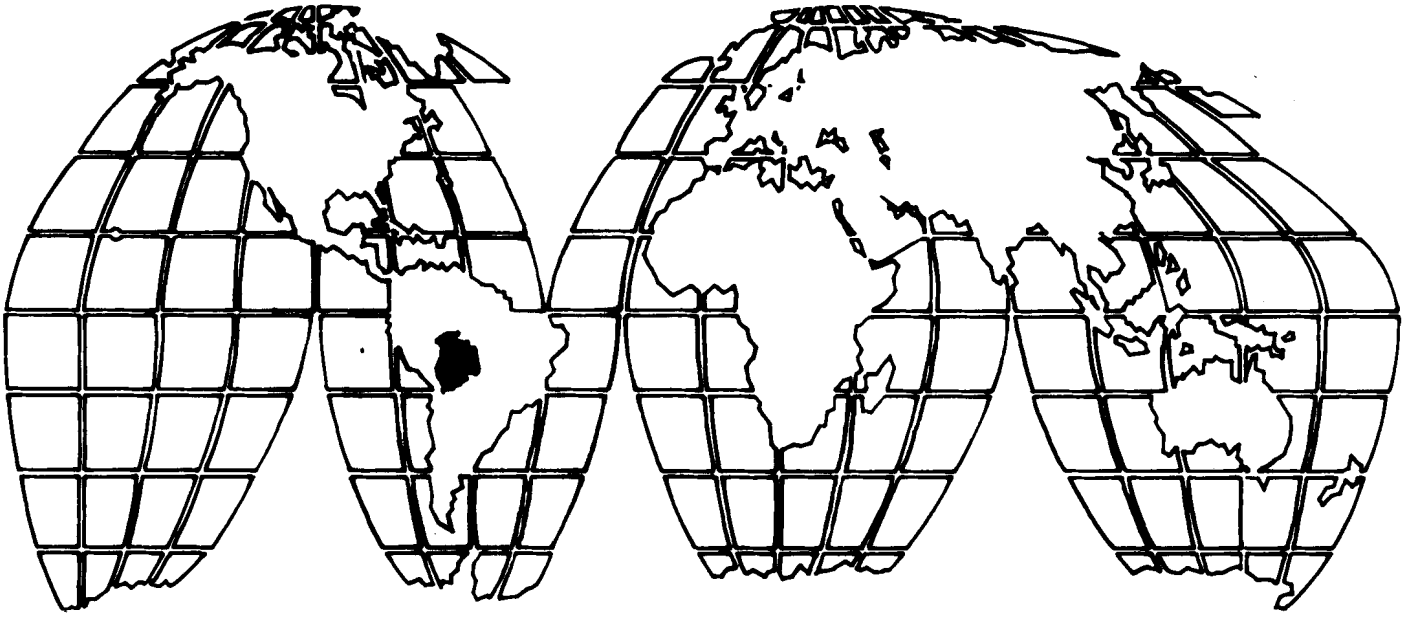
A.I.D. Project Impact Evaluation Report No. 16

Bolivia: Rural Electrification



December 1980

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(continued inside back cover)

BOLIVIA: RURAL ELECTRIFICATION

PROJECT IMPACT EVALUATION NO. 16

by

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FOREWORD

In October 1979, the Administrator of the Agency for International Development requested that, in preparation for an Agency-wide ex post evaluation system, between twenty and thirty projects be evaluated during the subsequent year, focusing on the impact of these projects in several representative sectors of the Agency's program. These impact evaluations are to be performed by Agency personnel and result in a series of studies which, by virtue of their comparability in scope, will ensure cumulative findings of use to the Agency and the larger development community. This study of the impact of Rural Electrification in Bolivia was undertaken as part of this effort. A final evaluation report will summarize and analyze the results of all the studies in each sector, and relate them to program, policy and design requirements.

ACKNOWLEDGMENTS

The impact evaluation team wishes to thank Malcolm Butler, Acting Director, and the staff of USAID/Bolivia for their generous support during the conduct of the field work for this report. In particular, we would like to thank Charles Moseley, Chief of the Engineering and Energy Division, who gave unstintingly and graciously of his time and far-ranging knowledge about rural electrification. He also went out of his way to introduce us to key professionals in the Bolivian power sector, facilitating our work immensely. Jaime Vizcarra from the Mission's Office of Evaluation accompanied us on most of our in-country travel and assisted us with many specific tasks.

We would also like to express our appreciation to persons in the Bolivian power sector for their generous cooperation. Our understanding of Bolivian electric power matters was enhanced enormously by the many hours devoted by Ing. Federico Lucero, assistant manager for distribution of ENDE. Dr. Ronaldo Castedo, Ing. Armando Lara and Ing. Orlando Rocabado, the managers of CRE, CESSA and ELFEC went way beyond the call of duty in spending time with us and instructing their staff to meet our requests. Several persons on the staffs of the electric utilities also deserve special mention for the considerable amounts of time they spent with us clarifying numerous technical aspects of electrification and escorting us to project sites. Though we cannot mention everyone here, we give special thanks to Ing. Orlando Yepes, Ing. Roger (Pino) Ramirez of CRE, Ing. Alberto Soria of ELFEC, and Prof. Rene Zarate, Sr. Jorge Mostajo and Ing. Eduardo Manjon of CESSA.

The field support of Prof. Juan de Dios Yapita and Alcira Bascope provided invaluable insights into Aymara and Quechua rural life. In addition, Ing. Roger Levy significantly contributed to our statistical analyses.

The list of persons who assisted our evaluation effort goes beyond those named above. There were many others from the professional, administrative and secretarial staffs of USAID/Bolivia and in the Bolivian power utilities who went out of their way to help us.

Finally, this study would not have been possible without the warm welcome extended to our team by rural families and communities in the Bolivia rural electrification program. It is our respect for their privacy which prevents us from mentioning them by name.

SUMMARY

Background: As part of an AID effort to assess the impact of its assistance in several development sectors, two rural electrification loans in Bolivia were selected for evaluation. The evaluation team consisting of a senior rural development officer, an anthropologist and an economist undertook its field work in a three week period in May and June 1980.

AID has funded four electrification projects in Bolivia. The initial grant in 1962 and loan in 1966 focused on the urban environs of the city of Santa Cruz while the last two loans in 1973 and 1974 were almost exclusively for rural electrification. This evaluation focuses on the impact of the 1973 and 1974 rural electrification loans which were to improve the social and economic conditions in the rural areas adjacent to six major urban areas located in the highland, valley, and tropical zones of Bolivia. It was assumed that the availability of electric power would stimulate the development of rural industry and irrigation as well as improve social conditions through residential and public service usage of electricity.

Project Effectiveness: By 1979, most distribution networks were constructed and energized, with the exception of the La Paz region. While it may be too early to ascertain the impact of the 1973 and 1974 loans and difficult to separate start-up problems from longer-term problems, comparisons between planned and actual electricity use can be made. The project provided electricity to 42,000 rural consumers, 20 percent less than projected for the first year after construction. The primary use of rural electrification was residential, for household lighting. A strong demand for residential connections existed beyond that planned for in the project and beyond the systems' current response capability. Average consumption per household, however, was lower than projected and the uses of electricity for irrigation and small industry were almost negligible which meant that the utilization of the systems' new capacity was less than anticipated. As a result, the utilities have not realized the revenues anticipated in the project design to achieve financial viability.

In addition, the intended use of electricity for night classes, for equipment in health centers and for public lighting have barely materialized. The team noted some promising initiatives, however, to use electricity for potable water systems.

Major Impacts: The preponderant positive impact of the rural electrification project was social. Household lighting improved the physical quality of life for 7 percent of the rural population of Bolivia. Electric light was more convenient, less expensive, safer and healthier than traditional lighting sources such as kerosene and candles. Electric power did not seem to play a catalytic role in

the economic development of rural areas nor to be a precondition for it.

Certain aspects of project design limited social and economic benefits of the projects and weakened the financial position of the electric utilities. Premature termination of financing for initial hookups resulted in the disproportionate exclusion of the poor from project benefits. Excessive technical design standards increased capital and operating costs of the systems. The equal urban-rural rate structure, though beneficial in some ways, provided insufficient revenues for utilities to expand the rural systems. Absence of an aggressive promotion program, including a mechanism to mobilize financing offered by beneficiaries, resulted in a smaller number of residential and productive consumers than was possible.

Lessons Learned:

1. Rural electrification projects should be located where evidence of demand for productive use of electricity is apparent in the form of already-existing productive activities based on other forms of power. Alternatively, if the real intent and probable impact is social, the project should be designed so as to maximize the number of household connections rather than provide high quality service to a smaller number of consumers.

2. Project designers should introduce cost constraints into the decision-making on technical design standards, partly by allowing more of these choices to be made by host-country technicians and by those who will be concerned with the revenue-earning operations of the utility.

