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072

Bolivia
Country Program Phase II
Rural Energy and Energy Efficiency Report on Operational Activities

May 2005

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JOINT UNDP / WORLD BANK
ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

PURPOSE

The Joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP) is a special global technical assistance partnership sponsored by the UNDP, the World Bank and bi-lateral official donors. Established with the support of UNDP and bilateral official donors in 1983, ESMAP is managed by the World Bank. ESMAP's mission is to promote the role of energy in poverty reduction and economic growth in an environmentally responsible manner. Its work applies to low-income, emerging, and transition economies and contributes to the achievement of internationally agreed development goals. ESMAP interventions are knowledge products including free technical assistance, specific studies, advisory services, pilot projects, knowledge generation and dissemination, trainings, workshops and seminars, conferences and roundtables, and publications. ESMAP work is focused on three priority areas: access to modern energy for the poorest, the development of sustainable energy markets, and the promotion of environmentally sustainable energy practices.

GOVERNANCE AND OPERATIONS

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FUNDING

ESMAP is a knowledge partnership supported by the World Bank, the UNDP and official donors from Belgium, Canada, Denmark, Finland, France, Germany, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. ESMAP has also enjoyed the support of private donors as well as in-kind support from a number of partners in the energy and development community.

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Bolivia: Country Program Phase II

Rural Energy and Energy Efficiency
Report on Operational Activities

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Energy Sector Management Assistance Program
(ESMAP)

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Preface

The ESMAP *Country Program Phase II—Rural Energy and Energy Efficiency (P056929)*—was financed with a Netherlands grant amounting to NLG 3,391,254 (Trust Fund TF022187–BO017901, equivalent to US$1,614,883). Tranches 1 and 2 of the grant, in the respective amounts of NLG 1,017,876 and NLG 1,356,502, were released and disbursed in the period 1998–1999. Tranche 3, in the amount of NLG 1,017,376, was released in the year 2000. A balance equivalent to about US$240,000 was not disbursed before the closing date of the grant (December 31, 2001), and was canceled.

The ESMAP Country Program Phase II was executed by the World Bank and implemented by the National Secretariat of Energy of Bolivia's Vice Ministry of Energy and Hydrocarbons. The World Bank provided a task manager and an energy specialist. The program activities, carried out by a number of local and international consultants, were coordinated by two local professionals operating in the National Secretariat of Energy: Mr. Enrique Birhuett for Rural Energy, and Mr. Antonio Ruiz for Energy Efficiency.

This Report on Operational Activities includes an executive summary and a main body of text comprising sections on background, program objectives, components, cost, and implementation; the Rural Energy component, and the Energy Efficiency component. The annexes provide more detailed information on the impact and sustainability of the components, the Rural Electrification Fund, and program costs.

The report was prepared by Mr. Alvaro J. Covarrubias (consultant). Messrs. E. Birhuett and A. Ruiz, coordinators of the ESMAP Country Program in Bolivia, and Frank Baumgardt (consultant) made valuable contributions to the report. Comments and suggestions were taken into account in the final version. The document was reviewed by Messrs. Philippe Durand (task manager, LCSFP) and Kilian Reiche (energy specialist, LCSFP), and edited by Ms. Deborah Davis. George Bouza , Matthew Gardner and Nidhi Sachdeva assisted in the formatting of the report, and Marjorie K. Araya (ESMAP) coordinated the production and dissemination process.

Abbreviations and Acronyms

ADC	Andean Development Corporation (*Corporación Andina de Desarrollo*)
BOE	barrels of oil equivalent
BPC	Bolivian Power Company
CEE	*Comisión Episcopal de Educación*
CESSA	*Compañía Eléctrica de Sucre S.A.*
CETHA	*Centro de Educación Técnica, Humanística y Agropecuaria*
CPEE	Center for the Promotion of Energy Efficiency
CPTS	*Centro para la Promoción de Tecnologías Sostenibles*
CRE	*Cooperativa Rural de Electricidad de Santa Cruz*
DSM	demand-side management
EDEL	Empresa de Electricidad Larecaja
EE	energy efficiency
ENDE	*Empresa Nacional de Electricidad* (National Power Company)
ESMAP	Energy Sector Management Assistance Program
FER	*Fondo de Electrificación Rural*
FERIA	*Facilitadores de Educación Rural Integral Alternativa*
FINE	*Fondo de Inversiones en Nuevas Energías* (Investment Fund for New Energies)
FUNDA-PRO	*Fundación para la Producción*
GDP	gross domestic product
GoB	Government of Bolivia
HV	high voltage
IFC	International Finance Corporation (*Corporación Financiera Internacional*)
KfW	Kreditanstalt für Wiederaufbau (German Development Bank)
LPG	liquefied petroleum gas
MHP	mini-hydroelectric plants
MTEP	Mid-term Evaluation of the ESMAP Program
NG	natural gas
NGO	non-governmental organization
NOGUB-COSUDE	Programa de Apoyo a Organizaciones No Gubernamentales - Agencia Suiza para el Desarrollo y la

	Cooperación (*NOGUB-COSUDE*)
NPCC	National Program on Climate Change (*Programa Nacional de Cambio Climático*)
NPV	Net Present Value
PISA	Pan American Investment S.A.
PNB	*Programa Nacional de Bio-Masa* (National Biomass Program)
RE	rural energy
REF	Rural Electrification Fund
SHS	solar home system
SINER	*Sistema de Información Nacional de Electrificación Rural*
SIRESE	*Sistema de Regulación Sectorial* (Sector Regulations)
UDAPE	*Unidad de Análisis de Políticas Económicas* (Economic Policy Analysis Unit, Ministry of Finance)
VMEH	Vice Ministry of Energy and Hydrocarbons
YPFB	*Yacimientos Petrolíferos Fiscales Bolivianos* (National Oil Company)

Units of Measure

Cf	cubic feet	
TCF	Tera cubic feet	= 10^{12} cf
Bbl	barrel	
MMBbl	million barrel	= 10^{6} Bbl
W	watt	
Wp	watt peak	
KW	kilowatt	= 1,000 Watt
MW	megawatt	= 10^{6} Watt
KWh	kilowatt-hour	
GWh	million kilowatt-hour	= 10^{6} kWh
Ha	hectare	= 10,000 m^{2}

Currency Equivalents

Currency	Boliviano (b$)
1.0 b$	= US$ 0.142
1.0 US$	= b$ 7.029 (May 2002)

Executive Summary

Background

1. Over the past two decades, the Energy Sector Management Assistance Program (ESMAP) has financed several projects to assist Bolivia in the development of its energy sector. The Bolivia Country Program Phase I (1986–1997) contributed to the design of a National Energy Plan; to policies and actions applicable to rural energy and energy efficiency; and to a dramatic structural reform of the energy sector (see *ESMAP Bolivia: Final Report on Operational Activities, August 2000*).

2. Substantial private participation in the energy sector began after the sector was reformed. Foreign investment in the sector from 1996 to 2000 totaled US$794.6 million, of which close to 81 percent (US$641.4 million) went to activities in the hydrocarbons sector, and the remaining 19 percent (US$153.2 million) to operations in the electricity sector, not including investment in the Bolivia-Brazil gas pipeline.

3. Rural electrification in Bolivia covers about 23 percent[1] of the population, compared to about 50 percent national coverage. Since the Popular Participation and Administrative Decentralization Laws of 1994 and 1995, electrification has been carried out almost exclusively by prefectures and municipalities, with modest financial support from international cooperation and negligible private investment. In the period 1997–2000, about 70,000 additional rural households were connected to electricity service through about 150 projects, at a total cost of about US$65 million.

Program Objectives and Components

4. The ESMAP Bolivia Country Program Phase II (ESMAP II) consisted of two main components: Rural Energy (RE) and Energy Efficiency (EE). The activities under these components were designed to help the government consolidate the achievements of Phase I and make further progress in the following ways: (a) strengthen the government's capacity to ensure sustainable development of rural energy and energy efficiency activities; (b) create incentives for energy efficiency and the use of renewable energy sources; (c) ensure the effectiveness of technical assistance and financing mechanisms designed to develop rural energy and energy efficiency; and (d) develop projects to demonstrate the penetration of rural energy and the application of energy efficiency measures.

Mid-Term Evaluation of the Program

5. A mid-term evaluation of the program conducted in September–October 2000 found that progress made toward achieving the objectives was less than 50 percent, primarily due to the program's complex implementation arrangements. Implementation

[1] According to the 2001 census.

management consisted of a task manager and an energy specialist on the World Bank side, and two local coordinators (one for RE and one for EE) in the Secretariat of Energy, plus large a number of short-term local and international consultants contracted on an ad hoc basis for the numerous activities. Interactions among the local team and the ministries, donors, the prefectures and municipalities, the Center for the Promotion of Energy Efficiency (CPEE), the local NGOs, the chambers of commerce, and the associations representing economic sectors and enterprises, and the final users were extremely time consuming. In addition, the implementation arrangements involved the administration of an unusually large number of contracts, which created a heavy administrative burden on Bolivia and the Bank and contributed to project delays.

Program Cost and Financing

6. The Rural Electrification and Energy Efficiency components were both financed with a Netherlands grant equivalent to US$1.6 million. About US$1.3 million was disbursed by the time the grant closed on December 31, 2001, and the remaining amount of US$276,585 was reimbursed to the Netherlands.

Rural Energy Component

7. Despite these difficulties, the Rural Energy component realized activities on three fronts:

- *Development of demonstration projects.* This activity explored the viability of the following delivery mechanisms: (a) extension of distribution grids by existing concessionaires (“Model 1”); (b) facilitation of the supply of solar home systems (SHS) by private suppliers or dealers to commercially attractive areas (“Model 2”); and (c) supply of electricity services to very remote, isolated communities through NGOs (“Model 3”). Other demonstration projects that were identified and analyzed included water pumping for rural farms, PV-powered video equipment in rural learning centers, and passive solar energy for heating rural schools in the highlands. For these demonstration projects, demand, supply options, market potential, and market barriers were identified, and first market development measures on demand and supply side were implemented.

- *Design and implementation of financial mechanisms*. This activity focused on the design of a Rural Energy Fund to promote rural electrification projects sponsored by concessionaires.

- *Institutional development*, which focused on strengthening the capacity of government, at the central, prefecture, and municipal levels, to carry out rural energy and energy efficiency activities.

Demonstration Projects

8. *Model 1* aims to encourage existing private distribution companies (concessionaires) to supply electricity to rural populations where the extension of electric distribution lines is not technically or financially viable. There is a potential market of about 340,000 households for this model in the area of influence of the five concessionaires (Electropaz, Elfec, Elfeo, CESSA, and Sepsa) operating in the central and western parts of the country.

9. The projects would be eligible for funding by the new *Fondo de Electrificación Rural* (FER), which has received pledging totaling US$1 million by Bolivian investors. In addition, the Andean Development Corporation (ADC) and the International Finance Corporation (IFC) have expressed their interest in leveraging at least US$5.0 million with a 4:1 debt/equity ratio.

10. *Model 2* seeks to remove barriers to the introduction of solar home systems (SHS) in rural areas. It defines a commercially oriented delivery model that would enable private entrepreneurs to supply SHS and related services to rural consumers, mainly households. This activity was executed by two local firms that are connected to multinational SHS manufacturers. Demand studies were conducted in several areas that had been pre-qualified as particularly promising for Model 2. Preliminary business plans for the private-sector-based delivery of SHS-based services to these areas were drafted by the two companies. However, the firms did not succeed in mobilizing the amount of subsidies and commercial financing they had calculated for the target areas in their business plan and, hence, none of the pre-identified SHS-based rural electrification projects came to closure by the end of the project. The results of this component have been transferred to a new rural electrification project (Decentralized Energy, Information, and Communication Technologies for Rural Transformation Project) currently under preparation by the World Bank, and to an ongoing UNDP/GEF-financed SHS project.

11. *Model 3* focuses on NGOs, which can have a comparative advantage in promoting decentralized rural electrification projects at the micro-regional level and executing them within a sound institutional framework. They can also assist the rural population, village micro-grid operators, and SHS owners in setting up mutually agreeable community-based systems for billing and collection. A local NGO identified and prepared preliminary designs for a US$10 million portfolio comprising 376 rural electrification proposals, submitted by 72 local institutions. The results of this activity have been transferred to a new rural electrification project under preparation by Kreditanstalt für Wiederaufbau (KfW—the German Development Bank).

12. *Water pumping*. This activity aimed to identify feasible pilot projects for increasing farm productivity through water pumping from wells. Water pumping projects were identified for irrigation of quinoa (for export), alfalfa (feed stock for dairy cows), potatoes, and breeding of llamas and alpacas *(camélidos)*. However, none of the projects was realized because of insufficient regulations regarding land titles and water use rights.

13. *Passive solar heating of rural schools.* This activity studied the feasibility of using passive solar energy for heating rural schools, and prepared guidelines for the design of schools with solar energy heating, especially in the highlands. A study prepared under this project indicated that the learning success of children in the highlands could be significantly hindered by extremely low temperatures resulting from the lack of heating in their schools. The guidelines may serve as a starting point for including passive solar heating as standard practice in the design and construction of many other types of buildings. The activity also involved preparation of a project to refurbish one rural school with solar heating.

Institutional Development

14. ESMAP II supported several activities aimed at strengthening the capacity of the central, prefecture, and municipal governments in key aspects of rural and renewable energies:

- Preparation of a database on energy information as part of the Sector Regulatory System (*Sistema de Regulación Sectorial*, SIRESE), and update of the database on 115 mini-hydroelectric plants totaling 6,300 kWp.

- Training of human resources in prefectures and municipalities in rural energy demand analysis and planning and evaluation methodologies, and provision of the *Comisión Episcopal de Educación* (CEE) with PV-powered audio-visual equipment to upgrade staff knowledge of rural energy.

- Strengthening of the prefectures of La Paz, Oruro, Santa Cruz, Cochabamba, Chuquisaca, and Potosí in the planning and analysis of rural electrification projects.

- Restructuring of the government's Rural Electrification Program (*Programa Nacional de Electrificación Rural*, PRONER), and assignment of rural electrification tasks established in the Decentralization Law to the prefectures.

- Introduction of sound technical, economic, and social methodologies into the prefectures' processes for evaluation and selection of rural electrification projects. The prefectures established three main criteria for prioritizing rural electrification proposals: (a) that the project should have a positive Net Present Value (NPV) for social benefits; (b) that an operator be responsible for operation and maintenance of the project; and (c) that the project decrease by at least 15 percent the production costs of local industry (mills, water pumping, stations, grain producers, and the like).

- Adoption by the prefectures of single-phase electric lines with ground return as an important, low-cost technology option for rural electrification lines.

- Preparation of a *Manual for Rural Electrification Projects*, which has expedited the approval and execution of new rural electrification projects.

- Training of trainers on the rational use of energy resources and preservation of bio systems and biodiversity, to be delivered to officials from 15 municipalities and nine departments.

Energy Efficiency

15. The energy efficiency component carried out four main activities: (a) the execution of energy efficiency pilot projects; (b) the study of electricity demand-side management (DSM); (c) co-generation of electricity by various enterprises; and (d) the design of mechanisms supporting energy efficiency.

Execution of Pilot Energy Efficiency Projects

16. These projects were intended to demonstrate the technical and economic feasibility of applying energy efficiency measures to industries and to train professionals and enterprises in the implementation of energy efficiency measures. The seven enterprises participating in this activity were: Cervecería Ducal (beer, Santa Cruz), Cervecería Sureña (beer, Sucre), Embotelladora Embol (soft drinks, Santa Cruz), Frigorífica Frigor (food, Santa Cruz), Tusequis (food, La Paz), Universaltex (textiles, La Paz), and Quinbol Lever (chemicals, Cochabamba).

17. ESMAP provided the enterprises with technical assistance in metering their industrial processes; defining internal energy cost centers; implementing measures to save electricity, heat, and water; identifying and applying improvements to their industrial processes; implementing software to monitor energy consumption; and training technical personnel. The program also assisted enterprises in reducing demand during peak hours, and in negotiating with the power distributor the most appropriate contract for electricity supply. The industries procured and installed meters for electricity, natural gas, and water; equipment to improve the power factor of consumed electricity; and thermal insulation for pipelines. They also repaired or replaced low-efficiency electric motors and machinery. An international consultant led the implementation of the pilots.

18. All seven enterprises achieved significant energy savings. However, the potential remains for further energy savings once the current economic crisis is over. The economic crisis has depressed demand, masking the effect of some of the energy-saving measurers, and has deterred enterprises from further energy efficiency investments.

Study on Electricity Demand-Side Management (DSM)

19. This study analyzed the structure of the daily electricity load curves of the *Cooperativa Rural de Electricidad de Santa Cruz* (CRE) and the *Compañía Eléctrica de Sucre S.A.* (CESSA) and proposed changes on the consumer side aimed at flattening these curves. It also surveyed and determined the operating parameters of the electrical appliances available in Santa Cruz and Sucre.

20. The study recommended implementing four energy-saving measures:

- For *illumination*: switching from incandescent bulbs and fluorescent lamps with electromagnetic reactance to fluorescent lamps with electronic reactance. This measure would decrease electricity consumption by 70 to 80 percent in the first case and 20 to 30 percent in the second case, thus significantly reducing the evening peak;
- For *refrigeration*: replacing old refrigerators with new ones, which consume about 50 percent less electricity;
- For *water heating*: using natural gas instead of electricity;
- For *air conditioning*: improving the design and construction of houses and buildings by adding thermal insulation in walls and roofs. This measure would decrease electricity consumption by about 70 percent.

21. The study estimated that installation of these energy-saving measures would cost about US$23.7 million in Santa Cruz and US$2.9 million in Sucre. The measures would save about US$26.3 million for residential consumers in Santa Cruz and US$3.2 million for residential consumers in Sucre over a ten-year period. During the same period, the power utilities would achieve investment savings in power generating facilities of about US$ 90 million in Santa Cruz and about US$16 million in Sucre.

