PD-AAG-007 (2)

[redacted]
Also

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UNITED STATES INTERNATIONAL DEVELOPMENT COOPERATION [redacted]
AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D. C. 20523

PERU

PROJECT PAPER

SMALL HYDRO DEVELOPMENT

AID/LAC/P-064

[redacted]

[redacted]

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

1. TRANSACTION CODE: A (A = Add, C = Change, D = Delete) — Amendment Number: _____

DOCUMENT CODE: 3

2. COUNTRY/ENTITY: PERU

3. PROJECT NUMBER: 527-0226

4. BUREAU/OFFICE: LA — 05

5. PROJECT TITLE (maximum 40 characters): Small Hydro Development

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 03 DD 06 YY 86

7. ESTIMATED DATE OF OBLIGATION (Under 'B.' below, enter 1, 2, 3, or 4)
A. Initial FY 81 B. Quarter 1 C. Final FY 82

8. COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY 81 B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total	7,200	2,600	10,000	7,370	2,630	10,000
(Grant)	(700)	(100)	(800)	(870)	(130)	(1,000)
(Loan)	(6,500)	(2,500)	(9,000)	(6,500)	(2,500)	(9,000)
Other U.S. 1.						
Other U.S. 2.						
Host Country		400	400		4,400	4,400
Other Donor(s)						
TOTALS	7,200	2,600	10,400	7,370	7,030	14,400

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1) FN	740	878	878			800	9,000	1,000	9,000
(2)									
(3)									
(4)									
TOTALS						800	9,000	1,000	9,000

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 100, 062, 825, 120

11. SECONDARY PURPOSE CODE:

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)

A. Code	BR						
B. Amount	10,000						

13. PROJECT PURPOSE (maximum 480 characters)

To promote rural and regional socio-economic development through the development of an institutional base capable of providing reasonably priced hydro--generated electrical energy for social and productive uses in rural towns in the sierra and high jungle.

14. SCHEDULED EVALUATIONS
Interim MM 13 YY 83 MM 11 YY 84 Final MM 11 YY 86

15. SOURCE/ORIGIN OF GOODS AND SERVICES: [X] 000 [X] 941 [X] Local [ ] Other (Specify) _____

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a _____ page PP Amendment.)

17. APPROVED BY
Signature: [signature]
Title: Leonard Yaeger, Director
Date Signed: MM 09 DD 04 YY 80

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION
MM 09 DD 05 YY 80

AID 1330-2 (8-79)

INSTRUCTIONS

The approved Project Data Sheet summarizes basic data on the project and must provide reliable data for entry into the Country Program Data Bank (CPDB). As a general rule blocks 1 thru 16 are to be completed by the originating office or bureau. It is the responsibility of the reviewing bureau to assume that whenever the original Project Data Sheet is revised, the Project Data Sheet conforms to the revision.

Block 1 - Enter the appropriate letter code in the box, if a change, indicate the Amendment Number.

Block 2 - Enter the name of the Country, Regional or other Entity.

Block 3 - Enter the Project Number assigned by the field mission or an AID/W bureau.

Block 4 - Enter the sponsoring Bureau/Office Symbol and Code. *(See Handbook 3, Appendix 5A, Table 1, Page 1 for guidance.)*

Block 5 - Enter the Project Title *(stay within brackets; limit to 40 characters).*

Block 6 - Enter the Estimated Project Assistance Completion Date. *(See AIDTO Circular A-24 dated 1/26/78, paragraph C, Page 2.)*

Block 7A. - Enter the FY for the first obligation of AID funds for the project.
Block 7B. - Enter the quarter of FY for the first AID funds obligation.
Block 7C. - Enter the FY for the last AID funds obligations.

Block 8 - Enter the amounts from the 'Summary Cost Estimates' and 'Financial Table' of the Project Data Sheet.
NOTE: The L/C column must show the estimated U.S. dollars to be used for the financing of local costs by AID on the lines corresponding to AID.

Block 9 - Enter the amounts and details from the Project Data Sheet section reflecting the estimated rate of use of AID funds.
Block 9A. - Use the Alpha Code. *(See Handbook 3, Appendix 5A, Table 2, Page 2 for guidance.)*

Blocks 9B., C1. & C2. - See Handbook 3, Appendix 5B for guidance. The total of columns 1 and 2 of F must equal the AID appropriated funds total of 8G.

Blocks 10 and 11 - See Handbook 3, Appendix 5B for guidance.

Block 12 - Enter the codes and amounts attributable to each concern for Life of Project. *(See Handbook 3, Appendix 5B, Attachment C for coding.)*

Block 13 - Enter the Project Purpose as it appears in the approved PID Facesheet, or as modified during the project development and reflected in the Project Data Sheet.

Block 14 - Enter the evaluation(s) scheduled in this section.

Block 15 - Enter the information related to the procurement taken from the appropriate section of the Project Data Sheet.

Block 16 - This block is to be used with requests for the amendment of a project.

Block 17 - This block is to be signed and dated by the Authorizing Official of the originating office. The Project Data Sheet will not be reviewed if this Data Sheet is not signed and dated. Do not initial.

Block 18 - This date is to be provided by the office or bureau responsible for the processing of the document covered by this Data Sheet.

UNITED STATES INTERNATIONAL DEVELOPMENT COOPERATION AGENCY
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

PROJECT AUTHORIZATION

Name of Country: Peru

Name of Project: Small Hydro Development

Number of Project: 527-0226

Number of Loan: 527-T-075

1. Pursuant to Section 103 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Small Hydro Development project for Peru (the "Cooperating Country") involving planned obligations of not to exceed Nine Million United States Dollars ($9,000,000) in loan funds ("Loan") and One Million United States Dollars ($1,000,000) in grant funds ("Grant") over a five-year period from date of authorization, subject to the availability of funds in accordance with the A.I.D. OYB/allotment process, to help in financing foreign exchange and local currency costs for the project.

2. The project ("Project") consists of instutionalizing the small hydroelectric program with ELECTROPERU through: (a) the carrying out of feasibility studies; (b) the installation of small-scale standardized hydroelectric installations, primarily in the 100 to 1000 kilowatt range; (c) the promotion in the target communities of income-producing activities using electricity; (d) training of preventive maintenance mechanics for the small-scale, standardized hydroelectric installations; and (e) the provision of technical assistance to ELECTROPERU.

3. The Project Agreement, which may be negotiated and executed by the officer to whom such authority is delegated in accordance with A.I.D. regulations and Delegations of Authority, shall be subject to the following essential terms and covenants and major conditions, together with such other terms and conditions as A.I.D. may deem appropriate:

a. Interest Rate and Terms of Repayment (Loan)

The Cooperating Country shall repay the Loan to A.I.D. in U.S. Dollars within twenty-five (25) years from the date of first disbursement of the Loan, including a grace period of not to exceed ten (10) years. The Cooperating Country shall pay to A.I.D. in U.S. Dollars interest from the date of first disbursement of the Loan at the rate of (i) two percent (2%) per annum during the first ten (10) years, and (ii) three percent (3%) per annum thereafter, on the outstanding disbursed balance of the Loan and on any due and unpaid interest accrued thereon.

b. Source and Origin of Goods and Services (Loan)

Goods and services, except for ocean shipping, financed by A.I.D. under the Loan shall have their source and origin in the Cooperating Country or in countries included in A.I.D. Geographic Code 941, except as A.I.D. may otherwise agree in writing. Ocean shipping financed by A.I.D. under the Loan shall, except as A.I.D. may otherwise agree in writing, be financed only on flag vessels of the United States and the Cooperating Country.

c. Source and Origin of Goods and Services (Grant)

Goods and services, except for ocean shipping, financed by A.I.D. under the Grant shall have their source and origin in the United States, or the Cooperating Country, except as A.I.D. may otherwise agree in writing. Ocean shipping financed by A.I.D. under the Grant shall, except as A.I.D. may otherwise agree in writing, be financed only on flag vessels of the United States.

d. Condition Precedent to Initial Disbursement (Loan and Grant)

Prior to any disbursement, or the issuance of any commitment documents under the Project Agreement, the Cooperating Country shall, except as A.I.D. may otherwise agree in writing, furnish to A.I.D. in form and substance satisfactory to A.I.D., evidence that an official of ELECTROPERU has been named Project Manager for the Project.

e. Conditions Precedent to Initial Disbursement (Loan)

Prior to any disbursement, or the issuance of any commitment documents under the Project Agreement for the Loan financed portion of the Project, the Cooperating Country shall, except as A.I.D. may otherwise agree in writing, furnish to A.I.D. in form and substance satisfactory to A.I.D.:

(1) A staffing plan for Project activities for the Oficina de Tecnologia Aplicada ("OPTA") within ELECTROPERU.

(2) A maintenance plan for the installations to be constructed under the Project.

(3) A description of the campaign which will be carried out to promote income-producing activities using electricity.

(4) A time-phased plan for the construction component of the Project.

(5) A policy statement setting forth the policy according to which the electrical rate structure for ELECTROPERU is set.

(6) Evidence of adoption by ELECTROPERU of methodologies acceptable to A.I.D. for carrying out pre-feasibility and feasibility studies for the construction of small scale standardized hydroelectric installations under the Project.

f. Covenants

The Cooperating Country shall covenant that, unless A.I.D. otherwise agrees in writing, it will:

(1) Carry out pre-feasibility and feasibility studies for the construction of small-scale standardized hydroelectric installations in the Departments of Cajamarca, Junin and San Martin.

(2) Not use Loan funds to finance small-scale, standardized hydroelectric installations with a generative capacity outside the range between 100 kilowats and 1000 kilowats.

(3) Obtain A.I.D. approval for each subproject to be financed under the Project prior to commencement of construction for such subproject.

(4) Cause ELECTROPERU to furnish to A.I.D. at the end of the second year of the Project and each year on an annual basis thereafter for ten years following the PACD, an analysis which quantifies the amount of subsidy to the OPTA program and the effect of the subsidy on ELECTROPERU's financial condition.

Acting Assistant Administrator
Bureau for Latin America
and the Caribbean

Date

Clearances:
LAC/DR:NParker: date
LAC/DR:MBrown: date 10/22
GC/LAC:BVeret: date
LAC.SA:WRhodes: date
Drafted:GC/LAC:DAAdams:ckg:10/5/80

PROJECT PAPER

SMALL HYDRO DEVELOPMENT

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*** Due to their size, the feasibility studies have not been included in the PP; however, they are available from Mission Files and in LAC/DR bulk file.**

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I. SUMMARY AND RECOMMENDATIONS

A. Recommendations

1. That a loan be authorized to the Government of Peru (GOP) in the amount of $9,000,000 with a 25 year term including a 10 year grace period, and at 2% interest during the grace period and 3% thereafter.

2. That a grant be approved in the amount of $1,000,000 to be incrementally authorized as follows:

a. FY 81 - $300,000
b. FY 82 - $200,000
c. FY 83 - $200,000
d. FY 84 - $200,000
e. FY 85 - $100,000

B. Participating Agencies

The Borrower and Grantee will be the GOP represented by the Ministry of Economy and Finance. The Ministry of Energy and Mines (MEM) will be the Ministry with direct Project responsibility. The Project's implementing agency will be ELECTROPERU a semi-autonomous agency of the MEM.

C. Summary Project Rationale and Description

The relationship between energy and economic development is as crucial in the developing countries as it was and continues to be in the industrialized nations. The process of economic growth is traceable in large part to the substitution of energy for muscle in the performance of every type of agricultural, industrial, and domestic task. It is hardly surprising, then, that prospects for growth in critical sectors of the less developed economies are linked, at least in part, to the development and exploitation of energy resources available to them.

Rural electrification has been given high priority by the GOP and the Ministry of Energy and Mines has chosen the mini-hydro generation systems alternative as the most appropriate for certain rural areas of Peru for the following reasons: a) the relative isolation of a significant portion of rural communities makes grid interconnection unfeasible; b) the poorly developed road network increases the costs and decreases the reliability of fuel supplies for diesel plants; c) the planned average size hydro installation is lower in total discounted cost relative to the diesel option; d) the price of oil is increasing continually; e) an in situ renewable energy resource is available; and f) expected social and economic benefits resulting from electrification.

The conditions of poverty facing the primary target groups is detailed in the Mission's most recent CDSS. Employment generating activities are seriously jeopardized by lack of dependable electrical supplies, with the potential being largely untapped for agriculture and agro-industry development, small business establishment (e.g. retail outlets, cottage industry), improvements in various crafts (e.g. carpentry), and the setting up of public services. In short - the infrastructure for support of enterprises and services is minimal or nonexistent.

Less than three percent of all homes in rural Peru have access to household electricity. Eighty-one percent of households use kerosene for lighting. The substitution of kerosene by electricity reduces user costs, causes less pollution and lessens demand and dependence on petroleum-based derivatives.

Traditionally, these direct benefits have been more easily identifiable in the short term than those resulting from municipal or productive uses. Residential electrification enables the users at initial stages, lengthen working hours and tap into sources of information (e.g. radio, television). Eventually, the users in many cases are able to purchase labor/time saving devices, primarily electrical appliances.

These basic examples of benefits accrued through household consumption of electricity aside, the stronger economic case for rural electrification is in terms of productive and municipal uses of electricity benefiting the rural poor. Additional benefits result from local industry procurement of materials used to build and maintain the infrastructure for such enterprises and services. Productive uses, such as those discussed above and others such as irrigation, will generate employment for that segment of the rural poor who must supplement their income from off-farm earnings. The municipal uses of electricity will facilitate the supply of services for evening education, civil centers, health clinics, street lighting. etc. These services will be more accessible to a larger percentage of the rural poor, i.e. those who will not be in a position to be included in residential electrification schemes.

Project beneficiaries, all residing in relatively isolated areas in the Sierra and high jungle are the target groups identified in the CDSS: independent market oriented farmers, agrarian reform beneficiaries, campesino communities and landless/near/rural poor. The impact of investment in electrical supply infrastructure for this group is twofold: First, it will raise the standard of living in rural areas through the provision of modern conveniences which are often one of the principal factors affecting rural-urban migration. Thus it will provide a counterweight to excessive urbanization through public lighting and household uses. It will also provide productive enterprises with cheaper and superior forms of energy thereby lowering their production costs. This gives rural industry the opportunity to compete with urban industries providing the possibility for additional rural job creation. Second, the Project will increase demand for inputs produced in Peru necessary for plant construction and installation such as certain electrical equipment, transmission lines, posts, labor, etc., and increase demand from rural town commercial outlets for electrical appliances, water pumps and other production related

equipment for farm, agro-industry, cottage industry, commerce, and home uses.

The purpose of this Project is to promote rural and regional socio-economic development through the development of an institutional base capable of providing reasonably priced, hydro-generated electrical energy for social and productive uses in rural towns in the sierra and high jungle. The Project will be implemented by ELECTROPERU through the Office of Applied Technology (OPTA). The Loan will finance studies, equipment and construction of standardized small-scale hydro-electric installations normally the 100 to 1,000 KW range located in the GOP's priority areas. The Project will concentrate its activities in the Departmentsof San Martin, Cajamarca, and Junin where the GOP has determined that the greatest development potential exists, and where other Mission regional development activities are underway.

The number and size of small-hydro plants to be constructed under the Project has not been determined other than establishing the parameters that plants will normally be in the range of 100 to 1,000 kilowatts. The pre-feasibility and feasibility study methodology which will be utilized in making these decisions is designed to identify those sub-projects which meet minimum technical, economic, social and environmental criteria.Application of this methodology will determine the size plants and in turn the size communities where the economic and resulting social benefits from the Project would be greatest. It is estimated that approximately 28 small hydro-electric plants with an average capacity of 300KW will be constructed. Total plant capacity under this project will be approximately 8.4 MW. The Project will benefit 53,000 families or 265,000 beneficiaries at a cost of $55 per beneficiary. Estimated installed capacity per household will be approximately 300 watts.

The $1.0 million companion grant will serve to strengthen an expand ELECTROPERU's ability to implement its small hydroelectric program. Through the provision of T.A. and training, the Grant will assist ELECTROPERU to evaluate the potential for small-hydro plants, conduct feasibility studies, ensure that standard operational programs for operating and maintaining hydroelectric plants are developed, i.e. administration, billing, operation and maintenance. Additionally assistance will be provided for program planning and the development of a promotional program for the productive uses of electricity in the Project area.

The Government of Peru (GOP) will finance the cost of the pre-feasibility and feasibility studies (US$0.7 million) provide personnel and support services to carry out the promotion activities (US$0.1 million) finance approximately one third of the plant construction cost (US$3.4 million) and provide maintenance support (US$0.24 million).

The Project responds to one of the most critical investment areas articulated by President Belaunde in his first address to Congress in August of this year. The country is embarking on a new high priority, small hydro-

electric program and has requested AID assistance in the design and implementation of this program. The Mission feels that given the high priority attached to this area by the GOP, a significant AID assistance package would have a major impact on establishing program policies, geographic focus, site selection methodologies, tariff structure, and other key policy and planning activities.

The proposed loan size is further justified in view of the fact that the Project will provide a necessary element in ensuring the success of the Mission's regional development efforts, namely the $15.0 million Integrated Regional Development loan and the $19.0 million Sub-Tropical Lands loan. These are major departmental development efforts and in order to maximize their success, the provision of electricity for productive purposes is both essential and timely.

Finally, both the GOP and the Mission anticipate the emergence of a national capability to manufacture the required turbines, generators and other essential machinery for a small hydroelectric plant. Investment of this nature can only be encourage through the assurance of a growing demand for this equipment. A significant AID loan will provide much of the necessary encouragement to the private sector indicating to them that investment in this area is warranted.

Project Components Financed by A.I.D.

In order to achieve the objectives of the Project as described before, the following components are planned to be financed from the A.I.D. contribution.

1. The Loan

The Project will finance plant construction (i.e. civil works, mechanical equipment, control and electromechanical equipment) and network systems, including household connections, for approximately 28 small-scale standardized hydroelectric installations normally in the 100 to 1,000 KW range, with an expected average plan size of 300 KW.

Actual construction of the small hydroelectric plants will be carried out by the four construction units from ELECTROPERU, while OPTA will be the entity supervising civil works and plant installation. OPTA will be responsible for contracting with private firms for actual field supervision. OPTA will be the agent for all procurement under the Project, based on OPTA direct procurement for all materials requirements for contract, as well as force account construction following practices used by ELECTROPERU on construction of previous hydroelectric projects. Construction activities will be carried out in groups of 4. Construction on the first group will begin during year 2 of the program. Construction on a new group will begin every six months thereafter until the beginning of year 5. ELECTROPERU's experience has been that on average it takes one year to put a small hydroelectric plant Project in service from the day that construction activities begin. Thus, all the 28 plants should be in service by the end of year five of the program. 9.0 million

will be provided from Loan funds to cover the partial cost of plant construction, which will include: 1) civil engineering works (US$2.5 million); and, 2) generation, control and other types of equipment as well as machinery (US$6.5 million). The cost of individual household connections will also be funded. The financing for this component will be complemented by GOP funds.

2. The Grant

a. Implementation Support for Promotion Campaign

The provision of electricity especially in rural areas, does not automatically lead to utilization at levels sufficiently high to approach full realization of its potential. The Project includes an educational component designed to inform and train the target communities on how to take advantage of electricity to expand the range of their economic activities and increase rural productivity. Local technical assistance will be provided to train rural promoters who will work with the Project communities during the first year of operation of the small hydroelectric power plant in each site. A detailed training curriculum will be developed to equip the promoters with the necessary technical and pedagogic skills. Peruvian specialists in small industry and farm development, crop storage and marketing, home economics, nutrition, anthropology/rural sociology, and a consultant with previous experience in the implementation of such promotion campaign will be engaged on a short-term basis for the design of the program curriculum. This consultant will also conduct the seminar in which eight promoters, who will support this component, will be trained. AID grant funds totalling US$100,000 will finance 50% of the salary and operation costs of implementing this component. This amount will be complemented by GOP funds in the same amount described below.

b. Technical Assistance

$870,000 in Grant funds will be provided to fund 102 person/months of U.S. short and long-term technical assistance to assist ELECTROPERU to strenghthen and expand its ability to implement the Project as described above. ELECTROPERU will enter into an institutional contract for all of the following technical assistance requirements.

1) A long term Project Advisor will be hired for the life of the project at a cost of $450,000. He will be located in Lima and report to the Project Manager in OPTA. His responsibilities will be to assist ELECTROPERU with Project implementation including development of personnel and technical assistance requirements for the program, recommendations regarding Project monitoring activities and assisting in the preparation and review of the pre-feasibility and feasibility studies.

2) AID funding will be provided to finance eight person/months ($80,000) for an energy economist. During the first few months of the Project, the economist will spend two months in Peru assisting OPTA in finalizing sub-project selection methodology and obtaining estimates of electricity demand in typical sub-project sites. During year 2, the economist

will spend three months in Peru assisting in the preparation and analysis of the first group of feasibility studies. He will spend an additional three months working with the feasibility study team in years 3 and 4.

3) AID funding has been provided to finance four person/months ($40,000) for an environmental impact analyst to work together with the economist on implementing the feasibility study component and training an ELECTROPERU counterpart.

4) AID funding has been provided to finance six person/months ($60,000) for a specialist in design and construction of hydroelectric plants to assist OPTA in the procurement of appropriate equipment and spare parts. He will spend two months working on the Project in years two, three and four.

5) AID will finance four person/month [illegible], for a curriculum development specialist to assist OPTA in the [illegible] of a training program for the energy promotion component.

6) AID will finance six person/months ($60,000) in year one to finance an energy planner to assist OPTA in planning the implementation of its national minihydro program.

7) AID funding will be provided to finance six person/months ($60,000) to assist ELECTROPERU in updating its pricing policy, billing and collection methods. This assistance will be provided during year one of the Project.

8) Four person/months of financing ($40,000) will be provided to contract for a hydroelectric maintenance specialist to assist in training four preventive maintenance mechanics.

9) Finally, $40,000 has been provided to finance an end of Project evaluation to be conducted by a team comprised of an economist, engineer and sociologist. This evaluation will be carried out during the last three months of the Project.

c. Maintenance

AID grant funds will be utilized to finance 50% ($30,000) of the salary and operation costs to implement this Project component. Four turbine-generator preventive maintenance mechanics will be hired at the beginning of year 3. Initially, they will receive a four month training program on all aspects of system maintenance. The program will prepare maintenance personnel who will have the responsibility for maintaining the turbine-generator systems and being on call to repair defective machinery.

Project Components Financed by Peru

In order to achieve the objectives of the Project as described above, the following components are planned to be financed from the Government

of Peru (GOP) contribution.

1. Pre-feasibility Studies

A preliminary estimate of the hydroelectric potential of many of the proposed sites has already been conducted. This information, developed with the assistance of the UNDP, will be combined with available economic and demographic information and utilized by the Project to undertake these studies. The examination will identify and prioritize a list of potential sites and identify possible additional sites not on the preliminary list. The focus of this activity will be on the departments of Junin, Cajamarca, and San Martin. The pre-feasibility studies component which will take 20 weeks and will cost approximately $200,000, will be paid for by the GOP as a portion of its counterpart contribution. The output of the pre-feasibility study component will be a list of 80 sites prioritized according to anticipated social, economic and technical benefits. GOP funds will be utilized to carry out detailed feasibility studies on those sub-projects identified in the previsous component containing the highest combined technical, social and economic returns, and approved by the Departmental Development Committees. Approximately 36 feasibility studies will be carried out by the same four teams that conduct the pre-feasiblity studies. Each feasibility study will take approximately four months to complete. This component will begin in year 2 and end in year 4 of the Project. The estimated cost of this component is $500,000 and will be assumed by ELECTROPERU as a portion of its counterpart contribution.

2. Promotion Campaign

The Promotion Campaign on income generating Productive Uses of Electricity described above will receive $700,000, in funding from the GOP which represents approximately 50% of the salary and operation cost of implementing this component. These funds will cover the costs of the four promotional teams composed of eight promoters as well as other salary and operations costs.

3. Construction

This component, as described above, will be jointly financed by the GOP and A.I.D. Thus, $2.09 million will be provided by the GOP for the civil engineering works. $1,030,000 will be funded by the GOP for procurement of equipment and $240,000 for supervision costs of this component.

Charges to Project beneficiaries will initially be on a flat rate basis, however, over a period generally of 2-3 years, households will be converted to meter systems provided by ELECTROPERU, the cost of which is amortized by the beneficiaries in monthly installments.

4. Maintenance

GOP funds for this component amount to $240,000, of which $30,000 corresponds to costs for salaries and expenses and $210,000 are budgeted for spare parts. The Project maintenance fund over the triennium of year 3 to year 5 will be more than 1.5% of the capital costs of the installed plant, which is current GOP policy.

D. Summary Findings

The Mission has found the Project to be administratively, technically, socially, economically and financially feasible and consistent with the development objectives of the GOP and those objectives set forth in USAID's CDSS document.

E. Summary Financial Plan

SUMMARY FINANCIAL PLAN
(In Thousands of U.S. dollars)

Investment Category	A.I.D. Loan	A.I.D. Grant	GOP	TOTAL
I. Studies (pre-feasibility and feasibility	-	-	700	700
II. Implementation Support for Promotion Campaign	-	100	100	200
III. Construction	9000	-	3360	12360
IV. Technical Assistance	-	870	-	870
V. Maintenance	-	30	240	270
Grand Total	9000	1000	4400	14400
	69%		31%	100%

F. Project Development Committee

1. USAID Staff

George Wachtenheim	Capital Development
Douglas Chiriboga	Agriculture Office
Alberto Larrabure	Engineering Office
César Espino	Capital Development
John Davison	Controller
Lee Twentyman	Development Resources
Edward Kadunc	Capital Development
Steve Whitman	Regional Legal Advisor

2. TDY Assistance

Willy Flores	NRECA
Donal O'Leary	NRECA
Cora Shaw	NRECA
Jack Fritz	DSB/EY
Dave Adams	LAC/DR

II. BACKGROUND

A. Country Setting

Energy development is an important element in the challenge that Peru will face over the balance of this century. As Peru moves to fulfill its need for expanded and secure energy supplies, the process will be complicated by a number of related considerations, such as regional diversity, population growth and migration and economic issues.

Peru is both large and geographically diverse, and the great differences between its three major regions present a number obstacles, not only to performing an integrated national energy assessment, but also to implementing several of the apparent solutions that emerge. For example, the Andean mountain ranges that separate the coastal plain, the central Peruvian Sierra and the jungle regions in the western Amazon basin offer both the promise of vast hydropower reserves and the problem of extremely difficult natural barriers over which the electrical energy to be generated by these resources must be transmitted. In addition, much of the potential petroleum resources in Peru are located in regions that are remote from centers of demand. Most of the undiscovered oil reserves are believed to lie beneath the Amazon rain forest in eastern Peru, while most of the petroleum is consumed in urban centers on the coastal plain and in the Sierra. This example highlights a situation that will present difficulties to energy development in Peru, especially after the year 2000. The development and transportation of additional energy resources will become more expensive as the most accessible energy sources are exhausted or their full potential reached. Thus, secondary energy forms the most feasible of which is hydro generation of electricity, will have to be implemented in order to meet Peru's energy requirements.

Population growth and trends in rural-to-urban migration will also exacerbate energy development problems in Peru. Projections for the year 2000 for Peru show that the total population will have doubled (from an estimated 16 million in 1976 to 33 million in the year 2000), while the rural population will remain almost constant (from an estimated 10 million in 1976 to 11 million at the end of the century). This anticipated population growth, will have a major impact on projections of energy requirements for Peru. Traditional grid connection programs aimed at increasing the electricity available to the Peruvian population at large, generally benefit urban centers not the rural population, which comprises AID's target group. Thus, in addition to grid decentralized generating capacity will be an essential component in any program designed to increase the availability of electricity in Peru, if the target group is to be reached. By not entering into a vigorous program aimed at decentralized power development the AID target group will be further disadvantaged as compared to coastal residents. The use of commercial fuels will increase, both on an absolute an relative (percentage) basis because the urban population relies primarily on these fuels and can be expected to continue to do so. Moreover, while the rural population now depends heavily on non-commercial energy sources, it can be expected to make increasing use of commercial fuels.

Although the abundance of its indigenous energy resources offers Peru a wide variety of opportunities, realizing them has been difficult in a fiscal climate characterized by economic stagnation, spiraling inflation and a large external debt. While Peruvian gross domestic product (GDP) grew at an average annual rate of 4.5 percent in the period 1970-76, the Peruvian economy suffered at the same time a sequence of international and domestic deficits that were accompanied by high inflation, falling production, and overvaluation of the Peruvian currency (sol) in foreign exchange markets. These internal economic and management problems agravated by declining world prices for Peru's principal export (copper) and a large and growing external debt, brought the Peruvian economy to a virtual standstill.

However, since mid 1978, the Government of Peru has taken strong measures to remedy these economic problems. Among these have been: efforts to cut imports, public sector budget cutbacks, a reduction in the real money supply to reduce inflation, and continuing adjustments of the currency exchange rate. Peru has also succeeded in restructuring its external debt so as to relieve pressure on its balance of payments problem over the short-and medium-term. In addition, prices of Peru's exports have recovered since the beginning of 1979, and Peruvian oil production has risen to the point where it exceeds domestic consumption. These factors have helped to convert Peru's balance of payments deficit into a surplus for the last year. The recessionary trend of falling production appears to have been reversed, which has helped to create a more favorable climate for further investment and growth. As a result, the proposed Project will address Peru's future requirements for energy resources in the broad context of a continued improvement in the economic situation and a return to sustained growth in productive potential.

B. Peru's Economic Development

Regional disequilibrium constitutes one of the main factors constraining the development of the Peruvian economy and is manifested through various physical and socio-economic phenomena. The distribution of isolated population centers and the dispersed natural resource potential are the result of the rugged topography characterizing fifty percent of the territory. Spatially these two factors do not manifest themselves with equal intensity, thereby resulting in a disequilibrium evidenced through the existence of depressed, densely populated areas basically dedicated to subsistence agriculture. The economic development of the country has consequently been concentrated in a few areas, primarily Lima, other coastal centers, and some mining centers and commercial cities in the Sierra and Selva. Approximately 7 million people, including the focus of AID's development efforts, live in the rest of the country, and are dedicated to activities of very low productivity in economically and socially depressed and stagnant regions in the Sierra, and the high jungle.

The above considerations have lead the GOP to plan the development of the country on a regional basis through departmental and regional development committees or organizations charged with the responsibility for proposing and implementing projects which address the causes of persistent poverty in the rural sierra and high jungle regions. This strategy is being supported by the Mission through its most recent loans

and grants, and is described in detail in the latest CDSS.

The continuing migratory flows out of rural areas in Peru are due in large part to the lack of adequate in-situ infrastructure which permit rural area development. The result of the continuing migrations, rather than ameliorating rural poverty, has over time transplanted the problem to the large urban centers where pueblos jovenes continue to expand at an alarming rate, generating a series of socio-economic problems both at the point of origin and in the new habitat. An important element of the basic infrastructure package which isolated rural populations must develop in order to complement efforts in basic health services, education, housing and in improving the productivity and profitability of farming, agro-industries and commerce, is the development of efficient electricity supplies and other energy sources.

While the process of economic development is associated with internal migratory movements, internal migration is motivated by economic opportunities available in different areas, which is in turn related to regional basic infrastructure and natural resource potential. By embarking on a more balanced regional development strategy, the GOP intends to complement its continuing rural infrastructure investments with the provision of efficient electrical supplies and other energy sources. These will improve the quality of life in the rural areas and provide a basic input required to fuel intermediate productive technologies in rural areas, where the main source of productive energy is still based on animal and human power.

Energy consumption in Peru may be categorized into the following socio-economic groupings:

(1) A centralized urban group consuming a large part of the commercial energy (commercial and residentail sectors) and the major part of indirect energy consumption, through the consumption of industrial products and in the use of transportation. Typically, energy is consumed through the use of electricity, liquid gas, gasoline, residual petroleum, etc.

(2) A periferal urban group constituted by marginal areas in the large cities, the result of migratory flows which have intensified in the past decade. This group consumes energy through the use of electricity and kerosene and indirectly through the purchase of industrial products and the use of mass transport.

(3) A decentralized rural group participating in the agricultural activities of the country and generating a substantial portion of the national agrarian product. Direct energy consumption is basically through the use of wood and kerosene. The principal indirect energy consumption for this group is diesel for transportation.

(4) A marginal rural group constituted by a very dispersed population without stable work and whose energy consumption is almost entirely direct, through the use of lower quality wood (branches) and dung.

Approximately 80% of the total energy investments in the country have been concentrated in group 1. The impact of these investments has been the intensification and consolidation of the export-mining and urban-industrial sectors. Three quarters of the remaining 20% has served to supply the energy demands of group 2 thereby indirectly (though not intentionally) contributing to the migratory flow. Intensifying investments in energy projects located in areas where group 3 is located will serve to help stem the migratory flow, stimulate the development potential, and increase the agricultural productivity and value-added processing which would create jobs for both groups 3 and 4, thus serving as a factor in reducing poverty amongst the poorest group.

A majority of the population living on the last two groups are located in relatively isolated areas on the higher elevations of the Pacific and Amazon watersheds and in the high jungle region. In general, isolated population centers on the Pacific watershed are dedicated to agriculture, cattle raising and mining. In the lower areas, the population is mostly mestizo and becomes progressively Indian toward the higher lying areas on the mountain range. On the high jungle in the Amazon watershed the majority of the population is mestizo, having emigrated from the Sierra and Coast. Resources are exploited with difficulty under unfavorable conditions due to lack of adequate infrastructure.

The variety of purposes for which energy is required in rural areas is surprisingly wide covering both household and "productive" uses. Energy availability is necessary to meet the agro-industrial demands which develops from local agriculture, and to expand craft industries and commercial activities, e.g. refrigeration in shops and services, motive power in workshops (carpentry, welding and repair shops), water pumping, mills, artisan industries, etc., as well as improve the standard of living by providing artificial lighting both private and public (e.g. schools and health centers). It is expected that efficient energy supplies will raise the level of output in agriculture and agro-related industries and through this the level of rural incomes. With the resulting increase in rural incomes and improved infrastructure, commercial activities would also tend to increase. The increased agricultural productivity, the growth in agro-industries, commerce and level of rural incomes will in turn create future increasing demands for energy.

C. Peru's Energy Resources and Consumption 1/

Peru is a developing country in the early stages of industrialization with an estimated (1978) per capita GDP of $665. As

1/ The following section provides a brief summary of Peru,s energy resources and consumption. The information presented below is based largely in the Joint Peru/USA Reports Vol I and Vol II, Annex 1) of the Peru/USA Cooperative Energy Assessment; The ...

such, its energy demand is relatively low, ranking 44th worldwide in energy consumption. In coal-equivalent units, Peru's energy consumption of 580 kilograms per capita represents approximately 6% of the per capita energy consumption in the U.S. Since there is a direct relationship between energy consumption and income, Peru's demand for energy is expected to increase as the standard of living improves.

In 1976, energy development represented 30% of total public investments. The energy sector employs 19,000 workers or approximately 0.3% of the economically active population. Large amounts of capital have been required to develop Peru's energy system; in 1976, the corresponding figure was $334 million or about 2.4% of the GNP.

Petroleum, wood, hydroelectric sources, natural gas and bagasse provides for Peru's energy requirements (See Table 1).

Table 1*

Primary energy consumption in Peru (1-Tcal = 10^{12} calories)

TYPE OF ENERGY	YEAR 1965		1970		1976		Annual Increment (%)
	Tcal	% of Total	Tcal	% of Total	Tcal	% of Total	
HYDROPOWER	2,868	5.8	4,107	6.6	6,158	7.3	7.2
NATURAL GAS	5,056	10.2	4,598	7.3	5,332	6.4	0.5
OIL	30,049	60.9	40,782	65.2	57,285	68.2	6.0
COAL	224	0.5	373	0.6	402	0.5	5.5
WOOD	7,538	15.3	8,798	14.1	10,190	12.1	2.8
BAGASSE	3,611	7.3	3,851	6.2	4,601	5.5	2.2
TOTAL	49,344	100.0	62,509	100.0	83,968	100.0	5.2

* Source: Peru/USA Cooperative Energy Assessment, Vol. II, Annex 1, pg 7.

... Political, Economic and Energy Profile for Peru prepared for the U.S. International Energy Development Program by the Office of Program Management Support, Argonne National Laboratory; and a report prepared by the Lahmeyer - Satzgitter Consortium for the German Society for Technical Assistance (GTZ) entitled "Development of Alternative Energy Sources, especially for Rural Electrification, Part 2".

As oil prices continue to rise, the economic rationale for substituting renewable sources of energy improves for oil. Peru appears to be in a comparatively favorable position to make a relatively smooth transition away from an economy whose energy needs are predominantly fueled by hydrocarbons to one that relies more heavily on alternative energy sources, through utilization of well-established, available technologies. In the short-term, a significant portion of the current energy requirements in remote areas can be met by taking advantage of under utilized hydropower resources available in these rural localities. Assessment of the feasibility of utilizing other renewable energy resources to meet longer-term demand should be carried out simultaneously.

Over a six month period during 1978, Peruvian and U.S. representatives and technical specialists worked collaboratively to assess both the energy resources that will be required by Peru through the year 2000 and the energy demand and supply options which are now or could be available to Peru over that interval. The description of overall energy demand and supply in Peru is presented in Annex II Exhibit G and is a central portion of a comprehensive information base on which the Government of Peru can base future energy plans and policies.

Annex II Exhibit G discusses the state of the following energy supplies: (1) fossil fuels, (2) geothermal power, (3) solar energy, (4) wind power, and (5) biomass. A discussion of hydro-power and electricity follows.

Hydro Power and Electricity

The theoretical hydroelectric potential for Peru, as calculated by the Ministry of Energy and Mines in 1979, reaches 206,108 megawatts (MW) distributed among the principal drainage areas as follows: 29,257 MW Pacific drainage, 176,287 MW Atlantic drainage, and 564 MW Lake Titicaca drainage. Taking into account the short term estimate achievable hydroelectric resources are about 30% of the theoretical potential, or about 58,000 MW of which approximately 3% is currently utilized. Thus Peru is a country rich in hydro-power resources, which are currently exploited in a very limited proportion.

Most of the estimated hydro-power potential, however, is associated with rivers draining into the Amazon Basin. Translating the achievable potential into reality requires diversion of rivers and/or extensive high voltage transmission lines, since this region is remote from the main load centers in coastal Peru. Presently, the only transmountain diversion of water is from the Mantaro River and Marañon River of the Atlantic Watershed which supplements Pacific area supplies.

The electricity supply sector is composed of ELECTROPERU, the public sector enterprise charged with system operation and project execution, and industrial enterprises which produce for their own utilization. ELECTROPERU has five operating regions: the north central,

north, southwest and eastern regions. The north-central region which includes Lima accounts for 87% of the electric energy demand. The other regions are served mainly by smaller isolated systems. The most significant autoproducers are Southern Peru Copper in the south-western region and CENTROMIN in the Central region.

The total electric power generation in 1975 was 7,486.2 GWh.[1/] Of this total, hydroelectric power generation represented 73.1% or 5,470 GWh, from 1,397 MW of installed hydroelectric capacity. Fossil Steam generated electricity represented 16.1% or 1,205 GWh from an installed capacity of 342 MW. Diesel generated electricity represented 9% or 673 GWh from an installed capacity of 416 MW. Publicly owned electricity generation facilities produced 62.3% of the total, while the difference was accounted for by plants associated with specific enterprises. Only 4.32% of the total electrical energy supplied by publicly owned facilities was produced by power plants of less than 5,000 KW during 1976, the equivalent figure for specific enterprises is 9.52%.

Table 2 below indicates the electricity consumption by sector during 1975.

Table 2

Electricity Consumption by Sector (1975)

SECTOR	GWh x 103	PERCENT
Industrial	2.16	29.1
Mining	1.86	25.2
Residential	1.25	16.9
Losses	0.78	10.6
Other	0.55	7.4
Public Authorities	0.30	4.0
Commercial	0.25	3.4
Agriculture	0.16	2.2
Fisheries	0.09	1.2
Total	7.40	100.0

Expansion of the electricity generation capacity for the period 1979-1980 is projected based on the utilization of hydro-electric resources by a planned added capacity of 1,520 MW, which will be implemented by 480 MW of coal-fired generation capacity. Table 3 below shows Peru's total installed electrical power capacity for various years.

1/ GWh = Gigawatt Hours

Table 3

Total installed electrical capacity

Year	Electrical Energy Generation Gigawatt hours (GHW)			Installed Capacity Megawatts MW		
	Hydro	Thermal	TOTAL	Hydro	Thermal	TOTAL
1965	2,668	1,338	4,006	693	604	1,297
1970	3,821	1,708	5,529	923	754	1,677
1975	5,470	2,016	7,486	1,397	962	2,352
1976	5,731	2,036	7,767	1,397	1,076	2,473
Annual Increment %	7.3	3.6	6.2	6.7	4.7	5.9

Source: PERU/USA Cooperative Energy Assessment, Vol. II, Annex 1, Pg. 9.

During 1976 approximately 4.2 million Peruvians, or about 25% of the population used electricity. 60% of this group is concentrated in Lima, and the remainder is located primarily in other urban areas. Thus, 3/4 of the total population, which is principally rural, lacked electrical services, and this group includes nearly all the AID target population as presented in the recent CDSS.

D. Peru's Energy and Energy Conservation Policies

The Oficina Sectorial de Planificación (OSP) of the Ministry of Energy and Mines of the GOP has the responsibility for preparing the framework for Peru's Energy and Energy Conservation Policies. Currently, the OSP has chosen a 10 year planning period until 1990.

The OSP has set as its principal objective the guaranteeing of the nation's energy supply in a timely manner to ensure that the energy needs for national and regional development are met. Other energy policy objectives are:

1) Minimize dependence on external sources of energy.
2) Maximize diversification in resource use.
3) Promote regional economic development through promotion of the location of certain industries in the interior of the country.

To meet the above stated objectives, the OSP has set the following general priorities:

1) Development of hydroelectric resources.
2) Augment the proven hydrocarbon resources.
3) Development of coal reserves.
4) Utilization of nuclear energy.
5) Utilization of geothermal energy.
6) Utilization of solar wind and biomass energy.

In specific terms, the GOP energy policy can be discussed under the headings of resources, production, conservation, investment and finance, prices, technological research, environmental conservation and human resources.

1) Energy Resource Development

Special emphasis is being placed on the following:

- Augmentation of petroleum and gas resources through a more vigorous exploration program.
- Development of a systematic inventory of the nation's coal resources.
- Continued work on the systematic evaluation of the nation's hydroelectric resources.
- Development of non-conventional resources such as solar and geothermal energy.

Production

In-country use of petroleum will be minimized through augmentation in the supply of other energy sources such as hydro, coal and solar energy.

Conservation

Conservation of the nation's non-renewable sources is promoted through:

1) More efficient industrial use of energy.
2) Substitution of hydrocarbons by other forms of energy.
3) Using a pricing policy to promote the rational use of electricity.

Financial Planning and Investment

A national energy investment program will be prepared to satisfy the energy demand while optimizing available resources such as financial, different energy sources etc.

Prices and tariffs in the energy sector will be adjusted to provide reinvestment capital: external and internal capital sources will also be utilized. Incentives will be provided for private national and foreign capital participation in the energy sector especially in the exploration and development of energy resources.

Prices

The most critical elements of an energy conservation program are the levels of energy prices and energy taxes.

Electrical pricing policy in Peru is designed to ensure that the energy sector will provide some reinvestment capital. The pricing policy in Peru is also designed to encourage the conservation of energy. (See for example Electroperu's pricing policy for household, commercial and industrial usage of electricity. Annex II F.) Peru's tariff structure although providing subsidized energy to remote villages, places a high price on mining, industrial, agro-industrial and urban users of electricity. This policy in addition to being an important energy conservation measure has the effect of providing Electroperu with sufficient income so as to provide for a small net surplus at the end of the year for reinvestment in the energy sector. Finally, the GOP's pricing policy provides a transfer of wealth mechanism for the country's economy.

Technological Research

Research is being conducted to identify the most efficient uses of electricity in the industrial sector (such as the mining, cement, paper and iron-use industries) particularly in the utilization of waste heat (for cogeneration).

Environmental Conservation

Environmental conservation is being promoted through the use of technologies and energy sources that have the least negative environmental impact.

Human Resources

A systematic training program is being established for the training and development of a group of high level energy planners.

In summary, energy conservation measures in Peru are recent and require additional research and promotion. The GOP however is aware of the need to implement such measures and can be expected to continue to strengthen its energy conservation policy.

E. GOP Priority for Mini Hydro Development

The GOP has given high priority within the new planning cycle to rural electrification, given the significant social, and economic benefits which result from such a program. The Ministry of Energy and Mines (MEM) has reviewed the various alternatives for accomplishing this objective and has determined that generation of electricity with hydro power is feasible both from an economic and engineering point of view. Additionally, an analysis of the potential hydro-power sites indicates that a major part of the sierra and high jungle population centers can be supplied with electricity from hydrogeneration, since

the potential sources of hydropower are distributed in nearly 1,000 high river basins, located near population centers in those areas. The previously cited figure of 58,000 MW of achievable hydro-electric development potential includes projects of over 30 MW, though not potential exploitations, located in the high points of river basins where high falls with small flows are frequently encountered. The typical parameters of these small potential hydro-electric sources in Peru are falls in the range of 100 mts to 300 mts with flows in the range of 200 to 500 lts. per second. It is possible to locate power plants of from 100 to 1,000 KW, the size range the proposed Project will finance, under these conditions. The MEM estimates that a complete national small-hydro program would require approximately 800 small hydroelectric plants averaging 200 KW each, at an estimated cost of $1400 per KW, requiring an investment of approximately $225 million.

The magnitude of potential mini-hydro development at a national level as determined by ELECTROPERU may be ascertained from Table 4 showing the number of communities, population, and the minimum energy requirements for domestic use these communities have. As this table indicates, there are over 1,000 communities inhabited by nearly 2 million people which could be served by small hydroelectric plants ranging in size from 50 to 700 KW. According to the 1972 census, there were 5.5 million rural inhabitants in Peru. The communities which can potentially be served with systems of the type proposed under the Project, thus represented approximately 36% of the rural population in the country.

In spite of the potential demand for electric service, isolated small rural communities located in the sierra and high jungle frequently can not be efficiently incorporated into the national interconnection grid projects of the Ministry of Energy and Mines because of the high construction costs of the transmission lines needed to service these communities relative to their limited demand for electricity. Most small population centers have thereby have not been considered when expansion of coverage by electrical service has taken place, contributing in this way to the vicious circle that demand for electrical energy in these communities is not developed because of the lack of supply, and supply is not developed because enough demand relative to interconnection costs has not evolved.

Diesel fueled electricity thus became the most common technology utilized for the generation of electricity in rural areas. In general, energy produced by the diesel fueled thermal plants is too expensive because of the low efficiency of diesel motors which results from inadequate maintenance and operating conditions, the increasingly expensive cost of fuel, and the lack of an adequate transportation network which further increases the price of fuel delivered at the plant.

A hypothetical cost comparison between a small hydro plant and an equivalent 200 KW diesel plant is illustrated using as an example a potential site in Laramate. The cost figures used are from preliminary study conducted in early 1979. Table 5 illustrates the cost aggregates for the two options. Fixed costs for the hydro option include civil

TABLE 4

NUMBER OF POPULATION CENTERS AND REQUIRED ELECTRICAL POWER

Population Centers (1972) Size (in population)	Number of Towns	Number of Beneficiaries	Power Plant Size (in KW)	Total (in KW)
500 to 1,000	571	412,735	50	28,550
1,000 to 2,000	349	472,036	75	26,175
2,000 to 4,000	163	434,034	150	24,450
4,000 to 6,000	61	289,758	200	18,300
6,000 to 8,000	26	178,292	500	13,000
8,000 to 10,00	16	152,116	700	11,200
TOTAL	1,196	1,939,561		121,675

Source: MEM, Commission for Small Hydroelectric Power Plants, November 1979

TABLE 5

CONSTRUCTION AND OPERATING COSTS (200 KW CAPACITY PLANTS)

Option	Fixed Costs	Operating Costs	Plant Life	Present Discounted Cost 13%	Present Discounted Cost 17%
Hydro	$225,661	$ 3,365	30 yrs.	$251,034	$ 245,393
Diesel	$ 44,000	$43,936	20 yrs.	$352,639	$ 291,262

works, penstock electro-mechanical equipment, 10% for engineering and administration and 10% for contingencies; operating costs include operating and maintenance costs. Fixed costs for the diesel option include the diesel motor and civil works; operating costs (assuming 3,000 hrs/yr. of operation, or a total annual energy production of 600,000 KWh) include oil, transport, lubricants, maintenance and operation. In terms of cost components, a diesel installation has lower investment costs and higher operating costs relative to an equal capacity hydro installation. In order to compare the costs of each alternative, the present discounted cost of each was calculated utilizing a real interest rate of 13% (INP recommendation) and a 17% rate (See last two columns Table 5). This analysis indicates that the most economic option is the hydro installation. The hydro option becomes more attractive when the useful life of the two options is considered.