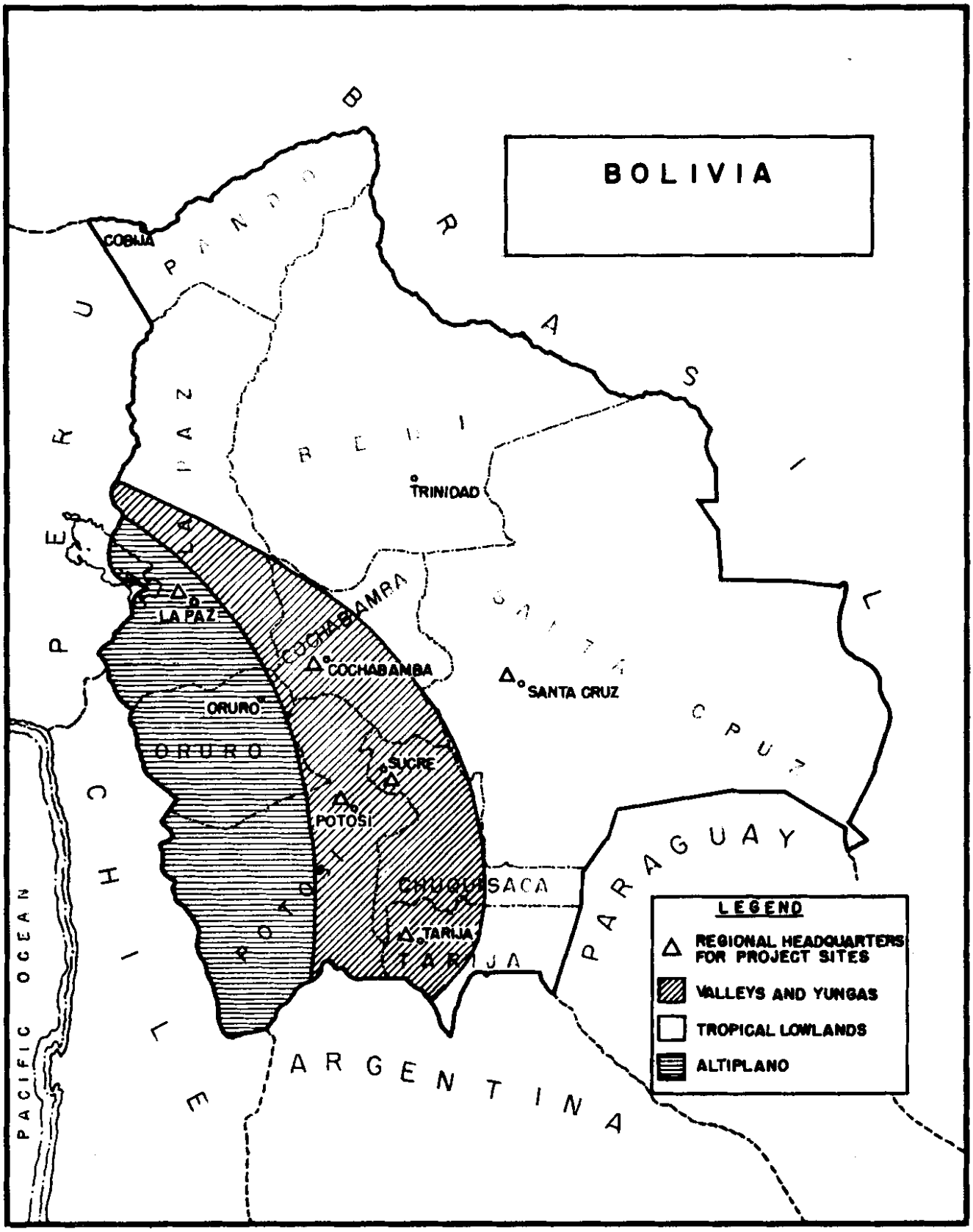
3. Rural electrification projects should attempt to ensure explicit linkage between electrification and one or two complementary development activities which result in both increased development impact and increased rural power consumption, such as potable water and irrigation in the Bolivian case.

4. Rural electrification projects should include a vigorous promotion program with materials to teach rural people how to obtain electric service and how to use it productively as well as a mechanism to mobilize private resources from beneficiaries. Such a program would spread project benefits to more residential and productive consumers and strengthen the financial viability of the electric utilities through increased consumption of electric power.

GLOSSARY AND ABBREVIATIONS

Cantón	An administrative unit roughly corresponding to a U.S. county.
Pueblo	The nucleated center of a cantón, roughly corresponding to a U.S. county seat.
AID	Agency for International Development.
IDB	Interamerican Development Bank (Banco Interamericano de Desarrollo).
BPC	Bolivian Power Company. A publicly owned electric utility which is a subsidiary of the Canadian International Power Company (CIPCO) of Montreal, Canada.
CESSA	Electric Cooperative of Sucre (Cooperacion Electrica de Sucre, S.A.), sub-borrower in the AID rural electrification loan.
CEY	Electric Cooperative of the Yungas (Cooperativa Electrica de Las Yungas), sub-borrower in the AID rural electrification loan.
COMIBOL	Bolivian Mining Corporation (Corporacion Minera de Bolivia).
CORELPAZ	Electric Cooperative of La Paz (Cooperativa Electrica de La Paz), sub-borrower in the AID rural electrification loan.
CRE	Electric Cooperative of Santa Cruz (Cooperativa Rural de Electrificacion), sub-borrower in the AID electrification loan.
DINE	(Direccion Nacional de Electricidad), Bolivian electric power regulating agency.
ELFEC	Electric Light and Power Company of Cochabamba (Empresa de Luz y Fuerza Electrica), sub-borrower in the AID rural electrification loan.
ENDE	National Electric Company (Empresa Nacional de Electricidad), executive agency for the AID rural electrification loan. An autonomous public enterprise created for the purpose of developing and implementing a national electrification plan for Bolivia; responsible for generating and wholesaling electricity.

GOB	Government of Bolivia.
INER	National Rural Electrification Institute (Instituto Nacional de Electrificacion), original sub-borrower for La Paz region of AID rural electrification loan, replaced by CORELPAZ and CEY.
SEPSA	Electric Services for Potosi (Servicios Electricos de Potosi, S.A.), sub-borrower in the AID rural electrification loan.
SETAR	Electric Services for Tarija (Servicios Electricos de Tarija), sub-borrower in the AID rural electrification loan.


BOLIVIA
COBIJA
PANDO
BENI
BRASIL
LA PAZ
TRINIDAD
PERU
COCHABAMBA
SANTA CRUZ
ORURO
SUCRE
POTOSI
CHUQUISACA
TARIJA
CHILE
PARAGUAY
ARGENTINA
PACIFIC OCEAN
LEGEND
REGIONAL HEADQUARTERS FOR PROJECT SITES
VALLEYS AND YUNGAS
TROPICAL LOWLANDS
ALTIPLANO

PROJECT DATA SHEET

1. Country:

   Bolivia

2. Project titles, numbers and dates:

   Rural Electrification I - 511-L/T-046 - 1973
   Rural Electrification II - 511-T-049 - 1974
   Amendment to RE I & II - 1974

3. Project funding ($ millions):

	Original	Amendment	Total
Rural Electrification I:			
U.S. loan funds	10.8	1.0	11.8
Government of Bolivia	1.2	3.6	4.8
	12.0	4.6	16.6
Rural Electrification II:			
U.S. loan funds	6.5	3.0	9.5
Government of Bolivia	2.2	1.1	3.3
	8.7	4.1	12.8

Scope: The projects funded: (a) design, engineering and construction costs to extend electric transmission, distribution and connection services to rural areas adjacent to the departmental capitals of La Paz, Cochabamba, Sucre, Tarija, Potosi and Santa Cruz; and (b) a limited amount of technical assistance to strengthen the management capabilities of the weaker electric utilities.

I. INTRODUCTION

For the first time in their lives thousands of subsistence farmers, herders, small merchants, and artisans who live in the adobe houses and huts that dot the rural Bolivian countryside have electric light. This is a result of the rural electrification program launched by the Government of Bolivia (GOB) in 1973 and co-financed by the U.S. Agency for International Development (AID). In a three week period in May and June 1980, an AID evaluation team consisting of a senior rural development officer, an economist and an anthropologist visited over 30 rural towns and villages in the three major geographic regions of Bolivia to determine the impact of electricity on the lives of rural people and on the rural economy. The team found that rural people of all ages and income levels valued electricity; they felt that electricity greatly improved the physical comfort of living in the countryside and believed that new life and vitality would come to their towns as a result of electricity. T ral electric power did not, however, seem to play a rural economic development nor to be a precon- d tead, the team had the impression that electricity was more a response to economic growth than the cause of it.

II. THE PROJECT SETTING

Although the per capita GNP of $630 ranks Bolivia as a middle income country, Bolivia must be regarded among the least developed countries on the basis of physical quality of life indicators presented in Appendix A. In 1977, over 60 percent of its total population lived in absolute poverty. The largest proportion of the poor are concentrated in the rural areas.

The project area of the rural electrification program is dotted with small towns and a patchwork of dispersed farming settlements. Mestizos, persons of mixed European and Indian ancestry, monopolize economic activity in rural towns. They form the basis of a small, emerging middle class. Among the poorer people in Bolivia are the Indian peasants who live in dispersed settlements surrounding the rural towns. They live in adobe houses with thatch or tin roofs. The majority use manure and wood for cooking and candles or kerosene lamps made from discarded tin cans for lighting. They farm small subsistence plots of land on the harsh arctic desert of the Altiplano, in the more hospitable valleys of Cochabamba, Tarija, Sucre and in the lowlands of Santa Cruz.

The only urban areas in Bolivia are the nine departmental capitals; they are the population centers and economic growth poles. The objective of the rural electrification program was to spread economic growth beyond the departmental capitals and simultaneously to improve the physical quality of rural life.

III. THE PROJECT

AID's electrification strategy in Bolivia evolved from urban to rural, from electricity generation to transmission and distribution, and from regional concentration to more regional balance in investments. In 1962, AID launched its first electrification project for the construction of three generating units to service the city of Santa Cruz. Santa Cruz was a boom town, its growth stimulated principally by the development of petroleum and gas industries and improved surface transportation to the rest of Bolivia. The focus of the subsequent 1966 AID loan remained urban power generation and distribution but included activities to develop the existing Rural Electric Cooperative in Santa Cruz (CRE) and to construct rural distribution lines. The already expanding economy of the Santa Cruz area received added impetus from the two electrification projects. A rapid increase in new industries within the service area was said to have resulted from the provision and upgrading of electric power.

On the basis of the Santa Cruz electrification experience, and in an attempt to improve the economic and social conditions confronting rural populations, AID signed two loans in 1973 and another in 1974 to extend electric service to the rural areas adjacent to five other departmental capitals in the highlands and valleys and to extend additional lines to rural and peri-urban zones of the Santa Cruz region. This evaluation addresses the impact of the 1973 and 1974 loans.

AID channeled funds to the National Electric Company (ENDE), which generated electricity for sub-lending to seven electric utilities charged with retailing and administering electrical service to their respective regions: Santa Cruz (CRE), Cochabamba (ELFEC), Sucre (CESSA), Tarija (SETAR), Potosi (SEPSA), and La Paz (CORELPAZ and CEY). Loan funds primarily financed design, engineering and construction costs and a limited amount of technical assistance from the National Rural Electric Cooperative Association (NRECA) to strengthen the management capabilities of the weaker distributing entities. A total of 53,000 rural consumers were projected to receive electricity by 1977, with that number almost doubling by 1986 to 81,000.

The purpose statement of the 1973 loan highlights the belief that the provision of electricity would accomplish the social and economic goals of the project:

> The purpose of the loan is to improve the economic and social conditions of the inhabitants of the rural areas adjacent to major population centers of Bolivia by providing them with electrical transmission, distribution and connection services on a self-supporting basis. (Emphasis added)

Thus, the two rural electrification projects assumed incorrectly that simply providing basic electric infrastructure would result in

improvement of economic and social conditions in the rural countryside. Specifically it was expected that electricity would stimulate the development of rural industry and irrigation, improve educational and health services, make life more comfortable for rural residents, and help deter the exodus from the countryside.