22. The study also identified financial, regulatory, and technical barriers to DSM, and the following measures to remove them:

- *Financing mechanisms to enable residential consumers to pay for energy-saving devices;*
- *The use of natural gas or liquefied petroleum to heat water* for bathing and other household needs;
- *Longer billing cycles;*
- *Studies of electric load curves* of power distribution utilities could be replicated by each power utility, and would help the utilities, consumers, and the regulatory agency to identify DSM measures and the regulatory changes that would make them possible. Such studies could also identify technical and financial barriers to energy efficiency and ways to remove them.

Co-generation Study for the Sugar Industry

23. This activity studied the potential for energy savings in the sugar industry and the feasibility of the sale of electricity surpluses generated by sugar processing. Two sugar refineries, Ingenio Azucarero UNAGRO (Minero – Santa Cruz) and Ingenio Azucarero GUABIRÁ (Guabirá – Santa Cruz), participated in the study. The energy audits carried out in these two enterprises measured the energy input to the production processes (crushing the sugar cane, production of waste in the form of bagasse, crystallization of the sugar) and the output of electricity surplus.

24. UNAGRO showed great interest in the results of the study and carried out its own feasibility study on co-generation, with the support of NPCC and the Swiss Government. The enterprise has also identified European and American institutions as potential partners for implementing the project recommended by the ESMAP-financed co-generation study.

25. Other important findings of the co-generation study are summarized below:

- *The competition introduced by co-generation could, in the long term, contribute to decreasing prices* paid for electricity by power distribution utilities and, consequently, by retail consumers;
- *The absence of regulations is constraining the development of co-generation;*
- *There are no regulations for setting a price for bagasse,* used as fuel for electricity generation;
- The *penetration of co-generation is constrained by a lack of public information.*

Mechanisms Supporting Energy Efficiency

26. *Technical assistance mechanisms.* The *Centro de Promoción de Tecnologías Sostenibles* (CPTS) was chosen to provide technical assistance in the rational use of energy, the introduction of energy-saving measures, and the establishment of practices to prevent or limit pollution created by economic activity. CPTS is educating government officials, the private sector, and civil society about energy efficiency and pollution prevention, and providing information and dissemination services upon demand. CPTS also liaises with other national and international institutions active in energy efficiency and pollution control. Its activities are being supported by USAID and the Government of Denmark.

27. *Financial mechanisms.* In an effort to remove the financial barriers facing energy efficiency and pollution control efforts, the World Bank/ESMAP and FUNDA-PRO (*Fundación para la Producción*) created the Biomass Fund in 2000. The Biomass Fund has US$1 million, and has already financed 53 biomass projects totaling US$389,000. Moreover, 99 projects totaling US$511,115 are pending approval by the financial intermediary. In 2001, the Biomass Fund decided to include energy efficiency and pollution control projects in the range of projects eligible for financing, based on technical assistance received by ESMAP II.

Lessons of Broad Applicability

28. Numerous studies and plans on rural energy and energy efficiency have been carried out in Bolivia by this and other ESMAP projects. However, these cannot show a record of achievements comparable to the impressive success of the technical assistance in the macro-restructuring of the energy business. Particularly, this ESMAP project delivered a wealth of data, analyses, designs, studies, and surveys that are now waiting for implementation by policymakers and interested parties. Why are they

waiting? The answer lies in the project's scope, its implementation arrangements, and exogenous conditions: a) the project comprised too many activities with different focuses that were to be executed simultaneously during a relatively short period of time, b) project implementation was coordinated by only two local professionals supervising numerous consultants, c) there were too many levels of administration and channels of communication with policymakers and d) subsidies for conventional fuels undermined possibilities for alternative energy sources.

Consequently, the lessons of broad applicability are:

- ESMAP projects should focus actions strongly on one or two major activities that are likely to have a successful outcome, especially if the project has a relatively small budget.
- Implementation of ESMAP projects should be started only when the policymakers have shown a definite commitment to the project.
- Subsidies for conventional fuels should be reduced or removed when alternative fuels would deliver a service equally or less costly than the subsidized fuel.
- The overhead cost of the project should be kept low by hiring as few consultants as possible.

1

Background: Rural Energy and Energy Efficiency

ESMAP Intervention in Bolivia

1.1 The Energy Sector Management Assistance Program (ESMAP) has been involved at several crucial points in the development of Bolivia's energy sector.

1.2 During 1986–1992, *a National Energy Plan was designed and implemented with ESMAP assistance.* The National Energy Plan strengthened the capacity of the former Ministry of Energy and Hydrocarbons in energy planning. It also defined energy policies aimed at: (a) ensuring the supply of economic and reliable energy to the internal market through the (then) state-owned national petroleum and gas (*Yacimientos Petrolíferos Fiscales Bolivianos,* YPFB) and national power entities (*Empresa Nacional de Electricidad,* ENDE), and the privately owned BPC; (b) promoting the rational use of energy in order to preserve the country's resources and reduce investment requirements; (c) boosting public finances by increasing energy sales; and (d) preserving the environment. The government attempted to implement these policies—though with limited success—by decentralizing decisionmaking, increasing investment in the sector while promoting efficiency in energy production and consumption, giving priority to the development and use of natural gas, and promoting the delivery of commercial energy to rural areas at adequate price levels. But because the National Energy Plan did not focus on rural energy or increased efficiency in end use, ESMAP subsequently carried out studies of energy supply and consumption issues in rural households.

1.3 During 1989–1991, *ESMAP carried out a study on enhancing the rational use of energy in critical sectors of the economy*, in order to promote balanced development. That study gave rise to the Household Rural Energy Strategy, which proposed: (a) decreasing the cost and improving the quality of lighting in rural households; (b) developing small, cost-efficient hydroelectric projects; and (c) improving the rational use of energy for cooking.

1.4 During 1993–1996, *the Action Plan on Rural Energy and Energy Efficiency (Phase I of the ESMAP Country Program)*, made a significant contribution to the design of policies and actions applicable to rural energy and energy efficiency. The

Action Plan coincided with implementation of a major economic reform program in 1994–1997, the most significant in the last 20 years. *Achievements of the rural energy component included:* (a) definition of a national Rural Electrification Strategy; (b) approval of a general regulatory framework for rural electrification; (c) establishment of the basis for definition of the National Rural Electrification Program (PRONER); (d) identification of basic problems related to the use of biomass as an energy source; and (e) design of the National Biomass Program. *Achievements of the energy efficiency component included:* (a) establishment of a situational report on final energy consumption, energy saving potential, and obstacles that impede the application of energy efficiency measures; (b) definition of a National Energy Efficiency Strategy; (c) development of the first experiences of energy diagnostics in industrial companies and the hotel sector; and (d) training of the first national technicians in energy audits.

1.5 During 1994–1997, ESMAP assisted in designing and implementing a *dramatic structural reform of the energy sector*, which took place in the context of a relatively undeveloped energy market. This included such actions as opening the sector to private agents by capitalizing YPFB and ENDE. The economic reform also included creation of the Sector Regulatory System (SIRESE), the preparation of which benefited substantially from the ESMAP studies. However, the reforms focused mainly on the cities, where the nascent energy market was sufficient to attract substantial private investment. It became clear that the structural changes in the energy sector were not sufficient to provide energy to large a part of the population (especially in rural areas), or to enable them to participate in the energy market. As a result:

1.6 During 1997–2001, Phase II of the ESMAP Country Program (ESMAP II) attempted to address the problems related to energy support and consumption that had been identified during Phase I. *This was considered crucial because of the impact of energy on other sectors, and because of the sector's close links to poverty reduction efforts, industrial competitiveness, and a clean environment.*

Institutional Setup and Allocation of Functions in the Energy Sector

1.7 The executive is responsible for both policymaking, through the Vice Ministry of Energy and Hydrocarbons (VMEH), and regulation of the sector, through the SIRESE. Private corporations and cooperatives are responsible for power generation and electricity distribution. Transmission of bulk power at high voltage levels is the responsibility of a government-owned transmission company, and management of the bulk power market and economic dispatch of electricity are done by the operations committee, comprising representatives of sector operators. Prices for electricity transmission and retail distribution are fixed by SIRESE, based on economic principles. Exploration, development, production, and transportation of natural gas and petroleum products are carried out by private companies; distribution of natural gas and petroleum products is administered by private companies and YPFB; retail prices for natural gas and petroleum products are fixed by the Superintendency of Hydrocarbons; and export of natural gas is run by YPFB as aggregator of gas produced by private companies.

Private Participation in the Sector

1.8 Private participation in the Bolivian energy sector became significant after the sector was reformed in 1994. Total foreign investment in the sector from 1996 to 2000—not including investments in the Bolivia-Brazil gas pipeline—amounted to US$794.6 million, of which close to 81 percent (US$641.4 million) went to activities in the hydrocarbons sector, and the remaining 19 percent (US$153.2 million) went to operations in the electricity sector. Annual investments in the energy sector reached a peak of US$333.1 million in 1998, but then declined to US$178.9 million in 1999 and to US$65.4 million in 2000.

Rural Electrification and Rural Energy

1.9 Electricity coverage in Bolivia is about 20 percent in rural areas, compared to national coverage of 50 percent. Since the Popular Participation and Administrative Decentralization Laws of 1994 and 1995, rural electrification has been carried out mainly by the prefectures and municipalities, with modest financial support from international donors, and negligible private investment. In the period 1997–2000, about 70,000 additional households were connected to electricity service through 150 projects costing about US$65 million. The lack of private investment utilizing gas-fueled plants instead of diesel-fueled generators in small cities far away from the interconnected power system—e.g., Trinidad and Cobija—has been draining fiscal resources, since diesel fuel is subsidized in amounts exceeding US$8 million a year. With regard to the consumption of rural energy other than electricity, 90 percent of rural households use biomass in the form of firewood and dung for cooking, which has direct negative impacts on family health and the environment.

1.10 Rural electrification has encountered a series of political and economic obstacles. Among them: (a) political action in the energy sector still focuses on hydrocarbons, the extension of gas networks for export, and urban electrification, since these sectors have an enormous impact on fiscal revenues; (b) the private sector lacks knowledge of the potential of rural markets, and lacks funding; (c) most energy sector agents know very little about renewable energy; and (d) the country lacks an adequate regulatory framework for rural electrification. Although decentralization and popular participation have had a positive impact on the situation in rural areas, the lack of appropriate regulations for rural areas means that many areas are not considered good risks by potential investors. Furthermore, public investment norms hinder private sector co-financing. Finally, there is a lack of coherence and coordination between rural electrification policies at the central government level and rural electrification implementation at the local level.

Energy Efficiency

1.11 Problems in the energy sector are also closely related to consumption in the domestic market, and to the fact that most consumers, particularly enterprises, lack a culture of energy efficiency. This is reflected in Bolivia's relatively high energy intensity, measured as the ratio of total final energy consumed to total gross domestic product. In

1999, the value of Bolivian energy intensity, expressed in constant 1990 U.S. dollars, was 3.1 (BOE/US$1000). This was more than the energy intensities of Argentina (1.6 BOE/US$1000), Brazil (2.1 BOE/US$1000), Peru (1.7 BOE/US$1000), and Chile (2.5 BOE/US$1000).

1.12 Implementation of energy efficiency measures has been constrained by the absence of companies and trained professionals who can help enterprises determine their characteristics of consumption; identify energy efficiency measures, including upgrading equipment; and determine their potential for co-generation.

2

Program Objectives, Components, Cost and Financing, and Implementation

Program Objectives

2.1 The central aim of ESMAP II was to enhance the sustainability of rural energy and energy efficiency activities by means of funding, technical assistance, and local training.

2.2 The specific objectives of ESMAP II, as stated in the Initiating Brief for a Trust Fund,[2] were to help the government achieve its policy objectives in the fields of rural energy and energy efficiency; and to develop the Energy Secretariat's capacity to implement, monitor, evaluate, and adjust policies and projects in the energy sector. This was to be achieved through institutional support and technical assistance to the Energy Secretariat to improve policies and sector regulations, and through technical interventions. These objectives were in line with the objectives and (partly unfinished) achievements of Phase I. In particular: (a) the Energy Secretariat was still too weak to ensure the sustainable development of rural energy and energy efficiency activities; (b) the existing regulatory framework lacked incentives to promote energy efficiency and the use of renewable energy sources; (c) the technical assistance and financing mechanisms designed to develop rural energy and energy efficiency were not fully functioning; and (d) there was a lack of a significant number of actually implemented pilot projects ("success stories") to demonstrate to all sector agents the potential of rural energy and energy efficiency measures.

2.3 To address this situation, the ESMAP II Project was designed according to the following principles:
Support for local investment rather than central investment

- Promotion of involvement of local stakeholders
- Support for local institutions related to the market and technology
- Ensuring a favorable environment for investment

[2] Initiating Brief for a Trust Fund and *ESMAP/Banco Mundial*, *Secretaría Nacional de Energía*, ESMAP Country Programme, *Fase II* , *La Paz, Junio de 1997*.

- Reduction of market distortions and enhancement of competition
- Consideration of new technologies to improve project implementation

Program Components

2.4 Originally, ESMAP II comprised three components: (a) Rural Energy (RE); (b) Energy Efficiency (EE); and (c) Biomass. However, the biomass component was separated from the program and converted into a large self-standing program. The RE and EE activities were designed to: (a) strengthen the National Energy Secretariat; (b) develop and strengthen the support mechanisms for RE and EE; and (c) develop concrete actions to demonstrate and disseminate the results of pilot projects.

2.5 *The mid-term evaluation of the program*[3] in September/October 2000 led to changes in its scope and activities. The evaluation revealed that: (a) program objectives were too ambitious in relation to the timeframe and the large number of parallel activities envisioned; (b) less than 50 percent progress had been made toward achieving the original objectives, with the biomass component lagging the most; (c) management problems had negatively affected the performance of the Bolivian team; and (d) a lack of focus on clients' needs by the Bolivian team had resulted in insufficient promotion of the program's products among ministries, donors, NGOs, and other stakeholders. The evaluation report recommended: (a) extending the program through December 31, 2000; (b) preparing an action plan to complete activities that would capitalize on ESMAP's strengths within the extended timeframe; (c) establishing better relations with clients, especially major decisionmakers in the government, donors, and NGOs; (d) clearly defining the tasks of ESMAP Bolivia, Bank staff in Washington, and the Bank's resident mission; and (e) expediting responses by Bank and Bolivian teams to mutual consultations, and intensifying Bank supervision.

Program Cost and Financing

2.6 The ESMAP Phase II program (RE, EE, and Biomass components) was to be implemented during the period of January 1997 to June 2000 (later extended to December 31, 2001) at a total cost of US$4.0 million. The RE and EE components are financed with a Netherlands grant of NLG 3,391,254 (Trust Fund TF022187–BO017901), equivalent to US$1,614,883. Tranches 1 and 2 of the grant, in the amount of NLG 1,017,876 and NLG 1,356,502, respectively, were released and disbursed in the period 1998–1999. Tranche 3, in the amount of NLG 1,017,376, was released in 2000. A balance equivalent to about US$240,000 was not disbursed before the closing date, December 31, 2001, and was canceled. The Biomass component was financed by another grant under the National Biomass Program and is the subject of another report.[4] (For further information on program costs, see Annex 7.)

[3] *Report on ESMAP-Bolivia Country Program Phase II and Bolivia National Biomass Program, Mid-Term Evaluation,* November 12, 2000.

[4] The Biomass component (US$2.4 million equivalent) was financed with grant TF022188-BO001110.

Program Implementation Arrangements

2.7 Under the original implementation arrangements, ESMAP was to coordinate and administer the program through a local team responsible for program execution. A Bank task manager (planning expert), assisted by an energy economist, was to guide and supervise the activities of the local team, operating under the National Secretariat of Energy, in cooperation with the National Directorate of Energy and Investments. The local team was also supposed to interact with the Investment Fund for New Energies (FINE), the Center for the Promotion of Energy Efficiency (CPEE), and the prefectures and municipalities, as well as with NGOs, chambers of commerce, and associations representing the various economic sectors and enterprises, and the final users. The local team was to comprise a coordinator (head of the team), six local engineers, two local economists, and seven international specialists in renewable energy, energy efficiency, rural energy, planning, and energy economics.

2.8 The actual implementation, however, had different arrangements. Although the Bank provided a task manager and an energy economist, the local team consisted of only two local coordinators (one for RE and one for EE) in the National Secretariat of Energy, while numerous local and international consultants were contracted on an ad hoc basis. This arrangement resulted in complex interactions between the local team and the ministries, donors, and NGOs associated with the program. Moreover, the negotiations and follow-up of the unusually large number of contracts and subcontracts generated by this arrangement, and the processing of payments for consultant services, created a heavy administrative burden on the Bank, which contributed to delays in many project activities.

3

The Rural Energy Component

3.1 The central objective of the rural energy component was to design and test mechanisms or models to provide rural populations with access to electricity. It consisted of activities on three fronts: (a) development of demonstration projects; (b) design and implementation of financial mechanisms; and (c) institutional development of the central government and government agencies. The activities were guided mainly by the geographical distribution of the population lacking electricity (about 3 million people). About 25 percent of that population (190,000 households) are more than 35 km from the distribution grid, and 20 percent (150,000 households) are in completely isolated areas. The remaining 55 percent (410,000 households) are located 10 to 35 km from the grid, which makes these households potential candidates for grid connection.

3.2 The demonstration projects explored the viability of three models for delivery mechanisms (see table 1): (a) extension of distribution grids by concessionaires; (b) creation of a commercial system for the supply of solar home systems (SHS) by private vendors; and (c) supply of electricity to isolated communities through NGOs. Other demonstration projects—targeted to the highlands—included water pumping for rural farms, and solar energy for heating rural schools.

3.3 The financial mechanisms activity sought to promote a private lending institution—a Rural Electricity Fund (REF)—for rural electrification projects sponsored by concessionaires (see Annex 3). The institutional development activity focused mainly on strengthening the Vice Ministry of Energy and Hydrocarbons (VMEH) in the technical and economic aspects of energy sources suitable for rural areas.