Rural electrification has been given high priority by the GOP as mentioned previously, and the Ministry of Energy and Mines has chosen the small hydro generation systems alternative as the most appropriate for the rural areas of Peru, for the following reasons: a) the relative isolation of a significant portion of rural communities makes grid interconnection unfeasible; b) the poorly developed road network increases the costs and decreases the reliability of fuel supplies for diesel plants; c) the planned average size hydro installations is lower in total discounted cost relative to the diesel option; d) the price of oil is increasing continually; e) an in-situ renewable energy resource is available; and f) expected social and economic benefits resulting from electrification.

F. Project Rationale

1. AID Assistance Strategy

The Mission's most recent CDSS (January 1980) sets forth a program strategy aimed at achieving economic growth with equity. The three components of this strategy are as follows:

a. Social Programs (Sierra emphasis) -- efforts in health, family planning, education, and nutrition directed primarily at the six million rural inhabitants of the poorest region of the country.

b. Sierra and High Jungle Economic Growth -- programs for food production, agricultural development, rural infrastructure and off-farm employment designed to increase the on-farm value added component of agricultural production, foster agriculture-related economic growth and raise incomes of the rural poor.

c. Coastal Urban Basic Human Needs -- major programs in P.L. 480 food aid and basic services through the HIG Program to assist the urban poor population which has suffered a severe decline in real income as a result of Peru's current economic crisis.

It is, of course, the Sierra and High Jungle Economic Growth component within which the Mini-hydro project forms an important part of the Mission's development strategy. The Project has been developed to maximize its economic development impact by institutionalizing the use of economic selection criteria in sub-project selection and by focusing on a decentralized, low-cost approach to energy production. The Project is compatible with other current Mission projects being implemented within this category, including: Sub-Tropical Lands Development; Rural Enterprises I and II; Rural Development Agri-business Fund; Research Extension, and Education; Improved Water and Land Uses in the Sierra; and Integrated Regional Development. The Project will also have a beneficial impact on sierra social programs such as the Integrated Primary Health Project and Mission sponsored family planning activities. The Mission believes that the institutionalization within the MEM of the capability to apply economic techniques to the selection of rural energy sub-projects and the institutionalization of the capacity to design, construct, administer, and maintain a decentralized energy system based on the application of the mini-hydro technology is justifiable on its own development merits, given the anticipated impact that this Project will have. It is however, the longer term synergestic effects that a mini-hydro development program has, when combined with other AID and GOP projects within the sierra-high jungle AID priority development zones, that makes the Project an attractive compliment to the current USAID portfolio.

2. Socio-Economic Rationale for Mini-Hydro Electrification

The relationship between energy and economic development is as crucial in the developing countries as it was and continues to be in the industrialized nations. The process of economic growth is attributable in large part to the substitution of energy for muscle in the performance of every type of agricultural, industrial, and domestic task. It is hardly surprising, then, that prospects for growth in critical sectors of the less-developed economies are linked to the development and exploitation of energy forms and new ways will require time to break down the economic,cultural, social and institutional barriers that generally impede technicological change. Thus, while it is necessary to develop reasonably priced, small-scale diversified energy sources, which are adaptable to a range of needs as well as physical and cultural environments, by itself this is inadequate to assure accelerated economic growth, especially in the agriculture sector.

Much of the phenomenal output of agriculture in the United States and other major food-exporting countries can be traced

to the massive application of power and fertilizer to land; labor inputs per unit of output diminished very rapidly as the pull of higher wages in manufacturing and services increased the cost of this input to agricultural production. A recent report 1/ which examined the energy demands of agriculture confirms that this is also the case in developing countries. Thus, it reveals a much higher degree of net energy usage and a closer correlation of energy application to productivity than had been anticipated.

Agricultural expansion in Peru is limited to tropical forests and poorly or infrequently watered, high plateaus, mountain ranges and desert lands, environments most unfriendly to agriculture. Increased energy inputs will be required to overcome these limitations in order to achieve the increases of food production required to satisfy rural needs and an expanding urban population, even more than they were in the fertile, temperate plains of the United States and other major food reporting countries.

The more promising energy production technologies involve conversion of hydro-power into electricity. To the extent that energy so produced relates to usage that are matters of comfort (lighting, radio, television, food preservation, space heating, cooling) they will not contribute immediately to improvement in national economic productivity, except for the backward linkages related to system installation and the purchase and maintenance of household appliances. Utilization which produced development through the improvement of agricultural productivity, the more efficient movement of cash crops to markets, brings in manufactured consumer goods at lower costs, creates farm services or off-farm employment opportunities have the most significant impacts.

Electricity will not profoundly affect theeconomies of developing nations unless it is dependable and cheap, conditions which large hydro-generated electric plants are usually able to fulfill, where topography permits and plantiful water supplies are available. Yet relatively small projects using water flow as a direct source of energy or to generate electricity can also be attractive in economic terms, even where there is no possibility of large-scale plant development. In these cases, small dams can be constructed by local labor with local materials combining long life with minimal maintenance over a considerable range of construction scales. Projects of this type also have major backward linkages in the national economy, which are often overlooked by policy makers.

1/ Pimentel, David, et al. 1973. Food production and the energy crisis. Science 1982: 443-449.

While Peru is attempting to pursue an aggressive hydro-electric program so as not to further increase dependance on fossil fuels for electrical generation, the major focus of these hydro-electric programs is keeping pace with Peru's coastal energy demands and in particular its more industrialized urban areas such as Lima, Trujillo, and Arequipa. However, these programs seriously tax the country's financial resources base. Thus, by assisting Peru to reorient and expand financial resources appropriate for the impoverish sierra and high jungle, this Project will transfer GOP resources to those areas thereby helping to address historic investment inequities that currently exist.

Based on these considerations, rural electrification has been given high priority by the GOP and the Ministry of Energy and Mines which has chosen the mini-hydro generation systems alternative as the most appropriate for certain rural areas of Peru for the following reasons: a) the relative isolation of a significant portion of rural communities makes grid interconnection unfeasible, b) the poorly developed road network increases the costs and decreases the reliability of fuel supplies for diesel plants; c) the planned average size hydro-installation is lower in total discounted cost relative to the diesel option; d) the price of oil is increasing continually; e) an in situ renewable energy resource is available; and f) expected social and economic benefits resulting from electrification.

Ten years ago a project selecting a mini-hydro technology would not have been economically feasible. This of course was not so much a result of technological constraints, but rather the result of the availability of very cheap petroleum based energy. A similar project would have been implemented with diesel generators, even in spite of the difficulties in operating them, enumerated elsewhere in this Paper. With the advent of OPEC pricing policies in 1974, which precipitated enormous increases in oil prices, a mini-hydro project became economically feasible.

The conditions of poverty facing the primary target groups is detailed in the Mission's most recent CDSS. Less than three percent of all homes in rural Peru have access to household electricity. Eighty-one percent of households use kerosene for lighting, while the substitution of kerosene by electricity reduces user costs, causes less pollution and lessens demand and dependence on petroleum-based derivatives. Employment generating activities for agriculture and agro-industry development, small business establishement (e.g. retail outlets, cottage industry), improvements in various crafts (e.g. carpentry), and the setting-up of public services is seriously jeopardized by the lack of dependable electrical supplies. In short - the infrastructure for home uses and support of enterprises and services is minimal or nonexistent.

Traditionally, the direct benefits of household use, have been more easily identifiable in the short term than those

resulting from municipal or productive uses. Residential electrification enables the users to at initial stages, lengthen working hours and tap into sources of information (e.g. radio, television). Eventually, the users in many cases are able to purchase labor/time saving devices, primarily electrical appliances.

The basic examples of benefits accrued through household consumption of electricity aside, the stronger economic case for rural electrification is in terms of productive and municipal uses of electricity benefiting the rural poor. Additional benefits result from local procurement of materials used to build and maintain the infrastructure for such enterprises and services. Productive uses, such as those discussed above and others such as irrigation, will generate employment for that segment of the rural poor who must supplement their income from off-farm earnings. Additionally, the municipal uses of electricity will facilitate the supply of services for evening education, civil centers, health clinics, street lighting, etc. There services will be more accessible to a larger percentage of the rural poor, i.e. those who will not be in a position to be included in residential electrification schemes.

Project beneficiaries, all residing in relatively isolated areas in the sierra and high jungle are the target groups identified in the CDSS. These may be classified as independent market oriented farmers, agrarian reform beneficiaries, campesino communities and landless/near rural poor. The impact of investment in electrical supply infrastructure for this group is twofold: First, it will raise the standard of living in rural areas through the provision of modern conveniences which are often one of the principal factors affecting rural-urban migration. Thus it will provide a counterweight to excessive urbanization by providing electrical power for household uses and public lighting. It will also provide local enterprises with cheaper and superior forms of energy, thereby lowering their production costs. This gives rural industry the increased opportunity to compete with urban industries providing the possibility for additional rural job creation. Second, the Project will increase demand for inputs produced in Peru necessary for plant construction and installation, such as certain electrical equipment, transmission lines, posts, labor, etc., and increase demand from rural town commercial outlets for electrical appliances, water pumps and other production related equipment for farm, agro-industry, cottage industry, commerce, and home uses.

(a) Forward Linkages

The major development impact resulting from rural electrification through a mini-hydro program will result through the impact of forward linkages to the target group. This Project has been designed to assure that these linkages will be maximized, which will be enhanced by the compatibility that the AID sierra programs have and due to the concentration of these programs in a few areas of the sierra. This Project has been designed to assure maximum forward linkage impact

on the selected regions by: 1) the incorporation of a program for productive uses of electricity for the towns participating in the mini-hydro system; 2) a sub-project development methodology which maximizes the development impact by a careful site selection process; and 3) locates sub-projects in regions where coordinating off-farm employment incentives under the Industrial Bank's $20 million Rural Enterprise Fund have been successful, but constrained by the lack of electricity in the Project areas secondary towns.

(b) Backward Linkages

The Mini-hydro Project has been designed so as to maximize backward linkages as a result of sub-project construction. Some equipment and virtually all materials, and services will be supplied by local firms and manufactures. For example, procurement of poles, lines conductors, small transformers, switchgear and sub-stations are either manufactures or assembled locally.

A longer term impact in forging strong backward linkages will be the development of a local capability to manufacture generators, turbines and other essential components of small hydro plants. Investments of this nature will be forthcoming once institutionalization of the small hydro-program has taken place and investors will be confident that there will be a continued demand for their equipment.

3. Relationship to Other Mission Activities

This Project will directly complement the Sub-Tropical Lands Development Project in the Department of San Martin, the Integrated Regional Development Project in the Departments of Junin and Cajamarca and the Rural Enterprise Projects active throughout the Project area. These projects will finance the development of productive rural infrastructure (roads, service centers, marketing facilities, land clearing, extension services, commerce and service businesses, etc.) Adequate energy supplies will greatly enhance the realization of the benefits expected from these projects, since energy constraints hinder increased farm productivity, the development of agro-industries and the expansion of commercial activities in the three departments.

a. Sub-Tropical Lands Project

The Sub-Tropical Lands Project is centered in the Bajo Mayo area of San Martin where, due to the concentration of high quality agricultural land, the potential is great for major increases in the production of both cattle and crops. Private agro-industrial efforts (e.g., grain processing and slaughterhouses) are already being developed and the provision of inexpensive electricity will greatly enhance expansion possibilities as well as efficient operation.

Specific activities being executed under the Project which will benefit from the provision of hydro-generated electricity are: (1) the establishment of farm machinery centers and (2) creation of a network of grain collection and processing centers. A farm machinery center and three sub-centers will be established and equipped with tractors, implements and maintenance capacity which will benefit from availability of electricity.

The Mini-hydro Power Project will by necessity be meshed with the IRD project in Junin and Cajamarca, in that a number of the sub-projects under th IRD project will specifically require an electrical infrastructure. Adequate electric power, not now available, is required for local manufacturing and commerce as well as for domestic use. In certain cases, urban demand also makes rural electrification in nearby areas economically feasible. Many smaller centers, if they possess electrical power at all, are still using thermal generators which tend to be expensive and require frequent maintenance.

Examples of sub-projects where beneficial results of the availability of an electrical infrastructure include: a) slaughterhouse construction, electrification for refrigeration and lighting: b) municipal market construction/improvement--electrification will facilitate the storage, distribution and sale of agricultural produce and allow more flexibility of working houses: c) transportation terminals lighting would allow more free movement of produce at night, thus helping in the effort to reduce spoilage which frequently occurs during transhipments which have required use of different bus or truck lines; and d) small scale irrigation where required by terrain conditions, and during slack hours of lighting consumption excess electrical capacity can be utilized to pump irrigation waters to agricultural lands, thus improving yields by intensification through vegetable production.

As demonstrated by the examples presented above, there are numerous opportunities for integration of and development of linkages between sub-projects of the Mini-hydro program with those now being designed and selected under the Sub-Tropical Land- and the Integrated Regional Development Projects. Furthermore, the development of the productive capacity generated by the improved infrastructure created under the latter on-going projects will create future demands for energy.

b. Rural Enterprises and Rural Development Agri-business

The Rural Enterprises Development Loan executed by the Banco Industrial and the Rural Development Agri-business Fund executed by the Central Reserve Bank, which provide financing for strengthening and developing rural enterprises and for promoting small businesses and agri-business, will in similar fashion generate increasing demands for reliable and efficient sources of energy for productive activities.

Increasing the supply of energy will simultaneously expand investment opportunities for sub-borrowers of both loans. Indeed Project evaluations for both Projects have identified the lack of infrastructure and particularly supplies of energy to be the most serious impediments for further outreach of these Projects from the main Sierra urban areas.

Sub-borrowers under the Rural Enterprises Loans (I and II) are establishing or strengthening/expanding the operations of individual small businesses such as restaurants, repair shops, machine shops, small-scale factories and carpentry services. Coverage under the loans extend throughout Junin, Cajamarca, San Martin. It is not difficult to see the rather straightforward linkages possible between Rural Enterprises and Small Hydro Development in terms of the future requirements for electricity for lighting, machinery repair (machinery is frequently sent to the coast for repair), use of power tools and for refrigeration among other uses.

The Rural Development Agri-business Fund will finance various small and medium-sized agro-related industries such as coffee processing, canning of fruits and vegetables and tanning of animal hides. Industries being developed in San Martin, Cajamarca and Junin will benefit from the lighting provided by mini-hydro generated electricity. This infrastructure will also open-up prospects for acquisition by certain businesses of more advanced processing equipment. It is important to note that the expansion of the infrastructure base (in this case through the provision of inexpensive electrical power) will reduce the investment risks associated with small business establishment on expansion, thus encouraging-entrepreneurship.

c. Other AID Activities

Finally, the Mini-hydro Project will impact to a lesser extend on agriculture related activities under the: (a) Agriculture Research, Extension and Education Project, extension services can be expanded into the evening hours; (b) Soy and Corn Production, farms threshers, grinders and other electrically powered processing equipment may be introduced; and, c) the Improved Water and Land Use in the Sierra and the On-Farm Water Management Project, will benefit from supply of energy for water pumping for irrigation. Complimentary benefits are also anticipated for the Mission's Integrated Health Project, where the addition of electricity will permit the introduction of more modern equipment, improvement in the cold-chain needed for vaccines and introduction of services during the evening hours.

4. Summary Rationale

It is clear that the lack of an infrastructure base in areas encompassing prospective sub-projects sites under the proposed Mini-hydro power Program is a serious constraint to development of small commercial enterprises and urgently required municipal services.

AID-sponsored activities already underway in these areas are attempting to build this base in a concerted manner. Provision of mini-hydro generated electricity, where it would be the most cost effective means of providing power, will have a synergistic impact on infrastructure development establishing the basis for entrepreneurial efforts in rural Peru; the firm establish of effective and wide-reaching public services in health, education and nutrition; and to stem migration toward major urban areas.

G. Other Donors

On May 19, 1980, the GOP and the Government of the Federal Republic of Germany signed a Technical Cooperation Agreement for a micro-hydro Program. The German Government will channel DM 5.0 million through the GTZ (The German Agency for Technical Cooperation) over a period of 3 years beginning in January 1981. German funds will be disbursed in the following manner:

1) DM 2.0 million will be used for the construction of micro-hydro plants and the installation of associated transmission lines.

2) Up to 174 person/months in technical cooperation will be provided. Major emphasis will be put on covering the following specialities: electrical engineering, civil engineering (hydraulics, project management), micro-hydro operation and maintenance, geology, hydraulic machinery and electrical machinery. The following specialties will be covered in more limited fashion: agronomy, irrigation, water law and license formulation.

3) The purchase of miscellaneous items such as 3 4-wheel drive vehicles, 2 sedans, drawing office instruments, etc.

At a meeting held on May 12, 1980, the Project Committed was informed by Dr. Uli Werner, from OEKOTOP (The Society for Appropriate Technologies for Rural Development, Berlin, under contract by the GTZ), that the German Mission is currently implementing an aggressive program for the implementation of pilot projects in other renewable energy resources, including wind, solar, biomass, etc. The pilot projects are to be constructed and evaluated by regional universities.

III. PROJECT DESCRIPTION

The goal which this five year $9.0 million loan and $1.0 Mission Grant Project addresses is: (a) Improvement of the quality of life of the rural poor by increasing the productive uses of hydro-electric power in rural areas; (b) Lessening Peru's dependence on petroleum for the production of electrical power; and (c) Amelioration of the ecological consequences produced by over harvesting of trees for firewood.

The purpose of the Project is to promote rural and regional socio-economic development through the development of an institutional base capable of providing reasonably priced hydrogenerated electrical energy for social and productive uses in rural towns in the sierra and high jungle.

In November, 1978, the Ministry of Energy and Mines (MEM) designated the Small Hydroelectric program as a top priority program area for the country and created a Ministerial Commission to plan and execute activities in this area.1/The first phase began in 1979, this multiphased Small Hydroelectric program was financed with GOP funds and included preliminary work on several mini-hydro projects, of which only one has been completed while the rest are still in the study and development stage. Future activities to be developed within the program include a significant expansion of small hydroelectric program. In order to provide a more effective administrative structure to carry out these activities, the GOP established an office (Oficina de Tecnología Aplicada, OPTA) within ELECTROPERU charged with supervising and coordinating the execution of the program.

Under this Loan/Grant Project, OPTA will be the principal office within the MEM responsible for the implementation of Project activities. The Project will consist of the institutionalization of the small hydro program within ELECTROPERU through a rational investment process based on pre-feasibility and feasibility studies which determine the location, and capacity of the systems to be installed, completion of the required physical works, installation of control and electro-mechanical equipment and construction of local distribution systems for design standardized, small-scale hydro-electric installations which will normally fall within the 100 to 1,000 KW range. The Project will concentrate its activities in the Departments of San Martin, Cajamarca and Junin, GOP priority areas where it has been determined that the greatest development potential exists, and which coincide with the location of other Mission regional development and health project activities. 2/

The number and size of small-hydro plants to be constructed under the Project has not been determined other than establishing the parameters that plants will normally be in the range of 100 to 1,000 KW. Annex II Exhibits A and B contain the proposed pre-feasibility and feasibility study methodology which is designed to identify those sub-projects which meet minimum technical, economic, social and environmental criteria. These methodologies will provide OPTA with a means to evaluate aspects of sub-projects which are currently not being evaluated

1/ Shortly after its formation the MEM approached AID for technical and financial assistance to fully institutionalize the program.

2/ The Project may be expanded during implementation to include the Department of Pasco, the site of the Mission's proposal FY 81 Pichis-Palcazu Development Project. Expansion to other regions is not contemplated.

since OPTA has been focussing attention only on technical feasibility. They have not incorporated economic, social nor environmental considerations into the site selection process. Application of this methodology will determine the communities and in turn the plant size where the economic and resulting social benefits from this Project would be greatest. The Project Development Committee estimates that approximately 28 small hydro-electric plants with an average capacity of 300 KW will be constructed. Total plant capacity under this Project will be approximately 8.4 MW at a cost of $1,722 per installed KW. 1/ The Project will directly benefit 53,000 families or 265,000 beneficiaries at a cost of $55 per beneficiary. Indirect benefits will reach a substantially larger number of people.

The $1.0 million companion grant will serve to strengthen and expand ELECTROPERU's ability to implement its small hydro-electric program. Through the provision of Technical Assistance and training, the Grant will assist ELECTROPERU to evaluate the potential for small-hydro plants, conduct feasibility studies, ensure that standard operational programs for operating and maintaining hydro-electric plants are developed. The latter include administration, billing, operation and maintenance programs and procedures. Additionally, assistance will be provided for program planning and the development of a promotional program for increasing the productive uses of electricity in the Project area.

The scope of the Project as described in the Mission's PID was broader than is being proposed in the PP, however, during intensive review the Mission learned in discussions with ELECTROPERU and the German foreign assistance representatives that several areas originally contemplated for AID financing are currently being addressed under the ongoing German energy program. These include an intensive technical assistance effort to develop a national energy plan, assistance in research and pilot demonstration activities in an alternative energy program focusing on wind, solar, biomass and biogas energy and the construction of micro-hydroelectric plants under 100 KW.

A. Project Activities 2/

Through the utilization of Project funds, the Project will finance pre-feasibility and feasibility studies to determine plant site and size, a program for the productive uses of electricity, installation of Mini-Hydro Systems, maintenance of these systems and technical assistance. These activities are described in more detail below. Sub-projects must show benefit/cost ratios greater than one at the pre-feasibility stage to qualify for feasibility studies. Likewise only those projects which show benefit/cost ratios greater than one at the feasibility study stage will be approved for financing under this Project.

1/ Including costs of pre-feasibility studies, promotion and maintenance programs.

2/ See Annex II Exhibit H for Log Frame indicating End of Project Status and input/output information.

1. Pre-feasibility Studies

A preliminary estimate of the hydroelectric potential of many of the proposed sites has already been conducted. This information, which was developed with the assistance of the UNDP, when combined with available economic and demographic information, will be utilized by the Project to undertake a reconnaissance/pre-feasibility examination. The purpose of this examination will be to prioritize the potential sites and identify possible sites not on the preliminary list. This activity, to be financed with GOP counterpart funds, will focus efforts in the Departments of Junin, Cajamarca and San Martin.

The methodology for conducting the pre-feasibility studies is explained in general terms in Section IV of the PP and in detail in Annex II, Exhibit A. It is anticipated that approximately 80 pre-feasibility studies will be carried out by four teams of seven professional and technical personnel from OPTA, the Project implementation office. These activities will be carried out under the general direction of the Program Manager, an OPTA official, who will designate four team directors who will have day to day responsibility for carrying out the pre-feasibility studies. Each of the four pre-feasibility study teams will consist of:

(i) 1 Electrical Engineer
(ii) 1 Civil Engineer
(iii) 1 Geologist
(iv) 1 Environmental Scientist
(v) 1 Economist
(vi) 1 Topographer
(vii) 1 Social Scientist

The pre-feasibility studies component, which will take about 20 weeks and will cost approximately $200,000 will be paid for by the GOP as a portion of its counterpart contribution. The output of the pre-feasibility study component will be a list of 80 sites prioritized according to anticipated social, economic and technical benefits.

The OPTA Program Manager in consultation with AID and the technical assistance consultants will make the final selection of those sub-projects that will be considered for in-depth feasibility studies. Selection will be based on objective criteria and consultation with Departmental Development Committees. Because the return to democracy has been recent, the future role and composition of these committees is not yet clear; however, every indication is that the decentralization process will continue and that these committees will play an increasingly important development role at the departmental level. While ELECTROPERU, as well as representatives from other Ministries, are members of each departmental committee and are therefore instrumental in defining the nature and location of investments to be made in each department, these committees will be consulted formally upon completion of the pre-feasibility study stage to assure that the selection process responds to the department's development priorities and complements other investments being made in each department.

2. Feasibility Studies

GOP funds will be utilized to carry out detailed feasibility studies (See Section IV and Annex II Exhibit B) on those subprojects identified in the previous component containing the highest combined technical, social and economic returns, and which are approved by the Departmental Development Committees.

Approximately 36 feasibility studies will be carried out by the same four teams that conducted pre-feasibility studies. Each feasibility study will take approximately four months to complete, and will begin in year 2 and end in year 4 of the Project. The estimated cost of this component is $500,000 and will be funded by ELECTROPERU as a portion of its counterpart contribution. AID financed technical assistance will be provided through one long-term project advisor, (60 m/m) who will initiate activities at the beginning of the Project, and through 42 m/m of short term technical assistance. The long-term advisor will provide general administrative and programmatic advice to ELECTROPERU, while the short-term advisors will provide assistance in the areas of economics and environmental impact assessment for a period of four months each working with the feasibility study teams during the initial stages of their work.

3. Promotion of the Productive Uses of Electricity

The provision of electricity especially in rural areas such as those included under the Project, does not automatically lead to utilization of the power at the full level of potential. Thus, the Project includes an educational component designed to inform and train the target communities on how to take advantage of electricity to increase economic activities and productivity. In order to implement the component, local technical assistance will be provided to train eight rural promoters, who will work with the target communities during the first year of operation of the small hydroelectric power plant at each site. A detailed training curriculum will be developed to equip promoters with the necessary technical and pedagogic skills to accomplish this activity. The promoters will be contracted by OPTA and report to the OPTA Project Manager. They will have a minimum of a high school education, and or appropriate rural experience.

Peruvian specialists in small industry and farm development, crop storage and marketing, home economics, nutrition, anthropology/rural sociology and a consultant with previous experience in the implementation of such promotion campaigns will be engaged on a short-term basis for the design of the program curriculum. This consultant will subsequently conduct the promoter training seminar. AID financed short-term technical assistance will provide a consultant for four months to assist in curriculum development. In addition AID grant funds totalling US$100,000 will finance approximately 50% of the salary and operation cost of implementing this component. ELECTROPERU will finance the remaining costs of this component.

The training course will last 4 months and will be designed to acquaint the promoters with relevant knowledge on: (a) the cultural and economic background of the communities concerned, including the prevailing production and the techniques utilized; (b) the available natural resources in Junin, Cajamarca and San Martin departments; (c) appropriate technology which might improve productivity in these areas; (d) the availability of credit for farm, small enterprise and agroindustry development; (e) marketing and distribution networks.

The promoters' tasks will consist of three parts: Promotion of productive uses of electricity for pumping for irrigation and potable water supply, agro industry, small industries and crafts development; promotion of social uses in form example health centers, schools etc.; and, promotion of household uses of electricity for food processing cottage industry, cooking, hygiene and storage. The emphasis of this activity will be to improve income generating productive uses of electricity. 1/

This training component will be implemented during the first year of the Project to assure that as the first group of AID financed sites are ready to enter the construction phase, the promoter's activities can begin. Through this training program and the technical back stopping of the OPTA office, the promoters will be responsible for:

1) Providing the needed technical and administrative information for the development of new economic activities.

2) Providing an inventory of available natural resources in thecommunity.

3) Informing the population on relevant technology to use electricity for time-saving and productive activities.

4) Informing the beneficiaries on the availability of credit for financing the new activities.

5) Advising the population on how to carry out the procedures to obtain credit.

6) Advising the population on marketing and distribution channels in the area.

The eight promoters will be divided into four teams, each comprised of one male and one female, one of whom is Quechua speaking. The team will spend 3 months in each community selected for the construction of an SHPP (Small Hydro Electric Power Plant). Each team will be responsible for field work in 3 communities during 9 months of the year and follow up work for the rest of the year.

In order to maximize the effectiveness of the promoters, the following elements must be kept in mind for the implementation of the promotion plan.

a) Commit the community to elect the members who will attend the promotion classes, and to submit a list of ideas on how electricity will be used for

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1/ Financing for productive uses of electricity is available through the fund established at the Industrial Bank by the AID financed Rural Enterprises I and II projects. The fund created by these two AID projects combined with counterpart contributions totals more than US$20 million.

production of goods and services. This will be done at the beginning of the construction stage to allow time for research on site specific solutions. Representatives of formal or informal institutions (e.g. Ministry of Education, traditional leaders) must assure adequate coordination with authorities.

b) The classes will take place during the evening hours when the adult population is released from its daily duties.

c) The promoters will speak the vernacular of the site.

d) Women will be hired to do the promotion work among women in order to maximize the impact of the program, since access to women by male extension agents in rural Peru is difficult. The estimated cost of this component is US$ 200,000 of which AID will finance 50% and 50% will be financed as a portion of the GOP contribution to the Project.

4. Installation of the Selected SHPP's

The Project will finance the complete installation i.e. civil works, mechanical equipment, control and electro-mechanical equipment and network systems including household connections for approximately 28 small-scale, standardized, hydroelectric installations in the 100 to 1,000 KW range. The expected average plant size is 300 KW. As stated earlier, quantity and sizes of plants will be determined through the application of the feasibility study methodology.

Where possible actual construction of the small hydroelectric plants will be carried out by the five existing construction units from ELECTROPERU, with OPTA being the entity supervising the construction of civil works and plant installation. Where necessary OPTA will contract private firms for actual construction and field supervision, a procedure which they are currently utilizing for some on-going projects. Short term technical assistance (6 m/m) will be provided for development of standardized equipment specifications and procurement assistance. Plant construction activities will be carried out for groups of 4 plants at a time. Construction of the first group will begin during year 2 of the program. Construction of a new group will begin every six months thereafter through the end of year 4. ELECTROPERU's experience has been that on average it takes one year to put a SHPP in service from the day that construction activities begin. Thus, all the 28 plants should be in service by the end of year five of the Project.

Communities will supply local unskilled labor. Where contracting for construction or supervision is required this activity will be carried out by OPTA using GOP counterpart funds. Off-shore procurement will be carried out by ELECTROPERU in accordance with AID procurement regulations. AID will finance a U.S. consultant to assist ELECTROPERU in the preparation of technical specifications and identification of appropriate equipment. This consultant will spend two months in Peru beginning in year two, and two months in years three, four and five for this purpose.1/

1/ The procurement specialist will be brought on board as soon as the first set of feasibility studies have been approved by AID; this is expected to occur at the end of year one.

Typically, the GOP experience in building SHPP's has been that the costs of the civil engineering works account for approximately 37% of the total installation cost of a SHPP with the equipment and machinery costs accounting for the other 63%. These figures were confirmed in carrying out the two feasibility studies done for PP preparation. Thus, 37% of the total SHPP installation budget has been assigned to the civil engineering works or US$4.59 million of which US$2.5 are provided by AID as part of the Loan and US$2.09 million come from GOP funds. US$240,000 has been budgeted for GOP financed supervision. Of the US$7.53 million for the purchase of equipment and machinery, US$6.5 million will be AID financed and US$1.03 million to be financed by the GOP. This component includes individual household

Charges to beneficiaries will initially be on an unmetered flat rate basis. Over a period of 2-3 years, households will be converted to a metered system the cost of which will be initially absorbed by ELECTROPERU and amortized by the beneficiaries in monthly installments. Flat rate charges average US .2 cents per kilowatt/hour for rural households which is substantially below current estimated costs for lighting by kerosene(which is also currently subsidized by the GOP) and candles. The Project anticipates average annual usage at 555 KW/ hours per household or an annual charge for usage of US$ 12.00. Current charges will be sufficient to cover operation and maintenance of the plant which is estimated at 1.5% of the plant cost. The figures incorporated in this paper use the current rate structure which subsidizes plant installation for rural users, however the new energy policy recently articulated by the Minister of Economy and Finance is to reduce this subsidy through a series of rate increases over time so as not to cause undue hardship on the target group. See Economic Analysis for additional information regarding affordability and usage.

5. SHPP Maintenance

Four turbine-generator preventive maintenance mechanics will be hired by ELECTROPERU at the beginning of year 3. Initially, they will receive a four-month training program on all aspects of SHPP maintenance to be conducted by a short-term U.S. consultant. They will have the responsibility for maintaining the SHPP turbine-generator systems and will be called on to repair defective machinery. In addition to financing four person/months for a U.S. consultant in machinery maintenance, AID grant funds will be utilized to finance 50% (US$30,000) of the machanic's salary and operation costs to implement this Project component. GOP funds for this program come to US$240,000 of which US$30,000 corresponds to salaries and expenses and US$210,000 are budgeted for spare parts. The projected SHPP maintenance fund over the triennium of year 3 to year 5 comes to more than 1.5% of the capital costs of the installed plant, which is a level in line with current GOP policy. The preventive maintenance mechanics will in turn train selected community representatives in the day-to-day operations and basic maintenance and repair responsibilities.

6. Technical Assistance

The Project includes 102 person/months of US short-and long term technical assistance. The Project Development Committee anticipates that ELECTROPERU will enter into an institutional contract for this technical assistance, which is described below. AID funding will be provided to finance:

a) A long-term Project Advisor (5w/y) for the Life of the Project at a cost of US$450,000. He will report to the Project Manager in OPTA and be located in Lima, but will have responsibility for frequent site visits. His responsibilities will include the following: (i) assisting OPTA in the development of personnel qualifications and selection standards for the employees to be hired by OPTA under the proposed Project; (ii) assisting OPTA in the technical preparation of pre-feasibility studies and feasibility studies; (iii) reviewing all studies and making recommendations for site selection to the OPTA Project Manager; (iv) assisting OPTA in arranging for provision of the U.S. short-term technical assistance; (v) developing simplified procedures for monitoring all aspects of the Project components. This person should have an MS degree in Electrical Engineering and at least 10 years of experience including experience in Latin America. He should have at least 5 years of Project Management experience at a minimum level of $2.0 million per year and should be fluent in Spanish.

b) Eight person/months (U.S.$80,000) for an energy economist. During years 1 and 2, the economist will spend two months each year in Peru assisting in the refinement of the pre-feasibility and feasibility study methodology and the preparation and analysis of the first group of feasibility studies, respectively. He will spend an additional four months working with the feasibility study team in years 3 and 4.

c) Four person/months (US$40,000) for an environmental impact analyst to work with the economist on implementing the feasibility study component and for training an ELECTROPERU counterpart.

d) Six person/months (US$60,000) for a specialist in design and construction of hydroelectric plants to assist OPTA in the procurement of appropriate equipment and spare parts. He will spend two months working on the Project in years two, three and four.

e) Four person/months (US$40,000) for a curriculum development specialist to assist OPTA in the design of a training program for the energy promotion component.

f) Six person/months (US$60,000) in year one to finance an energy planner to assist OPTA in planning the implementation of its national mini-hydro program.

g) Six person/months (US$60,000) to assist ELECTROPERU in updating its pricing policy,billing and collection methods. This assistance will be provided during year one of the Project.

h) Four person/months of financing (US$40,000) will be provided to contract for a hydro-electric maintenance specialist to assist in training four preventive maintenance mechanics.

i) Finally, US$40,000 has been provided to finance an end of Project evaluation to be conducted by a team comprised of an economist, engineer and sociologist. This evaluation will be carried out during the last three months of the Project.

IV. FINANCIAL PLAN

The total cost of this five-year Project is US$14.1 million of which US$10.0 million or 69% will be financed by AID. The Government of Peru will provide the remaining US$4.4 million.

The US$1.0 million grant will finance 102 person/months of US technical assistance. See Tables 6, 7, and 8 for a detailed financial plan, and Table 9 for a typical cost structure for a 200 KW small hydro-electric power plant.

TABLE - 6

SOURCES AND APPLICATION OF FUNDS
(In thousands of U.S. Dollars)

	Investment Category	A. I. D. Loan	A. I. D. Grant	GOP	Total
I.	Studies				
	- Pre-feasibility	-	-	200	200
	- Feasibility	-	-	500	500
II.	Implementation Support for Promotion Campaign				
	- Operation Expenses	-	100	100	200
III.	Construction				
	- Civil Engineering Works	2,500	-	2,090	4,590
	- Equipment and Machinery	6,500	-	1,030	7,530
	- Supervision	-	-	240	240
IV.	Technical Assistance 1/	-	870	-	870
V.	Maintenance				
	- Operation Expenses	-	30	30	60
	- Spare parts	-	-	210	210
	Grand Total	9,000	1,000	4,400	14,400
		69%		31%	100%

1/ Includes: 60 w/months of Project Advisor, 8 w/months of Economist, 4 w/months of Environmentalist, 4 w/months of Curriculum Specialist, 6 w/months of Energy Planner, 6 w/months of Tariff and Financial Administration Specialist, 4 w/months of Maintenance Specialist, 6 w/months of Procurement Specialist and 4 w/months of Evaluation Technician (Total of 102w/months).

TABLE 7

REQUIREMENTS OF FOREIGN EXCHANGE AND LOCAL CURRENCY

(In thousands of U.S.Dollars)

Investment Category	A.I.D. Loan FX	A.I.D. Loan LC	A.I.D. Grant FX	A.I.D. Grant LC	G O P FX	G O P LC	TOTAL
I. Studies							
- Pre-feasibility	-	-	-	-	-	200	200
- Feasibility	-	-	-	-	-	500	500
II. Implementation Support for Promotion Campaign							
- Operation Expenses	-	-	-	100	-	100	200
III. Construction							
- Civil Engineering Works	-	2500	-	-	-	2090	4590
- Equipment and Machinery	6500	-	-	-	630	400	7530
- Supervision	-	-	-	-	-	240	240
IV. Technical Assistance	-	-	870	-	-	-	870
V. Maintenance							
- Operation Expenses	-	-	-	30	-	30	60
- Spare Parts	-	-	-	-	210	-	210
Grand Total	6500	2500	870	130	840	3560	14400

TABLE 8

EXPECTED PROJECT DISBURSEMENTS BY YEAR

(In thousands of U.S. Dollars)

	Investment Category	Year I	Year II	Year III	Year IV	Year V	Total
I	Studies						
	GOP	150	350	200	-	-	700
II.	Implementation Support for Promotion Campaign						
	GOP	-	-	25	50	25	100
	AID	25	25	25	25	-	100
III.	Construction						
	GOP	250	400	1000	1000	710	3360
	AID	500	2500	3000	2000	1000	9000
IV.	Technical Assistance						
	AID	275	175	165	165	90	870
V.	Maintenance						
	GOP	-	-	220	10	10	240
	AID	-	-	10	10	10	30
	Total	1200	3450	4645	3260	1845	14400

TABLE 9

TYPICAL COST STRUCTURE FOR A MINI-HYDROELECTRICAL CENTRAL

Power = 200 KW
Water Flow (Q) = 500 Lts/Sec
Altitude (H) = 50 mts.

			(Thousands of Soles)
1.0	Construction Works		
1.1	Land cleaning and access road	S/.	270,0
1.2	Intake		18,639,5
1.3	Derivation canal		7,369,2
1.4	Sand trap		1,318,4
1.5	Chamber		1,440,2
1.6	Pressure conduit		2,172,9
1.7	Power house		2,789,8
	Sub-total (1.0)	S/.	34,000,0
2.0	Electro-mechanical Equipment		
2.1	Turbine/alternator	S/.	14,100,0
2.2	Other equipment		4,650,0
2.3	Transmission Line		25,150,0
2.4	Distribution network		12,100,0
	Sub-total (2.0)	S/.	56,000,0
	Grand Total (1) + (2)	S/.	90,000,0
		US$	300,000.0
	Cost/KW	US$	1,500.0 1/

1/ This cost excludes the cost of pre-feasibility study, feasibility study, promotion, maintenance and supervision which bring the total cost per KW to US$ 1,722 as previously stated.

V. INSTITUTIONAL ANALYSIS

A. Mini-hydroelectric Centrals Commission

On November 29, 1978, the Ministry of Energy and Mines (MEM) by Ministerial Resolution N° 1182-78-EM-DS, declared the implementation of the Mini-Hydroelectric Centrals Program of the highest sectoral priority and created the Small Hydroelectric Centrals Commission to formulate, direct, approve and evaluate the above-mentioned program. Within several months of its creation the Vice Minister of the MEM approached AID to solicit financial and technical assistance for a small hydro program. The Commission lead by OSPA's General Director, is composed of representatives from the following institutions:

(a) Ministerio de Energía y Minas (MEM)

- Oficina Sectorial de Planificación (OSPA)
- Concejo de Asesoramiento (COA)
- Dirección General de Electricidad (DGE)

(b) Empresa Pública de Electricidad del Perú (ELECTROPERU)

- Oficina del Programa de Tecnología Aplicada (OPTA)

(c) Instituto de Investigación Tecnológica (ITINTEC) and

(d) Compañía Hidrológica Andina (HIDRANDINA)

B. ELECTROPERU

ELECTROPERU (See Annex II Exhibit B for Organization Chart) is an autonomous public enterprise within the Energy and Mines Sector, it was established on September 12, 1972, with an authorized capital of 20.0 billion soles wholly owned by the GOP. By virtue of its Organizational Law, ELECTROPERU, assumed the entrepreneurial activities of the State in the electricity sub-sector with full responsibility for construction, supervision and operation of the nation-wide power supply system.

In 1976, the Peruvian power sector completed the process of reorganization

This entity has responsibility for system operation and project execution. A substantial proportion of the total generation is produced in captive facilities of various industrial, agricultural, and mining enterprises.

ELECTROPERU has five operating regions. The north-central region including Lima accounts for 87 percent of the electric energy demand. This region has two separate interconnected systems, Electrolima serving the metropolitan Lima area, and the smaller Chimbote-Trujillo system. The former is an extensive interconnected system with principal substations linking 230Kv transmission lines to each other and to generating plants. A 220Kv link between Electrolima and Chimbo-

te-Trujillo is planned. Other operating regions and their principal cities are shown in Table 10.

In the main these regions are served by small, isolated systems. In fact, ELECTROPERU is responsible for the operation of 250 isolated power plants.

The captive generating plants associated with industrial and mining enterprises are not connected to the ELECTROPERU system. The largest of these is Southern Peru Cooper in the Southwestern Region with a maximum demand of some 315MW followed by Centromin in the Central Region with a demand of 130MW.

Table 10

ELECTROPERU OPERATING REGIONS

Operating Region	Principal Cities
North	Bayovar, Piura, Talara
Southwest	Tacna, Arequipa, Puno
Southeast	Cuzco
East	Iquitos, Pucallpa

Electric Load Growth

Electric energy production in 1975 amounted to 7.4 gigawatt-hours (GWh). Consumption by sector (including losses) is shown in Table 11.

The median estimate of total electricity production in 1955 is 26.9×10^3 GWh, which corresponds to an average annual growth rate of 7.9 percent.

Table 11

ELECTRICITY CONSUMPTION BY SECTOR, 1975

	GWh x 10^3	Percent
Industrial	2.16	29.1
Mining	1.86	25.2
Residential	1.25	16.9
Losses	0.78	10.6
Other	0.55	7.4
Public Authorities	0.3	4.0
Commercial	0.25	3.4
Agriculture	0.16	2.2
Fisheries	0.09	1.2
Total	7.40	100.0

TABLE 12 GENERATION MIX 1975

Type	Capacity MW	Capacity Percent	Energy Produced GWh	Energy Produced Percent	Fuel Btu x 10^{12} Oil	Gas	Bagasse
Diesel	416	17.7	673	9.0			
Gas Turbine	202	8.8	138	1.8	17.8	2.3	5.0*
Fossil Steam	342	14.5	1,205	16.1			
Hydroelectric	1,397	59.2	5,470	73.1	--	--	--

* Highly approximate.

Capacity expansion plans for the period 1978-90 are based for the most part on futher exploitation of hydroelectric resources supplemented by substantial coal-fired generation. Specifically, of the planned added capacity, 1520MW are hydro, 480MW are coal. Planned generating facility additions over this are shown in Table 13.

TABLE 13 PLANNED GENERATING CAPACITY EXPANSION 1978-90

Mode	Station	Capacity (MW)	Operating Date
Hydro	Mantaro Units 4-5	228	1978-79
	Mantaro Units 6-7	228	1980
Hydro	Canon del Pa (addition & upgrading)	50	1979-80
Hydro	Poechos	11	1980
Hydro	Culqui	25	1981
Hydro	Machu Picchu (addition)	70	1979
Hydro	Restitucion	200	1981
Hydro	Yuncan-Paucartambo II & III		1983
Hydro	Charcani V	135	1982
Hydro	Sheque		
	Stage I	150	1986
	Stage II	150	1986
	Stage III	150	1988
Hydro	Majes		
	Stage I	272	1984-86
	Stage II	192	1990
Hydro	Olmos	370	1985-89
Coal	Alto Chicama		
	Stage I-II	240	1982
	Stage III-IV	240	1984
TOTAL		2000	

TABLE 14

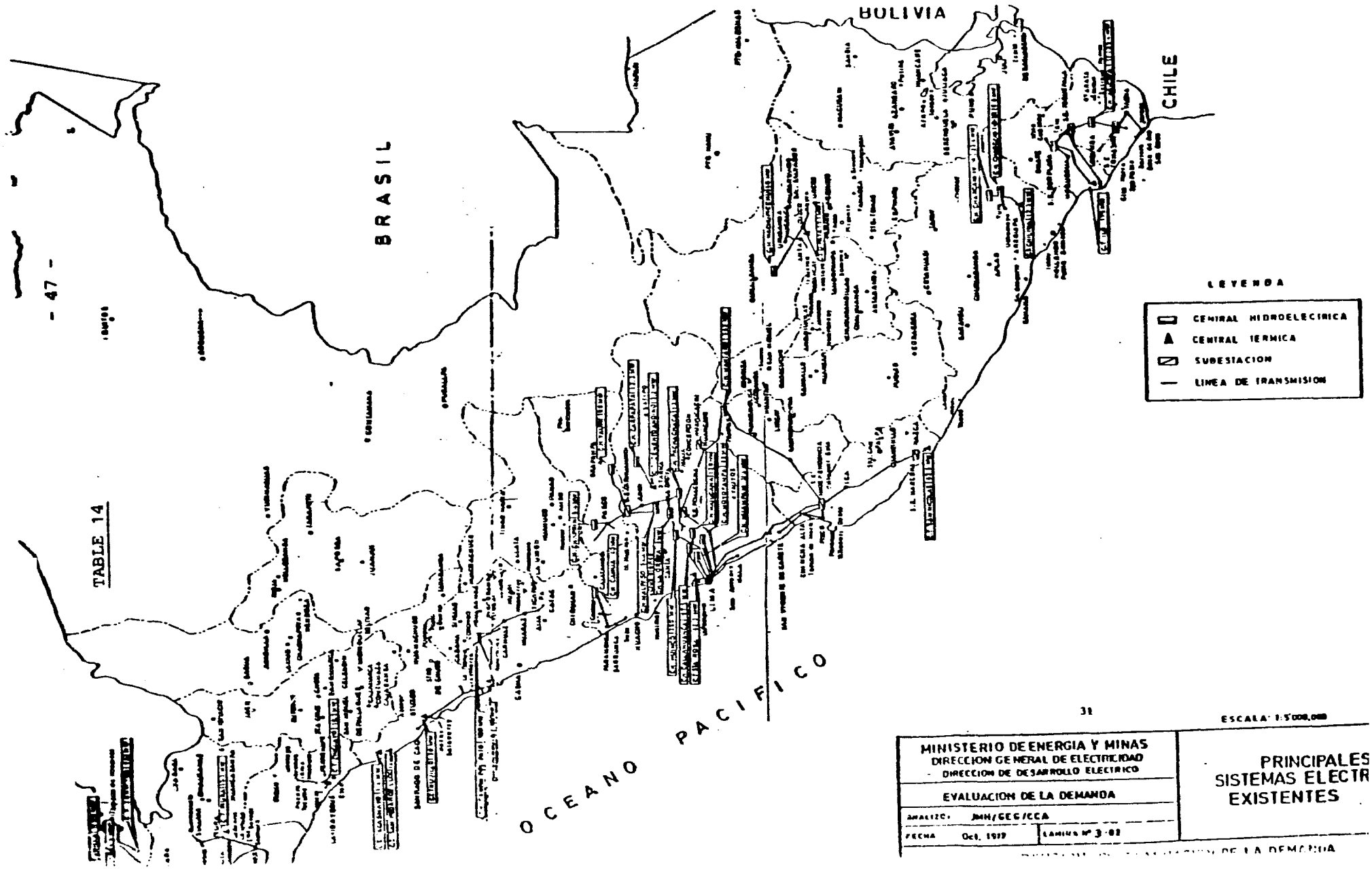

BRASIL
BOLIVIA
CHILE
OCEANO PACIFICO
LEYENDA
CENTRAL HIDROELECTRICA
CENTRAL TERMICA
SUBESTACION
LINEA DE TRANSMISION
31
ESCALA: 1:5'000,000
MINISTERIO DE ENERGIA Y MINAS
DIRECCION GENERAL DE ELECTRICIDAD
DIRECCION DE DESARROLLO ELECTRICO
EVALUACION DE LA DEMANDA
ANALIZO: JMH/GEG/CCA
FECHA Oct. 1977
LAMINA Nº 3-02
PRINCIPALES SISTEMAS ELECTR EXISTENTES

Table 15

PRESENT PRINCIPAL HYDROPOWER PLANTS

PERU *

NORTH REGION (Chimbote-Trujillo, etc.)