A corollary objective of the loans was to insure that participating electric utilities were capable of expanding to meet future demand with revenues generated from the sale of electricity. It was projected that the rate structure would permit a 9 percent rate of return which would be sufficient to make the utilities financially viable and capable of loading up the new system over a ten-year period.

IV. IMPACT ON THE QUALITY OF RURAL LIFE

A. Attitude of Rural People toward Electricity

> Electrification is the principal thing that is going to make our pueblo live; without it, our pueblo is going to die. If there were electric light, those who have migrated to the city would return here. Many have abandoned the pueblo for lack of light and other necessities.
>
> Raul Miranda, 68 years old
> Pucarani, La Paz Highlands

Rich and poor, young and old valued electricity. The statement of Raul Miranda is indicative of the importance that rural people attach to electric power. They often ranked it as important as potable water, education and health care. At a meeting of the community leaders from Manco Kapac Province on the Altiplano, each representative reiterated the desire to have electricity, potable water, schools and sanitary posts. In Sucre, we were told that an older woman resident of a rural community cried with joy on the day that the electrical system was inaugurated. She thought that she would never live to see the day that electricity would come to her town.

The willingness of rural people to pay significant capital costs to obtain a household connection--costs that increased manyfold when AID project credit ran out--also indicated the value placed on electricity. In addition, some communities, upon learning that they would not be connected to the system even though the primary distribution lines passed nearby, vandalized poles or wires. Some people living in dispersed rural communities moved their residence to towns or formed new towns in order to gain access to the new power. See Appendix B for further discussion of migration impact.

B. Changes in Life in the Rural Household

> It is 8:30 pm. The evening meal has been eaten. Margarita Aguayo de Cayo sits down next to the heap of corn kernels located in the middle of the single room adobe hut that she shares with her husband Cecilio. She tucks one leg under the folds of her home-spun skirt and begins to select rocks and other paraphernalia from the corn that she will grind for the next day's noontime meal. Cecilio is nearby, sharpening the blade to his oxen-pulled plow with a flat abrasive stone. Conspicuously, a single light bulb dangles from a black wire suspended from the crossbeam which supports the thatch roof.
>
> Falsuri, Cochabamba Valley

The team found that the predominant use of electric power in rural areas was for household lighting. A typical house had one or two light bulbs. Light allowed rural people to extend their day by two or three hours by not retiring immediately after the evening meal. With longer waking hours, people socialized more and some pursued productive activities, such as weaving or repairing agriculture equipment. In rare instances, the team observed electricity being used to power electric motors for work.

Household light affected the life of the rural woman the most since many of her activities revolve around the home. The rural woman used light in the evening to sort seeds and clean agricultural produce, to spin wool, to make and repair clothing and to weave blankets--activities that were previously undertaken in the daylight hours. Electric light was more convenient and cleaner for her to use than traditional kerosene lamps and candles since the wind could not blow out the light bulbs and there were no spills or wax to clean up. She no longer had to worry about the small children being burned. The bright light also made it easier for the older children to do their homework; they no longer complained about headaches from the kerosene fumes and eye-strain from the dim light. Most importantly, electric light was three to four times cheaper than kerosene or candle light which made it easier to stretch the family budget to cover the basics during the recent periods of high inflation. One rural woman volunteered that her family would not eat so well if it were not for the savings she realized from the electric light. In the three week period that the team was in Bolivia the price of bread doubled and that of sugar increased 120 percent.

The team visited both electrified and non-electrified rural towns and dispersed settlements and spoke with people who had electricity and those who did not. The team found that electricity reached both poor and better-off rural households. Both large towns and small

villages had high rates of household connections, approximately 60 percent of the households within reach of the lines. The percentage of Bolivia's rural population that the program reached, however, was much lower; only between 12 and 22 percent of the total households in electrified cantons received electric power. Of the total rural population of Bolivia, less than 7 percent received electricity under the two projects.[1]

Though the project provided electricity to 80 percent of the number of consumers projected in the project paper, these projections grossly underestimated demand for household connections. All of the utilities had a substantial backlog of applications to which they had been unable to respond for lack of funding and staff following the termination of the AID projects. We discuss the causes of this problem in Appendix D.

C. Social Service Effect

A major objective of the rural electrification projects was to improve the quality of life in rural areas through the use of electricity for potable water, health, education and public lighting programs. The benefits of these programs would be most significant for the poor because (1) they also accrue to non-users of household electricity, among whom the poor are disproportionately represented; and (2) because they are made possible by the availability of electric systems that rely mainly on electric power consumers for their income.

The team found that the most significant social service use of electric power was for potable water systems albeit on a modest scale. With the exception of the Sucre system, the use of electric power for streetlighting was still minimal. In towns where streetlights were installed, however, people stated that they felt safer walking at night and thought that socializing at night had increased. The use of electricity in schools and health posts has not resulted in expanded services through nighttime use or improved service quality through use of electric powered equipment.

The reasons for the lack of linkage between the installation of electrification systems and social service usages were various. First, the project included no mechanism, either financial or administrative, through which the linkage between electricity and social service uses would take place. Second, the public agencies responsible for health, education and potable water are typically among the weakest in terms of bureaucratic power and financing; electric power entities, in contrast, are usually among the strongest. This disparity in power between electric-power entities and social-sector agencies made it unlikely that the latter, on their own, would come

1. These percentages, of course, will be higher as further connections are made, given that the AID project installed ten to twenty years of distribution capacity.

up with the funds and the organization to take advantage of the new availability of electricity. Third, electricity was not as essential an input into the social service usages as it was portrayed in project justifications. In many cases, these services did not materialize or function well for reasons that had nothing to do with the availability of electric power. For example, health clinics functioned without refrigerators because they broke down and spare parts were not available, even though electricity was available. The vaunted advantage of electricity for night classes and vocational classes seemed to be the least likely to materialize. Most rural school teachers in Bolivia did not live in the towns where they taught, or were not interested in extending their work day. The projected night or literacy classes, moreover, depended on the mounting and funding of a program quite distinct from existing daytime programs.

V. FACTORS IN PROJECT POLICY AND DESIGN WHICH LIMITED DISTRIBUTIONAL IMPACT

The rural electrification systems financed under the project were expansions of urban systems out into their rural hinterlands, with the exception of the La Paz systems which will be exclusively rural. In each of these systems, rural consumers were charged the same rate as urban consumers. The unit costs of supplying electric power to rural areas were three to four times those for cities, mainly due to the dispersion of rural households and the lack of industrial loads. Therefore, the equal-rate policy signified a subsidy by urban users to their rural counterparts, an unusual reversal of a typically contrary phenomenon: the subsidization of the city by the countryside in the form of price controls on food, over-valued exchange rates, etc.

Even though the equal urban-rural rate had positive distributional implications with respect to the rural poor, the impact of that rate on utility management may ultimately redound to the disadvantage of the countryside, in the form of the reduction of future service to rural areas in favor of the city. That is, a mixed urban-rural utility charging equal rates for both services may give priority to its urban service over its rural, given that the rural service is considerably less profitable; this seemed to be happening in at least one of the sub-projects, the ELFEC utility in Cochabamba.

A final observation on project policy was that the disproportionate investment in the Santa Cruz system--more than double that of the next largest share--was not warranted given the much lower population densities in this area. It may also have exacerbated regional income inequalities, mainly between the Altiplano, where the majority of Bolivia's poor are concentrated, and the Santa Cruz lowlands, where per capita incomes are higher. Appendix C discusses this point in more detail.

One of the most significant distributional impacts of project design was the financing provided for the capital costs of house connections. Installment payments were spread over a seven year

period making the electrical connections affordable to poor people. The financing scheme could have reached more poor people but lack of selection criteria resulted in the provision of credit to all, even those who could have financed the hookup from their own resources. The financing ran out before all the connections to be made under the project were completed, due to cost overruns. Financing has not been available for further connections, the cost of which had more than doubled by the end of the project. In the first year after the systems were energized, therefore, those who wanted household connections had to make an initial payment of nearly U.S. $120, compared to the $4 to $8 down payment required of those with access to the early financing.

The consequences of the premature termination of financing for household connections fell most heavily on the poor. For several reasons the poor tended to connect last. Since they frequently migrated to obtain seasonal work, they were often not at home when initial fees were collected for the system. Also, during the workday, women were more frequently encountered in the house than men who had either migrated in search of seasonal employment or were working in fields at some distance from the household. Since many rural women in Bolivia were monolingual Aymara or Quechua speakers they had difficulty communicating with the monolingual Spanish representatives of the utility. Even for those rural women who spoke Spanish, social custom often proscribed their communicating with males without a male relative present. In addition, people were skeptical that they would ever see electricity in their communities. There is a long tradition in Bolivia of public officials collecting money from rural people to construct projects which are never realized. Since poorer people have little cash to risk, they were less likely to contribute to these schemes in advance of any evidence that electric power would actually be provided. Once they saw the lines and poles, they also wanted to receive electricity. However, installation was more expensive and had to be done by a private electrician rather than by the electric utility. People lacked the knowledge to contract for these services. Numerous instances were found in Santa Cruz, Cochabamba and Sucre in which poorer people were deprived of electricity for lack of the lump sum required for installation as well as lack of knowledge to contract for the proper installation services. Many instances of improper self-contracted installations were also found.

The team found that two related miscalculations in design limited the positive distributional impacts of the new electric power systems. First, the U.S. consultants designed the systems for a fewer number of consumers and a higher level of consumption per household than that which corresponded to the Bolivian reality. The significantly higher consumption standards projected by the consultants were based on U.S. rural electrification standards and on the assumption of aggressive promotion campaigns for electricity use on the part of utilities, which was not the case.

The degree of concentration of the rural population in Bolivia was also considerably underestimated. The underestimate resulted in

part from reliance by the consultant on old census data without adequate field checks to determine the growth of population and nucleation in the twenty intervening years. Consequently, several eligible communities were not connected, while several stagnant communities of dwindling size were connected. The effect of the overestimated average consumption per individual consumer and the underestimated population density was that the system had more generation, transmission and distribution capacity than projected (20 years instead of 10) while the utilities were unable to compensate for the lower average consumption by attending to the considerable additional demand for hookups, which would have helped to load up the excess capacity.