Table 3.1: Three Models for Rural Electrification

	Target population	*Subsidies to:*	*Technology*	*Supplying agent*
Model 1	Near presently existing grids (380,000 households)	Fixed assets: •Sub-transmission grids	• Ground return • Single-phase grids	Concessionaries: •Co-financing •Project execution •Operation
Model 2	Dispersed, with access (180,000 households)	Transaction cost reduction: •Marketing •Training •Information	• Photovoltaic solar home systems (SHS) of different sizes	Suppliers: •Co-financing •Project execution Local subsidiaries: •Operation
Model 3	Isolated, without access (150,000 households in extreme poverty)	Fixed assets, including: •Training •Information •Productive uses	• MHC, minigrids, small photovoltaic systems	Non-governmental organizations: •Co-financing •Project execution Local subsidiaries: •Operation

Demonstration Projects and Financial Mechanisms

Extension of Distribution Grids by Concessionaires (Model 1)

3.4 The objective of this activity (September 1999–January 2001) was to design and test an electricity delivery mechanism aimed at encouraging private distribution companies (concessionaires) to supply electricity to a segment of the rural population that was (a) currently without access to electricity, but (b) living at sites where the extension of electric distribution lines was feasible under certain technical and financial conditions.

3.5 This model was expected to be suitable for extending electricity distribution to about 340,000 households in the areas of influence of five concessionaires operating in the central and western parts of the country (Electropaz, Elfec, Elfeo, CESSA, and Sepsa—see table 2). These concessionaires have expertise in evaluating, executing, and operating grid-connected electrification projects; they also have the resources to finance part of the initial investment required by viable projects.

Table 3.2: Principal Characteristics of the Concessionaires

	ISD (%)	*Total no. of houses in area of influence*	*Houses with electricity in area of influence*	*Coverage in the area of influence (%)*	*Houses without electricity in the area of influence*
ELECTROPAZ	4.1	364,107	252,068	69.2	112,039
ELFEC	43.4	292,408	165,780	56.7	126,628
ELFEO (Oruro)	11.8	64,917	39,278	60.5	25,639
CESSA	30.0	72,987	33,149	45.4	39,839
SEPSA	12.4	67,757	30,068	44.4	37,689
TOTAL		**862,176**	**520,342**	**60.4**	**341,834**

Notes: Area of influence is defined as the total number of cantons where the company has activities related to electric power supply. ISD (*Indice de Servicio Departemental*; Departmental Service Index) is the relation between the number of cantons where the company is present and the total number of cantons in the department.
Source: Indicative Rural Electrification Plan—UDE/ESMAP-VMEH-1998

3.6 ESMAP decided to test Model 1 by designing a pilot project that would increase the density of rural household connections to the existing grids of the five concessionaires. The main design parameters of the model were as follows:

- Implementation period: five years
- Target population: 80,000 households
- Technical design: Single-phase electric networks with ground return
- Eligible projects:
  - Average connection investment per household: US$600
  - Contribution to investment by concessionaire: US$500 per connection
  - Subsidy to investment by municipalities and prefectures: US$100 per connection
  - Price to be paid by household: a flat tariff to be paid for a fixed number of kWh consumed monthly. The tariff would recover only the operating costs and the investments made by the concessionaires.
- Estimated investment: US$48 million, of which the concessionaires would finance US$40 million and the municipalities and prefectures would finance US$8 million.

3.7 Concessionaires would be eligible for a US$100 subsidy per connection if they committed to meeting these conditions.

3.8 An investment bank, Panamerican Investments S.A. (PISA), was contracted to design the financing mechanism for and promote the implementation of Model 1 under the following mandate:

- Mobilize private and public funds to assist electric distribution enterprises (concessionaires) in executing rural electrification works, particularly the connection of rural consumers to the distribution grid.

- Materialize public and private co-financing of rural electrification projects, including the subsidy incentives provided by the government and funds mobilized by the private sector and/or the concessionaires.

- Act as organizer, agent, facilitator, and, in some cases, executing agency of rural electrification projects. In all cases, the concessionaires would implement the project agreements.

- Provide electricity service to at least 80,000 new rural users. Implementation period: 48 months. For this purpose, PISA would attempt to ensure that distribution systems with concession contracts expand their systems, and that those without concession contracts (e.g., cooperatives) be converted to corporations or capitalized, and expand and strengthen their systems.

3.9 *Achievements*. Although none of the action plans that were designed have yet been executed, this activity has:

- Designed the Rural Electrification Fund (REF), with the likely participation of local private financial partners: (a) PRODEM pledged US$1.0 million; (b) Transredes pledged US$10.0 million to create a PRONER Foundation once FER is operating; (c) *Transportadora de Electricidad* indicated that it could contribute US$0.5 million to the REF; and (d) Procrédito, a microfinance entity, expressed keen interest in investing in the fund. Pension funds are prohibited from contributing to the REF by financial sector regulations.

- Interested the Andean Development Corporation (CAF) and the International Finance Corporation (IFC) in participating in the fund. The intention is to leverage at least US$5.0 million, with a 4:1 debt/equity ratio, to finance projects such as the expansion of the National High-Voltage Interconnected System and construction of high-voltage tie lines, and replacement of power generation sources in small, isolated systems.

- Conducted a survey of 50 electric enterprises that identified six entities as potential participants: Electropaz and Elfeo have definitely shown interest in the REF; Elfec and CRE indicated that they would join the REF once it is operational; and CESSA and Coset were converted from cooperatives to corporations, and therefore are considered good potential participants in the REF.

- Identified sector regulations as the main barrier to rural electrification, since the regulations do not consider the particular characteristics of rural markets. For example, the prevailing standards requiring high quality of service and the use of certain methodologies to measure electric loads are not appropriate for provision of electricity to rural consumers.

3.10 *Sustainability and replication.* These issues cannot be evaluated at this time because the REF is not yet in operation. In the future, the fund could become an important financing source for rural electrification projects in Bolivia.

Creation of a Commercial System for SHS Supply by Private Suppliers (Model 2)

3.11 The objective of this activity (January 2000–October 2000) was to create and test a commercial system enabling private entrepreneurs to supply SHS and related services to rural electricity consumers—mainly households. The commercial system would be designed to overcome barriers to the introduction of SHS in rural areas.

3.12 In Bolivia, as in other developing countries, the main barriers to private entrepreneurs introducing SHS in rural areas—and to rural populations accepting SHS technology—are: the lack of information about the number and geographical distribution of potential rural consumers (the rural market); the low capacity of rural consumers to pay for SHS; the lack of knowledge on the part of potential users and suppliers about the costs of and potential of SHS technology; and the lack of consumer credit, commercial credit, and subsidies for financing the relatively high initial investment cost for rural households. These barriers give rise to the perception that rural SHS projects are high risk (and in turn increase rates for commercial financing). ESMAP II designed and tested several measures for the removal of these barriers, as explained below.

3.13 Two local firms connected to multinational manufacturers of SHS—Alke and Sercoin—were contracted to execute program activity. In practice, these firms acted as intermediaries between the ESMAP team and the subcontractors who conducted the market surveys and public information campaigns. Based on the demand studies, the two local firms prepared draft business plans that were supposed to lead to a subsequent implementation of SHS projects in the target areas. However, the firms did not succeed in mobilizing the significant subsidies (and the commercial financing) they had calculated for SHS-based rural electrification projects with private participation in the target areas. Therefore, the outcome of this activity was not satisfactory. However, the business plans and demand data will be used in the preparation of future SHS projects.

3.14 There have also been some independent attempts, not linked to the ESMAP program, to introduce SHS. For example:

- In Santa Cruz, the CRE is implementing a relatively large rural electrification project based on SHS. It comprises the provision of electricity to rural households through the installation of 5,000 SHS. The initial investment cost is being financed with a 60 percent subsidy from the government. The monthly flat tariff, amounting US$9.0 per household, is expected to recover CRE's 40 percent investment cost, and the operation and maintenance costs of the system. When completed and proven to be commercially viable, this project will be a good example of SHS technology in rural Bolivian households. Currently, however, there seem to be issues regarding the long-term sustainability of service in this project.

- In La Paz, Cochabamba, and Santa Cruz, five existing dealers are selling an aggregate of about 1,000 units of 50-Wp SHS per year to urban customers, who install and operate the systems without any guarantee from the dealers. The dealers operate only in urban and peri-urban areas.

3.15 *Achievements*. Two demand studies were carried out by Sercoin and Alke. Sercoin surveyed 748 households in 120 communities spread over nine municipalities (Ravelo, Ocuri, Tupiza, Challapata, Atocha, Cotagaita, Vitichi, Pocoata, and Uyuni) and found that the average monthly capacity to pay ranged from US$2.75 to US$5.40. Alke surveyed 384 households in six municipalities (Camargo, San Lucas, Las Carreras, Incahuasi, Culpina, and Villa Abecia) and found that the capacity to pay ranged from US$2.25 to US$15.0, depending significantly on the income of the household.

3.16 Sercoin made several field visits to rural communities to demonstrate the operation of portable SHS, and distributed more than 1,200 brochures on the characteristics and use of SHS technology to heads of households.

3.17 Based on the demand studies, the two companies presented draft business plans for private-sector-led service delivery to the target areas based on SHS.

3.18 In addition, ESMAP II offered incentives to suppliers and operators in the form of subsidies to finance part of the initial investment required for SHS-based rural electrification projects. A request for submission of bids for SHS projects generated several project proposals that have not yet been implemented.

3.19 At this time, it cannot be concluded whether the delivery models for private-sector-led rural SHS that have been proposed by these two companies could be successfully replicated or would be sustainable in other areas.

Supply of Electricity to Isolated Communities through NGOs (Model 3)

3.20 The objective of this activity (August 1999–December 1999) was to design a mechanism to facilitate the participation of NGOs in the supply of electricity to people living in very isolated rural communities. It was based on the idea that NGOs have comparative advantages in identifying and implementing rural electrification projects at a micro-regional level, and in evaluating, co-financing, and executing such projects within a sound institutional arrangement. Although NGOs generally lack expertise on SHS, they are skilled at organizing rural communities and arranging training and technical assistance. NGOs could also help set up community-based systems for billing and collection that would be satisfactory to both consumers and suppliers/operators. Moreover, contrary to the profit-oriented objectives of concessionaires and SHS dealers, NGOs are less interested in obtaining high rates of return on rural electrification investments (to compensate for the high risk involved).

3.21 The SHS projects would target rural households that were extremely remote from electricity distribution lines and currently out of the reach of suppliers of SHS and related services. The NGO NOGUB-COSUDE was in charge of this activity.

3.22 *Achievements.* From 376 proposals submitted by 72 institutions, NOGUB-COSUDE identified and prepared preliminary designs for a US$10.0 million portfolio of rural electrification projects congruent with the parameters of Model 3. KfW (Germany) has shown interest in supporting that portfolio and encouraging private sector investment in those projects. KfW is conducting studies to ensure that a German grant of US$2.0 million is allocated to rural electrification projects with productive components such as water pumping.

3.23 Model 3 is expected to be sustainable and replicable as long as it is supported by agencies such as KfW.

Water Pumping for Rural Farms

3.24 The objectives of this activity (May 1998–December 1998) were to identify at least six cases where underground water pumping would increase the productivity of rural farms, and to implement, where feasible, three of them as pilot projects.

3.25 Pumping water from the water table (5 to 35 meters underground) to be used for irrigation and drinking could significantly increase the production of quinoa, alfalfa, and potatoes, and the breeding of llamas and alpacas *(camélidos)* in the highlands. About 145,000 ha in the provinces of Oruro, Potosí, La Paz, and Chuquisaca are being used for farming quinoa (15,000 ha), alfalfa (30,000 ha), and potatoes (100,000 ha) in relatively dry areas of the highlands, where superficial water is scarce. Quinoa is grown mainly for export, alfalfa is a feed stock for dairy cows, and potatoes are for general consumption.[5]

3.26 The pilot projects to be supported by this activity had to fit four key parameters:

- Ensure the supply of underground water in places where precipitation is near zero or the capacity to store rainwater is insufficient or non-existent;

[5] Quinoa farmers are represented by two institutions, the *Asociación Nacional de Productores de Quínua* and the *Central de Cooperatives Operación Tierra*, which provide them with quality control and export services. In the central highlands, milk farmers have the *Asociación de Productores de Leche*, which helps ensure the availability of sufficient alfalfa for feeding their cows. The *Asociación de Productores de Camélidos* assists *camélido* farmers in the production and commercialization wool, leather, and meat.

- Identify a potential market of at least 40,000 ha where underground water pumping could sustain economic farming, with investment in the range of US$3,800 to US$4,200 per ha. The total maximum investment would be US$168 million;

- Strengthen farmer organizations by involving them in the execution of the water pumping project; and

- Develop one of the projects to irrigate at least 1,000 ha with underground water pumping, at a cost not to exceed US$3,800 per ha. Renewable energy sources were to be used wherever they were less costly than extending the electric distribution lines. Project financing had to include the participation of private investors and/or financing institutions specialized in rural credits.

3.27 *Achievements.* Four potential water-pumping projects were identified for farming quinoa, alfalfa, and potatoes, and providing water for breeding *camélidos.* None have yet been implemented because of insufficient regulations on land titling and water use rights. Consequently, the sustainability and replication of these projects have not yet been tested. The preparation of the projects, however, has laid the groundwork for future implementation:

- *Quinoa project:* It was found economic and profitable to build and operate a 200-km distribution line to power electric water pumps for irrigation in the Uyuni-Colcha region. The project proposes to use electric water pumps instead of diesel pumps. The electric line would allow water pumping at the farming sites and replace the current practice of transporting an average of 50m^3 of water per ha twice a year from distant places, where water is pumped using diesel.

- *Alfalfa project:* It was found economic and profitable to build and operate a 20-km electric distribution line to power electric water pumps for irrigation in the Pacamaya region of the central highlands.

- *Potato project:* It was found economic and profitable to construct and operate a 50-km electric distribution line to power electric water pumps for irrigation in the Pampas del Moje region in the southern highlands. The availability of plenty of water would make it possible to use advanced farming methods, including fertilizers, pesticides, and new potato varieties.

- *Drinking water for camélidos*: It was found economic and profitable to use solar-powered electric water pumps to tap underground water in quantities sufficient for the breeding of llamas and alpacas.

Passive Solar Heating of Rural Schools

3.28 The objectives of this activity (May 1998–May 1999) were to study the feasibility of using passive solar energy for heating rural schools, and to prepare guidelines for designing schools with solar energy heating. This is in keeping with the goals of the Bolivia education reform, which aims, inter alia, to improve the physical infrastructure of hundreds of new schools throughout the country. It is also in keeping with the broader policy objectives of using renewable solar energy for heating, where feasible, and the application of energy efficiency measures. Where solar heating is feasible, it would displace LPG, electricity, and firewood as heating sources—or allow for heating in cases where schools are currently not heated at all.

3.29 The use of solar heating in schools is expected to improve the performance of students and teachers by creating a less uncomfortable environment. This is particularly important in the highlands, where temperatures are often as low as $-8\ ^{o}$ Celsius during the winter. A comfortable air temperature is in the range of 20 to 24 ^{o} Celsius.

3.30 *Achievements.* The study identified key factors influencing the design of schools equipped with solar heating:

- The outside walls of the building should enclose as many rooms as possible, in order to diminish exposure to the outside air temperature.
- The orientation of the largest side of the building should be NE-NW, to maximize the building's exposure to solar radiation.
- The south side of the building should have corridors to provide a proxy for an insulated south wall.
- The walls of the rooms exposed to solar radiation should have windows with an area equivalent to 15 percent of the floor area. This would also enhance the illumination of the rooms.

3.31 *Sustainability*. Based on these findings, a project to refurbish a rural school with passive solar heating, and a general guide for the design and construction of school buildings with passive solar heating, were prepared and made available to architects, engineers, and municipalities. The guide may serve as a starting point for preparing design and construction standards for other types of buildings using solar heating.

Institutional Development

3.32 The ESMAP II program supported several activities aimed at strengthening the capacity of the central government and selected government agencies in key aspects of rural and renewable energy. The program prepared a database on energy information, updated the database on mini-hydroelectric plants, and trained human resources in the prefectures and municipalities in rural energy demand analysis, and planning and evaluation methodologies.

3.33 ESMAP II also provided the *Comisión Episcopal de Educación* (CEE) with audio-visual equipment intended to upgrade staff knowledge of rural energy; Information and Communication Tecnology based services (such as phones, TV, video, computers, and the Internet) have been identified as another important potential use of electricity in rural areas of Bolivia. They are especially suited for the application of renewable energy technologies, as they promise a high local value-added at relatively low energy and power demands. Several rural learning centers of the CEE have been provided with photovoltaics powered video equipment, and CEE has developed curricula for adult education in the field of alternative energy.

The Rural Energy Information System (SINER)

3.34 The objective of this activity was to design and construct a database and the associated software for operating an Information System on Rural Energy (SINER), and to make them available to institutions, professionals in rural energy, and the public (see Annex 3).

3.35 *Achievements.* A consulting firm (SISTEMÁTICA) developed the database and input basic information on rural electrification. Twenty copies of the database were distributed to the VMEH, government agencies, and NGOs.

3.36 *Sustainability.* It is uncertain whether SINER will be sustainable, since VMEH has not allocated resources for updating and maintaining it, or for creating a Web page to facilitate public access. VMEH also needs to be proactive in coordinating the collection and evaluation of data entered into SINER.

Updating the Database on Mini-hydroelectric Plants

3.37 The objectives of this activity (May 1998–July 1998) were to create a database on hydroelectric projects of less than 500 kW, and develop a program of mini-hydroelectric plants (MHP) to be promoted by VMEH.

3.38 *Achievements.* A consultant updated and expanded the database on MHP prepared by Bolivia in 1988 with Bank support. A total of 115 projects and sites were identified as suitable and economical for constructing mini-hydroelectric plants totaling 6,300 kW at an estimated investment cost of US$17.2 million. This corresponds to an average 55 kW per project, requiring an investment cost per project of US$150,000 or the equivalent of about US$ 2,750 per kW installed.

Strengthening of Prefectures in Rural Electrification Planning

3.39 The objective of this activity (May 1998–July 2000) was to assist the prefectures in the planning and analysis of rural electrification projects.

