempiras/mes

12. Utilidades mensuales:
Cuánto gana Ud. en este negocio?_____Lempiras/mes

III. GENERACION DE EMPLEO Y FUENTES DE MATERIA PRIMA Y MATERIALES

13. Tenemos interés en establecer el impacto de la electrificación sobre el empleo. Nos podría indicar que empleos hay en su negocio, el tiempo que trabajan sus empleados, de dónde vienen y sus sueldos mensuales así:

Tipo de Empleo	Dias-Hombre/mes	Hombres C, A, H	Sueldo	Mujeres C, A, H	Sueldo	Total
13.1 Profesional						
13.2 Administrativo						
13.3 Especializado						
13.4. Obrero						
13.5. Familiar						
13.6 Otros						
13.7 Total						

Indicar: C proveniente de la comunidad, A del Aguan, H del resto de Honduras.

14. **Responder únicamente si el negocio existía antes de haber electricidad en la comunidad.** Desde que utiliza electricidad en su negocio:

14.1 Hay [ ] más o [ ] menos empleados trabajando en su negocio
Cuántos empleados más (o menos) tiene su negocio ahora?_____

14.2 Qué tipo de empleos se han creado o perdido debido al uso de la electricidad en su negocio?

		Mas	Menos
14.2.1.	administrativo	[ ]	[ ]
14.2.2.	especializados	[ ]	[ ]
14.2.3.	obreros	[ ]	[ ]
14.2.4.	familiares	[ ]	[ ]

14.3 Ahora que usa electricidad, ha aumentado o disminuido su producción?

[ ] aumentado [ ] disminuido Cuánto? _____

14.4. Qué nuevos productos elabora en su empresa desde que usa electricidad?

a._____ b. _____

c._____ d. _____

Cuántas horas al día se trabaja en su negocio?_____

16. También nos interesa conocer los materiales y materias primas que utilizan en la produccion de sus productos:

16.1 Materia Prima y Materiales	16.2 De quien Compra C, A, H	16.3 Cantidad que compra	16.4 Precio	16.5 Valor

Indicar: C=proveniente de la comunidad, A del Aguán, H del resto de Honduras.

IV. USO DE LA ELECTRICIDAD

Por favor indíquenos para qué actividades, dentro de su empresa, utiliza usted la electricidad (columna A):

	A	B
17.1. Iluminación	[ ]	[ ]
17.2. Ventiladores	[ ]	[ ]
17.3. Enfriamiento	[ ]	[ ]
17.17. Riego	[ ]	[ ]
17.5. Bombeo de agua	[ ]	[ ]
17.6. Equipo de Proceso	[ ]	[ ]
17.7. Otros_____	[ ]	[ ]
17.8. _____	[ ]	[ ]

18. Por favor indíquenos para cuáles de las actividades señaladas es la electricidad absolutamente indispensable, es decir, que sin ella su negocio no podría sobrevivir como actualmente está (Columna B).

19. Qué aparatos y equipos eléctricos usa en la producción?

	Equipo	HP	KW
19.1	_____	_____	_____
19.2	_____	_____	_____
19.3	_____	_____	_____
19.4	_____	_____	_____

20. **Responder únicamente si el negocio existía desde antes de haber electricidad en la comunidad.** Qué equipos y aparatos usaba en su negocio antes de que hubiera electricidad disponible? (indicar HP y combustible utilizado :leña, kerosina, diesel, gas propano, etc.):

	Equipo	HP	Combustible
20.1.	_____	_____	_____
20.2.	_____	_____	_____
20.3.	_____	_____	_____

21. En cuánto le sale mensualmente el recibo de la luz:

21.1. Cuando está produciendo_____L/mes

21.2. Cuando no está produciendo_____L/mes

21.3. Nos podría mostrar su último recibo (anotar valor y consumo en kWh):

a. Valor_____L b. kWh _____ c. Estaba produciendo? Si [ ] No [ ]