Compounding the inability of the utilities to connect up more users was the lack of attention in project design to possibilities for allowing potential users to finance line extensions or connections to the system. The team encountered many households that desired electricity and were willing, if necessary, to contribute financially for these extensions. Although the utilities were not against this practice, they were not set up to handle it, let alone promote it. The considerable potential for local participation in the loading up of the new power system was, therefore, not realized, resulting in more limited project benefits, particularly for the poor. Just as significant, the project neglected one of the rare opportunities for mobilization of private savings for infrastructure projects.

VI. IMPACT ON ECONOMIC DEVELOPMENT IN RURAL AREAS

In all of the systems visited, there were various cases of tailors and hat makers using sewing machines and electric irons; of small restaurants, juice stands and ice cream stands using blenders, refrigerators and record players, and of people using light to extend non-electric productive activities into the night. Santa Cruz was the only system where the team observed considerable use of electric power for small industry. Power was used here for corn, sugar and lumber mills and cotton gins. Most of these latter uses represented the substitution of central-system electric power for diesel power. The users said that their savings in operating costs were on the order of four to one.

The team had the impression that central-system electric power was more a response to economic growth than the cause of it. In some towns in the Cochabamba Valley and on the Altiplano where electric power had been available for several years, the team was struck by the lack of development of productive activity, or even of the switchover of small activities like flour mills from their own diesel motors to utility supply. In the Santa Cruz region, where productive use of power was more apparent, the team was impressed with the role that other economic factors had played as engines of growth--booms in cotton, beef, sugar cane, cocaine, contraband--and the fact that

most rural-based users had installed their own motors before the advent of central-system electricity. The lack of electric power, in other words, had not seemed to constrain Santa Cruz growth. That most of the industrial users in Santa Cruz were urban industries oriented toward urban markets, moreover, suggests that the industrial growth associated with the Santa Cruz grid was more urban than rural. The provision of rural electric power, in sum, did not seem to play a catalytic role in the economic development of these areas or to be a precondition for it.

The team found some evidence that in the medium-term (7-10 years), rural electrification may be a factor contributing to the emergence of viable secondary and tertiary towns in Bolivia. The secondary towns that the team visited in Santa Cruz, Cochabamba and on the Altiplano were provincial capitals which had had 24 hour electric service for over 7 years while the provincial capitals without electric service were administrative centers which remained 50 percent vacant on non-market days. Though this evidence is inconclusive, the relationship warrants further investigation. We explore this relationship in more detail in Appendix B.

VII. FACTORS CONTRIBUTING TO THE LACK OF PRODUCTIVE USES OF ELECTRICITY

A. Technical and Organizational Design

Despite the concern for productive uses and benefits expressed in project justifications, the rural electrification project was designed almost exclusively with residential consumption in mind. Even though irrigation was projected to play an important role in project benefits, representing between 15 to 30 percent of benefit flows in the cost-benefit analysis, no plans were made in the project, nor funds included, that would increase the probability that the irrigation potential would materialize. Moreover, no evidence was gathered in the project feasibility as to whether irrigation was profitable, given existing cropping practices, the capital costs of irrigation, and local availabilities of complementary inputs and services. For example, on the Altiplano irrigation was projected to account for 20 percent of the benefit flows. The question remains as to whether irrigation is economically desirable or feasible, given the harsh winters and problems of salinity.

The Valley Alto in Cochabamba and the Yacuiba Valley in Tarija were partial exceptions to the lack of irrigation design in the project. The distribution lines for these valleys were designed to accommodate the expected irrigation load. Exploitation of the opportunity for irrigation, however, was dependent on the programs of other agencies. Studies of irrigation potential, experimental drilling, water-use technology, etc., were not the responsibility of the utilities. The utilities, moreover, were not prepared to facilitate coordination with these agencies, nor to handle requests for organizational, financial, and technical assistance or hookups by water-user associations.

In the Cochabamba area, small programs of the Ministry of Agriculture and the Departmental Development Corporation projected installation of 30 electric irrigation pumps by 1981, each covering about 25 hectares. About 20 such systems already existed in the area, run by diesel pumps, and managed by indigenous water-user associations. Though a good start, this rate seemed inadequate given the importance of irrigation to the realization of project benefits in the early years after construction.

The lack of development of the project's irrigation objectives also represented an under-utilization of the ability of Bolivian farmers to organize themselves into small water-user associations. The few groups visited by the team in the Cochabamba area had been quite capable of forming informal organizations to obtain and manage pump-irrigation systems, and of contributing financially to the undertaking. The technical characteristics of such small irrigation systems--with simple equipment and small command areas--were highly compatible with traditions of intra-community cooperation and did not require the complex management necessary for larger, more centralized irrigation systems.

B. Costs to Users

The productive uses of electric power depicted in project justifications suggested small, dispersed industrial and service uses. A combination of rate structures, utility policies, and structural factors, however, seemed to work together against the use of electric power by the small rural producers. The problem resulted from the fact that (1) financing of the capital costs of connection was not available for small industrial or irrigation purposes; (2) large industrial users had access to official and commercial bank credit for expansion of their activities and frequent contact with supply firms for technical assistance in buying electrical equipment; small users did not have such access; and (3) rates charged for small industrial users were higher than for large industrial users.

A final reason for the paucity of small productive users in the new electric systems is that many potential productive uses of electric power in rural areas are seasonal, such as fruit and vegetable plants, sugar and flour mills, and cotton gins. Seasonal loads are unprofitable for a utility in that it has to supply a certain level of installed capacity that goes unused for a good part of the year. Likewise, grid power can be uneconomic for seasonal users because utilities charge minimum monthly rates regardless of usage. For this reason, the mere installation of central-system power may not elicit agro-industrial usage even where production already exists based on self-owned motors.

C. Promotion Policies

In the exceptional case where utilities did have promotional programs (CESSA in Chuquisaca), there was a tendency to promote the use of domestic household appliances rather than productive equipment. This type of promotion not only ignored productive use, but also had regressive distributional implications, since it was only the higher-income families that could afford the electric showers, the electric stoves, the hair dryers and the blenders that appeared in the promotional literature.

Many small producers interviewed by the team were confused and uninformed about (1) what they had to do and how much they had to pay in order to connect up to the new grid and (2) about what kinds of motors they needed to buy and where they could be obtained. The latter confusion resulted, in some cases, in the purchase of inappropriate motors. Small productive users frequently overestimated their markets and feasible production levels and hence their power needs.

Taken together, all considerations suggest that a small technical assistance and promotion effort by the utilities could have resulted in significantly more productive use, could have reduced wasted investment in inappropriate motors by potential users, and could have elicited the mobilization of private funds by potential users for extensions of the line and purchase of transformers.[2]

D. Broader Economic and Policy Reasons for the Low Level of Productive Use

Despite the concern for productive use expressed in project justifications, the Bolivians saw the rural systems as having exclusively social and political justifications. These investments were meant to carry light, not energy for production, to the rural population. The Bolivians viewed rural electrification as redressing the past imbalance in public-sector attention in favor of the cities. From the point of view of load management, moreover, the utilities felt no pressing need to seek out productive users in the rural areas since the urban base of the rural system provided a reasonable industrial load and its desirable characteristics.

Another possible reason that productive use was less than expected was that machine-based technologies of production in many cases may not have been competitive with existing labor-based

2. An interesting exception to the lack of a promotional program by the utilities was the self-initiated promotion activity of the Chuquisaca utility, CESSA. CESSA was attempting to negotiate a credit with the Banco Agricola, through which it would purchase a group of single phase motors and then retail them through sublending arrangements to productive users.

techniques, in which case the adoption of power-driven motors would not have been profitable. The lack of productive use may also have resulted from the fact that the rural systems were expanded out from the city along existing road networks. Roads radiating out from cities result in decreased urban-rural transport costs and thus facilitate the supply to rural areas of mass-produced articles which cannot be produced as cheaply in rural areas.

VIII. WHAT HAPPENS AFTER AID FUNDING STOPS?

A major objective of the project was to build within existing electric utilities the capability to load up and expand the system, thereby realizing the project's benefits and the revenues that were necessary for financial viability. The team found that the utilities, having completed construction and disbursement of AID funds, were not able to meet the demand for further connections due to financial and personnel constraints.

The principal factors contributing to the utilities' current weak financial position are examined briefly below. These factors not only increased capital and operating costs and reduced income flows to the utilities in the crucial post-construction years, but also reduced social and economic benefits of the project. A detailed discussion of the financial vaibility of the rural electrification systems is found in Appendix D.

High unit costs of construction and the excess capacity of the electrification systems in the initial years after construction are characteristic of rural electrification. As a result, it is essential to load up such systems as rapidly as possible. Therefore, the ability of the utility to add new consumers in the early years was crucial to the realization of the systems' economic benefits and to ensuring adequate revenues to the utility. The team found a number of design issues affecting the addition of new consumers to the system.

First, the project design assumed that the realization of a number of complementary government development plans for irrigation, potable water services, and agro-industry would help "create" an increased demand for electricity. The team found only isolated cases where complementary development programs were facilitating demand; irrigation and potable water programs in the Cochabamba region and potable water in the Santa Cruz region. The expectation that such other agency inputs would be forthcoming was overly optimistic given the inherent difficulties of coordinating, managing, and financing rural development schemes. In addition, the project design contained no explicit program or financial link between rural electrification and any of these activities thereby reducing the likelihood that they would materialize.

Second, the design did not include an adequate program to promote productive and social service usages which would generate more revenue

for the utilities in the critical transition stage from completion of construction to full operations. The promotional financing scheme to facilitate residential hookups terminated prematurely, did not employ criteria to ensure the maximum spread of benefits and lacked provisions to roll over loan repayments for the continuation of such financing.

Third, the design did not include a mechanism to mobilize private resources to extend rural electric services. While there were isolated instances of utilities allowing private citizens to pay more than their customary share of installation costs, there was not a systematic promotional effort along these lines. The team felt private resource mobilization had considerable but untapped potential given the high priority which communities attached to rural electrification. The net effect of capturing these resources would have been to increase the number of project beneficiaries and to augment revenues of the utilities.

Fourth, although the equal urban/rural rate structure had positive distributional impacts for rural consumers, it had adverse consequences for the financial viability of the utilities. The addition of a costly rural system to an urban one without sufficient compensating revenues put the utilities one step further away from earning an adequate rate of return. As in many Third World countries, the Bolivian utilities have political difficulties in charging adequate rates to cover operational costs and to allow for expansion. Urban dwellers are typically more vocal and organizationally effective in protesting rate increases than the more dispersed and less organized rural inhabitants. The urban/rural equal rate structure conveyed the political problem of raising rates to the rural systems. There was evidence that rural consumers could be charged higher rates. Independent autogenerated systems in Bolivia, for example, were able to charge rates three or four times those of the central systems. Other observations of the team regarding the advantages of independent systems over central systems are found in Appendix F.