3.40 The prefectures of La Paz, Oruro, Santa Cruz, Cochabamba, Chuquisaca, and Potosí participated in this activity (see Annex 5, table A5.1). The prefectures rely on different agents to develop and operate rural electrification projects. La Paz and Oruro rely only on local enterprises and electric cooperatives (which must be transformed into corporations within four years, in order to be recognized as valid agents for developing and operating RE projects). Santa Cruz and Cochabamba rely only on concessionaires, and Chuquisaca and Potosí rely on both concessionaires and local cooperatives (see Annex 5, tables A5.2 and A5.3).

3.41 All six prefectures have a Rural Electrification Unit, whose staff were trained by ESMAP II in the evaluation of proposed rural electrification projects using sound technical, economic, and social analyses. The training had a positive impact on the operation of rural electrification projects, the technologies used, and, ultimately, on the quality of the projects. The evaluation and selection of rural electrification projects are no longer guided by political criteria but, rather, by sound technical, economic, and social methodologies.

3.42 *Achievements.* PRONER was restructured and the prefectures were assigned the rural electrification tasks established by the Decentralization Law.

3.43 The prefectures adopted the following main criteria for prioritizing rural electrification proposals: (a) the project should have a positive NPV for the net social benefits; (b) an operator responsible for operations and maintenance (O&M) of the project should be appointed; and (c) the project should decrease by at least 15 percent the production costs of local industries (e.g., mills, water pumping stations, grain producers). The fulfillment of these criteria will be essential for VMEH to support or finance the proposals submitted by the prefectures.

3.44 The prefectures adopted single-phase electric lines with ground return as the preferred technology for rural electrification lines. For typical rural applications, this technology is economically superior to the three-phase electric lines utilized in the past.

3.45 A Manual for Rural Electrification Projects was prepared and is now used by most prefectures and consulting firms. The use of this manual has expedited the approval and execution of new rural electrification projects.

3.46 *Sustainability.* The approach to rural electrification projects adopted by the VMEH and the prefectures is likely to be sustainable. The prefectures now have staff trained in planning and analysis of rural electrification, based on simple but rational technical and economic methods. They also have a manual guiding project design and evaluation. However, there is room for further capacity building on this level.

Strengthening of Municipalities in the Rational Use of Energy

3.47 The objective of this activity (December 1998–May 2000) was to educate the business community and provide training to trainers from the educational units of the *Facilitadores de Educación Rural Integral Alternativa* (FERIA) in the rational use of rural energy resources and preservation of the environment (biosystems and biodiversity). The aim was to develop social capital as a way of enabling the poor to address their problems related to the inadequate use of energy and environmental resources.

3.48 Fifteen municipalities from nine departments participated in the activity, which was led by the *Comisión Episcopal de Educación.*(see Annex 5, table A5.1).

3.49 *Achievements.* A total of 283 technicians from the *Centros de Educación Técnica, Humanística y Agropecuaria* (CETHAs) were trained; energy and environmental diagnostics were carried out in 13 communities; profiles were prepared for five community projects; seven demonstrations of energy technology were carried out; a curriculum in energy and environment was prepared; and a training program for trainers was developed.

3.50 *Sustainability*. The training of trainers is expected to make this activity sustainable.

Strengthening of Empresa de Electricidad Larecaja (EDEL)

3.51 The objective of this activity (November 1998–January 1999) was to support EDEL, a state-owned power distributor, in improving its load factor by incorporating new loads from mining and agro-industrial companies in Caranavi, Yungas (North and South), Larecaja, and Muñecas; and to decrease the deficit in EDEL's year-end results by means of a tariff study. At the present time, EDEL has insufficient power demand to cover its financial and operational costs.

3.52 *Achievements.* A diagnostic carried out in the area showed that none of the agro-industrial companies had connected to the system—all of them were still using diesel for their activities. The same was true of some of the mining companies left in the area. The study identified two reasons for this situation: (a) a fall in gold prices caused some mining companies to close down, resulting in the EDEL project being oversized; and (b) diesel is subsidized, and diesel stamp prices are lower than the cost-per-unit of useful energy, making diesel the cheaper alternative.

3.53 To improve the situation, the diagnostic proposed:

- Establishing competitive and attractive tariffs for mining and agro-industrial companies, and incentives for local private financiers to finance conversions from diesel to electricity.

- Implementing load management programs.

- Transfering operation and maintenance to Electropaz, to allow for explicit cross-subsidies between the city of La Paz (200,000 connections) and Larecaja (3,500 connections).

- Extending the transmission line from Caranavi to Ituba and later to Trinidad. This would increase the demand to 10 MW and facilitate the replacement of subsidized diesel with electricity.

3.51 Despite these proposals, EDEL's situation has worsened because it was obliged, for political reasons, to reduce its tariffs, thus creating an even-greater deficit that must be covered by the state. In addition, the public bidding process for the transmission line from Caranavi to Trinidad was abandoned. EDEL is now being prepared for privatization, and needs to attract the industrial sector, improve the load factor, and reduce its fixed costs.

4

The Energy Efficiency Component

4.1 The aim of the Energy Efficiency Component (US$600,000) was to introduce the energy efficiency approach in end use, in order to increase economic competitiveness and reduce the impacts of energy use on the environment. The Energy Efficiency Component comprised four main activities: (a) execution of energy efficiency pilot projects; (b) study of electricity demand-side management; (c) co-generation of electricity by the sugar industry; and (d) design of mechanisms supporting energy efficiency.

Energy Efficiency Pilot Projects

4.2 The objectives of these projects (August 1999–November 2001) were to: (a) generate demand for energy efficiency in industry by demonstrating the technical and economic feasibility of applying energy efficiency measures in industry; and (b) contribute to training professionals and enterprises in the implementation of energy efficiency measures. The projects introduced, in seven enterprises, the mechanisms required for the rational management of energy in different production processes (see Annex 6, table A6.1).

4.3 Specific objectives were to:

- Provide every participating industry with methodologies and techniques to obtain, systematize, and analyze the information on energy consumption and management.
- Provide the companies with the methodologies and techniques required to determine energy-savings goals to be achieved in every company, as well as to monitor the actions to be developed.
- Establish in every company the analyzing techniques and criteria required for energy management.
- Define the organization and incentives neCessary for efficient energy management.
- Achieve the energy savings levels determined in the proposed goals.
- Evaluate the financial and economic benefits, as well as the sustainability of the implemented mechanisms and obtained results.

4.4 In each of these companies, ESMAP provided the neCessary technical assistance for the implementation of energy efficiency measures, whereas the companies committed to making the investments neCessary to achieve the programmed savings.

4.5 Technical assistance included:

- Plant measurements
- Definition of Energy Cost Centers
- Definition of electric and thermal-energy and water-consumption saving measures
- Advice for changes to be implemented in the companies
- Installation of software for monitoring the consumption of energy, and
- Training of technical staff.

4.6 The companies had to invest in:

- The purchase and installation of electricity, natural gas (NG), and water meters
- The purchase and installation of equipment for correction of the power factor
- The purchase and installation of isolation for pipes
- Repair of machines with losses
- Change of engines
- And other energy-saving measures.

4.7 SAGE, a Brazilian consulting firm, was contracted to lead implementation of the pilots. It provided support to the local team, PA Energía, with experts in technologies such as boilers, thermal insulation of pipelines, heat traps, and final use of heat. SAGE also trained the technicians who were to use the software for energy-consumption monitoring. The specific topics for which SAGE technicians provided assistance were:

- Boilers, transmission lines, isolation, traps, and final use of vapor.
- Cooling systems, compressors, evaporation condensers, and final use.
- Installation, adaptation of, and training in the “Montage” software for monitoring energy consumption.

4.8 The companies also received assistance in procedures related to control of the maximum power during peak hours, and the definition of adequate supply contracts with distribution companies.

4.9 *Achievements.* The seven participating enterprises achieved energy savings amounting to US$260,000 a year, or an average of US$37,000 (a 20-percent decrease) per company, with investment costs recovered in less than 18 months. There is potential for further savings once the country’s economic crisis—which has suppressed demand and deterred investment—is over. Most companies did not meet the programmed investment levels, mainly due to financial restrictions and decreased production levels in 2000 and 2001. Yet, despite these difficulties:

- All companies negotiated with their distribution companies to obtain tariffs more appropriate to their consumption of electric power. This enabled them to lower their power costs and to learn the characteristics of the tariff system in force, which will be helpful for future negotiations.

- In the industries in La Paz, Cochabamba, and Santa Cruz, the maximum demand during peak hours was displaced to lower costs. This was not possible in Sucre, as the distribution company does not use differentiated consumption time blocks.

- Most companies installed electricity and water meters, and related software, to enable monitoring of consumption. However, some companies were not able to adequately manage the software.

- All companies achieved an improved power factor due to investments in capacitor banks to compensate for reactive energies.

- While no investments were made in more energy-efficient cooling systems because of cost, some the food and beverage industries, which require this input, achieved small improvements by means of control measures and the isolation of tubing.

- Important improvements were achieved in systems for the generation, distribution, and use of vapor, including the regulation of boilers and improved isolation of tubing.

- Training was provided to the staff of the enterprises.

4.10 Annex 6 shows the results in terms of energy efficiency improvements for two selected enterprises (graphs A6.7, A6.8, and A6.9).

4.11 These activities also had some collateral effects:

- In the city of Santa Cruz, energy efficiency experiences were carried out through initiatives independent of the ESMAP pilot. Hotel Cortéz, where ESMAP carried out an energy diagnostic, independently implemented an energy savings plan that included: (a) replacement of incandescent lamps by compact fluorescent lamps; (b) demand control during peak hours; and (c) installation of the hotel’s own generation equipment for energy supply during peak hours. Other companies, such as the chicken farm Sofía, also implemented energy-saving measures.

- In the city of La Paz, companies such as THOR and TAUNUS have started to provide technical assistance in energy efficiency, and particularly in controlling maximum demand.

4.12 *Sustainability*. Given the permanent physical changes made to the facilities and the training provided to staff, it is reasonable to expect that the energy-saving measures will be sustainable.

4.13 *Replication*. The following results show the positive replication potential of the actions carried out in the pilots with the manufacturing companies:

- The results obtained are economically and environmentally viable for the companies. In all cases, investments have been relatively small, with short-term returns.
- Energy prices have economic rationality. The new tariff structure allows the companies to adequately use electric power.
- Technical assistance in energy efficiency is available, based on the training activities developed within the framework of ESMAP; in addition, other companies that provide this type of assistance have been set up.
- The CPTS will continue to promote energy efficiency activities.

4.14 In view of the growing interest of consulting firms in providing energy efficiency services, replication seems assured.

Study of Electricity Demand-Side Management (DSM)

4.15 The overall objective of this study (July 1998–November 1999) was to prepare the conditions for distribution companies to introduce demand-side management measures into their business administration. The specific objectives were to: (a) improve knowledge of the companies' daily and annual load curves, at the local and regional levels; (b) improve knowledge of the equipment and consumption habits of different economic and social categories of users; and, on that basis, (c) propose load management strategies that would benefit electricity-generating companies by postponing investment, and benefit consumers by decreasing electricity bills.

4.16 Two utilities participated in the studies: the *Cooperativa Rural de Electricidad de Santa Cruz* (CRE) in Santa Cruz and the *Compañía Eléctrica de Sucre S.A.* (CESSA) in Sucre. Activities were coordinated with the technical staff of the Commercialization Departments of CRE and CESSA, and with professionals and surveyors hired specifically for the study. The companies provided the neCessary measurement equipment, infrastructure, and work material, and ESMAP provided them with technical assistance. The distribution utilities supported the study with their professional staff, and hired the personnel needed to carry out the market surveys. They also contributed with measuring equipment, transportation services, office space, technology, and consumable materials.

4.17 The study covered:

- A survey of the supply of household appliances in the local market of every city and characterization thereof in terms of nominal power, size, cost, and origin.
- Design of surveys and specific methodology to assess the characteristics of final consumption in residential and commercial categories, for application in every city.
- Definition of the sample group to be surveyed in both categories, and training of surveyors.
- Installation of meters in selected houses, according to income levels. These measurements were used to verify the results of surveys.
- Surveys in Santa Cruz (350 interviews) and Sucre (30 interviews).
- Analysis and verification of results, discussion with technicians of all participating companies, and presentation to the Vice Ministry of Energy and Hydrocarbons and technical staff of the Superintendency of Electricity.

4.18 In addition, the information collected during the surveys and data on the annual growth of energy consumption in the residential sector made it possible to build two probable scenarios on the characteristics of consumption ten years from now. The first one maintains present conditions and the second one projects the expected conditions should the distributing company implement the recommendations of the study (see Graphs in Annex 6).

4.19 In Santa Cruz, characterization of the load curve for the residential sector per type of appliance and incidence thereof in peak and off-peak hours was charted. This curve was prepared for different types of consumption, specifically, users with consumption patterns: (a) under 120 kWh/month; (b) between 121 and 350 kWh/month; (c) between 351 and 500 kWh/month; (d) between 501 and 1,000 kWh/month; and (e) over 1,000 kWh/month. The results obtained were complemented with a survey on the socio-economic characteristics of the users in each category of consumption described above and were compared to consumption metered by the distribution company. Based on the survey, the savings potential could be identified through measurements of the Demand-Side Management and benefits for the distributor and users, without engendering decreased levels of comfort.

4.20 A comparison between projected electricity consumption and load curves, with and without the recommended energy-saving measures, indicated that installation of the energy-saving measures would cost about US$23.7 million in Santa Cruz and US$2.9 million in Sucre over a ten-year period (2001–2010). However, the measures would result in savings of about US$26.3 million to residential consumers in Santa Cruz and US$3.2 million to residential consumers in Sucre. During the same ten-year period, under the energy-saving scenario, the power utilities would avoid investment in power-generating facilities of about US$89.3 million in Santa Cruz and about US$15.6 million in Sucre. Additionally, the distribution company would obtain a higher load factor than it does at present. Furthermore, economic benefits for the company and users are significant, both with regard to displaced investments and the final invoice for users.

4.21 In the case of Sucre, the same scenarios were developed, but the size of the sample, as well as consumption categories, were different because Sucre is smaller and different from Santa Cruz. The consumption categories included consumers of: (a) less than 30 kWh/month; (b) between 31 and 200 kWh/month; (c) between 201 and 500 kWh/month; and (d) more than 500 kWh/month (see Annex 6).

4.22 The recommendations for CESSA in Sucre are the same as they are for CRE in Santa Cruz, except for the one related to air conditioning, which is not very relevant to Sucre, in view of its climate.

4.23 As Sucre is a small city, with a low level of industrialization and mainly household power consumption, lighting is an important factor in the maximum demand in peak hours. Hence, the impact of the replacement of incandescent lamps by compact fluorescent lamps is higher in the load curve, and results in economic benefits for CESSA, and especially for users.

4.24 *Achievements:* By disaggregating the residential load demand curves in the two cites by the type of electric devices that contributed to the curves throughout the day, the study was able to show that electric water heating and electric cooking were largely responsible for the morning peak, while electric lighting and electric cooking were largely responsible for the evening peak. It also found that in Santa Cruz, because of the semi-tropical weather, air conditioning contributes significantly to the load curve, particularly during the afternoon (between 12 noon and 5 p.m.). This is not the case in Sucre, where electric heating plays a significant role in the load curve during evening and night hours.

4.25 The study recommended, for both cities, the implementation of four energy-saving measures:

- For *illumination:* switching from incandescent bulbs and fluorescent lamps with electromagnetic reactance to fluorescent lamps with electronic reactance. This measure would decrease electricity consumption by 70 to 80 percent in the first case, and by 20 to 30 percent in the second, thus significantly reducing the evening peak demand;
- For *refrigeration:* replacing old refrigerators with new refrigerators, which consume about 50 percent less electricity;
- For *water heating:* using natural gas instead of electricity;
- For *air conditioning (Santa Cruz only):* improving the design and construction of houses and buildings by adding thermal insulation in walls and roofs. This measure would decrease electricity consumption by about 70 percent.

4.26 The study also identified the following financial, regulatory, and technical barriers to the implementation of energy-saving measures:

- *The relatively high cost of the energy-saving devices*, creating the need for financing mechanisms for residential consumers. It may be desirable for the utilities to finance the purchase and installation of the devices, but regulations prohibit them from charging customers for items other than electricity. Moreover, the power distribution utilities do not have incentives for promoting energy savings, which will diminish their cash flow by decreasing electricity consumption.

- *Electric heating of water for baths* often uses more than 5 kW per individual. This represents very high coincident electric loads on the power distribution system during short periods in the mornings and evenings. Heating water for bathing and other household needs using natural gas or LPG would reduce high peak loads during those hours.

4.27 The study also made important findings not directly related to energy savings. For example, the cost to utilities of monthly billing is very high for households consuming less than 120 kWh a month, and longer billing cycles would reduce billing costs. The study also found that, under current regulations, small businesses with installed capacity of up to 10 kW are receiving subsidized electricity services as residential customers. This is not fair and it calls for a change in the regulations.

4.28 *Replication.* The studies of the distribution utilities' electric load curves can be replicated, and will help utilities, consumers, and the regulatory entity to identify desirable energy-saving measures on the demand side, and the regulatory changes needed to make them possible.

Co-generation Study in the Sugar Industry

4.30 The general objective of this activity (May 1998–February 1990) was to study the potential for energy savings in the sugar industry, and the feasibility of increasing the sale of electricity surpluses generated by sugar processing. In particular, the study aimed to: (a) identify technical conditions under which bagasse can be used for electricity production; (b) determine the volume of steam and electricity used during the cutting of sugar cane (*zafra*); (c) identify the technological changes needed in the sugar mills to increase their co-generation capacity; and (d) define feasible scenarios for selling increased volumes of electricity to the power grid.