	Capacity-Megawatts
Canon Del Pato	100
Cahua	40
Subtotal	140

CENTRAL REGION (Lima-Pisco, etc.)

Chaprin	5.4
Yaupi	108
Malpaso	54.4
La Oroya	9
Carpapata	12.2
Pachachaca	12
Huinco	260
Matucana	120
Callahuanca	67.5
Moyopampa	63
Huampani	31.4
Ingenio	
Sicaya Huaricca	
Mantaro	342
Subtotal	1,084.9

SOUTH REGION (Arequipa-Cuzco-Moquegua, etc.)

Machupicchu	40
Charcani IV-VI	23.4
Charcani I-II-III	6.8
Aricota I-II	35.4
Subtotal	105.6

SUMMARY

NORTH REGION	140
CENTRAL REGION	1,084.9
SOUTH REGION	105.6
TOTAL	1,330.5

*From "Plan De Electrificacion Nacional", Ministerio De Energia Y Mines. December 1977.

Electricity Generation

In 1975 the generation mix by mode of generation was as shown in Table 12.

Publicly owned generation facilities constituted 62.3 percent of the total, captive plants associated with specific enterprises, 37.7 percent.

The Minister of Energy and Mines of Peru has prepared a map dated October, 1977 (See Table 14), showing the principal electrical facilities in existance. The present principal hydropower plants in Peru, as shown on the map are summarized in Table 15.

C. OPTA

To implement small hydro commission's directives, OPTA was created on December 15, 1978, as a Division within ELECTROPERU with the responsibility of supervising and coordinating the execution of the Small-hydroelectric Centrals Program. The principal functions of OPTA are as follows:

(a) To centralize, coordinate and carry-out studies concerning the generation of electricity for rural centers with a view towards the intensive use of hydro-electricity to replace petroleum as an energy source.

(b) To execute technical and economic studies of power systems ranging between 50 to 1,000 KW for the generation of electricity which would benefit isolated populated centers.

(c) To develop and implement norms, designs, and systems, as well as the standarization of procedures for the manufacture, installation and construction of hydroelectric plants to be executed by ELECTROPERU.

(d) To supervise the implementation of works performed by the five Executing Units of ELECTROPERU and;

(e) To act as the GOP counterpart institution in foreign assistance programs.

Its budget comes from 2 sources: (i) to provide a continuous source of revenue for its activities OPTA is guaranteed by charter 15% of the net revenues of ELECTROPERU from the previous financial year. For 1980 OPTA's budget from these sources came to S/. 375 million; (ii) OPTA has also direct budgetary access to the Public Treasury. In 1980 this budgetary source provided S/. 160 million.

Thus, OPTA's total budget for 1980 comes to S/. 535 million (approximately US$ 1.85 million).

D. The OPTA - AID SHPP Program

The institutional framework that is being put in place for the OPTA-AID SHPP Program will aim at a prompt and efficient program implementation. Special characteristics of that framework are:

1) Introduction of a pre-feasibility and feasibility study methodology which will consider economic, social and environmental concerns in addition to the technical criteria currently being used.

2) A strengthening of middle management.

3) Introduction of senior level engineers in all technical phases of the program.

4) Improvement in project planning and execution.

5) Introduction of experienced professionals in socio-economic sciences.

6) A new emphasis on plant maintenance.

7) A new emphasis on promotion of electricility for productive purposes.

8) Provision of high calibre consultants.

On completion of the OPTA-AID SHPP Program, OPTA will have a record of experience and credit-worthiness to apply for further international funding (from agencies such as the Interamerican Development Bank and the International Bank for Reconstruction and Development) to continue with a vigorous SHPP construction and maintenance program.

OPTA will initially contract the additional personnel. This has two major advantages: a) the time frame for budgeting and hiring direct hire employeescan be greatly compressed; and b) employees on contract can be easely replaced should they not be effective, an option not readily available in the case of direct hire employees. After two to three years all OPTA contract employees will be converted to direct hire status. During the same time frame the AID contribution to salaries will be progressively reduced to zero.

OPTA will contract the following additional personnel to implement the proposed project:

1) Two electrical engineers.
2) Four civil engineers.
3) One geologist.
4) Two economists.
5) One environmental scientist.
6) Eight promotores (50% AID financing).
7) Four maintenance mechanics (50% AID financing).
8) One topographer.
9) Two draftsmen.
10) Various support personnel i.e. drivers, secretaries, etc.

The costs for contracting the above professionals is included as the GOP counterpart contribution in the financial tables in the previous section.

VI TECHNICAL ANALYSIS

A. Introduction

The configuration of small decentralized hydropower systems may take a number of forms depending on site conditions. Both head and flow will determine the specific turbine arrangement most suitable. Table 16 shows typical application of various hydraulic turbines based on head and power output.

High head sites, especially with low flow, dictate the use of the Pelton turbine with efficiencies as high as 80 percent. This impulse unit spins at high speed converting the total energy head into a kinetic energy head, through a contracting nozzle. The water jet imparts kinetic energy on a bucket-like structure which causes rotary motion of the turbine wheel. Table 17 shows a typical Pelton turbine installation.

For somewhat lower heads, reaction turbines such as Francis or propeller turbines may be used as shown in Table 18. However, these units run slower, require more flow and are generally located in extensive civil work. At the other end of the spectrum, for low head, high flow sites, bulb or tube turbines are used. These units are generally installed in an axial flow direction and do not require scroll cases and elbow draft tubes commonly required with Francis or propeller units. Tables 19-25 show additional technical features of small hydro installations. These are more fully discussed in Annex II Exhibit B.

There are still other types of units for specialized applications such as the Ossberger Cross Flow Turbine or the Straflow Turbine. These units and others, however, are manufactured in the developed countries. Only a small number of companies are engaged in supplying and installing equipment but there are efforts underway to develop standardized units of the off-the-shelf variety. Development of a manufacturing capability within Peru would surely accelerate implementation of SDH.

For AC baseload plants which are completely independent of an existing grid, a synchronous generator is required. Whether a 50 or 60 cycle system, the speed of the generator must be constant and a speed increaser may be required so the generator can run at its design speed.

Another possibility is to generate DC current and convert it to AC via an inverter. A DC system is not sensitive to speed, therefore needs no governor.

For systems with no storage capacity, energy dissipating load control is required. Generally, if connected to a grid, excess power may be sold to the network and bought back when local demand exceeds supply. If there is no grid connection, excess power can be converted into heat and used in a process heat application.

During the elektro-mechanical system development phase, technical and economic decisions will be made regarding a suitable design for the proposed site.

The electro-mechanical, technology and engineering construction methods for SHPP are well developed and familiar to OPTA. What is not being currently applied is the application of detailed methodologies to both prioritize SHPP sites from a large list of potential sites and thereafter to apply economic, social and environmental criteria, along with technical determinations, in order to establish the feasibility of a specific project site. Thus, the technical analysis consists of a detailed methodology that has been designed to select the SHPP sites that will be eligible for AID financing. The methodology has two major components viz, a Pre-Feasibility Study Methodology and a Feasibility Study Methodology. The Pre-Feasibility (or reconnaissance) investigation methodology has two objectives i) elimination of those project sites that are unattractive from a technical, social, economic or ecological viewpoint. ii) prioritization (or ranking) of the remaining project sites using a combination of social, technical and economic criteria. The feasibility study methodology has been designed to investigate thoroughly whether, in fact, one of the screened, prioritized projects should be constructed and what steps should be taken for its implementation.

Thus, starting with a national catalog of possible SHPP sites (prepared under the auspices of the UNDP) the site selection methodology will first consider only those sites that are located in the Department of Cajamarca, Junin and San Martin. Then, a prioritized list of SHPP sites will be prepared. Finally, a definitive list of sites that will be eligible for AID Financing, will be generated (See Table 26).

Detailed Pre-Feasibility Study (PFS) and Feasibility Study (FS) methodologies have been prepared (See Annex II Exhibits A & B), what follows below is a narrative of the salient points of both methodologies.

B. The Pre-Feasibility Study Methodology

The Pre-Feasibility Study Methodology consists of five steps, namely:

a) Site Physical Characteristics
b) Physical Works
c) Economics
d) Social, Political and Environmental Criteria and
e) OPTA's Pre-Feasibility Decision Flow Chart

The content of each of these steps will be described in turn.

a) The Site Physical Characteristics are of three kinds viz i) power potential; ii) accessibility to communication routes and iii) proximity to the sites of load demand. The power potential of a site is a function of the net head and the available flow at a given site. Detailed instructions are provided on calculating these parameters. The accessibility of the site to all communication routes (such as paved roads, all-weather roads, horse trails) and its proximity to the centers of load demand are also covered.

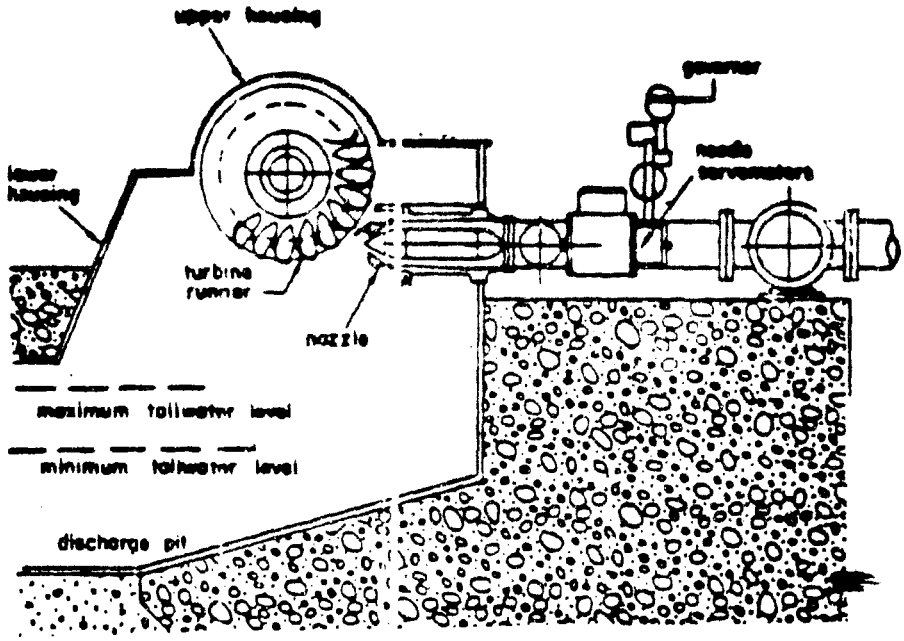
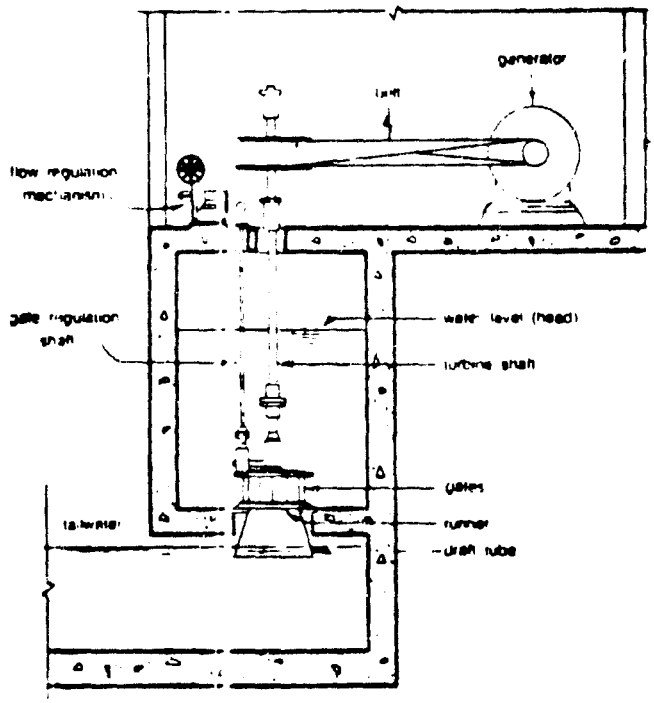
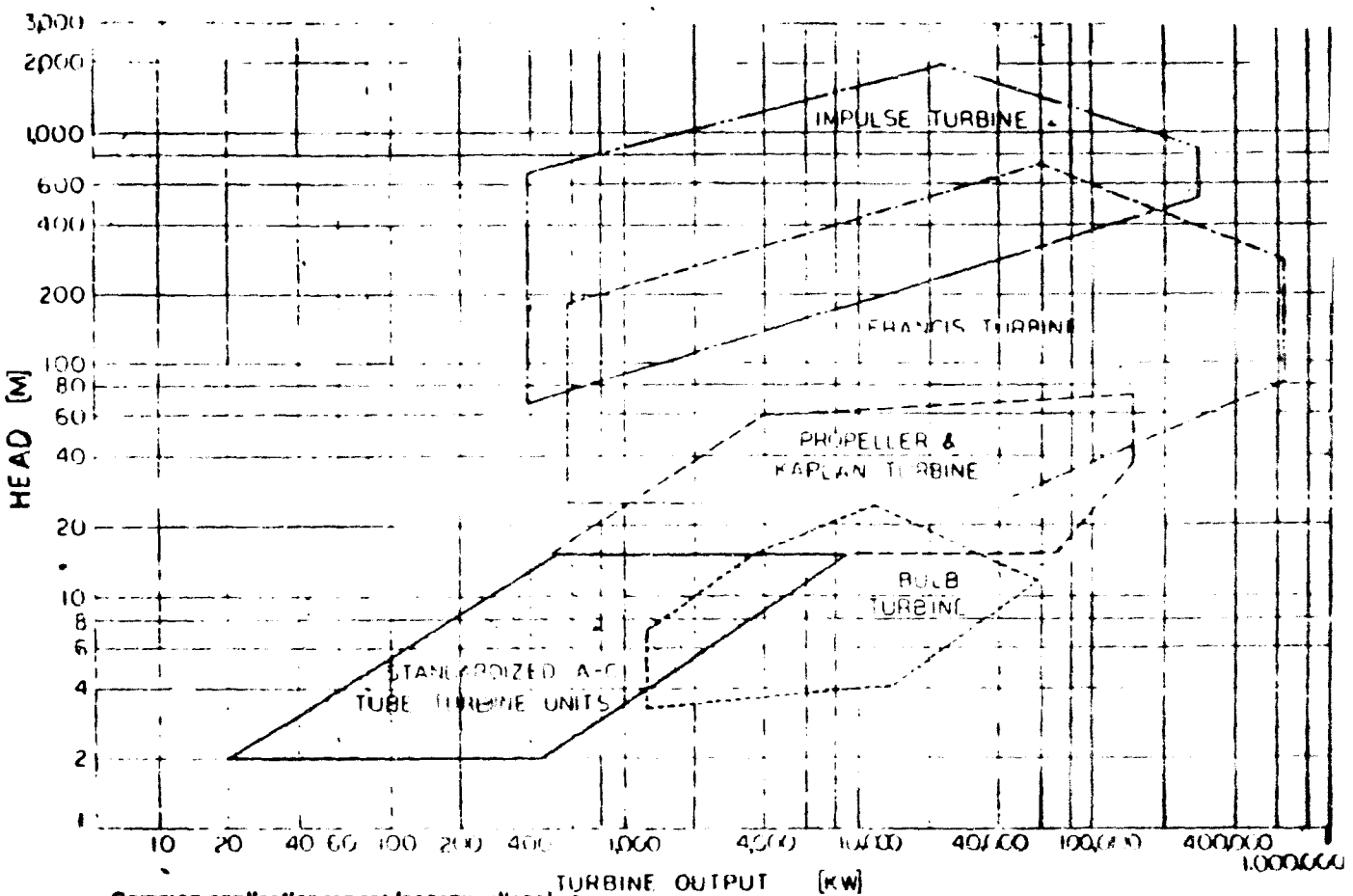


TABLE 17

TYPICAL PELTON TURBINE ARRANGEMENT



SMALL REACTION TURBINE FACILITY



Common application ranges for conventional hydraulic turbines.

TABLE 19

(from Ref. 8)

TABLE 19 **Sketch of a Small Hydroelectric Power Plant**

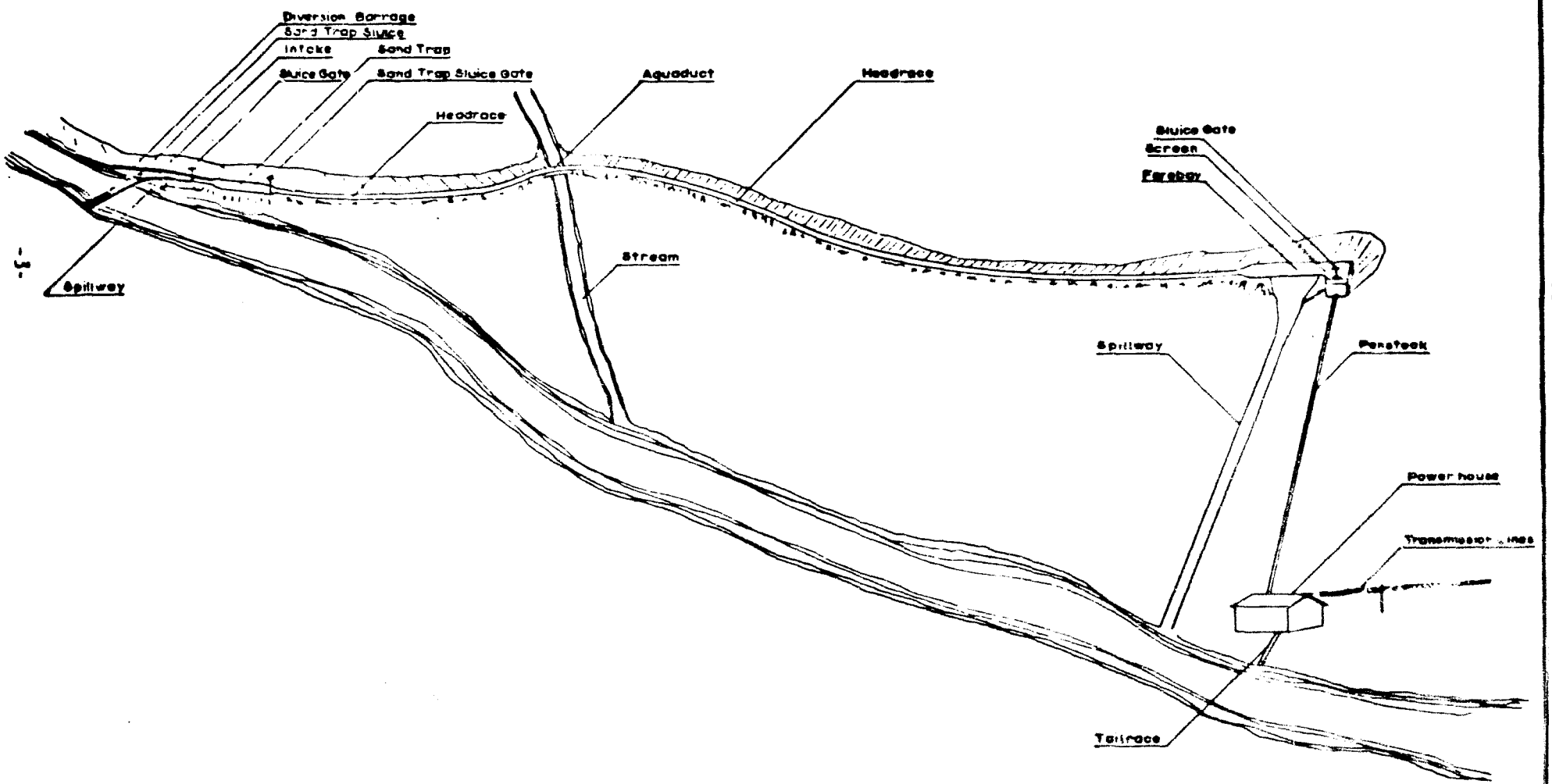
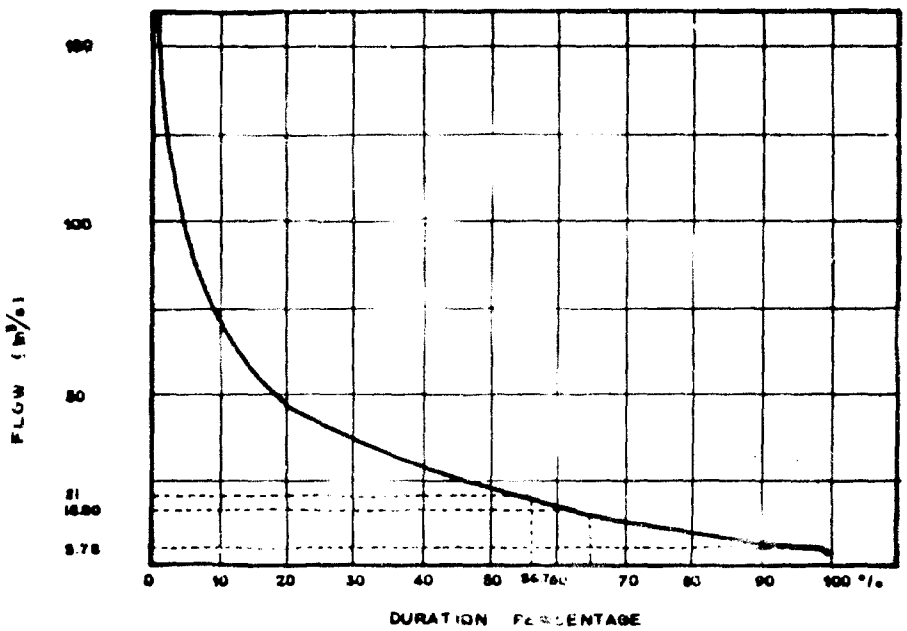


TABLE 20

FLOW DURATION CURVE OF WATER RESOURCES IN CARHUAQUERO POWER PLANT-CAJAMARCA PERU



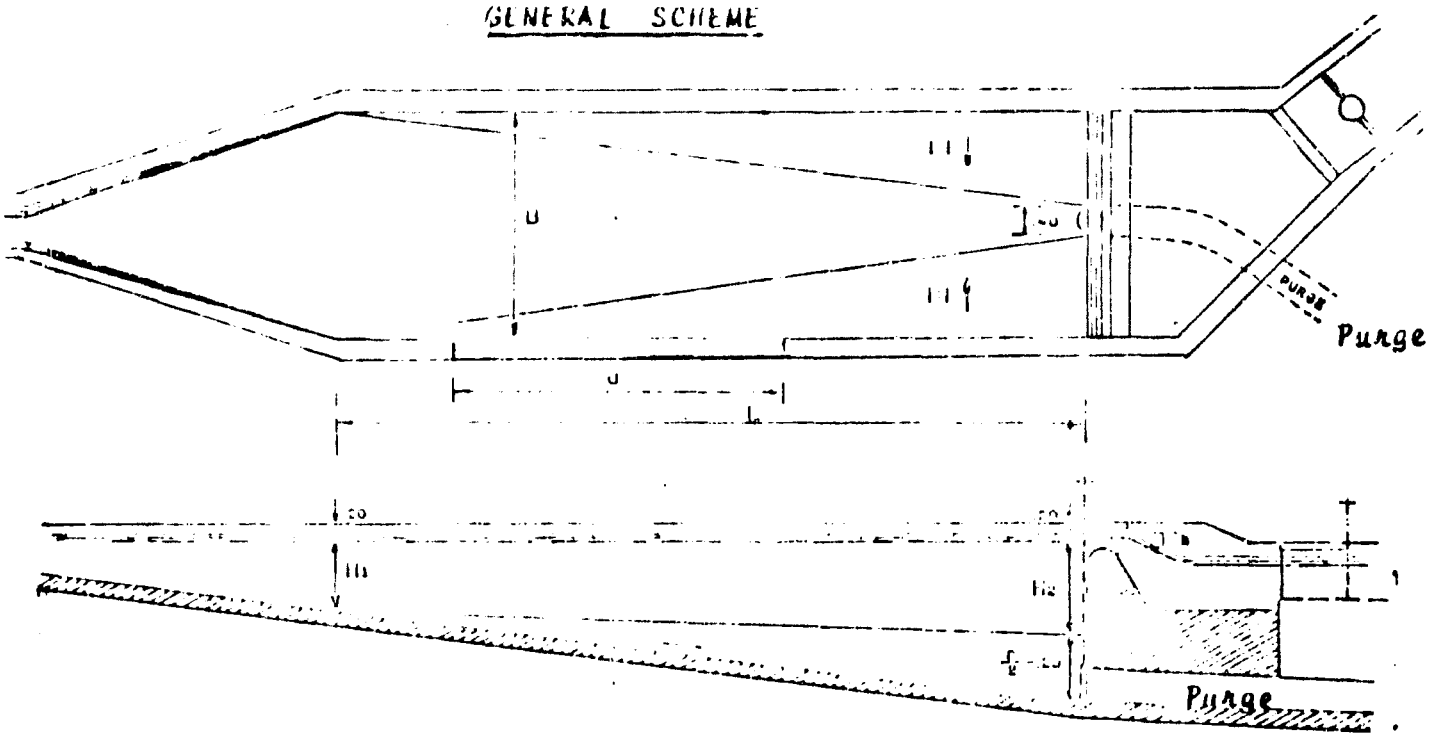
EXAMPLE OF A FLOW DURATION CURVE

TABLE 21

FIGURE

SANDTRAPS FOR SHPP SYSTEMS

GENERAL SCHEME

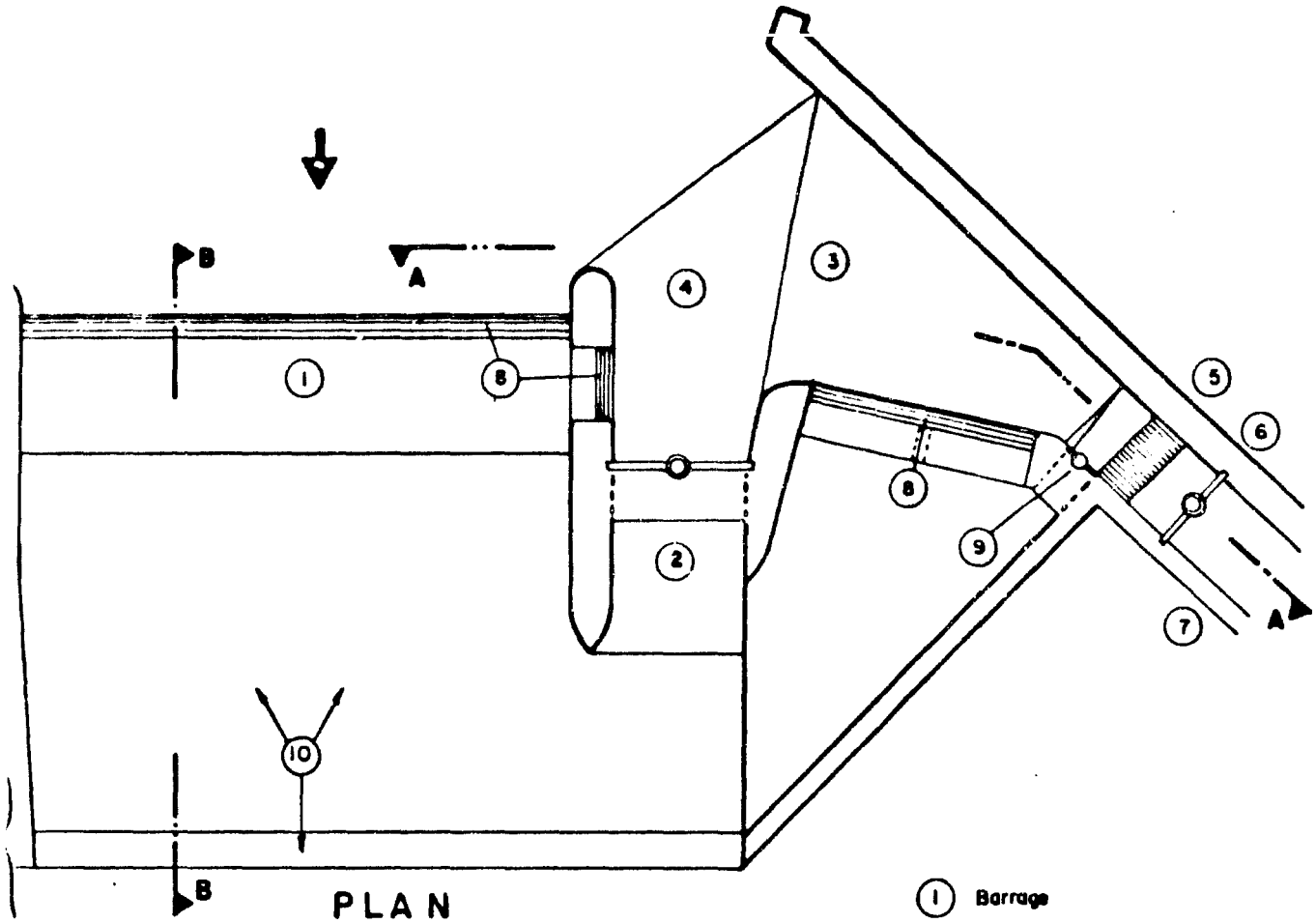


PRINCIPAL DIMENSIONS

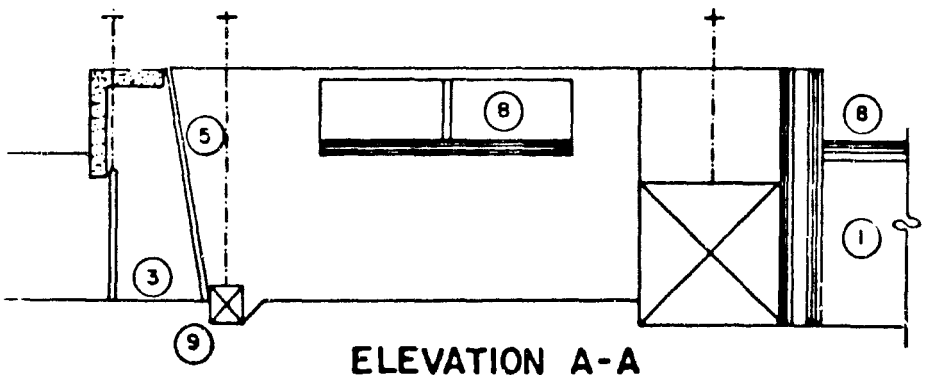
(IN METERS)

FLOW	TYPE	B	L	H_1	H_2	a	h	Purge Sluice
500 1/s	Primary	2.80 2.10 1.40	7.60 10.20 15.50	1.50 1.80 2.30	1.50 1.80 2.90	9.00 9.00 9.00	0.25 0.30 0.45	.40 x .40
200 1/s	Primary	[illegible] 1.40 1.00	4.80 6.20 8.60	1.10 1.30 1.60	1.10 1.30 1.90	3.50 3.50 3.50	0.20 0.25 0.35	.40 x .40
500 1/s	Auxiliary	1.80 1.40 1.00	[illegible] 6.20 8.60	1.10 1.30 1.60	1.10 1.30 1.90	5.00 5.00 [illegible]	0.35 0.45 0.60	.40 x .40
200 1/s	Auxiliary	1.20 1.00 0.80	3.10 3.50 4.30	0.70 0.85 1.00	0.70 0.85 1.10	3.50 3.50 3.50	0.25 0.30 [illegible]	.30 x .30

TABLE 22 **THE INTAKE STRUCTURE**

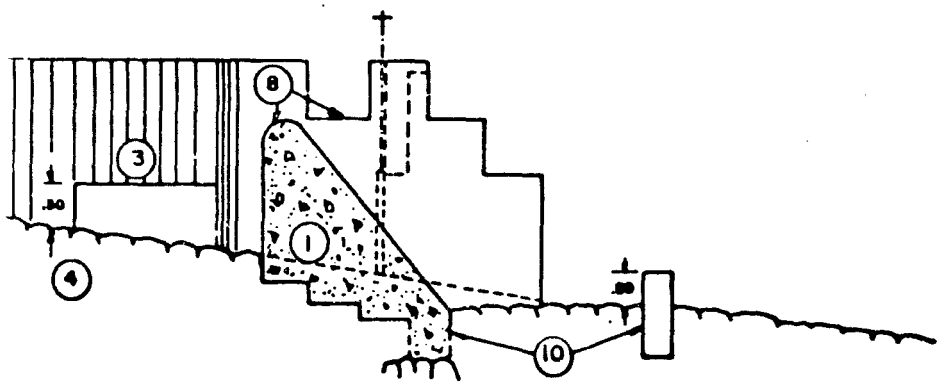


PLAN



ELEVATION A-A

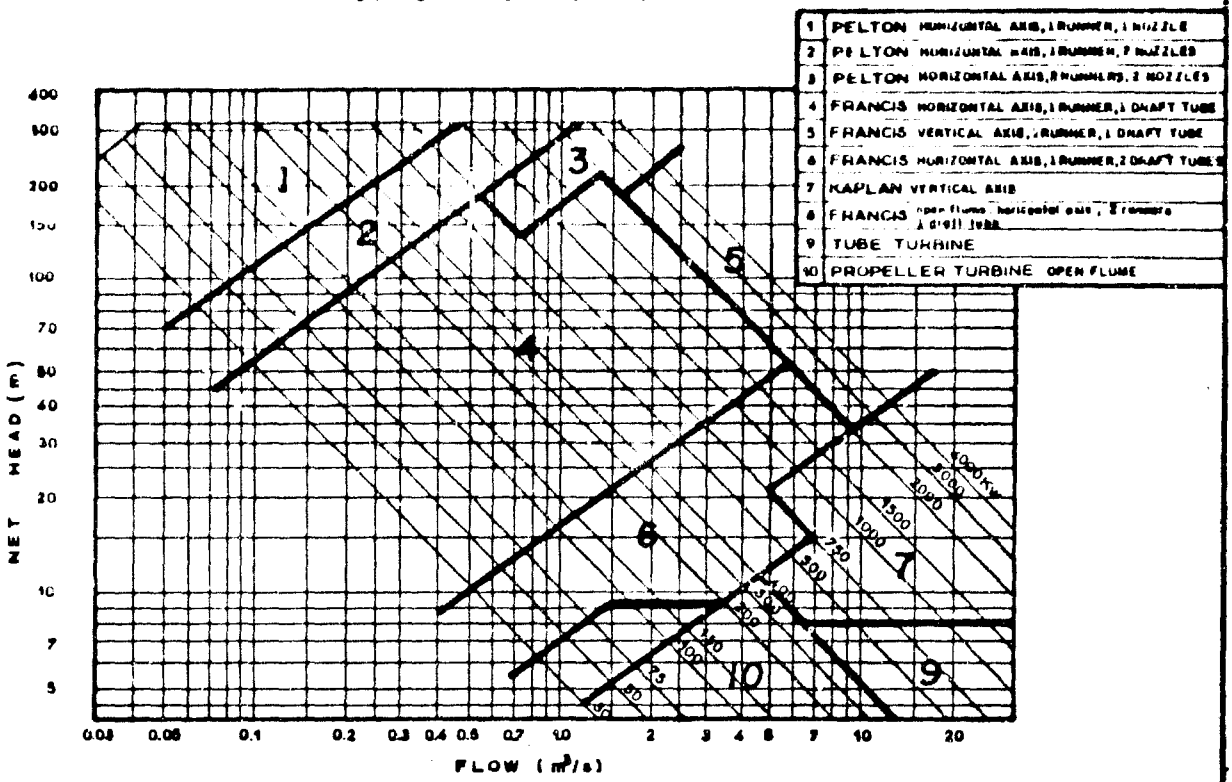
1. Barrage
2. River bottoms sluice gate
3. Concrete platform
4. Antechamber (Decantation Area)
5. Fine grating
6. Intake sluice gate
7. Sandtrap intake channel
8. Spillways
9. Sandtrap
10. Barrage Protector



ELEVATION B-B

TABLE 23

THE SELECTION AND CAPABILITIES OF SMALL HYDROELECTRIC TURBINES

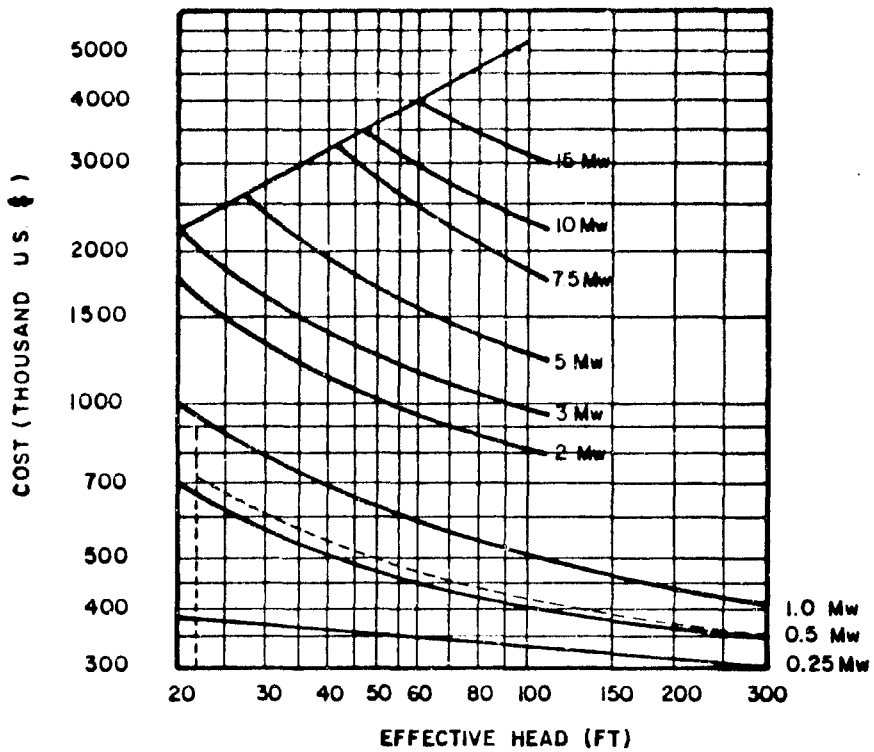


EXAMPLE For a flow (Q) = 2.1 m^3/s and a net head (H_N) = 20 m. find the point of intersection of the vertical line, that corresponds to Q= 2.1 and the horizontal line, that corresponds to H= 20. The graph indicates that the small hydroelectric system has a potential capacity of 300 Kw and that the proper type of turbine for this situation is a horizontal Francis turbine with 1 runner and 2 draft tubes

TYPE OF TURBINE

Reaction Turbine				
Propeller Turbine	Penstock / Open Flume	Horizontal axis / Vertical axis		Runners with fixed position blades (propeller) / Runners with adjustable blades (Kaplan
Reaction Turbine				
Francis Turbine	Penstock	Horizontal axis	One runner	One draft tube / Two draft tubes
			Two runner	One draft tube / Two draft tubes
	Open Flume	Vertical axis	One runner	One draft tube
(Impulse Turbine)				
Pelton Turbine		Horizontal axis	One runner	One nozzle / Two nozzles
			Two runners	Two nozzles / Four nozzles
		Vertical axis	One runner	Several nozzles

TABLE 24 **POWER FEATURE COST**

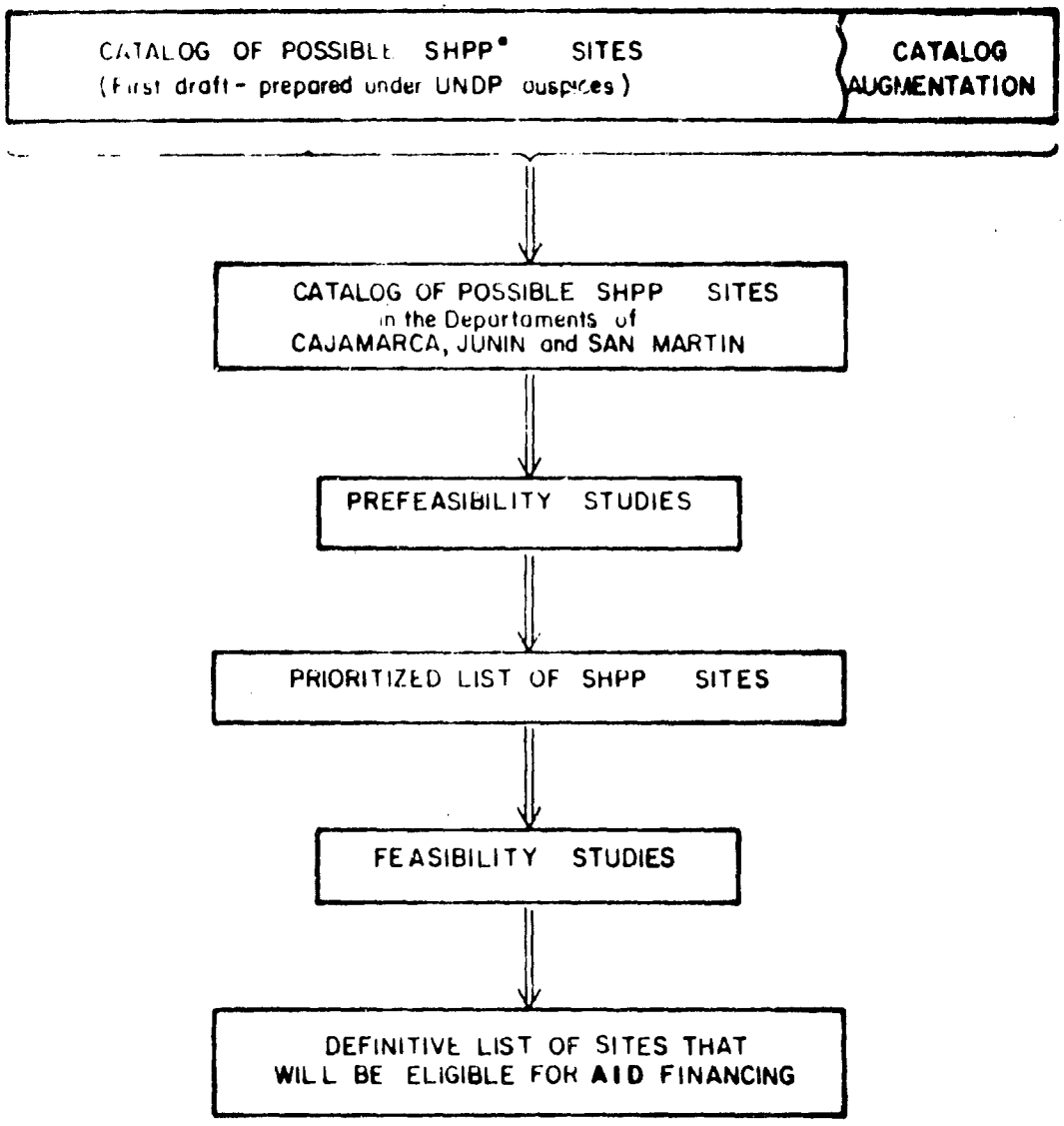


NOTES:

1. Estimated costs are based on a typical or standardized turbine coupled to a generator either directly or through a speed increaser, depending on the type turbine used.
2. Costs include turbine/generator and appurtenant equipment, station electric equipment, miscellaneous powerplant equipment, powerhouse, powerhouse excavation, switchyard civil works, an upstream sluice gate, and construction and installation
3. Costs not included are transmission line, penstock, tailrace construction, switchyard equipment, and dam modification or improvements.
4. Cost base July 1978.
5. For a multiple unit powerhouse, additional station equipment costs are $20,000+$58,000 x (n-1), where n is the total number of units.

Source: U.S. Army Corps of Engineers, "Feasibility Studies for Small Scale Hydropower Additions," July 1979, Volume 1, Page 4-7.

TABLE 26 **THE SITE SELECTION METHODOLOGY**



* SMALL HYDROELECTRIC POWER PLANT

Mantaro	342
Subtotal	1,084.9

SOUTH REGION (Arequipa-Cuzco-Moquegua, etc.)

Machupicchu	40
Charcani IV-VI	23.4
Charcani I-II-III	6.8
Aricota I-II	35.4
Subtotal	105.6

SUMMARY

NORTH REGION	140
CENTRAL REGION	1,084.9
SOUTH REGION	105.6
TOTAL	1,330.5

*From "Plan De Electrificacion Nacional", Ministerio De Energia Y Mines. December 1977.

b) The Physical Works encompasses i) type and size of plant, ii) approximate cost and iii) approximate power production. The choice of the type and size of plant (and its approximate power production capability) is dependent upon two factors viz the net head and the available flow. The capital costs of all necessary civil, mechanical and electrical engineering works are based on the effective (net) head and the plant capacity.

c) The Economic section covers three major topics: a) the market or demand structure, b) determination of the project benefits, c) evaluation of the project economic feasibility. A demand survey form has been designed to estimate the household demand for electricity. Where necessary, this information will be supplemented through use of ELECTROPERU's demand model. Load and energy forecasts will be made using an average growth rate of 5%, although this figure may be modified as more information is obtained through community surveys.

Annual project benefits accrue from i)the sale of electricity to consumers in the public, commercial, industrial and household sectors and ii) the surplus benefits that reflect consumer valuation of electricity usage. The income from the sale of electricity and cost savings resulting from the substitution of electricity for other energy sources is calculated by multiplying the total annual community consumption of electricity (stated in Kwh) by the unit selling price of electricity (Approx. 2 US¢ per Kwh for rural areas).[1/] As a first approximation the surplus benefits are assumedto be equal to the income from the sale of electricity. Special studies early in the project will be aimed at refining estimates of the value of surplus benefits.

d) The social political and environmental criteria section of the methodology is designed to make a preliminary assessment of the community's involvement in the SHPP installation. Specifically, the reconnaissance study investigates i) the community's willingness to contribute with labor to the construction, ii) its present energy expenditure, iii) its future plans with respect to the use of electricity and iv) a rough correlation between the existing power structure and any vested interest regarding electrification, v) the type of development which should be stimulated in a particular area (stable productive or protective), vi) the adequacy of water availability for area needs in terms of quantity and quality, and vii) the local interest and support to uphold the environmental project requirements.

Prefeasibility Decision Flow Chart (Table 26) indicates the order in which the technical, socio-political and economic sections of the prefeasibility study are carried out and the critical points where decisions must be made to continue with the prefeasibility study or discard a candidate subproject entirely.

C. The Feasibility Study Methodology

The feasibility study methodology has been designed to investigate thoroughly whether a project (that has passed the screening pre-feasibility stage) should be constructed, and the steps to be taken for its implementation

1/ After this document was drafted, tariff increases were announced by ELECTROPERU. The intention is to use current average tariffs for rural uses in the prefeasibility studies. [redacted]

source.

(b) To execute technical and economic studies of power systems ranging between 50 to 1,000 KW for the generation of electricity which would benefit isolated populated centers.

(c) To develop and implement norms, designs, and systems, as well as the standarization of procedures for the manufacture, installation and construction of hydroelectric plants to be executed by ELECTROPERU.

(d) To supervise the implementation of works performed by the five Executing Units of ELECTROPERU and;

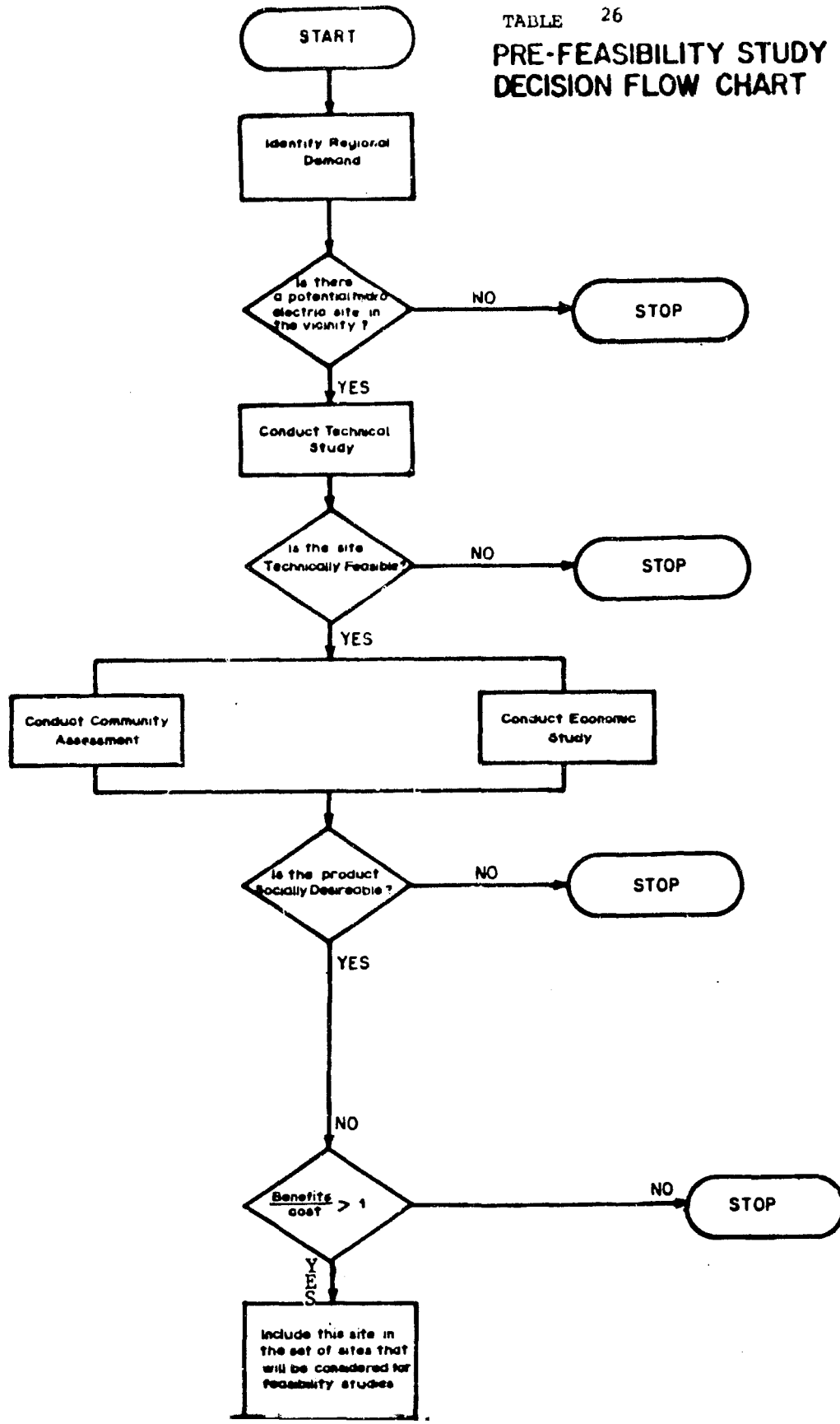
(e) To act as the GOP counterpart institution in foreign assistance programs.

