PD-ABJ-740
9/3/95

A.I.D. EVALUATION SUMMARY - PART I

1. BEFORE FILLING OUT THIS FORM, READ THE ATTACHED INSTRUCTIONS.
2. USE LETTER QUALITY TYPE, NOT "DOT MATRIX" TYPE.

IDENTIFICATION DATA

A. Reporting A.I.D. Unit: PD&I

Mission or AID/W Office USAID/Bolivia
(ES# DP-013/94)

B. Was Evaluation Scheduled In Current FY Annual Evaluation Plan?
Yes [x] Slipped [ ] Ad Hoc [ ]
Evaluation Plan Submission Date: FY 94 Q

C. Evaluation Timing
Interim [x] Final [ ]
ExPost [ ] Other [ ]

D. Activity or Activities Evaluated (List the following information for project(s) or program(s) evaluated; If not applicable, list title and date of the evaluation report.)

Project – No.	Project/Program Title	First PROAG or Equivalent (FY)	Most Recent PACD (Mo / Yr)	Planned LOP Cost (000)	Amount Obligated To Date (000)
511-0614	Electrification for Sustainable Development	July, 1991	Sept., 1996	19,200,000	14,200,000

ACTIONS

E. Action Decisions Approved By Mission or AID/W Office Director Action(s) Required	Name of Officer Responsible for Action	Date Action to be Completed
Modification of project logical framework as per recommendations in the midterm evaluation report.	Olivier Carduner	Nov., 1994

APPROVALS

F. Date Of Mission Or AID/W Office review Of Evaluation: (Month) (Day) (Year) 94

G. Approvals of Evaluation Summary And Action Decisions:

	Project Program Officer	Representative of Borrower/Grantee	Evaluation Officer	Mission or AID/W Office Director
Name (Typed)	Olivier Carduner	NRECA/Daniel B. Waddle	Jean Anne Beasley	Carl Leonard
Signature	[signature]	[signature]	[signature]	[signature]
Date	11/18/94	11/18/94	11/18/94	11/18/94

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ABSTRACT

H. Evaluation Abstract (Do not exceed the space provided)

The cooperative agreement between the United States Agency for International Development (USAID) and the National Rural Electric Cooperative Association (NRECA) for the Electrification for Sustainable Development (ESD) Project was signed on July 26, 1991 for five years. The project purpose in to support alternative development strategies to foment non-coca related economic development in Bolivia through investments in electrification infrastructure. Total USAID funding for agreement signature was $20 million. This scheduled midterm was done at the end of the third year of the project by a social-scientist institutional specialist, an electrification economist and an electrical engineer. Methodology consisted of document review and interviews with NRECA and counterpart personnel both in La Paz and Cochabamba. The major findings and conclusions are:

- The project focused on construction and/or rehabilitation of new and existing distribution systems, promotions of productive uses of electricity, technical assistance and training for electric utilities, and development of an institution to finance future electrification. Project performance has been excellent. Infrastructure construction is on schedule, assisted by good procurement and relations with counterpart utilities. Field evaluation of two advanced subprojects observed construction done according to NRECA standards.

- Productive Uses promotion has begun, with electric machinery outlets established for the two largest subprojects, and loan programs have also begun, although lowered USAID funding will make it difficult for ESD to achieve projected outputs as regards number of loans and total amounts loaned.

- Economic/financial studies were not done on all subprojects, and subprojects were often begun before the studies were complete, but all projects carried out were economically sound. The NRECA Demand Assessment Model (DAM) used to analyze projects has limitations which need to be corrected before the DAM is used again. No subproject was analyzed completely using a least cost analysis but in comparison of various investment alternatives, complemented by professional judgement, which worked well in nearly every case. The economic cost-benefit analyses show that all subprojects are promising, and the foreseen economic benefit should be surpassed with one or two exceptions.

- With the tariffs now approved, all projects analyzed should cover their operating costs and repay the NRECA investment, including interest to revolving funds NRECA has established. Positive economic and financial results will depend on the maintenance of adequate tariff levels. NRECA must watch the approval of new tari fs closely under the adjustment plan which the new Electricity Law will impose. The Electricity Law will permit co-financing and allow the operation of the Rural Electrification Finance Corporation (EFER) in the manner foreseen by NRECA.

Lessons learned from this evaluation:

- In future projects, financial and economic analyses should be carried out in a timely fashion and for all subprojects, including the formal analysis of minimum total economic cost. The selection of subprojects should be based on such studies. The time required for carrying out financial and economic studies can be reduced by simplifying field research, improving methodology, and increasing the sensitive of analysis.

- The six-week beneficiary assessments carried out by the Project were valuable, but assessments of similar quality could be done in less time with well-trained and supervised field personnel.

COSTS

I. Evaluation Costs

1. Evaluation Team Name	Affiliation	Contract Number OR TDY Person Days	Contract Cost OR TDY Cost (U.S.$)	Source of Funds
Stephen O. Stewart	Team Technologies	20		ESD
José Ignacio Coral M.	Team Technologies	20		ESD
Silvio Olivera	Team Technologies	20		ESD
	Total Cost of Evaluation		50,000 *	

* This includes per diems, overhead & daily rate.

2. Mission/Office Professional Staff Person-Days (Estimate) 5

3. Borrower / Grantee Professional Staff Person-Days (Estimate) 10

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A.I.D. EVALUATION SUMMARY - PART II

SUMMARY

J. Summary of Evaluation Findings, Conclusions and Recomendations (Try not to exceed the three (3) pages provided)
Address the following items:

- Purpose of evaluation and methodology used
- Purpose of activity(ies) evaluated
- Findings and conclusions (relate to questions)
- Principal recomendations
- Lessons learned

Mission or Office :	Date This Summary Prepared :	Title and Date Of Full Evaluation Report:
PD&I	September 15, 1994	Electrification for Sustainable Development Project

The purpose of this midterm evaluation was to assess how effectively and efficiently implementation and management of the Electrification for Sustainable Development Project has been carried out. Information collected will be used to refine or improve implementation. Methodology used was to focus on two main projects, Mizque-Aiquile and Valles Cruceños. During the field phase these projects were visited. Interviews were conducted with NRECA/Cochabamba personnel, PRODEM personnel and others involved with productive uses of energy. Other interviews were conduced with personnel of the Santa Cruz Electric Cooperative, municipal authorities in Aiquile and personnel at Agrocapital. Project documentation was also reviewed.

The Project Goal is increased employment, income and productivity in non-coca activities. The project purpose is affordable sustainable and customer-oriented service provided to more rural households and businesses. The Project was designed to focus on construction and/or rehabilitation of new and existing electric distribution systems, promotion of productive uses of electricity, technologies and energy conservation. The project planned for development of an institution to finance electrification and increase investment in electrification infrastructure beyond project completion date.

At present there are 32 ESD subprojects divided into four categories. RE (Rural Electrification) Economic Development Projects (14 subprojects) are those subprojects with a large number of direct beneficiaries and which therefore potentially have an impact on economic development. Pre-Electrification Projects (9) are subprojects with renewable energy systems in areas where it will not soon be feasible to extend the grid. RE Sustainability Projects (9) are those where technical assistance is provided to utilities, cooperatives, and regulatory agencies.

Project performance has been excellent. Infrastructure construction has been carried out on schedule, assisted by good procurement and relations with counterpart utilities. Field evaluations of two advanced subprojects, Mizque-Aiquile and Valles Cruceños, found that construction had been carried out according to NRECA standards and that these systems would require only minor adjustments.

Productive uses promotion has begun, with electric machinery outlets established for the two largest subprojects, and loan programs have also begun, although reduction in USAID funding will make it difficult for ESD to achieve projected outputs as regards number of loans and total amount loaned.

No subproject was analyzed completely using a least-cost analysis, but rather projects were analyzed on a strict comparison of various investment alternatives, complemented by professional judgement. These analyses functions for the Mizque-Aiquile project but were less successful with Capinota.

The financial viability of the Capinota subproject has improved since the pre-feasibility study with the additional industrial demand represented by COBOCE (Bolivian Cement Company). This subproject is somewhat behind schedule and needs to present its tariff proposal to DINE.

Positive economic and financial results will depend on the maintenance of adequate tariff levels. It will be necessary to watch closely the approval of new tariffs under the upcoming adjustment plan which the new Electricity Law will impose. This new law appears to be a certainty, in spite of the fact that the government has yet to submitted it to Congress.

Analyses show that the Electricity Law will permit co-financing and allow the operation of the Rural Electrification Finance Corporation (EFER) in the manner foreseen by NRECA. In light of the important institutional changes this new law will bring the creation of EFER is important so that it may exercise a leadership role within the private sector

ATTACHMENTS

K. Attachments (List attachments submitted with this Evaluation Summary, allways attach copy of full evaluation report, even if one was submitted earlier; attach studies, surveys, etc., from "on-going" evaluation, if relevant to the evaluation report.)

One copy of the full evaluation report, Electrification for Sustainable Development/Bolivia, Project Midterm Evaluation.

COMMENTS

L. Comments By Mission, AID/W Office and Borrower/Grantee On Full Report :

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XD ABJ-740-A
91397

ELECTRIFICATION FOR SUSTAINABLE DEVELOPMENT/BOLIVIA:

PROJECT MIDTERM EVALUATION

Project funded by:

U. S. Agency for International Development

Project implemented by:

National Rural Electric Cooperative Association

Midterm evaluation carried out by:

Team Technologies
Stephen Stewart, Team Leader
José Ignacio Coral M.
Silvio Olivera

July 1994

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EXECUTIVE SUMMARY

The cooperative agreement between the United States Agency for International Development (USAID) and the National Rural Electric Cooperative Association (NRECA) for the Electrification for Sustainable Development (ESD) Project was signed on July 26, 1991, for a period of five years. The purpose of the project is to support alternative development strategies to foment non-coca related economic development in both coca producing and non-coca regions of Bolivia through investments in electrification infrastructure. Total project funding from USAID at the time of cooperative agreement signature was $20 million. Counterpart funding has been sought and secured from collaborating utilities.

This scheduled midterm evaluation was carried out in a two-week period at the end of the third year of the project by a three-person evaluation team consisting of a social scientist-institutional specialist (team leader), an electrification economist, and an electrical engineer. The evaluation methodology consisted of document review, interviews with NRECA personnel in La Paz, interviews with counterpart personnel in Cochabamba and Santa Cruz, and site visits at Cochabamba, Quillacollo, Mizque, Aiquile, Mairana, and Mataral.

The Project Goal is increased employment, income and productivity in non-coca activities. The Project Purpose is affordable, sustainable and customer-oriented service provided to more rural households and businesses. The project was designed to focus on construction and/or rehabilitation of new and existing electric distribution systems, promotion of productive uses of electricity, technical assistance and training for electric utilities, and development of special projects, including use of renewable energy technologies and energy conservation. The project also planned for development of an institution to finance electrification and increase investments in electrification infrastructure beyond project completion date.

There are at present 32 ESD subprojects, divided into three categories. RE Economic Development Projects (14 subprojects) are those subprojects with a large number of direct beneficiaries and which therefore potentially have an impact on economic development. Pre-Electrification Projects (9 subprojects) are subprojects with renewable energy systems in areas where it will not soon be feasible to extend the grid. RE Sustainability Projects (9 subprojects) are those where technical assistance is provided to utilities, cooperatives, and regulatory agencies.

Initial financing from USAID was to be US$20 million with an additional US$5 million in local currency. As of March, 1994, counterpart funds totalled about US$8 million and disbursements from USAID/Bolivia were US$9 million. ESD has also received US$4.2 million in GEF funds for renewable energy.

Project performance has been excellent. Infrastructure construction has been carried out on schedule, assisted by good procurement and relations with counterpart utilities. Field evaluation of two advanced subprojects, Mizque-Aiquile and Valles Cruceños, found that

construction had been carried out according to NRECA standards and that the systems would require only minor adjustments.

Productive uses promotion has begun, with electric machinery outlets established for the two largest subprojects, and loan programs have also begun, although a reduction in USAID funding will make it difficult for ESD to achieve projected outputs as regards number of loans and total amount loaned.

Economic and financial prefeasibility studies were carried out on some but not all subprojects, and the decision to carry out the projects was taken often before the studies were complete. Nonetheless, all projects studied and carried out were economically sound. The NRECA Demand Assessment Model (DAM) used to analyze some projects has important limitations. Some of these limitations were corrected by NRECA and others need to be corrected before the DAM is used again.

No subproject was analyzed completely using a least-cost analysis, but rather projects were analyzed on a restricted comparison of various investment alternatives, complemented by professional judgement. These analyses functioned for the Mizque-Aiquile projects but were less successful with Capinota.

The economic cost-benefit analyses show that all subprojects are promising, and present indications are that the foreseen economic benefits will be surpassed, with the exception of Vinto, which has not demonstrated the expected numbers of productive use connections.

With the tariffs now approved, all projects analyzed should cover their operating costs and repay the NRECA investment, including interest to the revolving funds NRECA has established. In Valles Cruceños, which made extensive non-NRECA investments, financial viability depends on planned support from CORDECRUZ.

The financial viability of the Capinota subproject has improved since the prefeasibility study with the additional industrial demand represented by COBOCE. This subproject is somewhat behind schedule and needs to present its tariff proposal to DINE.

Positive economic and financial results will depend on the maintenance of adequate tariff levels. It will be necessary to watch closely the approval of new tariffs under the upcoming adjustment plan which the new Electricity Law will impose. This new law appears to be a certainty, in spite of the fact that the government has not yet submitted it to Congress.

Analysis shows that the Electricity Law will permit co-financing and allow the operation of the Rural Electrification Finance Corporation (EFER) in the manner foreseen by NRECA. In light of the important institutional changes this new law will bring, the creation of EFER is important so that it may exercise a leadership role within the private sector.

I. Conclusions, recommendations, and lessons learned

A. Conclusions and recommendations: engineering

1. *Computerized information system: Mizque-Aiquile*

Conclusion: Service operations and maintenance can be greatly facilitated by computer information systems, which the Mizque-Aiquile subproject does not yet have.

Recommendation: The Project should establish a computerized information system for the Mizque-Aiquile distribution system based on coordinates and including both system hardware and the ability to track system operations and maintenance.

2. *Distribution system poles: Mizque-Aiquile*

Conclusion: Some wood poles in the distribution system have large cracks. Since these cracks occur over 300 mm above ground, they meet NRECA standards, but these poles will probably deteriorate much more rapidly than poles without cracks.

Recommendation: NRECA technical specifications for aerial line wood poles should be tightened sufficiently to discard poles with large cracks, regardless of where the crack is located.

Conclusion: Some class 2 wood poles are below wood pole standards. The average of 100 meter span for 3X#1/0 ACSR and 1X#4N ACSR is too long, and the mechanical load might exceed the initial allowable moment of the pole.

Recommendation: Stricter quality control should be observed in the selection of wood poles. The span between two poles should not exceed the initial allowable moment of the poles.

3. *Large electric motors: Mizque-Aiquile*

Conclusion: The use of large electric motors by consumers on the feeder could create a 'dip' at motor start-up.

Recommendation: An analysis should be carried out to determine the maximum size of electric motor that can be connected to the feeder without requiring a starting compensation device. On the basis of this analysis, ELFEC should develop and communicate policies regarding the use of motors to both customers and electric machinery distributors.

4. *Possible flashover on pin insulators: Mizque-Aiquile*

Conclusion: Two skirt "cap & pin" insulators used on 24.9/14.4 kV distribution lines can suffer flashover from dust accumulation.

Recommendation: The feeder should be analyzed to determine where insulators are more susceptible to dust deposit. Where appropriate, these insulators should be replaced with insulators of the same type but of higher "B.I.L."

5. *Eventual voltage drop: Mizque-Aiquile*

Conclusion: A voltage drop above 10% should be expected once all projected load materializes.

Recommendation: At least one set of 3-phase voltage regulators will be required. A detailed study will be needed to determine the optimum location for this set of regulators.

6. *Feeder without sufficient protective devices: Mizque-Aiquile*

Conclusion: Long extensions of feeder without a sufficient number of protective automatic devices can result in an unnecessary number of customers without service for a longer period of time.

Recommendation: More cascaded reclosers should be installed. A study should be carried out to determine the optimum locations.

7. *Voltage instability due to capacitance effect: Mizque-Aiquile*

Conclusion: The long length of the feeder might create voltage instability due to the capacitance effect of the line.

Recommendation: Conduct a stability analysis in order to determine the compensation required.

8. *Protection for transformers: Valles Cruceños*

Conclusion: High and low voltage terminals on plant service transformers inside the plant building are exposed and could cause a serious accident.

Recommendation: Protective barriers should be installed around these transformers.

9. *Parallel gas pressure reduction system: Valles Cruceños*

Conclusion: The single gas pressure reduction system could fail and put the entire generating plant out of service

Recommendation: A stand-by system should be installed.

10. *Gas reservoir: Valles Cruceños*

Conclusion: Gas lines above ground are exposed to accidents or possible sabotage, which would shut the plant and generating system down.

Recommendation: If funds are available, a high pressure gas reservoir system with sufficient capacity to assure at least 24 hours of plant operation should be installed.

11. *Yard illumination: Valles Cruceños*

Conclusion: There is insufficient yard illumination in the area of the gas pressure reduction station.

Recommendation: More lights should be installed in this area.

12. *Fire extinguishers: Valles Cruceños*

Conclusion: The plant has insufficient fire control in the form of fire extinguishers.

Recommendation: An adequate number of fire extinguishers should be installed in strategic areas.

B. Conclusions and recommendations: economic-financial

13. *Maintaining acceptable tariffs*

Conclusion: Good economic and financial results depends on the maintenance of tariffs at acceptable levels.

Recommendation: NRECA and its Bolivian utility counterparts need to watch closely to assure that approved tariffs are set at acceptable levels.

14. *Vinto*

Conclusion: The Vinto subproject is not achieving the results which were expected.

Recommendation: NRECA and ELFEC need to continue to promote the incorporation of new connections and the use of credits, preferably for productive uses.

15. *Capinota*

Conclusion: The Capinota subproject, which is behind schedule, will now include demand from the COBOCE cement plant. ELFEC has not yet sought approval for tariffs.

Recommendation: The subproject must be pushed forward with a tariff study including the COBOCE demand and the subsequent presentation for approval of proposed tariffs.

16. *EFER and the Electricity Law*

Conclusion: The proposed Electricity Law does not run counter to the EFER as conceived. The authorizations foreseen for the FNDR will facilitate co-financing.

Recommendation: The Electricity Law should continue to be supported by NRECA.

17. *The creation of EFER*

Conclusion: EFER should include as one of its tasks the development of a guidebook on the criteria for rural electrification development. EFER should act as a counterpart to FNDR to jointly establish norms and should participate in promoting initiatives concerning the governing rules for the Electricity Law.

Recommendation: ESD should continue to promote the establishment of EFER.

18. *EFER in the Bolivian electric sector*

Conclusion: The development of the rural electric sector in Bolivia is still in its early stages, and the Electricity Law implies important institutional changes.

Recommendation: EFER should be reanalyzed and designed as an institution no larger than necessary. The existence of EFER should depend on initial goals that are overly ambitious.

C. Conclusions and recommendations: project administration

1. *New logical framework*

Conclusion: The original logframe for the ESD project has been improved regarding the specificity of verifiable indicators and means of verification, and the new (1994) logframe will provide final evaluators with a much improved evaluation tool.

Recommendation: The 1994 logical framework should be approved as the official ESD logframe.