4.31 Two sugar companies—*Ingenio Azucarero* UNAGRO (Minero, Santa Cruz) and *Ingenio Azucarero* GUABIRÁ (Guabirá, Santa Cruz)—participated in the study, and five consultant firms were involved in its execution. Activities were carried out within the framework of actions contemplated in the Pilot Plan for Energy Efficiency in the Industrial Sector. These included:

- Energy diagnostics aimed at analyzing the sugar production process, to determine usage and efficiency at all stages: crushing of the sugar cane, production of waste in the form of bagasse, and crystallization.

- Analysis of the characteristics of sugar cane and the parameters of the bagasse as fuel (fiber and water content, and caloric value of bagasse), and the operating characteristics of boilers and electricity generators.

- Assessment of power production costs in the plant, and estimation of the costs and feasibility of increasing generation capacity under different scenarios, in order to determine the benefits of producing electricity for sale to the grid.

- Definition of several scenarios for future operation of the enterprises, including producing electricity for sale to the grid.

- Analysis of the environmental impact of increased greenhouse gas emissions from burning larger volumes of bagasse, and identification of mitigation and compensation possibilities.

- Dissemination of the results of the study among industry executives and professionals and government authorities, and submission to the *Programa Nacional de Cambio Climático* of Bolivia (PNCC) and the Andean Finance Corporation (CAF), with support from the Dutch Biomass Technology Group. The results were also presented to other entities, such as the National Climatic Change Program of the Ministry of Sustainable Development and Environment.

4.32 *Achievements:* The ESMAP study elicited several important findings about the technical and economic possibilities of co-generation, and barriers to co-generation that need to be removed:

- If all the bagasse produced by the 4,000 to 5,000 tons of sugar cane processed daily by the four sugar industries of Santa Cruz were used for electricity generation, a surplus of about 15 MW could be supplied to the grid. This is equivalent to 27 percent of the 220-MW peak demand served by CRE.

- The seasonal nature of the sugar cane crop means that generation of surplus electricity would be possible only from April to October. However, this would help the power utilities meet the peak demand in Santa Cruz during that period.

- The competition introduced by co-generation could eventually contribute to decreasing the price paid for electricity by distribution utilities, and, consequently, by retail consumers. The current absence of competition has enabled the power-generating companies in Santa Cruz to charge higher prices for locally produced natural gas than for gas imported by power utilities elsewhere in the country.

- There is also potential for other industries to realize co-generation.

- Increasing co-generation in the sugar industry (and other industries) requires increasing the efficiency of steam generation by replacing the fuel combustion systems, and installing high-pressure boilers, additional electric power generation and load dispatch equipment.

- The lack of regulations is constraining the development of co-generation. For example, the Electricity Law contemplates the multi-purpose use of natural energy resources (Article 5), but there are no regulations allowing co-generation contracts for power and energy, particularly in the sugar industry, where power surpluses are seasonal. In addition, there are no regulations for setting a price for bagasse used as fuel for electricity generation; the price for bagasse as waste is near zero, but its price as a fuel would certainly be higher.

- A lack of public information is also constraining the development of co-generation, especially information on the advantages and shortcomings of the technology, experiences with co-generation projects, and possibilities for support from international institutions, based on international agreements to reduce greenhouse gas emissions.

4.33 In addition, the UNAGRO sugar mill, which delivers close to 2 MW to CRE during August and September, showed great interest in the results of the study, and subsequently carried out its own feasibility study on co-generation, with support from PNCC and the Swiss Government. UNAGRO is now seeking European and American partners to implement the project recommended by the co-generation study.

4.34 *Sustainability and Replication*. The co-generation studies can be replicated, and will help the enterprises, electricity consumers, the regulatory entity, and financial sources to identify viable co-generation projects. Such studies will also identify changes needed in the regulations, and the technical and financial barriers to realizing co-generation.

Mechanisms Supporting Energy Efficiency

4.35 The objective of this activity (May 1998–December 2001) was to introduce technical assistance and financial mechanisms to help ensure the sustainability of energy efficiency.

Technical Assistance Mechanism

4.36 The *Centro de Promoción de Tecnologías Sostenibles* (CPTS) was the mechanism responsible for technical assistance. It was created in April 1998 by VMEH and the National Chamber of Industry on the basis of the shared experiences of the Environmental Pollution Prevention Project (EP3) and the energy efficiency component of ESMAP Phase I. The overall objectives of the mechanism were to contribute to rational energy use and pollution prevention activities in different sectors, and support development of a market for energy efficiency and pollution mitigation services.

4.37 The mechanism aimed, in particular, to: (a) strengthen enterprises, consulting firms, and specialized technicians in energy efficiency and pollution prevention; (b) provide information; (c) create a positive attitude toward energy efficiency and pollution prevention among government officials and civil society; and (d) liaise with other national and international institutions active in energy efficiency and pollution control activities. Locally, CPTS has closely coordinated with the National Chamber of Industries and its branches, which has enabled its activities to achieve a countrywide reach.

4.38 *Achievements*. Since 1998, CPTS has provided technical assistance to 12 enterprises in carrying out diagnostics for pollution prevention and energy efficiency. The enterprises included textiles; slaughterhouses; chemical, sugar, beer, and soft drink manufacturers; metallurgy; leather industries; and dairy farms. ESMAP donated specialized equipment to CPTS for the diagnostics.

4.39 CPTS trained seven engineers from three enterprises specialized in energy efficiency diagnostics, granted scholarships to 20 students preparing theses on environmental issues in industry, supported the Ecological Efficiency Prize as an incentive to industry, and created a Web page with environmental information.

4.40 *Sustainability and Replication*. Over the last few years, CPTS has become a reputable technical assistance institution with a highly qualified professional staff in the fields of energy efficiency and pollution control. Since USAID and the Government of Denmark are now supporting CPTS financially, its operations are expected to be sustainable, at least in the medium term. As an institution, CPTS lends itself to replication in other Latin American countries.

Financing Mechanism

4.41 Phase I found that a lack of experience with assessing energy efficiency and renewable energy projects, and the resulting unavailability or high cost of financing, were some of the most important obstacles to executing such projects. As a result, Phase II included support for a Biomass Fund, which was set up by means of a contract between the World Bank and the *Fundación para la Producción* (FUNDA-PRO). The principal objective of the fund is to create the conditions for access to credit for industries that implement projects on the rational use of biomass.

4.42 The Biomass Fund began with US$1 million, of which US$800,000 was contributed by the Netherlands and US$200,000 by FUNDA-PRO. It has funded 53 biomass projects totaling US$389,000. Moreover, 99 projects totaling US$511,115 are pending approval by the financial intermediary.

4.43 After the Biomass Fund was separated from Phase II activities in 2000 and became a self-standing program, its scope was extended to include other activities related to energy efficiency and pollution prevention in urban industries, especially small and medium enterprises. CPTS and the National Chamber of Industry are now looking for additional funds to strengthen the Biomass Fund. The Danish Cooperation and the

Cooperation Agency of the Swedish Government are interested in providing support. A final report on the Biomass Fund has been issued separately.

4.44 *Sustainability and Replication*. Because CPTS, the National Industry Chamber, the Danish Cooperation, and the Swedish Government have all expressed their interest in supporting the Biomass Fund financially, the Fund is expected to be sustainable, at least in the medium term. The long-term sustainability of this mechanism will depend on whether a permanent flow of sufficient funds can be secured.

4.45 It is not clear whether the Bolivian model of a Biomass Fund can be replicated in other countries, since the support for such a fund depends largely on donor interest.

Support for the Vice Ministry of Energy and Hydrocarbons

4.46 Support for VMEH focused on the development of regulations and norms to enable institutionalization of the developed measures and to introduce the principles and methodologies needed to ensure sustainability of the actions developed by ESMAP.

4.47 *Achievements*. In the case of the energy efficiency component, it was not possible to develop specific norms. However, some legal instruments were developed or revised, e.g., the Environmental Regulation of the Electric Power Sector, the Electric Services Regulation, and the Public Lighting Regulation, the latter at the request of the National Chamber of Industry.

4.48 VMEH also received support to prepare the National Energy Balance, the principles and internal norms of which are now used as an instrument to analyze the sector.

Elaboration of the National Energy Balance

4.49 The objective of this activity (January 2001–November 2001) was to develop the principles and internal regulations to enable institutionalization of the National Energy Balance, which provides comprehensive information on production, transformation, and consumption of energy in different sectors. The information supplied by the NEB, together with other macroeconomic indicators, is indispensable for the design and definition of energy policies.

4.50 The specific objectives of this activity were to:

- Update information on the obstacles that impede permanent elaboration of the NEB.
- Propose standards and internal procedures in VMEH to enable institutionalization of the NEB.

4.51 Activities included:

- Analysis of information supplied by different institutions on the production, transformation, and consumption of energy in the country.
- Analysis of information flows from these institutions to VMEH.
- Analysis of the flow and management of energy information in the VMEH, including procedures, management of information, instruments for analysis, technical means, and dissemination of results.
- Collection of information from the Superintendencies of Electricity and Hydrocarbons.
- Estimation of non-commercial energy consumption, such as firewood, bagasse, and dung.
- Analysis of the gathered information and preparation of the National Energy Balance.
- Updating and revision of the energy balances for the last ten years.
- Presentation of results to technicians of different departments of VMEH.
- Publication of the National Energy Balance.

4.52 *Achievements*. All tasks were completed and a proposal was submitted to VMEH for institutionalization of this instrument. VMEH must approve internal norms for full institutionalization. Presently, staff of the Vice Ministry can access energy information from 1991–2002 through the online system, and some staff have been trained for the analysis and permanent updating of the NEB.

5

Lessons of Broad Applicability

5.1 Numerous studies and plans on rural energy and energy efficiency have been carried out in Bolivia by this and other ESMAP projects. However, these cannot show a record of achievement comparable to the impressive success of the technical assistance in the macro-restructuring of the energy business. Particularly, this ESMAP project delivered a wealth of data, analyses, designs, studies, and surveys that are now waiting for implementation by policymakers and interested parties. Why are they waiting? The answer lies in the project's scope, its implementation arrangements, and exogenous conditions: a) the project comprised too many activities, with different focuses, that were to be executed simultaneously during a relatively short period of time; b) the project implementation was coordinated by only two local professionals supervising numerous consultants; c) there were too many levels of administration and channels of communication with policymakers; and d) subsidies for conventional fuels undermined possibilities for alternative energy sources.

5.2 Consequently, the lessons of broad applicability are:

- ESMAP projects should focus actions strongly on the one or two major activities likely to have a successful outcome, especially if the project has a relatively small budget.
- Implementation of ESMAP projects should be started only when the policymakers have shown a definite commitment to the project.
- Subsidies for conventional fuels should be reduced or removed when alternative fuels will deliver a service equally or less costly than the subsidized fuel.
- The overhead cost of the project should be kept low by hiring a small number of consultants.

Annex 1

Rural Energy Component – Sustainability and Impacts

Product	Strategy and Sustainability	Prospects and Replication	Benefits
Rural Electrification: Model 1 – Extension of distribution grid by existing concessionaires	The *Fondo de Electrificación Rural* (FER) was designed. PRODEM pledged US$1.0 million to the FER. Transredes pledged US$10.0 million. *Transportadora de Electricidad* indicated they would contribute US$0.5 million. Procrédito, a micro-finance entity, expressed interest in the FER. The IFC and ADC have indicated interest in the FER (see text for details).	Six potential users of the FER have been identified: CRE, Electropaz, Elfeo, Elfec, CESSA and Coset (the latter two were cooperatives that converted into corporations). The main barriers to the development of rural electrification are the sector regulations and standards, which do not consider the particular characteristics of rural markets (e.g., the requirement that rural service have the same high quality of urban service). The regulations forbid the use of pension funds in the FER.	Several projects sponsored by private concessionaires would be implemented once the FER is funded and fully operational. These projects would initially benefit about 40,000 rural households. If FER became operational, up to 40,000 additional rural household could be connected to electricity service over the subsequent years.
Rural Electrification: Model 2 – Supply	There are five SHS dealers currently operating in the	Potentially, about 10,000 rural households could	

Product	Strategy and Sustainability	Prospects and Replication	Benefits
of Solar Home Systems (SHS) by private entrepreneurs (dealer model)	urban and peri-urban markets of Bolivia. Demand studies and business plans were prepared. However, based on the high subsidy requirements calculated in these draft business plans, the companies did not succeed in mobilizing sufficient subsidies and commercial financing to demonstrate private sector-led SHS-based rural electrification.	be provided with SHS in the target areas studied for this activity by SHS dealers.	
Rural Electrification: Model 3 – Supply of electricity to very isolated communities through Non-governmental Organizations (NGOs)	The basic idea of this model is to identify and implement rural electrification projects in the most isolated areas, by using the comparative advantages that the NGOs have to promote development projects at a micro-regional level. Contrary to the profit-oriented objectives of concessionaires and dealers of SHS, the NGOs are less interested in obtaining high rates of return on rural	From 376 proposals submitted by 72 institutions, a US$10.0 million portfolio of rural electrification projects was prepared. The KfW (Germany) has shown interest in supporting the portfolio. KfW is conducting studies to ensure that a German grant of US$2.0 million is allocated to rural electrification projects having productive components such as water pumping.	The beneficiaries of these projects are rural households located very far from the electric distribution lines and out of the reach of SHS dealers.

Product	**Strategy and Sustainability**	**Prospects and Replication**	**Benefits**
	electrification investments.		
Water Pumping in Rural Farms	Four potential water-pumping projects were identified for farming *quínoa*, alfalfa, and potatoes, and water for breeding *camélidos* (alpacas and llamas). These projects were found profitable but none were realized because the lack of regulations on land titles and water use rights has deterred their implementation. The projects were submitted to the Ministry of Agriculture.	The sustainability and replication of the projects is not yet tested. The Ministry of Agriculture should take action in promoting these projects. Private investors and financing institutions specialized in rural credits could participate in the financing of these projects.	Water pumping would ensure the supply of underground water in places where the precipitation is near zero or the rainwater storage capacity is insufficient or nonexistent. About 40,000 ha could be irrigated by pumping underground water. It would require investments of between US$3,800 and US$4,200 per ha. Renewable energy sources could be used for pumping water in isolated places.
Solar Heating in Rural Schools	A project for the refurbishing of a rural school with solar heating, and a guide for the design and construction of new school buildings with solar heating were prepared. The project and the guide were disseminated to architects, engineers, and municipalities. This guide will help the Ministry of Education prepare standards for the design and construction of	Two policy objectives of the government will be met: (i) the use of renewable solar energy for heating; and (ii) the application of energy efficiency measures. The application of these policies will also displace, where currently applied, LPG, electricity, and firewood as heating sources.	Solar heating of schools will improve the performance of students and the efficiency of teachers and staff. It will create a warm environment, stimulating students and teachers and inviting them to study and work. It will benefit schools in the highland regions, where night temperatures often drop to -8 ^{o} Celsius in the winter season. A desirable air temperature is in the

Product	Strategy and Sustainability	Prospects and Replication	Benefits
	schools buildings using passive solar energy for heating purposes.		range of 20 to 24 degrees Celsius, with a relative air humidity of 40 percent.

Annex 2

Energy Efficiency Component – Sustainability and Impacts

Product	Strategy and Sustainability	Prospects and Replication	Benefits
Support to Vice Ministry of Energy and Hydrocarbons (VMEH)	Definition of a framework for energy efficiency. Design and preparation of an information system and an energy balance. The strategy and instruments supporting it are sustainable as long as the GoB is committed to the framework for energy efficiency and to the provision of resources to maintain the information system.	The strategy and information system supporting it have to be tailored to the particular conditions prevailing in the country. Conceptual replication may be possible.	The lack of a framework for energy efficiency and the instruments supporting it would significantly hinder the implementation of activities promoting energy efficiency.
Technical Assistance Mechanism through the Center for the Promotion of Sustainable Technologies (CPTS)	The *Centro de Promoción de Tecnologías Sostenibles* (CPTS) was chosen as the instrument for the provision of technical assistance in the rational use of energy, the introduction of energy-saving measures, and the practices for avoiding/limiting pollution created by economic activity. The strategy is to: (i)	Application of the strategy in other developing countries is plausible. CPTS as an institution lends itself for replication in countries similar to Bolivia.	Since 1998, the CPTS has provided technical assistance to 12 enterprises for carrying out diagnostics of pollution prevention and measures to increase energy efficiency. A wide range of enterprises has benefited from this technical assistance (textiles; slaughterhouses; chemical, sugar, beer, and soft drinks