Its budget comes from 2 sources: (i) to provide a continuous source of revenue for its activities OPTA is guaranteed by charter 15% of the net revenues of ELECTROPERU from the previous financial year. For 1980 OPTA's budget from these sources came to S/. 375 million; (ii) OPTA has also direct budgetary access to the Public Treasury. In 1980 this budgetary source provided S/. 160 million.

Thus, OPTA's total budget for 1980 comes to S/. 535 million (approximately US$ 1.85 million).

TABLE 26

PRE-FEASIBILITY STUDY DECISION FLOW CHART



On completion of the OPTA-AID SHPP Program, OPTA will have a record of experience and credit-worthiness to apply for further international funding (from agencies such as the Interamerican Development Bank and the International Bank for Reconstruction and Development) to continue with a vigorous SHPP construction and maintenance program.

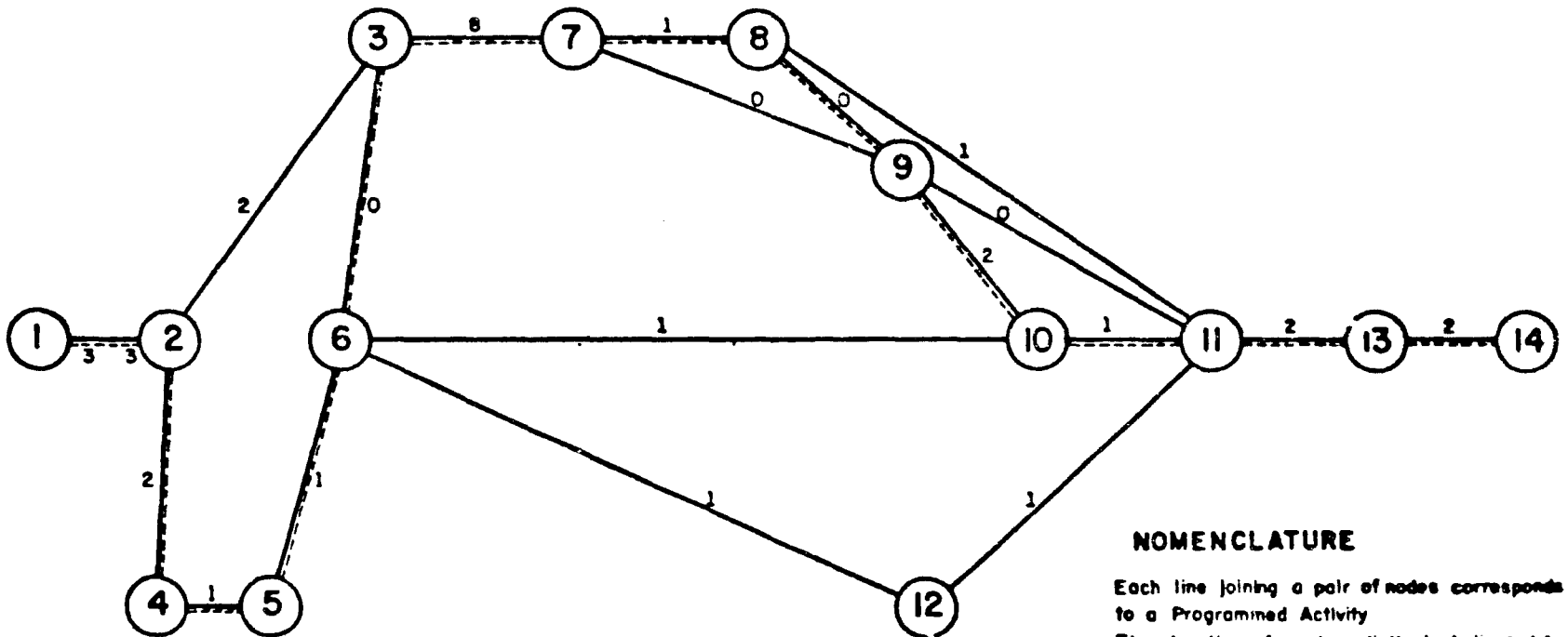
OPTA will initially contract the additional personnel. This has two major advantages: a) the time frame for budgeting and hiring direct hire employeescan be greatly compressed; and b) employees on contract can be easely replaced should they not be effective, an option not readily available in the case of direct hire employees. After two to three years all OPTA contract employees will be converted to direct hire status. During the same time frame the AID contribution to salaries will be progressively reduced to zero.

OPTA will contract the following additional personnel to implement the proposed project:

1) Two electrical engineers.
2) Four civil engineers.
3) One geologist.
4) Two economists.
5) One environmental scientist.
6) Eight promotores (50% AID financing).
7) Four maintenance mechanics (50% AID financing).
8) One topographer.
9) Two draftsmen.
10) Various support personnel i.e. drivers, secretaries, etc.

The costs for contracting the above professionals is included as the GOP counterpart contribution in the financial tables in the previous section.

TABLE 27 | FEASIBILITY STUDY PERT FLOW CHART



NOMENCLATURE

Each line joining a pair of nodes corresponds to a Programmed Activity

The duration of each activity is indicated by the lone number on each line

(e.g. the SHPP system costing is represented by line 9-10 and will require 2 man weeks)

The hash line indicates the critical path.

See also table 7.7

There are still other types of units for specialized applications such as the Ossberger Cross Flow Turbine or the Straflow Turbine. These units and others, however, are manufactured in the developed countries. Only a small number of companies are engaged in supplying and installing equipment but there are efforts underway to develop standardized units of the off-the-shelf variety. Development of a manufacturing capability within Peru would surely accelerate implementation of SDH.

For AC baseload plants which are completely independent of an existing grid, a synchronous generator is required. Whether a 50 or 60 cycle system, the speed of the generator must be constant and a speed increaser may be required so the generator can run at its design speed.

Another possibility is to generate DC current and convert it to AC via an inverter. A DC system is not sensitive to speed, therefore needs no governor.

For systems with no storage capacity, energy dissipating load control is required. Generally, if connected to a grid, excess power may be sold to the network and bought back when local demand exceeds supply. If there is no grid connection, excess power can be converted into heat and used in a process heat application.

During the electro-mechanical system development phase, technical and economic decisions will be made regarding a suitable design for the proposed site.

TABLE 27A - EXTRA INFORMATION FOR THE FEASIBILITY STUDY PERT FLOW CHART

CODE	Activity - Description	Professional Level of Effort (Man-weeks)
1-2	Prefeasibility Study	3
2-3	Characterization of the Site and Existing Facilities	2
2-4	Community Field Survey	2
3-7	Detailed Engineering Design	8
4-5	Community Profile Determination	1
5-6	Demand/Load Forecast	1
6-10	Economic Benefits Calculation	1
6-12	Immediate Social Impacts	1
7-8	Environmental Impacts	1
8-11	Environmental Analysis	1
9-10	SHPP System Costing	1
10-11	Economic Analysis	1
11-13	Project Implementation Plan	2
12-13	Long-Term Social Benefits	1
13-14	Final Report Preparation	2

N.B. Activities with zero effort are not shown. They are included in the PERT chart merely as information conduits.

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It consists of the following steps (See Table 27 and Table 27A).

a) Socio-economic demand profile

The socio-economic demand profile chapter provides the guidelines for the determination of the potential energy demand, income distribution effect of electrification, and cost savings potential in the community to be served by SHPP, based on public facilities, productive activities, community energy use, family time allocation and community structure surveys. Special studies will be undertaken of the communities ability to purchase electricity using domestic and productive appliances and equipment so as to avoid investments in communities where only a few can afford to hook up even though many would save current expenses by doing so. This assessment is also based on the community's population profile, its interaction with its milieu, and its social dynamics. The demand profile for household, public and productive uses will be estimated for the life of the Project.

b) Technical Analysis

The technical analysis consists of three major activities: 1) description of the site characteristics and existing facilities, 2) engineering design and 3) assessment of the environmental impacts.

The site characteristics and existing facilities description includes: 1) the location and accessibility of the site as well as on the characteristics of the river basin, 2) existing electrical service, 3) area hydrology, 4) area geology and 5) area topography; 6) generation of the flow duration curve and 7) the calculation of the prognosticated supply potential.

The project engineering description section includes the 1) site preparation, 2) the intake structure, 3) the canal/penstock, 4) the powerhouse, 5) the turbine generator, 6) the switch-yard, 7) other mechanical and electrical equipment and the distribution system.

The feasibility study of each site for a small hydroelectric power plant will include an environmental assessment that will be conducted by the Agency of the GOP that has the necessary capabilities in this field, namely la Oficina Nacional de Estudios de los Recursos Naturales (ONERN).

The environmental assessment will detail the impact of all physical actions related to the construction of the SHPP on the locale's ecology including flora and fauna. In particular the following effects will be detailed:

- Potential impacts on migratory fish populations due to small changes in streamflow, temperature and other parameters and due to blasting activities.

- Impacts of sedimentation at the sandtrap and forebay.

- Potential impacts of access road and transmission line construction on wildlife habitats.

- Potential health impacts of impoundment construction such as breeding ground for schistomatiosis.

Measures to minimize the environmental impacts should be detailed where pertinent. Examples of such actions are:

- fish ladders to provide upward mobility for fish
- judicious planting of trees in the vicinity of the powerhouse to minimize the effects of soil erosion.

c) Costing Analysis

The costing analysis provides guidelines on how to calculate direct costs (i.e. civil engineering, electro-mechanical and other costs), and indirect costs as well as operating and maintenance costs.

d) Economic Analysis

The economic analysis chapter indicates the procedure to calculate the Benefit/Cost ratio. The economic analysis synthezises the findings of the demand load profile, the engineering design and the costing analysis. The section consists of three parts: 1) the calculation of the sub-project's economic benefits, which includes the revenue from the sale of electricity and the surplus benefits due to cost savings and added productivity in income generating activities resulting from the introduction of electricity; 2) total cost calculations, and 3) an economic evaluation of the Project.

e) Social Analysis

The social analysis chapter underlines the criteria for analyzing the immediate and potential impacts of electrification by SHPP on the community's household, public and productive sectors.

D. Feasibility Study Summary

Two sites where OPTA plans to install SHPPs were randomly selected in order to conduct feasibility studies according to the Feasibility Study Methodology described above. The only criteria imposed on the selection of sites was that one site be located in the High Jungle and the other in the Sierra.

Tabalosos Project: The Tabalosos Project is located on Polopunta Creek, (a tributary of the Mayo River) about 2 Kms from the village of Tabalosos in the Department of San Martin. The Project would have an eventual installed capacity of 560 KW and, at full production level, would produce about 238 MWh in an average year. The Project area contains an estimated 1833 families, 84% of the employed workers are dedicated to agriculture, producing mainly coffee, tea, sugar cane and fruits.

The Project consists of intake structure, penstock, power-station and transmission and distribution lines. Water will pass through a 0.5 meters

diameter penstock, 392 meters long. The power-station will be of standard design and built of concrete. It will contain two Horizontal Axis Pelton turbines, one installed now and the second installed later; each turbine will be coupled to a generator rated at 280 KW. Power from the project will be transmitted to the villages of Tabalosos, San Miguel, Shanao and Pinto Recodo over 10.0 KW transmission line, 13.5 Kms. in length.

The construction costs of the Project include the direct costs of the civil works, contractors administrative costs, contingencies, and profit, national taxes, purchase and installation of equipment, of ELECTROPERU's engineering, design, management and contingencies cost. The estimated cost of the project, at Augusut 1980 price levels is $793,000. Annual operation and maintenance costs are $15,256.

A study of the potential environmental impacts of the Project shows that there are no deleterious environmental impacts.

The economic analysis of the Project indicates that at a 15% discount rate, the Project is feasible. The Sensitivity Analysis produced the following results:

	Sensitivity Analysis B/C Tabalosos		
Price/KWH	2.5¢	3 ¢	3.5¢
B/C	1.02	1.22	1.42
Surplus Benefits	100%	100%	100%

Namora Project: The Namora Project is located about three kilometers from the village of Namora, in the Department of Cajamarca. It uses waters that are taken from the Namora River. The Project would have an installed capacity of 170 KW and, at full production level, would produce about 380 MWh in an average year.

The Project area contain an estimated 25000 families, 70 of the employed workers are dedicated to agriculture, producing mainly potatoes, corn and barley and raising primarily cattle and sheep.

The Project consists of intake structure, penstock, power-station and a transmission line. Water will pass through a two food diameter penstock 83 meters long. The power-station will be of standard design and built of concrete. It will contain two Francis Horizontal Axis Turbines; each turbine will be coupled to a generator rated at 85 KW. Power from the Project will be transmitted to the villages of Namora and Marara over 10.0 KV trasmission line, 25 Kms. in length.

The construction costs of the Project include the direct costs of the civil works, contractors administrative costs, contigencies and profit, national taxes, purchase and installation of equipment, and ELECTROPERU's engineering, design, management and contingencies costs. The estimated cost of the Prject, at August 1980 price levels is $421,000. Annual operation and maintenance costs come to $9,671.

A study of the potential environmental impacts of the Project shows that there are no deleterious environmental impacts.

Eht Economic Analysis of the Project indicated that a 15% discount rate, the B/C ratios is 0.34. The Sensitivity Analysis produced the following results:

Base Case	Price / KWH		Surplus		Benefits	
2 ¢ KWH	2.5 ¢	3 ¢	(3¢)	200%	(3¢)	300%
0.34	0.42	0.48	0.72		0.98	

The results of the above two studies indicate that, on economic grounds, one of the sites is not appropriate for SHPP installation.

The results from these two studies serve to underline the need to perform reconnaissance pre-feasibility studies to prioritize SHPP sites, before undertaking feasibility studies in order to reduce the probability of inappropriate sites being subjectd to more rigorous and expensive feasibility analysis. Both the Mission and the GTZ have recognized this need and have accordingly, designed measures to address the problem.

VII. ECONOMIC ANALYSIS

A. Introduction

The efficiency of decentralized SHPP as a source of energy for hundreds of small towns in the Peruvian highlands and Ceja de Selva is attributed to the isolation of the towns which makes grid interconnection unfeasible and thereby autogeneration attractive, the poorly developed road network which increases the costs and decreases the reliability of fuel supplies for diesel plants, the sharp increases in the price of oil which makes the planned average size hydro installation lower in total discounted costs relative to the diesel option, and the existence of an in-situ renewable energy resource which can be tapped by a fully developed technology. Additionally, a SHPP has a built-in check against inflation because of the low operation and maintenance costs involved. The implementation of hydro technology may also contribute increasingly to the generation of foreign exchange since an equivalent average size diesel plant would utilize approximately 1700 barrels/year.

The consideration noted above support the implementation of specific technology as a means of providing electrical energy. The economic justification for the Project is based on the cost and benefit calculations given below on the program as a whole and on the cost effectiveness of SHPP versus diesel, the major alternative source of electricity.

The goal of improving the quality of rural life is related to an improvement of the production capacity of rural areas. This can be accomplished by increasing the efficiency of the productive apparatus and/or by increasing the availability of factors of production. Efficient production (a resource allocation optimization problem) is generally limited by its effective constraint, be it labor, capital, technology or management. An adequate supply of low cost, reliable and continuous energy is a necessary, though not a sufficient, condition for efficient production, required for the realization of the Mission's strategy in Sierra Social Programs and High Jungle Economic Growth.

The remainder of this section develops the economic analysis of the Project, based on benefit-cost models. The objective is to review and analyze the cost of program implementation as well as the benefit stream accruing to the provision of continuous and dependable electric power. The Project's benefit stream is a function of the social rate alternatively of the opportunity shadow rate for urban consumers, surplus benefits and/or resource savings. The economic costs of the program are defined as the stream of values required to produce the hydroelectric power, which include the following: construction and capital costs, engineering desing, technical assistance, training, O & M, and other related costs required to keep the plants in service and strengthen OPTA's program.

B. Cost Effectivenes: SHPP vs. Diesel Generation

A hypothetical cost comparison between a small hydro plant and an equivalent 200 KW diesel plant is based on a potential site in Laramate. The cost figures used are from a preliminary study conducted in early 1979. The following illustrates the cost aggregates for the two options.

CONSTRUCTION AND OPERATING COSTS (200 KW CAPACITY PLANTS)

Option	Fixed Costs	Operating Costs	Plant Life	13%	17%
Hydro	$225,661	$ 3,385	30 years	$251,034	$245,393
Diesel	$ 44,000	$43,936	20 years	$352,639	$291,262

Fixed costs for the hydro option include civil works, penstock, electro-mechanical equipment, 10% for engineering and administration and 10% for contingencies; operating costs include operating and maintenance costs. Fixed costs for the diesel option include the diesel motor and civil works; operating costs (assuming 3,000 hrs/yr. of operation, or a total annual energy production of 600,000 KWh) include diesel fuel, transport, lubricants, maintenance and operation. In terms of cost components, a diesel installation has lower investment costs and higher operating costs relative to an equal capacity hydro installation. In order to compare the costs of each alternative, the present discounted cost of each was calculated utilizing discount rates of 13%, 17% (see last two columns above). This analysis indicates that the most economic option is the hydro installation. The hydro option becomes even more attractive when the useful life of the two options is considered. Since benefits to be gained are presumably not affected by the kind of generator used, we can conclude that the hydro option is preferred over diesel.

C. Benefits and Costs

SHPPs are intended to serve both economic and social aims. In evaluating the economics of the Project, it will be useful to consider these two aims individually so that each can be separately assessed. The proposed method for calculating the benefit-cost of the program includes only the types of benefits that are readily quantifiable. The non-quantifiable benefits will be assessed at a later stage.

The minimum amount of benefits related to an electrification program can be measured by the amount of revenue collected from the customers. Generally, however, total benefits are in excess of the minimum amount which is paid for electricity. This is because:

a) Electricity is cheaper than alternative sources of energy.

b) Electricity is of superior quality to the alternatives.

c) **Electricity makes possible new and extra activities.**

As such, total benefits equals the amount paid for the consumer for electrical inputs plus surplus benefits. Surplus benefits consist of one or more of the following:

a) Cost savings relative to the alternative source of energy.

b) The value of difference in quality.

c) The value of any extra output or activity generated by lower costs and or a change in quality.

Based on this approach, the total economic benefits of each project will be equal to gross power sales, plus the surplus benefit associated with:

- residential, commercial and public lighting
- provision of municipal services dependent on electricity
- the use of electric motors compared to diesel engines

There is no doubt that such surplus benefits, associated with the availability and the reliability of electric power, do exist. On the basis of the relative cost of kerosene and electricity, and the degree of illumination obtained from electric light (see Cost Savings Analysis), it is reasonable to assume that the surplus benefit of electricity for residential costumers is at least equal to the minimum benefit measured in terms of the revenue derived from that group of beneficiaries.* We therefore assume that the surplus benefits will be equal (100%) to the amount of revenue to be collected from power sales; consequently the benefit-cost analysis will include such surplus benefit calculations at both pre-feasibility and feasibility study stages until a more precise estimate can be obtained. An economist will be contracted early in the first year of the Project to work specifically on this problem.

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* Residential Lighting Cost Savings Analysis:

Illumination Factor 1/		: 1 KWH - 2.08 liters of kerosene
Cost of fuel (kerosene)		: 2 ¢ per liter
HH lighting/HH electric consumption		: 0.60
Average yearly usage per HH		: 555 KWH
HH lighting factor		: 555 x 0.60 = 333 KWH
or		: 333 x 2.08 = 692 liters
Summary:	annual fuel costs	$13.84
	capital costs (annualized)	$12.60
	replacement and parts	$10.00
	sub-total	$36.44
	lighting costs: 333 x .025	$ 8.32
	housewiring (annualized)	$12.13
	replacements	$ 5.00
	sub-total	$25.45
	Net Cost Savings	$10.99

1/ Source: NRECA-IPD, Washington, D.C.

It is assumed that electricity will generally be preferred over other types of energy even if it costs more, because of quality difference. The value of this difference, however, is difficult to determine. Clearly the additional amount of lighting associated with the use of electricity represents part of the surplus benefit. Although this surplus benefit is difficult to quantify, the additional lighting hours and higher degree of illumination represent an improvement in the standard of living of the rural households. In most cases this also implies that school age children will read with more comfort and for longer hours (i.e. surplus benefits as a result of education). For some households this will also mean extra working hours, and hence more income from handicrafts, repairshops and other productive activities (i.e. surplus benefits as a result of increased family income).

Based on the general level of income of the rural areas of Peru, and the economic prospects of the three departments, it is most likely that electric appliances and electric tools will be used after electrification. Therefore, the most immediate change in the village will be substituting of electric bulbs for candles and kerosene lamps, with a resultant increase in labor productivity.

D. Economic Evaluation

The economic evaluation includes the economic benefits associated with both power sales and assumed surplus benefits; costs used are those associated with supplying the power and strengthening OPTA' SHPP program. To evaluate the desirability of the SHPP Program, the expected benefits will be compared to the expected costs. Future benefits and costs of the program are discounted to give the present values. The benefit and cost streams are calculated over a 25 year period. Twenty-five years is used as a conservative estimate for the purposes of this analysis, experience indicates that SHPP's last for 30 years or more.

The following additional assumptions are made in order to calculate the economic returns of the program. Total operating and maintenance costs (O & M) will be equivalent to 1.5% of total capital investments per annum during the operating life of the program, the economic value or benefit per KWh sold for all plants which will be 2.5¢ (shadow retail rate); energy sales will increase at 12% per annum up to year 10; and surplus benefits will be measured at 100% the value of revenue to be collected from power sales.

Based on the assumptions discussed in the preceeding pages of the Section and the data summarized in Table 32, Table 28 indicates the estimated annual benefits at 2 ¢/KWh, Table 29 indicates the estimated annual benefits at 2.5/KWh, Table 30 presents the estimated annual costs of the Project and Table 31 presents the results of the benefit cost calculations.

The rate schedule will be simple, so that explanation to the consumer will be easy. A minimum bill (i.e. 46 KWH/month) per household will be recommended. Currently, ELECTROPERU delegates all billing and collection to its regional offices.

Meters for residential connection are not included in the costs of the program because of the high costs of each unit (approx. $120) compared to the per capita cost of the whole program ($55); instead "limitadores" or low camp fuses will be installed in each household and commercial unit, thus

TABLE 28

ESTIMATED ANNUAL BENEFITS
(In thousands of $)

Year	Energy SAles	Surplus Benefits	Total Benefits	P.W. * 15%
1	-	-	-	-
2		-	-	-
3	168	168	336	221
4	356	356	712	407
5	544	544	1088	541
6	648	648	1296	560
7	726	726	1452	546
8	813	813	1624	532
9	910	910	1820	517
10	1019	1010	2020	499
11	1019	1019	2038	438
12	1019	1019	2038	381
13	1019	1019	2038	324
14	1019	1019	2038	287
15	1019	1019	2038	255
16	1019	1019	2038	218
17	1019	1019	2038	190
18	1019	1019	2038	165
19	1019	1019	2038	143
20	1019	1019	2038	124
21	1019	1019	2038	108
22	1019	1019	2038	94
23	1019	1019	2038	82
24	1019	1019	2038	71
25	1019	1019	2038	61

* Total P.W. Benefits: 6,764

TABLE 29

SHADOW RETAIL RATE BENEFITS
(In thousands of $)

Year	Energy Sales	Surplus Benefits	Total Benefits	P.W. 1/ 15%
1	-	-	-	-
2	-	-	-	-
3	210	210	420	276
4	445	495	890	509
5	680	680	1360	676
6	810	810	1620	700
7	907	907	1814	682
8	1015	1015	2030	664
9	1137	1137	2274	646
10	1273	1273	2546	629
11	1425	1425	2856	613
12	1596	1596	3192	598
13	1596	1596	3192	536
14	1596	1596	3192	450
15	1596	1596	3192	399
16	1596	1596	3192	341
17	1596	1596	3192	292
18	1596	1596	3192	259
19	1596	1596	3192	223
20	1596	1596	3192	195
21	1596	1596	3192	169
22	1596	1596	3192	147
23	1596	1596	3192	128
24	1596	1596	3192	112
25	1596	1596	3192	96

1/ Total P.W. Shadow Benefits: 9,345

TABLE 3

ESTIMATED ANNUAL COSTS 4/

(In thousands $)

YEAR	CAPITAL COSTS 3/	COUNTERPART COSTS 1/	TOTAL COSTS	P.W. (15%) 2/
1	590	400	990	861
2	2560	750	3310	2502
3	3060	1445	4505	2964
4	2060	1060	3120	1785
5	1030	745	1775	882
6	-	-	-	-
7	-	-	-	-
"				
"				
"				
25				

1/ Includes O&M costs

2/ Total P.W. costs: 8,994

3/ 30% of Grant funds are attributed as direct cost to the sub-projects financed by the loan.

4/ These figures are derived from Table 7.
Costs which are based on actual costs of a 200 KWH plant, just completed by ELECTROPERU. Since costs/KWH declines as plants become longer this represents a conservative estimate of costs.

TABLE 31 IRR CALCULATION

YEAR	Total Costs	Total Benefits	Net Annual Benefits	P.W. 18%	P. W. 17%
1	1200	--	(1200)	(1016)	(1026)
2	3450	--	(3450)	(2477)	(2522)
3	4645	445	(4200)	(2558)	(2642)
4	3260	918	(2342)	(1208)	(1250)
5	1860	1417	(443)	(194)	(202)
6		1708	1708	633	666
7		1921	1921	603	640
8		2152	2152	572	613
9		2410	2410	543	586
10		2699	2699	515	561
11		3022	3022	489	538
12		3384	3384	464	514
13		3598	3598	418	468
14		3838	3838	378	426
15		4107	4107	342	390
16		4408	4408	312	357
17		4745	4745	285	327
18		5122	5122	260	302
19		5545	5545	231	283
20		6019	6019	219	259
21		6019	6019	236	223
22		6019	6019	158	193
23		6019	6019	133	163
24		6019	6019	113	138
25		6019	6019	96	120
Net:				(463)	124

IRR = 17.21%

increasing the probability of a large percentage of hook-ups. 1/

As the system matures, increasing average consumption and diversifying trade, farming and other productive activities in the area, there will be a need to review the tariff and its relevance to an improved consumer classification.

Technical Data

Average Plant Size:	300 KW
Estimated Annual Energy Generation per Plant:	1,050,000 KWh
Average Cost per Plant:	$400,000
Total No. of Plants	28

Estimated Installed Capacity

	INC.	CUM.
8 Plants at end of Year 2	2,400 Kw	2,400 Kw
16 Plants at end of Year 3	2,400 Kw	4,800 Kw
24 Plants at end of Year 4	2,400 Kw	7,200 Kw
29 Plants at end of Year 5	1,200 Kw	8,400 Kw

Estimated Annual Energy Generation (At 40% load factor)

Year	
3	8,400.000 Kwh
4	16,800.000 Kwh
5	25,200,000 Kwh
6	29,400.000 Kwh

SOURCE: PFS Methodology NRECA-AID, Lima 1980

Shadow Pricing:2/ Benefit/cost ratios are calculated using the 2 ¢ per Kwh social (subsidized) rate and 2.5 ¢ per Kwh shadow rate (the rate for urban households) representing the market or real price for Kwh. The economic analysis utilizing the shadow rate gives a better approximatior of the returns generated by the program, from a national perspective.

Results of Table 31 Benefit Costs Analysis:

a) 0.75 at 2 ¢ per Kwh
b) 1.04 at 2.5 ¢ per Kwh

The ratios compare the present value of future cash revenues to the present value of the original capital costs and all other costs incurred during the give year program along with O & M costs. (See Financial Analysis).

1/ For the discussion of the equity advantages of flat metered charges, see AID J. Tendler's paper.

2/ Following the completion of this analysis the Peruvian government increased the electrical tariff such that 2.5 ¢ Kwh shadow price is approximately equal to the actual price. A real shadow price would be in the range of 3.5 - 4¢ Kwh.

Under alternative b (B/C = 1.04) the program can be considered economically feasible.

E. Section 611 (b) Compliance

Section 101 of the Foreign Assistance and Related Programs Appropriations Act, 1979, requires that A.I.D. apply to certain water and related land resource construction projects that it supports, the standards and criteria used in determining the feasibility of similar, federally funded projects in the United States. Section 611(b) of the FAA, as amended, requires the application, insofar as practicable of the Principles and Standards (1973) of the Water Resources Council.

The Mission will ensure that these requirements are met in substance. The cost-benefit analyses to be prepared for all sub-projects which involve contruction will show discounted total benefits greater than discounted total costs. The form and result of these analyses will constitute accomplishment of the substantive economic analysis requirements of Section 611(b). In addition, the two feasibility studies performed as part of the intensive review demonstrate ELECTROPERU's capability to use the sub-project methodology incorporated in this PP. Environmental considerations in project concept and general design have been addressed in the Initial Environmental Examination and will be fully integrated in the detailed planning and implementation of sub-project construction activities. This will constitute fulfillment of the substance of the environmental concerns portion of Principles and Standards.

The Mission concludes that adherence to the sub-project analysis methodology will ensure that the principles embodied in the applicable legislation will be met for each sub-project.

TABLE 32

DATA SUMMARY

1.	Total Costs (including Grant)	$14,400.000
2.	% of GOP Contribution	31
3.	% of AID total funding	69
4.	No. of potential beneficiaries	265,000
5.	No. of estimated HH connections	53,000
6.	Per capita costs of the Program	$ 55
7.	No. of SHPP's	28
8.	Estimated installed capacity	8,400 KW
9.	Estimated annual generation	29,400,000 KWh
10.	Cost per KW of installed capacity	$1,723
11.	Average HH consumption per year	555 KWh
12.	Average cost per Pre-feasibility Study (80 sites)	$2,500
13.	Average cost per Feasibility Study (Approx. 35 sites)	$14,286

VIII SOCIAL ANALYSIS

This Chapter presents some elements for the discernment of the social impacts of electrification by the SHPP Program.

a) An overview of the spatial distribution of Peru's population.

b) A description of rural energy consumption pattern.

c) An assessment of the impact of:
   i) household use of electricity
   ii) public use of electricity
   iii) the role of women

d) General considerations for the promotion of the productive uses of electricity in the service communities.

A. Spatial Distribution of the Population of Peru

The population of Peru is irregularly distributed throughout the territory, with a strong migratory flux toward the cities of greater economic growth located on the Coastal region. (Tables 33 and 34).

The unchecked growth of cities causes the unbalanced development of the terciary sector and the under-utilization of human resources, reflected in low incomes in the urban sector. One of the immediate effects of the pauperization of the cities is the overcrowding of marginal population around cities-which offer public services in the areas of health, schools, housing, electricity, potable water and drainage facilities. These services are available to a minimal proportion of the rural population.

Only 1/4 of the total population of Peru has electricity, 60% of the consumers of electricity reside in Lima Metropolitan Area.

B. Rural Energy Consumption Patterns

According to the results of the Project "Balance Nacional de Energía"[1/], energy consumption in the rural areas is in traditional fuels such as firewood, dung, and agricultural waste. Coal utilization is on the decline. Commercial fuels such as kerosene and liquified natural gas are in greater demand, particularly for cooking purposes. (See Table 35).

Traditional energy supply and demand patterns are frequently integrated into complicated agricultural and socio-economic systems.

1/ Ministerio de Energía y Minas - Programa de Naciones Unidas para el Desarrollo, Lima, 1978.

In many agrarian ecosystems, almost no agricultural product is wasted (not being put to some productive use) and fuel is produced either jointly or as an alternative to other valid outputs. In the transition from traditional to modern land tenure systems, fuel-collection rights are sometimes lost. Fuel gathering is typically women's work, and women are generally responsible-for using it in cooking.

In many areas of the Peruvian jungle, forests are being depleted as a result of land-clearing for agricultural purposes. This can lead not only to the use of dung and crop residues to meet basic energy needs, but also to shortages of wood for other essential purposes (e.g. housing). In some areas of the high jungle, potential environmental damages of this nature compromise the soil and water resources on which future food production depends.

Fuel gathering is an important contributor to deforestation, but clearing of land for agricultural purposes and animal grazing are at least as important. Whatever the causes, deforestation forces the rural population to spend as much as 25% of its time and/or income obtaining fuel for cooking. (Hughart, p. 5).

Fuel scarcity can affect agricultural productivity by forcing people to stop using animal dung and crop residues as fertilizers and soil conditioners. In some areas this is yet of minor importance, (i.e. in the Ceja de Selva) while in areas where the soil is poor it reduces productivity markedly. (i.e. the Sierra).

The magnitude of these environmental costs is not known with any precision, but we do know that they are serious and that the increasing pressure of population on resources will prevent the continuation of centuries-old fuel gathering and usage practices. At the current rate of deforestation, the tropical forests of developing countries, (which now cover half of their aggregate land areas), would disappear in about 60 years. (Hughart, p. 5-6).

C. Assessment of the Impact of Electrification by SHPP

The SHPP program attempts to bring electricity to isolated rural communities in the country. The AID sponsored program is concentrated in the departments of Junin, Cajamarca (Sierra) and San Martin (Ceja de Selva).

The SHPP program recognizes the fact that the lack of a reliable and inexpensive energy source is a deterrent to the development of the productive capacity of the population, and fulfills the needs for energy of an increasing population in a context of rising international oil prices.

Projects and programs to designed the supply of and decrease the demand for woodfuels (firewood and charcoal) are especially important in the mountainous catchment areas of agriculturally important river basins (like the Ceja de Selva) and in arid and semi-arid zones. (i.e. the Sierra).

An energy source that permits the utilization of modern technology at low monetary and environmental cost is necessary to upgrade productivity and living standards of the rural population. Hence, the SHPP program is expected to have an impact on practically every facet of the lives of the beneficiaries.

Even though electricity is not a need in itself, population growth and modernization virtually require the use of electricity and mechanical energy.

Previous rural electrification experience has shown that its first impact is in the substitution of kerosene and candles for electric light. Electric lighting is more efficient, of superior quality, less expensive and has no pollution effects on small enclosed rooms, especially during the cold season. Better lighting provides more hours in the day for working and studying. This is true for both private and public uses.

But electricity is more than light bulbs. Electricity provides the high quality energy source necessary to power machines. It facilitates the introduction of the technologies that upgrade output in quality and quantity in less production time.

i) Productive Uses of Electricity

In the rural areas of Peru, agriculture is the main economic activity of almost all of the population. Land scarcity, anticuated means of production and a high rate of population growth in a context of unfavorable rural/urban income distribution place the campesino in a situation of endemic poverty. This situation necessitates technical innovation to improve on-farm productivity and off-farm employment creation in order to improve the standards of living of the rural population and stem rural exodus.

On-farm irrigation extends the farming season and also allows for intensification of farming practices to such crops as vegetables. Electricity can be used to power irrigation pumps at a lower cost than thermal operated plants. Mills and grinders can prepare animal food. Poultry farms can be illuminated and heated with electricity. Perishables can be stored in refrigerated chambers.

On those farms where animal and agricultural waste is being used for heating and cooking, electrical appliances could allow them to be reallocated to fertilize the soil. Where the vegetative cover is depleted in search for fuelwoods, new cooking fuels would reduce danger of soil erosion.

The possibility of milk refrigeration and processing plants in the community increase the farmer's possible sources of income and jobs, and, potentially increase animal protein consumption in the community.

Non-agricultural productive uses of electricity provide farmers with an alternative to farming and lowers their dependence on fluctuating market prices. They do require varying degrees of skills and availability of financing the operation and purchase of appropriate machinery.

The introduction of machinery will facilitate the initiation of agroindustrial activities (e.g. saw mills, canneries, mills and silos, meat processing, fruit preserving).

Small business development would be encouraged through longer operating hours and electrical equipment for bakeries, retail and wholesale shops, ice making, gas pumps, brick making and others.

The work and productivity of tradesmen (like lumberjacks, carpenters, welders, mechanics, electricians, weavers, seamstresses, tailors, shoemakers, leather tanners, butchers) will be improved with the utilization of electric tools. Their work will also become less strenuous.

Hotels, restaurants, market kitchens will benefit from higher quality lighting.

A training component must be integrated to the SHPP Program to advice the community on how to use their resources, provide pertinent information on appropriate technology marketing, distribution and financing possibilities for the implementation of the community's projects.

ii) Household Use of Electricity

Household activities account for the largest share of the demand for traditional energy in rural areas. Initially electricity will be used to substitute kerosene and candles, mainly for lighting purposes. Lighting augments the time and nature of activities that can be performed in the household, e.g. reading for educational and entertainment purposes, and food and textiles production for household consumption and income generation.

Electricity also allows the substitution of traditional technologies for electrical appliances which save time and effort in the performance of domestic duties. The chief use of energy at the basic needs level is for cooking (including the boiling of water, baking and brewing of beverages). Local and regional problems in the supply of traditional cooking fuels (firewood, dung, crop residues, charcoal) as explained above have increased their cost in time and cash for Peru's rural population.

iii) Public Uses of Electricity

The availability of electricity in the community will improve the living standard of the whole population. Electricity not only allows longer operating hours to public services but permits the electrification of storage, pumping, cooking devices at lower monetary and environmental cost.

Schools

The upgrading of lighting and lengthening of school's operating hours extend the reach of education facilities. The availability of electricity lighting improves conditions for the provision of evening classes. These are more accesible to community members who are occupied during the day. Hence, evening classes can be organized to impart formal or non-formal education for adult literacy classes, awareness courses in health, nutritional education, child care, and training in arts and crafts.

Health

Longer operating hours, improve the accessibility and effectiveness of health posts. The installation of electrical equipment such as refrigerators lengthen the life and effectiveness of many medications (e.g. antiofidicos).

Markets and Other Community Centers

Marketing facilities would be upgraded through lighting, as well as through the provision of electricity for cutting, storing, and refrigeration of perishables for butchers, dairy farmers, restaurants, etc.

The use of Community Centers, diners, store rooms, assembly halls, become more attractive with better lighting.

Public Lighting

The lighting of public places (parks, roads, streets) decreases the danger of accidents for pedestrians and drivers.

Rural Exodus

In addition, the attainment of improved living standards will not only stem rural exodus but attract some emigrants back to the rural community. This will alleviate crowding in urban housing and transportation, and return skilled and unskilled labor to the countryside.

iv) The Role of Women

Women in rural Peru assume and perform an important role in production and marketing. As household organizers, they determine the disposal of cash income (particularly in the Sierra where male migration is widespread), process the food, and perform the domestic chores.

As agricultural producers, a woman's contribution to the family's agricultural labor (e.g. sowing, harvesting) in the Department of San Martin is 60% that of the male head of household. She must also perform the domestic tasks (e.g. processing agricultural products) and prepare the mid-day meal in the field. In addition, she carries excess produce to local markets within the region. 1/

Electricity in the household will improve women's working conditions. They will be able to perform their domestic duties in an improved environment. If electric appliances are acquired, women will be able to make their tasks less burdensome. The utilization of time--saving devices will permit women to undertake and explore new activities (income generating, child development, training, education, leisure).

By processing foods women augment the value of their production, and can increase their income by marketing it.

Through the provision of credit and technical assistance women will contribute to the community's productive use of electricity.

1/ According to information on women in Tarapoto. AID P.P. Peru-Development of Sub-Tropical Lands, Ja. 31, 1978, p. 56.

Table 33

DISTRIBUTION OF THE POPULATION
(Census of 1940, 1961 and 1972)

YEAR	POPULATION			PERCENTAGE		
	TOTAL	URBAN	RURAL	TOTAL	URB.	RURAL
1972	13'538,208	8'058.495	5'479,713	100	59.6	40.4
1961	9'906,746	4'698.178	5'208,568	100	47.4	52.6
1940	6'207,967	2'197.133	4'010,834	100	35.4	64.6

SOURCE: Censos Nacionales de Población 1940, 1961, y 1972

Oficina Nacional de Estadísticas (ONE)

Table 34

DISTRIBUTION OF THE URBAN POPULATION ACCORDING TO SIZE OF CITIES

SIZE (THOUSANDS INHABITANTS)	NUMBER OF CITIES				PERCENTAGE OF CITIES			
	1940	1961		1972	1940	1961		1972
Less than 2							47	
2 - 2.5			75				1.2	
	176	242			45.6	29.2		
2.5 - 5.0			126				3.2	
5 - 20			110	311			7.8	23.1
20 - 100	1	23		27	23.2	21.6		14.0
100 - 1000	1	2		8	31.2	6.6		19.0
More than 1000	-	1		1	-	42.6		43.0

SOURCE: Oficina Nacional de Estadística (ONE)

Table 35

RURAL POPULATION COOKING FUELS CONSUMPTION

FUEL	1961 POPULATION	%	RURAL POPULATION 1972 POPULATION	%
Commercial Fuels:				
Electricity	6,659	0.1	7,873	0.1
Oil	3,577	-	-	-
Kerosene	354,858	7.0	434,473	8.0
Gas	4,582	-	23,866	0.4
Non specified*	116,802	2.3	9,497	0.2
SUB-TOTAL	486,478	9.5	475,709	8.9
Non-Commercial Fuels:				
Charcoal	46,161	0.9	-	-
Firewood	3'732,183	73.2	4'089,419	75.3
Dung and Agricultural Waste	834,857	16.4	868,494	16.0
SUB-TOTAL	4'613,801	90.5	4'957,913	91.2

* Includes dwellings without stoves

SOURCE: Balance Nacional de Energía

IX ENVIRONMENTAL ANALYSIS

The development of SHPP's will have different environmental implications for the two slopes of the country: the Pacific dry and the Atlantic wet.

The Atlantic slope is generally wetter as a more uniform rainfall distribution. It is sparsely populated; in many places colonization is only beginning to occur whereas in others vast lowland areas are still entirely uninhabited. The general environmental concerns of this portion of the country deal with the direction and quality of the colonization process into the hinterland as well as the correct intensification of agriculture in the fertile intermontane valleys.

To the degree that SHPP's are used to fortify the effort to establish stable and productive rural enterprises that will be conservative of the resource base, the environmental objectives of this Project will be met. Where SHPP's are put in areas of spontaneous colonization, where little or no control is exercised over proper resource use and management, and where land use capabilities are generally marginal, they will be doing a disfavor to the maintenance of environmental quality.

The dry Pacific slope is generally drier and characterized by a having a more marked wet-dry season. Where agriculture can occur it normally is dependant upon the use of irrigation. Since this portion of the country is in essence entirely developed, the problem is not one of directing land development, but rather the intensive use of the better agricultural lands to take pressure off the more marginal hilly uplands.

To the degree that SHPP's promote the intensification of rural industries and enterprises and improve the lot of small farmers without entering into conflict with more basic water supplies, they will be doing a service to rural development and at the same time promoting a better overall environmental quality.

The small hydroelectric power plant project will have several important benefits directly relatable to the environment. It will encourage the organization and advancement of the hydrometeorological data collection service of Peru, which is actually very deficient. The Project will permit ELECTROPERU to incorporate natural resource professionals into its organizational structure under OPTA, thereby giving them an environmental analysis capability. Spin Off effect will undoubtedly occur producing a more generalized environmental education benefit throughout other parts of the organization, perhaps even to the large scale hydropower projects division where currently environmental considerations aren't being adequately incorporated into the planning and development of works.

Finally, the rural populations affected by the SHPP's will receive some environmental education and technical training and will have the opportunity to manage and

The direct, environmental impacts of construction and operation of SHPP facilities funded by this program are expected to be relatively minor. Most SHPP's will be constructed on different streams, in widely scattered locations, and therefore will probably have no significant additive effect if each facility is found to be environmentally acceptable. If two or more SHPP facilities are to be developed on the same stream, special consideration should be given to the possibility of significant adverse environmental impacts.

Of greater significance to aquatic resources in the project area are indirect effects arising from the provision of electricity. Regional developments following electrification could include increases in the human population (either by promoting immigration or stemming emigration), agricultural (irrigation) activities, livestock production, and industries, any of which could have important consequences to the water and land use patterns in the region. Population increases in the regions served by SHPP electricity will create a greater demand for potable and/or irrigation water and water treatment. Small communities that presently have no drinking or waste water treatment facilities may encounter increasing problems with waterborne diseases as the population increases the ability of the environment to assimilate their wastes decreases. Similarly, increased need for irrigation water or food fishes may occur as an indirect result of rural electrification, and may add unacceptable stresses to limited resources. It is of great importance that different programs which affect land and water resources within a region be coordinated so that present on projected additive impacts can be identified and mitigated at an early stage in the planning process. See Annex I Exhibit F for a revised IEE.

X IMPLEMENTATION PLAN

A. Implementation Arrangements

The Project will be implemented over a five year period. The Loan Agreement will be signed by September 25, 1980. It is anticipated that the Conditions Precedent will be met three months after signing the loan agreement and ELECTROPERU will begin work on identifying a consultant firm to provide the required technical assistance during that period.

The role of USAID in Project implementation will be one of close coordination with the OPTA Project management; assisting the GOP in procurement and contracting activities and contracting for the final Project evaluation.

Monitoring will be excercized by a USAID Project Committee with the following responsibilities:

1. Project Management. The Project Manager for the Project will be assigned from the Mission's Capital Development Division of the Development Resources Office. The Project Manager will work closely with the OPTA Project Manager and the technical assistance contract team to ensure that provisions of the AID Project Agreement and Implementation letters are met. A member of the Mission's Engineering Office will work closely with the AID Project Manager during Project implementation.

2. Joint Annual Reviews. Joint annual reviews will be an essential feature of Project implementation. The reviews to be undertaken by AID and the GOP, will be carried out on three levels: a) an assessment of aggregate consequences over time; b) a review of the administrative structure and functioning of the small hydroelectric program; and c) an evaluation of the impact of the hydroelectric program on Project beneficiaries.

3. The Evaluation Officer from the Program Office will coordinate the annual evaluations.

4. The Mission Controller will review disbursement/reimbursement requests for conformity with A.I.D. regulations and will ensure that adequate financial controls are followed.

5. Additional Mission offices, such as the Executive Office and RLA, will be called upon as appropriate.

B. Reporting

The following reports will be required to assist the Mission in monitoring the Project:

1. A quarterly report from OPTA on activities and counterpart expenditures completed and projections of activities and counterpart expenditures for the next quarter.

2. OPTA will develop an annual implementation plan which will include a projection of project activities for the coming year in addition to an annual operating budget which will include inter-alia GOP counterpart allocation and A.I.D. local currency requirements.

3. An annual report from the consultant group on activities completed during the year and a proposed plan of activities for the coming year. Included in the annual report will be an assessment of the institutional status of small hydroelectric program.

C. Disbursement Procedures

No deviation from A.I.D. established disbursement procedures is anticipated. Materials and equipment procured in the United States or other Code 941 countries will be paid through A.I.D.'s standard letter of commitment/letter of credit procedure. Requests to open letters of commitment will contain appropriate certification that the items listed are required for the Project and are eligible for financing under the loan or grant. Disbursement for local currency costs will likewise be made in an established manner with OPTA.