Fifth, the project generally adhered to standards and practices of the Rural Electrification Administration of the United States. This meant that technical specifications were more consistent with capital costs, load characteristics, quality of service requirements, per capita incomes and transport conditions of the United States rather than with those of Bolivia.

The team found numerous examples of inappropriate or excessive design standards and practices:

- use of meters rather than flat charges;
- use of house meters which could not register the low household consumption levels;
- use of more utility poles than was necessary;
- overly refined voltage regulators;
- use of medium tension lines where low tension lines would suffice; and

— use of one large construction contractor for each regional subsystem, resulting in energization of the entire system in the final stage of construction rather than a phased energization, community by community, which would have produced earlier revenues to utilities.

These factors, illustrate not only the extent to which project costs were greater than necessary, but also once construction was over and operations began, how they weakened the administrative and financial viability of the utilities and thus reduced the potential social and economic benefits of the project.

IX. CONCLUSIONS

1. The dominant impact of rural electrification was social. Household lighting was extended to many rural people and areas. Both poor and better off households benefited, although limitations in financing for initial hookups and excessive technical design standards resulted in the disproportionate exclusion of the poor from project benefits. The operating costs to consumers for electric light were much less than the costs of traditional light sources such as kerosene and candles. Electric light was more convenient especially for women and it was safer, cleaner and healthier than traditional lighting sources. Use of electric light to extend nighttime use of educational or medical facilities was minimal, however, as was use of electricity for equipment to improve social services.

2. Providing electricity was neither a catalyst for economic development of rural areas nor a precondition to it. The anticipated productive uses of electric power, primarily for irrigation and small industry, have not yet materialized. While a productive response to electric power is a slower process than its residential adoption, there was little indication that rural electrification itself would be a major stimulus to future economic development. Where rural industry and irrigation development has occurred, it has been accomplished with self-generating diesel systems in response to price incentives and other factors such as the availability of credit and technical assistance.

3. Adhering to U.S. technical design standards had adverse distributional, financial and economic impacts. Distributionally, fewer consumers than possible were connected to the system and the poor were disproportionately represented among the unattended requests for connections. Financially, the utilities were burdened with a costly power system which sold considerably less power than had been anticipated. They were unable to fully realize the capacity of that system to generate revenues for debt service and expansion. Economically investment costs were greater than necessary and the systems were not able to realize the projected benefits from productive uses of electric power.

4. There was a lack of local participation in the project design process by those who would have to bear the burden of the higher operating costs associated with this excessive design. The use of more appropriate technical standards was further inhibited by the strong bias of AID and international contractors to follow higher "internationally accepted" standards.

5. The utilities are unlikely to respond adequately to the growing demand for household connections. The financial viability of the utilities which was not strong prior to expanding to rural areas, was further undercut by the rural electrification program. Contributing to this problem were: rates that do not reflect the real costs of rural services; excessive technical design standards; lack of a concerted promotional effort to increase the number of productive and residential rural consumers; and the inability of utilities to use local private financing to help expand services.

X. LESSONS LEARNED

1. Future electrification projects should not assume that demand for productive use is waiting to be "released" by the provision of power. Alternatively, if the real intent and probable impact is social, the project should be designed accordingly, i.e., for the maximum number of household connections and a lower quality consistent with use for lighting only. In addition, the project should be justified over alternative social investments such as potable water, education, or health.

2. Rural electrification projects should attempt to identify and ensure explicit linkage between electrification and one or two complementary development activities which result in both increased social and development impact along with increased rural power consumption, such as potable water and irrigation in the Bolivia case. This is not to advocate an integrated rural development approach to rural electrification.

3. Vigorous promotion programs are needed in rural electrification projects particularly in the critical construction and operation of the new systems. Promotional activities should educate beneficiaries on the use of electricity for something besides household light, provide financing to connect poorer households, and encourage private financing offered by beneficiaries for connections and line extensions.

4. AID and project designers should be skeptical of using U.S. technical standards for rural electrification and attempt to develop standards more appropriate to the reality and costs of the project environment. Cost constraints should be introduced into the design process, contracting arrangements, and implementation procedures. Giving host-country technicians and those concerned with the revenue-earning operations of the utility a greater voice in design choices would help ensure this.

APPENDIX A

PHYSICAL QUALITY OF LIFE INDICES

BOLIVIA: COMPARISON WITH MIDDLE AND LOW INCOME COUNTRIES (1977)

Indicator	Bolivia	Median Value	
		Low Income Countries	Middle Income Countries
(Previous Page Blank I.S. $ (1977)	630	170	1,140
Life expectancy at birth	52	50	60
Crude Birth Rate/1000	44	40	35
Crude Death Rate/1000	15	15	11
Percentage Change in Crude Death Rate, 1960-1977	-34.8	-31.8	-28.7
Child Death Rate (Age 1-4)/1000	22	19	11
Percentage of Population with access to safe water	34.0	28.0	59.0
Daily per Capita Caloric Supply as Percentage of Requirements	77.0	91.0	107.0
Total Students Enrolled in Primary School as Percentage of Age Group	80.0	73.0	92.0
Percentage of Total Population living in absolute poverty	64.0	52.0	16.0

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APPENDIX B

MIGRATION IMPACT

A. Rural to Rural Migration

A striking change is occurring in the settlement pattern in the rural Bolivian countryside; people are moving from dispersed to nucleated rural settlements. It is not possible to attribute each case of nucleation to rural electrification since this process began to coalesce in Bolivia in the 1960's, the decade after the land reform. However, there is evidence that the process is being accelerated by the provision of electricity.

Two phenomena are occurring: The formation of new towns and the elongation of nucleated settlements along the electrical line which tends to follow a previously existing road. It was difficult to determine the extent to which nucleation was a previous response to the road, to the desire and possibility of obtaining electricity, or to the interaction of the two. However, many persons constructing new houses along the road indicated that they were doing so in access to electricity. The road itself had t motivation to induce the move and the dust ving next to the road may have provided a disincentive in the past. In addition, several families were maintaining two houses, one in the dispersed community to be close to the agriculture fields and one in the town to gain access to public services, specifically electricity.

The team felt that the nucleation induced by the roads and the electric lines had potential positive impacts for the rural poor. It brought them closer to other services like health, education and potable water. The creation of denser population groupings, in turn, contributes to making the supply of such services by public agencies more economic and, therefore, perhaps more likely. Politically, nucleated settlements presented an effective mechanism for rural populations to communicate their needs to government and other central agencies. All of the electrical utilities visited indicated that many nucleared communities not included in the first phase of the rural electrification project were putting pressure on them to be connected to the system. Several of these communities were being connected. Socially, there was tremendous pride associated with forming or being part of a nucleated center. Each community wanted its own plaza, church, school, sanitary post, potable water system, market. Without exception, all communities visited also wanted to receive electrical service.

Clearly, nucleation also carried with it adverse impacts. Frequently, an initial deterioration of the physical quality of life resulted from congestion and the over-taxing of existing health and

water facilities. Typically, a lag-time occurred between the demand for and the up-grading or initial provision of these services. In addition, nucleation resulting from the appearance of roads and electricity usually was associated with increased land prices around the new facilities. The poor were least able to afford lands close to these facilities and thus frequently had to live beyond their reach.

B. Urban to Rural Migration

One of the anticipated social impacts of rural electrification stated in the loan paper was to slow down or reverse the process of rural to urban migration by increasing employment opportunities and income in rural areas. In the short-run in Bolivia, this is unlikely to occur due to the interaction of previously existing phenomena which serves as a deterrent for industry to decentralize.

The rural electrification systems in Bolivia were undertaken in rural areas immediately adjacent to departmental capitals. For at least two decades, factors have coalesced to attract the labor force from rural areas to these urban areas. First, unavailability of land in densely populated provinces immediately adjacent to departmental capitals has led to high rates of out-migration and seasonal migration of rural youth to productive urban centers. Industries are located in or on the outskirts of the departmental capitals because services such as transportation, credit, electric power and labor have been available there for some time. Smaller industrial concerns which might be located in rural areas have a difficult time competing with large industries because both credit and the electric rates favor large industries. Second, the successive years of out-migration of youth has led to a demographic skewing of the rural population which serves as a further deterrent for industry to decentralize. For example, the Altiplano and Cochabamba are characterized by high dependency ratios in rural areas; that is, there are more persons pre-adolescent and over 50 than in the productive ages between 15 and 50. Thus, the labor force and service facilities which attract industry are located in the departmental capitals, not the rural areas immediately adjacent to them.

Some evidence does exist, however, to suggest that in the medium to long term electric power may give economic and social vitality to provincial capitals adjacent to departmental capitals. The viable secondary and tertiary cities that the team observed in the Santa Cruz, Cochabamba and La Paz areas had 24 hour electric service for at least 7 years. Provincial capitals on the Altiplano which did not have electric service were 50 to 60 percent abandoned except on market day. Of the three provincial capitals visited on

the Altiplano, Pucarani, Copacabana and Achacachi, only Achacachi had 24 hour electric power since 1972. Only in Achacachi did we encounter people in the street or find general stores, restaurants, boarding houses, tailors and other small businesses open on non-market day. In contrast, the streets of both Pucarani and Copacabana were conspicuously empty on non-market days. Many of the shop owners and residents returned to their agriculture fields or to their homes and shops in La Paz on non-market days, leaving the towns conspicuously vacant. These observations are particularly surprising for the town of Copacabana, a major pilgrimage and tourist center since the Virgin of Copacabana is the patron saint of Bolivia. Except on market day, in Copacabana business activity is limited to seven large hotels which use their own diesel generators and a few handicraft stands for tourists. We observed additional evidence of this relationship in Santa Cruz. In the market town of Villa Busch where electric lines were still being installed, two-story brick buildings to replace shanty-type vending stalls were also under construction. Investment in more substantial stores and residences was correlated to the provision of electric power.

It should be noted, however, that in the case of Achacachi as well as the provincial towns of Cochabamba and Santa Cruz which have had electric power for at least seven years, that although electricity led to a proliferation of small business activity that it has not resulted in a deepening of productive activity to industrial uses such as agro-processing plants. This mixed and partial evidence of the relationship between electric power and the growth of secondary towns raises many questions which warrant further investigation.