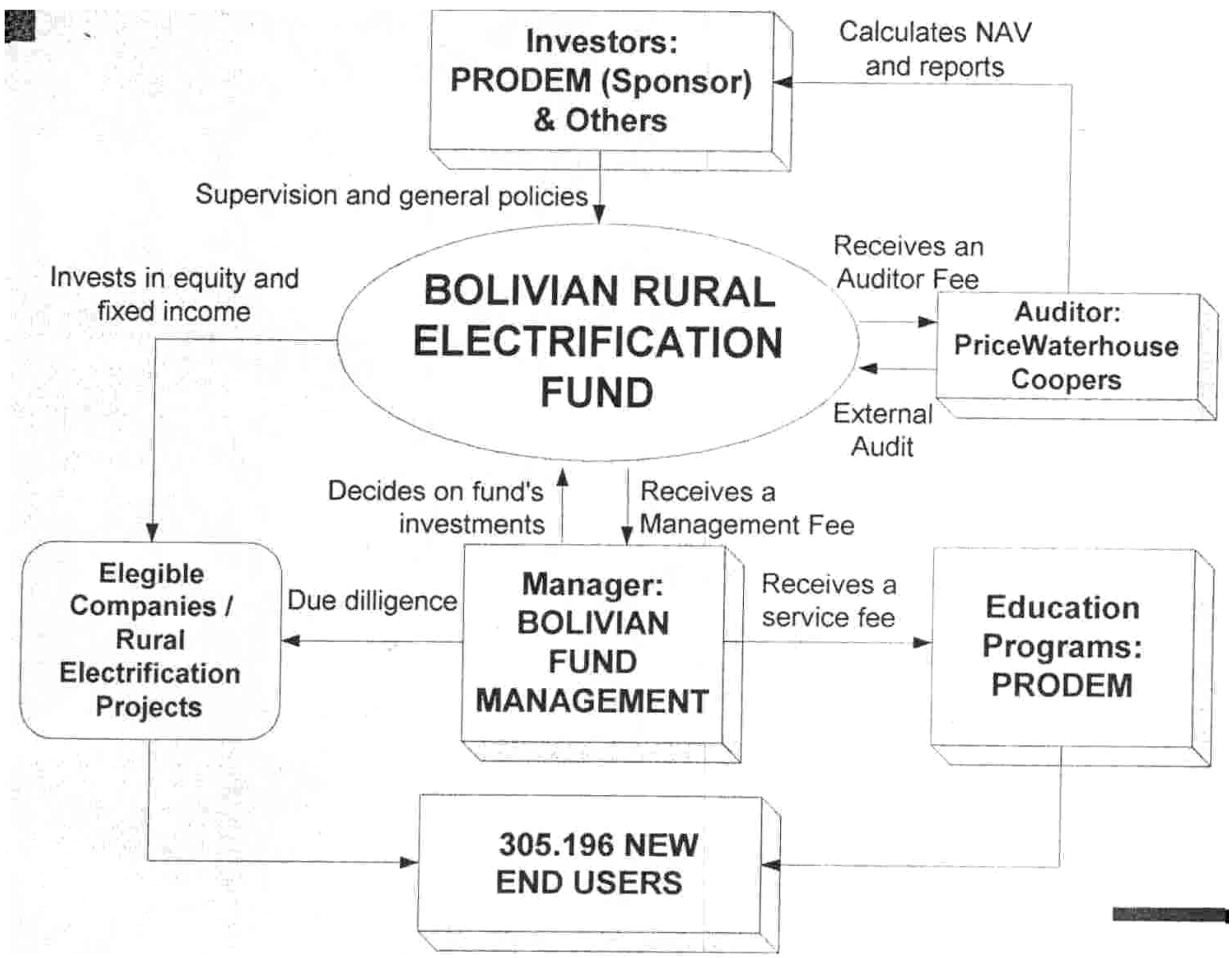
Product	Strategy and Sustainability	Prospects and Replication	Benefits
	strengthen enterprises, consulting firms, and specialized technicians in energy efficiency and pollution prevention; (ii) provide information and diffusion services upon demand; (iii) induce a positive attitude toward energy efficiency and pollution prevention among government officials and civil society; and (iv) to liaise with other national and international institutions active in energy efficiency and pollution control activities. Since USAID and the Government of Denmark are now supporting CPTS financially, CPTS' operations are expected to be sustainable, at least in the medium term		industries; metallurgic and leather industries; and dairy farms). The CPTS trained 7 engineers from 3 small local enterprises specialized in the diagnostics of energy efficiency, granted scholarships to 20 students who were preparing theses in environmental subjects related to the industrial sector, supported the "Ecological Efficiency Prize" as an incentive to the industry, and created a Web page on environmental information.
Financial Mechanisms: This activity aimed at creating mechanisms to remove the financial barriers that have thwarted the execution of both energy efficiency and renewable energy projects in Bolivia. These barriers are: (i) the high financing costs arising from a perception of these as being high-risk	In 2000, the Bank and *Fundación para la Producción* (FUNDA-PRO) signed a contract creating the Biomass Fund, which raised US$1.0 million from the Netherlands (US$800,000) and FUNDA-PRO (US$200,000). In 2001, it was decided that energy efficiency and pollution control projects would also be eligible for financing	The Bolivian model of the Biomass Fund can be replicated in developing countries in cases where certain industrial countries have a particular interest in providing financial support to activities in energy efficiency and pollution control.	The Biomass Fund reduces the financial barriers that have thwarted the execution of both energy efficiency and renewable energy projects in Bolivia.

Product	Strategy and Sustainability	Prospects and Replication	Benefits
projects; (ii) the short repayment periods of loans and credits; and (iii) the complex systems of guarantees for loans and credits.	by the Biomass Fund. The Fund is expected to be sustainable, at least in the medium term, as long as CPTS, the Netherlands, and other countries continue to support it. Its long-term sustainability will depend on establishing additional mechanisms to ensure that it receives a steady flow of funds.		
Energy Efficiency in the Industry	Seven enterprises located in Sucre, Santa Cruz, and La Paz (beer, soft drinks, food, textile, and chemical industries) implemented energy-saving measures to demonstrate their technical and economic feasibility. ESMAP provided the industries with technical assistance on metering industrial processes, defining energy cost centers, and measures to save electricity, heat, and water. It also advised the industries on the selection of methods to reduce their power demand, and on the most appropriate contracts for electricity supply. The industries procured and installed meters for electricity, natural gas, and water; equipment to improve the power factor of electricity consumed	The success achieved with the energy efficiency measures implemented in the seven industries has prompted other industries to follow suit. The CPTS is supporting those industries. Moreover, other independent firms are also providing technical assistance services on energy efficiency to industrial and service companies.	The decrease in the energy input to the industry will decrease the cost of outputs, which, in turn, will benefit both the enterprises and the consumers. At the same time, energy efficiency will reduce the impact on the environment.

Product	Strategy and Sustainability	Prospects and Replication	Benefits
	and the thermal insulation for pipelines; and repaired or replaced low-efficiency electric motors and machinery.		
Demand-Side Management (DSM): Analyses of the structure of the daily electricity load curves. Proposal of changes on the consumer side aimed at flattening the daily load curve. Identification of technical, financial, and regulatory barriers.	The study designed and carried out a survey with a sample of 650 residential consumers in Santa Cruz and Sucre, and installed kWh meters in selected households. The study also determined operating parameters for electrical appliances available in Santa Cruz and Sucre, and identified barriers (technical and financial) hindering the application of energy efficiency measures.	The studies of electric load curves of power distribution utilities can be replicated.Such studies will help the utilities, the consumers, and the regulatory entity to identify the desirable energy-saving measures on the demand side and the changes in the regulations required to make this possible.	The changes proposed would benefit both the electricity-generating companies by postponing investment in additional generation capacity and the consumers by decreasing the electricity bills.
Co-generation in the Sugar Industry: Study of the potential for energy savings in the sugar industry and the feasibility of increasing the sale of electricity surpluses generated by the sugar industrial processes. Determination of barriers to co-generation. Evaluation of the potential for co–generation in Bolivia.	To define feasible scenarios for selling co-generation to the power grid, and remove regulatory barriers constraining the development of co-generation.Electricity law contemplates multi-purpose uses of natural energy resources, but there are no regulations applicable to co-generation contracts for power and energy, or for setting a price for bagasse used as fuel.	The co-generation study can be replicated in other industries. Identification of the technical conditions under which the bagasse is used for the production of electricity. Determination of the technological changes needed in the sugar mills in order to increase the generation of electricity. Identification of current regulatory barriers.	If all the bagasse produced as a side product of the 4,000 to 5,000 tons of sugar cane processed daily by the four sugar industries of Santa Cruz were used for electricity generation, they could supply a surplus of about 15 MW to the power grid of CES. This is equivalent to 27 percent of the 220 MW peak demand served by the rural cooperative of Santa Cruz.

Annex 3

The Rural Electrification Fund (FER)



Annex 4

Statistical Data – Energy Sector

Table A.4.1: Main Energy and Economic Indicators, 1991–2001

	1991	*1996*	*2001*
Total population (million)	6.3	7.1	7.9
Population growth rate (%/yr)	2.33	2.33	2.33
Rural population as percentage of total		43	
GDP per capita		US$700	
External debt/GDP (%)		80	
Domestic energy demand:			
Electricity		800 MW(~ 4,000 GWh)	
Liquid hydrocarbons		20,000 BOE/year	
Natural gas			
Export of energy:			
Natural gas			
Liquid hydrocarbons			
Growth rate of energy demand (%)		4.5	
Urban electrification coverage (%)		95	
Rural commercial energy coverage (%)		12	
Rural electrification coverage (%)	<12%	13%	23%
Natural gas reserves (TCF):			
Proven		3.75	23.84
Probable		1.94	22.99
Possible		4.13	23.18
Total		9.82	70.01
Petroleum reserves (MMBbl):			
Proven		132.60	440.49
Probable		116.03	451.47
Total		248.63	891.06
Installed power capacity (MW):			
Hydroelectric		307.7	393.4
Thermal		668.5	944.6
Total		996.2	1338.0

Sources: VMEH, YPFB, UDAPE (*Unidad de Análisis de Políticas Económicas),* Economic Policy Analysis Unit.

Table A.4.2: Indicators of Final Energy Consumption and Intensity in Bolivia,

	2001
Energy consumption (BOE/capita)	2.7
Electricity consumption (kWh/capita)	400
Energy intensity (BOE/US$1000)	3.1
Rural households without access to electricity service	about 700,000

Table A.4.3: Natural Gas Reserves
TPC (*)

	1997	*1998*	*1999*	*2000*	***2001***[6]
Proven	3.75	4.16	5.28	18.31	23.84
Probable	1.94	2.46	3.30	13.90	22.99
Possible	4.13	3.17	5.47	17.61	23.18
Total	9.82	9.79	14.05	49.82	70.01

(*) TPC: Tera Cubic Feet: 10^(12) cubic feet
Source: YPFB.

Table A.4.4: Oil Reserves
MMBbl (*)

	1996	1997	1998	1999	**2000**
Proven	132.6	137.78	150.11	396.52	440.49
Probable	116.03	67.17	87.95	295.49	451.47
Total	248.63	204.95	238.06	692.01	891.96

(*)MMBbl: Million Barrels
Source: Vice Ministry of Energy and Hydrocarbons.

Table A.4.5: Installed Capacity per type of generation
MW (*)

	1995	1996	1997	1998	1999	**2000**
Hydro-energy	306.7	307.7	325.0	341.9	393.1	393.3
Thermal	521.5	688.5	668.9	700.9	872.5	944.6
Total	828.2	996.2	1013.8	1042.8	1265.6	1338.0

(*)MW: Mega Watt
Source: Vice Ministry of Energy and Hydrocarbons, Yearly Report of the *Bolivian Power Sector* (2000).

[6] Data from 2001 correspond to the certification carried out by DeGolder & MacNaughton on January 1, 2001 for 98.4 percent of proven and possible reserves.

Annex 5

Data on Rural Energy Component

Table A.5.1: Locations for Possible Intervention

Department	*Province*	*Municipal Section*	*Name of CETHA*
La Paz	Ingavi	Viacha	Qurpa
La Paz	Bautista Saavedra	Charazani	Aynikusun
La Paz	Caranavi	Caranavi	Alcoche
La Paz	Muñecas	Ayata	Titicachi
La Paz	Sud Yungas	Irupana	Irupana
Oruro	Cercado	Toledo	Socamani
Potosí	Chayanta	Ravelo	Chirucasa
Chuquisaca	Belisario Boeto	Villa Serrano	CEITHAR
Cochabamba	Estevan Arze	Anz aldo	Anzaldo
Cochabamba	Tiraque	Tiraque	Tiraque
Tarija	Arce	Bermejo	Emborozú
Santa Cruz	Velasco	San Ignacio de Velasco	Granja Hogar
Beni	Vaca Diez	Riberalta	Riberalta
Beni	José Ballivián	San Borja	El Palmar
Pando	Nicolás Suarez	Porvenir	Porvenir

Table A.5.2: RE Operators by Prefecture

Prefecture	*Operator for RE*	*Observations*
La Paz	Emprelpaz Elfasa Edel	These companies are present to some extent in the rural area. Electropaz, the principal concessionary of the department of La Paz, is almost completely absent in rural electrification.
Oruro	Power cooperatives	This prefecture delegates O&M to local cooperatives only (about 15) and provides them with technical assistance. The principal concessionaire (Elfeo) only makes bulk sales to the cooperatives, which is illegal.
Chuquisaca	CESSA and power cooperatives	The prefecture basically works with the principal concessionaire (CESSA) and local cooperatives to extend rural electrification projects.
Potosi	Sepsa and power cooperatives	Sepsa is still a public distribution company that covers almost all electrified areas of the department of Potosí, except for the principal mining centers.
Santa Cruz	CRE	The prefecture only delegates all RE projects to CRE (the principal concessionaire).
Cochabamba	Elfec	The prefecture only delegates all RE projects to Elfec (the principal concessionaire).

Table A.5.3: Principal Companies and Cooperatives in the Departments of Oruro and Potosí (Year 2001)

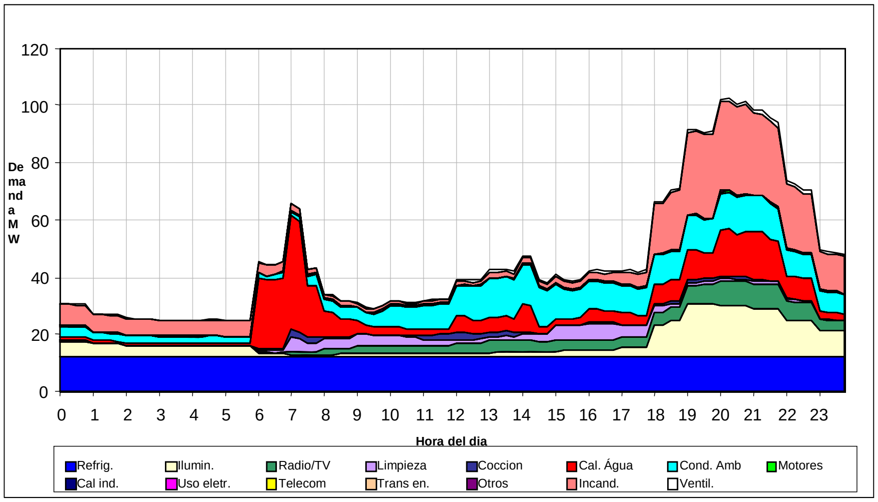
Name	**Approx. demand (kW)**	**Domestic users (approx.)**	**Estimated losses in %**	**Legal status**	**Years of existence**	**Expansion plans**	**Attitude toward Renewable Energy**	**Observations**
Atocha	550	800	40	Cooperative	30	No	Indifferent	The important clients are mining cooperatives. They operate according to resolutions of the Superintendency of Electricity for pricing. This cooperative administers the power distribution systems of COMIBOL. They purchase energy from Valle Hermoso (Rio Yura).
Uyuni	1000	4000	25	Cooperative in conversion	25	Yes	Indifferent	They possess various depreciated assets without refinancing. They purchase energy from Valle Hermoso (Rio Yura).
Rio Mulatos	-	120	25	Committee	5	No	Indifferent	They have a debt with Valle Hermoso, which was negotiated for payment in parts. They have started the procedure for conversion into a corporation.
Machacamarca	159	600	45	Cooperative in conversion	33	No	Indifferent	The distribution system needs complete renewal. They buy energy in bulk from Elfeo.
Pazña	77	330	15	Cooperative	20	No	Indifferent	They buy energy in bulk from Elfeo. One person is in charge of administration.
Huari		600	25	Municipality	10	Yes	Indifferent	Monthly losses amount to Bs. 2,000 and are covered by the municipality. They buy energy from CBN (beer brewery). They also administer the drinking water system.
Emdecasa (Caracollo)	217	1500	20	Corporation	30	Yes	Expectant	Plans are related to extensions of the prefecture that will be administered by the company.

Name	**Approx. demand (kW)**	**Domestic users (approx.)**	**Estimated losses in %**	**Legal status**	**Years of existence**	**Expansion plans**	**Attitude toward Renewable Energy**	**Observations**
Coopsel 5 de Agosto (Eucaliptus)	-	2300	20	Cooperative	20	Yes	Expectant	The principal customer is Inti Raymi. Different projects are being implemented with the Prefecture of Oruro.
Elfasa (Patacamaya)	1000	6000	18	Corporation	6	Yes	Active	The company has executed various projects in coordination with the prefecture. There are conflicts with the municipality of Sica-sica.
Sevaruyo		110		Committee	1	No	Indifferent	Huari sells energy “in bulk” to the population. The population is responsible for the collection of invoices and for reserving some money for repairs. They have no expert staff.
Camargo	620	2750	25	Cooperative	25	Yes	Indifferent	The principal project is the generation of electricity with natural gas and construction of a transmission system up to Carreras. There are cheaper solutions available than the one Coserca proposes.
Setar-El Puente	150	530	15	Subsidiary of Setar	1	Yes	Indifferent	Setar administers the system that was financed by the prefecture, the European Union and the cement plant of El Puente.