V. OTROS DATOS IMPORTANTES

22. Uso de la Tierra (para actividades agrícolas **solamente**):

22.1. Tiene terreno propio? Si [ ] No [ ]

22.2. Si no es propio, desde cuándo arrienda?_____

22.3. Si es propio, de qué tamaño es?_____

22.4. Cuánta tierra propia o arrendada tiene produciendo ahora?_____

22.5. Cuáles son sus principales cultivos o actividades?

22.5.a._____

22.5.b._____

22.5.c._____

22.6. Cuánta tierra propia o arrendada tenía produciendo antes de que hubiera electricidad en su negocio o en la comunidad?_____

22.7. Cuáles eran sus cultivos o actividades (antes de la electricidad)?

22.7.a. _____

22.7.b. _____

22.7.c. _____

23. Financiamiento: trabaja o ha trabajado con algún crédito en el último año?
[ ] Si [ ] No

23.1. De cuánto es o fue_____ _____ _____

23.2. Quién se lo dio _____ _____ _____

23.3. Para qué sirvió _____ _____ _____

23.4. Qué mes lo obtuvo _____ _____ _____

23.5. Interés _____ _____ _____

23.6. Ya lo(s) pagó _____ _____ _____

24. Qué ventajas y desventajas ha traido el uso de electricidad a su negocio, y a su comunidad:

_____

_____

_____

25. Comentarios_____

_____

_____

_____

_____

_____

ANNEX 9: TYPICAL PRODUCTIVE USES OF ELECTRICITY IDENTIFIED IN 14 SMALLER ELECTRIFIED COMMUNITIES

PRODUCTIVE USE OF ELECTRICITY	Corozal	Jutiapa	Cayo Sierra	Copete	El Olvido	Sta. Barbara
1. FOOD AND BEVERAGES BUSINESS	4	12	3	2	2	2
2. ICE CREAM SHOPS	0	2	0	0	0	0
3. GAS STATION	0	1	0	0	0	0
4. WOOD WORKS	3	4	0	0	0	0
5. SMALL MISC. BUSINESS	1	6	0	0	0	0
6. LARGE BUSINESSES	0	3	0	0	0	0
7. TAILOR SHOP (LARGE)	2	2	0	0	0	0
8. TAILOR SHOP (SMALL)	8	8	2	1	1	0
9. WELDING SHOP	0	0	0	0	0	0
10. AUTO AND MOTOR REPAIR	0	1	0	0	0	0
11. BICYCLE REPAIR	0	0	0	0	0	0
12. TIRE REPAIR	0	2	0	0	0	0
13. POOL HALL	1	3	0	0	0	0
14. GENERAL STORES (PULPERIAS)	16	22	5	2	2	4
15. LEATHER WORKS	0	1	0	0	0	0
16. BAKERIES	0	0	0	0	0	0
17. CORN MILL	1	2	2	0	0	2
18. BUTCHER SHOP	0	1	0	0	0	0
19. CASSAVA PROCESSING	1	0	0	0	0	0
20. CHEESE PROCESSING	0	1	0	0	0	1
21. REFRIG. & ELECTRONICS REPAIR	0	1	0	0	0	0

22. SOFT DRINKS AND BEVERAGE WAREHOUSE	0	1	0	0	0	0
23. HARDWARE STORE	0	0	0	0	0	0
24. CEMENT BLOCK MANUFACTURING	0	0	0	0	0	0
25. WOOD INDUSTRY	0	0	0	0	0	0
26. WOOD & METAL FACTORY	0	0	0	0	0	0
27. CATTLE RANCH	0	0	0	0	0	0
28. MILK PRODUCTION FARM	0.	0	0	0	0	2
29. MILK COLLECTION CENTER	0	1	0	0	0	0
30. FISHING & PACKING INDUSTRY	0	0	0	0	0	0
31. OIL PROCESSING INDUSTRY	0	0	0	0	0	0
32. BASIC GRAIN WAREHOUSE	0	0	0	0	0	0
33. BANANA PRODUCTION & PACKING	0	0	0	0	0	0