APPENDIX C

REGIONAL INCOME DISPARITY

The distribution of AID investments among the various rural electrification systems in Bolivia may have had the effect of exacerbating the disparity in regional income - mainly the disparity between the Altiplano, where the majority of Bolivia's poor are concentrated, and the Santa Cruz lowlands, where population densities are lower and per capita incomes are higher. The largest share of the rural electrification investment went to the Santa Cruz areas, and was more than double that of the next largest share, which went to Cochabamba; the Santa Cruz provinces that received electrification, however, had only one-third the population density of those provinces electrified on the Altiplano, only one-fourth the density of the Cochabamba area, and three-quarters the density of the Sucre area. Since the cost of rural electrification is a function of the dispersion of the population to be served, it is more economic to electrify the more densely populated regions first, if, as in the Bolivian case, residential consumption is the principal use.

Of the areas electrified under the Bolivian project, the Santa
 the most capable of providing at least part of
if. The department is unique in that it has large petroleum and gas reserves, on which it earns a 12 percent royalty, which currently yields about U.S. $1 to 3 million a month. Evidence of this strong local funding capacity is the fact that the oil royalties were mobilized for loan financing for all the counterpart of the Santa Cruz sub-project and, when there was a large cost overrun, for that as well; U.S. $1.5 million of the royalties also financed, during the period of the AID electrification project, the extension of electric power to the industrial park at the edge of the city of Santa Cruz. The relative abundance of local funding in Santa Cruz is also witnessed by the utility's tendency to use equipment and design standards that are considerably higher than those of the other systems. Finally, the lesser relative need of the Santa Cruz area--in terms of rural population density—for large outside loans for rural electrification may explain why more than half of the household connections were made in the suburban, albeit poor, area of the city of Santa Cruz. Santa Cruz, then may not have merited its large proportion of the project's investment funds--for reasons of distributional equity, population density, and demonstrated ability to finance infrastructure investments locally.

Despite these considerations, AID had other reasons to invest in Santa Cruz. Although Santa Cruz had lower population densities than elsewhere, rural electrification was thought to have more productive potential there and was perceived as an obvious need for the area's burgeoning growth. Moreover, the electric utility in Santa

Cruz was a going enterprise by the time of the second loan to it in 1973, and therefore seemed more able to absorb such a large investment. On the Altiplano, in contrast, the urban utility in La Paz had no interest in undertaking rural electrification, and there was no obvious institutional alternative.

AID has had various reasons for investing so heavily in Santa Cruz--in other sectors as well as in electrification. Santa Cruz was considered to be a rapidly growing, frontier-like area, based mainly on the processing of agricultural products, lumber, beef, cotton, sugar and cocaine; contraband has also been significant in the area's growth. The Santa Cruz area, it was hoped, would be a receptor of spontaneous migration from the intermontane valleys and the Altiplano and would thus come to be the solution to the intractable problems of poverty in those areas. It was considered to be free of the political and "attitudinal" problems of the Altiplano, with its Aymara and Quechua inhabitants, many of whom are not fluent in Spanish. Santa Cruz, it was felt, had more of a "Western" spirit of entrepreneurial vigor and efficiency; it was where you could "get something done." Finally, the Bolivian government had considerable political interest in directing more public-sector investment toward Santa Cruz ever since the 1950s, out of a concern that this area had closer links to Brazil and Argentina than to the rest of Bolivia; the U.S. government shared that concern.

The large infrastructural investments of AID in the Santa Cruz area were not without implications for political developments in Bolivia, as well as for regional inequalities and public-sector neglect of the Altiplano. Santa Cruz has long been a center of separatist sentiment in Bolivia, and has tended to be the source of more conservative political movements and coup actions by the military. The disproportionate investments of AID in Santa Cruz may well have contributed to a strengthening of these particular political forces in Bolivia. The Altiplano and the valleys have seen the growth of strong labor and peasant organizations, associated with more reformist political actions. Given this background, it would seem that AID's current interest in investing proportionately more in Santa Cruz than in the Altiplano should be re-evaluated in light of the U.S. government's interest in supporting Bolivian moves toward civilian government and democracy.

APPENDIX D

THE ELECTRIC UTILITIES AS VIABLE FINANCIAL ENTITIES

The team was impressed with the fact that once AID project funds were disbursed and the new system was in place, the utilities seemed to experience a post-project "letdown" during which they were unable to carry through with the ongoing task of connecting up new consumers. There was a backlog of unattended requests for house connections and line extensions soon after the system went on stream, a backlog that seemed to result from financial and personnel constraints. Clearly, this inability to facilitate productive uses was, in part, a result of the financially lean character of these post-construction years.

It is important to point out the significance of this problematic transitional period before going into the reasons for it. The unit costs of rural electrification are about three or four times those of urban electrification in Bolivia, which means that rate charges based on full-cost recovery would make the price of electricity prohibitive. Rural electricity rates, therefore, usually

ee of subsidization, at least in the early years as considerable excess capacity. With the high ---- ------ -- ---al electrification, capacity is usually installed to handle projected growth in demand for up to about ten years. In the Bolivian case, the overdesign of equipment and the overestimation of average residential consumption resulted in capacity for closer to 20 years. The high costs and excess capacity of the initial years after construction meant that it is essential to load up the system as rapidly as possible, the marginal costs of adding the new consumers, in other words, are extremely low as compared to the high initial average costs. The ability of the utility to meet demand for new connections in the early years, then is crucial to the realization of the system's economic benefits and to the channeling of adequate revenues to the utility.

The difficulties of bringing new consumers into the system and other impediments to the financial viability of Bolivian utilities can be analysed according to four sets of considerations: program design, rate structures, the mixing of rural systems with urban ones, and technical design considerations.

The program design. As designed by donors, rural electrification projects are treated as discrete construction tasks, with a beginning and an ending, when donor funds are completely disbursed. The connection of new consumers, in contrast, is an ongoing activity, requiring more aggressive behavior and organizational activity on the part of the utility itself--in contrast to the contracted-out nature of the construction task. The thinking out of electrification projects is done mainly by design and construction engineers, both

on the donor and the recipient side, whose task it is to get an installation built. The managers of a utility's ongoing commercial operations are less involved in design; this tends to reinforce the tendency to treat the project as a discrete task and to neglect the transition from construction to ongoing activity.

Neglect of the transition from construction to operation is common in all infrastructure projects. Roads are an obvious example, where the post-construction activity of maintenance is frequently neglected when construction is completed. The neglect of future ongoing activities in roads, however, is far less damaging to the project than in the case of rural electrification. Failure to maintain the road will not prevent its economic and financial benefits from being realized, at least in the crucial early years after completion of construction. In electrification the case is the opposite: the neglect of the ongoing activity constrains the realization of the project's benefits immediately after construction by depriving the utility of early potential revenues. This problem initiates a process by which the utilities become less and less able to grow independent and strong.

The perception by Bolivian power authorities and utilities that donor funding for further investment will be necessary and available contributes to the neglect of the post-construction phase. Faced with difficulties in loading up the new AID-financed systems, Bolivian power authorities and utilities seem to be focusing most of their concern on the prospects for negotiating another rural electrification loan (Phase III), this time from another donor.

Rates. As in many third-world countries, public utilities have political difficulties in charging rates that will cover their costs and allow an adequate margin for expansion. Financial analysis of utility records shows that the two larger and older systems, Santa Cruz and Cochabamba, have been earning about 7 percent return on their assets, close to the allowable 9 percent. The current year is an exception, because of a 25 percent foreign exchange devaluation in late 1979 that resulted in large cost increases to the utilities, combined with an election year that made it difficult to raise rates accordingly.[5] In 1980, then, the Cochabamba and Santa Cruz companies will earn only around 3 percent while the three smaller southern systems are considerably worse off and will end the year in the red.

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5. Some utilities did not even increase their residential rates by the full 30 percent authorized because of expected political difficulties.

As is common in such systems, depreciation funds are being spent for operating costs, thus are already creating difficulties for meeting requests for new connections. With their low population densities and small size (one-fifth to one-tenth that of Cochabamba and Santa Cruz) the southern systems may be unable to reap the economies of scale inherent in electric power systems. This raises some doubt about the economic wisdom of having added rural systems to these urban utilities at this stage of their growth.

Another consequence of the inadequate rate return is that the utilities are considerably delinquent in their payments to ENDE for purchased power; delays in payment of five to six months are not unusual. Delinquency, it should be noted, can be a sign of power as well as of weakness: the financially better-off Santa Cruz system, for example, causes at least as much delinquency problems for ENDE as the weaker systems. The implications of this customary delinquency, of course, are that the utilities are forcing ENDE to provide them with interest-free operating capital.

The difficulty of raising electricity rates has various causes. Policymakers, for one, are interested in keeping urban rates from rising too rapidly, as part of their general concern for keeping down the price of urban wage goods. With the current policy of charging equal rates to urban and rural consumers, the difficulty of raising urban rates is conveyed to the rural system, where increases in rates cause little protest and are less politically difficult. It should be noted that as Bolivia moves toward a civilian government and democracy, and hence is more responsive to public pressures, the difficulty of raising electric power rates is likely to increase. A continuation of the rate problem, in other words, may be a concomitant of success in broader political developments.

A political understanding of the rate problem reveals one of the disadvantages of the central-system approach to rural electricity, as opposed to independent units for individual towns, an approach now being contemplated by the Bolivia Mission's micro-hydro project. Central-system electricity magnifies the political problem of raising rates because it brings the cities into the rural system, with their more vocal and effective protests against rate increases. In contrast, when an electric utility serving only one town or area raises its rates, consumer discontent does not reverberate through all the towns and cities of the region or country. Perhaps this is why independent autogenerated systems in Bolivia are able to charge rates that are three to four times those of the central system.

Finally, higher rates may not be as aggressively pursued by the Bolivian utilities because of a false sense of security inspired by the generous terms of loans from donor organizations. The long initial grace periods coincide with the time when the company should be pursuing new customers and greater revenues through vigorous service and expansion. To the extent that the lack of concern about rates in this initial period is a result of the "easiness" of the grace period, the loan terms contribute to the problem. Correspondingly, the willingness of donor organizations to enter into discussions about subsequent loans immediately after completion of previous projects no doubt contributes to the utilities' sense of security about being able to find funds for expansions without reforming the rate system. Though adequate rates are usually the subject of covenants or conditions of donor loan agreements, these conditions are often not met, or looked after by the donor, partly because of the recognition of the political difficulty of raising rates at any particular moment.