D. Lessons learned

1. The DAM model has a series a important limitations and simplifications. Future use of the DAM, probably not as part of this project, should introduce methodological improvements to the model.
2. In future projects, financial and economic analyses should be carried in a timely fashion and for all subprojects, including the formal analysis of least total economic cost. The selection of subprojects should be based on such studies. The time required for carrying out financial and economic studies can be reduced by simplifying field research, improving methodology, and increasing the sensitivity of analysis.
3. The six-week beneficiary assessments carried out by the Project were valuable, but assessments of similar quality could be done in less time with well-trained and supervised field personnel.

II. Background

A. Introduction

The cooperative agreement between the United States Agency for International Development (USAID) and the National Rural Electric Cooperative Association (NRECA) for the Electrification for Sustainable Development (ESD) Project was signed on July 26, 1991, for a period of five years. The purpose of the project is to support alternative development strategies to foment non-coca related economic development in both coca producing and non-coca regions of Bolivia through investments in electrification infrastructure. Total project funding from USAID at the time of cooperative agreement signature was $20 million, of which $15 million was to be provided in foreign currency and $5 million in local currency. Additional counterpart funding has been sought and secured from collaborating utilities.

The Project Goal, as stated in the logical framework is: "Increased employment, income and productivity in non-coca activities." The Project Purpose, as stated in the logical framework, is: "Affordable, sustainable and customer-oriented service provided to more rural households and businesses."

The project was designed to focus on four principal areas:

- construction of new and/or rehabilitation of existing electricity distribution systems;
- promotion of productive uses of electricity;
- technical assistance and training for electric utilities; and
- development of special projects, including use of renewable energy technologies and energy conservation.

The project also planned for development of an institution to finance electrification and increase investments in electrification infrastructure beyond project completion date.

There are at present 32 ESD subprojects, divided into three categories. Category I, RE Economic Development Projects, consists of 14 subprojects, defined as those subprojects which have a large number (over 200 to several thousand) of direct beneficiaries and therefore potentially have an impact on economic development. Category II, Pre-Electrification Projects, consists of nine subprojects, defined as those subprojects with renewable energy systems in areas where it will not be feasible to extend the grid during the next decade or so. Category III, RE Sustainability/Efficiency Projects, consists of nine subprojects, defined as subprojects where technical assistance is provided to utilities, cooperatives, and regulatory agencies, including load management and training activities.

B. Methodology

Due to time constraints, this midterm evaluation could take an in-depth look at only a sample of the 32 subprojects. The evaluation terms of reference specifically indicated that the

evaluation would not consider the nine renewable energy projects, which were only recently initiated.

The evaluation team determined that it would be preferable to focus on two main projects, the Mizque-Aiquile (MA) grid extension subproject and the Valles Cruceños (VC) isolated generation subproject, for several reasons. First, these are large projects: NRECA's investment in MA is US$900,000 and will result in around 2,600 connections, while NRECA's investment in VC was $US1.6 million and will result in around 5,000 connections. Second, these subprojects are both complemented by productive uses subprojects: US$100,000 for VC and US$314,000 for MA. Third, these subprojects involve two institutions, Cochabamba Power and Light (Empresa de Luz y Fuerza Eléctrica de Cochabamba - ELFEC) and the Santa Cruz Electric Cooperative (Cooperativa Rural de Electrificación - CRE), both of which are involved in several other ESD subprojects. A close look at the MA and VC subprojects would include an examination of two of the most important NRECA counterparts. Fourth, the MA and VC projects are among the subprojects farthest along, so that evaluation of these projects should provide an indication of how other projects can be expected to progress.

The evaluation accordingly included a field phase to visit these two projects. One day was spent in the Cochabamba area and included visits to ELFEC; interviews with NRECA/Cochabamba personnel; a visit to PRODEM, the productive uses counterpart for the Vinto grid densification carried out by ELFEC; and an interview with the productive uses counterpart for MA, Agrocapital. The next day was spent en route to MA, where the distribution system was inspected, and in Aiquile, where the evaluators had the opportunity to interview municipal authorities. The following day included an inspection of the VC generation facility and interviews with personnel from CRE, while the fourth day involved interviews with CRE personnel in Santa Cruz.

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III. Engineering of RE Economic Development Subprojects

A. Overview and methodology

The ESD project includes considerable infrastructure construction. Ten of the 14 Category I RE Economic Development Projects are construction projects with total ESD financing of US$7.393 millions. The subprojects are the following:

Project	Project Type	Estimated # of connections	ESD financing (US$ millions)
1 Vinto	Densification	200	.026
2 Mizque-Aiquile	Grid extension	2,100	.900
3 Chapare	Grid extension	1,500	.800
4 16 communities	Grid extension	500	.227
5 Capinota	Grid rehab	2,300	.560
6 Bermejo	Grid rehab/sol gen	3,000	1.100
7 Camiri	Grid rehab/gen	4,500	.330
8 Valles Crucenos	Isolated generation	5,000	1.600
9 Concepcion	Mydro generation	500	.150
10 Riberalta	Biomass generation	3,000	1.700
TOTAL		22,600	7.393

With this level of financing, it is essential that analysis of the quality of the construction be carried out. The methodology used in evaluating the engineering of these subprojects included document review of all projects except 4, 9, and 10, which are too recent to be evaluated effectively. In addition, subprojects 2 and 8 were visited in the field, where visual inspection was carried and interviews were done with project counterpart personnel. The methodology also included a review of alternatives, an analysis of construction standards (including materials used), a review of designs, and consideration of the construction schedules.

B. Mizque-Aiquile

1. *Relation to logical framework*

The Mizque-Aiquile grid extension subproject forms part of NRECA's Category I, RE Economic Development Projects. It contributes to the Project Purpose through the following Objectively Verifiable Indicators (Logical Framework, 1994):

- 15,000 new residential connections in ESD projects (EOP)
- 2,000 new PU connections in utilities with PU programs (EOP)
- 2.4 MWh increase in energy sales for PU/year in utilities w/PU progs (EOP)
- 3.6 MWh increase in energy sales/year in ESD projects (EOP)
- 50% of households in project area receive electricity (EOP)
- Collection rate is 90% + over one year for each ESD new connection project (EOP)
- New department or staff responsible for customer service in utilities w/PU progs (EOP)

2. *Introduction*

The towns of Mizque and Aiquile are located in the Valles Altos of Cochabamba, an area that has been identified as a focal point for the alternative development program. These towns serve an area with a population of over 30,000, and the towns themselves have previously been served by two isolated power stations using diesel-fired engines. Both electric systems operated four to five hours each evening and served only the immediate area within the town limits.

The purpose of this subproject was to interconnect Mizque, Aiquile, and the surrounding areas with the national grid through the Cochabamba Power and Light Company (Empresa de Luz y Fuerza Eléctrica de Cochabamba - ELFEC). This involved the addition of 182 km of feeder at 24.9 kV and 32 km of single phase lateral at 14.4 kV phase to ground. The beneficiaries of the subproject are divided into three main categories: residential users, productive uses, and institutional, this latter including churches, schools, hospitals, and others.

For the most part, the construction of the project was carried out as scheduled, beginning September 1, 1993, and ending April 15, 1994, when the main line was energized. Delays have occurred in two areas. First, the construction was to include 37 new distribution transformers, manufactured by Jimelco. Three of these transformers experienced short circuits on the primary windings shortly after being installed, while fifteen others failed preliminary tests at ELFEC prior to installation, which means that 49% of the transformers were not able to enter into service. These transformers will obviously need to be replaced by Jimelco, a process which may take until the end of 1994. The other problem has involved individual service connections due to delays in receiving connection materials from the provider. It is expected that the materials will arrive in September and the connections completed by December.

As a result of these delays, according to the ELFEC Technical Manager, just 50% of the projected residential customers have been connected, and just 30% of productive end users have been connected, plus four institutional users. The total number of connections at present is 484 in Mizque and 1127 in Aiquile for a total of 1611. Connections along the line are now

expected to be around 1000, and the total number is thus expected to eventually exceed 2600, or 500 more than the 2160 connections originally planned.

3. *Analysis of alternatives*

According to the prefeasibility study for this subproject, the projected demand at year 20 is calculated at 1400 kW. In order to serve this load, two main aspects were considered: (1) the selection of the energy source and (2) the preliminary design and cost estimation of the distribution system. The alternatives for energy supply included isolated systems, energized using gas or diesel combustion cycle motors or hydroelectric generation, and interconnected systems.

a. Isolated systems

Combustion cycle motors using gas

An installation of this type was considered at the town of Tipa Pampa located 15 km south of Aiquile, adjacent to a natural gas pumping station run by the oil and natural gas company, Yacimientos Petroliferos Fiscales Bolivianos - YPFB. This alternative would have required the purchase of two gas motors of 580 kW each, the construction of a building to house the plant, and the connection of the plant to a 24.9/14.4 kV distribution system, at a total cost of US$1.4 million. In addition to the high cost of the system, ELFEC refused to assume responsibility for the system, since it would have required having a team of technicians dedicated exclusively to the operation and maintenance of the plant.

Hydroelectric generation

Two different options were considered for the installation of a hydroelectric plant, one at Tucma with a total capacity of 353 kW. This plant was already under construction by a private company, and the approximate cost of finishing the project was US$898,000. In addition to being rather expensive, the output of the plant would not meet the demand requirements of Mizque and Aiquile. The second option was to build a hydroelectric plant at San Gerónimo with a generation capacity of 836 kW at a cost of $4 million; the high cost alone eliminated the project from further consideration.

Diesel generation

As mentioned above, Mizque and Aiquile already had diesel generators, two 180 kW Caterpillars and a 100 kW Cummins in Aiquile and a 102 kW Caterpillar and a 90 kW Scania Negrini in Mizque. These generators were financed by USAID and installed two years earlier to provide electricity for the two towns about five hours per night. An interconnection between the two towns with the four generators running simultaneously would provide an installed capacity of 652 kW. This option was discarded because of the problems connecting the two towns, the fact that even with interconnection demand would not be met, and the previous history of operation and maintenance of the existing generators.

b. Interconnected systems

In an interconnected system, the electric energy is supplied by the national interconnected system grid or by interconnection to another isolated system. In both cases, the same number of communities would be electrified, and the following three alternatives were considered.

Interconnection to the Electric Cooperative of Sucre - CESSA

This alternative would require the construction of a 151 km feeder system from Sucre to Aiquile in three steps. First, it would require converting the 49 km of single phase line from Sucre to Rio Chico to three phase line at a cost of $245,000. Second, it would require the construction of 67 km of new three phase line from Rio Chico to Zamora at a cost of $469,000. Third, it would require the construction of 35 km of three phase line from Zamora to Aiquile at a cost of $128,000. The total cost would be $842,000 without including Mizque, but the main disadvantage would be that the line would cross departmental borders, causing sociopolitical and institutional problems.

Interconnection to the Valles Cruceños distribution system

The Valles Cruceños subproject, discussed in detail elsewhere in this document, was to have a nominal generation capacity of 1950 kW and a distribution system at 24.9/14.4 kV. The alternative would consist of the construction of 100 km of three phase line from Saipina to Aiquile at an estimated cost of $700,000. This alternative would contain the same problem of interdepartmental connection and its accompanying political and institutional problems, but more importantly, the Valles Cruceños isolated generation system would not have sufficient capacity for the addition of Mizque-Aiquile.

Interconnection to ELFEC of Cochabamba

This alternative consisted of the construction of a new 24.9/14.4 kV line from Paracaya to Mizque (88 km) at a cost of $575,000. This alternative was both the least expensive and the one which avoided crossing departmental boundaries. The total cost of the subproject (US$ 1,592,600) was within budget, including the construction of 182 km of 24.9/14.4 kV distribution lines, the construction of 32 km of 220 V secondary lines, the installation of 37 distribution transformers of 14.4 kV - 220 V, and the service installation to users.

4. *Analysis*

The evaluation team met with the NRECA engineer and the ELFEC engineering technical manager, reviewed the technical information related to the project, and concluded that this project was designed taking into consideration all the system parameters and in compliance with REA standards to optimize the quality of service during the entire life of the subproject and at a minimum cost. During the field visit from Paracaya to Aiquile, the evaluation team carried out spot checks of line construction and concluded that it was built in compliance with REA specifications and drawings for 24.9/14.4 kV line construction.

Nonetheless, the evaluation team presents the following technical observations concerning the MA subprojects:

a. Computer information system

One element recommended for the system is a computerized information system to gather and track information about the system for managers, engineers, and operations personnel. Such a system should include information on transformer capacity, transformer demand load, conductor type and size, primary and secondary line, lateral fuse size, and so on. The system should be used to track system failure through input of information on system failure in different parts of the system, information which will be valuable to operations and maintenance personnel.

This system should be developed using a continuous grid coordinate system for the area derived from maps of absolute coordinates for the country. This system could be developed in-house using off the shelf computer software. The evaluation team is unaware if such information systems already exist for other utilities in the country. Assuming they do not yet exist, the ESD Project could pilot this effort with a view toward eventual implementation nation-wide.

b. Pole size/class and span length

During field observations, the evaluation team noticed that some pole which are supposed to be NRECA 12 m class 2 do not meet the specified standard circumference of 695 mm or 221 mm diameter at two meters above the base but are rather under size. As a consequence, the length of the spans are too long, an average of 100 meters for 3 X #1/0 ACSR and 1 X #4 N ACSR. It is recommended in general that the length of the spans be reduced or the class of the pole increased. If this is not done, the mechanical load might exceed the initial allowable moment of the pole.

c. Cracks in wood poles

During field observations, about five km before the town of Rodeo, a spot check was carried out which discovered a distribution pole (Class II) with a crack of 900 mm above the ground which was 750 mm long, 20 mm wide, and 20 mm deep. According to NRECA technical specifications for wood poles for aerial lines, the condition of this pole is acceptable, because the crack is over 300 mm above ground.

However, based on the experience of the evaluation team, even though the humidity in this area is low, humidity will accumulate in this crack and mix with dust, creating an acid that in a few years will destroy the pole. NRECA and ELFEC should identify such poles and note in the data base (see above) that these poles will probably require replacement in the near future.

d. Use of large electric motors

In spite of the fact that during the evaluation team's field trip, no limitations on electric motors were presented, it is possible that a large motor (for example, 50 hp) could be installed which could cause a voltage dip when starting which would be perceptible to other customers on the line. Such a situation could prove problematic to a customer, especially if a personal computer or other sensitive equipment were connected to the line fed by the feeder.

This situation requires a more in-depth analysis to determine the maximum acceptable size of motor for this system, or the maximum size of motor without a starter compensation device.

e. Insulator flashover

NRECA standards stipulate that the post insulators used on a 24.9/14.4 kV distribution system should be "cap and pin" two skirt insulators. Experience has shown that dust deposits along the insulator skirt surface, coupled even with very low humidity at night, creates a mixture with the dust deposited on the insulator surface. This mixture, due to the action of the electric field and the small leakage current along the surface of the insulator, can begin to deteriorate the insulator and to increase the amount of dust mixture on the insulator surface. With time, flashovers will occur until the insulator is finally destroyed.

f. Excessive voltage drop

The project future load on this feeder is about 1.4 mW. When this load materializes, a voltage drop of about 10% toward the end of the 182 km feeder around Zamora can be expected, especially when the electricity use is fully implemented in agriculture. To counteract this problem, the installation of at least one set of voltage regulators at some point on the feeder is recommended.

g. Installation of recloser

Considering the length of this feeder, the number of installed OCRs does not appear sufficient. The installation of cascaded OCRs would assure more reliable service and fewer customers out per service interruption. One suggestion would be to install a single phase OCR at the Aiquile road going to Zamora, where the fuse switch is installed. A temporary failure created by a tree branch or something similar might put these customers out of service for hours.

h. Voltage instability

The long length of this feeder might create voltage instability due to the capacitance effect of the line, which might require the installation of some compensation on the line to overcome this effect. This observation will require a more in-depth analysis, because it is based only on experience, and there is not analysis to substantiate the remark. A stability analysis is recommended.

C. Valles Cruceños

1. Relation to logical framework

The Valles Cruceños isolated generation subproject forms part of NRECA's Category I, RE Economic Development Projects. It contributes to the Project Purpose through the following Objectively Verifiable Indicators (Logical Framework, 1994):

- 15,000 new residential connections in ESD projects (EOP)
- 2,000 new PU connections in utilities with PU programs (EOP)
- 2.4 MWh increase in energy sales for PU/year in utilities w/PU progs (EOP)
- 3.6 MWh increase in energy sales/year in ESD projects (EOP)
- 50% of households in project area receive electricity (EOP)
- Collection rate is 90% + over one year for each ESD new connection project (EOP)
- New department or staff responsible for customer service in utilities w/PU progs (EOP)

2. Introduction

The Valles Cruceños generation subproject was carried out between NRECA and the Santa Cruz Electric Cooperative (Cooperative Rural de electrificación - CRE) to provide energy for the area known as the Santa Cruz Valleys (Valles Cruceños). NRECA's contribution consisted of the electric generators, while CRE provided generation station infrastructure and

the distribution lines. The subproject serves 54 towns in the provinces of Caballero, Florida, and Valle Grande, providing continuous service to more than 5,000 users.

The system was energized on February 26, 1994, on schedule and within budget, at a total cost of US$5.6 millions. In addition to NRECA's contribution of US$1.6 million, the subproject was financed by CRE and by the Santa Cruz Regional Development Corporation (Corporación Regional de Desarrollo de Santa Cruz - CORDECRUZ). The description below includes the entire project, not just that financed by NRECA.

The project consists of six main elements:

- Installation of three 650 kW nominal power generators at 3.3 kV, 50 hz. The generator motors are gas combustion cycle engines manufactured by Caterpillar and run on natural gas from an existing pipeline which runs through the plant site.
- Construction of a step-up substation with two 2,500 kVA power transformers at 3.3-24.9 kV and three feeder positions and the installation of the protection equipment for the entire substation.
- Installation of a water treatment plant, including the protection and central equipment.
- Installation of a gas regulating and measuring system.
- Construction of 293 km of primary distribution lines and 150 km of secondary lines.
- Installation of 128 distribution transformers.

3. Analysis of alternatives

According to the prefeasibility study carried out by ASINELSA S.A., the projected maximum demand for the system in the year 2010 would be 3535 kW. In order to serve this projected load, 11 alternatives were considered, the first six of them based on feeding into the system from Santa Cruz, where CRE is the city electric utility, to Samaipata, San Isidro, Mataral, or Mairana. Alternatives seven through 10 involve the installation of isolated gas or diesel combustion cycle generators at one or more towns in the Valles Cruceños area, such as Samaipata, Mairana, Mataral, and Pulquina.

The best alternative turned out to be one involving the installation of an isolated gas combustion cycle generator at Mataral, since this location offered the most convenient routes to the distribution system serving the three regions of the subproject. In addition, natural gas was the cheapest combustion material, and the location of the generator was next to the natural gas pipeline.

4. Engineering analysis

The load projection analysis that substantiates the subproject indicates a maximum demand of about 1200 kW in 1994 and about 3500 kW in year 20. The system had an actual demand of 1300 kW on July 9, 1994, which appears to confirm the projection analysis.

An analysis of the procurement files at the NRECA office in La Paz confirms that the bidding and ordering process for the equipment at the Mataral generation plant was conducted in a fair way and in timely fashion. The design of the plant building is adequate and meets the safety requirements for this type of operation. The water treatment and cooling system design has

been done using the most recent technology and is able to satisfy the cooling requirements of the generation plant. The gas regulation and measuring station was designed to meet present and projected demand on a normal operating basis.