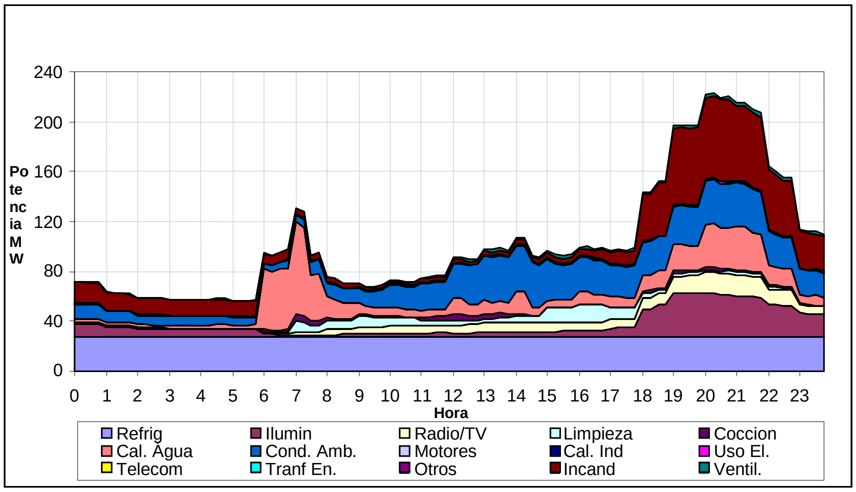
Annex 6

Data on Energy Efficiency Component

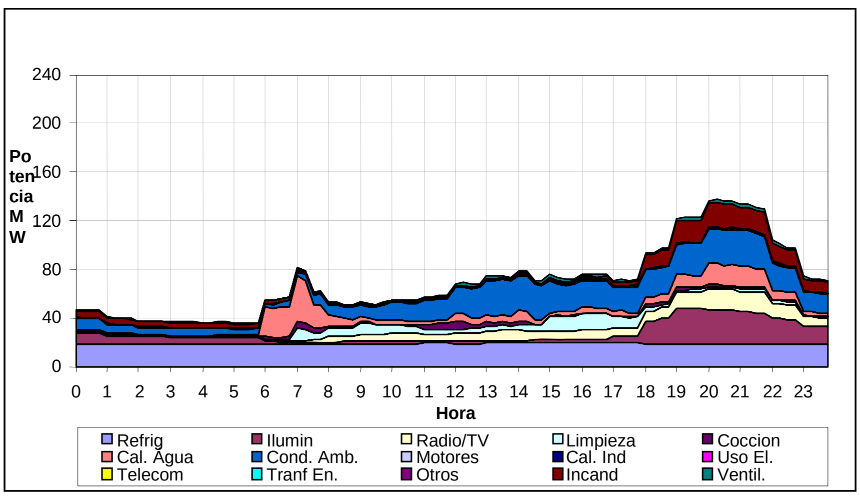
Graph A.6.1: Household Electricity Demand by Type of Use in Summer – Santa Cruz (1998)



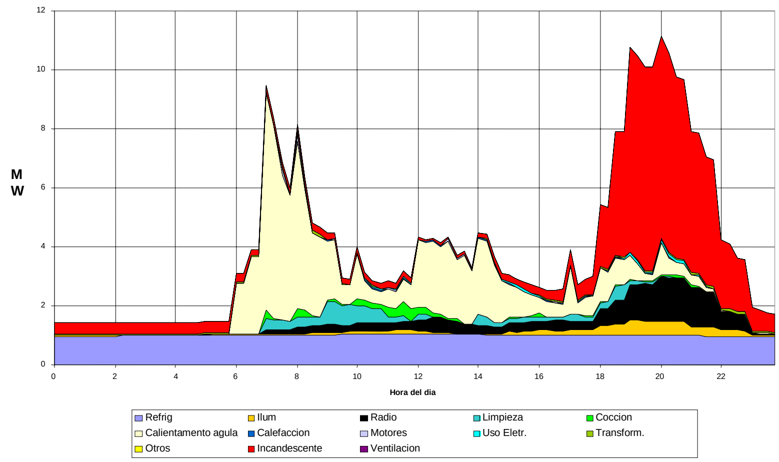
Graph A.6.2: Projected Household Electricity Demand by Type of Use in Summer without Energy Efficiency Measures – Santa Cruz (2009)



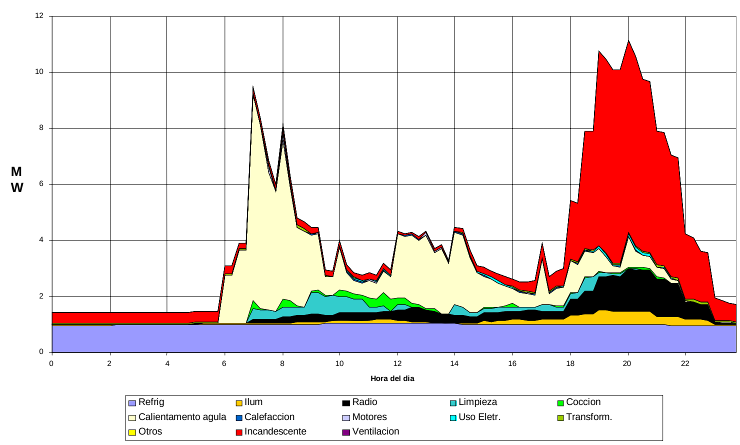
Graph A.6.3: Projected House Electricity Demand by Type of Use in Summer with Energy Efficiency Measures – Santa Cruz (2009)



Graph A.6.4: Household Electricity Demand by Type of Use in Summer – Sucre (1998)



Graph A.6.5: Projected Household Electricity Demand by Type of Use in Summer without Energy Efficiency Measures – Sucre (2009)



Graph A.6.6: Projected Household Electricity Demand by Type of Use in Summer with Energy Efficiency Measures – Sucre (2009)

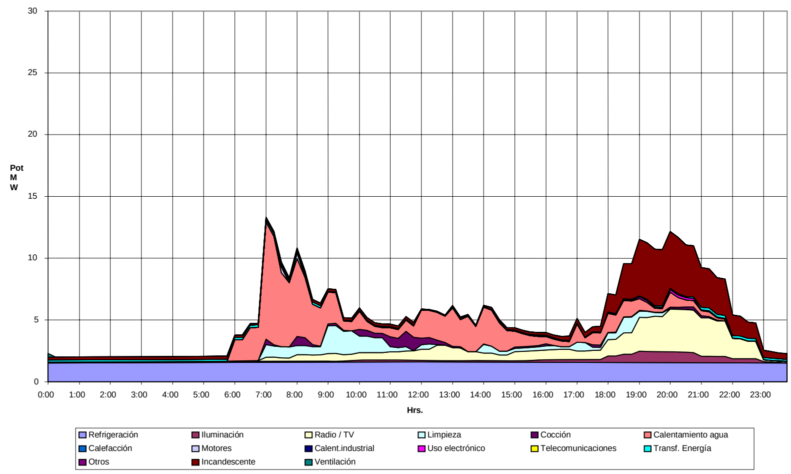


Table A.6.1: Demand-Side Management in Santa Cruz and Sucre

Santa Cruz

	Demand			I	
Maximum Demand	Without Savings	With Savings	Savings	Total Reduction in Investment	Invest. Nec. For Savings
	MW	MW	MW	US$ x	
Demand for lighting	97.81	47.23	50.58	60,696	15174
Demand for refrigeration	27.01	18.91	8.1	9,720	8100
Demand for air conditioning	31.75	25.4	6.35	7,620	?
Demand for heating	18.84	9.42	9.42	11,304	?
Total	***175.41***	***100.96***	***74.45***	***89,340***	***23274***

	Consumption			
Consumption	Without Savings	With Savings	Savings	Reduction in Annual Costs
	GWh/mo	GWh/mo	GWh/mo	US$ x
Consumption for lighting	20.83	10.13	10.7	11,556
Consumption for refrigeration	19.45	13.62	5.83	6,296
Cons. for air conditioning	14.61	11.69	2.92	3,154
Consumption for heating	9.92	4.96	4.96	5,357
Total	***64.81***	***40.4***	***24.41***	***26,363***

Sucre

	Demand				
Maximum Demand	Without EE Measures	With EE Measures	Savings	Total Reduction in Investment	Investment Required for Savings
	MW	MW	MW	US$ x 1.000	US$ x 1.000
Demand for lighting	16.4	5.4	11	14,300	2.448
Demand for refrigeration	2.2	1.5	0.7	910	500
Demand for heating	0.63	0.31	0.32	416	?
Total	***19.23***	***7.21***	***12.02***	***15,626***	***2.948***

	Consumption			
Maximum Demand	Without Savings	With Savings	Savings	Annual Reduction Costs
	GWh/mo	GWh/mo	GWh/mo	US$ x 1.000
Demand for lighting	2.33	0.7	1.63	1,760
Demand for refrigeration	1.7	1.2	0.5	540
Demand for heating	1.8	0.91	0.89	961
Total	***5.83***	***2.81***	***3.02***	***3,262***

Table A.6.2: Companies Participating in Energy Efficiency Pilot

Company	*Activity*	*Location*
Cervecería DUCAL	Beer brewery	Santa Cruz
Embotelladora EMBOL	Soft drinks	Santa Cruz
Frigorífico FRIGOR	Food	Santa Cruz
UNIVERSALTEX	Textiles	La Paz
TUSEQUIS	Food	La Paz
Quimbol Lever	Chemical products	Cochabamba
Cervecería SUREÑA	Beer brewery	Sucre

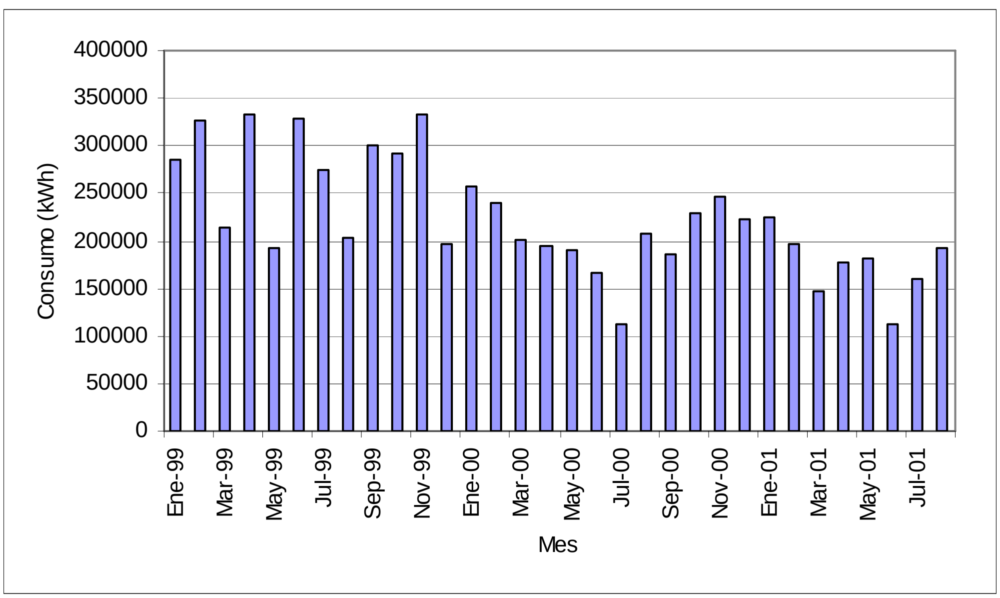
Table A.6.3: Companies in which CPTS Has Carried out Diagnostics on Pollution Prevention (PP), Pollution Control (PC), and Energy Efficiency (EE)

COMPANY	*ADDRESS*	*AREA*	*DATE*	*OBSERVATION*
TANNING				
1.Zamora S.A Oruro	Av. Velasco Galvarro Nº 6542 Tel.: 591-52-74740	Tanning & shoe manf.	2001	PP and EE
2.TOMY Cochabamba	Calle Manco Kapac S-0592 Tel: 591-42-24737	Tanning	1996	PC
3.CURMA Ltda. Cochabamba	Calle Mama Ocllo S-892 Tel: 591-42-59395	Tanning	1996	PC
4.MACUBOL Ltda La Paz	Av.Chacaltaya #1010 Tel: 591-2-306664	Tanning	1996	PC
TEXTILES				
1.FORNO S.A. La Paz	Av. Chacaltaya # 789 Tel.: 591-2-351511	Textile	1996	PC
2.ALBUS S.R.L La Paz	Av. Vásquez #912,Pura Pura Tel: 591-2-305859	Textile	1996	PC
3.UNIVERSALTEX Ltda. La Paz	Av. Bush #1572 Tel: 591-2-226926	Textile	1996	PP and EE
SLAUGHTERHOUSE				
1.VASCAL S.A. Cochabamba	Av.Pando #1144 Tel: 591-42-43643	Slaughterhouse (poultry)	1996	PC
2.TUSEQUIS Ltda La Paz	Av. 6 de marzo s/n, km 7,El Alto Tel: 591-2-850070	Meat processing	1996	PP and EE
3.FRIDOSA	Carretera Cotoca Km.12	Slaughterhouse	1996	PC

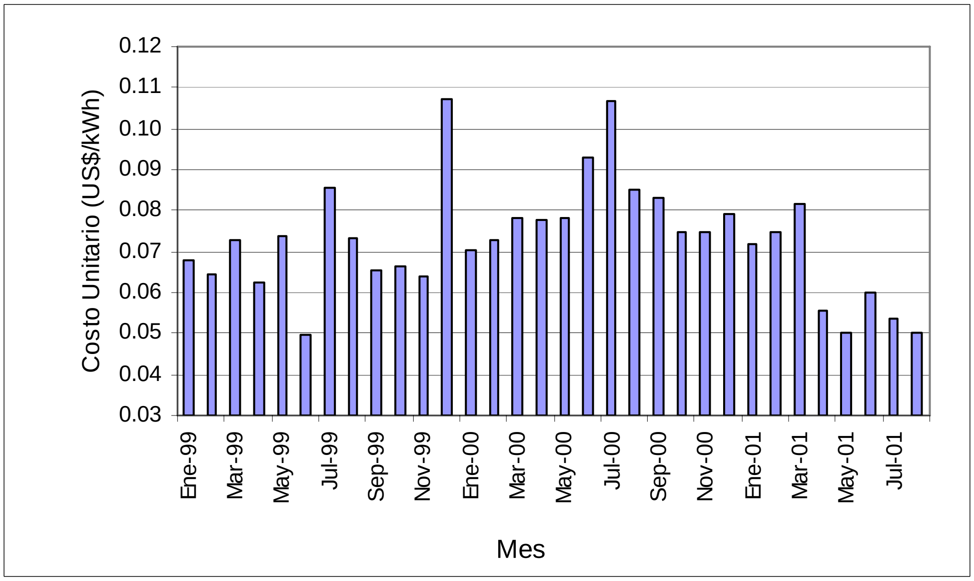
COMPANY	*ADDRESS*	*AREA*	*DATE*	*OBSERVATION*
Santa Cruz	Tel: 591-3-882323	(cows)		
4.FRIGOR	Parque Industrial P.I. 44	Slaughterhouse	1999	PP and EE
Santa Cruz	Tel: 591-3-464970	(cows)		
CHEMICAL IND.				
1.CORIMEXO Ltda.	Parque Industrial PI-5	Galvanoplasty	1996	PC
Santa Cruz	Tel: 591-3-462167			
SUGAR MILLS				
1.UNAGRO	81 km al norte de Santa Cruz	Sugar mill	1998	PP and EE
Santa Cruz	Mineros			
2.GUABIRÁ	Montero	Sugar mill	1998	PP and EE
Santa Cruz	Tel: 591-092-20225			
BEER BREWERIES				
1.Cervecería Bol.	Av. Montes final autopista	Beer brewery	1997	PC
Nacional - La Paz	Tel: 591-2-350448			
2.TAQUIÑA S.A.	Av. Centenario Final	Beer brewery	2000	PP and EE
Cochabamba	Tel: 591-4-287500 al 05			
3.SIDS S.A.	Calle Mauro Nuñez Nº16	Beer brewery	2000	PP and EE
Sucre	Tel: 591-6-441112			
SOFT DRINKS				
1.EMBOL	Av.Blanco Galindo Km.10,Piñami	Bottling soft drinks	1996	PC
Cochabamba	Tel: 591-42-63000			
2.EMBOL	Río Seco, Carr. Panamericana	Bottling	1997	PC
La Paz	Tel: 591-2-860085	soft drinks		
3.EMBOL	Parque Industrial Km.3.5	Bottling	1997	PC
Oruro	Tel: 591-52-78198	soft drinks		
4.EMBOL	C. Juana Azurduy s/n, Z.Carapunku	Bottling	1997	PC
Sucre	Tel: 591-64-43000	soft drinks		
5.EMBOL	Av. Francisco Lazcano s/n	Bottling	1997	PC
Tarija	Tel: 591-66-34303	soft drinks		
6.EMBOL	Parque Industrial PI-6	Bottling	1997	PP and EE
Santa Cruz	Tel: 591-3-465252	soft drinks		
DAIRY PRODUCTS				
1.PIL ANDINA S.A.	Av. Blanco Galindo, km 10.5	Dairy products	1999	PP and EE
Cochabamba	Tel: 591-4-264300			
2.IPILCRUZ S.A.	Carretera a Warnes, km 27.5	Dairy products	2000	PP and EE
Santa Cruz	Tel: 591-92-32155			

COMPANY	*ADDRESS*	*AREA*	*DATE*	*OBSERVATION*
QUINOA (Foodstuffs)				
1.Jataryi - Tunupa Oruro	Comunidad Vito - Oruro Tel.: 052-77600; 018 44609	Quinoa processing	2001	PP and EE
2.ANAPQUI Challapata	C. Loayza Nº 333, Edif Mcal Ayacucho, piso 13, Of. 1311-LP	Quinoa processing	2001	PP and EE
METALLURGY				
1.Allied Deals Vinto - Oruro	Vinto - Oruro Tel.: 052-78102; 052-78104	Tin smelter	2001	PP and EE
HEALTH SERVICES				
1.Hospital del Niño La Paz	Calle Mayor Zubieta sn Tel: 591-2-245076	Hospital	2000	PP and EE
2.Centro Prosalud La Paz	Av. Circunvalación esq. Calle 15 Tel.: 0801-8001	Health center	2000	PP and EE
3.Centro Prosalud El Alto	Plaza Busch # 52 Tel: No tiene	Health center	2000	PP and EE

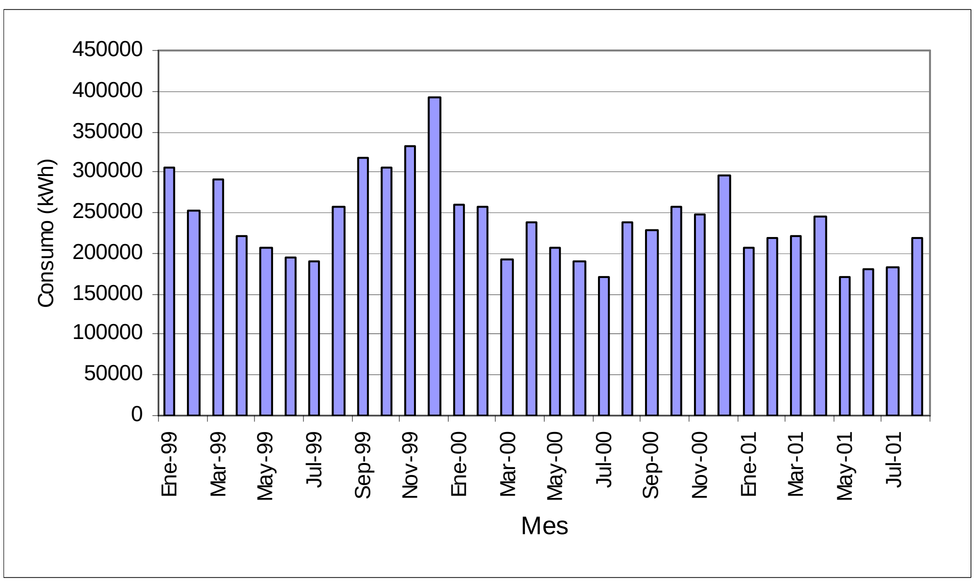
Graph A6.7: Electric Power Consumption Company 1