Adding rural systems to urban utilities. The new rural systems of the AID project represent fairly small additions, in terms of the number of consumers and kilowatt-hours sold, to existing urban systems.[6] Rural consumption represents no more than 25 percent of the total number of consumers and 10 percent of the electricity consumed. Though it is true that the systems are preponderantly urban and therefore do not fit the U.S. model of rural electrification, the team found that there were some distinct advantages, as well as disadvantages, to the urban-rural mix.

Given the difficulties in developing productive rural uses and their desirable load characteristics, the existing urban base of the system represents an important contribution to the financial viability of the utility. The preponderance of urban consumption in the systems, moreover, allows the high costs of rural service to be spread over and diluted in the much larger, less costly urban load. Attaching rural electrification programs to existing urban utilities was also the only way that the AID project could attach its investments to established entities with some history in the field of electric power distribution. The extreme difficulties encountered under the project in creating cooperative utilities from scratch for the exclusively rural systems of the Altiplano

6. The Altiplano and Yungas systems are exceptions; they are exclusively rural because the utility supplying the city of La Paz, a foreign power company, was not interested in expanding into the rural areas.

and the Yungas are good illustrations. Finally, when a utility supplies power to an urban area, this seems to give it strength and political power that exclusively rural suppliers do not have.

One example of the institutional difference between rural and urban utilities is the comparison between ENDE, the state-owned power-generating company, and INER, the more recently created rural electrification institute which provides independent diesel units to towns beyond the central-system grids. INER was to play an important role in the Altiplano and Yungas systems but was supplanted by ENDE mainly because of INER's weakness and inadequacy vis-a-vis ENDE. ENDE has been wholesaling power to the urban systems expanded under the AID project, and thus has an independent source of income. INER, in contrast, is dependent on central government budgets. Though AID tried to strengthen INER through the rural electrification project, it was difficult to overcome the basic structural problem--i.e., that the electric power field is already dominated by ENDE, whose strength is based on earning its own revenues from selling bulk power to urban systems. In such a situation, it seemed foreordained that INER, with an exclusively rural mandate and no independent source of revenue, would not be able to do as adequate a job as ENDE, or to keep it from invading its domain.

AID's actions with respect to the urban-rural question, in light of this analysis, might be interpreted as somewhat contradictory. On the one hand, AID insisted that rural rates not be higher than urban rates; at the same time, AID tried to strengthen INER as an electric entity that would deal exclusively with rural power. The equal rate policy, however, would prevent INER from earning revenues consonant with rural costs. There seems to be no logical reason why an entity like ENDE or the urban distribution utilities, which have built their financial and managerial strength on urban systems, would not be qualified or interested in taking on rural electrification. Indeed, as the growth of the existing urban systems levels off, the rural areas can offer to such entities one of the few possibilities for continued rapid growth. All this is not to say that it would be best for an urban-based entity to take on a new rural system, as indicated by the following discussion of the disadvantages of such a mixed system. It is only to say, rather, that entities involved in urban electric power will confer a certain strength to the rural electrification effort.

Another advantage of the expansion of urban utilities into rural areas is that this mechanism offers a unique opportunity to

tax one sector in favor of another in a way that is consistent with some important development objectives. The urban-rural combination, along with the single rate charged for both types of consumers, represents a "tax" (1) on the cities in favor of the countryside; (2) on industry, to the extent that it is mainly located in and around cities, in favor of agriculture and rural development; and (3) on better-off residential consumers, who are more than proportionately located in cities, in favor of poorer consumers who are concentrated in rural areas.[7] Where tax policies affecting redistribution are difficult, the accomplishment of such transfers through the rate charged for electric power is a significant achievement. It is notable, moreover, that this transfer is made through the electric power rate, one of the most public and politicized prices that exists. Bolivian power managers consistently expressed the urban-rural subsidization rationale for the equal rates as their own "personal" opinions, the rationale never having been stated as policy. Urban consumers then have not been aware of this "tax" as an increase or an element of their monthly electricity bills.

There are distinct disadvantages to building a rural system on top of an existing urban one, especially in the Bolivian case. Though there is logic to spreading the higher costs of rural service over the large urban service, it should be remembered that the urban rate is already inadequate, because of the political difficulties of raising it. The addition of a rural system to an urban one, with the same rate, puts the utility one step further away from earning an adequate return. As noted previously, the urban component of the urban-rural system will make rate increases more politically difficult than in an exclusively rural system, given the population density and political character of cities. A new and exclusively rural system, moreover, is politically able to start out with a relatively high rate since monthly electricity bills will typically be lower than previous costs to consumers of lighting with kerosene and candles, or will be lower than charges by previously existing independent systems.

Examples of the greater ease of charging higher rates in rural areas are that (1) the highest residential rate in the AID-financed project will be that of the only exclusively rural system (CORELPAZ on the Altiplano) with a kilowatt-hour and minimum charge more than

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7. This transfer is not fully realized if declining block rates are charged for increased residential consumption as in the case of two of the Bolivian utilities.

twice those of other systems and (2) minimum consumption levels charged by the utilities are higher in the AID-financed rural systems than in their urban components, even though average rural household consumption is lower than average urban household consumption.[8] This difference in minimum consumption charges resulted from the utilities' reluctance to raise the urban minimum charge on the occasion of introducing the higher new rural minimum out of fear that the urban consumers would react to the higher minimum charge as if it were a rate increase.

Another disadvantage of the urban-rural mix and the equal rate is that the utilities know they can count on the urban market for the good characteristics of industrial load and steady growth. As a result, they tend to be less aggressive in fostering the growth of the rural market and developing a productive load. Noticeably the one utility that has started a rural promotion program on its own (CESSA in Sucre) has an urban base that has grown at half the rate of others.

Perhaps the most serious disadvantage of the urban-rural mixed utility, combined with the uniform rate, is that the rural service is perceived by utility management as less profitable than the urban service. This means that utilities may give priority to urban maintenance, service and expansion. The tendency to neglect the rural service for the urban, of course, will be even more pronounced in times such as the present with inflation, credit contraction, and difficulty in gaining rate increases. A low priority for rural service was apparent in the ELFEC system in Cochabamba, which was delaying plans to set up offices to service the rural system, even though it had been energized for two years.

The final, and most obvious problem of adding a rural system to an existing urban one, is the "fungibility" problem. When a utility receives large injections of outside capital for an activity that represents a small fraction of its service and revenues, it will be difficult to keep this injection of funds from "leaking" into services. This is particularly true when other funds are not available for expanding needed urban services. The utilities will spend project funds for "rural" expansion immediately adjacent to

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8. It is interesting that though the CORELPAZ retail rate is the highest, this utility will be the most subsidized one in the system because it is being created from scratch. ENDE will charge CORELPAZ about 30 percent less for purchases of bulk power than it charges to the rest of the utilities and will allow CORELPAZ to treat the amounts owed to ENDE as a loan. This is a significant subsidy since purchased power accounts for about 50 percent of utility costs.

the city, an expansion that they might have undertaken anyway, and invest funds of their own that are thereby freed up in further urban services. This is probably an accurate description of what happened in the Santa Cruz system, where more than half the household connections went into the suburban areas on the fringe of the city. The addition of the new rural systems to the established urban ones, in sum, means that the rural system may not get the attention and funds that it would if it were not combined with its more powerful urban counterpart.

Technical design. A further reason for the problematic transition of the AID-financed utilities from the construction to the operation phase was a certain lack of concern for cost in the project's technical design. This was, in part a result of adherence to the standards and practices of the Rural Electrification Administration of the United States. This meant that technical specifications were consistent with capital costs, load characteristics, per capita incomes and transport conditions in the United States rather than in Bolivia.

Some examples of inappropriate or excessive design standards, as attested to by AID and Bolivian engineers were:

1. The requirement of a maximum distance of 60 meters between utility poles, as opposed to the 100-130 meters between poles that is acceptable in less-developed countries. The longer distance between poles exposes the lines to higher probabilities of damage from wind, but the costs of interrupted service in a Bolivian rural system are much lower than in the United States, with its larger and more sophisticated industrial loads. In the Bolivian case, not only is the country's output considerably less affected by electric power cuts or changes in voltage, but the rural systems have almost no productive load. The insistence on a 60 meter distance between poles required almost double the number of poles for the project. Since the costs of utility poles represents a significant share of the cost of electrification projects, this requirement could not help but have had a significant impact on costs.

2. Because of the U.S. standards employed to estimate average residential consumption, transformer size was often twice that of what was necessary.

3. Individual house meters were used, rather than charging flat monthly rates, despite the better judgment of some Bolivian power managers. Since a large majority of rural households consume no more than the minimum monthly charge, a flat monthly rate would have been reasonably equitable and accurate. The costs of reading meters with the current system, in contrast, are significant, given the dispersion of the rural communities and the difficult access to many of them during the rainy season.

4. The capacity of the household meters was considerably higher than the typical consumption levels of the rural users; this meant the meters were not able to register the minimum consumption levels.

5. In many cases, three-phase rather than single-phase lines were installed, where there was no indication that industrial loads would be forthcoming. Three-phase lines are 50 percent more costly than single-phase lines, and can be added later to the single-phase system, if demand warrants.

6. Voltage regulators were used to insure a fine tuning of voltage that was way beyond the needs of the system. Four-step regulators, rather than the more costly and sophisticated thirty-two step regulators would have been adequate for systems where broader steps in voltage have little deleterious effect on output.

7. Medium-tension lines were used in many cases where low-tension lines would have been adequate. This meant higher costs not only in lines, but in the costs of stepping down the power to communities along the way.

8. Another factor increasing costs was the practice of requiring the use of a single large design firm to design and supervise the whole project, and of single construction contractors for each complete system. When one contractor is responsible for construction of a complete system, it is to his convenience to work on the whole system at once in stages--all the staking at once, all the meters at once, etc. This meant that no one part of the system was energized until the last piece was in place--instead of the system being energized community by community, or sub-area by sub-area. In the Altiplano system, for example, meters were installed in user houses up to two years before the system was energized. This "indivisible" approach to constructing and energizing the system, though the most logistically and financially convenient for the contractor, was costly for the system in both economic and financial terms. The realization of the benefits of the investment were being delayed for one or two years, and the utilities were foregoing revenues that they might be earning if the system were energized community by community. Finally management of the new system would have been easier for the utility to absorb if it were energized gradually, instead of all at once.