The generation system is capable of meeting the present and projected demand after the year 1996. The system is able to sustain 90% of the existing peak demand load on a first contingency with one generation set out of service. The protection relay scheme for the generation plan and for the substation meet the protection requirements of the system. The control system of the generating plant was designed using sound engineering judgement and is capable of responding quickly to operator commands.

In the meeting with the NRECA subproject engineer at the NRECA office in Cochabamba, the evaluation team obtained a copy of the Performance Test Reports showing the results of tests performed at the inauguration of the plant. Based on this information, the evaluation team concludes that the system is performing according to the expectations of the design.

The plant facilities at Mataral were visited with the plant manager. The evaluation team was able to observe that the construction of the system was carried out in accordance with design expectations, the assembly of the system was work of high quality, and the CRE had implemented strict methodology in conducting system operation and maintenance.

In spite of the general high quality of the subproject, certain problems were detected. First, the plant service transformers inside the plant building need protective barriers. An accidental contact with the high or low tension could be fatal. Second, at the station adjacent to the plant there is a single set of components for achieving gas pressure reduction. It would be advisable to have a parallel system on stand by to the existing station, since in the event of a malfunction of a component of the pressure reduction station, the entire generation system would be out of service.

Third, the evaluation team observed that the gas line is above ground on a good portion of the route to Mataral. An automobile accident or act of sabotage near the plant site could interrupt plant operation for a period of a few hours or a few days. The construction of a high pressure gas reservoir system with sufficient capacity to assure at least 24 hours of plant operation would overcome this potential problem.

Fourth, the yard illumination system for the area of the gas pressure reduction station is deficient and requires increased lighting. Finally, it was noticed that the Mataral plant does not have adequate fire extinguishers to deal with emergencies.

D. Capinota

These sites were not visited by the evaluation team. The information below is based on document review and on interviews with NRECA subproject engineers.

1. *Relation to logical framework*

The Capinota grid rehabilitation subproject forms part of NRECA's Category I, RE Economic Development Projects. It contributes to the Project Purpose through the following Objectively Verifiable Indicators (Logical Framework, 1994):

- 15,000 new residential connections in ESD projects (EOP)
- 2,000 new PU connections in utilities with PU programs (EOP)

- 2.4 MWh increase in energy sales for PU/year in utilities w/PU progs (EOP)
- 3.6 MWh increase in energy sales/year in ESD projects (EOP)
- 50% of households in project area receive electricity (EOP)
- Collection rate is 90% + over one year for each ESD new connection project (EOP)
- New department or staff responsible for customer service in utilities w/PU progs (EOP)

2. *Introduction*

Capinota is a community of almost 10,000 people located approximately 60 km to the west of Cochabamba. It has been served by a local cooperative through a 6.0 kV distribution system fed by a 4.5 mVA substation owned by the COBOCE cement plant located in the Irpa Irpa area. However, the quality of the electric service provided has been problematic due to over-saturation of the line and poor attention to users on the part of the cooperative. The estimated initial demand for the subproject is about 1.89 mW and a demand of 2.85 mW at year 20.

3. *Analysis of alternatives*

The subproject at Capinota presented three alternatives. The first alternative involved increasing the transformer capacity of the COBOCE substation. While this alternative would have been the least expensive, COBOCE indicated that it did not want the installation to continue to be used to serve the cooperative at Capinota. The second alternative involved reconductoring ELFEC's feeder 70 km between Quillacollo and the Capinota cooperative. This alternative was not considered viable because the length of the feeder would result in low reliability and voltage drops toward the end of the feeder would be high.

The third alternative involved the installation of a new 3.5 mVA, 115-24.9/14.4 kV substation at Irpa Irpa. This alternative was considered viable because it would provide an adequate source to satisfy present and future demand. The substation will be connected to the national grid, will offer the advantage to ELFEC of closing the loop on the 115 kV transmission circuit, and will increase the service reliability to the Playa Ancha-Parotani sector. In addition, one of the two feeders from this substation will be dedicated to the COBOCE cement plant with a projected demand of 1.5 mW.

The distribution portion of this subproject consists of the addition of about 14 km of 24.9/14.4 kV distribution feeder and about 28 km of 380/220 volt secondary line. The towns which will benefit from the subproject, in addition to Capinota, are Buen Retiro, Iatamaco, Sarco Bamba, and Irpa Irpa.

According to the bid documents, the construction of this project was awarded on June 15, 1994, and construction work is projected to start on August 15, 1994 with a completion date of December 15, 1994. The original in-service data was February, 1994, but was delayed due to a disagreement between ELFEC and the Capinota cooperative.

The procurement of materials, equipment, and contracted services for this project have been made in accordance with NRECA norms. In a meeting with the NRECA engineer in charge, it was concluded that the engineering for this subproject is based on REA engineering

standards. The amount budgeted for this subproject is US$560,000. It is premature at this point to elaborate further on the actual cost of the subproject.

E. Camiri

1. *Relation to logical framework*

The Camiri grid rehabilitation and generation subproject forms part of NRECA's Category I, RE Economic Development Projects. It contributes to the Project Purpose through the following Objectively Verifiable Indicators (Logical Framework, 1994):

- 15,000 new residential connections in ESD projects (EOP)
- 2,000 new PU connections in utilities with PU programs (EOP)
- 2.4 MWh increase in energy sales for PU/year in utilities w/PU progs (EOP)
- 3.6 MWh increase in energy sales/year in ESD projects (EOP)
- 50% of households in project area receive electricity (EOP)
- Collection rate is 90% + over one year for each ESD new connection project (EOP)
- New department or staff responsible for customer service in utilities w/PU progs (EOP)

2. *Subproject description*

Camiri is a town with a population of over 15,000 in the cordillera region of Santa Cruz that has for many years been one of the key petroleum producing center in Santa Cruz. Camiri has previously been service by an independent cooperative which unfortunately has functioned very poorly due to gross mismanagement. The independent power generating station is fairly new, but it is in grave danger of total failure if an immediate rehabilitation of the system is not carried out.

In this subproject, NRECA financed the rehabilitation of the generating system, while CRE will finance the rehabilitation of the distribution system. ESD financing for this project is US$320,000. Rehabilitation of the generation system involves overhauling the three generating units which have nominal power of 850 kW. According to information provided by the NRECA engineer at the Cochabamba office, the overhaul of the last of these units (#3) was completed on July 3, 1994.Performance tests have already been carried out on units #1 and #2, and their power output was 850 kW for each unit. Units #1 and #2 are already in service, and #3 will be in service by the end of July. This subproject is thus nearly completed within budget and as scheduled.

F. Bermejo

1. *Relation to logical framework*

The Bermejo grid rehabilitation and isolated generation subproject forms part of NRECA's Category I, RE Economic Development Projects. It contributes to the Project Purpose through the following Objectively Verifiable Indicators (Logical Framework, 1994):

- 15,000 new residential connections in ESD projects (EOP)
- 3.6 MWh increase in energy sales/year in ESD projects (EOP)

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- 50% of households in project area receive electricity (EOP)
- Collection rate is 90% + over one year for each ESD new connection project (EOP)

2. *Project description*

Bermejo is a town with a population of approximately 22,000 people in southern Bolivia on the border with Argentina. It has been served by an electric utility that provides service to nearly all of the department of Tarija, Servicios Eléctricos de Tarija - SETAR, through an interconnection with the national grid of Argentina. However, due to poor management on the part of SETAR, Bermejo has been experiencing frequent power cuts from the Argentine supplier.

The purpose of the subproject is to rehabilitate the distribution system of Bermejo and to install a new natural gas power plant in the town. The national grid power supplier, Empresa Nacional de Electricidad - ENDE, will co-finance the cost of the project, which will include civil works related to the construction of the new powerhouse, purchase of generator sets, and a gas line, as well as the rehabilitation of the distribution system. The total amount budgeted for this subproject is US$2 million, of which ESD will finance US$1.1 million and ENDE the rest. ENDE will further assume responsibility for managing the system.

The subproject consists of the following components:

- The installation of two gas combustion cycle units with a capacity of 950 kW each, at 6600 kV.
- The reconductoring of 5.8 km of feeder with new poles at 24.9/14.4 kV.
- The extension of the existing distribution facilities 1.8 km at 24.9/14.4 kV.
- The installation of 47 km of secondary line at 380/220 volts.
- The installation of 25-150 kVA, 24.9/14.4 kV-380/220 distribution transformers. These new transformers are required because the existing line is 6.6 kV and the proposed line is 24.9 kV.

Information on alternatives demonstrated that this subproject was the most viable alternative to resolve the supply problem at Bermejo. According to information obtained from NRECA files in La Paz, the invitations for bid for the generation portion were issued on time, and the bidding process was conducted as specified in the bidding procedure.

Through conversation with the NRECA subproject engineer at Cochabamba, it was discovered that the civil works for the construction of the powerhouse are about 70% completed, and completion is expected by July 25, 1994. The installation of the generating units will begin on July 19, 1994, and all the necessary tests are expected to be conducted in September, 1994. According to the NRECA subproject engineer, ESD financing is within budget limits.

Work on the distribution system has been delayed, due to ENDE's lack of action in taking financial responsibility for the distribution construction. According to the subproject engineer, this problem has now been resolved, and distribution system construction is scheduled to begin by the end of July, 1994, and will be completed by the end of October, 1995.

G. Chapare

1. Relation to logical framework

The Chapare grid extension subproject forms part of NRECA's Category I, RE Economic Development Projects. It contributes to the Project Purpose through the following Objectively Verifiable Indicators (Logical Framework, 1994):

- 15,000 new residential connections in ESD projects (EOP)
- 3.6 MWh increase in energy sales/year in ESD projects (EOP)
- 50% of households in project area receive electricity (EOP)
- Collection rate is 90% + over one year for each ESD new connection project (EOP)

2. *Project description*

Over two years ago the United Nations Development Drug Control Program (UNDCP) signed an agreement with ENDE to electrify the Chapare corridor from Cristal Mayu to Bulu Bulu, providing 24 hour electric service via a 34.5 kV line to all the communities along the new road from Cochabamba to Santa Cruz. The UNDCP project funds were insufficient to complete the project, but all primary line was installed and perhaps 70% of the connections initially targeted. Moreover, the project completely neglected to connect the major loads on the line, particularly industries which may eventually help the project pay for itself.

ENDE completed all the necessary design work, but management of the project has now been transferred to ELFEC, which is NRECA's counterpart for the current project activity. The scope of the project consists of four phases:

- Installation of services to the industrial sector.
- Connection of all potable water systems to the grid, including conversion from diesel to electric pumps.
- Residential electric service to those areas with existing primary lines but no secondary lines.
- Extension of the distribution grid to an additional 1500 customers.

Installation of services to the industrial sector consists of installing 38 distribution transformers to 37 industries, plus the installation of about 28 km of three phase and 2.7 km of single phase distribution line. The engineering for this phase was completed in February, 1994. At the present time, about 50% of the transformers are installed, and completion of construction for this phase is projected for mid-September, 1994. Project activities are advancing on schedule, and completion of the entire project is expected by December, 1994.

The engineering has been done according to NRECA standards, and the equipment and material procurement conducted according to NRECA norms. The total project cost is approximately $US1.2 million, of which ESD will finance US$800,000.

IV. Technical Assistance and Load Management

A. Technical assistance program

1. *Overview*

The technical assistance program was created in order to satisfy the requests made to NRECA for technical assistance. Among the 150 electric cooperatives, municipal utilities, and others that exist in Bolivia, NRECA receives two to five requests per week for such technical assistance. In order to provide this assistance to a large number of utilities, NRECA joined in partnership with the larger utilities to do so.

2. *Methodology*

The methodology of evaluation of the technical assistance component consisted of document review of the various technical assistance subprojects and interviews with NRECA personnel. None of these subprojects was visited in the field.

3. *Chiquitania*

The Chiquitania region of Bolivia has about 15 independent electric cooperatives, all of them isolated generation plants. The Chiquitania cooperatives vary as regards number of members from as few as 200 members to as many as 1200. Due to their small size, all were weak in both administrative and technical aspects.

With a view toward seeking solutions to their problems, NRECA selected five of the cooperatives in this region for technical assistance, three larger cooperatives (San José, San Ignacio, Robore) and two smaller ones (San Javier, Santiago). The subproject consisted of a three-day training seminar on administration, technical programs, and safety. In addition, NRECA hired a full-time person to install computer hardware and software and to assist the cooperative in technical matter. As a result, a computer management and accounting system (Sistema de Administración Contable por Computadora - SACC) and billing software is being developed. In order to promote safety, NRECA facilitated the acquisition of software by the Chiquitania cooperatives.

As a result of this technical assistance, the three larger cooperatives have shown overall improvement, especially as regards increased collection and fewer system losses. The two smaller cooperatives showed slight improvement: their lack of advancement was judged to be due to the lack of basic and technical skills among cooperative personnel. It is unlikely that they will be able to function well without help from larger cooperatives. The total cost of this subproject was $US50,000.

4. *Beni*

A technical assistance subproject was implemented at the Santa Ana, Magdalena, and Trinidad electric cooperatives in the northern jungle department of Beni. The total number of

cooperative members involved was 6,500, including 1000 in Santa Ana, 500 in Magdalena, and 5000 in Trinidad. General improvement has been noted in financial management and non-technical losses.

5. CORELPAZ

NRECA also worked with CORELPAZ, a large cooperative of 22,000 members in the department of La Paz but serving only the rural area outside the city. In this subproject, NRECA was asked to carry out a diagnostic to determine what administrative and technical measures would be necessary to put the utility on a sound financial basis. When the diagnostic was completed, board elections were held, the cooperative was reorganized, and an NRECA-backed management team was installed in the second half of 1993.

After it was found in April, 1994, that the new board would not assume the existing debts, NRECA suspended the technical assistance program. The government intervened and asked NRECA to assume the direction of the administration once again. NRECA agreed with the provision that the cooperative be liquidated and a new utility service company be formed. Debts have now been rescheduled, assets have been reevaluated, and the cooperative is ready to be sold. NRECA's investment in this subproject is US$100,000.

6. Sector support

The National Electricity Directorate (Dirección Nacional de Electricidad - DINE) is the government entity which, among other things, is charged with setting tariffs in Bolivia. Although it is supposed to be a purely technical institution, it is sometimes subject to political pressures, usually to establish lower than viable rates. NRECA has entered into an agreement with the National Association of Electric Utilities (Asociación Nacional de Empresas Eléctricas - ANELEC) to provide technical assistance to DINE in the form of five technicians, computers and office equipment, and training for one year. ESD will provide US$60,000 and ANELEC will provide US$40,000 of the total cost of the subproject, which is US$100,000.

The rationale for this assistance was to provide assistance to DINE at a time in which a new regulatory institution is in the process of being formed. This new institution, the National Superintendency for Electricity (Superintendencia Nacional de Electricidad - SNE), will be financed by a tariff levy on the electric utilities. This new regulatory structure is essentially the one proposed by NRECA following a sector analysis in 1992.

7. Wood quality control

NRECA has been the chief contributor to the creation of quality standards for wood poles and has helped bring about the adoption of these standards throughout Bolivia. NRECA hired a wood quality control expert to develop these specifications, implement the training on the specifications at the wood pole treatment plant, supervise quality control in the wood treatment process. Once this was accomplished, NRECA has promoted the acceptance of these specifications as a national standard. The NRECA investment in this subproject was US$80,000.

B. Load management

1. Overview

One of the goals of the ESD is to establish a culture of more efficient use electric energy throughout the Bolivian power sector, including load management with industrial users. Electric utilities are organized to meet peak or maximum demand, the moment when the highest demand exists for electricity. If a utility can reduce this peak demand or at least maintain it a present levels, it will not be required to acquire further generating power. Load management refers to utilities working with large industrial users, any one of which can affect peak load, so that peak demand does not rise.

This can be done in a number of ways, but one way is to charge a higher tariff to an industrial user during peak demand hours. If this or other methods can lead the industrial user to concentrate power use during non-peak hours, the industrial user saves money by paying a lower tariff, and the utility saves money because it is not forced to add expensive new generation.

One of the goals of ESD is to establish a pattern of more efficient use of electric energy throughout the Bolivian power sector, including load management. To this end, NRECA has initiated load management programs with the four largest utilities in the country, including ENDE, ELFEC, CRE, and most recently, COBEE.

2. Methodology

The methodology of evaluation of the load management component consisted of document review of the various load management subprojects and interviews with NRECA personnel. None of these subprojects was visited in the field.

3. Description of load management program

The load management subproject can be divided into three phases. During the first phase, an analysis of the impact of load management on the national generation utility and on distribution utilities was carried out, such as those in Santa Cruz, Cochabamba, and La Paz. The second phase involved the purchase of 35 electric demand meters to enable NRECA and its counterparts to design time of use and curtailable industrial rates.

The third stage has involved developing a pilot project with 12 industrial users of each distribution utility and applying the appropriate rate with each customer, as well as communicating the objectives of the pilot project to each one. It is hoped that this subproject will show the way toward sound and sensible load management policies for Bolivian utilities. The cost of the subproject with ENDE, CRE, and ELFEC was US$80,000, where NRECA provided US$60,000.

On the basis of work done by NRECA in Cochabamba and Santa Cruz, COBEE has contracted NRECA to perform a similar study in La Paz. The estimated cost of the study is US$45,000, not including meters, of which US$30,000 will be paid by COBEE. NRECA will procure 21 meters for the study, but the total cost will be reimbursed by COBEE.

V. Economic, Financial and Social Analyses

A. Sample Analyzed

The group of subprojects selected for economic and financial analysis consists of those in Category I, RE Economic Development subprojects. As mentioned above, pre-electrification subprojects (Category II) were not included in the terms of reference, and most Category III subprojects (training, load management, technical assistance) are not considered here, since subprojects of this type are not subjected to economic or financial studies. The exception is the establishment of the RE Finance Corporation (Empresa Financiera de Electrificación Rural - EFER), which is included below in the section on institutional analysis.

Time limitations made it impossible to study all subprojects in Category I. A selection was therefore made to include those subprojects using the following criteria: (a) generally large subprojects which are in advance stages of implementation, (b) subprojects with economic and financial studies, and (c) subprojects which were possible to visit in the field. Included were the following: Mizque-Aiquile, Valles Cruceños, Vinto, and Capinota. This selection includes both the infrastructure construction subprojects as well as the related productive uses subprojects.

The above sample was not determined by using statistical methods. In cases such as this, a large sample is an adequate substitute for statistical representativeness. Normally, a sample is considered sufficiently large when it includes more than 30% of the total population. Sample sizes in this case are the following:

- Number of subprojects with investment costs: four out of 10 were analyzed, or 40% of the total population.
- Number of subprojects with credit: the total population was studied.
- Estimated number of connections: 9,600 were included from the total of 22,600, or 43% of the total population.
- Amount of investment financed by ESD: US$3.637 analyzed of the total of US$7.957, or 46%.

Regarding rigor, the conclusions regarding specific subprojects are site-specific and therefore are not to be extended to other subprojects without further analysis. The practical use which NRECA may obtain from the conclusions and commentaries therefore depends on NRECA's ability to extend these observations to those projects not analyzed during the present midterm evaluation.

B. Project financial and economic analyses

1. *General comments*

This section presents general comments regarding the financial and economic analyses carried out directly by NRECA which may be of use for future evaluations, including for programs outside Bolivia.

a. The DAM methodology

NRECA's most highly developed economic and financial tool which they used in the analysis of their principal subprojects, is the model called Demand Assistance Model DAM. This section presents the principle characteristics and limitations of this model.

The model assigns signficant importance to quantifying the benefits of electricity consumed in productive uses. Benefits from residential use and public lighting are estimated using indicators which are not included as benefit per customer and which are calculated outside the model itself.