Schedule of Major Events

Loan Agreement signed	9/80
CPS met	1/81
Contracting for technical assistance	3/81
Long term advisor and economist	5/81
Hiring local personnel	1/81
Prefeasibility study component begins	2/81
Feasibility study component begins on four sub-projects	6/81
Procurement specialist arrival	9/81
Construction activities begin on four sub-projects	10/81
Promotion campaign begins	10/81
Annual Evaluation	1/82
Maintenance program begins	10/82
Annual Evaluation	1/83
Annual Evaluation	1/84
Final impact evaluation	7/85
PACD-all Project activities completed	9/85

D. Procurement Procedures

ELECTROPERU will be the action agent for all procurement under the Project. Procurement is based on ELECTROPERU direct procurement for all materials requirements for contract as well as force account construction. ELECTROPERU has developed a capability for host country procurement through the many large hydroelectric projects it has previously implemented. Procurement of all goods and services will follow AID regulations with regard to source and origin and competitive bidding requirements. No procurement list is included due to the ICI design of the

Project. Each approved feasibility study will include a detailed set of specifications for goods and services to be procured under the Project. OPTA will utilize ELECTROPERU's procurement office to do all procurement. ELECTROPERU's procurement office has approximately 10 years of experience in the procurement for projects ranging from the mini hydro size to $200 million projects. ELECTROPERU will receive procurement assistance (grant-funded) starting as soon as the first set of feasibility studies are completed.

For the AID grant-funded technical assistance, host country contracts are envisioned. ELECTROPERU has both the capability and experience to develop, negotiate and implement host country contracts. An estimated 102 person/months of U.S. hosrt and long-term technical assistance is envisioned for the Project.

E. Evaluation Plan

Two types of evaluations will be carried out under the Project.

1. Yearly (Output Level) Progress Evaluations

OPTA and AID will hold a yearly progress evaluation in January of each year starting in 1982. OPTA's progress report for the preceeding quarter will be expanded to include an overall review of progress in implementing the Project. This report will serve as the basis for discussing the targets for output achievement vs. actual performance, timeliness of AID and GOP inputs; OPTA contracting procedures and AID approval processes; and, in general, any implementation problems that are affecting output achievements. In the later years of the project, these annual evaluations will monitor improvement in OPTA's institutional capability to continue to extend electrical service to rural areas as well as the completion of physical project outputs.

2. Impact Evaluation

a. State of the Art

The state of the art of impact evaluations of rural electrification programs was dealt with in some detail in a recent AID financed evaluation of NRECA activities.1/ That report distinguishes between Type I impact studies, which attempt to establish causality between rural electrification and evelopment objectives, and Type II impact studies which can be, "used to provide evidence of any positive changes among the target population which coincide with, but are not necessarily attributable to the introduction of rural electrification programs". Impact studies carried out to date have been Type II studies. As such they share the characteristics-negative and positive - noted on page 77 of DAI's report:"..(they provide) no measure of the magnitudes or levels of benefit and little potential for cost/benefit analysis; (but are sufficient to) suggest to reasonable men that rural electrification...(has)..positive benefits".

Evaluations planned as part of recently approved rural electrification programs are attempting to move closer towards the Type I analysis.

1/ Development Alternatives, Inc. An Evaluation of the Program Performance of the International Program Division of NRECA. Prepared under Contract No. AID/otr-c-1383, January, 1977.

b. Impact Evaluation Strategy

It is difficult, if not impossible, to try to design an evaluation strategy that will provide answers within the project implementation period to a broad range of questions about the impact of rural electrification and the causal links between it and increased incomes and well-being of AID's target group. Thus, DSB funded research may be more appropriate for further analyzing possible causal links between rural electrification and decreased birth rate, improved health, and rising incomes (or savings from current expenditure levels).

Accordingly, the project evaluation strategy will focus on a more limited objective: documenting and analysing the rate of adoption of electricity for productive purposes by low income rural residents and assessing the direct impact strategy.

c. Impact Evaluation Plan

Shortly after signature of the loan agreement, USAID will request from DSB the services of an evaluation specialist, to design an evaluation methodology for implementing the strategy, collection instruments and a data collection and storage process. The data collection process will be designed to fit into OPTA's normal operations to the maximum degree possible in order to minimize data collection costs. The evaluation specialist will train local personnel in the data collection procedures adopted.

OPTA will use its funds to finance local costs attendant to gathering baseline data such as income, present productive activities (farming, cottage industries, service sector occupations) production volume and processes, and intention to adopt electrification in the productive processes. As these data will be collected throughout the life of the project, the communities surveyed will have had electricity for from one to four years. The evaluation design will match these users against families that don't desire electricity and those who live in villages that will not be electrified under the program for control purposes. Comparisons also will be made with families who were OPTA customers before the project began.

Near the end of the project, AID will request the services of a firm specialized in evaluation to carry out the impact evaluation. This contract will involve a sample survey of users for varying periods of time, analysis of the data and preparation of the evaluation report.

ANNEXES

AGENCY FOR INTERNATIONAL DEVELOPMENT
UNITED STATES AID MISSION TO PERU
C/O AMERICAN EMBASSY
LIMA, 1 PERU

TELEPHONE 286200

CABLE. USAID/LIMA

ANNEX I
Exhibit A

CERTIFICATION PURSUANT TO SECTION 611(e) OF

THE FOREIGN ASSISTANCE ACT OF 1961, AS AMENDED

I, Leonard Yaeger, the principal officer of the Agency for International Development in Peru, having taken into account among other factors the maintenance and utilization of projects in Peru previously financed or assisted by the United States, do hereby certify that in my judgment Peru has both the financial capability and the human resources capability to effectively maintain and utilize the capital assistance project: Small Hydroelectric Development.

This judgment is based upon the implementation record of the previous projects implemented in Peru, and the quality of the planning which has gone into this new project.

Leonard Yaeger
Director, USAID/Peru

Date: September 4, 1980

"AÑO DE LOS LEGÍTIMOS CIUDADANOS"

MINISTERIO DE ECONOMIA Y FINANZAS

Lima, 04 SET 1980

OFICIO Nº 1449-80-EF/75.02

Señor
Leonard Yaeger
Director de la
Agencia para el Desarrollo
Internacional - AID -
Presente

Tengo el agrado de dirigirme a usted, con el objeto de elevar a su consideración una solicitud para el financiamiento parcial del Proyecto que hemos denominado "Desarrollo de Mini-Centrales Hidroeléctricas", mediante un préstamo de US$ 9'000,000.00 y una donación de US$ 1'000,000.00. El valor total del Proyecto asciende a - US$ 14'400,000.00 por lo que el Gobierno Peruano participará con fondos de contrapartida con la cantidad de US$ 4'400,000.00 o sea con el 31% del valor total del Proyecto. En lo que respecta al préstamo, consideramos que éste debe ser a largo plazo (mínimo de 25 años con 10 años de gracia) y con términos concesionales (2% de interés para el período de gracia y 3% durante el pago del principal).

En cuanto al contenido del Proyecto, debo señalar - que contempla la construcción de aproximadamente 29 plantas hidro-eléctricas ubicadas principalmente en los Departamentos de San Martín, Junín y Cajamarca, con rangos de potencia que oscilan entre los 100 y 1,000 kilowatts y con una capacidad de planta total de 8.4 M. Se estima que alrededor de 53,000 familias serán beneficiarios directos del Proyecto a un costo de US$ 55.00 por beneficiario. Como Agencia Ejecutora será designada ELECTROPERU, institución que cuenta con la responsabilidad y la capacidad para llevar adelante el Proyecto con la debida diligencia y eficiencia.

El Gobierno del Perú considera de primordial importancia la ejecución del Proyecto propuesto, el que constituye una alternativa óptima a las fuentes convencionales de generación de energía -

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eléctrica. El proyecto contribuirá al desarrollo socio-económico de las áreas rurales que se beneficiarían con la ejecución del mismo. Por lo tanto, solicitaría por su intermedio presentar a consideración de la Agencia para el Desarrollo Internacional la aprobación del financiamiento para el proyecto "Desarrollo de Mini-Centrales Hidroeléctricas".

Al anticiparle nuestro amplio interés en el referido proyecto y en espera de una resolución favorable a nuestra solicitud, hago propicia la oportunidad para reiterarle Señor Director, mi más distinguida consideración y estima.

Atentamente,

Manuel Ulloa Elías
Ministro de Economía, Finanzas y Comercio.

DRAFT PROJECT AUTHORIZATION

Name of Country/Entity: PERU

Name of Project: Small Hydro Development Project

Number of Project:

Number of Loan:

1. Pursuant to Section 103 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Small Hydro Development Project for Peru involving planned obligations of not to exceed $9 million United States Dollars in Loan funds and $1 million United States Dollars in Grant funds over a five year period from date of authorization, subject to availability of funds in accordance with the A.I.D. OYB/allotment process, to assist in financing foreign exchange and local currency costs for the Project.

2. The Project consists of institutionalizing the small hydroelectric program with ELECTROPERU through: (a) the carrying out of feasibility studies; (b) the installation of small-scale standardized hydroelectric installations, primarily in the 100 to 1000 kilowatt range; (c) training of target communities in the productive uses of electricity; (d) training of preventive maintenance mechanics for the small-scale, standardized hydroelectric installations; and (e) the provision of technical assistance to ELECTROPERU.

3. The Project Agreement, which may be negotiated and executed by the officers to whom such authority is delegated in accordance with A.I.D. regulations and Delegations of Authority, shall be subject to the following essential terms of covenants and major conditions, together with such other terms and conditions as A.I.D. may deem appropriate.

4. a. Interest Rate and Terms of Repayment

Peru shall repay the Loan to A.I.D. in U.S. Dollars within twenty-five (25) years from the date of first disbursement of the Loan, including

a grace period of not to exceed ten (10) years. Peru shall pay to A.I.D. in U.S. Dollars interest from the date of first disbursement of the Loan at the rate of (a) two percent (2%) per annum during the first ten (10) years, and (b) three percent (3%) per annum thereafter, on the outstanding disbursed balance of the Loan and on any due and unpaid interest accrued thereon.

b. Source and Origin of Goods and Services

Goods and services, except for ocean shipping, financed under the Loan portion of the Project shall have their source and origin in countries included in A.I.D. Geographic Code 941 or Peru, except as A.I.D. may otherwise agree in writing. Ocean shipping financed by A.I.D. under the Loan portion of the Project shall have its source and origin in the United States or Peru. Goods and services, except for ocean shipping, financed under the Grant portion of the Project shall have their source and origin in the United States or Peru, except as A.I.D. may otherwise agree in writing. Ocean shipping financed by A.I.D. under the Grant portion of the Project shall have its source in the United States.

c. Conditions Precedent to Initial Disbursement (Loan and Grant)

Prior to any disbursement, or the issuance of any commitment documents under the Project Agreement, for activities financed under either the Loan or Grant, Peru shall furnish, in form and substance satisfactory to A.I.D.:

1. Evidence of adoption by ELECTROPERU of methodologies acceptable to A.I.D. for carrying out pre-feasibility and feasibility studies for the construction of small-scale standardized hydroelectric installations under the Project.

2. Evidence that an official of ELECTROPERU has been named project manager for the Project.

d. Conditions Precedent to Initial Disbursement (Loan)

Prior to any disbursement or the issuance of any commitment documents under the Project Agreement, for activities financed under the Loan, Peru shall furnish, in form and substance satisfactory to A.I.D.:

1. A staffing plan for project activities for the Oficina de Tecnología Aplicada (OPTA) within ELECTROPERU.

2. A maintenance plan for the installations constructed under the Project.

3. A description of the campaign to promote the productive use of electricity.

4. A timed-phased plan describing the construction component of the Project.

e. Covenants

1. Peru covenants that pre-feasibility and feasibility studies for the construction of small-scale standardized hydroelectric installations will be carried out in the Departments of Cajamarca, Junin and San Martin, except as A.I.D. may agree otherwise in writing.

2. Peru covenants that except as A.I.D. may otherwise agree in writing, small-scale, standardized hydroelectric installations with a generative capacity outside the range between 100 kilowatts and 1000 kilowatts will not be financed under the Loan.

Assistant Administrator
for Latin American and
the Caribbean

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ANNEX I

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COUNTRY CHECKLIST

Listed below are, first, statutory criteria applicable generally to FAA funds, and then criteria applicable to individual fund sources: Development Assistance and Economic Support Fund.

A. GENERAL CRITERIA FOR COUNTRY ELIGIBILITY

1. FAA Sec. 116. Can it be demonstrated that contemplated assistance will directly benefit the needy? If not, has the Department of State determined that this government has engaged in a consistent pattern of gross violations of internationally recognized human rights?	The Department of State has not so determined.
2. FAA Sec. 481. Has it been determined that the government of recipient country has failed to take adequate steps to prevent narcotics drugs and other controlled substances (as defined by the Comprehensive Drug Abuse Prevention and Control Act of 1970) produced or processed, in whole or in part, in such country, or transported through such country, from being sold illegally within the jurisdiction of such country to U.S. Government personnel or their dependents, or from entering the United States unlawfully?	It has not been so determined. The GOP has an active narcotics control program with USG support.
3. FAA Sec. 620(b). If assistance is to a government, has the Secretary of State determined that it is not controlled by the International Communist movement?	The Secretary of State has so determined.
4. FAA Sec. 620(c). If assistance is to government, is the government liable as debtor or unconditional guarantor on any debt to a U.S. citizen for goods or services furnished or ordered where (a) such citizen has exhausted available legal remedies and (b) debt is not denied or contested by such government?	No such case is known.
5. FAA Sec. 620(e)(1). If assistance is to a government, has it (including government agencies or subdivisions) taken any action which has the effect of nationalizing, expropriating, or otherwise seizing ownership or control of property of U.S. citizens or entities beneficially owned by them without taking steps to discharge its obligations toward such citizens or entities?	The GOP is fully aware of USG requirements for prompt, adequate, and effective compensation regarding expropriation of US investments. To date there have been several expropriation claims settled to the satisfaction of both Governments, including Marcona Mining Company's claim in September 1976 and the recent Gulf Oil Corp. claim.

A. 6. FAA Sec.620(f),6200,FY 80 App.Act, Sec.511,512,513.Is recipient country a Communist country? Will assistance be provided to Angola, Cambodia, Cuba, Laos or Vietnam? Will assistance be provided to Afghanistan or Mozambique without a waiver. — No.

7. FAA [illegible] Is recipient country in any way [illegible] in (a) subversion of, or military [illegible] against, the United States or any country receiving U.S. assistance, or (b) the [illegible] of such subversion or aggression? — No.

8. FAA [illegible]. Has the country permitted, or failed to take adequate measures to prevent, the damage or destruction, by mob action, of U.S. property? — No.

9. FAA [illegible]. If the country has failed to institute the investment guaranty program for the specific risks of expropriation, inconvertibility, or confiscation, has the AID Administrator within the past year considered denying assistance to such government for this reason? — Yes.

10. FAA Sec. 620(o); Fishermen's Protective Act of 1967, as amended, Sec. 5. If country has seized, or imposed any penalty or fine against, any U.S. fishing activities in international waters:

a. Has any deduction required by the Fishermen's Protective Act been made? — a. Not to the Mission's knowledge.

b. Has complete denial of assistance been considered by AID Administrator? — b. Yes. On Nov. 16, 1979 Peru siezed U.S. fishing boats in international waters. On February 22, 1980, the Treasure Department certified that a seizure of U.S. fishing boats had occurred. A U.S. embargo was imposed on the importation of Peruvian tuna fish. The U.S. Embassy has kept Washington and AID/W informed of all developments.

11. FAA Sec. 620; FY 80 App. Act Sec. 518. (a) Is the government of the recipient country in default for more than 6 months on interest or principal of any AID loan to the country? (b) Is country in default exceeding one year on interest or principal on U.S. loan under program for which App. Act appropriates funds? — No

12. FAA Sec. 620(s). If contemplated assistance is development loan or from Economic Support fund, has the Administrator taken into account the percentage of the country's budget which is for military expenditures, the amount of foreign exchange spent on military equipment and the — Yes

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A.12.

amount spent for the purchase of sophisticated weapons systems? (An affirmative answer may refer to the record of the annual "Taking Into Consideration" memo: "Yes, as reported in annual report on implementation of Sec. 620(s)." This report is prepared at time of approval by the Administrator of the Operational Year Budget and can be the basis for an affirmative answer during the fiscal year unless significant changes in circumstances occur.)

13. FAA Sec. 620(t). Has the country severed diplomatic relations with the United States? If so, have they been resumed and have new bilateral assistance agreements been negotiated and entered into since such resumption? — No

14. FAA Sec. 620(u). What is the payment status of the country's U.N. obligations? If the country is in arrears, were such arrearages taken into account by the AID Administrator in determining the current AID Operational Year budget? — The information available at the Mission indicates that Peru is up to date on its U.N. obligations.

15. FAA Sec. 620A, FY 80 App. Act, Sec. 521. Has the country granted sanctuary from prosecution to any individual or group which has committed an act of international terrorism? Has the country granted sanctuary from prosecution to any individual or group which has committed a war crime? — No

16. FAA Sec. 666. Does the country object, on basis of race, religion, nationality or sex, to the presence of any officer or employee of the U.S. there to carry out economic development program under FAA? — No

17. FAA Sec. 669, 670. Has the country, after August 3, 1977, delivered or received nuclear enrichment or reprocessing [illegible] materials or technology, without [illegible] safeguards? Has it detonated a nuclear device after August 3, 1977, a "[illegible] nuclear weapon State" under the [illegible] nonproliferation treaty? — No

B. FOREIGN CRITERIA FOR COUNTRY ELIGIBILITY

1. Development Assistance Country Criteria

a. FAA Sec. 102(b)(4). Have criteria been established and taken into account to assess commitment progress of country in effectively involving the poor in development, on such indexes as: (1) increase in agricultural productivity through small-farm labor intensive agriculture, (2) reduced infant mortality, (3) control of population growth, (4) equality of income distribution, (5) reduction of unemployment, and (6) increased literacy? — Yes

B.1. IDC Act of 1979

b. FAA Sec. 104(d)(1)./ If appropriate, is this development (including Sahel) activity designed to build motivation for smaller families through modification of economic and social conditions supportive of the desire for large families in programs such as education in and out of school, nutrition, disease control, maternal and child health services, agricultural production, rural and urban development, and assistance to urban poverty and through community-based development programs which give recognition to people motivated to limit the size of their families. — Only indirectly.

2. Economic Support Fund Country Criteria

a. FAA Sec. 502B. Has the country engaged in a consistent pattern of gross violations of internationally recognized human rights? — N/A

b. FAA Sec. 533(b). Will assistance under the Southern Africa program be provided to Mozambique, Angola, Tanzania, or Zambia? If so, has President waived prohibition against the assistance by determining that such assistance will further U.S. foreign policy interests. — N/A

c. FAA Sec. 609. If commodities are to be granted so that sale proceeds will accrue to the recipient country, have Special Account (counterpart) arrangements been made? — N/A

d. FY 80 App. Act, Sec. 510 Will assistance be provided for the purpose of aiding directly the efforts of the government of such country to repress the legitimate rights of the population of such country contrary to the Universal Declaration of Human Rights? — N/A

e. FAA Sec. 620B, PL 94-328 Sec. 406. Will security supporting assistance be furnished to Argentina or Chile? — N/A

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6C(2) - PROJECT CHECKLIST

Listed below are statutory criteria applicable generally to projects with FAA funds and project criteria applicable to individual fund sources - Development Assistance (with a subcategory for criteria applicable only to loans), and Economic Support Fund.

CROSS REFERENCES: IS COUNTRY CHECKLIST UP TO DATE?
HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PROJECT?

A. GENERAL CRITERIA FOR PROJECT

1. FY 80 App. Act unnumbered; FAA Sec. 634A; 634(b): (a) Describe how authorizing and appropriations Committees of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that figure)?

Congress will be notified. Project will not be authorized and agreement will not be signed until notification period has expired.

2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial, and other plans necessary to carry out the assistance and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?

3. FAA Sec. 611(a)(2). If further legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?

N/A

4. FAA Sec. 611(b); FY 80 App. Act Sec. 501. If for water or water-related land resource construction, has project met the standards and criteria as per the Principles and Standards for Planning Water and Related Land Resources dated October 25, 1973?

Yes. See Economic Analysis, Section E., for a fuller statement.

5. FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability effectively to maintain and utilize the project?

Yes

6. FAA Sec. 209. Is project susceptible of execution as part of regional or multilateral project? If so why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.

No. Project is specific to Peru.

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A.

7. FAA Sec. 601(a). Information and conclusions whether project will encourage efforts of the country to: (a) increase the flow of international trade, (b) foster private initiative and competition; (c) encourage development and use of cooperatives, credit unions, and savings and loan associations, (d) discourage monopolistic practice (e) improve technical efficiency of industry, agriculture and commerce, and (f) strengthen free labor unions.

The Project will increase the flow of international trade and indirectly will improve technical efficiency of industry, agriculture and commerce.

8. FAA Sec. 601(b). Information and conclusion on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).

Goods and services under the Project will be supplied, where appropriate, by private contractors from the United States.

9. FAA Sec. 611(b), Sec. 636(i). Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized to meet the cost of contractual and other services.

The GOP is supplying over 25% of the Project's costs. The AID funds will be used to provide most of the foreign exchange costs.

10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?

No.

11. FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?

Yes.

12. FY 80 App. Act Sec. 504. If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar, or competing commodity?

N/A

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria

a. FAA Sec. 102(b), 111, 113, 281(a). Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained

The Project will serve the overall development needs of Peru and will encourage agricultural and rural development and the involvement of the poor in such development by increasing the availability of electric power for productive, job-creating uses.

B.1.a.

basis, using the appropriate U.S. institutions, (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions, (c) support the self help efforts of developing countries, (d) promote the participation of women in the national economies of developing countries and the improvement of women's status, and (e) utilize and encourage regional cooperation by developing countries?

b. FAA Sec. 103, 103A, 104, 105, or 107. Is assistance being made available (include only applicable paragraph which corresponds to source of funds used. If more than one fund source is used for project, include relevant paragraph for each fund source.)

(1) [103] for agriculture, rural development or nutrition, if so, extent to which activity is specifically designed to increase productivity and income of rural poor, [103A] if for agricultural research, is full account taken of needs of small farmers,

The assistance is being made available for rural development, under Section 103 of the FAA. The Project will help build energy infrastructure in rural areas and hence promote the development of these areas.

(2) [104] for population planning under sec. 104(b) or health under sec. 104(c), if so, extent to which activity emphasizes low-cost, integrated delivery systems for health, nutrition and family planning for the poorest people, with particular attention to the needs of mothers and young children, using paramedical and auxiliary medical personnel, clinics and health posts, commercial distribution systems and other modes of community research.

N/A

(3) [105] for education, public administration, or human resources development, if so, extent to which activity strengthens nonformal education, makes formal education more relevant, especially for rural families and urban poor, or strengthens management capability of institutions enabling the poor to participate in development;

N/A

(4) [106] for technical assistance, energy, research, reconstruction, and selected development problems, if so, extent activity is

N/A

(i) technical cooperation and development, especially with U.S. private and voluntary, or regional and international development, organizations;

(ii) to help alleviate energy problems,

(iii) research into, and evaluation of, economic development processes and techniques;

(iv) reconstruction after natural or manmade disaster;

(v) for special development problem, and to enable proper utilization of earlier U.S. infrastructure, etc., assistance;

(vi) for programs of urban development, especially small labor-intensive enterprises, marketing systems, and financial or other institutions to help urban poor participate in economic and social development.

c. (Section 110) Is appropriate effort placed on use of appropriate technology?

d. (Section 110(a)). Will the recipient country provide at least 25% of the costs of the program, project, or activity with respect to which the assistance is to be furnished (or has the latter requirement been waived for a "relatively least-developed" country)?

e. (Section 110(b)). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to the Congress been made, and efforts for other financing, or is the recipient country "relatively least developed"?

f. (Section 281(b)). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development, and supports civil education and training in skills required for effective participation in governmental and political processes essential to self-government.

g. (Section 122(b)). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase of productive capacities and self-sustaining economic growth?

2. Development Assistance Project Criteria (Development Loans)

a. (Section 122(b)). Information and conclusion on capacity of the country to repay the loan, including reasonableness of repayment prospects.

b. (Section 122(b)). If assistance is for any productive enterprise which will compete in the U.S. with U.S. enterprise, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan?

The Project is specifically designed to develop, demonstrate, and disseminate technologies appropriate to the needs of the rural population in Peru.

Yes. The GOP will provide over 25% of the costs of the Project.

The Project does not involve grant capital assistance.

The Project fulfills an expressed GOP need. Peruvians were involved closely in its design. The Project will be carried out through a variety of Peruvian institutions.

Yes, the project is designed to identify technology that will help to increase Peruvian energy and economic production. Thus it should directly contribute to the country's self-sustaining economic growth.

The Mission's judgment is that the country does have the capacity to repay the loan and will repay the loan.

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3. Project Criteria Solely for Economic Support Fund

a. FAA Sec. 531(a). Will this assistance support promote economic or political stability? To the extent possible, does it reflect the policy directions of section 102? N/A

b. FAA Sec. 533. Will assistance under this chapter be used for military, or paramilitary activities? N/A

B. 5C(3) - STANDARD ITEM CHECKLIST

Listed below are statutory items which normally will be covered routinely in those provisions of an assistance agreement dealing with its implementation, or covered in the agreement by imposing limits on certain uses of funds.

These items are arranged under the general headings of (A) Procurement, (B) Construction, and (C) Other Restrictions.

A. Procurement

1. FAA Sec. 602. Are there arrangements to permit U.S. small business to participate equitably in the furnishing of goods and services financed?	Yes. AID procedures encouraging small business participation will be followed.
2. FAA Sec. 604(a). Will all commodity procurement financed be from the U.S. except as otherwise determined by the President or under delegation from him?	Yes.
3. FAA Sec. 604(d). If the cooperating country discriminates against U.S. marine insurance companies, will agreement require that marine insurance be placed in the United States on commodities financed?	N/A
4. FAA Sec. 604(e). If offshore procurement of agricultural commodity or product is to be financed, is there provision against such procurement when the domestic price of such commodity is less than parity?	N/A
5. FAA Sec. 608(a). Will U.S. Government excess personal property be utilized wherever practicable in lieu of the procurement of new items?	Yes.
6. FAA Sec. 603. (a) Compliance with requirement in section 901(b) of the Merchant Marine Act of 1936, as amended, that at least 50 per centum of the gross tonnage of commodities (computed separately for dry bulk carriers, dry cargo liners, and tankers) financed shall be transported on privately owned U.S.-flag commercial vessels to the extent that such vessels are available at fair and reasonable rates.	Such provision will be written in Project Agreement.
7. FAA Sec. 621. If technical assistance is financed, will such assistance be furnished to the fullest extent practicable as goods and professional and other services from private enterprise on a contract basis? If the	Yes.

A.7.

facilities of other Federal agencies will be utilized, are they particularly suitable, not competitive with private enterprise, and made available without undue interference with domestic programs?

8. International Air Transport Fair Competitive Practices Act, 1974. If air transportation of persons or property is financed on grant basis, will provision be made that U.S.-flag carriers will be utilized to the extent such service is available? — Yes.

9. FY 80 App. Act Sec. 505 Does the contract for procurement contain a provision authorizing the termination of such contract for the convenience of the United States? — Yes, such contracts will.

B. Construction

1. FAA Sec. 601(d). If a capital (e.g., construction) project, are engineering and professional services of U.S. firms and their affiliates to be used to the maximum extent consistent with the national interest? — Yes.

2. FAA Sec. 611(c). If contracts for construction are to be financed, will they be let on a competitive basis to maximum extent practicable? — Yes.

3. FAA Sec. 620(k). If for construction of productive enterprise, will aggregate value of assistance to be furnished by the United States not exceed $100 million? — N/A

C. Other Restrictions

1. FAA Sec. 122 (b) If development loan, is interest rate at least 2% per annum during grace period and at least 3% per annum thereafter? — Yes.

2. FAA Sec. 801(d). If fund is established solely by U.S. contributions and administered by an international organization, does Comptroller General have audit rights? — N/A

3. FAA Sec. 620(h). Do arrangements preclude promoting or assisting the foreign aid projects or activities of Communist-bloc countries, contrary to the best interests of the United States? — Yes, arrangements will preclude activities as stated.

4. FAA Sec. 636(i). Is financing not permitted to be used, without waiver, for purchase, long-term lease, or exchange of motor vehicle manufactured outside the United States, or guaranty of such transaction? — Yes.

5. Will arrangements preclude use of financing

a. FAA Sec. 104(f). To pay for performance of abortions or to motivate or coerce persons to practice abortions, to pay for performance of involuntary sterilization, or to coerce or provide financial incentive to any person to undergo sterilization?

b. FAA Sec. 620(g). To compensate owners for expropriated nationalized property?

c. FAA Sec. 660. To finance police training or other law enforcement assistance, except for narcotics programs?

d. FAA Sec. 662. For CIA activities?

e. FY 80 App. Act Sec. 504 To pay pensions, etc., for military personnel?

f. FY 80 App. Act Sec. 506 To pay U.N. assessments?

g. FY 80 App. Act Sec. 507 To carry out provisions of FAA sections 209(d) (Transfer of FAA funds to multilateral organizations for lending.)

h. FY 79 App. Act Sec. 112. To finance the export of nuclear equipment, fuel, or technology or to train foreign nations in nuclear fields?

i. FY 79 App. Act Sec. 601. To be used for publicity or propaganda purposes within United States not authorized by the Congress?

Arrangements preclude the financing of all items listed.

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TAGS:

SUBJECT: DAEC REVIEW OF PERU RENEWABLE ENERGY DEVELOPMENT PID

1. SUBJECT PID WAS REVIEWED AND APPROVED BY THE DAEC ON FEBRUARY 23, 1980. AUTHORITY FOR THE MISSION TO APPROVE THE PROJECT WAS NOT GRANTED SINCE THE LOP FUNDING LEVEL EXCEEDED THE MISSION'S DELEGATED AUTHORITY. MOREOVER, IT WAS RECOMMENDED THAT THE PROJECT BE SIGNED WITH THE NEW GOVERNMENT TO ASSURE FULL GOVERNMENT SUPPORT. THE FOLLOWING GUIDANCE IS GIVEN FOR PP DEVELOPMENT.

2. PROJECT RATIONALE: THE PP SHOULD ESTABLISH A SOCIO-ECONOMIC DEVELOPMENT RATIONALE FOR THE $11 MILLION A.I.D. INVESTMENT IN RENEWABLE ENERGY, ESPECIALLY FOR THE $3.6 MILLION FOR RURAL ELECTRIFICATION USING SMALL SCALE HYDRO-POWER GENERATION. BASICALLY, WE WERE CONCERNED WITH THE NEED TO DEMONSTRATE LONGER TERM BENEFITS OF THE PROJECT TO THE MISSION'S TARGET GROUP AND TARGET GEOGRAPHIC AREAS. THE PP SHOULD CONTAIN A DETAILED DESCRIPTION OF THE PROJECT'S RELATIONSHIP TO AND SYNERGISTIC IMPACT ON ONGOING MISSION ACTIVITIES IN THE RURAL DEVELOPMENT SECTOR, SUCH AS THE INTEGRATED REGIONAL DEVELOPMENT PROJECT AND SUBTROPICAL LANDS PROJECT. THE PP SHOULD ALSO CLEARLY EXPLAIN HOW THE LACK OF ELECTRIC POWER IN A.I.D. PRIORITY GEOGRAPHIC AREAS IS A CONSTRAINT TO FUTURE ECONOMIC DEVELOPMENT IN THE REGION AND HOW THE SITE SELECTION CRITERIA AND SELECTION MECHANISMS USED IN THE PROJECT WILL INSURE THE PROVISION OF COST-EFFECTIVE ELECTRIC POWER IN THOSE AREAS. SPECIFIC REFERENCES ON HOW PROJECT IMPLEMENTATION WILL BE LINKED TO THE INTEGRATED REGIONAL DEVELOPMENT PROJECT, THE ROLE OF THE DDC'S IN SITE SELECTION, THE COORDINATION BETWEEN ELECTROPERU AND THE DDC'S, ETC. SHOULD BE INCLUDED IN THE PP. IN SHORT, WHAT LONGER-TERM DEVELOPMENT IMPACT CAN WE EXPECT FROM THE PROJECT, BEYOND A RESOURCE TRANSFER TO ENABLE ELECTROPERU TO CONSTRUCT 35 ADDITIONAL SYSTEMS FOR ITS ON-GOING MINI HYDRO PROGRAM?

UNCLASSIFIED

3. GOP ENERGY POLICY: THE PROJECT SHOULD BE DEVELOPED

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WITHIN THE OVERALL CONTEXT OF PERU'S ENERGY POLICY,

SPECIALLY THE GOP'S POLICY WITH RESPECT TO ALTERNATIVE ENERGY DEVELOPMENT. WE UNDERSTAND THE GERMAN GOVERNMENT HAS BEEN ASSISTING THE GOP TO DEVELOP A NATIONAL ENERGY PLAN FOR 1977 - 1982 ESPECIALLY TARGETED ON SUPPLY AND DEMAND FOR ELECTRICITY. IN ADDITION, THE GOP IS PROPOSING TO DEVELOP A NATIONWIDE RURAL ELECTRIFICATION PLAN FOR SMALL HYDRO-ELECTRIC POWER PLANTS. THE MINI HYDRO SYSTEM CONSTRUCTION AS WELL AS THE ALTERNATIVE ENERGY PROGRAM COULD BE ANALYZED WITHIN THE CONTEXT OF THESE PLANNING EFFORTS IN ORDER TO IDENTIFY ANY NEEDS FOR STRENGTHENING GOP'S INSTITUTIONAL PLANNING CAPACITY.

THE PP SHOULD ALSO INCLUDE A DISCUSSION OF THE GOP'S ENERGY CONSERVATION GOALS AND ACTIONS (E.G., HAVING CAN BE ACHIEVED BY IN PODUCING MORE EFFICIENT EQUIPMENT IN POWER PLANTS, BETTER INTERCONNECTIONS, IMPROVED LOAD FACTORS AND SMALLER DECENTRALIZED RENEWABLE SYSTEMS FOR RURAL AREAS) AND RELATE HOW THE PROJECT'S OUTPUTS WILL AFFECT OVERALL GOP CONSERVATION EFFORTS. FURTHER, DURING INTENSIVE REVIEW THE MISSION SHOULD EXAMINE ELECTROPERU'S RURAL ELECTRIFICATION TARIFF STRUCTURE TO DETERMINE: (1) IF THE SYSTEM IS TOTALLY SELF FINANCING AND COVERS THE OPERATING AND MAINTENANCE COSTS OF THE SYSTEM OR IF IT REQUIRES A SUBSIDY FROM OTHER PARTS OF THE SYSTEM OR THE GOP; (2) IF THE SYSTEM IS REVENUE-GENERATING, WHETHER THE INCOME IS REINVESTED IN THE SMALL-SCALE HYDRO SYSTEMS OR REVERTS TO THE GRID-CONNECTED RURAL ELECTRIFICATION PROGRAM; AND (3) WHETHER CONSERVATION AND EQUITY CONSIDERATIONS ARE PROVIDED FOR THROUGH THE RATE STRUCTURE, E.G. THE LARGE CONSUMERS OF ELECTRICITY (INDUSTRY, URBAN AREAS) ARE CHARGED MORE THAN THE SMALLER CONSUMERS (LOW-INCOME RURAL AREAS).

. FEASIBILITY STUDIES: IN ORDER TO SATISFY REQUIREMENTS OF FAA 611(A) AND (B), AT LEAST TWO FEASIBILITY STUDIES FOR SMALL-SCALE HYDRO SYSTEMS SHOULD BE COMPLETED DURING INTENSIVE REVIEW AND SHOULD CONTAIN THE NECESSARY BENEFIT/COST ANALYSIS FOR MINI HYDRO SYSTEM CONSTRUCTION. AS PART OF THESE STUDIES, WE SUGGEST THE MISSION INCLUDE COMPONENTS WHICH SHOULD EXAMINE THE DEMAND FOR AND USES AND AFFORDABILITY OF ELECTRICITY BY THE TARGET GROUP. WE ARE INTERESTED IN THE EXTENT TO WHICH THE MISSION CAN DOCUMENT HOW THE TARGET GROUP IN THE PROJECT AREAS IS USING OR WILL MAKE PRODUCTIVE USE OF THE ELECTRICITY, WHETHER DERIVED FROM A DECENTRALIZED OR GRID-CONNECTED SYSTEM, AND IN THE TARGET GROUP'S ABILITY TO PAY MONTHLY CHARGES. AS A RESULT OF THE ANALYSIS, THE SIZE OF EACH SYSTEM TO BE CONSTRUCTED, BASED ON CURRENT AND PROJECTED DEMAND FOR ELECTRIC POWER, CAN ALSO BE ESTABLISHED AND THE ESTIMATED CONSUMPTION OF 220 WATTS PER HOUSEHOLD MENTIONED IN THE PID CAN BE VERIFIED. LASTLY, THE INSTITUTIONAL CAPACITY OF ELECTROPERU TO IMPLEMENT SUB-PROJECTS AND MANAGE LOAN FUNDS EFFECTIVELY SHOULD BE ANALYZED AND WILL BE IMPORTANT IN MEETING 611 REQUIREMENTS. THE PP SHOULD ALSO MENTION WHAT IF ANY SUB-PROJECT APPROVALS WILL BE RETAINED BY THE MISSION IN LIGHT

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F THE FACT THAT AN ICI APPROACH HAS BEEN PROPOSED USING
LECTROPERU.

. ENVIRONMENTAL ASSESSMENT: THE PID PROPOSED THAT
NDIVIDUAL ENVIRONMENTAL ASSESSMENTS BE CONDUCTED ON
ACH SITE AS PART OF THE FEASIBILITY STUDIES DURING
ROJECT IMPLEMENTATION. HOWEVER, THE CURRENT SET OF
ECTION 116 REGULATIONS DOES NOT ALLOW FOR A POSITIVE
ETERMINATION AND EA SUBSEQUENT TO THE OBLIGATION OF
UNDS. THEREFORE, THE MISSION IS REQUESTED TO UNDERTAKE
URING INTENSIVE REVIEW A PROGRAMMATIC ENVIRONMENTAL
SSESSMENT WHICH WOULD DEVELOP GUIDELINES OR CRITERIA AND
A METHODOLOGY FOR CONDUCTING ENVIRONMENTAL ASSESSMENTS
ITE BY SITE FOR SMALL-SCALE HYDRO SYSTEMS. THE LAC
UREAU'S ENVIRONMENTAL ADVISOR WILL ASSIST THE MISSION IN
REPARING THE SCOPE OF WORK FOR THE PROGRAMMATIC
SSESSMENT. IN ADDITION, THE PP SHOULD CLARIFY THE
RRANGEMENT FOR TRAINING ELECTROPERU TECHNICIANS FOR
ARRYING OUT ENVIRONMENTAL ASSESSMENTS AND DESCRIBE HOW
HIS ASSESSMENT CAPABILITY WILL BE INSTITUTIONALIZED IN
LECTROPERU.

. PROPOSED EX-IM BANK FINANCING: SUBSEQUENT TO THE
AEC REVIEW LAC/DR AND MISSION REPRESENTATIVES EXPLORED
HE POSSIBILITY OF EX-IM BANK FINANCING FOR THE EQUIPMENT
OMPONENTS OF THE MINI-HYDRO PROGRAM. IN A MEETING ON

EBRUARY [illegible], 1980, THE REPRESENTATIVES HERE TOLD THAT
HE EX-IM BANK WAS NOT INTERESTED IN FINANCING ANY PART OF
HE PROPOSED PROJECT.

. FINANCIAL PLAN: IN LIGHT OF OUR DECLINING LAC BUREAU
RANT AVAILABILITIES, THE MISSION SHOULD CONSIDER LOAN
INANCING THE LOCAL COSTS FOR THE CONSTRUCTION OF CIVIL
ORKS AND EQUIPMENT COMPONENTS OF THE ALTERNATIVE ENERGY
PROGRAM AS WELL AS PART, OR ALL, OF THE PROPOSED TECHNICAL
ASSISTANCE.

FYI: DS/EY CAN BE HELPFUL TO THE MISSION IN IDENTIFYING
SPECIALISTS TO PROVIDE TDY SERVICES, AND POSSIBLY FINANCE
FEASIBILITY STUDIES. MISSION SHOULD CONSULT FRITZ/BROWN
MEMO OF FEBRUARY 22, COPY OF WHICH WAS POUCHED TO
USAID/LIMA FINANCE OFFICER WACHTENHEIM. NEWSOM

INITIAL ENVIRONMENTAL EXAMINATION (IEE)

Project Location	:	Peru
Project Title	:	Mini-Hydro Energy Development
Funding	:	FY 80 Loan: $9.0 million Grant $1.0 million
Life of Project	:	5 years
IIE Prepared by	:	Frank Zadroga NRECA Environmental Consultant
Date Prepared	:	August 1980

Environmental Action Recommended:

The USAID/Peru Project Committee has undertaken a complete Initial Environmental Examination (IEE) of the Project environmental impacts and has arrived at a recommendation for a negative Determination. In view of the fact that the individual projects to be financed under the Program have not yet been selected, the Committee believes that it is not feasible at this time, to conduct any further environmental analysis. It is instead recommended to include in the Program a technical assistance component to strengthen the GOP capability for preparing environmental analysis on a case by case basis prior to individual project approval.

Concurrence:

I have reviewed the Initial Environmental Examination for the Mini-Hydro Energy Development Project and concur in the recommendation.

Leonard Yaeger
Director
USAID/Peru

I. PROJECT DESCRIPTION:

The purpose of the Project is to promote rural and regional socioeconomic development, by complementing rural infrastructure with electrical supplies for household, productive and social uses and to contribute to the substitution of oil in the generation of electricity by taking advantage of the hydro-power resources scattered throughout the sierra.

Loan funds will finance studies, civil works, electro mechanical equipment and network systems of a number of standarized small scale hydro-electric installations in the 100 to 1000 KW range in regions where AID is concentrating its development efforts. The typical parameters of the proposed small hydroelectric projects are: Falls in range of 100 to 300 mts. with flows in the range of 200 to 500 lts. per second and the expected average size is 300 KW.

The Grant funds will strengthen and expand the GOP implementing agency (ELECTROPERU)'s capacity for developing and operating Mini Hydro-electric plants and systems.

II. IMPACT IDENTIFICATION AND EVALUATION FORM

Impact Areas and Sub-areas 1/	Impact Identification and Evaluation 2/
A. LAND USE	
1. Changing the character of the land through:	
a. Increasing the population	M
b. Extracting natural resources	N
c. Land clearing	L to M
d. Changing soil character	L
2. Altering natural defenses	L
3. Foreclosing important uses	L
4. Jeopardizing man or his works	N
5. Other factors	
B. WATER QUALITY	
1. Physical state of water	L to M
2. Chemical and biological states	L to M
3. Ecological balance	L to M
4. Other factors	

1/ See Explanatory Notes for this form.

2/ Use the following symbols:
N - No environmental impact
L - Little environmental impact
M - Moderate environmental impact
H - High environmental impact
U - Ucknown environmental impact

IMPACT IDENTIFICATION AND EVALUATION FORM

C. ATMOSPHERIC

1. Air addtives _____ L
2. Air pollution _____ L
3. Noise pollution _____ L
4. Other factors

_____ _____

_____ _____

D. NATURAL RESOURCES

1. Diversion, altered use of water _____ M
2. Irreversible, inefficient commitments _____ L
3. Other factors

_____ _____

_____ _____

E. CULTURAL

1. Altering physical symbols _____ L
2. Dilution of cultural traditions _____ M
3. Other factors

_____ _____

_____ _____

F. SOCIOECONOMIC

1. Changes in economic/employment patterns _____ L
2. Changes in population _____ M
3. Changes in cultural patterns _____ M
4. Other factors

_____ _____

_____ _____

IMPACT IDENTIFICATION AND EVALUATION FORM

G. HEALTH

1. Changing a natural environment _____ L to N
2. Eliminating an ecosystem element _____ L to N
3. Other factors

_____ _____

_____ _____

H. GENERAL

1. International impacts _____ N
2. Controversial impacts _____ N
3. Larger program impacts _____ N
4. Other factors

_____ _____

_____ _____

I. OTHER POSSIBLE IMPACTS (not listed above)

none _____

_____ _____

_____ _____

See attached Discussion of Impacts

III. Discussion of Impacts:

A. Land Use:

1. a) SHPP's will have little if any direct effect in increasing local populations but indirectly, through better public services, marketing, recreational and educational facilities and increased employment opportunity, thereby occur immigration to the communities or surrounding areas. The net effect will be a moderate impact.

   b) The use of water for hydro power generation is non consumptive and no inter-basin diversions or other form of water resource extraction will occurr. Other resources will not be directly affected.

   c) The SHPP requires some land clearing for the site preparation and penetration of the access road. Under optimum conditions with community cooperation in the protection of the watershed no further clearing should take place in the area of the site. If proper protection is not provided rapid colonization and clearing will occur by means of the access road and could extend to a much larger area. Some land clearing will also occur in either case away from the project site by the new colonists that will be drawn to the area. The impact is judged as being from light to moderate.

   d) The impacts of construction will cause soil disturbance only on a small area at the plant site and along the road. Those areas that are cleared as a result of the Project will also suffer from changing soil characters to lesser or greater degree according to land use practices post deforestation. Overall impacts will likely be little.

2. SHPP's will in no significant way alter natural defense systems. By means of indirect effects such as clearing and altering of hydrologic regimes that could happen if the hydropower site and its access road are not adequately protected, the natural defense system of the watershed could be negatively affected. This could, however, have to occur against the recommendations of the project and the overall potential impact is considered slight.

3. SHPP's are not competitive in their use of water and with proper site selection, planning and project design the majority of the possible conflicts can be avoided. The impact here is light.

B. Water Quality:

The operation of a run-of-the-river SHPP that does not utilize a large impoundment will have little or no effect on water quality. Diversion of water through the SHPP will have little effect on its temperature or on the concentrations and ionic forms of dissolved gases or minerals. Those aquatic organisms, such as downstream migrating fish, which are impinged against the intake debris screen

or passed through the penstock and turbine, will suffer mortality. In most instances this impact will be small, since SHPP's withdraw small amounts of water and are located on small streams that do not support large numbers of aquatic animals.

SHPP development will have a greater impact on water quality and aquatic biota when the design of the facility involves impounding a substantial volume of water or diverting water from another basin. Inter-basin (inter-watershed) diversion has the potential for introducing water of inferior quality (contaminants, disease organisms, different physical/chemical characteristics) into another stream. Impoundment of water for store-and-release types of operation can cause a multitude of impacts to water quality and aquatic resources, including altered temperature regime, decreased dissolved oxygen levels, increased concentrations of ammonia, hydrogen sulfide and chemically reduced ionic forms of iron and manganese. An impoundment constitutes a physical barrier to upstream and downstream fish migrations, facilitates uptake of contaminants into the food web, changes structure and composition of the aquatic biological community, and may promote the development of nuisance aquatic plants. In many cases, these factors would result in a moderate impact, even on small streams.

Construction of the SHPP will introduce dust, eroded soil, oils, greases, and other construction chemicals into the water. These potential impacts can be controlled easily and, due to the small size of the SHPP, the resultant toxic, turbidity, and sedimentation effects are expected to be minor.

C. Atmospheric:

Although the SHPP's will not be directly responsible for air or noise pollution effects, the indirect effects of the growth and industry resultant from the electricity will cause increased levels of noise and air contaminants in the urban centers. These effects are considered little.

Construction of the SHPP facility and its access road will generate dust and noise. Because of the small scale of this project, the impacts are expected to be slight.

D. Natural Resources:

Since SHPP operation does not consume water or significantly alter its quality, alternative water uses will not be hampered in most instances. However, water will be withdrawn from a stretch of channel downstream of the intake structure and upstream of the discharge, and the possibility exists that flow

might be reduced during certain times of the year, below that necessary to support aquatic life. The affected section of the stream could serve as a source of water for irrigation, human or livestock consumption, industrial uses, or dilution of domestic sewage or industrial effluents. These users might find the quantities of water available to be limited during all or part of the year due to SHPP diversion.

Population growth resulting from the provision of electricity will put greater demand on natural resources (greater need for water and arable land; fish for human consumption; greater waste disposal problems).

No major irreversible or inefficient commitments of land or water resources are anticipated as a result of the SHPP development program.

E & F. Cultural and Socio-Economic:

Although the net social value of SHPP development is expected to be positive, there are some negative ramifications of the program that should be noted. If the provision of electricity to a village promotes significant immigration of people from other areas of Peru, dilution of local customs, language patterns, and cultural traditions may result. Increased population in general will put greater demands on food production capabilities, as well as create greater needs for drinking and wastewater treatment facilties. Small communities that presently have no drinking or wastewater treatment may encounter increasing problems with waterborne diseases or simple availability as the population increases and the ability of the environment to assimilate their additional wastes proportionately decreases. These problems may have unanticipated social ane economic consequences, all arising as a secondary effect of rural electrification.

G. Health:

As with water quality impacts, the operation of SHPP facilities per se is not expected to affect human health or the transmission of waterborne dieseases. However, SHPP designs incorporating inter-basin diversions or water inpoundments can promote waterborne disease problems. Water contaminated by human sewage or runoff from livestock enclosures could, by inter-basin diversion, introduce diseases into a previously uncontaminated stream. Water inpoundments provide increased habitat for disease vectors, such as mosquitoes, and alternate hosts of human and animal parasites, such as snails.