ANNEX 10: CATEGORIES AND LINKAGES OF IDENTIFIED PRODUCTIVE USES OF ELECTRICITY

	PRODUCTIVE USES OF ELECTRICITY	BACKWARD LINKAGES	FORWARD LINKAGES
1.	Rice Warehouse **(C)**	- Rice producing coops. (R)	- Wholesalers (R/NR)
2.	Lumber Yard **(I)**	- Sawmills (R) - Lime stone processing (R)	- Furniture industries (R) - Carpentry shops(R) -Final consumers (R)
3.	Furniture Making (Large) **(I)**	- Sawmills(R) - Hardware stores (R)	- Final consumers (R/NR)
4.	Wood Industry **(I)**	- Lumberyards (NR)	- Standard Fruit Company (R) - Final consumers(R)
5.	Wood & Metal Factory **(I)**	- Sawmills (R) - Steel industry (NR)	- Final consumers (R) - Exports (NR)
6.	Cattle Ranch **(I)**	- Agricultural stores (R)	- Meat distribution centers (NR)
7.	Milk Production Farm **(I)**	- Agriculture stores (R)	- Milk collection centers (R/NR)
8.	Milk Collection Center **(I)**	- Milk producers (R)	- Final consumers(R)
9.	Fishing & Packing Industry **(I)**	- Cardboard box manufacturers (NR) - Packing materials manufacturers (NR)	- Exports (NR)

10.	Oil Processing Industry **(I)**	- Oil nut producing coops. (R) - Fertilizer distributors (NR) - Plastic industries (NR)	- Soap and other chemical industries (NR) - Cattle farms (R)
11.	Basic Grain Warehouse **(C)**	- Maize producers (R)	- Final consumers (R/NR)
12.	Banana Production & Packing **(I)**	- Cardboard box manufacturers (NR) - Fertilizer industry (NR) - Plastic industry (NR) - Repair services (R)	- Export (NR)
13.	Sawmill **(I)**	-Hardware store (R)	- Lumberyards (R) - Export (NR) - Final consumers (R/NR)
14.	Agricultural Machinery Repair **(S)**	- Motor parts (NR) - Electric materials (NR)	- Final consumers (R)
15.	Gas Station **(S)**	- Oil companies (NR)	- Final consumers (R)
16.	Cement Block Manufacturing **(I)**	- Sand extraction industry (R) - Cement factory (R)	- Final consumers (R) - Construction industry (R)
17.	Tailor Shop (Small) **(I)**	- Thread, fabrics and other sewing materials wholesalers (R)	- Final consumers (R)
18.	Tailor Shop (Large) **(I)**	- Thread, fabrics and other sewing materials wholesalers (NR)	- Final consumers (R)

19.	Cheese Factory (I)	- Small and large milkers (R) - Salt and other milk processing materials (R)	- Final consumers (R)
20.	Agricultural Stores (C)	- Agricultural supplies distributors (NR)	- Agriculturalists (R) - Cattle farmers (R)
21.	Butcher Shop (C)	- Chicken, pork and beef producers (R)	- Final consumers (R)
22.	Leather Works (I)	- Leather distributors (NR)	- Final consumers (R)
23.	Corn Mill (S)	- Hardware stores (R)	- Final consumers (R)
24.	Furniture Making (Small) (I)	- Sawmills (R) - Hardware stores (R)	- Final consumers (R)
25.	Food & Beverage Business (S)	- Beer & Drink wholesalers (R) - Chicken, beef and pork producers (R/NR) - Bakeries (R)	- Final consumers (R)
26.	Hardware Stores (C)	- Tool distributors (NR) - Cement factories (NR) - Electric materials (NR) - Other hardware material distributors (NR)	- Final consumers (R)