The primary limitation of the model is that it is only applicable to new RE expansion projects where there would be no electricity without the project. The model contains only one set of variables, ie. the number of customers, tariffs, marginal costs, etc, which represents the project implementation scenario. To comprehensively analyze the benefits, existing customers in a situation where the project is not implemented would be necessarily analyzed as well.

This limitation in the model was not taken into account during the first few analyses carried out by NRECA, and it produced results which were overly optimistic. In these cases, the benefits of the subprojects were overvalued since existing users without the project were perceived to gain as much benefit from the project as newly connected users.

A second limitation of the model is that the financial costs of construction are considered to be the same as the corresponding economic costs. The following are the primary differences between financial and economic costs:

- Regarding the amount, economic costs do not include taxes and all types of transference, and they take into account shadow prices. Financial costs iclude all payments, and they do not make corrections which differentiate through shadow prices the value of the corresponding opportunity costs.
- Regarding the year in which they occur in the cost flow, the economic costs are incurred at the moment in which the productive resources are removed from the rest of the economy to be used in the project. The financial costs, on the other hand, are incurred at the moment in which the institution makes payment. In general, economic investment costs appear during the first few years and financial costs appear during the entire period analyzed.
- Not all financial costs are economic costs, and vice versa. Two cases are important: (1) donations can constitute an economic cost but not a financial cost when payment is not required, such as in a revolving fund; and (2) interest paid for credit constitutes a financial cost but not an economic cost.

Although the error mentioned previously had been detected by NRECA, all of the analyses reviewed during the evaulation included it. Also, it is not possible to know whether the

correct financial costs are greater or less than those estimated in the studies. Since it is from the financial analysis that an adequate tariff structure can be deduced, one concludes that it is not possible, based on these studies, to determined whether or not the required tariff levels to achieve adequacy have been overestimated.

There are other limitations, simplifications, or omissions in the model which are described in the following section on the improvements introduced by NRECA/Bolivia.

b. Improvements introduced by NRECA

NRECA has progressively introduced substantial improvements to its economic and financial analyses. They are as follows:

- An improved benefit indicator for residential customers, calculated using the program RESALC. Through this program, NRECA has obtained an average between the indicator of benefit for users brought in by the subproject and the indicators which corresponds to the existing users in the absence of the subproject. However, it would be preferable to treat the two classes of users independently, since the average refers to the relative participation of new and existing users in the absence of the subproject, a participation which normally varies over the entire period of time considered in the cost-benefit analysis.
- The differentiation between construction economic costs and the corresponding financial costs. There are still a few methodological improvements to be included, such as the elimination of indirect taxes from the economic costs, the clear specification of the order in which the analyses are presented, and a more rigorous differentiation between exchangeable and nonexchangeable goods.

c. Methodological improvements still needed

Apart from those mentioned above, additional methodological improvements could be introduced by the following:

- Distinguish between electricity and incremental energy losses caused by subprojects. The presentation does not allow for the analysis of the relative importance of losses. In addition, these are not projected correctly, since they have been calculated under the assumption of a fixed percentage of loss, which is methodologically incorrect.
- Adequate maintainance of the values employed as marginal costs of electricity with their respective analyses. It is not clearly specified that the values employed are actually calculated according to the income of the subproject electric systems. In addition, in all of the studies, the magnitude of these costs does not vary during the period of simulation, which does not conform to the changes expected in real fuel prices.
- Include the salvage value of investments made, estimated for the year in which the cost-benefit analysis is carried out. This omission has occurred in all of the studies and implies a lowered profitability of the subprojects.
- Include the benefits obtained by freeing up productive resources. These resources are valued as the opportunity costs of equipment, such as usable generation equipment, cables, and other recyclable items. In some subprojects, such as Mizque-Aiquile, the project will free up relatively new diesel generation

equipment which will be usable elsewhere. These resources are of significant importance.

- Improve the estimation of the benefits of productive uses of electricity. In all the cases reviewed, only the benefits of cost savings from electrification were considered. The elimination of the effects of greater production and higher quality is acceptable, when the information on which to base them is not reliable. The main problem involves the treatment of producers who exist in the absence of the subproject and for whom the benefits from the subproject are overestimated. The studies therefore assume that in the absence of the subproject, the cost of existing equipment is equal to the replacement cost.

d. Availability and opportunity in economic and financial analyses

Of the 10 subprojects in Category I, only six have financial analyses and only the four included in the sample analyzed here have economic analyses.

In the majority of cases, the decision to implement the subprojects was made before the respective economic and financial analyses were completed. An important exception was the feasibility study for the Valles Cruceños subproject, which was contracted out by NRECA.

This contradicts the importance given in the project plan to the availability and timeliness of these analyses, since they were intended to illustrate how to carry out correct subproject selection.

One reason for the delay or lack of availability in applying detailed research is the decision to carry out data collection of the DAM. The decision by management to carry out the subprojects before analyses were completed meant that a significant delay in project development was avoided, but the decision was supported by subjective judgement only. The evaluation team recommends that in the future, management decisions be supported by studies which are simpler and thus require less time to carry out, but which provide an analysis which is sufficiently sensitive to orient such decisions.

The fact that the studies were not available on time diminished their importance, but they were still used in subproject follow-up, the identification of communities to electrify, the approval of tariffs, the review of goals for productive uses, and for NRECA, a better understanding of the subprojects.

In spite of the methodological and practical problems which occurred during the economic and financial analysis process of the subprojects, the evaluation team concludes that all of the subprojects implemented in this review were sound subprojects. This fact should not lead to the omission of economic and financial studies in the future, since they still constitute the one methodological tool which allows for the evaluation and ordering of projects according to their economic feasibility.

2. *Commentaries on specific studies*

a. Demand analysis

Comments on demand analysis presented below applies to all subprojects, since they were the same methodology. In general, the demand for electricity for productive uses was calculated separately from the demand for residential use. The criteria adopted are the following:

- The demand estimates for the first year of the subproject were carried out with a high degree of detail. In the case of productive uses, the number and consumption of each class of projected productive users was studied. In the case of residential use, the number of initial customers and the unit consumption were studied in detail.
- Demand for general and other consumer categories is calculated in detail, both for number of consumers as well as consumption per consumer.
- Demand projection is based on reasonable growth rates, both for number of consumers as well as consumption per consumer. Parameters are included to assure that growth in numbers of consumers is reasonable.
- In no case are econometric calculations used based on relevant explanatory variables.

The evaluation team considers that the methodology followed is both simple and satisfactory, and it might have been made simpler, reducing field time in favor of the experience of those carrying out the studies and increasing the sensitivity of the demand analysis.

The calculations in the economic benefits by residential users assumes that the price elasticity of demand is -0.5. As far as the evaluation team was able to see, this value is not supported by any econometric studies done in Bolivia. Nonetheless, the value appears adequate in that it is similar to that employed in other countries with similar projects. It may even be possible that the absolute value of the elasticity is even greater, given the relatively high tariffs and the low projected consumption, which would signify greater benefits from additional consumption by the consumer.

In spite of having explicitly considered the price elasticity mentioned above, in none of the analyses is the projected consumption diminished in conjunction with simulated increases in the tariffs. This methodological inconsistency should be corrected in future studies.

b. Mizque-Aiquile subproject

The following comments are based on a critical analysis of the prefeasibility study, on the meeting with the Technical Manager of ELFEC, and on direct observations at the subproject site on July 9, 1994.

General comments

The economic and financial study for this subproject was carried out by NRECA and contains the best analysis of all similar studies. The model used is the DAM, and all of the comments presented above apply in this case, including those which make reference to improvements in the DAM. This section will therefore not repeat those comments.

Least cost analysis

The prefeasibility study lacks a formal analysis of the least economic cost. It substitutes an engineering analysis in which a comparison is made only of the investment costs of the different alternatives, and includes qualitative comments on the relative advantages of the options compared.

The qualitative analysis of alternatives refers to (a) differences in coverage, (b) delays in beginning the subproject in reference to the central hydroelectric alternative, (c) differences in

reliability, and (d) the institutional advantage of linking the subproject to ELFEC and not to the Cooperativa Eléctrica de Sucre S.A. (CESSA) or the Cooperativa Rural de Electricidad (CRE). The first three differences are in economic benefit, while the fourth relates to administrative restrictions.

Since all of the qualitative differences favor the alternative which was selected, and since this is also the lowest investment cost, the evaluation team concludes that the subproject in effect constitutes the alternative with the lowest economic cost.

Cost benefit analysis

The cost benefit economic analysis shows an NPV (12%) of US$455,172 and an IRR of 16.51%. For these favorable economic indicators to occur, the following are required:

- Initially, connect 1,677 residential consumers with a combined initial consumption of 382,000 kWh/year, which represents 30.4% of the initial demand. After 20 years, the number of consumers should rise to 3,027 and their consumption to 1,411,272 kWh/year, representing 27.3% of the demand served.
- An initial connection of 350 productive users with a combined consumption of 517,764 kWh/year, which represents 41.1% of the initial demand. After 20 years, there should be 765 productive end users consuming 3,006,768 kWh/year, which represents 58.1% of the demand.
- An average tariff charge of US$0.113/kWh, 80% higher than the current ELFEC tariff of US$0.063/kWh.

From the favorable economic indicators and the principal suppositions regarding demand and tariffs on which they are based, the following conclusions can be drawn:

- There is a positive benefit margin of US$455,172 in today's dollars. This margin might increase by as much as US$200,000 as a result of lowered real investment costs. It is not possible to know the value of the actual investment costs, since the subproject has not yet finished connecting consumers.
- The economic viability of the subproject will depend on achieving the predicted demand, especially regarding productive uses of electricity, which are responsible for the greatest proportion of the quantified benefits.

The evaluation team concludes, by direct observation, that it is impossible to determine firm conclusions regarding demand. There are residential consumers outside the population centers which have not yet been connected and which did not have electricity before the project. The connection of these consumers and those with productive uses is about to be carried out.

c. Valles Cruceños subproject

The following comments are based on a critical analysis of the economic feasibility study, and are complemented by observations carried out in the field on July 10, 1994.

Least cost analysis

The feasibility study does not present a formal least cost analysis to demonstrate that the alternative selected represents the least economic cost option.

In spite of the above, and based on the design of the subproject and its particular characteristics, the evaluation team concludes that there is no reasonable doubt that the

subproject effectively meets the requirements of being of least total cost, for the following reasons:

- It achieves an efficient reduction of costs through economies of scale by requiring just one group of qualified operators during a 24-hour period, which would not be possible in the case of isolated generation.
- It uses natural gas, a relatively abundant resource in Bolivia with a lower opportunity cost relative to other fuel sources, such as diesel or gasoline.
- It is located near an existing gas line, which implies almost no associated costs for gas transport.
- It is located near the geographic center of electricity demand, which allows it to serve the demand through three primary lines with minimal conduction and with reasonable investment costs.
- It allows for service all along the primary lines, which promotes the incorporation of productive uses in rural areas. Several potable water pumps will be served by the subproject, permitting incremental energy benefits, lowered costs, and opening up productive resources.

Cost benefit analysis

Concerning the cost benefit analysis carried out, the evaluation team came to the following conclusions: (a) From a methodological point of view, it is based on economic efficiency prices, and it is adequate for the type of study required. (b) From a practical point of view, the assumptions are acceptable, and the adjustments made do not misrepresent the results obtained. The most important adjustments consist of the omission of the salvage values of equipment as well as the benefits obtained by freeing up resources. Both omissions make the subproject less atrractive, and if the subproject is a good one, it would appear even better without these omissions.

Two things in this study should be highlighted:

- It contains the explicit calculation of the average long term marginal cost. This indicator, which is of basic importance in the economic evaluation of electrification projects, is not adequately presented in the analyses presented by NRECA.
- There is the similarity between the average tariff employed (US$0.16/kWh), the calculation of the average long term marginal cost (US$0.1587/kWh), and the tariff finally approved by DINE (US$0.155/kWh). This leads to the conclusion that the study reflects reality regarding tariffs and the benefits associated with them.

The study concludes that the subproject has a positive net present value (NPV) of $416,000 in 1990 dollars expressed in economic efficiency prices and an internal rate of return (IRR) of 13.6%.

The study presents a sensitivity analysis of investment costs, reliability, and programmed rationing. All indicate that the subproject is acceptably robust.

The study allows one to conclude that the economic benefit of the subproject depends only on achieving the projected demand and on tariffs being maintained at the level now approved. These are therefore the indicators which CRE should monitor regularly with a view to

promoting the use of electricity and to assure that future decisions by DINE do not negatively affect the subproject.

d. Vinto subproject

The comments in this section are based on a critical analysis of the project feasibility study and on meetings held July 8, 1994 in Cochabamba, with Federico Maida of Agrocapital and with the Technical Manager of ELFEC, Ramiro Mendizábal, as well as in Quilacollo with Luis Mujica, Manager of the PRODEM branch.

This subproject, also known as the Densification Program, has the principal goal of increasing the economic and financial returns on an already existing rural distribution system. The subproject includes five activities: (a) installation of new connections, (b) change of connections from single to three-phase, (c) acquisition of new productive uses equipment, (d) an increase in consumption from existing productive uses without changing connection type or acquiring additional equipment, and (e) an increase in consumption by residential consumers.

The subproject began with a pilot project located on an ELFEC feeder to the west of the city of Cochabamba which extends from Vinto to Playa Ancha. ELFEC itself is in charge of the connections. The initial investment planned by NRECA amounted to US$200,000 of which US$100,000 were earmarked to support ELFEC in the construction of connections and the rest for a fund for credits at PRODEM.

The specific goal was to benefit the 200 consumers which were financially and economically most promising, based on a system of priorities established in the study carried out by NRECA. The most promising consumers were those which made productive uses of electricity and who usually required changes in connection from single phase to three-phase, or those who would be new consumers with three-phase connections.

According to the Technical Manager, ELFEC has carried out the 200 connections planned in the pilot project. However, instead of the 200 productive use connections, the connections actually include 192 new residential consumers and just eight with productive uses. Of these eight, just two were actually using electricity productively.

The investment costs were reduced due to the reduced cost of single phase connections. Because of this, NRECA's provided ELFEC with just US$35,000. At the same time, NRECA increased the funds destined for PRODEM by US$37,000 to defray operational costs.

Economic analysis

For the economic analysis, NRECA used a module of the DAM called PU CALC, which was designed to analyze productive uses of electricity. The results of the study indicate that the subproject possessed a financial benefit/cost ratio of 1.19 and an economic benefit/cost ratio of 1.05.

The methodological treatment of the economic analysis using the PU CALC module is correct. Two problems were identified in reviewing the study:

- For lack of reliable information, benefits from increased production and better quality were not included, and only benefits from reduced costs were included. This weighed against the subproject.

- In looking at existing consumers without the project, it was assumed that the opportunity cost of the non-electric machinery displaced by machinery acquired through the subproject would be equal to the cost of the new electric machinery. This is a bias in favor of the subproject.

In light of these two problems, it is not possible to conclude that the results of the study adequately represent the benefits which might be attributable to the subproject.

Financial analysis

There are no specific comments on the financial analysis of the subproject, which is not significant for the following reasons:

- It does not lead to a determination of tariffs, since it is not possible to use tariffs to discriminate between project beneficiaries and already existing consumers using the same electric system.
- The investment costs and incremental costs are low.

ELFEC actions

Since the consumers who were actually connected are not as promising as originally planned, it can be concluded that the pilot project is not fulfilling its expectations. As mentioned above, it was ELFEC's responsibility to carry out the connections. If one supposes that the 192 new residential connections should have been carried out by ELFEC even without the subproject, in the natural course of incorporating new consumers in the system, one might conclude that the pilot project has actually not yet begun. If this is not the case, one can only conclude that the subproject is not producing the expect results.

Credit activities

There has been less activity in the credit program than expected. To date, PRODEM has made just 90 loans to productive users. According to Eduardo Sánchez of NRECA, the low number of credits by PRODEM is due mainly to the policy of PRODEM to make loans only to solidarity groups.

Insufficient credit is a real problem. One reason is the PRODEM restriction which allows for loans only to solidarity groups, which lowers the demand for credit, since not all those seeking credit are able to form part of a group. In addition, according to Mujica, PRODEM's promotion activities are being carried out only in communities where the formation of solidarity groups is known to be fairly easy. This points to a problem of insufficient promotion.

The number of loans made by private financial entities is also low, possibly due to the high interest rates charged, which are 18% per year based on the dollar value. Another reason may be the collateral in land assets which these entities require. In any case, it can be concluded that the pilot project is not receiving the planned support in the area of credit.

e. Capinota subproject

The following comments are based on a critical analysis of the prefeasibility study and on conversations held July 8, 1994, in Cochabamba with the Technical Manager of ELFEC, Ramiro Mendizábal.

The community of Capinota has had electricity since 1972, provided by a cooperative (Cooperativa de Servicios Eléctricos de Capinota). The source of energy is a 4.5 MVA substation which belongs to the the cement firm, Cooperativa Boliviana de Cemento - COBOCE, which will no longer be able to provide electricity due to its own increased demands. The Capinota 6.0 kV primary grid is in a deteriorated state, and present service has high voltage regulation and low reliability.

The subproject includes: (a) the construction of a new 3.5 MVA substation, 115/24.9 kV, located in Irpa Irpa near the COBOCE substation; (b) the rehabilitation of the existing primary grid, adapting it to the new voltage; and (c) the construction of a low tension distribution system. The demand is composed of the population centers of Capinota, Irpa Irpa, and Buen Retiro; the communities now electrified between Irpa Irpa and Yatamocko; the communities already electrified between Buen Retiro and Parotani; and the industrial demand of COBOCE.

The implementor and owner of the subproject is ELFEC. The institutional viability of the subproject requires the dissolution of the cooperative, which has not yet taken place. Materials have been purchased and construction contracts signed. ELFEC has not yet solicited tariff approval from DINE.

Least cost analysis

The study does not contain a formal least cost analysis but rather an engineering analysis in which three alternatives are considered: (a) energy provided from the COBOCE substation, rejected for institutional reasons; (b) rehabilitation of the ELFEC feeder between Quillacollo and Capinota, rejected because of problems of reliability and voltage regulation; and (c) the subproject described above.

The evaluation team supports the decision to implement the subproject. It also feels that in the future, the presentation of a formal least cost analysis clearly demonstrating that the alternative selected involves least total economic cost, should not be omitted.

Cost benefit analysis

Methodologically, the analysis commented here is identical to that used by NRECA for the Mizque-Aiquile subproject, and the comments presented above for that subproject apply here as well. When the prefeasibility study was carried out, it was not certain that the COBOCE demand would be included, which was about 1.5 MW. This demand has now definitely been included, which significantly improves the economic and financial viability of the subproject.

C. Project financial viability and sustainability

1. General comments

In general terms, rural electrification projects often lack financial viability due to their high investment costs and relatively low consumption, which produces income insufficient for the recuperation of the total investment plus operating costs, as well as being profitable. This problem was noted by NRECA in its first semi-annual reports.

The analysis presented in this section on the financial viability of the subprojects is based on the agreements signed between NRECA and its counterparts, and which in every case takes into account the criterium that income should be sufficient to cover operating costs and to

recuperate the NRECA investment. In addition to income from tariffs, there may be other sources of income, such as government subsidies or other donations which do not necessarily require repayment and which may, in this case, be considered as part of funds to cover losses.