A secondary effect of the SHPP program on health is population growth, which entails increased risk of disease epidemics resulting from inadequate drinking water and waste treatment.

H. General:

Because of the small size and scattered location of the SHPP facilities, no international, controversial, or large program environmental impacts are anticipated from the proper planning and implementation of this project.

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SELECTION OF SITES FOR THE CONDUCT OF PRE-FEASIBILITY STUDIES

The Commission for Small Hydroelectric Power Plants (CSHPP) of the Ministry of Energy and Mines has identified (in 1979) over 1,000 communities, with a cumulative population of nearly 2 million which could be served by approximately 800 small hydroelectric power plants (SHPP). These hydroelectric plants would range in size from 50 to 900 KW with an average size of 200 KW. For the 1980 - 1982 triennum, the CSHPP has identified 88 sites, with generating capacities ranging from 100 to 900 KW, where small hydroelectric power plants could be installed.

In its first full year of operation (1979), the Small Hydroelectric Power Plants Program included 39 sites in a variety of activities ranging from preliminary studies to putting into full operation. Currently the Planning Office for Applied Technology (OPTA) of Electroperu is using informally a number of technical and socio-economic critera in the selection of sites for the possible installation of small hydroelectric power plants. It is the policy of Electroperu that service areas located more than 20 kms. from the national grid are eligible for participation in the SHPP Program. This policy is based on a detailed economic study that compared the cost (per Kwh) of supplying electricity to service areas located at different distances from the national grid with the cost of providing the same service through a SHPP. For service areas located more than 20 kms. from the national grid the marginal cost of supplying electricity from a SHPP was lower than through any alternative system. (Egoavil 1979).

The feasibility or reconnaissance investigation methodology, that is described below, has been developed with the specific objective of enabling OPTA to prioritize systematically the selection of SHPP sites. In this way, OPTA will be able to optimize the use of the human and financial resources currently at its disposal.

Additionally, a pre-feasibility study is designed to reduce the chance of unfavorable findings, thus, it will have to maximize the potential for identifying attractive sites. In general, small hydro projects are justified economically on the value of power that can be generated and the benefits related to the substitution of other alternative sources of energy. Figure 1 is a sketch of a typical small hydroelectric power plant.

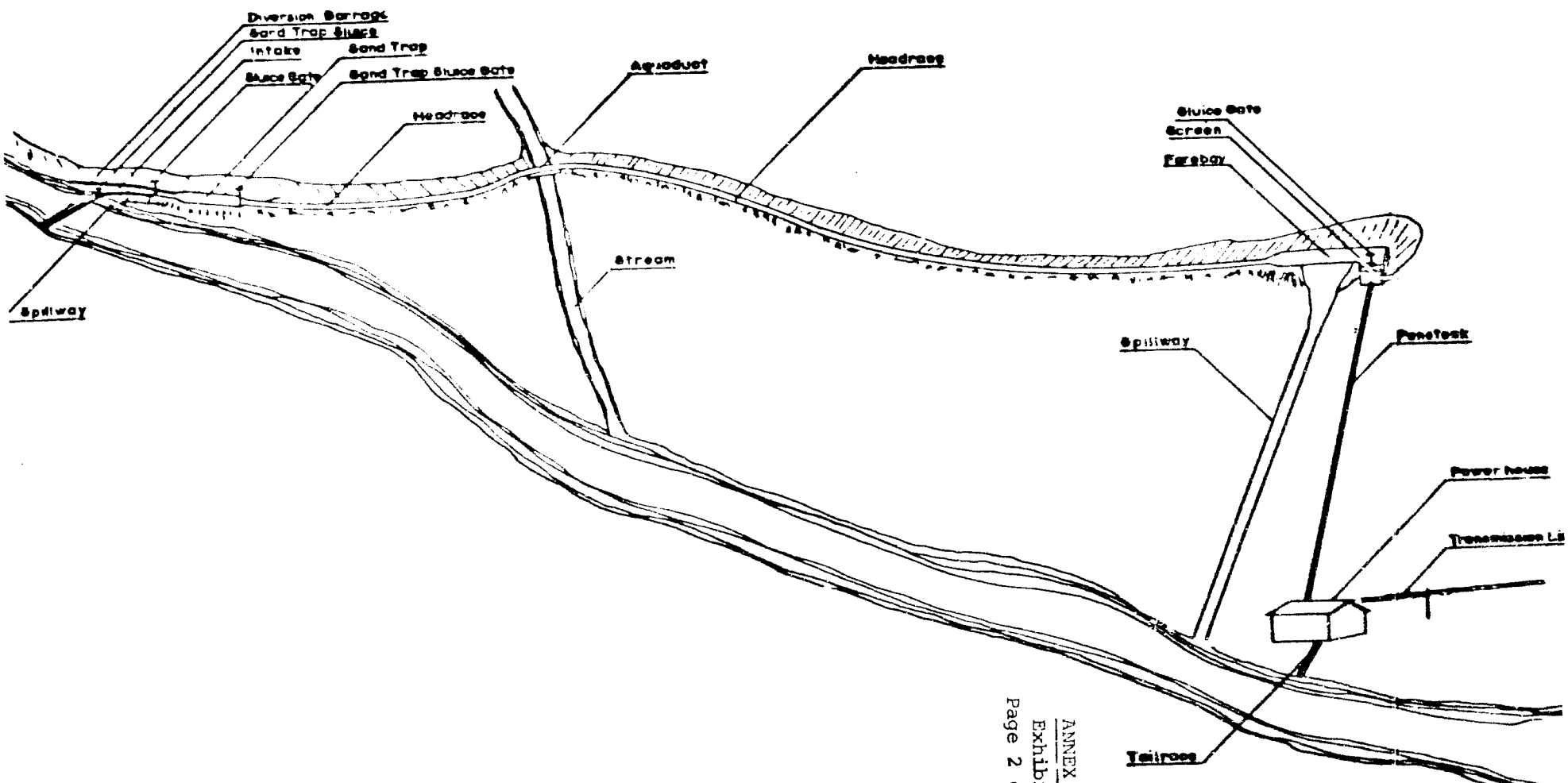
This manual is mainly based on historical reconnaissance studies and technical data (supplied by OPTA and U.S. Government entities such as the International Programs Office and the Idaho Operations Office of the Department of Energy). The pre-feasibility technology encompasses a number of technical (such as site physical characteristics and physical works), economic, social, political and environmental factors. In the following sub-sections, these factors are discussed in some detail. The interrelationships between all the technical, social and economic factors are shown in Figure 5 (pre-feasibility decision flow chart).

a) Site Physical Characteristics

The site physical characteristics are of three kinds:

i) Energy potential

Figure 1 A Sketch of a Small Hydroelectric Power Plant



ii) Accessibility to Communication Routes
iii) Proximity to the Sites of Load Demand

The discussion of site physical characteristics will treat each of the above three items in turn.

i) Power Potential

The power potential (P) is a function of two variables I) the net head (H_n) and II) the available flow (Q), according to the following mathematical formula:

$P = 7.5\ Q.H_n$ where
P = year-round availability of energy (KW)
Q = the available flow (cubic meters per second)
H_n = the net head (meters)

The discussion of the energy potential continues by treating the net head and the available flow as separate items.

The Net Head (H_n)

The net head available at any particular site is determined by deducting from the gross head (the difference in geodesic elevation between the water levels at the intake points and the tailrace) the head losses that are generated as the water flows to the turbine and from the turbine. The head losses are caused principally by friction in the headrace and the penstock (See Fig. 2). Other miscellaneous head losses include such factors as trash rack losses, intake losses, bends and sudden expansion on contraction losses upstream of the turbine and velocity head losses on the downstream side.

Headrace losses come to (1/300 - 1/1,000) of the gross head; penstock friction losses come to (1/50 - 1/200) of the gross head. Miscellaneous losses range from 0.2m to 1.0m (Nozaki, 1968).

As a first approximation

$H_n = H_g\ (1-\frac{1}{300} - \frac{1}{50}) - 1.0 = 0.976\ H_g - 1.0$ where H_g = the gross head (meters).

The available flow

Just as the net head (H_n) is site specific, so also is the available flow (Q). A two-step hydrolic analysis is used to calculate the available flow:

1) An appropriate record of flow versus time period (year, month, day) is generated. In statistical terms this record is called a time series.

2) A flow duration curve is generated.

The methodology for preparing a flow duration curve is first to rank order the time series by daily mean flows according to magnitude. The rank ordered values are then assigned order numbers, the largest beginning with order 1. The order numbers are then divided by the total number in the record and multiplied by 100, thereby representing the percent of days that a particular mean flow has been equaled or exceeded during the period of record analyzed.

The flow duration curve represents graphically the results of the above analysis where the flow (Q) is plotted against the percent exceedance. References to flow duration curves are usually made as Q_{50}, Q_{30}, Q_{10} etc, indicating the flow values at the percentage point subscripted. Fig. 2 is an example of a flow duration curve. Q_{20} values are good starting points for sizing equipment (Gladwell 1980). Ideally, a flow record of 5 - 10 years should be available. For the sites of small hydroelectric facilities a 2 -3 year record is acceptable.

ii) Accessibility to Communication Routes

The accessibility of the proposed site of the small hydroelectric system is an important consideration. The location of feasible existing communications routes (such as roads, riding trails, navigable rivers etc.) should be identified. Communications routes with neighboring communities should be described. The importance of the neighboring communities and their distance from the community under study should be detailed.

Where pertinent, the locations of possible new communication routes (such as roads, access trails etc.) should be identified. Topological and climatic characteristics that would impede access to the proposed site should be specified.

The exact location of the power house should be indicated in terms of the distance to the nearest point on an existing road.

iii) Proximity to the Sites of Load Demand

It is important to indicate the distance of travel (in kilometers) of the transmission lines from the power house to the center of the demand locale. This is achieved by tracing a profile of the terrain over which the shortest possible accessible length of transmission lines can be located.

b) Physical Works

Three aspects of the physical works will be covered:

1) Type and size of plant
2) Approximate cost, and
3) Approximate power production

In the following sub-sections, these items will be dealt with.

FLOW DURATION CURVE OF WATER RESOURCES
IN CARHUAQUERO POWER PLANT-CAJAMARCA
PERU

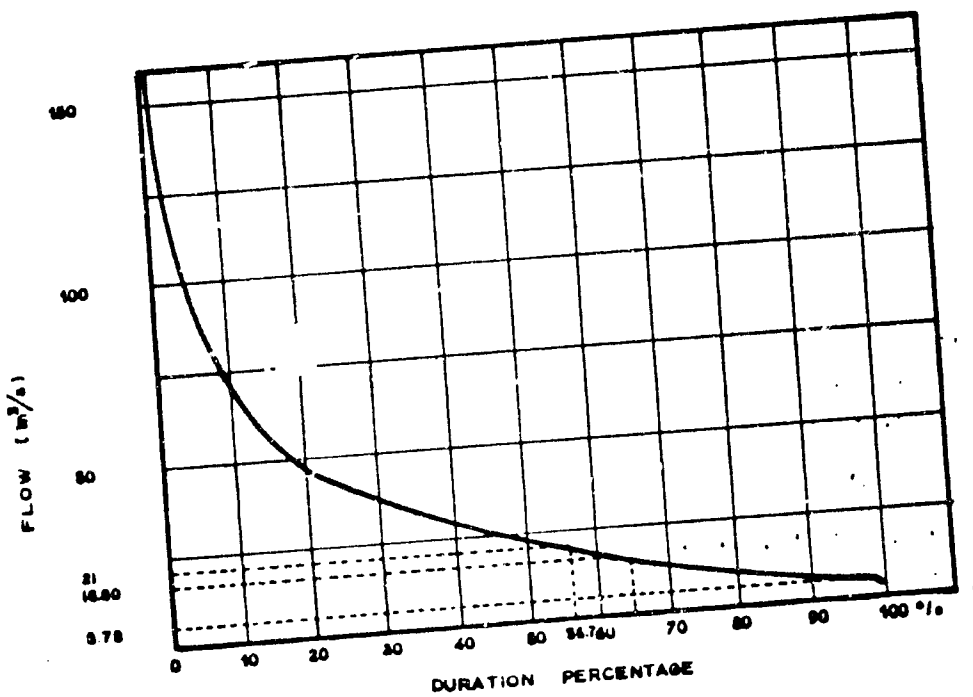


FIG. 2 EXAMPLE OF A FLOW DURATION CURVE

1) Type and size of plant and its approximate power production

The selection of the type and size of plant is dependent on an interaction between the net head available and the flow. By following exactly the instructions provided in Fig. 3, the most appropriate site specific turbine can be chosen, and its energy potential can be calculated.

2) Approximate cost

The approximate capital costs are estimated by first using Fig. 4. They include turbine/generator and appurtenant equipment, station electric equipment, miscellaneous powerplant equipment, powerhouse, powerhouse excavation, switchyard civil works, and upstream slide gate and construction and installation. Second, multiply this number by two to cover the cost of transmission lines, penstock, headrace and tailrace construction plus switchyard equipment and dam construction or modifications.

c) Economics

Three major subjects will be covered in this section: the market or demand structure, the economic and financial determination, and the perspectives to identify other development projects and productive uses in the area.

1) Demand Structure

The proposed small hydroelectric power plants (SHPP) program for Peru has both economic and social aims. Most of the economic benefits derive from meeting the demands of residential consumers, small businesses, and the farming community. The potential beneficiaries of the project, therefore, are not only village households, but also commercial and agro-economic entities such as shops, landowners, irrigation pumps, small mills and other productive units.

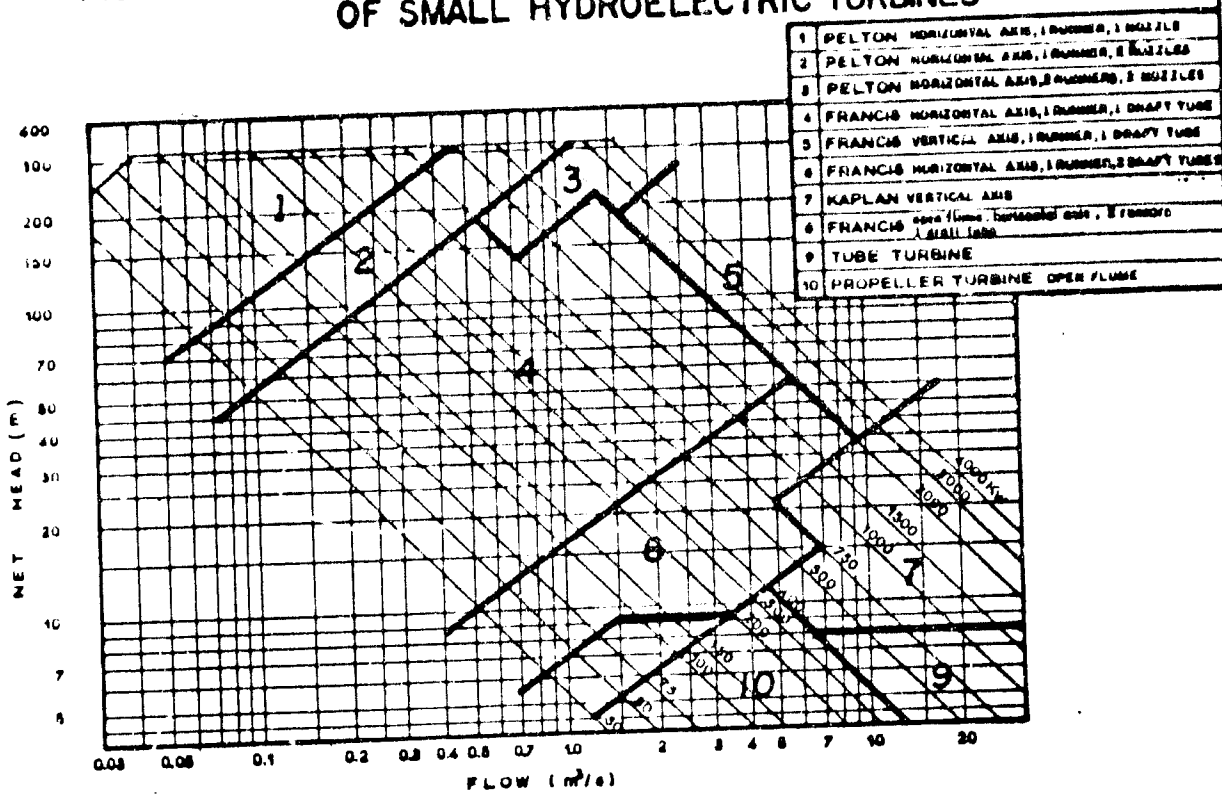
As part of a simplified methodology that will enable OPTA to quantify the load on a future SHPP, the socio-economic aspects of the service area will be described principally in terms of the potential demand and the usage of electricity as an alternative to traditional sources of energy.

In determining the demand structure, the factors listed in Table 1 will be considered. In the absence of detailed information, Electroperu's demand model will be used. Electroperu is combining the results of census data taken in 1961 and 1972 to project population growth profiles. Census data are also used to correlate the number of households in the demand area with its population.

The survey form for the SHPP (Table 4) will be used to generate data on household consumption and expenditure of electrical and other forms of energy.

Using the assumption of an average per capita load factor of 60 Watts, the following population load chart will be used as a first approximation for demand estimates.

FIGURE 3 THE SELECTION AND CAPABILITIES OF SMALL HYDROELECTRIC TURBINES

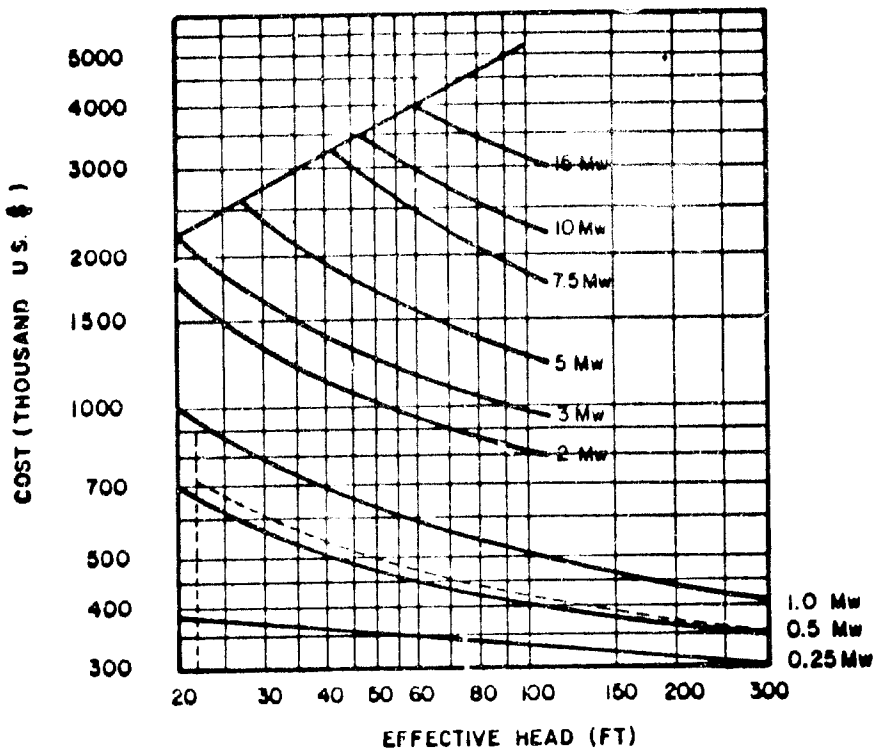


EXAMPLE For a flow (Q) = 2.1 m^3/s and a net head (H_N) = 20 m. find the point of intersection of the vertical line, that corresponds to Q= 2.1 and the horizontal line, that corresponds to H= 20. The graph indicates that the small hydroelectric system has a potential capacity of 300 Kw and that the proper type of turbine for this situation is a horizontal Francis turbine with 1 runner and 2 draft tubes

TYPE OF TURBINE

Reaction Turbine Propeller Turbine	Penstock Open Flume	Horizontal axis Vertical axis	Runners with fixed position blades (propeller) Runners with adjustable blades (Kaplan	
Reaction Turbine Francis Turbine	Penstock Open Flume	Horizontal axis Vertical axis	One runner Two runner One runner	One draft tube Two draft tubes One draft tube Two draft tubes One draft tube
(Impulse Turbine) Pelton Turbine		Horizontal axis Vertical axis	One runner Two runners One runner	One nozzle Two nozzles Two nozzles Four nozzles Several nozzles

FIGURE 4 POWER FEATURE COST



NOTES:

1. Estimated costs are based on a typical or standardized turbine coupled to a generator either directly or through a speed increaser, depending on the type turbine used.
2. Costs include turbine/generator and appurtenant equipment, station electric equipment, miscellaneous powerplant equipment, powerhouse, powerhouse excavation, switchyard civil works, an upstream sluice gate, and construction and installation
3. Costs not included are transmission line, penstock, tailrace construction, switchyard equipment, and dam modification or improvements.
4. Cost base July 1978.
5. For a multiple unit powerhouse, additional station equipment costs are $20,000+$58,000 x (n-1), where n is the total number of units.

Source: U.S. Army Corps of Engineers, "Feasibility Studies for Small Scale Hydropower Additions," July 1979, Volume 1, Page 4-7.

No. of inhabitants	Demand
500 - 1000	30 - 60 KW
1000 - 2000	60 - 120 KW
2000 - 4000	120 - 240 KW
4000 - 6000	240 - 360 KW

Source: After Nozaki (1968)

Load and energy forecasts will then be made using an annual average growth rate of 5% (Nozaki, 1968). For example, the demand load of a community of 2000 inhabitants, with an annual average growth rate of 5%, will be, after 10 years:

$$120 \text{ Kwh } (1+0.05)^{10} = 195.46 \text{ Kwh.}$$

Table 1

FACTORS TO BE CONSIDERED IN MAKING THE DEMAND SURVEY

1. Current number of inhabitants
2. Average household size
3. Average current household expenditure on energy other than electricity
4. Number of projected connections
5. Number of small industrial enterprises
6. Number of commercial establishments
7. Number of schools, health centers and other community services
8. Current and projected demand for electrical energy
9. Average monthly KWh consumption per household
10. Basic assumptions for the survey

2) Benefit and Cost

Benefits consist of revenues plus surplus benefits. Revenues are the product of tariff times estimated electricity consumption in each year. Costs consist of total capital costs plus annual operating and maintenance costs. Both will be projected over the useful life of a SHPP and discounted at 15 percent.

3) Surplus Benefits

The introduction of electricity into rural areas has the potential of providing a variety of economic benefits. In the case of resource savings, surplus benefits result because some previously used energy resources have been substituted by electricity not for residential lightning but also for cooking, appliances, equipment repair, entertainment and productive tools.

This aspect of rural electrification will be dealt with at greater length at the feasibility methodology level; however, it is clear that to achieve income redistribution and employment generation within a community, promotion of the productive usage of electricity for small shops, farms, and service units will be required from OPTA to support the SHPP program.

Additional surplus economic benefits derive from the role which the availability of electricity can plan in promoting improved agricultural productivity through irrigation, through the expansion of agro--industrial enterprises and through the creation of job opportunities as a result of the diversification of economic activities in the area.

Because of these considerations, the preliminary screening model will at first value surplus benefits at 100% of the value of predicted power sales. As stated in the text of the Project Paper, this value will be changed when a better estimate is made available early in the Project's life as a result of a special study for this purpose financed under the Project.

4) Economic Feasibility

A project will be considered economically feasible when discounted benefits exceed discounted costs. The benefit-cost ratio analysis will use a discount rate that represents the social rate of return on capital. An example of this computation forms part of the case study described in the text of the Project Paper.

The proposed methodology will rank alternative sites according to economic returns. A preliminary determination of project feasibility may be made in part on the basis of the benefit-cost ratio.

If the ratio is greater than 1, the project will tentatively appear to be feasible, and further evaluation will then be recommended.

If the ratio is less than one, the project will be eliminated from consideration.

Projects will be ranked on the basis of the benefit-cost ratio and feasibility studies performed in that order.

5) Projected Subsidy required from ELECTROPERU

A projected subsidy calculation will indicate the degree to which each plan is expected to pay for itself. Such calculations could take the form of (a) discounted revenues divided by discounted costs (both denominated in currency units of constant purchasing power -- i.e., excluding inflation) or (b) cost per per Kwh versus average price per Kwh charged to consumers (both discounted and denominated in constant purchasing power currency units).

6) Identification of Links with other Development Projects

Electricity is a basic element for the adoption of technologies which widen a community's range of possible economic and social activities. Thus, a SHPP project can have a synergistic effect on development projects in the area. Therefore, in a reconnaissance study, it is necessary to gather information on ongoing local, national and international development projects in the SHPP catchment area funded by development entities.

In the private sector, this information is inferred from the responses to the survey form for SHPP. Preliminarily information on development programs that are funded by national and international agencies is available in a report published by the National Institute of Planning of the GOP (INP) entitled Evaluación Global de la Cooperación Técnica Internacional recibida durante 1978 published in October 1979. Later editions will be used as they become available. If necessary, such information will be supplemented from other sources (such as INP), especially with regard to new projects. The donor agencies can also provide information on specific projects that are envisaged or are being implemented in the SHPP catchment area.

Then, Table 3 can be used to identify the linkages between the development projects and the supply of electricity in the catchment area.

d) Social, Political and Environmental Criteria

This subsection deals with the methodology for integrating social, political and environmental impacts into a reconnaissance study. The methodology is designed to analyze the target community's capacity to capitalize on the benefits associated with SHPP electrification (See Table 3 Socio-Economic Impacts of Electrification by Small Hydroelectric Power Plants). A methodology is developed to make a judgement on the effects of the installation of the SHPP (and all the associated civil/electrical/mechanical works associated with an SHPP system) on the local environment.

i) Social and Political Criteria

The SHPP program takes as a basic premise a high degree of community participation in the construction of the SHPP facilities. To this end the community will organize a "Pro-electrification Committee" which is responsible for coordinating all pertinent community construction with Electroperu. The committee is compased of representatives of different sectors of the community.

The organization of Pro-electrification Committees follows a long-standing tradition of rural collective work organization in Peru (called faenas). This tradition is still very much alive in the communities of the Sierra and the High Jungle.

A methodology has been designed to sharpen Electroperu's perception of the community's involvement in the SHPP program. The methodology consists of four steps:

1) Compilation of available data from GOP sources such as census data.

2) A social and economic survey will be made of the community using the supplied survey form (Table 4).

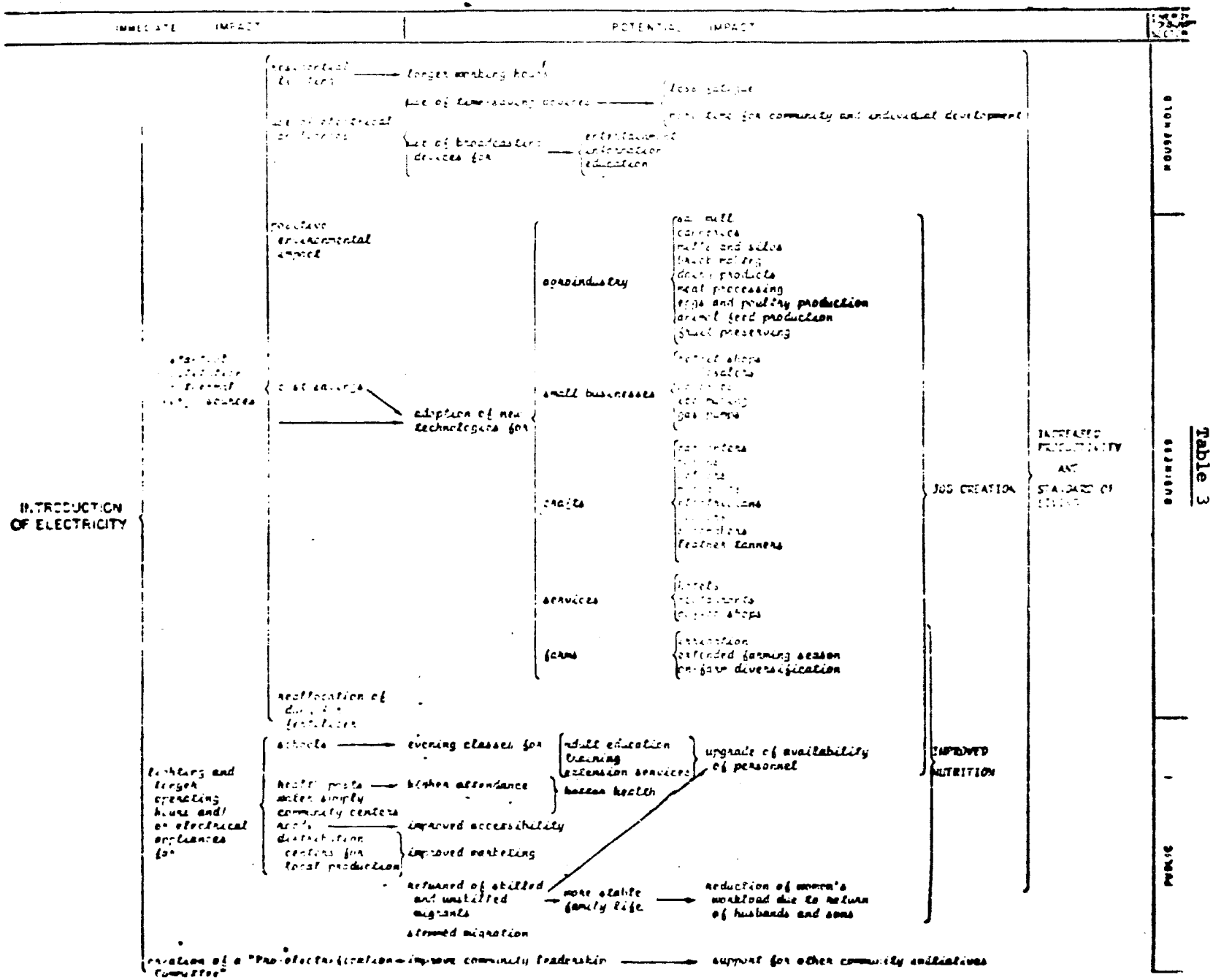
3) Tallying the results of the survey.

4) Integrating and analyzing the results of steps 1) and 3).

The survey will be conducted at the municipal office.

Table 3

BY SMALL HYDROELECTRIC POWER PLANTS



A 2 day-long survey is appropriate and realistic for a pre-feasibility study, the survey should be conducted in the vernacular language of the interviewed be it Spanish, Quechua or another indigenous dialect.

The survey is directed to different sectors of the population:

1. Farmers
2. Public servants (e.g. school teachers, nurse)
3. Tradesmen
4. Craftsmen
5. Businessmen
6. Professionals
7. Political figures (e.g. village chief)
8. Regional businessmen

An adequate number of representatives of each of these sectors will be interviewed.

TALLYING AND ANALYZING THE SURVEY RESPONSES

Once the survey has been completed, the results are compiled for computing the community demand load for electricity and for assessing the community participation in the SHPP Project (Table 5).

The survey results will be analyzed to answer the following questions.

a) Does the SHPP Project benefit exclusively those who hold the highest political, social and economic ranks of the community or does it also provide service to all economic sectors? (identified by their monthly expenditures in energy resources).

b) Is there a correlation between the number of people participating actively in the project (through cash donations and/or participating in the faenas) and the number of potential hook-ups?

c) Do the members of the Pro-electrification Committee (created for the organization of the faenas) utilize their position for individual political or economic gain from the SHPP electrification?

d) Will the creation of new opportunities for enterpreneurs, skilled and unskilled labor, and surplus farmers automatically improve the standard of living of the poorest sector of the community?

Finally the survey results are checked and correlated with the data that has compiled from GOP sources.

General Environmental Criteria for Prefeasibility Study

The prefeasibility study for each site for a small hydroelectric power plant will include an environmental assessment that will be conducted by Electroperu, the GOP Agency that has basic project development responsibility. More advanced and detailed analysis of SHPP's at the feasibility level will be carried out by some other independant institution with recognized capability in the environmental field, namely La Oficina

TABLE 4

SURVEY FORM FOR SHPP

Name of community:

_____

Name of representative:

_____

Sector represented:

Date:

_____

Electric Service Available:

None

Diesel_____ Other _____

Sector willing to contribute to the project:

Labor (man/days) _____ Money $ _____

Materials _____

Economics: Energy expenditures for household

per month

1. less than $ 2
2. $ 3 - $ 4
3. $ 4 - $ 6
4. $ 7 or more

Number of sector electrical hook-ups _____

Projected h/h consumption _____ KWH (mo)

Value of Demand .....$ _____

Affordability _____

Immediate and potential uses in the sector within the

household (lighting, cooking, (entertainment) _____

Cottage industry _____

Agroindustry _____

Small businesses _____

Agriculture _____

Public Services _____

Foreseeable drawbacks _____

Evaluation:

TABLE 5

SUMMARY OF THE RESULTS OF THE COMMUNITY SOCIO-ECONOMIC SURVEY

SECTOR	Population total hook number ups	Current monthly average energy expenditures	Participation in SHPP Project man/day	$	Projected Uses of Electricity immediate	future
Farmers						
Public Servants						
Tradesmen						
Craftsmen						
Businessmen						
Professionals						
Political figures						
Regional businessmen						
Totals						

Nacional de Evaluación de los Recursos Naturales (ONERN) or some other designated professional group. This approach will both assure that Electroperu develop an internal capability of and sensitivity to environmental assessment but at the same time provide for a critical and objective analysis of each proposed SHPP by a capable and independant second party with power of mitigation or cancellation prior to the initiation of construction.

There is a common tendency in Latin America to colonize forested hinterlands, to expand the agricultural frontier, to improve economic conditions and reduce rural to urban migrations. When adequate analysis is not made of the potential productivity of these new areas and orientation given accordingly to the colonization process, however, frequently the expected riches of the new frontier quickly turn into degraded and eroding wastelands that in turn take their toll on small colonist-farmers. In the wake it is also normal to find depleted forests, fish and wildlife (upon which the colonists have had to subsist) and perhaps the initiation of watershed disbalanced that will likely yet worse if land use does not improve.

In Perú, new colonization efforts and a "conquista" attitude prevail throughout the Ceja de Selva (high jungle) and Selva (lowland jungle) areas. It is in these areas where many of the new demands for public services in the form of roads, schools, electricity, etc. will come. It is most critical that the GOP develop an organized and rational procedure for promoting such colonization. Basic reconnaisance information concerning slopes, soils, climate, forest resources, etc. will permit the government determined what is viable and what is not, on a first order approximation, and therefore orient its credit, roads, school and educational services, etc. to the specific needs of each zone. Not to do this is to open the floodgates to unwanted wastage of natural resources and unnecessary human misery.

SHPP, like many other type of public services, can play a decisive factor in the promotion or deterance, success or failure, of a rural village. Studies will therefore determine, on a reconnaissance level, land use capabilities and general resource potential for those areas where colonization is occuring and SHPP's are being requested, to determine if it is justifiable that these areas be opened up and in what way. It is likely that some will be determined rich agricultural and/or forest resources areas and should be opened up. Others may be too steep with poor soils, and too wet and should best be kept in protection forests. In these later cases SHPP's should be negated at a prefeasibility stage.

In determining SHPP prefeasibility for already developed Sierra and Coastal regions, prefeasibility considerations should basically be based upon points 2 and 3 of this section. However, in special cases where sites have little or no resource productive potential or are located within inherent protection areas because of their steep physiographic and/or extreme ecological conditions, similar criteria as mentioned above should be applied and SHPP prefeasibility determination should be negative.

It is a primary objective of prefeasibility analysis to, on a first order, distinguish viable and non-viable projects. From an environmental point of view there are three basic considerations that should be taken to permit

passing on to a feasibility stage:

1) Should development be stimulated in the area and if so what type of development will be stable, productive, and protective of the resource base?

2) Is the available water resource of the watershed concerned of adequate quality, quantity and regime to meet project needs?

3) Is there adequate local interest and support to uphold the environmental protection requirements of the project?

1) Of special concern in undeveloped rural areas is the early establishment of productive land uses that will be sustainable and non-exploitative of the renewable natural resource base (soil, water, forests, fish, wildlife, etc.). In certain areas, for example, local rural industries should be based on agriculture, while in others their resources make them most suited for forestry on fisheries.

2) For all sites the availability for adequate stream flows to ensure efficient and reliable hydroelectric power generation is a fundamental criterion that must be satisfied at the prefeasibility stage of site evaluation. Recent, accurate records of streamflow and sediment discharges for a minimum 2 - 3 year period must be available in order to determine the appropriate size and type of turbines and to predict the daily and seasonal availability of water for generation of electricity.

Streamflow and sediment recording installations, suitable to the conditions of each particular site, should be installed as early as possible for all sites that are to be considered for SHPP's. At the time of any given prefeasibility determination if the required 2-3 years of base data does not exist for any given potential site. That site will be deferred from consideration until such information is available.

Every effort will be made at the prefeasibility stage of identify all existing or potential public and private water users (including minimum flows necessary to support fish and other aquatic organisms) that affect flows in the stream. The location of all water intakes and discharges in the affected area, as well as the respective flow rates and nature of the affluents, must be developed. Only in this way can potential water use conflicts which might prevent SHPP development be identified and resolved.

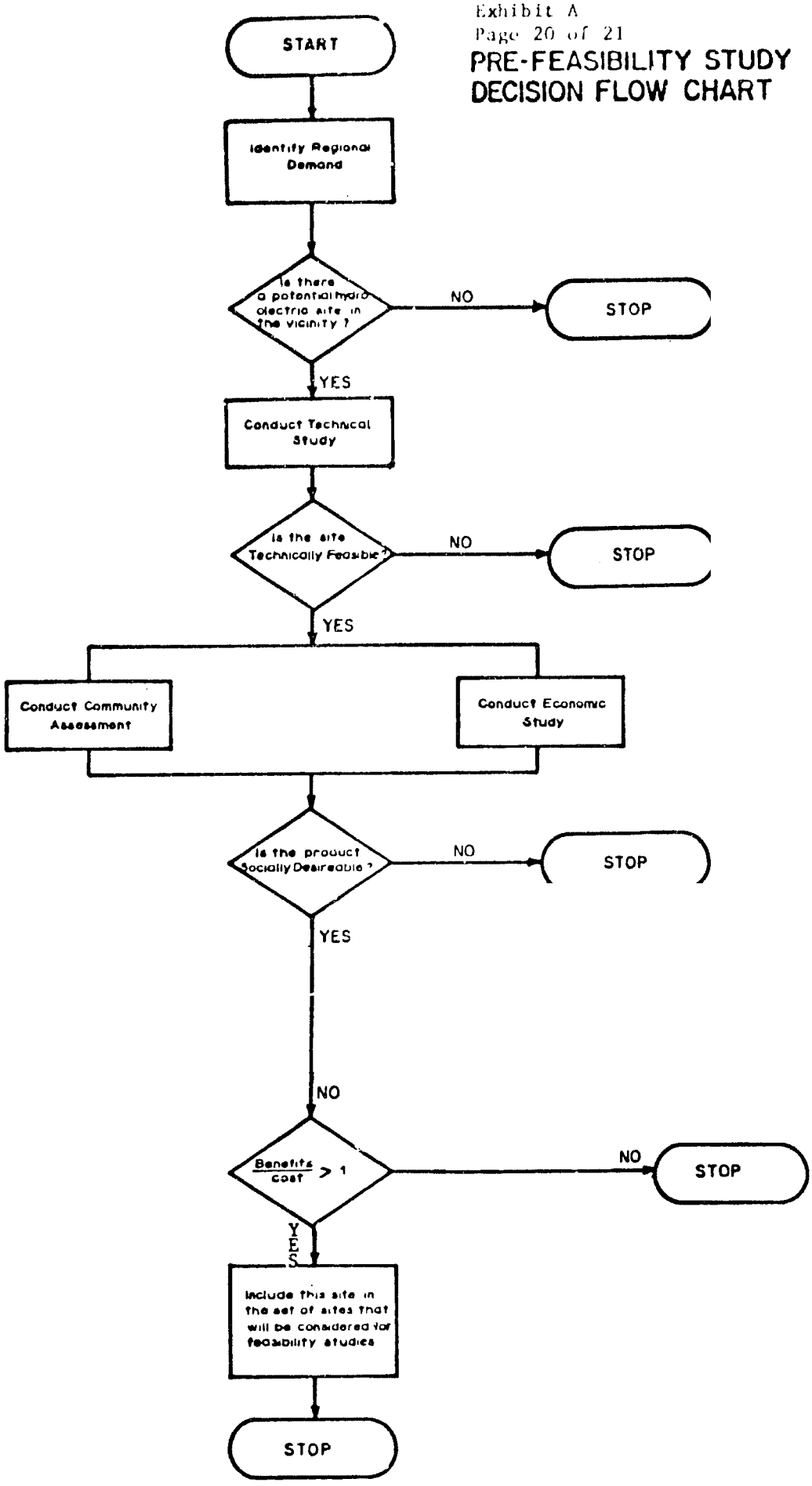
It is important to determine at the prefeasibility stage if the proposed site is near or in a protected area that enjoys special legal status or if its land use capability is such that it should be declared as, or as part of awildlands area. If a protected river or area (for example, a national park, a forest reserve, a wildlife preserve, sanctuary, or refuge) is threatened by construction and operation of a SHPP, it may be legally impossible or unrecommendable to develop at that site, whatever the projected be benefits. Similarly, if the existence or habitat of any rare or endangered plant and animal species are threatened by SHPP development, the site may not be feasible from both an environmental and legal stand-point.

3) The local community (ies) to be benefited by a SHPP should be involved in the planning and development of the Project as early on as possible. It is important that they be in agreement with the Project and support it in all its ramifications, with respect to the environment it may be necessary for the local people to provide lands for the project site and roads right of way way; for certain projects a protection watershed will need to be established and the local government on the GOP will have to provide these lands, forest guards and other minor resources for assuring an adequate water resource for the SHPP. Such potential requirements as these, although not yet fully developed at the prefeasibility stage should be discussed with the community and an affirmation of full cooperation (if possible written) should be received from the community before proceeding on to feasibility stages.

e) OPTA's Prefeasibility Decision Flow Chart

Figure 5 is a decision flow chart that has been designed for the Planning Office of Applied Technology (OPTA) of Electroperú for conducting a pre-feasibility study. It shows the order in which the technical, socio-political and economic sections of the pre-feasibility study are carried out, and the critical points where decisions must be made to continue with the pre-feasibility study or to discard it entirely.

PRE-FEASIBILITY STUDY DECISION FLOW CHART



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FEASIBILITY STUDY METHODOLOGY

INTRODUCTION

The feasibility study methodology has been designed to investigate thoroughly whether project (that has passed the screenin' e-feasibility stage) should be constructed and what steps should be taken for its implementation. The feasibility study methodology consists of seven parts:

1) Potential energy determination (including a community profile and a demand forecast).

2) A technical analysis (that will generate a complete description of the site's topographic, geologic and hydrologic conditions, the existing electrical service, the use of water upstream and downstream from the proposed site, plus a complete description of all the civil and electro/mechanical engineering activities related to installation of a SHPP and their associated environmental impacts).

3) A costing analysis (including detailed information on all civil engineering works, electromechanical costs, indirect plant costs and operation and maintenance costs).

4) Economic analysis (including detailed information on the economic benefits accruing to the project).

5) Institutional analysis (that describes in detail how the project will be managed and includes information on how the participation of other governmental entities within and without Electroperu is optimized).

6) Social analysis (that describes the expected social benefits from implementing the project) and

7) Environmental analysis (that reviews all the favorable and unfavorable environmental impacts that result from the installation of the SHPP).

a) SOCIO-ECONOMIC DEMAND PROFILE

This section of the feasibility study methodology will characterize a community in terms of its current socio-economic milieu. Subsequently, the following information will be generated:

i) An electricity demand forecast.

ii) An evaluation of the short and medium term socio-economic impacts of electrification in the community with a special emphasis on the project's impact on women.

The following assumptions have been made:

1) A PFS has been carried out and the site has been found suitable for the installation of an SHPP.

2) The community at-large is favorable to contributing to the construction of the SHPP. This is confirmed by checking the results of the PF study survey to see if the number of man days of work offered are sufficient to perform the civil works assigned to the community.

3) The methodology takes as a frame of reference the socio-cultural milieu of small isolated communities that are located in the Sierra and the High Jungle.

i) COMMUNITY PROFILE

To assess the socio-economic soundness of the SHPP, the PFS has provided, grosso modo, the profile of current and future energy use. At the feasibility stage, the study requires an in-depth analysis of the community.

The feasibility study will consist of two steps:

A) Gather data from the following sources:
1) The results of the PFS.
2) Supplementary census data.
3) An in-depth survey of the locality.

B) Analyze the data, and where pertinent indicate possible adverse impacts. Further information is given below on the data gathering and analysis steps:

A) Data Gathering

PART 1 - The PFS gives data on the
- size of population
  number of inhabitants
  number of households
- length, travel time and means of transportation (e.g. by truck, by automobile, by horse, on foot)
- projected improvements.

PART 2 - The survey continues by collecting data on the community's population, public facilities, and private sector economic activities. To achieve this objective, the community authorities will be interviewed using the procedure outlined in Tables 1 to 3.

PART 3 - A community's social structure and distribution of power may tend to block certain activities and facilitate others, inhibit the formation of certain types of relationships and foster the development of others.

Hence, the study will investigate the distribution of the community's social structure in terms of economic and political power in order to identify the actual ultimate beneficiaries of the project. In order to gather relevant information to perform an assessment of the community's social structure, key information sources in the community will be consulted. The results of these findings will serve to identify the sample for the family interview. (Use Table 4)

PART 4 - In order to evaluate the foreseeable impacts of electricity on a family's allocation of time to household, leisure and economic activities, selected families will be interviewed (using the format in Tables 5 and 6). These families will be chosen according to the following criteria:

- land size
- off-farm wealth
- political power
- education
- migration pattern

A representative sample of families will be interviewed.

The interviewer must be able to speak the vernacular of the site (e.g. Spanish, Quechua). If possible he/she will be a person known to the community (e.g. a local nurse, school teacher or social worker).

B. ANALYSIS OF THE DATA

The data obtained from the prefeasibility study, the national census and the feasibility study survey are used to answer questions related to the use and effects of electricity.

It can be assumed that the lighting of public facilities will benefit the whole community. The survey will also indicate if electricity will upgrade the availability of public services, by extending their operating hours, by expanding their premises, and/or by adding new ones. The consolidated results from using tables 1 and 2 will indicate in which services improvements will be made.

The introduction of electricity will allow for the adoption of time-saving devices by industry, commerce, artisans, the agricultural sector and by households. The extra "free" time generated can be used for income-generating activities, individual development and leisure activities. The consolidated results from using tables 3 and 6 will point out what activities can be mechanized to optimize the use of time.

The evaluation must also prioritize the appropriate actions that need to be taken to promote new productive uses of electricity in the locality. These actions can include: appropriate technology information and demonstration sessions, vocational and technical training, organization for communal purchase of grinding mills, water pumpts, cold storage plants for fruits and vegetables or medicines, etc.

The consolidated results from Table 4 will serve as a basis to assess the income distribution effect of electrification. This is done by checking whether a positive correlation exists between those persons with economic and political power and the envisioned expansion of productive economic activities. (Table 3).

TABLE 1 COMMUNITY SURVEY

LOCALITY: DISTRICT: PROVINCE: DEPARTMENT:

POPULATION	MALE	FEMALE	CHILDREN	TOTAL
RURAL a) Subsistence b) Minifundistas c) With > 5 ha.				
URBAN				
TOTAL				

AUTHORITIES (include pro-electrification committee)

NAME	POSITIONS	YEARS IN SERVICE	ADDRESS

Indicate number of families interested in immediate hook-up to the SHPP: a) Subsistence b) Minisfundistas c) With > 5 ha d) Urban

AVAILABLE SERVICES	YES/NO	SYSTEM	WILL THIS SYSTEM BE REPLACED BY AN ELECTRICAL ONE AFTER ELECTRIFICATION?
PUBLIC LIGHTING		(DIESEL, OIL,.....)	