27.	Bakeries **(I)**	- Firewood producers (R) - Flour, sugar, oil and basic grain wholesalers (R)	- Small stores (R) - Final consumers (R)
28.	Auto & Motor Repair **(S)**	- Hardware stores (R) - Auto-part distributors (NR)	- Final consumers (R)
29.	Bicycle Parts Business **(S)**	- Bicycle parts distributors (NR)	- Final consumers (R)
30.	Welding Shop **(S)**	- Electric materials distributors (NR) - Aluminum, iron and bronze distributors (NR)	- Final consumers (NR)
31.	Bicycle Repair **(S)**	- Hardware stores (R) - Bicycle part businesses (NR)	- Final consumers (R)
32.	Soft Drinks & Beers Warehouse **(C)**	- Soft drinks & beer industry (NR)	- Food and beverage businesses (R) - Final consumers (R)
33.	Tire Repair **(S)**	- Hardware stores (R)	- Final consumers (R)
34.	Private Health Clinic **(S)**	- Medical supplies distributors (NR)	- Final consumers (R)
35.	Cassava Processing **(I)**	- Cassava producers (R) - Firewood producers (R)	- Final consumers (R)
36.	Refrigeration Repair **(S)**	- Hardware stores (R)	- Final consumers (R)

37.	Small Miscellaneous Business (C)	- Various supplies distributors (R)	- Final consumers (R)
38.	Carpentry Shops (I)	- Hardware stores (R) - Lumberyards (R)	- Final consumers (R)
39.	General Stores (Pulperias) (C)	- Soft drinks & beer warehouses (R) - supermarkets (R) - various products distributors (R)	- Final consumers (R)
40.	Pool Hall (S)	- Soft drinks & beer warehouses (R) - Supermarkets (R)	- Final consumers (R)
41.	Large Businesses (C)	- Various supplies distributors (NR)	- Final consumers (R)
42.	Ice Cream Shops (C)	- Fruit producers (R) - Milk producers (R) - Supermarkets (R) - Ice cream industries (NR)	- Final consumers (R)

(I) Industrial Activity
(S) Service Activity.
(C) Commercial Activity.

(R) Regional (located in the Aguan Valley).
(NR) Non Regional

ANNEX 11: COMMUNITIES SAMPLED FOR THE SOCIAL IMPACTS STUDY

ELECTRIFIED COMMUNITIES

CEIBA SYSTEM		
1.	JUTIAPA*	11
2.	NUEVA ARMENIA	9
3.	EL COROZAL	19
TOCOA SYSTEM		
4.	SONAGUERA*	37
5.	TOCOA*	38
6.	MONTE ABAJO	6
7.	ZAMORA	10
8.	CAYO SIERRA	10
9.	CEIBITA (TOCOA)	3
10.	LA BOLSA	3
11.	LA CEIBITA (SAVA)	8
12.	SINAI	5
13.	SAVA*	19
14.	COPETE	3
TRUJILLO SYSTEM		
15.	COOPERATIVA HONDURAS AGUAN	7
16.	COOPERATIVA SUYAPA	5
17.	LA POLLA	5
18.	DOS BOCAS DE STA. ROSA	5
19.	JERICO*	9
20.	SANTA FE	10
21.	EL CARBONAL*	10
OLANCHITO SYSTEM		
22.	COLONIA SUTRASCO*	10
23.	EL CARRIL*	12
24.	EL NANCE	9
25.	TEGUAJINAL	10
26	OLANCHITO*	10

NONELECTRIFIED COMMUNITIES

27.	SELIM (TRUJILLO)	10
28.	PIEDRAS AMARILLAS (CEIBA)	11
29.	BARRANCO CHELE (TOCOA)	10
30.	SAN LORENZO (OLANCHITO)	10

* Communities were either urban or "suburban," that is contiguous with a large town.

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