2. *Comments on specific projects*

a. Mizque-Aiquile subproject

Tariff level

According to the ELFEC Technical Manager, the average tariff approved by DINE and used by ELFEC is US$0.11/kWh, very close to the tariff of US$0.13 which the prefeasibility study considered as adequate to achieve the financial viability of the subproject. The evaluation team did not review the calculations made for the average tariff. It is hoped that the tariff calculations depended closely on the approved tariffs for the general and small industry categories and thus on the number of consumers with productive uses who participate in the subproject. Since the composition of consumers by tariff categories is still unknown, it is not possible to make any further judgements on the expected value of the average tariffs approved by DINE.

Tariff structure

The approved tariff structure is similar to that used at present for Cochabamba and possesses the same general characteristics as the structure of the Valles Cruceños subproject commented below. The marginal tariff for the energy block between 21 and 120 kWh/month is US$0.096/kWh for the residential category and US$0.144/kWh for the general category. There is a straight tariff for public lighting of US$0.119/kWh, while the industrial category has a demand tariff of US$50.673/kW plus a consumption tariff of US$0.077/kWh.

Tariff adequacy

To date there are insufficient reliable data for the presentation of a complete tariff analysis. The commentaries below are based on the prefeasibility study and on the supposition that the average tariff will in fact be US$0.11/kWh.

- If the demand projected in the prefeasibility study occurs, the subproject will be financially self-sufficient, although with no added margin. The study estimated a financial NPV, discounted at 12%, of just US$74,798 based on an average tariff of US$0.113/kWh, just slightly above the existing tariff.
- The prefeasibility study financial analysis takes into account the entire cost of construction (US$1,413,116) and not just the funds provided by NRECA (US$900,000). It is therefore possible that over the long term, there would be no problem in recuperating the NRECA investment.
- Regardless of whether the total investment or just the NRECA investment is considered, the subproject will have losses during the first few years. Depending on the growth of demand and the maintenance of the established tariffs, the subproject could produce a positive balance in about the year 2003.

b. Valles Cruceños subproject

Tariff level

The subproject feasibility study estimated that the Average Long Term Incremental Cost would be US$0.159/kWH. Based on that study's data, CRE carried out a tariff analysis and developed a tariff approval application for US$0.165/kWH, which was presented to DINE in March, 1994 .

DINE replied with an initial average tariff of US$0.1115/kWh. After a CRE presentation illustrating CRE's reasoning to DINE, the latter agreed to authorize an average tariff of US$0.155/kWH.

It is worth highlighting the CRE's success in achieving a tariff schedule which is clearly favorable to the subproject, since it constitutes a positive precedent for other NRECA subprojects in Bolivia. CRE's success is due in particular to the following considerations:

- the fact that the subproject beneficiary communities had been paying a tariff substantially higher than the tariff CRE was asking for; and
- the dynamic and timely CRE presentation, supported by enough studies to adequately support CRE's viewpoint with DINE.

Tariff structure

The approved tariff structure is similar to that in effect among other electricity distribution utilities and possesses the following general characteristics:

- It distinguishes among the residential, general, small industry, large industry, and public lighting categories.
- It includes minimum charges and energy tariffs for consumption above base consumption.
- In the large industry category, there is one tariff for demand and another for energy.

Based on the approved tariff levels and on studies carried out in other countries , it is possible that there will be changes among consumers between categories, eventually leading to a poor distribution of resources. CRE's General Manager states that it is Bolivian government policy to progressively diminish these changes, eventually approving tariffs which more closely correspond to the costs of service.

Tariff adequacy

The financial studies carried out by CRE indicate that:

- With a tariff including taxes of US$0.165/kWh during 1995, income will be US$185,049 less than costs. Income includes sales of energy and the subsidy from CORDECRUZ. Costs include operation, financial, and depreciation costs over all assets. By 1998, income will overtake costs through growth in the number of consumers and in per unit growth. By 2001, the overall accumulated situation will be positive.
- With a tariff of US$0.15/kWh, it will take an additional two years to achieve a positive situation.
- The subproject will produce income sufficient to cover operating costs and to repay the NRECA investment. Thus, the Special Investment Fund described in the

Financial Cooperation and Technical Assistance Agreement will have sufficient resources to be managed as planned.

Although the financial self-sufficiency discussed here can only be confirmed later, at least one year after subproject operations begin, there are other indicators which permit a preview. The demand at the generation station has already exceeded the amount projected in the feasibility study, and an industrial client has already been connected with a demand of 250 kW.

c. Vinto subproject

The pilot project was designed with the supposition that all costs other than connections or necessary modifications to the distribution system would be charged to the consumers. Because of this, the financial viability for ELFEC requires only that income from the subproject be sufficient to cover variable costs plus its marginal costs from consumers.

The pilot project without doubt is financially viable for ELFEC, since the cost of block energy is between US$0.04 and US$0.045/kWh and the average tariff to consumers is about US$0.08/kWh. In this situation, each additional consumer represents an improvement for ELFEC, although it would be even better if they were productive users.

Looking at the NRECA funds destined for credit, there is also no doubt about the financial viability of the pilot project, since they create a revolving fund, and the loans made with this fund produce higher financial returns than the interest rate which they would produce. The evaluation team therefore concludes that there is no reasonable doubt concerning the financial viability of the pilot project.

d. Capinota subproject

The inclusion of the COBOCE demand, as mentioned above, dramatically improves the financial viability of the subproject. The prefeasibility study does not conform exactly to the final design of the subproject, but it does present a very similar case, which consists of the subproject plus the demand of the blocks called D, E, and G, which were not to be profitable from the financial point of view. Obviously, this case is less desirable than the actual subproject. Since it includes the COBOCE demand, the case commented on here does not require the 40% tariff increase in relation to that of Cochabamba, as initially recommended by NRECA, but rather an increase of just 20%.

Since ELFEC has yet to present its application for tariff approval to DINE, it is recommended that a tariff study be carried out as soon as possible. The financial viability of the subproject will be confirmed through this study. However, with the information available at this time, and with the confirmed additional COBOCE demand, it is already possible to state that there is no doubt that the subproject will be financially viable.

D. Rural Electrification Finance Corporation (EFER)

1. Historical conception of EFER

Rural electrification programs in Bolivia have in general been financed through donations. The donations have been destined specifically to support utilities, to construct projects, and to provide technical assistance. There have never been resources sufficient to implement a

system of self-sufficiency with financial, technical, and supervision support for rural electrification.

According the project logical framework, the purpose of the project is to provide efficient, accessible, and sustainable rural electric service. To make this possible, it is necessary to include initiatives which will make self-sustainability possible for rural electrification after the project has been completed. For this reason, NRECA has placed considerable importance on the creation of a financial institution, called the Rural Electrification Finance Corporation (Empresa Financiera de Electrificación Rural - EFER), modeled after the National Rural Utilities Financing Corporation in the United States. The purpose of this entity would be to obtain funds for rural electrification projects from national or international loan agencies and to provide the technical support required for the continued development of both cooperatives and private utilities.

In March, 1992, a prefeasibility study concluded that such a corporation would be viable only if there were a sufficient number of commercially attractive projects, plus great interest among the utilities qualified to receive loans. Because of the unencouraging findings of the study, the concept of EFER was modified to both public sector and commercial capital, as a public fund supported in part by the taxes consumers pay as part of their monthly electric bills.

NRECA adopted the position that the government should promote the development of rural electrification by the private sector and through funds destined to finance rural electrification projects. In principle, the Ministry of Energy and Hydrocarbons accepted this position.

At the present time, the executive branch of the government is preparing a bill, called the Electricity Law, and hopes to get the bill through the Congress this coming August. This Law will constitute the basis for the regulation and development of the Bolivian electricity sector and will define important aspects concerning the organization and development of rural electric systems.

2. *The Electricity Law*

The government has been carrying out a process of discussion and promotion in favor of the Electricity Law which it hopes will lead to its rapid passage in the Congress. The modernization planned for the electric sector seems to indicate that the Law has a good chance of being passed.

The political process mentioned above has included radical changes in the proposals as regards rural electrification. The present proposal, which appears to have a high level of acceptance, according to NRECA, includes the following:

- The promotion of rural electrification co-financed with the private sector, using resources from the National Fund for Regional Development (Fondo Nacional de Desarrollo Regional - FNDR), from the Regional Development Corporations, from Municipalities, and from Territorial Base Organizations.
- The authorization of the FNDR, the Corporations, the Municipalities, and the Territorial Base Organizations to contract with private investors for the implementation of projects.
- The authorization of the FNDR, along with the private sector, to establish norms for the evaluation of rural electrification projects for the co-financing in

coordination with the National Electricity Superintendency (Superintendencia Nacional de Electricidad - SNE).

- Prohibit the FNDR from studying projects other than those proposed by the Territorial Base Organizations, the Municipalities, and the Corporations.
- Obligate the Corporations to earmark at least 5% of their annual investment budget to finance rural electrification grid projects, low output systems, renewable energy, and programs to improve the efficiency of existing systems.
- The regulation and control of utilities which provide rural electrification by SNE.

3. *Situation analysis*

The commentaries presented below are based on the Electricity Law bill described in the previous section. First, it is notable that the Electricity Law bill does not run counter to the basic principles laid out by NRECA for EFER. On the contrary, the authorizations planned for FNDR make possible co-financing without the existence of a fund with public contributions in EFER, which is like the original NRECA initiative. This modification has clear institutional and fiscal advantages which make it highly recommendable.

Second, it is important to recognize that the formal development of the rural electricity sector in Bolivia is in its early stages. As the EFER prefeasibility study showed, there are few utilities and cooperatives which possess sufficient long-term rural electrification planning capability. This has important implications regarding the mission and sizing of EFER.

The mission of EFER should be to act as a guide regarding the development of criteria for rural electrification. EFER must constitute a qualified counterpart to decide with FNDR, how projects should be evaluated and the initiatives to be incorporated in the operational aspects of the Electricity Law. The creation of EFER should not be delayed, since this would considerably diminish its opportunity to assume a leadership as referred to in the preceding paragraph.

Third, because of the incipient development of the Bolivian rural electrification sector, EFER should not be any larger than absolutely necessary to carry out its functions, taking into account that it would be starting out in a dynamic environment which will include important institutional changes.

This recommendation concerning its size will have important consequences concerning EFER's functions, especially during its initial period of functioning:

- First, the regulatory functions assigned to SNE will allow EFER to avoid the planned advisory functions to DINE.
- Second, EFER could avoid exercising its technical assistance functions regarding standard rural electrification grid projects, in order to dedicate its energies to promoting projects involving modern technology which possess high resource potential, such as those involving renewable energy or energy conservation.

It is questionable whether the very existence of EFER depends on initially ambitious objectives which are beyond its capability of implementation.

Finally, the Bolivian electric sector lacks a private or mixed economy bank dedicated to the energy sector. Should this be modified, it could have a positive impact on EFER.

The strengthening and economic development of the energy sector will depend on the eventual existence of such a bank. A good example of this is the Colombian bank, which was initially oriented just toward the electric sector through the National Electric Financing (NEF) entity but which now has expanded to include the entire energy sector. The reform of the Colombian electric sector has been supported by the development possibilities which the NEF provides. The institutional development and economic efficiency of distribution utilities have been clearly strengthened by the NEF .

The analyses necessary to develop such a bank would allow for the following:

- Eliminate the banking functions from EFER and achieve savings in costs through fewer personnel and other banking requirements.
- Manage the contributions of FNDR, the Corporations, the Municipalities, and the Territorial Base Organizations using private management criteria. This would allow for the benefits which accompany the timely availability of resources and which are not subject to the tedious budget and treasury processes.
- Participate in the growing Bolivian monetary market in attracting and placing resources with the benefits of financial profit and new sources of income.

E. Beneficiary Assessments

1. *Relation to logical framework*

The Beneficiary Assessments contribute to the Project Outputs through the following Objectively Verifiable Indicators (Logical Framework, 1994):

- 6.14 studies of user perspectives using participant observation by year three of project

These outputs contribute to the part of the Project Purpose which refers to provision of customer-oriented rural electrification, along with loans for connections, information for electricity users, and customer services departments of utilities.

2. *Description and analysis of Beneficiary Assessments*

The ESD Project carried out beneficiary assessments (BA) in four project areas (Mizque-Aiquile, Valles Cruceños, Bermejo, and rural areas of the Department of La Paz) to collect information from beneficiaries on the impending electrification. The reason for the BAs was to maximize the socioeconomic impact of the subprojects by consulting beneficiaries on issues related to use, costs, and benefits of electricity as well as delivery of electricity service. The information obtained should have implications for project design and for rural electrification counterparts, such as ELFEC and CRE, to provide them with a profile of the beneficiaries regarding electrification.

The first BA was based on NRECA's participation in a group known as the Beneficiary Assessment in the Power Sector (BAPS) comprised of the World Bank, the ODA, the DGIS (Dutch bilateral assistance), and NRECA. The group wanted to apply the BA methodology which has been developed by the World Bank ("Listen to the People," Larry Salmen, World Bank), based on the experience in the World Bank and on that of other well-known anthropologists, to rural electrification projects. It is unusual for infrastructure projects to apply this sort of anthropological method, since they are analyzed and implemented by

economists and engineers, not social scientists. NRECA will be publishing a revised version of the MA study in a synthesis edited by the World Bank.

The BAs utilized a methodology, not hitherto used in rural electrification, which was based on the premise that "the efficiency and success of development projects can be enhanced by including the intended beneficiary of development projects in the design and implementation of the projects" (Mizque-Aiquile BA, p. 1). This methodology was that of participant-observation, well known to anthropology where it was developed, with the premise that residence in a community for an extended period of time would allow researchers to come to a broad understanding of the orientations, prejudices, and outlook of the members of the community regarding the use and benefits or disadvantages of electricity, new connections, costof service, billing and collection, technical aspects of service, and customer relations with the utility.

The first NRECA BA was carried out in MA. An expert in the method planned the operation and trained the field researchers in the technique, but did not himself participate in the field work. Field work was carried out by two experienced researchers in each of four communities, including Mizque and Aiquile as well in two smaller communities: Vacas, which had limited electricity before the MA project, and Quiroga, which did not. The eight researchers produced reports of 164 conversations, 24 semi-structured interviews, 21 cases of participant observation, seven case studies, 15 focus groups, and 24 other contact situations. The researchers were well trained and produced a high-quality report. The same researchers later carried out a two-week BA of Valles Cruceños.

The findings of the BAs were presented to ELFEC concerning MA and to CRE concerning VC. The principal findings included:

- Potential users want and need information regarding policies and procedures for new connections, the cost of electricity and the cost of connection.
- Potential users wanted to know the scope of electrification and when it would be available.
- Potential users expressed opinions which might be of use in designing or modifying the billing and collection process.
- Potential users expresed concerns about the technical aspects of service.

The findings were well-received by the majority of the personnel of the two utilities, although the ELFEC Technical Manager did not feel that the BA presented much in the way of new important information. The evaluation team feels that the studies do present valuable information both for NRECA in its relationship with the two utilities as well as for the complementary subprojects dealing with productive uses.

The amount of time required to complete an adequate BA using participant observation methods may vary from one site to another, based on local conditions and the nature of the project to be carried out. The evaluation team feels that six weeks may have been an excessive amount of time to spend on the BA in MA, especially considering the fact that it will be a one-time effort. The evaluation team is of the opinion that a series of three two-week studies would have been preferable, for the following reasons:

a) Beneficiary involvement. In relation to the process of electrification and the taking advantage of its benefits, the study is just one "photograph" of the process taken before the

MA electrification was completed. It does provide an idea of the expectations of the communities regarding electrification, but it does not show how they will be consciously brought into the process, and there are other moments at which a similar "photograph" might be taken to complement the pre-electrification one.

For example, the evaluation team arrived in Aiquile and met with municipal authorities, who were anxious to express a series of doubts and misunderstandings. For example, how was it that ELFEC charged all users an additional 12% for street lights but only certain streets were lighted? why was the tariff higher in Aiquile than in Cochabamba? why was electrification extended to the south as far as Quiroga but not to the east to cover houses within the boundaries of Aiquile?

NRECA has carried out an information campaign in the MA area to counter the lack of correct information concerning the electrification, but based on the questions put to the evaluation team in Aiquile, this campaign has not achieved the expected results.

It seems that instead of taking one long pre-electrification "photograph" (six weeks), NRECA should have taken three photos at different stages of two weeks each. The first would have been taken when the actual BA was carried out, the second at the present time to learn of the problems in adjusting to the new electrification, and the third once electrification was complete and the productive uses stores and Agrocapital had begun to function, about the middle of 1995.

b) Study cost. The suggested change in study strategy would not involve much in the way of additional costs, since it does not contemplate any more costly expert advice than the BA. An expert would be hired for the same amount of time to quickly learn about the area and to train the field researchers. The field researchers could spend the same six weeks in the field but divided into three segments: pre-electrification, immediate post-electrification, and six-nine months later when the productive use infrastructure (store, credit, etc.) had begun functioning well.

This criticism of the length of time used in the MA study does not mean that six weeks or even longer of continuous residence might not be required in a BA. Complex or conflictive situations such as that described for CORELPAZ might well require more time, where the participant observation methodology would be perhaps the only effective one.

In conclusion, the evaluation team concludes that while the BAs carried out may be a valuable contribution to project success, a reorientation toward shorter and repeated field work researcher would provide better results. In this way, it would be possible to chart the trends of public opinion at different stages of the project and therefore to design improved publicity campaigns.

F. Promotion of Productive Uses

1. *Relation to logical framework*

The Mizque-Aiquile, Valles Cruceños, and Vinto productive uses promotion subprojects form part of NRECA's Category I, RE Economic Development Projects. They and other similar subprojects will contribute to the Project Purpose through the following Objectively Verifiable Indicators (Logical Framework, 1994):

- 2,000 new PU connections in utilities with PU programs (EOP)

- 2.4 MWh increase in energy sales for PU/year in utilities w/PU programs (EOP)
- New department or staff responsible for customer service in utilities w/PU programs (EOP)

The productive uses promotion subprojects contribute to the Project Outputs through the following Objectively Verifiable Indicators (Logical Framework, 1994):

- 5 PU programs established by year 3 of project

2. *Overview of productive uses promotion*

The promotion of the productive use of electricity is one of the main foci of this Project, as it is in NRECA projects in other parts of the world. The promotion of productive uses is motivated by two key reasons, one financial and related to the strength and ability of the electric utility to survive and grow, and the other economic and related to improved income and employment among rural people.

Regarding the utility, rural electrification is expensive and does not produce attractive financial returns. Even if generation is not a problem, the construction of a rural distribution system requires a heavy investment in thousands of poles, hundreds of kilometers of wire, and substantial quantities of all of the accompanying distribution hardware. At the same time, the return on this investment is relatively small, at least at the beginning. The 182 km MA distribution system will reach only 2600 customers by the end of 1994, while an urban system might reach the same number of customers in a large neighborhood in a city. The small number of paying customers reached by rural electrification means that the utility will have a difficult time in recuperating just the operations and maintenance costs of the rural system, much less the original capital investment costs.

The productive uses of electricity can help offset utility costs by boosting the amount of electricity used--and paid for--by rural customers. If the rural customer purchases and runs a hefty amount of electrical equipment, he or she will use more electricity and thus pay for more electricity. If the customer uses electricity only for evening lighting using a few light bulbs, the customer will pay little for electricity and the utility will there gain a minimum amount on its investment. The promotion of productive uses is thus oriented in part toward stimulating increased electricity use because of its positive effect on the utility.

For customers in rural Bolivia, however, one of the poorest countries in the hemisphere, to purchase electric machinery and to pay for high electric bills stemming from running that machinery, the machinery must contribute to some economic activity which brings the customer more income than he or she is paying out in higher electric bills.