TABLE 2 - PUBLIC FACILITIES SURVEY

PUBLIC FACILITIES	NUMBER	AREA (m)2	NUMBER OF ROOMS	NUMBER OF LIGHT BULBS 75w. 50w. 25 w.	OTHER USES	OPERATING HOURS	ELECTRICITY DEMAND	DAILY ATTENDANCE (users o emp.)	WILL NEW FACILITIES BE BUILT OR OLD ONES SERVICE EXPANDED AFTER ELECTRIFICATIO m2 has employees
SCHOOLS									
CHURCHES									
HEALTH POSTS									
MUNICIPAL OFFICE									
POST OFFICE									
POLICE STATION									
COMMUNITY CENTERS									
JUDGE'S OFFICE									
MOVIE THEATER									
BANK									
HOTEL									
PHARMACY									
WAREHOUSE									
COMMERCIAL ESTABLISHMENTS, IN THE LOCALITY AND NEIGHBORING COMMUNITIES									
RETAIL SHOPS									
WHOLESALE									

TABLE 3 - LOCAL PRODUCTIVE ACTIVITIES

1) PRODUCT | MACHINERY USED | TOTAL PRODUCTION | REVENUE | 1979 REVENU

AGRICULTURE

potatoes
maize

CATTLE RAISING

bovines
ovines and goats
auquenids

INDUSTRIES

INDUSTRIES IN NEIGHBORING COMMUNITIES

2) SOCIAL OR ECONOMIC DEVELOPMENT PROJECTS IN THE AREA (PRIVATE OR PUBLIC)

SITE	IMPLEMENTING AGENCY	TYPE	CHARACTERISTICS (machinery, number of people involved)

3) WHICH OF THE ABOVE PRODUCTIVE ACTIVITIES WILL CHANGE IF ELECTRICITY IS BROUGHT TO THE LOCALITY? HOW WILL THAT AFFECT THE JOB MARKET?

4) What percentage of people have (or have access to, e.g. borrow) sufficient resources to buy the appliances/equipment needed to electrify these activities?

TABLE 4 - COMMUNITY STRUCTURAL ASSESSMENT

INFORMATION SOURCE	INFORMATION TO BE COLLECTED
LAND TITLE RECORDS	**LAND TENURE PATTERN** — NUMBER Number of landless peasants Number of minifundistas (less than 5 ha.) Number of comuneros Others (e.g. urban)
MUNICIPAL EMPLOYEE	**DISTRIBUTION OF OFF-FARM WEALTH** Number of families owning non-agricultural productive enterprises. Number of community's notables (e.g. doctor, judge, political leaders). Others (e.g. urban)
MUNICIPAL EMPLOYEE	**DISTRIBUTION OF POLITICAL POWER** — PERCENT Percentage of families represented in local committees. Percentage of families which influence the community's decision making process.
MUNICIPAL EMPLOYEE	**MIGRATION PATTERNS** Size of migration flux Migration seasons Length of absence/stay Sexual distribution of migratory labor Male: Female:
LOCAL SCHOOL TEACHER	**EDUCATION LEVEL** — M W % of men and women with primary education % of men and women with secondary education % of men and women with higher education % of men and women with vocational education % of illiterate population
LOCAL COMMUNITY	**WAGE RATES IN THE AREA** TYPE — PRICE — LOCAL AVAILABILITY Carpenter /day Mason /day Unskilled worker /day

TABLE 5 - COMMUNITY'S ENERGY USE PROFILE

NAME	OCCUPATION	FAMILY SIZE	INCOME	RESIDENCE NUMBER OF ROOMS	PRESENT ENERGY USE IN S/.								REQUIRED SERVICES					TYPE OF SERVICE Residential Commercial Industrial Public
					kerosene	gas	bundles firewood	coal	batteries	candles charcoal others	Total	lighting	radio	sewing machine	clothes iron	other		
Subsistance (S) Minifundista (M) 5 ha (5) Urban (U)																		
TOTAL																		

* Does your family have (or have access to e.g. borrow) the resources required to purchase these appliances?
* Are you willing and able to pay for hook up?

TABLE FAMILY TIME ALLOCATION

NAME:
FAMILY SIZE:
LAND SIZE:

AGRICULTURE (Name Products)	MAN days/yr	MAN Hrs/day	WOMAN days/yr	WOMAN Hrs/
tilling				
sowing				
weeding				
irrigation				
harvesting				
transport				
others				
GARDENING				
PROCESSING				
husking				
milling				
drying				
others				
ANIMAL RAISING				
cattle				
auquenids (e.g. alpacas, vicunas, llamas)				
sheep				
goats				
poultry				
other				
DOMESTIC				
water fetching				
firewood gathering				
dung collecting				
washing				
cooking				
sewing				
other				
COTTAGE INDUSTRY				
knitting				
weaving				
candle making				
wood carving				
others				
MARKETING				

1. WHICH OF THE ABOVE ACTIVITIES WILL YOU MECANIZE AFTER ELECTRIFICATION?

2. Do you have or have access to (e.g. borrow) sufficient resources to buy the equipment to electrify such activities?

Role of Women

In rural Peru the woman is the family member who spends the most time in the house; therefore, she will be the family member who will benefit the most from electric lighting and from the use of mass communication facilities (such as radios), for entertainment and education.

The rural woman has the primary responsibility for i) domestic chores (cooking, washing, food processing), ii) gardening, iii) raising small animals, iv) undertaking selected agricultural activities and v) transport and marketing of produce and household crafts. Specific actions can be identified from her usage of time (Table 6). Time intensive activities such as water fetching, firewood gathering and dung collecting will be eliminated or reduced if electricity is used to pump water for drinking and small-scale irrigation (through electricity powered water pumps), and substitute traditional fuels for cooking and heating.

Possible Adverse Results

The PFS methodology has been designed to assess whether electrification may affect negatively some members of the community. The newly collected data from the feasibility study allows the planner to sharpen this evaluation.

For instance, the demand for the services of candles, firewood and kerosene merchants will decrease as substitution for electricity occurs. They will therefore be adversely affected unless provisions are made to facilitate their entry into different activities.

Another adverse impact can stem from the competitive use of water. Where the water flow is insufficient to meet both the SHPP and upstream irrigation demands, it will be necessary to arrange for the rational use of water and, possibly plan for the construction of a dam.[1/]

ii) Demand Load Forecast

The results of the survey will also be used to forecast the demand load for the community.

The following list details the step sequence in making the demand load forecast:

1) Calculate household energy use for the whole community.
2) Calculate community public energy uses.
3) Calculate industrial and commercial energy use.
4) Calculate agricultural energy use.
5) Calculate total energy demand.
6) Calculate average household consumption

1/ Ing. Octavio Mendoza Montesino, info. Interno 047-79 (26/12/79), "Planificación del Caudal Hidrológico de la Central Hidroelectrica de Izcuchaca", Distrito Izcuchaca, Provincia Huancavelica, Departamento de Huancavelica.

7) Cost savings per household.

Step 1 - Calculate h/h energy use

X = number of families at subsistence level
Y = number of minifundistas
Z = number of families with more than 5 ha. 1/
O = number of other families (e.g. 'urban')
a = proportion of X who would hook-up
b - proportion of Y who would hook-up
d = porportion of Z who would hook-up
l = porportion of O who would hook-up

a) Calculate average consumption of electricity for families for type x, y, z and O.

X_c = average consumption for family X
Y_c = average consumption for family Y
Z_c = average consumption for family Z
O_c = average consumption for family O

Table 5 indicates the prognosticated use for each type of family. Table 7 is used to determine the required energy capacity for each kind of appliance.

b) Calculate total h/h consumption = H_c

$$H_c = a X X_c + b Y Y_c + d Z Z_c + l O O_c$$

Step 2 - Calculate community public facilities electricity use (= C_c)

a) Use Table 2 to determine the energy required for all public services.

For drinking water, assume a demand of 20 liters/inhabitant/day 1/. Calculate C_c by multiplying the power needed to pump a liter of water by the total annual water consumption.

Step 3 - Calculate industrial and commercial demand (= I_c). Tables 2 and 3 will indicate the establishment which will be hooked up. Table 8 determines the energy required by typical scale enterprises.

1/ These categories are only indicative. They will vary according to the economic base of the power structure of the specific community.

Step 4 - Determine agricultural electricity consumption (+ A_c)

For irrigation (see Table 3) 50 m^3/ha/year[2/].
For animals (see Table 3): 40 liters/animal/day[2/].

Calculate Ac by multiplying the power required to pump a liter of water by the total annual water consumption.

Step 5 - Calculate community = D_c

Step 6 - Calculate average h/h consumption.
Aug. $H_c = \frac{D_c}{n}$

Step 7 - Cost Savings (Affordability)
Present monthly expenditures in energy sources likely to be substituted by electricity (candles, batteries, kerosene).

a) Average expenditure by surveyed familis S/.

(1) Average H_c/month Kwh
(2) Rate per Kwh 5 S/.

b) Average h/h monthly expenditures (1x2) S/.
c) Cost savings = a - b

ESTIMATING THE DEMAND GROWTH OF THE COMMUNITY

In order to calculate demand for electricity by household, commerce, agriculture, public services, etc., initial year estimates will be extrapolated according to the growth factors developed below.
a) Population growth. To forecast the population growth rate of the community the following elements are taken into account:

- Total population growth (Crude birth rates minus crude death rates) _____
- Plus net migration (influx to the poblado from the casaríos minus emigration, see results of Table 4) _____

Apply the following formula for calculating population for year n, where

P_n = total population for year n

P_o = population of year 1980

r = the population growth rate

x is the difference between n and 1980

1/ O. Chaquea Blanco, Opcit p. 21.
O. Chaquea Blanco, Op.cit p. 25.

TABLE 7 - DEMAND LOAD FOR HOUSEHOLD ITEMS

Light bulbs	25, 50, 75 or 100 w.
Fluorescent lamp (equivalent to 100 w.)	20 w.
Radio	5 w.
Television (18")	14 w.
Refrigerator (6 ft.)	180 w.
Blender	100 w.
Fan	35 w.
Sewing machine	100 w.
Small clothes iron	300 w.

SOURCE: O. Chaquea Blanco et. al. Viabilidad de las micro centrales hidroelectricas en Colombia, Fundación Mariano Ospina Perez, Bogotá, Octubre 1979, pgs. 21 and 23.

TABLE 8 DEMAND LOAD FOR SMALL SCALE ENTERPRISES

ACTIVITY	REQUIRED CAPACITY (Kw)
CARPENTRY	3 - 15
BAKERY	2 - 5
CRAFTS	1 - 2
SMALL SAWMILLS	15 - 30
GRINDERS	10 - 20
FLOUR MILL	3 - 20
LOOMS	0.5 - 6
COFFEE GRINDER (COMMERCIAL)	5 - 30
QUARRY MILL	6 - 30
ICE MAKING	6 - 60
IRRIGATION PUMP	2 - 100
BRICK FACTORY	1 - 5
ALBERGUE (20 guests)	2 - 5
RESTAURANT	1 - 2
VEGETABLE CANNING	5 - 20
DAIRY PRODUCTS	2 - 10
MILK (cooling and pre-evaporation)	5 - 20
ELECTRICAL AND MECHANICAL WORKSHOPS (repairs)	5 - 15
GAS PUMPS	2 - 100
SILOS	3 - 5

SOURCE: PROGRAMA REGIONAL DE PEQUEÑAS CENTRALES HIDROELECTRICAS DE OLADE, REQUERIMIENTOS Y METODOLOGIAS PARA LA IMPLEMENTACION MASIVA DE PEQUEÑAS CENTRALES HIDROELECTRICAS EN LATINO AMERICA, DOCUMENTO DE TRABAJO, QUITO, 26 DE JUNIO DE 1980, ANEXO VIII.

So,

$$P_n = P_o \quad (1+r)^x$$

b) Prognosticate the economic growth rate of the community. In order to calculate the economic growth rate of the community, g, for the 1979 and 1980 production figures that result (see Table 3) from the field survey will be used. To obtain more precise estimates, or if locality production figures were not available census data for production growth in the region should be consulted. The paramenter g will be multiplied by a number B (beta) which accounts for the added after-electrification economic impetus and its multiplier effects. The determination of B will follow criteria set by Electroperu in response to GOP policy.

c) Once the parameters r and g are calculated, the formula that appears below will be applied for determining the total demand for year n. The following assumptions are used.

H_c will grow at rate g

A_c and I_c with growth at rate (g)

C_c will growth at rate r

Calculations for year n

1) The number of h/h is P_n divided by the average family size in year n

2) The average family consumption is calculated thus:

$$H_{cn} = H_c \ (1 + g)^x$$

3) The total h/h electricity consumption in the number of n/n times the average Hc for year n

4) The electricity demand for productive activities (A_c; I_c) will grow for year n to

$$A_{cn} \quad I_{cn} = \text{Production initial year } (1+q)^x$$

5) The electricity demand for public services (Cc) will grow for year n to

$$(C_{cn}) = C_c \ (1 + r)^x$$

6) The total demand for year n will be

$$(P_{cn}) = H_{cn} + A_{cn} + I_{cn} + C_{cn}$$

COST SAVINGS ANALYSIS METHODOLOGY

The following guidelines provide a basis for quantifying cost-savings that result from substituting electricity for kerosene and diesel for households and farms respectively.

1. Residential Lighting

a) Assumptions

1) It is estimated that a pressurized kerosene lamp provides lighting equivalent to two forty watt flourescent lights.

2) A pressurized kerosene lantern requires one liter of kerosene for six hours of operation. Thus the daily operation of one lantern will be equivalent to 2 x 40 x 6/1000 = 0.48 Kwh.

3) Kerosene lamps have an average life of 3 years.

4) Light bulbs will be replaced 2 times/year.

5) House wiring depreciation: 5%/year.

6) Interest rate: = 15%/year.

b) Illumination factor

1 liter (kerosene) = 0.48 Kwh
1 Kwh = 2.08 liters

c) Economic Retail Price of kerosene per liter

wholesale price per liter S/. _____
indirect subsidy _____
economic wholesale price _____

b. Technical Analysis

The technical analysis consists of three major activities:

1. Site Characteristics and Existing Facilities
2. Project Description
3. Environment Impact

Each of these activities is described below under a separate heading:

i) Site Characteristics and Existing Facilities

The site characteristics and existing facilities are discussed under the following headings

1. Site Characteristics
2. Existing Electrical Service
3. Area Hydrology
4. Geology

5. Topography
6. Flow-Duration Analysis
7. Prognosticated Power

1. SITE CHARACTERISTICS

A narrative that describes the site in general terms will be provided:

I) Location (Province, Department, distance to the nearest town-latitude and longitude);

II) Access to the site in terms of existing and possible future communication routes (see also section 7 a) i); and

III) Characteristics of the river basin (topsoil cover, rainfall, runoff, underground aquifers).

2. EXISTING ELECTRICAL SERVICE

Where pertinent, the existing electrical service will be described in detail. In particular, the following items will be described fully:

1) The Power house.
2) The Electrical generating system (including the electromechanical equipment, the generator, (plus all pertinent instrumentation).
3) The Control system (including the instrumentation and control options.
4) The Control panel for the distribution system.
5) The Distribution system (including the operating voltage and the number of phases).

3. AREA HYDROLOGY

This section should include i) the Name of the stream and all connecting catchment areas ii) The Area of the watershed at the site iii) All Major uses of the stream water at the site and upstream and downstream from the site iv) The Mean, maximum and minimum stream discharge and v) The Name and current use of any impoundment, lake or reservoir in the catchment area.

Data should also be included on:

i) Regional precipitation ii) The Location of stream gauges iii) The Length, extension and correlation of the precipitation and stream flow records.

Hydrological studies will be developed to the highest possible level of confidence. The precision of the hydrological studies has high leverage on the design and the cost of the civil engineering works and on the electro/mechanical equipment.

4. GEOLOGY

A study of the site geology should be made with particular emphasis on the following topics.

1. Rock and Soil Types
2. Joints
3. Faults
4. Landslide hazards
5. Seismic potential (in terms of a Richter magnitude earthquake at a given distance)
6. Foundation conditions.

Where pertinent, drilling and/or geophysical surveys will be conducted to verify the geological adequacy of the site. The report of the geological site study should also detail (when appropriate) the corrective/preventive actions that should be taken to ensure the continued functioning of all civil engineering works associated with the SHPP. Examples of such corrective/preventive actions are the following: (Orellana Diaz, 1979)

1) Afforestation of hillslides to reduce the possibility of landslides.

2) Covering a tailrace with a concrete cover in areas that are prone to landslides.

5. TOPOGRAPHY

A topographical survey will be made of the site and surroundings of the proposed SHPP. Special attention will be paid to the proposed locations of i) The intake facilities (including the diversion barrage and sand trap), ii) The Headrace and a strip of 20 meters wide on each side of it, iii) The Forebay, iv) The Penstock and v) The power house.

The report on the topographical survey will include the following documentation:

1. A topographic map and an elevation profile of the entire SHPP system (from the intake point to the end of the tailrace) using a scale of 1:1000.

2. Topographic maps of key elements of the SHPP using a scale of 1:2000 (such as the intake facilities, the forebay, the penstock and the power house).

3. Notes on those geographical features (and their exact locations) that will affect the construction and functioning of the SHPP system (such as geological faults, ravines, large boulders, etc.)

6. FLOW-DURATION ANALYSIS

A flow-duration analysis is undertaken to characterize the river flow that is available for the generation of energy at the headrace intake point (See Figure 4). The methodology for conducting a flow-duration analysis is first to prepare a flow-duration curve. Second, using the information provided by the flow-duration curve, a flow value is chosen for calculating the prognosticated power.

The methodology for preparing a flow duration curve is first to rank order the time series by daily mean flows according to magnitude.

All site preparation activities shall be conducted by the contractor under the direction of Electroperu's site engineer.

The site clearing shall consist of the removal of all woods and trees from those areas where the civil engineering works will be carried out. The terrain will be graded for subsequent afforestation.

The contractor will ensure himself of the exact location of the key structures of the SHPP such as the intake point, the sandtrap, the headrace, the forebay and the power house.

Temporary access trails shall be constructed to each one of these structures, where possible, the temporary access trails shall not cross the proposed location of any of the SHPP elements such as the headrace. Of particular importance is the construction of an access trail between the forebay and the power house.

Earth moving activities include excavations, cuttings and landfills. Where necessary, all pertinent water flows will be bypassed or diverted (using temporary facilities) to ensure that all earth-moving activities will be executed under dry conditions. Special note will be taken of the following considerations:

I) Landfills shall not contain grass or residual vegetable matter.

II) All earth moving shall be conducted in a manner to conform to the civil engineering design specifications.

III) All excess residual material resulting from the earth moving activities.

2. <u>THE INTAKE STRUCTURE</u>

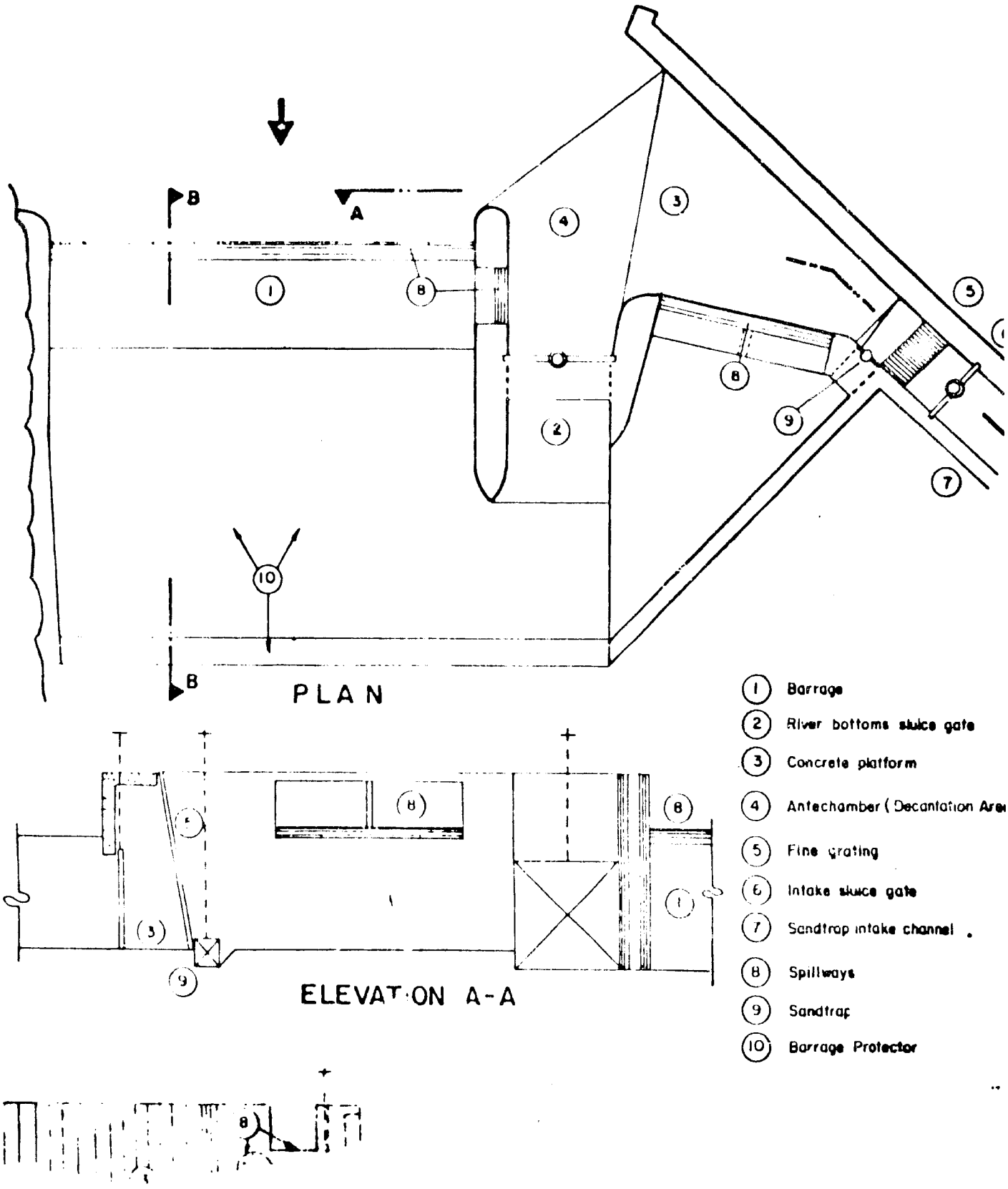
The intake structure consists of 10 elements:

1. The Barrage (complete or partial, fixed, temporary or seasonal)
2. River bottoms sluice gate
3. Concrete Platform
4. Antechamber
5. Fine Grating
6. Intake Sluice
7. Sandtrap Intake Channel
8. Spillways
9. Sandtrap
10. Barrage Protector

The design of the intake structure depends on the following factors:

1. Location (e.g. at a curve or in a straight stretch of the river channel).
2. The Site Topography (slope of the river bed, valley width).

FIGURE 1 THE INTAKE STRUCTURE



3. The SHPP design flow and the angle of deflection of the barrage.
4. The Ratio of the SHPP design flow to the maximum and minimum river flows.
5. Materials transport (quantity, frequency and size of materials transported by the river such as floating bodies, silt, stones, etc.)

Because of the wide variability in these parameters, no standardized intake structure can be designed. However, a general conceptualized drawing is available that shows the interconnections of all the elements that make up an intake structure (See Figure 9). Also, the following guidelines will be followed in designing the different elements of the intake structure:

I) The Barrage will be constructed of plastered concrete and include a spillway. In cases where the SHPP flow is approximately equal to the dry season river flow, the barrage can be changed temporarily using stones and wood.

II) The River Bottoms Sluice Gate will be custom designed to control the entry of stones and boulders into the SHPP system. The gate control handle will be so located that it is manoeuvreable during the times of maximum river flow.

III) The Concrete Platform will be 30 cm. above the level of the antechamber, and of sufficient length to ensure that the maximum water flow velocity at this point is 50 cm./second. For those rivers of the sierra which tend to carry stones and boulders, the concrete platform will be protected by a coarse screen of 2" bars located 20 cm. apart. In areas where floating trees and debris abound in times of flooding, (such as in the high jungle) a protective barrier shall be constructed above the concrete platform.

IV) The Floor of the Antechamber will slope slightly towards the river bottoms sluice gate and shall be made of concrete or stones set in concrete.

V) As mentioned previously, the spillways can be located in the barrage. They can also be located at the edges of the antechamber and of the concrete platform (See Figure 9). The width of the spillway (L) = the max of L_1 and L_2 or L_3, where
L_1 = 20 meters for every m^3/second of the SHPP design flow
L_2 = 0.5 meters for every m^3/second of the maximum river flow; (the access bridge height will be 1.5 meters above the crest of the spillways).
L_3 = 0.2 meters for every m^3/second of the maximum river flow (in this case the access bridge height will be 2.5 meters above the crest of the spillways).

VI) The Sandtrap will be designed to ensure that no articles larger than 0.3 mm. diameter will be carried out into the tailrace and beyond. This is achieved by designing the sandtrap for a maximum water velocity of 20 cm/second. (See Figure 10).

VII) Erosion in the upstream facade of the barrage will be reduced by constructing a barrage protector of at least 50 cms. height) upstream from the barrage (See Figure 9).

3. Canal/Penstock

This section covers all the civil engineering works that are put in place between the outlet of the intake structure and the power house. It is divided into three parts

I) The Headrace Design
II) The Forebay Design and
III) The Penstock Design

The Headrace Design

The Headrace Design will encompass two objectives i) movement of water with the minimum possible head loss and ii) keeping the headrace construction costs to a minimum.

In engineering practice, these objectives are accomplished by using a headrace with a trapezoidal cross-section and a slope between 1 and 2.5%. Erosion of the headrace lining is minimized if the water velocity is maintained within certain limits. For example, for a concrete-lined headrace the maximum recommended velocity for sierra (sandy) water is 1.33 meters / second. Figure can be used for calculating the key dimensions of the headrace. Tables 8, 9, 10, 11, 12, 13, 14 and 15 of Nozaki (1968) will be used for calculating the volume of concrete needed, the surface area of the concrete lining and the volume of the excavation works.

The Forebay Design

Table 15 of Nozaki (1968) will be used to calculate all the critical dimensions of the forebay. Knowing the SAPP design flow rate, we will calculate the values of 33 different parameters ranging from the diameter of the penstock to the water velocity as it leaves the forebay and passes through the fine screen on the way to the penstock.

The Penstock Design

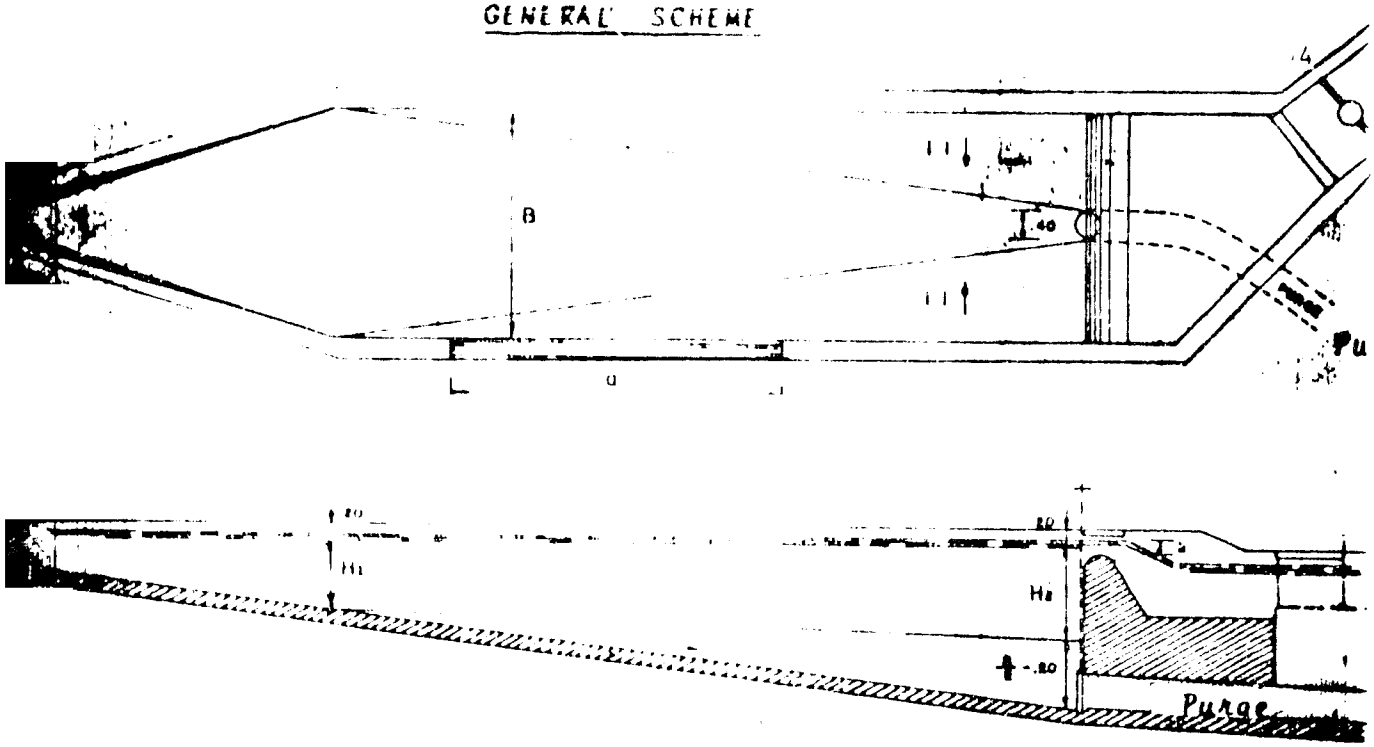
Once the penstock diameter has been calculated, it is rounded up to correspond to the diameter of commercially available tubing in Peru. Nozaki (1968) has prepared a series of graphs for calculating i) the water need loss in the penstock ii) the thickness of the penstock iii) the weight of the penstock and iv) the dimensions of the penstock supports (See Table of Nozabi).

4. Powerhouse

Nozaki (1968) has prepared standarized designs for constructing power houses for generating systems of up to 600 Kw capacity. Table 18 is used for calculating the area of the powerhouse. Once this known the full powerhouse dimensions are calculated using Tables 35, 36-1 and 36-2

SANDTRAPS FOR SHPP SYSTEMS

GENERAL SCHEME



PRINCIPAL DIMENSIONS

(IN METERS)

FLOW	TYPE	B	L	H_1	H_2	a	n	Purge Sluice
500 l/s	Primary	2.80 2.10 1.40	7.60 10.20 15.50	1.50 1.80 2.36	1.50 1.80 2.90	9.00 9.00 9.00	0.25 0.30 0.45	.40 x .40
200 l/s	Primary	1.80 1.40 1.00	4.80 6.20 8.60	1.10 1.30 1.60	1.10 1.30 1.90	3.50 3.50 3.50	0.20 0.25 0.35	.40 x .40
500 l/s	Auxiliary	1.80 1.40 1.00	4.80 6.20 8.60	1.10 1.30 1.60	1.10 1.30 1.90	5.00 5.00 5.00	0.35 0.45 0.60	.40 x .40
200 l/s	Auxiliary	1.20 1.00 0.80	3.10 3.50 4.30	0.70 0.85 1.00	0.70 0.85 1.10	3.50 3.50 3.50	0.25 0.30 0.40	.30 x .30

5. Turbine-Generator

The turbine-generating system is designed by the contractor that wins the competitive procurement. The following data are provided to the contractor by Electroperu.

Turbine

i) head ii) flow rate III) materials to be used in constructing the turbine system and iv) control systems v) fail-safe options.

Below are given typical material specifications for turbines (Electroperu 1979).

The following parts shall be constructed from cast iron I) the spiral case II) the regulation ring III) the outlet draft tube IV) the base plates V) the case and head of the shaft bearings etc.

The turbine axis will be constructed from forged steel. The turbine rotor will be constructed from cast chrome nickel high quality steel. A governor will be provided with both manual and automatic control options; a turbine speed tachometer will also be included.

Both sound and visual alarms and an automatic shut off capability will be provided to indicate high temperatures and low pressures in the lubricating oil. An automatic shut off capability will also be provided for the situation when the turbine's speed tends to get out of control.

Generator

The capacity of the alternator is provied by Electroperu. Usually, the alternator will be aim-looled and will be coupled directly to the turbine. The generator will be required to meet a specified KVA value at a specific temperature rise, power factor, 60 Hertz and a continuous overload rating of a specified percent.

Station service power will be supplied at a speficic voltage through 3 phase dry-transformers and through circuit breakers of specified capabilities.

Where necessary, the generator will be connected to a power transformer located in a small yard near the power house. The transformer rating will be specified.

6. Switchyard

Circuit breakers will be of the air magnetic on vacuum interruptor type as appropriate. They will be rated to interrupt the maximum xpected fault current and will be used to put the unit on-line during the normal start-up sequence and to take the unit off-line.

7. Transmission Lines

Table 23 of Nozaki (1968) is used to calculate the voltage and the diameter of the transmission lines' conductor once the demand load (s)

and the distance(s) of travel to the electrical energy market are known.

Environmental Impact

Section 1 discusses the types of potential environmental impacts that should be considered when evaluating the feasibility of a SHPP site for development. The checklist in this section provides suggestions for the type of information that should be collected and analyzed in order to assess the relative significance of these impacts at a given site. Most of the necessary information is at the reconnaissance level, that is, it can usually be quickly obtained by examining existing maps, reports, and publications, or by contacting appropriate people in government agencies, universities, or local communities. The items requested by the checklist are intended to represent the minimum information needed to cover a wide range of potential sites located across the country. In certain instances, particular factors may be inappropriate or additional questions may need to be asked in order to understand and predict the environmental impacts of the site development.

1) Are topographical maps available (1:25,000 if possible) which show the location of the SHPP facility components and, if a water impoundment is planned, the bathymetry of the future reservoir?

2) Are low-level aerial photographs of the site and watershed available?

3) Are stream flow data available for a number of years in order to ensure both adequate flows in the stream and reliability of SHPP operation?

4) What rainfall data exists for the study area? Do rainfall intensity values also exist?

5) How much water will be withdrawn for SHPP operation and where will the intake and discharge structures be located?

6) What are the alternate water uses in the area?
Determine the location of all water intakes or discharges in the affected areas and determine flow rates and nature of effluents.

7) Are there important wetlands that could be affected (for example, drained or filled with sediment) by construction and operation of the SHPP?

8) What other water bodies (lakes, reservoirs, etc.) are associated with the surface waters of the study area?
What special geologic (geomorphologic or tectolinear) relationships might exist between these? (Consult ONERN publications).

9) According to the Life Zones (Ecological) map of Peru what Life Zones occur in the watershed under study?
What runoff distribution could naturally be expected from each Life Zone according to water balance estimations? How many effectively dry months are there in each water year?

10) Is there a map of actual land use for the area. What are the predominant land uses? If not, can the information be obtained from air-photographs on field reconnaisance?

11) Are there land use capability or land use potential maps developed for the general study area? What resource use potentials exist for the watershed of concern?

12) Is the SHPP site near a protected area (preserve, sanctuary, refuge, dedicated area) that may require special consideration?

13) Are stream waters near the site used for fish spawning, nursery, or feeding areas, or as migration routes?

14) Are any rare, endangered, or commercially or recreationally important species present in the region?

15) What are the principal aquatic species present in the area affected by SHPP construction and operation?

16) What species are harvested for sport or commercial purposes in the area? What is the harvest level and seasonality of harvest? What fishes are harvested from the stream for food by the local community?

17) Are there any pre-existing (natural or man-induced) environmental stresses in the area? Are any future developments planned for the area that might add additional stresses? Characterize and, if possible, quantify these stresses.

18) What is the nature and size of suspended sediments in the stream? What is the bedload of the stream?

19) Are any water quality data available, especially regarding temperature, dissolved solids, salt, nutrient, and dissolved oxygen levels, or the presence of toxic materials or disease organisms?

20) What projected or active mining activities occur in the study area? Are these open pit or tunnel minds and how are wastes handled?

21) Are there any unique plant design features (impoundment, trans-basin diversion) which would necessitate special consideration with regard to environmental impacts?

22) What are the possibilities for avoiding, reducing, or mitigating environmental impacts of SHPP site development by adequate prior planning?

Responses to all of these requests for information should be provided. If no information is available for a particular item, it should be expressly stated, along with a list of people contacted in the search. If certain information is critical to final assessment and could be generated with relatively little time and resource expenditure (i.e. field checking), this should be done. When all available information has been assembled, the significance of environmental impacts arising from development and operation of the SHPP should be judged by competent people with experience in

environmental impact assessments (See Project Activities section of the Project Description) by weighing the cost of irreversible impacts or preventative and mitigative measures agains the benefits of electricity to the community. In general, due to the small scale of SHPP developments sophisticated monetary quantifications of environmental costs and benefits are not justified. However, for certain impacts that involve excessive costs or benefits and that therefore have a decisive role in the acceptance or non acceptance of a given site, it may be desirable to estimate monetary costs and/or benefits.

c. COSTING ANALYSIS

The costing analysis is divided into two sections:

i) Direct and Indirect Plant Costs (including Civil Engineering Costs and Electro-mechanical Costs) plus the Indirect Plant Costs.

ii) Operating and Maintenance Costs

d. DIRECT PLANT COSTS

This subsection includes the Costs of the Civil Engineering Works and the Electro-mechanical and Other Costs. Each of these items will be dealth with separately.

Civil Engineering Costs

It will be assumed that the Civil Engineering works will be carried out by a contractor under the supervision of a site engineer drown from OPTA's staff. The Civil Engineering costs are site specific. They include the direct cost of civil works, contractor's overhead, contractor's profit, purchase and installation of equipment, contingencies; indirect costs such as management, supervision, contracting O & M. Detailed estimates of quantities will be calculated from the project plans, and unit prices or lump sum costs will be estimated for each item of work.

Contracts for the Civil Engineering works are subject to competitive bids. Each contractor is required to return to Electroperu a form similar to Table II. The capital cost per kilowatt capacity is compared by Electroperu personnel with the reported unitary capital costs in recent bids for similar plants.

Electro-Mechanical and other Costs

Electro-mechanical costs are provided on an itemized basis by competitive bid according to instructions supplied by Electroperu (See Section "Turbine-Generator") and according to AID regulations. Once again Electroperu's experience with recent bids for similar equipment will be used to judge the reasonableness of the bid sale price.

Prevalent Electroperu policy will be used to calculate the engineering and design costs plus the management costs of the project. The transportation and installation of all and the electro-mechanical equipment will also be allowed for. To allow for unforeseen construction problems, changes in design,

TABLE 11 BID FOR PERFORMING THE CIVIL ENGINEERING WORKS FOR A SHPP

Contractor's Name _____

Project _____

Plant Capacity _____ Kw

Av. Annual Energy _____ Kwh Date _____

Direct Costs

1. Preliminary works
2. Temporary civil works
3. Site Clearance
4. Intake
5. Headrace
6. Pressure case and sandtrap
7. Penstock
8. Power house
9. Spillway
10. Subtotal

Indirect Costs

11. Administrative
12. Other indirect costs
13. Subtotal (items 11+12).
14. Contingencies (20% of items 10 + 13)
15. Subtotal (items 13+14)
16. Contractors profit (15% of item 14)
17. Subtotal (items 15+16)
18. Direct national taxes (5% of item 17)
19. Total costs (items 17 + 18)

TABLE 12 ELECTROPERU COST ESTIMATE SHEET

Project: Date:

Plant Capacity: Av. Annual Energy _____ Kwh

Description: $

1. Turbine, generator
2. Station electrical equipment
3. Miscellaneous power plant equipment
4. Transmission line
5. Engineering and design
6. Management
7. Construction costs (from Table 7.16, Line 19)
8. Subtotal
9. Contingencies (10% of item 8)
10. Total installed cost (items 8+9)
11. Cost per installed kw.

errors or omissions in estimating values, a contingency allowance of 20% will be added on all costs. Table 12 is an example of a cost estimate sheet that is used by Electroperu.

i) Operating and Maintenance Costs

It is Electroperu's experience that O & M Costs are approximately 1.5% of the direct investment costs.

d. ECONOMIC ANALYSIS 1/

Introduction

This chapter provides the guidelines for the economic analysis of the feasibility investigation. The prefeasibility study methodology has outlined the procedure to calculate the Benefit/Cost ratio, and the Net Present Value in a simplified fashion. The feasibility study will follow a more detailed methodology for calculating these values.

The economic analysis synthesizes the findings of the socio-economic load profile, the engineering design, the environmental analysis, and the costing analysis chapters of this methodology. This section consists of 3 parts:

1) Calculation of the Project Economic Benefits
2) Costs Calculations
3) An Economic Evaluation of the Project.

i) Calculation of the Project Economic Benefits

Assumptions

The following assumptions are made:

1) Electricity is of superior quality than other sources of energy used by the community. This is grounded upon a) electricity's capacity to power machinery which require a constant flow of energy at a given voltage (standarized in Peru at 200 volts per phase), b) electrical lighting can provide higher lumens per unit of cost, c) energy generated by SHEP a renewable source of energy -- is less detrimental to the environment.

2) All estimates will be based on local currency and then converted to U.S. Dollars.

3) A planning horizon of 30 years and an opportunity cost discount rate of 15% have been set by Electroperu.

Benefits

The benefits will come from the following sources:

- Revenue from the sale of energy, i.e. this will be the product of the load and the applicable tariff structure.

- The cost savings (surplus benefits) due to the substitution of other energy sources

1/ A final calculation of the degree of subsidy required by the plant from ELECTROPERU is included as part of the Economic Analysis. (See also Annex I Exhibit B page 11).

(thermal or fossil) by electricity (See Appendix I).

The present worth of the total benefits for year (B_n) are calculated as follows:

$$B_n = t_n D_{cn} + s_{in} P_i + s_{tn} P_t + s_{xn} \cdot X + s_{yn} Y + s_{zn} \cdot Z + S_{on} O + (C_{cn} + I_{cn}) (1+r)^{-n}$$

Total Benefits — Revenue — Surplus — Benefits

Where B_n = Benefits accrued in year n ($)

C_{cn} = Cost savings in community public services activities in year n ($)

D_{cn} = Total demand for year n (Kwh)

I_{cn} = Cost savings in the industrial sector in year ($)

X = # of families at subsistence level that would hook up

Y = # of minifundistas that would hook-up

Z = # of families with more than 5 ha. that would hook-up

O = # of other families (e.g. urban) that would hook-up

r = the discount rate

s_{in} = Ave. cost savings in year n per irrigation pump ($)

s_{tn} = Ave. cost savings in year n per shallow tubewell pump ($)

s_{xn} = Ave. cost savings in year n for h/h in category X_2 ($)

s_{yn} = Ave. cost savings in year n for h/h in category Y ($)

s_{zn} = Ave. cost savings in year n for h/h in category Z ($)

S_{on} = Ave. cost savings in year n for n/n in category O ($)

t_n = electricity tariff in year n ($/Kwh)

P_i = # of irrigation pumps

P_t = # of tubewell pumps

The total benefits over the planning horizon of 30 years (B) is calculated as follows:

$$B = \sum_{n=1}^{30} B_n$$

ii) <u>Cost Calculations</u>

The total costs for the project will be the present value of all

expenses incurred over the 30 year planning horizon of the project.

The total costs are calculated as follows:

$$C = C_t + \sum_{n=1}^{30} \frac{.015 C_i}{(1+r)^n}$$

Where C_t = Total installed cost (Table 12)

C_i = Direct investment costs (Table 11)

iii) An Economic Evaluation of the Project

To evaluate the desirability of an SHPP project at the feasibility level, the expected benefits are compared to the expected cost. The Net Present Value of the benefit and cost streams, the Benefit/Cost Ratio and the Internal Rate of Return will be calculated.

Net present value: The net value of an investment today is higher than the same amount of money in the future. Therefore, the expected benefits and costs will be discounted at a rate which reflects the opportunity cost of capital. The 15% rate will be used.

The Benefit/Cost Ratio will be the ratio of the discounted benefit and cost values over a planning horizon of 30 years.

Table 13 shows how all the economic data can be assembled and processed to calculate the Benefit/Cost Ratio. Figure 14 shows the feasibility study flow chart and Figure 14A gives the feasibility study organization chart. Table 15 describes the events in the PERT flow chart.

e. Social Analysis Methodology

Introduction - The social impact of electrification by SHPP on the community is powerful, pervasive and difficult to quantify. It is Powerful because of the immense potential that is offered to the community through i) the adoption of electricity-based technology, ii) the enlargement of the realm of possible activities (both productive and social), as well as iii) the savings in time and money as [illegible] with a more efficient allocation of time and other energy [illegible]. The impact is Pervasive because of the introduction of an SHPP affects all dimensions of a community's (social, political, economic, environmental) at the local, regional national and international levels. The impact is Non-quantifiable due to the pervasiveness of the effects of electrification, which combine synergistically with other elements of the social and economic infrastructure to yield results that are unique and site-specific. Furthermore, the state of the art in a methodology for quantifying social, political, environmental effect, in any milieu, beyond first-stage economic effects is primitive and controversial, and cannot be applied in present-day Peru without incorporate national cultural criteria.

TABLE 13 - ECONOMIC EVALUATION CHART

	Discount Factor	Capital Costs	O & M	Total Costs	PW Total Costs	Sales	Surplus Benefits	Total Benefits	PW Total Benefits
YEAR 1									
YEAR 2									
YEAR 3									
4									
5									
"									
"									
"									
YEAR 30									

Discount Rate =

Benefit Cost Ratio = PW Total Benefits / PW Total Costs

expenses incurred over the 30 year planning horizon of the project.

The total costs are calculated as follows:

$$C = C_t + \sum_{n=1}^{30} \frac{.015 C_i}{(1+r)^n}$$

Where C_t = Total installed cost (Table 12)

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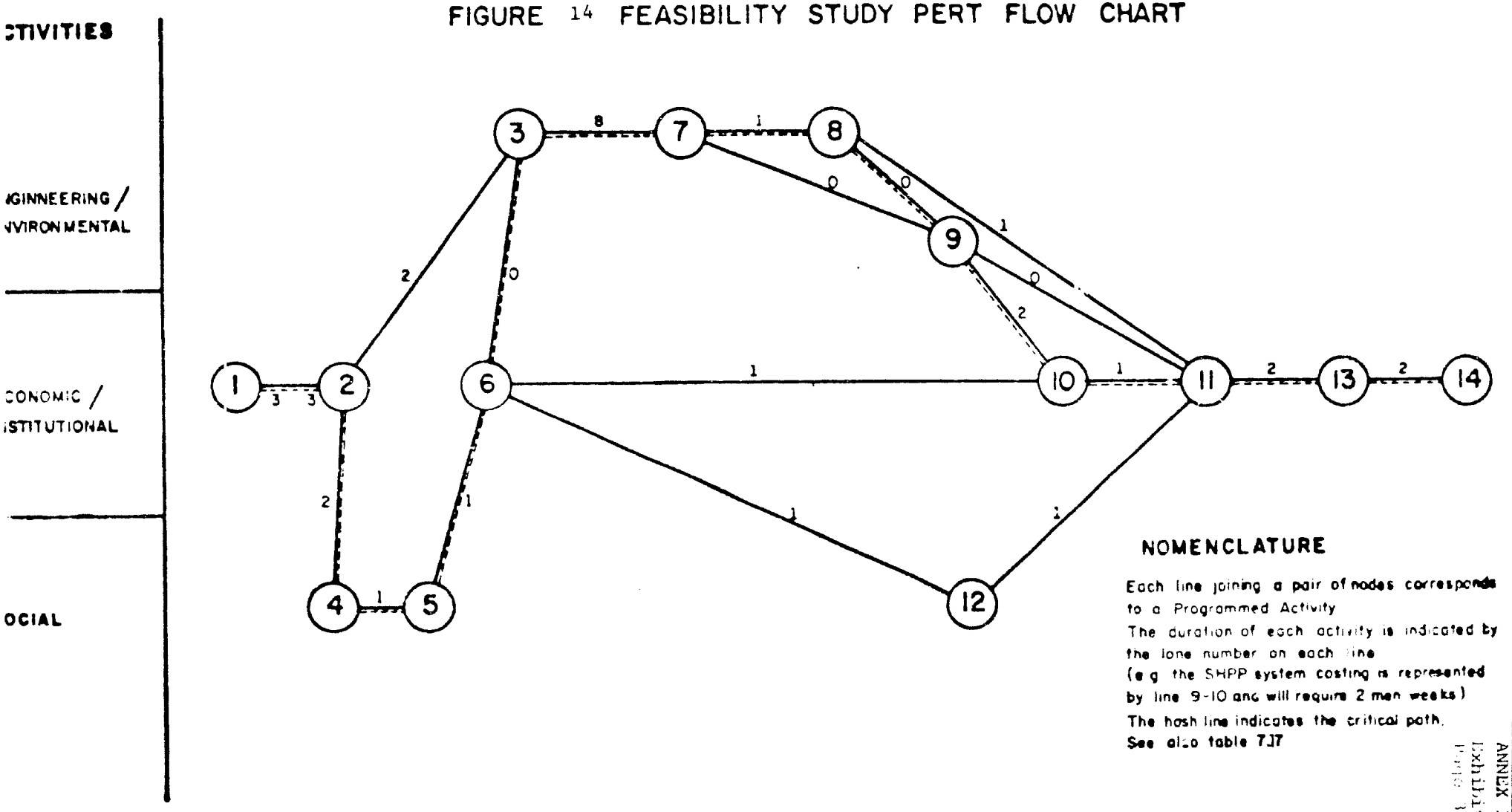
YEAR 1									
YEAR 2									
YEAR 3									
4									
5									
..									
YEAR 30									

Discount Rate = _____ %

Benefit Cost Ratio = PW Total Benefits / PW Total Costs

FIGURE 14 FEASIBILITY STUDY PERT FLOW CHART



NOMENCLATURE

Each line joining a pair of nodes corresponds to a Programmed Activity

The duration of each activity is indicated by the lone number on each line

(e.g. the SHPP system costing is represented by line 9-10 and will require 2 man weeks)

The hash line indicates the critical path.