The above examples illustrate not only the extent to which the project costs were greater than necessary but also how this weakened the administrative and financial viability of the utilities, once construction was terminated. Not only do the inappropriate design standards burden the utility with higher amortization payments, but they also lead to higher operating costs, such as the costs of reading meters. These higher operating costs, in turn, contribute to the problems associated with the transition from construction to operation, and the inability of the utilities to connect up new customers as rapidly as they should.

Overdesign in such projects results, in part, from the structure of the project design process: the project designers, AID and the consultants, are not those who will have to bear the burden of higher operating costs associated with inappropriate design. Indeed, there is a distinct disincentive for the consultant to use less sophisticated standards; if he strays from international standards, he may be held accountable for any inadequacies in the system.

The lack of cost constraints, put in another way, results from the project being designed by those whose business is to build things rather than make them yield a return. The engineer's task is completed when a structure is finished; what happens afterward is somebody else's concern. The problem of overdesign, then, is not an easy one to solve, it is due not so much to people making inappropriate decisions but to the absence of certain cost constraints in the environment of project design, and from the lack of sufficient involvement of those with operational responsibilities.

It is interesting to note that more appropriate design standards were rapidly forthcoming on two occasions. The first and most dramatic instance was precipitated by the petroleum crisis of 1973 and 1974. Large overruns in estimated project costs caused the AID mission in Bolivia to request a project amendment to cover the new costs. Because of limitations on AID/Washington and counterpart funding to cover the overrun, something had to give. Since the Bolivians had insisted strongly on their social objective of maximizing the number of residential connections, the only thing that could give way was the design standards. Distances between poles were increased to 100 meters and many of the three-phase lines were cut back to single-phase lines.

Another sudden appearance of cost constraints, and their effect on the choice of equipment standards, could be seen after utilities used up the equipment and materials for house connections acquired with AID funding. Left to their own resources to finance the acquisition of such materials, the utilities reverted to simpler and less costly materials.

One approach suggested for some of the problems discussed above is a more piecemeal pattern of design and construction. In contrast to the usual practice of having a single large foreign consultant design the whole system, down to the specification of each community to be connected, this alternative approach would design beforehand only the primary distribution lines and the areas to be connected. It would then be left to the commercial department of the utility, after the basic system was in place, to connect up communities as it saw fit. The advantages of this more piecemeal approach are the following:

1. It puts in charge of the community selection process the utility department that is most preoccupied with the revenue-earning capacity of the system.

2. It allows for establishment of criteria for connecting communities, and places the burden on the community to seek out the utility, show that it meets the criteria and, if appropriate, to come up with some of the connection costs.

3. By delaying the selection of communities to be served, one would avoid: (a) connecting communities that do not have the population or production potential that they seemed to several years earlier and (b) leaving out communities that have turned out to be dynamic and more populated in the many years intervening between project design and termination of construction.

4. The piecemeal approach to design facilitates the mobilization of community organization and resources in connecting up to the system, thus tapping the private sector capital that is available for expansion of the system.

5. The piecemeal approach allows the system to be energized as one goes along, making for a more rapid realization of economic and financial returns on the investment.

6. This approach allows for contracting out much smaller pieces than does the traditional approach which contracts out the whole system to one construction firm. The traditional approach not only requires adapting to the contractor's convenience of energizing the whole system only after all construction is completed; it also makes it quite difficult to get rid of a contractor for unsatisfactory performance, because of the high cost involved in stopping all construction until a new contractor is found. Several Bolivian engineers in charge of project supervision told the team that contractor performance was woefully inadequate in some cases, warranting termination of the contract. But because the contractor was responsible for the whole system, they were loathe to undergo the high cost of stopping construction. Smaller construction contracts let out with several firms, they felt, would make them less hesitant to replace an inadequate contractor since the replacement process would not jeopardize the pace of construction of the rest of the system. The ability to replace contractors when performance was inadequate, in turn, would lead to a more competitive environment between contractors resulting in better performance.

7. Having a number of contractors for discrete construction tasks, would result in better control by the executing entity and better contractor performance. Each contractor would be bidding for a small geographic area that was more comprehensible, and the demands of the task would be more concretely understood. The single large construction task, it was felt, frequently led to unrealistic commitments by contractors who often made serious misjudgments about their ability to get equipment into the area, about labor practices, etc.

8. Dividing construction and community selection into small discrete tasks, it was also felt, would make it easier for local contractors, with more limited capacity than large foreign contractors, to participate in construction. Local contractors, by virtue of their more limited equipment and capital resources, were also accustomed to using more appropriate and labor-intensive construction techniques. The large equipment used by the single foreign contractor was often associated with long delays for importation and serious difficulties and delays in transporting equipment to the site, given the broken terrain of much of Bolivia and the relative absence of paved roads.

The team has elaborated this suggested approach in some detail as a way of illustrating possible ways of addressing problems discussed here, namely, the lack of cost constraints in the design of AID rural electrification projects and the overemphasis on construction in contrast to the relative neglect of the ensuing operations and revenue-earning tasks. It should be noted that this approach is based principally on the suggestions and observations of the USAID/Bolivia and host country personnel most familiar with the rural electrification program. Further talks with project designers in AID and recipient countries would probably turn up a myriad of other suggestions for dealing with these problems.

APPENDIX E

EVALUATION METHODOLOGY

The impact evaluation team consisted of three members with extensive field experience in South America: the team leader, a rural development officer from the Near East Bureau, an anthropologist from the Bureau for Program and Policy Coordination, and a development economist contracted for the evaluation study. The Assistant Evaluation Officer and the Engineering Officer from the Bolivian Mission assisted the team on specific tasks. Bilingual research assistants (Spanish/Aymara and Spanish/Quechua) provided support in the field investigation.

The team spent the first two weeks in the field to collect data and a final week in La Paz to obtain additional information and to prepare a preliminary draft of the findings; these findings were shared with the Mission in a debriefing session.

impact of the rural electrification projects, the team were:

1. to determine the social and economic benefits attributable to the use of electricity;

2. to determine if the utilities had the capacity to load-up the electric distribution system after termination of AID funding; and

3. to identify and analyze the key factors contributing to or inhibiting the achievement of the intended social, economic and institutional objectives.

Three criteria were used for site selection:

1. length of time the system was energized: systems which were energized for the longest period of time were preferred over those which were still under construction or recently completed;

2. ecological and cultural variation: sites representative of the three distinct climatic and cultural areas of Bolivia were chosen;

3. ease of access to sites for field visits considering the limited time available for the investigation and the great distances between regions affected by the program.

In each of the four regional systems visited, Santa Cruz, Cochabamba, Sucre, and La Paz, all team members conducted interviews with

residential beneficiaries as well as those using electricity for productive purposes (i.e., irrigation and small industry). Personnel from the National Electric Company and four distributing entities were interviewed to obtain information on project technical design, implementation procedures, rate policies, and other matters pertaining to the delivery of services. Personnel from other agencies which provided complementary services such as credit to small industry, irrigation development, potable water services, etc. were also consulted in each region.

Interview guidelines were developed by the team and later modified as the evaluation progressed. Guidelines were also used for contacts with utility and other agency staff. The team purposely maintained an open-ended interviewing style both to facilitate the flow of information, as well as to explore fully the interrelationships of electricity use with a wide range of social and economic activities.

In each region, the team typically first visited the utility management and technical staff for briefings on project problems and progress. Subsequently, the team divided up and each member made field visits, following the different distribution lines which radiated from the departmental capital to its rural hinterland. A variety of electricity users (i.e., residential, school, commercial establishments, small industries, etc.) were interviewed in approximately 30 towns and smaller settlements along the entire distribution line rather than randomly pre-selecting communities and informants. This enabled the team to determine impact in the unique context of each community and to pursue questions in greater depth, frequently selecting subsequent interviewees based upon information provided by previous informants.

During the three to four days generally spent in a given region, team members usually divided information gathering and analysis tasks pursuant to their interests and technical expertise. The anthropologist concentrated on residential uses of electricity, comparative costs of traditional energy sources with electricity, settlement patterns and their relationship to electricity availability, attitudes toward electricity, community and individual development priorities, etc. The economist dealt more with information pertaining to rate structures, technical design factors, productive uses of electricity, and financial and economic issues relevant to the institutional delivery system. The team leader concentrated on selected productive and social usage as well as the nature and extent of other sector inputs which complemented the rural electrification program. While this degree of specialization was maintained, there was frequent and purposeful overlap in data gathering and information sharing throughout the study to integrate the findings and analyses.

APPENDIX F

GRID SYSTEMS VS. INDEPENDENT UNITS

All the distribution systems of the Bolivian rural electrification projects were based on the concept of grid systems with distribution lines radiating from existing urban power systems. The team did not directly address the question of central power vs. independent systems, though the National Electrification Institute and the Santa Cruz District Development Corporation have funded the placement of diesel generating units in outlying rural towns. The evaluation of the central systems did yield some points that are relevant to the comparison between central and independent systems. They take on added importance because of the new economic possibilities for independent systems in a country like Bolivia, with its potential for small generation units based on renewable sources of power, mainly hydroelectric.

The principal observations of the team regarding central-system electricity as compared to independent systems were: (1) electri-

through central systems tied to cities tends to ibly more difficult to charge rates that allow utilities to cover their costs and engage in continuous expansion of the system. Independent systems, with less consumers and no large cities to protest rate hikes are better able to charge the higher rates consonant with higher costs of rural electricity. (2) Electrification through independent systems allows more selectivity in the communities chosen for investment, both in terms of production potential and population density. In contrast a central system dictates that lines radiate from a city along existing roads, a criterion which may or may not coincide with population density and production potential. (3) Though one of the justifications of rural electrification is to facilitate more decentralized economic growth and stem rural-urban migration flows, the central system approach may in some cases increase rather than decrease the tendency toward urbanization. The spread of rural-electrification lines out from the city expands the reach of the city by providing amenities to the settlements of urban poor on the city's periphery and by upgrading the kind of urban infrastructure that attracts industry. (4) The small size of many of the communities connected under this project (about 60 percent had less than 100 houses) and the lack of productive uses in these communities suggests that independent systems might be a less costly approach to electrification given the availability of micro-hydro sites in Bolivia. (5) Except for parts of the Santa Cruz system, the installation of central-system rural electricity in the Bolivian project skipped the usual first stage of electric growth, i.e., the use of independent systems or diesel generators owned by productive users. The absence of a first stage was in many ways indicative of the absence

of opportunities for productive use of power. (6) Finally, and in contradistinction to the previous points, the major organizational differences between central and independent systems need to be explored, mainly whether the task of creating a multitude of small independent utilities is as feasible as strengthening a smaller number of much larger ones.

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