Graph A6.8: Cost Variation Company 1



Graph A6.9: Electric Power Consumption Company 2



Annex 7

Program Cost: Rural Energy and Energy Efficiency Activities

Energy Efficiency Component	
Consultancies	US$335,000
Measuring equipment	39,000
Rural Energy Component	
Consultancies	445,000
Component Implementation	
Local coordination/supervision (time)	226,000
Local coordination/supervision (travel)	52,000
World Bank headquarters cost (time and travel)	197,000
Local operating costs	17,000
Training workshop and equipment	14,000
Mid-term review	7,000
Total	**US$ 1,332,000**

Annex 8

List of Final Reports

No.	*Consultoría*	*Consultor/a*	*Título del Informe Final*
COMPONENTE ENERGÍA RURAL			
1.	Identificación de Potencialidades del Bombeo de Agua con Energías Renovables en el Sector Agropecuario.	INFOLAN INTERNATIONAL SRL. (Ing. Wolfgang Rolón)	Electrificación y Bombeo de Agua para el Desarrollo Agropecuario: nuevas posibilidades para la electrificación rural en Bolivia.
2.	Elaboración y Facilitación de Ejecución del Proyecto Bombeo Solar de Agua para Abrevaderos de Camélidos - Provincia Sajama, Oruro e Identificación de Perfiles de Proyecto para Seis Regiones.	Ing. Wolfgang Rolón	Bombeo de Agua para Abrevaderos de Camélidos en el Departamento de Oruro.
3.	Estudio-Diseño de Aprovechamiento de Energía Solar Pasiva en Edificaciones Escolares de Regiones Rurales Remotas.	P.A. & Partners (Lic. Javier Gil)	Evaluación Técnico-económica de las Opciones Aaprovechamiento Solar Pasivo en Escuelas de Puna.
4.	Diseño e Implementación del Sistema de Información en Energía Rural (SIENER)	Sistemática Consultores	Diseño e Implementación del Sistema de Información Energética Rural (SIENER).
5.	Actualización de la Base de Datos de Proyectos Minihidráulicos en los Departamentos de La Paz, Cochabamba, Potosí y Chuquisaca	Ing. Walter Canedo	Actualización de la Base de Datos de Proyectos Minihidráulicos en Bolivia (menores a 500 kW).
6.	Preparación y Ejecución del Proyecto: Electrificación Rural en Zonas Aisladas y Dispersas con la Participación de Organismos No Gubernamentales de Desarrollo - Modelo 3	Programa de Apoyo a Organizaciones No Gubernamentales - Agencia Suiza para el Desarrollo y la Cooperación (NOGUB-COSUDE)	1. Programa para el Desarrollo de la Electrificación en Zonas Aisladas o Dispersas PRONER - MODELO 3. 2. Marco de Orientación General para el Desarrollo del Modelo.
7.	Cualificación de Recursos Humanos para el Uso Racional de	Comisión Episcopal de	Proyecto: Cualifación de Recursos Humanos para el Uso Racional de

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	Recursos Energéticos y la Conservación del Medio Ambiente en 15 Mmunicipios del País.	Educación (CEE)	Recursos Energéticos y la Conservación del Medio Ambiente, en 15 Municipios del País.
8.	Implementación Institucional del Programa de Cualificación en Tecnología Energética y Medio Ambiente en las Unidades Educativas de FERIA.	Comisión Episcopal de Educación (CEE)	Proyecto: Implementación Institucional del Programa de Cualificación en Tecnología Energética y Medio Ambiente en las Unidades Educativas de FERIA.
9.	Apoyo a la Elaboración de los Planes Departamentales de Electrificación Rural.	Consultora Sur	1. Apoyo a la Elaboración de Planes Departamentales de Electrificación Rural. 2. Metodología y Procedimientos para la Evaluación de Proyectos de Electrificación Rural. 3. Programa de Electrificación Rural Norte de Potosí-Estudio Complementario a los Proyectos de Electrificación Rural - Sacaca-San Pedro, Huaylloma\Acasio, Sacaca-Caripuyo, Cantones Caripuyo. 4. Municipio de Challapa - Estudio Complementario al Proyecto de Electrificación Antakhahua. 5. Departamento de Oruro - Estudio Complementario al Proyecto de Electrificación Belén de Choquecota. 6. Departamento de La Paz - Estudio Complementario al Proyecto de Electrificación Calacachi. 7. Departamento de Oruro - Estudio Complementario al Proyecto de Electrificación Rural Chipaya. 8. Municipio de Andamarca - Estudio Complementario al Proyecto de Electrificación Orinoca. 9. Departamento de Potosí - Estudio Complementario al Proyecto de Eectrificación Rural Tica Tica-Calazaya. 10. Municipio de Coroico - Estudio Complementario al Proyecto de

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			Electrificación Tocaña. 11. Proyecto Cambio de Sistema de Generación Eléctrica Camargo .- Estudio Económico financiero. 12. Proyecto 2100 Módulos Fotovoltaicos Oruro. 13. Proyecto Electrificación Rural Bautista Saavedra. 14. Proyecto Electrificación Rural Bautista Saavedra. 15. Proyecto Electrificación Comunidad Indígena Querqueta. 16. Proyecto Electrificación Rural Cóndor Apacheta. 17. Proyecto Electrificación Rural Huarancoco Grande. 18. Proyecto Electrificación Rural Iruma-Vinto. 19. Proyecto Red Secundaria Machacamarca. 20. Proyecto Electrificación Rural Malla. 21. Proyecto Electrificación Rural Matecani, Toloma e Irutira. 22. Proyecto Electrificación Rural Toma Toma. 23. Proyecto Electrificación Rural Yani.
10.	Estudios de Factibilidad del Mercado Rural de Electrificación - Modelo 1	Panamerican Investments S.A.	Bolivian Rural Electrification Fund Feasibility Study.
11.	Elaboración de un Proyecto de Fortalecimiento de la Empresa de Electricidad Larecaja (EDEL) en su Area de Concesión.	Ing. Reynaldo Castañón Lic. Marcelo Uribe	1. Proyecto de Fortalecimiento de la Empresa de Distribución Eléctrica Larecaja (EDEL). 2. Addendum al Informe Final: Proyecto de Retorno al Equilibrio Financiero de la Empresa de Distribución Eléctrica Larecaja (EDEL).
12.	Desarrollo de Planes de Acción para la Provisión de Servicios	SERCOIN Ltda.	1. Planes de Acción para la Provisión de Servicios Energéticos

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	Energéticos con Sistemas Fotovoltaicos Domésticos en Areas Rurales, en el Marco del PRONER - Modelo 2		con Sistemas Fotovoltaicos. 2. Plan de Acción Zona 1: Cotagaita, Tupiza y Vitichi. 3. Plan de Acción Zona 2: Atocha, Tomave y Uyuni. 4. Plan de Acción Zona 3: Ocurí y Ravelo.
13.	Desarrollo de Planes de Negocios para la Provisión de Servicios Energéticos con Sistemas Fotovoltaicos en Areas Rurales, en el Marco del PRONER - Modelo 2	Alke & Co. (Boliviana) S.A.	1. Plan de Electrificación Rural con Sistemas Fotovoltaicos: Municipio San Lucas. 2. Plan de Electrificación Rural con Sistemas Fotovoltaicos: Municipio Culpina. 3. Plan de Electrificación Rural con Sistemas Fotovoltaicos: Municipio Camargo. 4. Plan de Electrificación Rural con Sistemas Fotovoltaicos: Municipio Incahuasi. 5. Plan de Electrificación Rural con Sistemas Fotovoltaicos: Municipio Riberalta. 6. Plan de Electrificación Rural con Sistemas Fotovoltaicos: Municipio Guayaramerín. 7. Plan de Electrificación Rural con Sistemas Fotovoltaicos: Municipio Moco Moco. 8. Plan de Electrificación Rural con Sistemas Fotovoltaicos: Municipio Puerto Acosta. 9. Plan de Electrificación Rural con Sistemas Fotovoltaicos: Municipio Viacha. 10. Plan de Electrificación Rural con Sistemas Fotovoltaicos: Municipio Puerto Carabuco.
14.	Implementar el Funcionamiento de Sistemas Audivisuales-fotovoltaicos en las Unidades Educativas de FERIA.	Lic. Javier Reyes Aramayo	Proyecto: Implementar el Funcionamiento de Sistemas Audivisuales-fotovoltaicos en las Unidades Educativas de FERIA.

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15.	Provisión de Equipos Audiovisuales-Fotovoltaicos para las Unidades Educativas de FERIA.	SERCOIN Ltda.	Acta de entrega final: Provisión, Instalación y Puesta en Funcionamiento de Sistemas Audiovisuales Alimentados con Energía Solar en las Unidades Educativas de FERIA.
16.	Elaboración de la Guía de Diseño y Equipamiento para Unidades Escolares Aprovechando la Energía Solar Pasiva	Arq. José H. Vásquez Daniel Cabrera	Guía de Diseño y Equipamiento para Unidades Escolares. Aprovechando la Energía Pasiva. Proyecto de Refacción, Ampliación y Construcción Escuela Muro Pilar-Mejillones.
COMPONENTE EFICIENCIA ENERGÉTICA			
1.	Manejo de la Demanda - Fase 1	Dr. Alessandro Barghini Ing. Renán Orellana	Manejo de la Demanda Eléctrica en Bolivia y Conservación de Energía. Anexos Manejo de la Demanda en la Ciudad de Sucre.
2.	Manejo de la Demanda en Sucre y Santa Cruz - Fase 2	Dr. Alessandro Barghini Ing. Renán Orellana	Manejo de la Demanda en las Ciudades de Sucre y Santa Cruz.
3.	Lineamientos para una Estrategia de Acceso a la Energía Eficiente en Bolivia	Ing. Miguel Fernández Ing. Carlos Ríos	Lineamiento para una Estrategia de Acceso a Energía Eficiente en Bolivia.
4.	Plan Piloto de Eficiencia Energética en el Sector Industrial	P.A. & Partners	Informe Final.
5.	Programa M&T en el Sector Industrial	P.A. & Partners	Informe Final Programa Monitoring & Targeting Sector industrial.
6.	Diseño y Validación del Módulo General de Eficiencia Energética	P.A. & Partners	Energía y Medio Ambiente: Módulo Eficiencia Energética.
7.	Adquisición de Equipos de Medición	TEC	Acta de transferencia de equipos a la Cámara Nacional de Industrias e inventario de equipos.
8.	Balance Energético Nacional (BEN)	Ing. Orlando Melgar	1. Reportes del Sistema de Información del Balance Energético Nacional 1996-2000. 2. Propuestas de Instrumentos Normativos e Institucionales para Garantizar el Flujo de Información para la Elaboración del Balance Energético Nacional.
9.	Apoyo al Programa M&T en el Sector Industrial de Bolivia	SAGE Ltda.	Final Report: Support Monitoring and Targeting at the Industrial

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			Sector in Bolivia.
10.	Actividades del CPTS: Curso de Capacitación, Elaboración de Cartera de Proyectos, Difusión de Resultados, Diagnóstico Energético del Edificio Centro de Comunicaciones La Paz	Cámara Nacional de Industrias	Informe de Capacitación, Cartera de Proyectos y Difusión.

Joint UNDP/World Bank
ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

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Côte d'Ivoire	Workshop on Rural Energy and Sustainable Development, January 30-31, 2002. (French Only)	04/05	068/05
Ethiopia	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Ethiopia - Action Plan.	12/03	038/03
	Sub-Saharan Petroleum Products Transportation Corridor: Analysis And Case Studies	03/03	033/03
	Phase-Out of Leaded Gasoline in Sub-Saharan Africa	04/02	028/02
	Energy and Poverty: How can Modern Energy Services Contribute to Poverty Reduction	03/03	032/03
East Africa	Sub-Regional Conference on the Phase-out Leaded Gasoline in East Africa. June 5-7, 2002.	11/03	044/03
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	The Kenya Portable Battery Pack Experience: Test Marketing an Alternative for Low-Income Rural Household Electrification	12/01	05/01
Malawi	Rural Energy and Institutional Development	04/05	069/05
Mali	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Mali - Action Plan. (French)	12/03	041/03
Mauritania	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Mauritania - Action Plan. (French)	12/03	040/03
Nigeria	Phase-Out of Leaded Gasoline in Nigeria	11/02	029/02
	Nigerian LP Gas Sector Improvement Study	03/04	056/04
	Taxation and State Participation in Nigeria's Oil and Gas Sector	08/04	057/04
Regional	Second Steering Committee: The Road Ahead. Clean Air Initiative In Sub-Saharan African Cities. Paris, March 13-14, 2003.	12/03	045/03
	Lead Elimination from Gasoline in Sub-Saharan Africa. Sub-regional Conference of the West-Africa group. Dakar, Senegal March 26-27, 2002 (French only)	12/03	046/03
	1998-2002 Progress Report. The World Bank Clean Air Initiative in Sub-Saharan African Cities. Working Paper #10 (Clean Air Initiative/ESMAP)	02/02	048/04
Senegal	Regional Conference on the Phase-Out of Leaded Gasoline in Sub-Saharan Africa	03/02	022/02
	Elimination du Plomb dans I'Essence en Afrique Sub-Saharienne Conference Sous Regionales du Groupe Afrique de I'Quest. Dakar, Senegal. March 26-27, 2002.	12/03	046/03
South Africa	South Africa Workshop: People's Power Workshop.	12/04	064/04
Swaziland	Solar Electrification Program 2001—2010: Phase 1: 2001—2002 (Solar Energy in the Pilot Area)	12/01	019/01

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	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Tanzania - Action Plan.	12/03	039/03
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	Technology Assessment of Clean Coal Technologies for China Volume I—Electric Power Production	05/01	011/01
	Technology Assessment of Clean Coal Technologies for China Volume II—Environmental and Energy Efficiency Improvements for Non-power Uses of Coal	05/01	011/01
	Technology Assessment of Clean Coal Technologies for China Volume III—Environmental Compliance in the Energy Sector: Methodological Approach and Least-Cost Strategies	12/01	011/01
Thailand	DSM in Thailand: A Case Study	10/00	008/00
	Development of a Regional Power Market in the Greater Mekong Sub-Region (GMS)	12/01	015/01
Vietnam	Options for Renewable Energy in Vietnam	07/00	001/00
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	Vietnam's Petroleum Sector: Technical Assistance for the Revision of the Existing Legal and Regulatory Framework	03/04	053/04
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Regional	Roundtable on Opportunities and Challenges in the Water, Sanitation And Power Sectors in the Middle East and North Africa Region. Summary Proceedings. May 26-28, 2003. Beit Mary, Lebanon. (CD)	02/04	049/04

LATIN AMERICA AND THE CARIBBEAN REGION (LCR)

Brazil	Background Study for a National Rural Electrification Strategy: Aiming for Universal Access	03/05	066/05
Bolivia	Country Program Phase II: Rural Energy and Energy Efficiency Report on Operational Activities	05/05	072/05
Ecuador	Programa de Entrenamiento a Representantes de Nacionalidades Amazónicas en Temas Hidrocarburíferos	08/02	025/02
Guatemala	Evaluation of Improved Stove Programs: Final Report of Project Case Studies	12/04	060/04
Mexico	Energy Policies and the Mexican Economy	01/04	047/04
Nicaragua	Aid-Memoir from the Rural Electrification Workshop (Spanish only)	03/03	030/04
	Sustainable Charcoal Production in the Chinandega Region	04/05	071/05
Regional	Regional Electricity Markets Interconnections — Phase I Identification of Issues for the Development of Regional Power Markets in South America	12/01	016/01
	Regional Electricity Markets Interconnections — Phase II Proposals to Facilitate Increased Energy Exchanges in South America	04/02	016/01
	Population, Energy and Environment Program (PEA) Comparative Analysis on the Distribution of Oil Rents (English and Spanish)	02/02	020/02
	Estudio Comparativo sobre la Distribución de la Renta Petrolera Estudio de Casos: Bolivia, Colombia, Ecuador y Perú	03/02	023/02
	Latin American and Caribbean Refinery Sector Development Report – Volumes I and II	08/02	026/02
	The Population, Energy and Environmental Program (EAP) (English and Spanish)	08/02	027/02
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	Energy from Landfill Gas for the LCR Region: Best Practice and Social Issues (CD Only)	01/05	065/05

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	Cross-Border Oil and Gas Pipelines: Problems and Prospects	06/03	035/03
	Monitoring and Evaluation in Rural Electrification Projects: A Demand-Oriented Approach	07/03	037/03
	Household Energy Use in Developing Countries: A Multicountry Study	10/03	042/03
	Knowledge Exchange: Online Consultation and Project Profile from South Asia Practitioners Workshop. Colombo, Sri Lanka, June 2-4, 2003	12/03	043/03
	Energy & Environmental Health: A Literature Review and Recommendations.	03/04	050/04
	Petroleum Revenue Management Workshop	03/04	051/04
	Developing Financial Intermediation Mechanisms for Energy Efficiency Projects – Focus on Banking Windows for Energy Efficiency	08/04	058/04
	Evaluation of ESMAP Regional Power Trade Portfolio (TAG Report)	12/04	059/04
	Gender in Sustainable Energy Regional Workshop Series: Mesoamerican Network on Gender in Sustainable Energy (GENES) Winrock and ESMAP	12/04	062/04
	Women in Mining Voices for a Change Conference (CD Only)	12/04	063/04
	Renewable Energy Potential in Selected Countries: Volume I: North Africa, Central Europe, and the Former Soviet Union, Volume II: Latin America	04/05	070/05

Last report added to this list: ESMAP Technical Paper 072/05.