The promotion of productive uses of electrification thus represents the possibility of both a positive financial gain for the utility as well as a positive economic gain for the customer. Ideally, electric utilities serving rural areas should develop productive uses campaigns in their own self-interest, and as will be shown below, the CRE utility of Santa Cruz is doing so, stimulated by NRECA. International assistance missions, such as USAID, are also interested in productive uses promotion, because it represents an important element in increasing rural income and employment, and helping to stem rural to urban migration.

Productive uses promotion utilizes several strategies. First, it requires purely promotional activities, such as radio spots, local television programs, pamphlets, and meetings with potential beneficiary groups, activities carried out by NRECA in MA and by CRE/NRECA in

VC. Second, it requires the existence of a source of electricity-driven machines, both household appliances and electric motors. The MA subproject has helped establish an electric goods store in Aiquile for this purpose, while CRE has established its store in Mairana. Third, potential buyers require a source of credit to be able to purchase electric machinery on time. The MA subproject has established a relationship with the Agrocapital for this purpose, CRE will provide credit through its store selling electric appliances and equipment purchase with NRECA funds, and the Vinto area is being served by PRODEM.

Detailed analysis of these subprojects is present below.

3. *Mizque-Aiquile (MA)*

The MA grid extension subproject provides electricity from ELFEC in Cochabamba to the towns of Mizque and then Aiquile in the area known as the Valles Altos ("High Valleys") of the department of Cochabamba, as well as to the communities between Cochabamba and Mizque, between Mizque and Aiquile, and some 30 km beyond Aiquile on the road to Sucre. At the time of the evaluation, electricity had arrived at the towns of Mizque and Aiquile but not the surrounding communities, which are expected to receive electricity by the end of 1994. The number of connections at that time should more than double the present number of connections.

The productive uses promotion program in MA is based on two entities: a private sector electrical goods supply store, Agentes Generales S.A. (AGSA) and an NGO to supply loans for productive uses, Agrocapital. The AGSA store is located in Aiquile and is run by a Mr. González beginning two months ago. González at present sells only items provided by AGSA, which consist of water pumps, motors, air compressors, electric arc welding machines, and auto mechanic equipment.

The single phase water pumps include manual ($60) and automatic ($118) types, are capable of pumping water 40 meters up, and are expected to be used especially to irrigate vegetable plots. The single motors are expected to be used by carpenters and guitar and charango makers and the three-phase motors for mills. It should be noted that there are 42 charango shops in Aiquile, and instruments made in Aiquile regularly win national contests for best instrument. Air compressors and arc welding machinery are needed for vehicle mechanics and other uses.

The electric machinery on sale in Aiquile is considerably cheaper in comparison with diesel equivalents, which González also sells. A 15 horse-power diesel motor costs US$ 1,900 while a similar electric motor costs $314. In addition, maintenance costs for diesel motors are much higher than electric motors. Another advantage of electric motors for irrigation is that they can be installed underground inside the well, making them nearly impossible to steal or damage.

González has made just a few sales for cash since beginning the store, including two automatic water pumps and one manual water pump. He stated that has made no credit sales because Agrocapital has not yet established a locale in Aiquile, although it has inquired about renting one. Federico Maida of Agrocapital stated that it does not plan to intensify operations in Mizque and Aiquile until the surrounding communities have been connected, which means some time before the end of 1994.

Agrocapital has begun operations in Mizque on a small scale, although it expects to increase operations considerably once electrification is complete. It has provided seven loans in Mizque: four television sets (an understandable purchase during the World Cup), two freezers, and one water pump.

The case of the pump requires further comment. First, Agrocapital will make a personal loan of up to $300 which requires the borrower to demonstrate that he or she is a good credit risk, but no collateral is required, which was the case of all loans but that of the water pump. Second, if collateral is required, it must be in the form of land, not the article purchased, and the borrower must demonstrate that he or she is owner of the land. Third, Agrocapital is not interested in lending money for a pump if the borrower cannot install it, and in this case, Agrocapital has loaned enough money to pay for not only the pump but also the drilling of the well. This is important, for while some borrowers with lands close to a river will require only the pump, many others will require the drilling of the well in addition to the pump.

NRECA has signed a US$300,000 contract with Agrocapital for the MA loan program, with US$250,000 destined to loan portfolio to be administered as a revolving fund, and US$50,000 for set-up and operations costs. The contract permits them to grant relatively large loans, but also obligates them to provide at least 150 loans by the end of the ESD project in July, 1996. The loan for the water pump and well drilling was $10,100.

González in Aiquile has indicated that there is high interest in his merchandise, particularly from those outside Aiquile who have not yet been connected. They regularly visit his store in Aiquile to ask about electric products, but they understandably cannot make concrete decisions concerning purchases until (1) they have received electrical connection and (2) Agrocapital establishes operations in Aiquile. At the time of this evaluation, the prospects appear promising for productive uses in MA, but hard evidence will not be available for another year.

4. *Valles Cruceños (VC)*

The VC isolated generation subproject carried out between NRECA and CRE established generation in Mataral in the VC, about equidistant between Comarapa and Samaipata, with the purpose of providing electricity for these valleys, for Valle Grande some 60 km away to the south, and for end user groups along these lines. The project was inaugurated only recently (February, 1994). The NRECA ESD project provided the generator sets for the subproject, while CRE provided the distribution lines.

The productive uses subproject established in conjunction with the VC generation subproject will be carried out directly by CRE. CRE has opened a electric machinery and appliances store in Mairana. To do so, it purchased and renovated a piece of property on the town plaza at a cost to CRE of about $70,000, and stocked it with merchandise on consignment from various suppliers, including AGSA, the supplier for the Aiquile store. Yearly operations of the store are expected to be about $47,000.

The store has only been open for a month and a half, as CRE only began working on the store concept at the beginning of 1994. NRECA funds have not been used so far but $100,000 will be available shortly for loans to cooperative members. According to Jaime Solares, Head of the Productive Uses Department at CRE, the policy of the CRE store will be to sell only to CRE members, although this policy is almost unnecessary, since there will be very few, if

any, individuals with electricity anywhere near the store who do not have CRE electricity and are therefore not CRE cooperative members.

CRE has identified three main problems with the store at this point in time. First, it appears obvious that one store to serve the entire VC area is insufficient. The CRE productive uses coordinator estimates that two additional stores will eventually be necessary, one in Valle Grande and one in Saipina, but CRE will await the results of the Mairana store before opening additional stores. In the meantime, CRE has begun to utilize local fairs to offer its goods to supplement the Mairana store.

Second, the opening of the store has produced a series of internal administration problems in CRE. For example, the CRE purchasing department carries out all purchase for the cooperative, which in one way or another are all oriented toward improving and maintaining electric service. The purchase or acquisition of merchandise for the store, however, is fundamentally different, since it is intended for resale. Also, the CRE store must logically provide a guarantee for its products, something which is an alien concept for the normal CRE operations. Nonetheless, it seems probable that this sort of problem will eventually be resolved, although it may take some time and slow the store development.

The third problem involves communication. The CRE store, like any other retail outlet, needs to advertise its existence and the merchandise it sells. Equally important, it needs to demonstrate the advantages of its electric machinery to potential buyers. To do so, CRE is planning to establish demonstration sites in key locations with local farmers, for example, to show off the advantages of electric water pumps.

In addition, it expects to use radio and local television. Bolivia has a system of local television stations as well as radio for even small towns. In Mairana, for example, the evaluation team observed a funeral in progress and then witnessed a television announcement of the death of a local woman at the CRE store in Mairana. Obviously, both local radio and local television should be used by CRE to communicate its products in the area.

CRE also plans to work through the Association of Small Industries (Asociación de Industrias Pequeñas - ADEPI), which is an NGO umbrella organizations for small producers such as shoemakers, tailors, metal shops, bakeries, and more than 100 other activities. CRE's strategy will be to provide ADEPI with information on available machinery while CRE provides technical assistance to its members on how to use it.

5. *Vinto*

Vinto is an area located relatively close to the departmental capital of Cochabamba where ELFEC and NRECA carried out a densification or back-fill operation to increase the number of customers in an area which was already electrified. This operation would have the effect of increasing the number of ELFEC paying customers with comparatively little investment, which was US$26,000 from NRECA and US$6,000 from ELFEC to connect 200 new customers to the existing grid.

Productive uses promotion for Vinto did not involved establishing a store, due to the nearness of Cochabamba and the town of Quillacollo, both good sources of electric motors and home appliances. While a large number of productive uses were identified in the area, most of the connections were domestic. One productive use, visited by the evaluation team, which showed promise was the conversion of vehicle motors to electric ones for the processing of

lime and chalk. While two loans have been made to this group, traditional practice and the existence of vehicle motors has meant that few conversions have been made.

The credit entity in charge of providing loans for Vinto is the Foundation for the Promotion and Development of Microenterprise, PRODEM, an NGO which has been so successful in its micro-lending operations that it was able to form a for-profit commercial bank, Banco Solidario - BANCOSOL, to access commercial capital for the expansion of its operations. PRODEM has been promoting loans for productive uses in Vinto, often combining non-NRECA funds with funds from other sources for loan customers requiring both electric machinery and funds for complementary activities. About 90 loans have been granted so far.

6. Discussion

Both the MA and CV productive use stores appear promising, but any evaluation of real impact will have to await the final evaluation. Still, some observations can be made:

- Of the two subprojects, CRE's appears the strongest, mostly because it is a unitary operation: CRE itself provides the credits, sells the machinery, and eventually reaps the benefits of increased energy consumption.
- The CRE store has already been able to stock merchandise from several sources, and the present stock includes all types of electric appliances as well as motors and pumps, while the AGSA store in Aiquile contains only motors and pumps and not home appliances. González believed that he would have to enter into a separate relationship with another supplier for home appliances.
- González himself cannot provide credit through the AGSA store, but must send potential clients to the Agrocapital office (still not installed) for credit, or to other credit sources in the area.
- It is unclear as to exactly who would eventually provide the communication services in MA which CRE will provide in CV. Aiquile has a local radio and television system, but it is uncertain as to whether the AGSA store or Agrocapital would develop and pay for radio and television spots for the area.
- The store-credit operations in MA will require considerable communication between Agrocapital and AGSA for them to be successful.

The apparent advantages of the CRE situation do not imply that the MA productive uses subproject will not succeed. In fact, the MA situation is one which rural electrification projects will encounter most often, both in Bolivia and elsewhere, and they do function elsewhere, such as in Guatemala. These remarks are intended to point out areas which need attention by the NRECA productive uses subproject in MA.

7. Potential for increased income and employment

The evaluation team was able to observe that in VC, considerable river bottom land was already irrigated, usually using diesel, gasoline, or natural gas-driven pumps, although there were a few gravity-fed systems as well. Electric pumps cost one-half to one-third that of other pumps, so installing an electric pump represents an income savings for farmers. Electric pumps also require less maintenance than other pumps, again a savings, and electric pumps are cheaper to run than gasoline or diesel pumps, but more costly than natural gas.

An increase in income from the ESD Project in MA and CV would appear to derive primarily where pumps are installed where they did not exist before. In VC, irrigated land is reported to be four to five times more valuable than non-irrigated land. Irrigated crops produce up to three times more than non-irrigated crops, even during the rainy summer months (September-February). Farmers can produce 20 metric tons of tomatoes per hectare worth B.16,667 on irrigated land compared with just six metric tons worth B.5,000 on non-irrigated land. Similarly, a farmer can produce 8-12 metric tons of corn per hectare on irrigated land as opposed to just three metric tons on non-irrigated land. During the dry winter months (March-August), of course, non-irrigated land produces nothing while irrigated land continues to produce. The increase in income from irrigation is thus obvious. Agricultural employment also increases with irrigation, since a farmer requires three times as much labor to harvest 20 metric tons of tomatoes as he needs for six metric tones.

For the ESD Project to document dramatic increases in income and employment, it will need to identify cases where new land is brought under irrigation using electric pumps. A case in point is the individual in Mizque who recently purchased not only the pump but also the drilling of the well, a clear case of newly irrigated land. It is probable that there will be numerous similar cases once the final connections are made and Agrocapital begins operations in earnest in MA.

VI. Project Administration

A. Project history

USAID and NRECA began working in rural electrification during the 1970s in two phases of project effort with NRECA carrying out the preliminary studies but not implementation. In Phase I, $11.8 million in USAID funds was expended for generation and distribution in Santa Cruz and Cochabamba. Phase II expended $9.5 million in USAID funds and covered projects in Chuquisuca, Potosi, Tarija, and La Paz. Lessons learned from the 1970's projects were that line construction in Bolivia was difficult and expensive, local construction materials such as poles were scarce, and local professional capacity was less than expected.

In 1989 and 1990, NRECA teams visited Bolivia through an AID buy-in to the NRECA core grant to assess conditions in the rural electrification subsector and subsequently a workshop was hosted by NRECA in La Paz to discuss the results. The workshop was attended by representatives of the Bolivian electric power distributing entities as well as government and development agency officials. Among the principal problems identified were inadequate tariffs, lack of technical and managerial skills, lack of productive uses of electricity, lack of construction standards, and a scarcity of financing for connections and system improvements.

The present project is one of the outcomes of the NRECA groundwork in 1989-90. In May of 1991, NRECA produced a PID-like proposal and in June produced a Project Paper-like document, leading to the signing of the project in July of 1991. From this time until a revised Project Paper was completed, NRECA and AID operated under a Collaborative Assistance Mode, which allowed NRECA to continue refining project design while initiating certain implementation steps. As of the approval of the revised Project Paper in February, 1993, the AID-NRECA relationship has been a Cooperative Agreement. Project completion date is still July, 1996.

As regards modifications in project design, ESD has been modified in the sense that subprojects involving renewable energy, particularly solar energy, have grown from what was originally a minor role to a much more substantial one at present. This was done not by reallocating original project funds but rather through two funding add-ons, US$1.7 million from the LAC bureau and US$2.5 million from USAID/Washington accounted for as part of the Global Environmental Fund. ESD now has nine renewable energy projects in progress, but since they had begun relatively recently, NRECA decided not to include them as part of the present mid-term evaluation but rather evaluate them separately at some time in 1995.

B. Relation of project to other USAID projects

1. Overview

Successful development strategies should develop links and coordination among projects. As an example, a project aimed at promoting new export crops in isolated areas must be coordinated with other projects which provide the necessary credit for crop inputs and

transportation infrastructure (roads, bridges) to get the crop to market. The ESD Project is no exception. It can be successful only through links and coordination through development investments in roads, enterprise promotion, education, and health.

2. Methodology

The methodology employed in this section consists of review of the USAID/Bolivia Action Plan for Fiscal Years 1995-1996, published in April, 1994, and relating the ESD to the other projects in the USAID portfolio.

3. ESD In Strategic Objective Program "Trees"

USAID/Bolivia has identified two Agency Goals with accompanying Strategic Objectives and Program Outcomes, which relate to the ESD. The first of these Agency Goals is: *Encouraging Broad Based Economic Growth with the accompanying Strategic Objective of Expanded Economic Opportunity and Access.* These are accompanied by two Program Outcomes which are related to the ESD: (1) Increased employment opportunities in no-coca industries and (2) Increased non-coca economic opportunities in the Chapare and associated areas.

The Program Outcome of increased employment opportunities in non-coca industries is almost identical to the Project Goal of the ESD project (see above). Projects contributing to the Program Outcome are the following:

1. Project number 0580 Management Training Project
2. Project number 0584 Training for Development Project
3. Project number 0616 Technical Support for Policy Reform Project
4. PL-480 Title II Program, 1992-1994, 1995-1997
5. PL-480 Title III Program, 1992-1994, 1995-1997
6. Project number 0577 Industrial Transition
7. Project number 0585 Export Promotion Project
8. Project number 0594 Community and Child Health
9. Project number 0596 Micro and Small Enterprise Development
10. **Project number 0614 Electrification for Sustainable Development**
11. Project number 0617 Cochabamba Regional Development
12. Project number 0618 CARE Community Development

The Program Outcome of increased employment opportunities in the Chapare and associated areas identifies the following projects as contributing to the Program Outcome:

1. Project number 0605/30/39 Economic Recovery Programs 1993, 1995, 1996
2. Project number 0613 Drug Awareness and Prevention Project
3. **Project number 0614 Electrification for Sustainable Development**
4. Project number 0617 Cochabamba Regional Development Project

The second of the Agency Goals is: *Protecting the Environment with the accompanying Strategic Objective of Reduced Degradation of Forest, Soil and Water Resources and Protected Biological Diversity.* These are accompanied by one Program Outcome which is related to the ESD: Improved public and private institutional capacity for sustainable use and environmental protection.

This Program Outcome identifies the following projects as contributing to the Program Outcome:

1. Enterprise for the Americas Initiative
2. Project number 0611 Bolivian Peace Scholarship
3. **Project number 0614 Electrification for Sustainable Development**
4. Project number 0617 Cochabamba Regional Development
5. Project number 0621 Sustainable Forestry Management
6. PL-480 Title III
7. Project number 598-0780 Environmental support Project, New York Botanical Garden
8. Project number 598-0782 Parks in Peril

C. Donor coordination

Apart from NRECA and USAID, there are four international agencies working in Bolivia. The Inter-American Development Bank (IDB) has been the primary agency working with ENDE on generation, but is not involved in electric sector reform. The World Bank has restructured its program with Bolivia and has been heavily involved in the development of the new Electric Law. Both the Germans (through GTZ) and the Dutch have been active in promoting renewable energy. The fact that other international donors have not targeted the same areas as NRECA and ESD has meant that little donor coordination has been necessary.

D. Assessment of Project objectives

1. Definition of objectives

The Project objectives, as stated in the Terms of Reference, are the following:

- Project Goal: Increased employment, income and productivity in non-coca activities
- Project Purpose: Efficient, affordable, sustainable and customer-oriented rural electrification service provided in the target area [to more rural inhabitants]

The Project Purpose has been modified slightly in the 1994 Logical Framework to read as follows:

- Affordable, sustainable and customer-oriented service provided to more rural households and businesses

While efficiency continues to be a focus of the ESD project, the fact that it is implied in both affordability and efficiency has caused it to be dropped from the Project Purpose. This evaluation will therefore consider the 1994 Logical Framework Project Purpose in assessing the Project objectives.

2. Methodology

The methodology used in assessing the clarity and realism of the project objectives was to look at them in the context of the measurable indicators and means of verification in the logframe. If the objectives related closely to the measurable indicators, they were considered clear. If the measurable indicators related closely to the means of verification, and if the means of verification seemed usable in a final impact evaluation, the objectives were considered realistic.

3. Goal-level objective

The measurable indicators for the goal-level objective of increased employment, income and productivity in non-coca activities are (1.1) jobs created from electricity-using activities in the project area, (1.2) increased production in enterprises with new or improved electric service, and (1.3) increased income from productive use of electricity. These measurable indicators are obviously closely related to the ^bjective, and the goal-level objective is considered clear.

The means of verification for the three measurable indicators of the goal-level objective consists of a random sample survey of households and businesses (ex-post opinion of respondent). In other words, the final impact evaluation will require carrying such a survey which will contain questions related to how many new jobs were created by electricity-using activities, how productivity has increased in various productive activities as a result of new or improved electric service, and how much additional income the increased productivity has produced.

The best means of verifying the measurable indicators would have been a household/business baseline survey carried out before project intervention and then repeated at the end of the project. However, in spite of the fact that an ex-post household/business survey must rely on the respondents' memory regarding previous income and productivity, a carefully crafted survey of this type can be an adequate means of verification. On this basis, the goal-level objective is judged to be realistic.

4. Purpose-level objective

There are eight measurable indicators for the purpose-level objective which must relate to affordable, sustainable, and customer-oriented service provided to more rural households and businesses. To detect the relationship between the purpose-level objective and the measurable indicators, it is convenient to break down the purpose-level objective into component parts and relate those parts to the measurable indicators.

a. Affordable

Affordable service relates to the capacity of customers to pay for electricity. The principal measurable indicator of affordability is indicator 1.6, Collection rate is 90% + over one year for each new ESD connection project. If billings are collectable, the service is deemed affordable, and the objective is clear in this sense. The objective is also realistic, since the corresponding means of verification consists of utility records on customer payment, which should be readily available to the project and thus to final evaluators.

Another measurable indicator of affordability is indicator 1.2, 2000 new PU connections in utilities with PU programs. If customers sign up to use electricity productively, it implies

clearly that electricity is affordable for productive uses. The objective is also realistic, since the corresponding means of verification consists of project and utility customer connection records, which again are readily available.

b. Sustainable

Sustainable service related to the capacity of the utility to continue to provide reliable service over time, which in turn relates to sufficient energy sales to customers. Measurable indicators 1.3, 1.4, 1.6, and 1.8 are clearly related to this part of the purpose-level objective. Indicators 1.3 and 1.4 refer to increased MWh sales of energy, both for productive uses and overall. The indicators are realistic because the means of verification consists of utility sales records by customer class, which is information which should be readily available to the project and to evaluators. Indicator 1.6 was mentioned above: service is sustainable only if payment is received for the service. Indicator 1.8 refers to positive incremental annual net operating income to utilities applying load management programs. This information is also available at the utilities.

c. Customer-oriented

Indicator 1.7 posits the existence of a new department or staff responsible for customer service in utilities with productive use programs, which shows a clear and obvious relationship to the purpose-level objective. The objective is realistic, since the means of verification consists of interviews with responsible utility staff who will be able to affirm whether the new department and/or staff exist and are engaged in customer service.

d. More rural household and businesses

Indicators 1.1 and 1.2 relate to 15,000 new residential and 2,000 new productive uses connections, showing a clear relationship to the purpose-level objective. These indicators are easily verified through project and utility customer connection records, which demonstrates that they are realistic objectives.

5. *Probable purpose-level impact*

There is every reason to expect that the ESD Project will achieve and, in many cases, surpass most of its purpose-level targets regarding impact. The following sections present information on these targets.

a. New residential and productive use connections

The ESD target for new residential connections was 15,000 and for new productive uses connections was 2,000, for a total of 17,000 new connections. While it was not possible to distinguish between residential and productive uses connections at the time of the evaluation, Project records indicate that the total number of connections resulting from present subprojects will be about 26,700, about 78% over the target. The breakdown is as follows:

Valles Cruceños	7,000	(new connections)
Mizque-Aiquile	2,600	
Capinota	1,800	
Bermejo	3,000	

Camiri	3,000
Chapare	1,800
Riberalta	3,500
16 communities	700
Concepción*	300
San Julián*	2,000
Other photovoltaic*	1,000
TOTAL	26,700

(= Pre-electrification renewable subprojects not covered by this mid-term evaluation)*

There is no information as yet concerning whether 50% of households in the project area received electricity. This will require a clear definition of project area for each subproject and then a project house-count, as stated in the logical framework.

b. Increases in energy sales and collection rates

The ESD targets for increased energy sales were 2.4 MWh increase in energy sales per year from productive uses in utilities with productive uses, and 3.6 MWh increase in energy sales per year overall in ESD projects. This target has proved to be extremely conservative, since the energy sales from the CRE operation at Valles Cruceños running at 60% of capacity should overshoot the overall target by 20 times. Again, it is not possible at this time to separate out productive uses energy sales, but there is no doubt at all that the target has already been met.

As regards collection rates, none of the subprojects has been in operation long enough to make a firm statement concerning collection rates. Nonetheless, ELFEC has informed ESD that its initial collection rate for the Mizque-Aiquile subproject is its highest collection rate for a rural area, which is a good indication of the probable success rate for this indicator.

c. Customer service

The ESD target for customer service is that each utility with a productive use program have a new department or staff responsible for customer service, and the utilities in this case are ELFEC and CRE. CRE fulfills this target, as it has actually had a customer service department before ESD began.

ELFEC has been less than successful in this regard. A good customer service department should carry out at least two activities: (1) receive and resolve customer complaints about service and (2) look for ways to project the utility in a positive way into community life, such as through promotion of productive uses. ELFEC has had no tradition of carrying out these types of activities, but it has established a customer service/productive uses office, and it is hoped that it will become at least marginally functional by the end of the Project.

d. Load management

The purpose-level target regarding load management is positive incremental annual net operating income to utilities applying a load management program. It is too early to make a projection regarding this indicator, since ESD is still in the pilot stage regarding load

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management. However, there are good indications that the target will be met, since there are pilot test programs in place with 12 industrial ELFEC customers and another 12 industrial CRE customers.

Once the pilot programs are concluded, it will be possible for each utility to implement load management throughout their service areas, and utility records of net income attributable to load management will become available. COBEE has also begun to work with ESD on load management but has not advanced as far.

e. Reasons for success

Looking at the probable impacts of ESD, it is evident that it is a highly successful project. There appear to be two main reasons for this success: good counterpart relations and an excellent Project staff. Local counterparts have contributed heavily to the success of ESD through counterpart funding and cooperation. They have done so because the ESD subprojects were clearly good projects and in the interest of the utilities to carry out, including investing their own funds to do so.

However, good projects do not just appear; they must be designed, developed, and implemented, and this requires good technical personnel. The evaluation team believes that the ESD personnel have played a key role in the perceived success of the Project. The ESD Chief of Party combines high energy, a sensitive understanding of the local scene, and excellent management skills, and he is no doubt a major reason for ESD success. He has put together an excellent staff, both local and international.

E. Annual workplans and semi-annual reports (SAR)

ESD annual workplans are developed on a fiscal years basis. The evaluation team was able to examine the 1993 workplan (October 1992 to September 1993) and the 1994 workplan (October 1993 to September 1994). The workplans are organized and written well, and contain the following sections: overview, summary of previous year's progress, current year's activities, and a summary and conclusions section.

The breakdown of activities varies somewhat but includes sections on construction, productive uses, technical assistance, the formation of EFER, renewable energy/special projects, and the administrative and financial plan. The FY93 workplan also contained profiles of subprojects which had just begun or were about to begin. The summary of FY93 activities in the FY94 workplan relates closely to the activities project in the FY93 workplan.

The semi-annual reports (SAR) do not follow the workplan fiscal year format. The SARs follow a calendar year format of January-June and July-December, which makes it somewhat difficult to read the SARs and workplans together. The SAR calendar format naturally followed the beginning of the project in July, 1991. The SARs do, however, follow the general organizational format of the workplans as regards overview and reporting on progress in the various activity areas.

Both workplans and SARs contain budgetary information, including project expenses to date, broken down into foreign and local currency expenditures. The budgets are clear and self-explanatory.

F. Procurement and outside technical assistance

1. *Procurement*

Procurement has generally not been a problem. The fact that so many ESD subprojects are at or nearing completion is the best indicator that procurement has been carried out in a timely and efficient fashion.

One problem occurred concerning transformers purchased from Jimelco through Florida Finance. When the transformers arrived in Bolivia, some had broken bushings, and the question arose as to whether they were new transformers as required by contract or reconditioned ones. All the transformers were tested, variations in performance were found, and it was eventually learned that the original manufacturer had purchased transformer cores and other components from different sources but that the transformers were, in fact, new.

Three of the transformers had short circuits and six others failed in the field after being installed. The manufacturer has since replaced all nine, and the transformers have a two-year guarantee as of July, 1994.

Another problem concerns connections in the Mizque-Aiquile subproject. These connections should have been installed by now. The reason for the delay is that ESD purchased materials in bulk at the beginning of the project. This strategy avoided having a subproject designed and ready but then having to wait six-nine months to procure materials. This strategy, while perhaps risky if appropriate subprojects had not materialized, was in part responsible for the rapid implementation of many of the subprojects.

However, the amount of material needed for connections was underestimated at that time, with the result that an additional procurement was required, and the time needed for this additional procurement has slowed the carrying out of some of the Mizque-Aiquile connections. It should be pointed out that the fact that ESD will actually achieve 78% more connections than originally planned for may explain the shortfall. In any case, the Mizque-Aiquile connections will be completed by the end of 1994.

2. *Outside technical assistance*

According to the Chief of Party, the ESD strategy from the beginning was to use as little outside technical assistance as possible and attempt to use Project staff whenever possible and/or to hire local professionals. Still, some outside technical assistance was required.

Outside technical assistance was used for Project economic analysis and was judged to be adequate but not excellent. Outside TA was also employed for wood pole treatment and was excellent. ESD brought in NRECA experts in the use of the DAM methodology, but this TA failed to convince ESD of the reliable applicability of the DAM to the Bolivian situation. Outside TA was used in implementing the beneficiary assessments, and those involved in the assessments were satisfied with the TA. Finally, outside TA was employed to work on regulatory reform, and recommendations from this effort have been or will be used in the establishment of SNE as the Bolivian regulatory agency.

G. Monitoring and evaluation framework

1. *Logical framework history*

There are three project logical frameworks (logframe) available for the ESD project: 1991, 1993, and 1994 (proposed). The 1991 logframe, found in Annex D of the PP-like document, is both a rich source of information and an example of flawed logframe development. The flaws include the following: the project goal and purpose are basically the same and should be considered the project purpose. The verifiable indicators are often not indicators but activities or tasks, and the means of verification relies on unspecified "project reports." The detailed tasks are the primary reason it is too long at 12 pages.

On the positive side, the 1991 logframe does provide a wealth of information on activities and tasks as well as the key assumptions required for tasks to be carried out. This information should be included in the task analysis of outputs in a separate monitoring framework, which will be presented in more detail below.

The 1993 logframe, consisting of just two pages, is much more tight and concise. Project outputs have been reduced from 22 to five, while the verifiable indicators are now true indicators, not tasks or activities, with just one indicator per output. The means of verification are more exact, rarely stating simply "project reports" but rather the type of report. This 1993 logframe did, of course, have the advantage of being developed after the project had actually begun.

The 1994 proposed modification to the logframe is even more specific, providing additional end of project indicators which are more closely related to the project purpose. This logframe should be approved and should form the basis for eventual project impact evaluation.

2. *Monitoring and reporting*

NRECA, following AID instructions, has prepared a monitoring format based on the logframe indicators to be used in preparing semi-annual reports (SARs), which in turn are used by AID in preparing its own SARs for Washington. The format is also used to set targets for the next reporting period, and these targets in turn form the basis for the monitoring format. The NRECA Project Status Report (= AID SAR) list the EOPS indicators in the left column followed by columns listing the EOPS targets, next period target, planned target for the present period, actual achievement for the period, and the cumulative planned and accomplished numbers for the target (see following example).

	Planned			Accomplished		
		Period		Period		%
Indicator	LOP	Cum	Next		Cum	LOP
Incremental growth in rural electric service connections	15,000	850	1250	1500	178	178	1%

NRECA to date has not collected data on its indicators using a systematic methodology, but this is about to change. NRECA hired a senior social scientist in mid-1993 to take charge of

monitoring and evaluation, among other tasks, and has recently hired a local junior social scientist to assist her with the task.

This monitoring and evaluation (M&E) team has set itself the following tasks:

1. Identify existing data sources. To do this, they have identified, in NRECA, (a) what files NRECA has, (b) in which file drawer the files are found, (c) the external source of the data in the files, (d) whether the data is in fact available, and (e) which NRECA employee is responsible for the data.

2. Identify report type. They have also identified exactly what type of data file should contain the data. If the data should come from a source outside NRECA, they have identified the data source.

3). Prepare data collection instruments. While previously much of the SAR information had to be collected ad hoc, the M&E team is now preparing data collection forms for those responsible for specific data to regularize and systematize the collection of these data.

4. Develop new indicators. As mentioned above, the 1994 proposed logframe contains more explicit indicators than the previous logframe, which will provide future evaluators with concise points of departure.

5. Design an evaluation plan. Considerable effort has gone into the final evaluation plan. The NRECA social scientist in Bolivia has authored a guide document for NRECA for the evaluation of rural electrification projects world-wide. The guidelines are being applied to the ESD project.

In conclusion, the ESD monitoring and reporting system was unsystematic during the first two Project years, but reliable information could be found for inclusion in SARs and other reports. With the improvements being installed at present, Project management should be able to more easily prepare reports, and the final impact evaluation will be facilitated as regards identifying and locating relevant data.

ANNEX 1: STATUS OF OUTPUTS

This annex charts the ESD project outputs and their measurable indicators according to the 1994 Logical Framework, plus their current status as of July, 1994.

Outputs	Indicators	Status
Training programs for utility or coop staff or users developed and implemented	500 utility staff and/or users trained in one of following: O & M, billing, accounting, admin., PU by EOP	Over 2000 now trained, but PU training has lagged.
Tech assist to utilities & RE entities	5 technical assistance programs established by year 4 of project	5 TA programs established
Viable load management program developed	2 utilities implement load management progs by year 3 of project	2 utilities in process of implementation
PU (credit, information & TA) programs established	5 PU programs established by year 3 of project	2 big programs (ELFEC, CRE), 2 small ones (CESSA, CEY)
	* 1500 loans made totalling US$1 million by EOP	Just $0.4 total funds available
Loans for residential connections made	1500 loans from utilities to new customers	9600 loans (all ELFEC & CRE connections)
Beneficiary assessments carried out	4 studies of user perspectives using participant observation by years 3 of project	4 studies carried out
Information disseminated to consumers	5 information programs carried out by EOP	5 programs already carried out

Feasibility studies carried out	20 economic and financial feasibility studies completed by EOP	More than 20 studies done at this time
Renewable energy systems established	300 households receive electricity from renewable energy systems by EOP	Over 300 now
	Billing & maintenance systems operational for all renewable projects upon their initiation	Implemented, but will be redone

* The only output which is lagging involves productive uses loans. Project target of US$1 million is now not possible because of funding cuts. Number of total loans will undoubtedly be lower as well, a reflection of fewer funds to lend.

ANNEX 2: METHODOLOGIES USED BY CONSULTANTS

1.Financial and Economic Specialist

Analytical model used was that of the Inter-American Development Bank. Studies were considered acceptable if they would be acceptable to the IDB. The application of the model was carried out in conjunction with the following activities:

- Review of documents, studies, guides for the application of models, and other written information.
- Discussion of written information with implementors and persons in charge of project supervision
- Visits to project sites when possible.
- Discussion of commentaries and critiques with professionals from NRECA and counterparts.
- Obtention and inclusion of observations, commentaries, and additional information from NRECA professionals based on preliminary reports, when judged appropriate by the evaluator.

2. Rural Electrification Engineer

Analysis was based on the NRECA standards for distribution and generation systems, which is closely parallel to REA standards, as well as the consultants own experience in electrification. Analysis was carried out in conjunction with the following activities:

- Review of documents, studies, guides for the application of models, and other written information.
- Discussion of written information with implementors and persons in charge of project supervision
- Visits to project sites when possible.
- Discussion of commentaries and critiques with professionals from NRECA and counterparts.
- Obtention and inclusion of observations, commentaries, and additional information from NRECA professionals based on preliminary reports, when judged appropriate by the evaluator.

3. Project Management/Evaluation Specialist

No one specific analytical model was used. Analysis was based on broad previous in USAID project design, monitoring, and evaluation, including the use of logical frameworks. Analysis was carried out in conjunction with the following activities:

- Review of documents, studies, guides for the application of models, and other written information.

- Discussion of written information with implementors and persons in charge of project supervision
- Visits to project sites when possible.
- Discussion of commentaries and critiques with professionals from NRECA and counterparts.
- Obtention and inclusion of observations, commentaries, and additional information from NRECA professionals based on preliminary reports, when judged appropriate by the evaluator.

ANNEX 3: DOCUMENTS REVIEWED

- Annual Workplans for the Electrification for Alternative Development Project, FY 1993-1994.
- Semi-Annual Progress Reports 1-5, NRECA.
- Alternative Development Rural Electrification Project Proposal (PID-like document), NRECA, May 24, 1991.
- Alternative Development Rural Electrification Project (PP-like document), NRECA, June 7, 1991.
- Electrification for Alternative Development Project (Cooperative Agreement document), NRECA, March 1993.
- Beneficiary Assessment of the Mizque-Aiquile Subproject, NRECA, April 1993.
- Project Status Reports (SAR-like documents), NRECA, 1991-1993.
- Monitoring and evaluation file, NRECA/La Paz.
- Equipment procurement file, NRECA/La Paz.
- Loand flow study file, NRECA/La Paz.
- Performance test file, NRECA/Cochabamba.
- Line staking file, NRECA/Cochabamba.
- Specifications and drawings for 14.4/24.9 KV line construction by REA.
- Technical specifications for wood poles for aerial distribution. NRECA.
- Investigación de Campo y Diseño del Program de Usos Productivos: Valles Cruceños, David Kittelson et. al, NRECA, November, 1993.
- Estudio de Abastecimiento y Planificación Eléctrica de los Valles Cruceños, Informe V, ASINELSA, S.A.
- Informe Económico sobre Valles Cruceños, Gerencia Administrativa y Financiera de CRE, 1991.
- Pliego Tarifario para Valles Cruceños, José Kreidler, March 2, 1994.
- Acta de Reunión de Personeros de DINE y CRE para tratar el Tema de Tarifas Eléctricas de Valles Cruceños, April 28, 1994.
- Resolución DINE 04.1.1.021/94, Ministerio de Hacienda y Desarrollo Económico, SEcretaria Nacional de Energia, Abril, 1994.
- Diseño del Program de Densificación de la Red Eléctrica en el Valle Bajo de Cochabamba, NRECA/La Paz, July, 1992.
- Estudio de Prefactibilidad: Reconstrucción y Expansion del Sistema Eléctrico de Capinota, NRECA/La Paz, March, 1993.

- Estudio de Prefactibilidad: La Electrificación de Mizque-Aiquile y Pueblos Aledaños, NRECA/La Paz, March, 1993.
- Análisis de Socios de la Cooperativa Rural Eléctrica La Paz, NRECA/La Paz, October, 1993.
- Demand Assessment Methodology for Screening and Site Selection of Rural Electrification Projects, NRECA/CARES (Guatemala), July, 1991.
- Designing an evaluation plan: guidelines for rural electrification projects, NRECA, March, 1994.

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ANNEX 4: PERSONS/INSTITUTIONS CONTACTED

USAID/Bolivia

Peter Natiello, Project Officer

NRECA/La Paz:

Dan Waddle, Chief of Party

Silvia Torres, Social Scientist

David Kittelson, Productive Uses Specialist

Omar Vargas, Economist

Ricardo Quiroz, Computer Programmer

Ariel Teran, Computer Programmer

Belinda Román, Office Manager

Rodrigo Muñoz, Monitoring & Evaluation Specialist

NRECA/Cochabamba:

Jaime Cabrera, Engineering Assistant, Mizque-Aiquile subproject

Fernando Ghetti, Engineering Assist., Valles Cruceños subproject

Eduardo Sánchez, Productive Uses Coordinator

Ibert Cruz, Engineering Assistant, Valles Cruceños subproject

PRODEM/Quillacollo:

Luis Mojica, General Manager

AGROCAPITAL/Cochabamba:

Federico Maida, Credit Agent for Valles Altos

ELFEC/Cochabamba:

Ramiro Mendizábal, Technical Manager

CRE/Matarai:

Carlos Montaño, Plant Manager

CRE/Mairana:

Rinaldo Durán, Manager of CRE PU electric store

Nelson Orquera, Auxiliar of CRE PU electric store

CRE/Santa Cruz:

José Kreidler, General Manager

Alan Durán, Technical Manager

Juan Carlos Ribera, Manager of Consumer Relations

Jaime Solares, Head of Productive Uses

Aiquile:

Luis Torrico, Town Mayor

Elizabeth Ferrufino, Chairwoman of City Council

President of Civic Committee

Three Members of City Council

Sr. González, Manager of AGSA electrical goods store

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ANNEX 5: LIST OF SITE VISITS

July 5-7:	NRECA offices in La Paz
July 6:	USAID/Bolivia in La Paz
July 8:	NRECA offices in Cochabamba
	ELFEC offices in Cochabamba
	PRODEM offices in Quillacollo
	Productive uses promotion area in Vinto
July 9:	Distribution line to Mizque and Aiquile
	Mayor and City Council in Aiquile
	AGSA productive uses store in Aiquile
July 10:	Valles Cruceños generation plant in Mataral
	Valles Cruceños productive uses store in Mairana
July 11:	CRE offices in Santa Cruz
July 13-19:	NRECA offices in La Paz

ANNEX 6: EVALUATION TERMS OF REFERENCE AND SCOPES OF WORK

ELECTRIFICATION FOR SUSTAINABLE DEVELOPMENT
MIDTERM EVALUATION

TERMS OF REFERENCE

I. Scope of the Midterm Evaluation

NRECA distinguishes between the following types of evaluations:

> *Midterm*, "program" or "process" evaluations focus on how effectively and efficiently the project implementation and management process is carried out. Their objective is to provide information that can be used to improve or refine implementation of the RE program. In Logical Framework terms they focus on project *Outputs, Inputs and Activities.*
>
> *Impact evaluations* focus on achievement of the objectives, primarily those defined in project documents. Their objective is to measure change resulting from project interventions and draw causal inferences about project activities and outcomes. In Logical Framework terms they focus on *Objectively Verifiable Indicators* of project Goal and Purpose.

II. ESD Project Background

Project Budget

The Electrification for Sustainable Development Project (formerly ADEP, Electrification for Alternative Development Project) began in July, 1991 with funding from the United States Agency for International Development in Bolivia.

Initial financing from USAID was to be $16.7 million, with an additional $10 million in local currency contributions from the Dirección de Financiamiento Externo y Monetización, DIFEM, and counterpart contributions from utilities and cooperatives. As of March, 1994 counterpart funds totalled some $8 million and disbursements from AID Bolivia, $9 million. Further disbursements may well be significantly lower than programmed at project inception.

In addition to AID Bolivia funds, the ESD project has received $1.7 million from USAID funding of the Global Environment Facility for the purpose of initiating a Renewable Energy and Efficiency Program in Bolivia. Another $2.5 million were received in 1993, for a total of $4.2 million for renewable energy.

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Project Objectives

The Goals and Project Purpose were established in the ESD revised Project Logical Framework.

Project Goal: Increased employment, income and productivity in non-coca activities

Project Purpose: Efficient, affordable, sustainable and customer-oriented rural electrification service provided in the target area [to more rural inhabitants]

Project Components

The activities required to achieve project objectives fall into the following components:

1. Project identification and economic, financial and social assessment.

2. Project selection and design, including costing and tariff analysis

3. Project construction/implementation, including financing and procurement of equipment.

4. Technical assistance and training to electricity distribution entities and regulatory agencies, including load management.

5. Development of programs to promote the productive (income-generating) use of electricity.

6. Financial and technical support for development and sustainabililty of the electricity sector.

7. Development of a renewable energy program

The renewable energy program, initiated in 1993, will not be examined in this midterm evaluation.

Project Technical Staff

Project Chief-of-Party, Daniel Waddle

Senior technical staff:

1. Special Projects Coordinator, Fernando Haderspock
2. Productive Uses Specialist, David Kittelson
3. Institutional Specialist, James Newberg
4. Social Scientist, Silvia Torres

Other technical staff:

1. Engineering Assistant, Jaime Cabrera

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2. Engineering Assistant, Danilo Carranza
3. Engineering Assistant, Ibert Cruz
4. Load Management/Renewable Energy Specialist, Andrew McAllister
5. Computer Programmer, Ricardo Quiroz
6. Productive Uses Coordinator, Eduardo Sánchez
7. Computer Programmer, Ariel Terán
8. Economist, Omar Vargas
9. Evaluation Specialist, Vacant
10. Communications Specialist, Eliminated

III. Evaluation Specialists Required and Level of Effort

Three specialists are required to carry out the evaluation. They will be responsible for collecting, processing and analyzing data on the ESD project.

1. Program Management and Evaluation Specialist

2. Economic Analyst

3. RE Engineer

It is assumed that the Program Management and Evaluation Specialist will be the Evaluation Team Leader. Draft Scopes of Work for specialists are attached.

The level of effort is 20 days (60 person-work-days), including travel days to and from Bolivia.

IV. Midterm Evaluation Questions

The evaluation team will address the questions that follow in order to carry out the midterm evaluation of ESD.

General Project Management/Implementation:

1. Does the project have clear and realistic objectives?

2. How do these objectives relate to GOB and USAID development objectives?

3. Have viable project annual implementation plans been developed and met?

4. What modifications in project design have been made/should be made?

5. Have project Inputs (including technical assistance, financing and commodities) been available in a timely way and is the procurement system efficient and appropriate?

6. Have project Outputs (per annual work plans and Logical Framework) been delivered on schedule?

7. Is there good indication that the project will achieve its intended impacts as described by the Project Purpose?

8. Do counterparts and beneficiaries understand and support the project goals and activities? Have good working relations been established between NRECA and the counterparts and regulatory agencies?

9. Does project staff represent the mix of skills and capabilities required to carrying out the project activities?

10. Has the appropriate outside technical assistance been obtained?

11. Has effective coordination among other donors to the electricity sector taken place?

12. Is there a system for monitoring and reporting project progress in place and how effective is it?

13. Are measures to collect appropriate empirical data for impact evaluation (end-of-project impacts, including environmental and gender aspects) in place?

14. Do project expenditures conform to budget? Do they conform to meeting project objectives?

Economic and Social

1. Have financial, economic and social analyses been effectively and appropriately carried out?

2. Are projects being implemented expected to be be sustainable in terms of financial viability?

3. What links and coordination are there between RE projects and other development investments in roads, entreprise promotion, education and health? What is the general potential contribution of RE to greater production, productivity and employment?

4. What potential for productive use of electricity is there in selected projects, and what is their role in the financial and economic viability of the projects?

Engineering

1. Have least-cost standards and design been applied?

2. Are engineering designs adequate and appropriate?

3. Have project construction schedules been set and met?

4. Has construction work been of acceptable quality?

5. Are construction materials of adequate and appropriate quality?

V. Method of Evaluation

Evaluators will travel to Bolivia and assess project implementation using the methods described below, as appropriate.

1. Review of project documents, including project papers, work plans, studies, designs and reports. These will be provided by the project Chief of Party in La Paz.

2. Conduct structured interviews of key players in the project, including project technical staff, project counterpart staff in ELFEC, CRE, and other collaborating utilities, USAID staff, and others as appropriate.

3. Travel to utilities and construction sites.

Prior to arrival in Bolivia, the contractor/evaluators will submit to NRECA a proposed work plan for the evluation, including methodology and schedule of activities. This work plan will be finalized with USAID Boliva and NRECA upon arrival of the team in Bolivia.

VI. Evaluation Reporting Requirements

The evaluators will produce a written report of findings, conclusions, recommendations and lessons learned. An oral presentation and a 6 copies of the draft of the report in English will be submitted to NRECA and USAID-Bolivia 2 days before the departure of the evaluation team from Bolivia.

NRECA and USAID will respond within ten working days. The final evaluation report will incorporate comments and be produced within 10 working days after receipt of NRECA and USAID comments. Ten copies of the report in English will be provided to NRECA and USAID.

The report should include the following:

1. Table of Contents

2. Executive Summary

3. Presentation of Findings, Conclusions and Recommendations of project implementation and effectiveness with specific reference to a) engineering, financial-economic, institutional and social aspects included in the evaluation questions and b) the Project Logical Framework.

4. Body of the Report, including project background, evaluation methodologies employed, evidence and discussion of findings and conclusions, and a discussion of lessons learned

5. Appendices, to include:

   a. Status of Outputs
   b. Description of evaluation methodologies used by each specialist
   c. List of documents reviewed
   d. List of persons and institutions consulted
   e. List of site visits
   f. Summary of recommendations.
   g. Evaluation Terms of Reference and Scopes of Work

   and any other special topics deemed necessary by the Evaluation Team.

In addition to the report, the evaluators will prepare Sections H and J of USAID's Evaluation Summary Form 1330-5, which can be obtained from NRECA or USAID Bolivia's evalualtion officer.

ANNEX 7: EVALUATION QUESTIONS REFERENCED TO DOCUMENT

The Terms of Reference for the ESD midterm evaluation contain a list of 23 questions to be addressed in order to carry out the evaluation. These questions are listed below in the order they are found in the Terms of Reference, along with the sections of the document and/or page numbers where the questions are addressed:

General Project Management/Implementation:

1. Does the project have clear and realistic objectives?

   See VI. Project Administration, D. Assessment of project objectives.

2. How do these objectives relate to GOB and USAID development objectives?

   See VI. Project Administration, B. Relation of project to other USAID projects

3. Have viable project annual implementation plans been developed and met?

   See VI. Project Administration, E. Annual workplans and semi-annual reports (SAR)

4. What modifications in project design have been made/should be made?

   See VI. Project Administration, A. Project History.

5. Have project Inputs (including technical assistance, financing and commodities) been available in a timely way and is the procurement system efficient and appropriate?

   See VI. Project administration, F. Procurement and outside technical assistance, 1. Procurement.

6. Have project Outputs (per annual work plans and Logical Framework) been delivered on schedule?

   See Annex 1, Status of Outputs.

7. Is there good indication that the project will achieve its intended impacts as described by the Project Purpose?

   See VI. Project Administration, D. Assessment of project objectives, 5. Probable purpose-level impact

8. Do counterparts and beneficiaries understand and support the project goals and activities? Have good working relations been established between NRECA and the counterparts and regulatory agencies?

   See VI. Project Administration, D. Assessment of project objectives, 5. Probable purpose-level impact, e. Reasons for success

9. Does project staff represent the mix of skills and capabilities required to carry out the project activities?

   See VI. Project Administration, D. Assessment of project objectives, 5. Probable purpose-level impact, e. Reasons for success

10. Has the appropriate outside technical assistance been obtained?

    See VI. Project administration, F. Procurement and outside technical assistance, 2. Outside technical assistance.

11. Has effective coordination among other donors to the electricity sector taken place?

    See VI. Project Administration, C. Donor coordination.

12. Is there a system for monitoring and reporting project progress in place and how effective is it?

    See VI. Project Administration, G. Monitoring and evaluation framework, 2. Monitoring and reporting.

13. Are measures to collect appropriate empirical data for project evaluation (end-of-project impacts, including environmental and gender aspects) in place?

    See VI. Project Administration, G. Monitoring and evaluation framework, 2. Monitoring and reporting. But nothing specific on environment or gender yet identified.

14. Do project expenditures conform to budget? Do they conform to meeting project objectives?

Economic and Social

1. Have financial, economic and social analyses been effectively and appropriately carried out?

   See IV. Economic, Financial and Social Analyses, A. Economic and financial analysis, and E. Beneficiary assessments

2. Are projects being implement expected to be sustainable in terms of financial viability?

   See IV. Economic, Financial and Social Analyses, B. Financial viability

3. What links and coordination are there between RE projects and other development investments in roads, enterprise promotion, education and health?

   See V. Project Administration, B. Relation of project to other USAID projects

   What is the general potential contribution of RE to greater production, productivity and employment?

   See IV. Economic, Financial and Social Analyses, D. Productive use promotion, 4. Potential for increased income and employment

4. What potential for productive use of electricity is there in selected projects, and what is their role in the financial and economic viability of the projects?

   See IV. Economic, Financial and Social Analyses, D. Productive use promotion

Engineering

1. Have least-cost standards and design been applied?

   See III. Engineering Analysis

2. Are engineering designs adequate and appropriate?

   See III. Engineering Analysis

3. Have project construction schedules been set and met?

   See III. Engineering Analysis

4. Has construction work been of acceptable quality?

   See III. Engineering Analysis

5. Are construction materials of adequate and appropriate quality?

   See III. Engineering Analysis

ANNEX 8: ACRONYMS

DINE	Dirección Nacional de Electricidad
ELFEC	Empresa de Luz y Fuerza Eléctrica de Cochabamba
CRE	Cooperativa Rural de Electrificación de Santa Cruz
COBEE	Compañía Boliviana de Energía Eléctrica (La Paz)
ENDE	Empresa Nacional de Electricidad
SETAR	Servicios Eléctricos de Tarija
CORDECRUZ	Corporación Regional de Desarrollo de Santa Cruz
DIFEM	Dirección de Financiamiento Extranjero y Monetización
INALCO	Instituto Nacional de Cooperativas
PRODEM	Programa de Desarrollo de la Microempresa
BA	Beneficiary Assessments
MA	Mizque-Aiquile
VC	Valles Cruceños

ANNEX 9: LOGICAL FRAMEWORK

Following is a copy of the Logical Framework project design.

Project Name : Electrification for Sustainable Devel't
Est. Completion : July 96
Date of Revision: July 94
Design Team :

Narrative Summary (NS)	Measureable Indicators (OVI)	Means of Verification (MOV)	Important Assumptions
Goal: 1 Increased employment, income and productivity in non-coca activities	1.1 Jobs created from electricity-using activities in project areas (EOP-End of proj) 1.2 Increased production in enterprises w/new or improved electric service (EOP) 1.3 Increased income from productive use of electricity (EOP)	1.1 Random sample survey of households and businesses (ex post opinion of respondent) 1.2 Random sample survey of households and businesses (ex post opinion of respondent) 1.3 Random sample survey of households and businesses, (ex post opinion of respondent)	(Goal to Supergoal) 1 Out-migration is reduced as a result of enhanced economic prospects
Purpose: 1 Affordable, sustainable and customer-oriented service provided to more rural households and businesses	1.1 15,000 new residential connections in ESD projects (EOP) 1.2 2,000 new PU connections in utilities with PU programs (EOP) 1.3 2.4 MWh increase in energy sales for PU/year in utilities w/PU progs (EOP) 1.4 3.6 MWh increase in energy sales/year in ESD projects (EOP) 1.5 50% of households in project area receive electricity (EOP) 1.6 Collection rate is 90% + over one year for each ESD new connection project (EOP) 1.7 New department or staff responsible for customer service in utilities w/PU progs (EOP) 1.8 Positive incremental annual net operating income to utilities applying load management program (EOP)	1.1 Project and utility customer connection records 1.2 Project and utility customer connection records 1.3 Utility sales records by customer class 1.4 Utility sales records by customer class 1.5 Census or project house-count data and utility customer lists 1.6 Utility records on customer payment 1.7 Interviews with responsible utility staff 1.8 Utility records of net income attributable to project	(Purpose to Goal) 1 Electrification (new or improved service) allows increase in output/ productivity/quality 2 New enterprises can be created or existing ones expand operations 3 Markets for expanded operations exist in project site or elsewhere 4 A significant proportion of productive users operate on a scale that permits hiring paid labor
Outputs: 1 Training programs for utility or coop staff or users devloped and implemented 2 Tech assist to utilities & RE entitites 3 Viable load management	1.1 500 utility staff and/or users trained in one of the following: O & M, billing, accounting, administration, productive use of elec. by EOP 2.1 5 technical assistance programs established by year 4 of project 3.1 2 utilities implement	1.1 Project and utility records of persons trained 2.1 Interviews with key staff; review of program plans and their application 3.1 Interviews with key	(Output to Purpose) 1 Approved tariffs permit utilities to cover operating costs over the medium term 2 Utility management is ab to implement the TA program (assign staff, reorganize work,etc) 3 Key customers participat in load management progr

Narrative Summary (NS)	Measureable Indicators (OVI)	Means of Verification (MOV)	Important Assumptions
programs developed	load management progs by year 3 of project	staff; review of program plans and their application	4 Utilities are willing to adopt a consumer-oriented approach to service
4 PU (credit, information & TA) programs established	4.1 5 PU programs established by year 3 of project	4.1 Interviews with key staff; review of program plans and their application	5 Existing and potential enterprises are willing and able to invest in electrifying
	4.2 1,500 loans made totalling US $1 mn by EOP	4.2 Credit agency and project records	6 Utilities/other entities willing/able provide adequate maintenance and billing for renewable energy systems
5 Loans for residential connections made	5.1 1,500 loans from utilities to new consumers	5.1 Credit agency and project records	
6 Beneficiary assessments carried out	6.1 4 studies of user perspectives using participant observation by year 3 of project	6.1 Review of studies; and of their applicaton through staff interviews	
7 Information disseminated to consumers	7.1 5 information programs carried out by EOP	7.1 Project records and review of information program plan	
8 Feasibilities studies carried out	8.1 20 economic and financial feasibility studies completed by EOP	8.1 Review of studies and analysis of their use	
9 Renewable energy systems established	9.1 300 households receive electricity from renewable energy systems by EOP	9.1 Utility or implementor records, project records, site visits	
	9.2 Billing & maintenance systems operational for all renewable projects upon their initiation	9.2 Utility or implementor records, project records, site visits	

ANNEX 10: LIST OF ESD PROJECTS

Following is a list of the ESD projects.

ESD PROJECTS

NO.	PROJECT NAME	CATEGORY	PROJECT TYPE
1	Vinto	Economic development	Denisification
2	Mizque-Alquile	Economic development	Grid Extension
3	Chapare	Economic development	Grid Extension
4	16 Communities	Economic development	Grid Extension
5	Capinota	Economic development	Grid Rehabilitation
6	Bermejo	Economic development	Grid Rehabilitation and Isolated generatio
7	Camiri	Economic development	Grid Rehabilitation and Isolated generatio
8	Valles Crucenos	Economic development	Isolated generation
9	Concepcion	Economic development	Hydrogeneration
10	Riberalta	Economic development	Biomas generation
11	PU Valles Crucenos	Economic development	Credit for equipment
12	PU Mizque-Alquile	Economic development	Credit and Inforamtion
13	PU Vinto/K'aspicancha	Economic development	Credit and promotion
14	Chapare	Economic development	Comsumer Information
15	PV CRE Pilot Project	Pre Electrification Projects	Renewable energy
16	PV CRE Expansion project	Pre Electrification Projects	Renewable energy
17	PV potable water	Pre Electrification Projects	Renewable energy
18	PV COAINE	Pre Electrification Projects	Renewable energy
19	PV COAINE Expansion	Pre Electrification Projects	Renewable Energy
20	PV Altiplano I	Pre Electrification Projects	Renewable energy
21	PV Altiplano II	Pre Electrification Projects	Renewable energy
22	PV Radio Learning Program	Pre Electrification Projects	Renewable energy
23	PV Park Program	Pre Electrification Projects	Renewable energy
24	Beni	Sustainability	Technical assistance
25	Chiquitania	Sustainability	Technical assistance
26	CORELPAZ	Sustainability	Technical assistance
27	Sector Support	Sustainability	Technical assistance
28	Wood Quality Control	Sustainability	Technical assistance
29	Load Management	Sustainability	Load Management
30	Load Management	Sustainability	Load Management
31	Sustainability sector financing	Sustainability	Establishment of EFER
32	Training Modules	Sustainability/Efficiency	Training material development