See also table 7.17

FIGURE 14A FEASIBILITY STUDY ORGANIZATION CHART

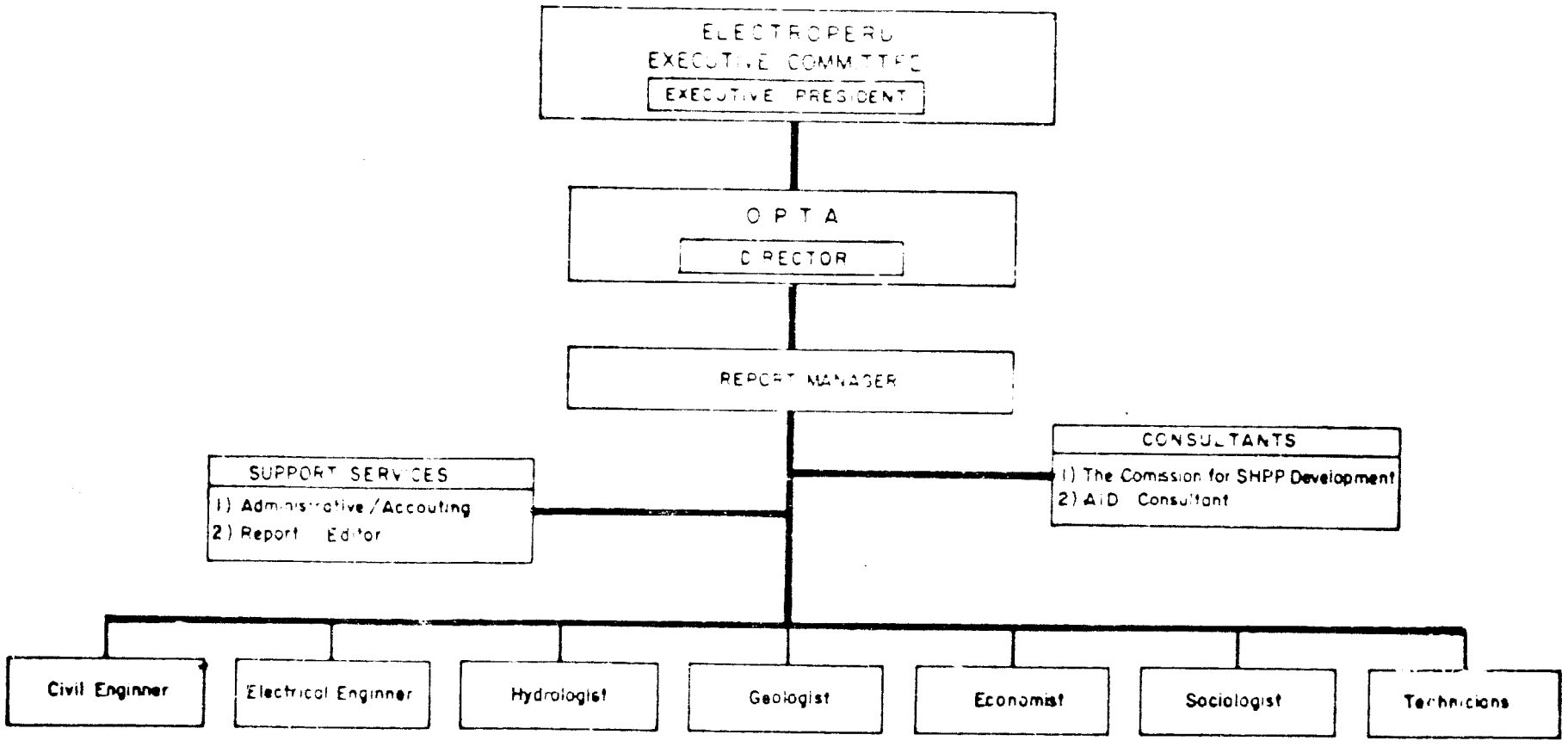


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TABLE 13 - EXTRA INFORMATION FOR THE FEASIBILITY STUDY PERT FLOW CHART

CODE	Activity - Description	Professional Level of Effort (Man-weeks)
1-2	Prefeasibility Study	3
2-3	Characterization of the Site and Existing Facilities	2
2-4	Community Field Survey	2
3-7	Detailed Engineering Design	8
4-5	Community Profile Determination	1
5-6	Demand/Load Forecast	1
6-10	Economic Benefits Calculation	1
6-12	Immediate Social Impacts	1
7-8	Environmental Impacts	1
8-11	Environmental Analyses	1
9-10	SHPP System Costing	1
10-11	Economic Analysis	1
11-13	Project Implementation Plan	2
12-13	Long-Term Social Benefits	1
13-14	Final Report Preparation	2

N.B. Activities with zero effort are not shown. They are included in the PERT chart merely as information conduits.

The methodolol'gy for performing the social analysis at the feasibility stage begins by making an heuristic distinction between immediate and medium term impacts of electrification by SHPP.

Medium-term or potential impacts are reflected in changes in local customs. These changes include:

I) The adoption of time-saving devices such as electricity-powered machinery;

II) The allocation of organic energy sources to other uses (e.g. animal dung for fertilizer) or their conservation (e.g. a slower rate of deforestation and depletion of coal resources) and

III) The initiation of new activities (e.g. agroindustry, audio-visuals for education); etc.

This following sections provide the feasibility study methodology criteria for analyzing the immediate and potential impacts of electrification by SHPP on the a) household, b) business, and c) public sectors of a community.

The Household Sector electrical energy will allow household dwellers to spread their activities over more hours in the day. This time will be used to increase production, leisure, or educational activities. In the medium term this can lead to increased income, social power or education achievements. In summary, electrification will allow the household dweller to improve his/her standard of living.

The Private Sector - Again, in the private sector, the introduction of electricity will allow the extension of operating hours for industrial and commercial establishments. By substituting for thermal energy sources, electricity permits cost-savings and a sounder environment. Potentially, the availability of an inexpensive source of energy encourages the development of productive economic activities in the area, such as agroindustry, small businesses crafts, trades, services and farms. Table specifies the activities that benefit from electricity in each of these categories.

The Public Sector - The immediate impact of electrification on the public sector is the provision of lighting in public facilities. Longer operating hours are feasible improve delivery of the service to an increased number of people. Illumination after dark improves public safety on the streets for pedestrians and drivers. In the medium term, artificial lighting permits the organization of evening classes for people who are occupied during the day in areas such as adult literacy education vocational training, nutritional education, and technical training. In the long run, if productivity and living standards of the community are upgraded, the

the attractiveness of migration to urban areas may be reduced. A concomitant impact will be to slow the unchecked growth of already overcrowded cities.

f. Environmental Impact

Mini-hydro installations (SHPP) will require the diversion of streamflow. Depending upon the runoff available and the design flow of the hydroelectric installation, this impact may vary from complete stoppage for a certain distance downstream to a simple reduction in streamflow. In general, flow disruption impacts will be potentially larger for dryer regions and smaller streams (in Peru especially the Sierra and Coastal zones) and less for the wetter Atlantic slope areas (Ceja de Selva and Selva zones) or large Diversions will normally vary from a minimum of 200 liters/second to a maximum of one cubic meter per second.

The discharge of the tailrace back into the stream will likewise cause flow disruption impacts. Increased flows will give rise to large forces and possible channel degradation in the form of bank erosion, and sedimentation effects.

1. Sedimentation and Turbidity Effects

Sedimentation impacts are important from two points of views from the point of view of sediment loads in the stream and their impact on the feasibility and maintenance of the turbine (i.e. sediment causes turbine pitting and accelerated wear), and from the point of view of sediment impacts due to project construction and operation.

Different mini-hydro equipment installations have variable sensitivities to sediment damages. Water wheels, for example, can withstand heavy sediment loads with few adverse effects. Turbines, on the other hand, are much more subject to excessive wear and pitting when coarsegrained sediments are entrained in the generation waters. In general, however, it is most desirable to maintain as high as physical water quality as possible. This can be attained by the development of a watershed management plan in which the land use in the attachments are made to suit the land use capability and through a strict control of the construction impacts of the project (road building, cutting of the canals, etc.). Information on sediment loads is an important criterion for both feasibility determination and the design of the engineering structure. The quantification of suspended sediments should be initiated early on, prior to prefeasibility analysis.

The impacts of turbidity and sediment transport effect both the biotic community in the stream and the physical aspects of water quality. High sediment loads fore close certain water uses such as potable water and irrigation. Where impoundment or decreased water velocities occur, sediment loads will drop out and fill up engineering structures (irrigation canals, reservoirs).

The sediment discharge of a basin in related to several factors including climate and geology. Also proper land use is of utmost importance in maintaining erosion rates as close to their natural geologic rates as possible. When improper land use occurs, especially the deforestation of steep lands and subsequent establishment of grazing or

agriculture, erosion rates are generally accelerated and sediment transport in the stream is generally increased.

Sedimentation can have adverse impacts on aquatic organisms by burying rock or gravel fish-spawning areas, and smothering clams, mussels, other bottom-dwelling organisms, fish eggs, and rooted aquatic plants. By changing the texture and composition of the substrate, sedimentation will cause a shift in the composition, abundance, and distribution of aquatic biota, generally in a negative manner. The severity of these impacts are modified by (1) the amount and rate of sediment transport, (2) the velocity, turbulence, and flow rates of the stream, and (3) the frequency and magnitude of naturally occurring erosion and sediment deposition.

2. Alternate Water Uses

Since the operation of a SHPP does not consume water or significantly alter its quality, the major impact with regard to alternate water uses will result from the fact that water is temporarily diverted from the stream. This raises the possibility that other users which withdraw water from the section of the stream affected by the diversion (below the SHPP intake structure and above the tailrace) will not obtain adequate quantities during all or part of the year. The affected section of the stream could serve as a source of water for irrigation, human or livestock consumption, industrial uses, or dilution of domestic sewage or industrial effluents. In addition, it is important to maintain minimum flows in all sections of the stream in order to ensure the survival of resident aquatic organisms and allow migrations of fishes. Prior to judging the feasibility of a SHPP site, every effort must be made to identify all existing or potential alternate water users and resolve any water use conflicts that arise from the construction and operation of the SHPP.

Under certain circumstances groundwater resources can be depleted by a SHPP. Where diversion occurs from an effluent stream (one that is above the water table and therefore contributes to groundwater supplies) it is likely that localized impacts will be noted in groundwater recharge in that stream between the points of diversion and discharge. This could affect water availability in wells and in the stream channel (there would be no baseflow recharge) and hamper uses of water for domestic consumption, irrigation, etc. The area potentially affected by this type of impact, it was mentioned previously, is delimited by points of diversion of water from and recharge to the stream.

In cases where influent stream conditions occur baseflow recharge to the stream channel will occur rapidly and no negative impacts will occur.

A global analysis of all water uses within the basin has to be carried out to identify points of possible conflict. Water uses can generally be categorized into consumptive and non-consumptive uses with irrigation and hydroelectric power generation representing respectively these two cases. A primary constraints is the amount of water available for use in the stream. Important considerations involve the points of extraction or diversion of water, the points of discharge into the receiving waters as well as alterations in water quality that might occur. Based upon the interaction

The rank ordered values are then assigned order numbers, the largest beginning with order 1. The order numbers are then divided by the total number in the record and multiplied by 100, thereby representing the percent of days that a particular mean flow has been equaled or exceeded during the period of record analyzed.

The flow duration curve represents graphically the results of the above analysis where the flow (Q) is plotted against the percent exceedance. References to flow duration curves are usually made as Q_{50}, Q_{30}, Q_{20}, etc. indicating the flow values at the percentage point subscripted. Fig. 3, Annex II is an example of a flow duration curve.

The prognosticated power is a function of the flow value at a predetermined subscripted percentage point (e.g. Q_{20}).

7. PROGNOSTICATED POWER

The prognosticated power is calculated in terms of the net head (H_n) and the available flow (Q) according to the following mathematical formula

$$P = 7.5 \; Q H_n \quad \text{where}$$

P = year-round availability of power (Kw)

Q = the available flow (cubic meters per second)

H_n = the net head (meters)

Refer to section (II A.1.b.i.) for further details on calculating the prognosticated power of the SHPP.

ii) ENGINEERING DESIGN

The project description will be made under the following headings:

1. Site Preparation
2. Intake Structure
3. Canal/Penstock
4. Powerhouse
5. Turbine-Generator
6. Switchyard
7. Other mechanical and electrical equipment
8. Distribution System

1. SITE PREPARATION

The site preparation consists of the following activities:

I) Site Clearing
II) Location of the key structures of the SHPP
III) Laying down temporary access routes
IV) Earth Moving
V) Disposal of land clearing residue

of these factors certain combinations of water uses on a given stream can be compatible whereas other combinations will not be compatible.

Legal constraints concerning water use have to be considered to determine priority uses and water rights acquired by prior water users. Depending upon the points of extraction and discharge of waters, it may be necessary to apply for concessions for SHPP projects.

In general, impact can be expected to be larger in cases of complete use of the streamflow and in cases when other water uses are associated with the SHPP that are more degrading of water quality, such as irrigations. Thus, although the hydroelectric use may not in itself alter water quality, the occurence of less dilution effect and higher concentration of contaminants downstream may occur.

Water use conflicts are much more likely to occur in the Coastal and Sierra regions because of the relative scarcity of water here and the common practice of irrigation.

The use of water for hydroelectric generation is non-consumptive and therefore in the case of SHPP's very little if any loss of water will occur. The spatial distribution of the water volumes in the river will be altered and analysis should be directed to assessing water quality or shortage impacts in the stretch of river between diversion and discharge points.

Flood Control

SHPP, because of the very small volumes of water involved, will have little or no effect in either mitigating or increasing flood flows. Only for those unusual cases where inter-basin-transfer and/or impoundment are involved minor benefits or impacts may be noted. Impoundment could ameliorate flood flows whereas inter-basin transfer which would represent net loss of water from the generating basin, could have the effect of reinforcing unusual events in the receiving basin and mildly increasing flood flows.

3. Water Quality

Operation of run-of-the-river SHPP facilities the size included in this program will have little or no effect on water quality in the streams. Such water quality parameters as temperature and concentrations of dissolved gases and minerals will not be altered by diversion and passage through the penstock and turbines. While turbidity and suspended solids levels the diverted waters may be reduced in those plant designs which incorporate sand and sediment traps, this will not have a negative impact on the receiving waters.

Direct water quality impacts occur, however, at those sites whose designs include (1) diversion of water from one source or watershed to another, or (2) creation of a substantial impoundment of water above the intake structure. Diversion of water from another source to augment existing flows will introduce to the receiving stream water with different physical and chemical characteristics, and the possibility should be considered that this water will be of lower quality than the water in the receiving stream.

For example, if flow-augmentation water is taken from the vicinity of mines, processing facilities, or industrial discharges, it may contain elevated concentrations of heavy metals, turbidity, or salts. Water draining land devoted to irrigation and intensive agriculture frequently has elevated levels of temperature, turbidity, dissolved minerals and plant nutrients, pesticides, and herbicides.

Another way in which water quality may be degraded in the stream containing the SHPP facility is by physical and chemical processes which occur within a water impoundment. The most common event, especially in relatively deep, sheltered reservoirs, is that the water will undergo thermal stratification. Not only does this have the effect of creating water that is warmer at the surface and colder at the bottom than the normal stream temperature, but it results in a depletion of dissolved oxygen levels and greater concentrations of hydrogen sulfide and reduced ionic forms of iron and manganese. All these impoundment effects can lead to a serious degradation of downstream water quality.

Finally, the indirect effects of mini-hydroelectric development on water quality should be considered. Industrial growth that the provision of electricity will promote could result in a greater demand for water (industrial uses) or a decline in water quality (effluent discharges). Similarly, population growth following electrification could create a greater demand for surface water for human consumption and for the treatment and dilution of domestic wastes. This growth could alter both the quantity and quality of water in the streams of the area.

4. Impacts to Aquatic Organisms

There are numerous impacts to aquatic organisms that must be considered when evaluating the feasibility of a SHPP site. Some impacts, such as turbine mortality, are potential problems for any type of facility design, whereas others, such as interference with upstream migration of fishes, are generally of greatest concern when water is impounded for a store-and- release type of operation. This section will briefly discuss important effects that hydroelectric generation can have on aquatic biota.

Turbine mortality occurs when organisms are carried into the intake structure along with diverted water and pass through the turbines before being discharged back into the receiving stream. These small, nonsore-enable organisms, including drifting aquatic insects, zooplankton, and fish eggs, larvae, and juveniles, are subjected to sudden and extreme pressure changes, turbulence, shear forces, abrasion against the walls of the penstock, and contact with the turbine blades. Most studies of turbine mortality have dealt with fish, and it has been found that increased hydraulic head and/ or increased turbine runner speed resulted in increased turbine mortality. Lowest mortality occured when turbines were running at peak efficiency, and at low efficiencies turbine mortality was as high as 100 percent.

Organisms which are too large to pass through the intake debris screen, yet cannot avoid the flow, may be trapped against the screen in a process called impingement. These animals, commonly downstream-migrating fish such as trout and salmon, eventually suffer mortality due to asphyxiation and physical damage.

Temporary diversion of water for hydroelectric power generation results in decreased flow in that portion of the river downstream from the intake structure and upstream of the turbine discharge. Under low stream-flow conditions, this can result in a significant decline in the natural flow available to support fish and bottom-dwelling animals (insects, crayfish, snails, clams) in that stretch of river. In extreme cases the river may dry up completely due to complete diversion for power generation, resulting in a loss of these bottom organisms and a potential blockage for upstream and downstream migrating fish.

Many fish undergo seasonal upstream migrations for spawning. The use of a dam as a means of impounding or diverting water for a SHPP facility could seriously hinder or prevent these migrations. The possibility for such limitation of reproductive potential of commercially important or endangered fish species should be considered in the feasibility study.

Maintenance dredging, to remove sediment deposits from the sandtrap and the area around the intake structure, will result in temporary increases in suspended material and turbidity, low dissolved oxygen tensions, and high concentrations of dissolved minerals and toxic contaminants. If dredged material is allowed to enter the receiving stream, silt and sand deposition and the alteration of substrate and bottom habitat will result. Increased turbidity can decrease the productivity of aquatic plants by decreasing sunlight penetration and can disorient visually-feeding fish. High suspended solids concentrations cause stress or death to aquatic animals by clogging their gills or feeding structures. Low dissolved oxygen levels or high concentrations of toxic substances will result in stress or death to aquatic biota. Finally, improper disposal of dredged sediment can smother bottom-dwelling animals and fish eggs, or alter the benthic community structure by changing the texture and composition of the substrate.

Evaluation of these impacts is especially important for streams that contain commercially or recreationally valuable aquatic species, or species that enjoy legal protection due to their unique or endangered status. For example, a stream that supports an important food fish for the local community must be carefully protected from the types of impacts described in this section, so as not to threaten this component of the food supply. It should also be borne in mind that many SHPP sites will be located on streams that have a very low natural flow, especially during the dry season. Diversion of a portion of this water for hydropower production will further reduce the ability of that stream to support aquatic life, and therefore may represent a serious additional stress to fish and fish food organisms.

5. Waterborne Diseases and Parasites

As with water quality impacts, the operation of a SHPP facility *per se* is not expected to affect the transmission of waterborne diseases. Although the self-purifying capacity of water moving quickly in a non-turbulent flow through a headrace and penstock may be reduced relative to movement of that same parcel of water over the natural streambed, this factor will probably not be significant in most cases.

Facility designs incorporating inter-basin (water-shed) diversions or water impoundments can promote water borne disease problems. Water

contaminated by human sewage or runoff from livestock enclosures can spread a wide range of diseases, and they could be introduced into a previously uncontaminated stream by inter-basin diversions. The impoundment of water into hydroelectric reservoir could enhance survival of disease organisms, since those factors which are critical to self-purification of water in a stream (turbulence, sunlight penetration, oxygenation) are reduced or eliminated in a reservoir. Finally, water impoundments provide increased habitat for disease vectors, such as mosquitoes, and alternate hosts of human and animal parasites, such as snails.

Indirect effects of SHPP development on the incidence of waterborne diseases and parasites must also be taken into account when evaluating a site. Provision of electricity to a community may lead to an increase in the human and/or livestock population, and the resulting increased risk of disease epidemics would necessitate the installation of adequate drinking water and waste treatment facilities.

6. Construction Impacts

The effects of SHPP construction on the aquatic environment fall into two categories: (1) turbidity and sedimentation, and (2) water quality degradation. Construction of a road to provide access to the site, as well as on-site construction of the various components of the SHPP facility, will result in the disturbance and movement of erodible soils, Unless mitigative measures are taken, such as the construction of dikes to retain stormwater runoff soil will eventually be washed into the streams. The effects of the resultant increases in turbidity, suspended solids, and sedimentation on aquatic organisms were previously described.

In addition, oils, greases, and chemical wastes from the construction of the concrete canals and turbine building may be carried into the streams and seriously degrade water quality, especially under low flow conditions. The toxic effects of these chemical wastes would cause stress or death to aquatic animals.

The significant physical impacts of construction of SHPP's are limited to sedimentation and turbidity effects on receiving water and the opening up of access into sometimes virgin and delicate watershed protection zones. The origin and mitigation aspects of accelerated erosion around the construction site, including the access road have already been discussed under the aquatic impacts. Associated physical impacts include downstream sitation and perhaps increased sediment loads in the headrace. Such occurrances will have negative effects on downstream water uses as well as SHPP operation and maintenance costs. Usually such slope instability and erosion problems are short-term if proper revegetation and water control practices are employed. Dry to and climates make revegetation slower and in general less effective whereas in humid areas revegetation frequently occurs profusely and almost spontaneously if there is sufficient stability to permit rooting.

Road construction providing access to the site is normally responsable for much more earth movement and disturbance than SHPP site preparation activities. The magnitude of the sitation impact, which will

principally effect stream hydrogy and aquatic communities, can be reduced by sound engineering practices of road construction, especially as they affect water control and site stabilization. When properly constructed and stabilized a road may cease to produce significant amounts of sediment in a short time period (2-5 years).

The potentially most detrimental long term impact of road construction is the opening up of forest protection and critical watershed areas to spontaneous colonization. A common occurance in Latin American water resource development projects has been that colonization and its resultant erosion and torrential hydrologic effects have completely stopped the projects. The Anchicayá hydroelectric project in Colombia is an excellent example of where the investment was lost by reservoir sedimentation a very few years after construction due to colonization in the headwaters region of the watershed which was made accessible by the project road. Spontaneous colonization of marginal protection areas produces innumerable impacts on soil, water, forest and wildlife resources both on-site and downstream. Wherever possible, in order to avoid such impacts and to insure the useful life of the downstream SHPP, contractual agreements should be developed with the benefitting communities so that they help develop and implement a watershed protection plan. For virgin forested watersheds the best approach would be protection involving local forest guards. Where the watersheds are already populated, the plan should be oriented toward promoting proper soil and water conservation practices and compatible landuse. In either case community involvement will be important to the success of the project and the involvement of the community in such watershed management activities will have beneficial social effects in promotion environmental education and awareness.

Land Use and Development

SHPP development will have an effect of promoting development and increased populations in the area of influence of the project. Construction of a hydro-installation should consider land use capability where relevant for the drainage area feeding the project. In many cases, it may be advisable to declare a forest reserve, or some other category of wildland that will assure the required protection. Rights-of-way for the access road including rights to reforest or in some other may stabilize slopes is also necessary.

Proper land use in the watershed is important to the avoidance of a complex series of impacts that could far outweight the total direct impacts of SHPP construction and operation. These long term impacts which basically have to do with improper land use and deforestation of steep uplands watershed degradation will lead to erosion and sediment discharges, torrencial low regimes and decreased dry season base flows. These impacts will have negative effects on plant operation and maintenance costs and will thereby effect the SHPP useful life.

The promotion of proper land use in the project area is an activity that offers multiple opportunities for benefits. Potable water supplies, recreation areas, forest reserves with certain restricted possibilities of wood product extraction, and other compatible uses could be promoted so that the community appreciates and takes advantage of the multiple use possibilities.

It is extremely important that the community develop both an understanding of the relationships between proper land use and the maintenance of good water quality, quantity and timing and a feeling of responsibility toward the management and protection of "their own watershed".

With respect to overall land use, irreversible and irreparable committments of resources will not be important except in cases of installation of the SHPP on important waterfalls or in rivers where the wild character or esthetic quality of the site will be irreversibly damaged. In other cases that involve impoundment, the inundation of soil and mineral resources and biotic impacts such as those mentioned previously would constitute irreversible and irreparable committments.

7. Variables

The environmental aspects of SHPP development discussed in the preceding sections have been based on the conceptualized design of a run-of-the-river, small capacity (1000 Kw) hydroelectric installation utilizing high hydraulic heads and low flows. It is also assumed that the majority of potential supplies will not require a substantive impoundment or inter-basin (inter-watershed) diversion of water for successful development. It is recognized however, that specific sites will require modifications to this generalized plan. This section describes the potential environmental impacts of these modifications.

Inter-Basin Water Diversion

Inter-basin diversions of water, which include such works as the tapping of water from lakes or other standing water bodies (independant or in another watershed), the transfer of water from the Atlantic slope to the Pacific slope, or simply the transfer of water from one adjacent or nearly adjacent watershed to another, invariably involves a net loss of water from the donor basin and a net gain to the recipient basin. The impact of such gains and losses of water may be positive or negative depending upon water use, water abundance in both basins and several other factors.

Effects of inter-basin water diversion on water quality in the receiving stream or the spread of water-borne diseases and parasites have already been discussed. To the extent that inter-basin diversion requires additional construction of canals and access roads, the environmental impacts (sedimentation, water quality, effects on aquatic biota) will also be increased.

Water Impoundment

Creation of an impoundment to ensure adequate year-round availability of water for SHPP operation has a number of significant environmental impacts, many of which are more serious than those associated with operation of a run-of-the-river facility. The impounded water inundates terrestrial habitat as well as stream habitat and potential spawning sites for riverine fish. Aquatic organisms adapted to flowing water in the unimpounded stream will be replaced by species which are adapted to life in a reservoir habitat. Depending on the particular situation, this change in aquatic community composition may be either beneficial or detrimental from a human

use standpoint, and its desirability must be evaluated on a site-specific basis.

Storage of water in a reservoir will result in water quality changes, many of which were discussed. . Retention of water within a reservoir increases the exposure time of aquatic organisms to contaminants and may therefore both aggravate acute and chronic toxic effects. Bio-accumulation of toxic chemical through the aquatic food chain can also be increased by the impoundment of contaminated water.

Dams used to impound water for SHPP operation may present an impassable barrier for upstream-migrating fish and would therefore limit the reproductive success of species that undergo these migrations for the purpose of spawning. Similarly, downstream migrating fish, such as juvenile trout, may have their normal movements delayed or halted by the presence of the reservoir and dam.

One biological effect of reservoir creation which has additional relevance to SHPP operation and maintenance, as well as alternate uses, it the problem of nuisance aquatic plants. Many new reservoirs are rapidly colonized by floating plants (such as water hyacinths) or rooted, submersed vegetation (such as Blades). Not only do these plants have profound effects on the aquatic biological community, but also they can clog the SHPP intake structure, increase evapo-transpiration losses of water from the reservoir, reduce the effective water volume of the reservoir, harbor disease vectors and parasite hosts, and hinder alternate reservoir uses (such as fishing, swimming, livestock watering). Due to the ability of reservoirs to retain inflowing sediments and nutrients, these large plants, as well as microscopic plants known as algae, can attain very great densities, and their subsequent decomposition or release of toxins can significantly degrade the water quality. The development of excessive growths of nuisance aquatic vegetation, and the cost of its subsequent control, must be given serious consideration when examining the feasibility of a SHPP site, especially those located in warm climates or low attitudes.

The fact that impoundments retain sediments implies a need for a more conservative upstream land use if premature sitation of the reservoir is to be avoided. Appropriate watershed management or protection measures should be conditioned to the construction of an impoundment.

Downstream impacts of impoundments can take the form of other phenomena other than those already mentioned, on water quality and biotic communities. Degradation of reaches of stream channel below the dam may lead to bank collapse, undercutting of bridges and other structures, and the initiation of headwater erosion into adjacent hilly or mountain regions. Changes in the normal flow regime of the river through regulation can lead to the haulting of flooding of riparian agricultural lands (with negative effects on fertility), variations in ground water levels and in/and migrations of the salt-water fresh water interface on coastal area. Even beach formation of adjacent coastal areas may be impared by the reduction of river sediments.

By slowing down inflowing water, reservoirs act as sediment and nutrient traps. Lower water velocities in the reservoir decrease the sediment transport capacity, and suspended material settles out within the reservoir.

This has the effect of (1) decreasing the useable volume of the reservoir (which may require periodic maintenance dredging), and (2) increasing the erosive potential of water leaving the reservoir (which may result in downstream erosion of sandbars, streambanks, docks, and bridge abutments). Because quiet waters in the impoundment permit the growth of aquatic plants, inflowing nutrients are taken into the food web and retained within the reservoir, thereby decreasing the fertility of downstream waters.

Regulated flows which result from reservoir releases designed to optimize SHPP generation will cause water level fluctuations on a daily and reasonal basis which are different from natural flows. This can have effects on physical, chemical and biological processes both within the reservoir and downstream of the reservoir. These impacts include alteration of the thermal regime, leaching of bed and bank substrate materials, altered downstream erosion, and exposure of fish spawning grounds. For most SHPP installations these effects will probably not be significant, but the potential seriousness of altered water level fluctuation patterns will be directly related to the size of the impoundment and its releases.

Size of the Project

As with most man-induced stresses, the magnitude of environmental impacts resulting from SHPP development is generally related to the size of the facility. That is, a 100 Kw facility is likely to cause fewer problems than a 1000 Kw facility, simply because the amounts of construction material, watershed disturbance, grading and diverted water are less for the smaller facility. Of equal importance, however, is the amount of water diverted relative to the total flow in the stream. A 100 Kw plant may have a greater impact if it withdraws a proportionally amount of the flow from a small stream than a 1000 Kw plant located on a large river. The significance of environmental impacts can vary seasonally; a 100 Kw SHPP may have little adverse impact during high stream flows in the rainy season but may represent a significant stress to the aquatic system during times of low flow. These variable conditions must be considered during the conduct of the feasibility study in order to arrive at a reliable evaluation of environmental impact.

Farming

a) Diesel vs. electric pumps for irrigation:

Low Lift Pumps Assumptions:

1) A single pump set driven by an electric motor is considered to have 150% more sustained capacity than diesel driven sets of similar horsepower rating.

2) The pump set is usually replaced every 6 years.

3) A single phase 7.5 H.P. electric motor is replaced every 10 years.

4) A 7.5 H.P. diesel engine is replaced every 6 years.

Additional information:

- average pumping hours per year on season
- fuel consumption

- fuel cost and electricity rate
- maintenance costs, including replacement, labor and other costs.

ESTIMATED ANNUAL COST

	DIESEL MOTOR	ELECTRIC ENGINE
Motor/engine annualized cost	$ _____	$ _____
centrifugal pump set annualized cost	$ _____	$ _____
fuel/electricity cost per year	$ _____	$ _____
maintenance cost per year	$ _____	$ _____
Compare total costs	$ _____	$ _____

b) Shallow Tubewell

Assumptions

1) A single motor driven shallow tubewell is considered to have 140% more sustained pumping capacity than a diesel.

2) The pump, pipe and fittings are replaced every 10 years.

3) A single phase 5 HP motor and contactor is replaced every 10 years.

4) A 5 HP diesel engine is replaced every 6 years.

Additional information:

- average pumping hours per year
- fuel and maintenance costs

	Annual Costs	
	Diesel Motor	Electric Engine
well and casing	$_____	$_____
centrifugal pump	$_____	$_____
motor/engine	$_____	$_____
electricity/fuel	$_____	$_____
maintenance	$_____	$_____
TOTAL	$_____	$_____

P.S. s_{tn} = average cost savings per tubewell pump

economic wholesale price S/.

distribution & marketing S/. _____

economic retail price S/.

c) kerosene lighting costs per year

economic retail price x 365 liters	S/.	
capital costs of kerosene lantern (annualized)	S/.	
replacement & parts	S/.	_____
total costs/year	S/.	

d) electric lighting costs per year

electricity (.02 x 0.48 x 365)	S/.	
light bulbs expenditure per year	S/.	
capital costs (wiring, meters) (annualized)	S/.	_____
total costs/year	S/.	

e) cost savings per household

total kerosene costs/year	S/.	
(-) total electricity costs/year	S/.	_____
net cost-savings/year	S/.	

P.S.

Let s_{xn} = Ave. cost savings in year n for H/H in category

s_{yn} = Ave. cost savings in year n for H/H in category

$_{zn}$ = Ave. cost savings in year n for H/H in category

POWER SALES FOR SELECTED SHPP

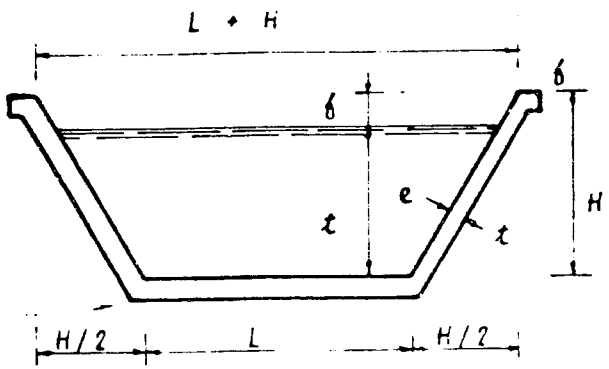
Locality/Province	Actual Urban Population 1/	Daily Service Hours	Installed Capacity (Kw)	Sales (GwH)	Number of Connections	Avge. KwH Connection/Yr.
Otuzco/La Libertad	10,200	24	312	.433	736	588
Acobamba/Junin	9,800	24	220	.496	438	1,134
Huanachuco La Libertad	8,900	24	178	.356	873	408
Chuquibamba/Arequipa	3,700	18	200	.402	556	723
Tayabarba/La Libertad	4,300	14	300	.322	548	591
Huaychaca La Libertad	6,000	12	361	.177	598	296
Cascas Contumazá Cajamarca	6,300	12	240	.332	808	411
Pomabamba Ancash	3,400	12	228	.208	352	593
Coracora/Ayacucho	5,500	12	196	.236	645	366
Ayabaca/Piura	5,200	8	200	.237	439	541
Huarochiri/Lima	3,200	6	320	.114	274	416

1/ Estimated Population growth: 2.5% per year.

Source: Electroperú, División de Estadística , Lima, 25 de Julio de 1980.

DESIGN OF TRAPEZOIDAL CHANNELS WITH A WALL

SLOPE RATIO OF 2:1



Thickness of the Concrete Lining e = 10 cm.

			FLOW PROFILES									
			I		II		III		IV		V	
Velocity v (m/s) and Flow Capacity Q (l/s)	Slope	Is the Channel Lined?	v	Q	v	Q	v	Q	v	Q	v	Q
	1 %	Yes	0.23	43	0.26	65	0.28	100	0.31	130	0.35	210
		No	0.56	100	0.62	155	0.70	250	0.73	310	0.83	500
	2.5 %	Yes	0.37	66	0.42	105	0.46	165	0.47	200	0.55	330
		No	0.89	160	0.99	250	1.13	400	1.18	500	1.33	800
Dimensions	Bottom Width L		0.35		0.45		0.50		0.60		0.70	
	Height H		0.45		0.55		0.60		0.70		0.80	
	Distance between channel Edge and Water Height. f		0.10		0.16		0.13		0.20		0.20	
	Water Height t		0.35		0.39		0.47		0.50		0.60	
	Wet Cross Section A		0.180		0.252		0.355		0.425		0.600	
	Wet Boundary C		1.12		1.32		1.58		1.72		2.04	
	Hydraulic Radius K		0.295		0.190		0.225		0.247		0.294	

NOTE: The dimensions F and t change slightly (± 2 cm) with changes in the channel slope and the kind of lining used.

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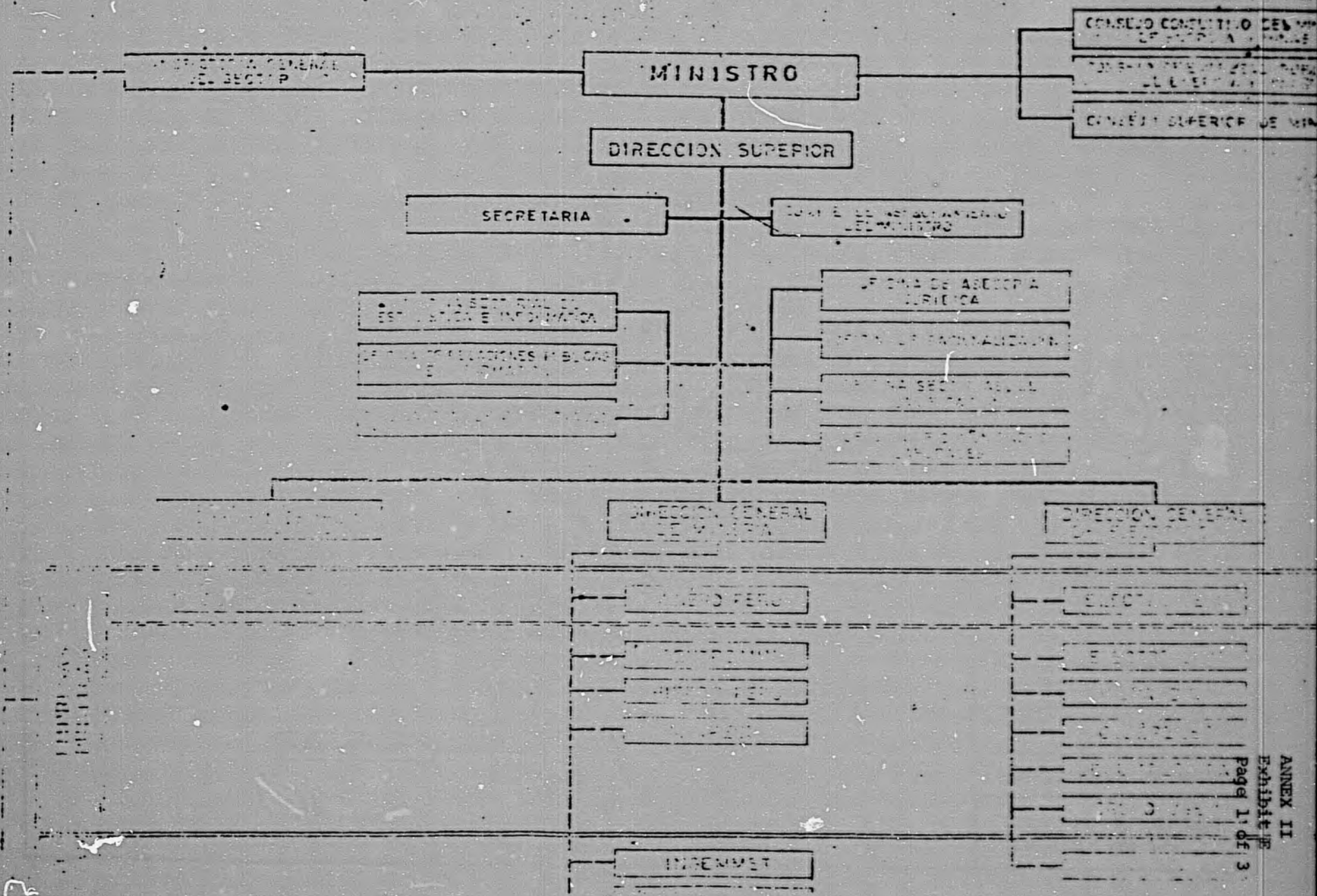

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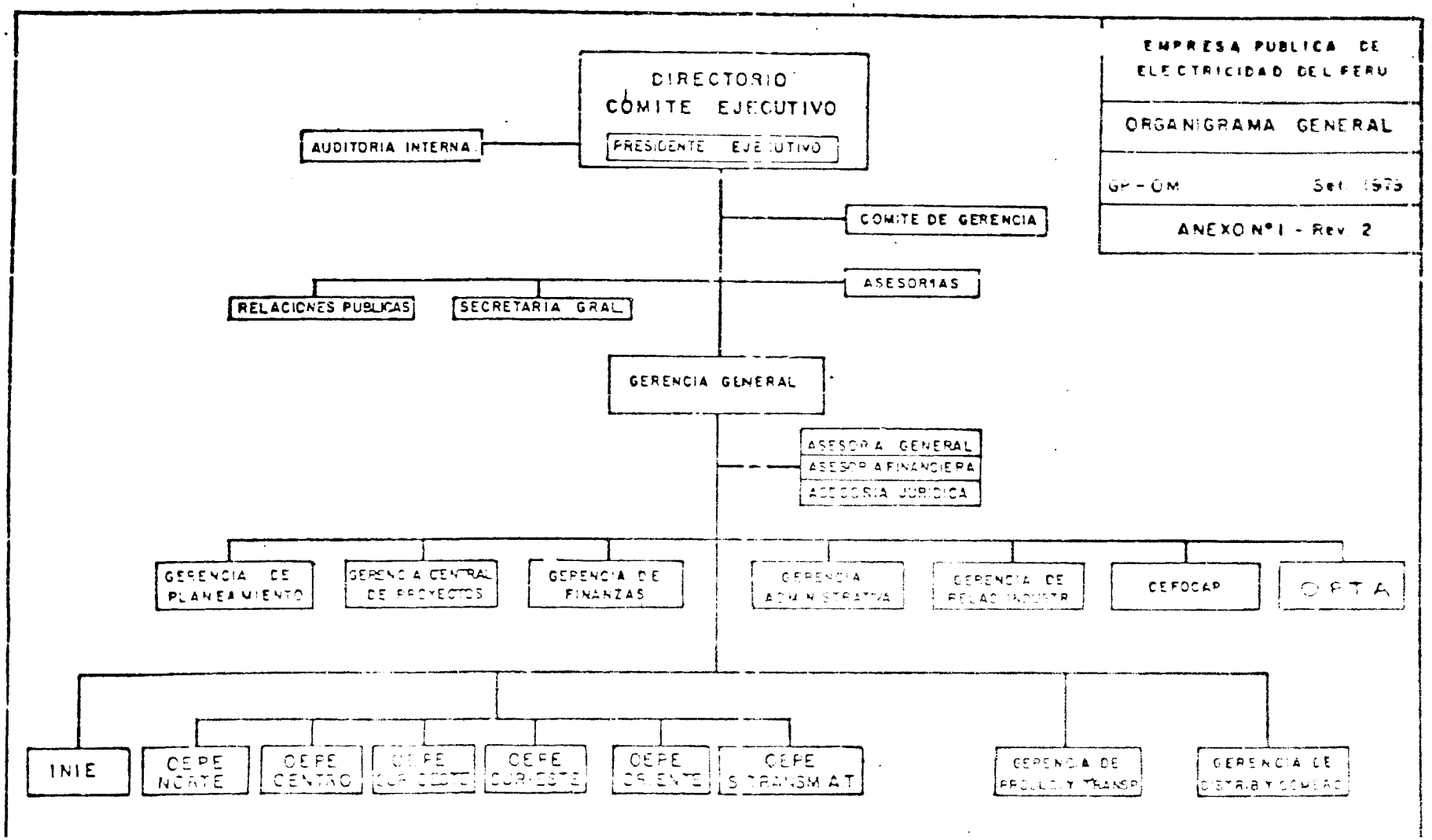
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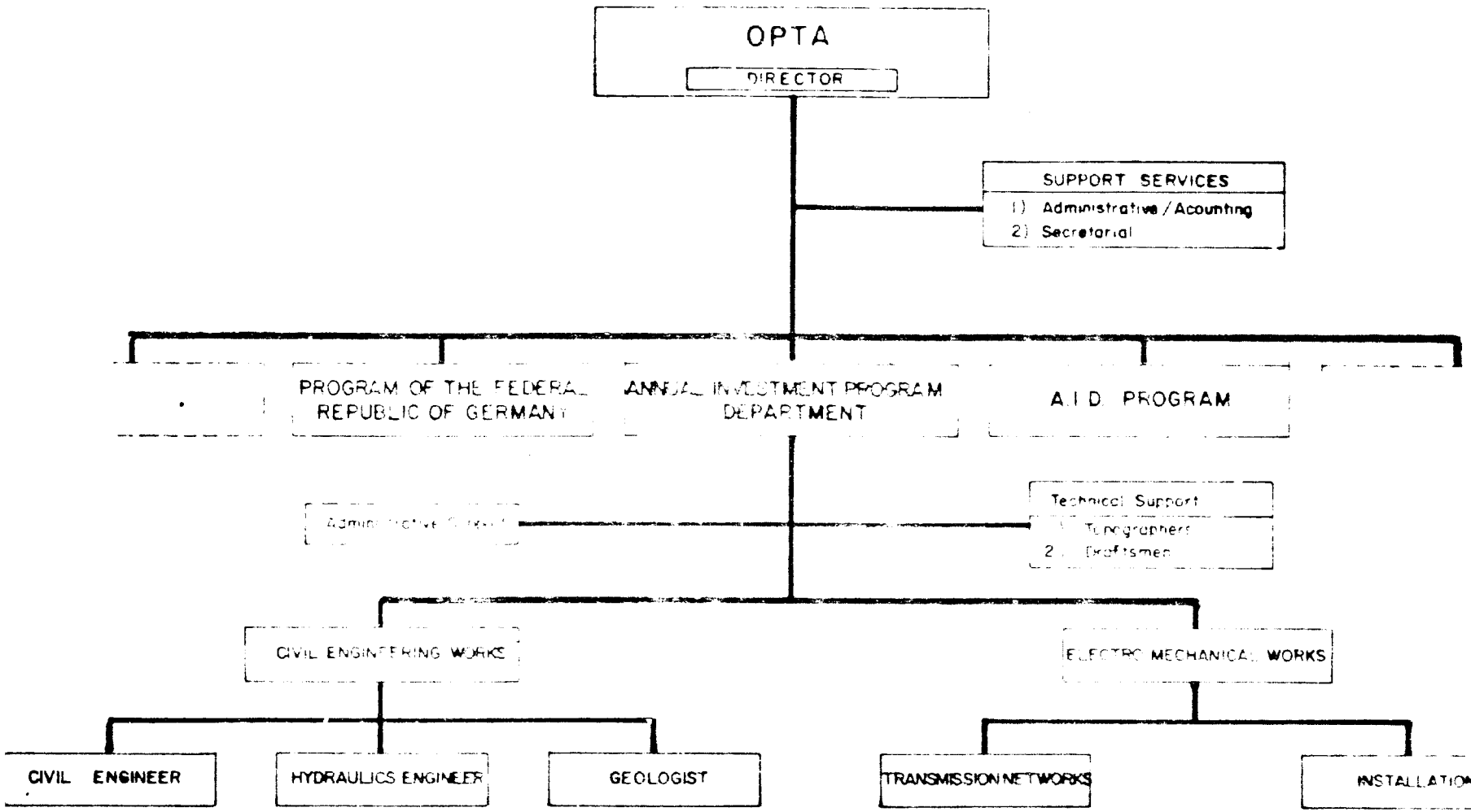

ANNEX II
Exhibit E
Page 3 of 3

TRANSCRIBIR
DIRECCION
Electricidad

"Año de los Deberes Ciudadanos"

Resolución Ministerial N° 03[illegible]

27 JUN. 1980

CONSIDERANDO :

Que es necesario modificar algunas tarifas de los servicios públicos de electricidad como consecuencia del aumento registrado en los costos de operación de dichos servicios :

Estando a lo dispuesto por el Decreto Ley 21732 ;

Con la opinión favorable del Director General de Electricidad y del Director Superior ;

SE RESUELVE :

ARTICULO 1°.- Modifícase las tarifas fijadas a ELECTROPERU por las Resoluciones Ministeriales Nos. 552- y 592-79-EM/DGE de fecha 11 de Julio de 1979 y 03 de Agosto de 1979, respectivamente, que se señala a continuación :

A.- Tarifas para consumo industrial comprendidas en los pliegos tarifarios I, II, III y IV.-

Tarifa N° 30	Industrial Menor :		
	Potencia contratada menor de 50 KW.		
	Por potencia instalada	S/.	260.00 KW-mes
	Energía Activa	S/.	9.30 KWh
Tarifa N° 31	Industrial Mayor .		
	Potencia contratada igual o mayor a 50 KW.		
	Suministros con alimentación a tensiones nominales de hasta 2,300 voltios:		
	Máxima demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	1,620.00 KW-mes
	Energía Activa	S/.	8.00 KWh
	Energía Reactiva	S/.	4.20 KVArh

Tarifa N° 32 Industrial Mayor :

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	Potencia contratada de 50 a 999 KW Suministros con alimentación a tensiones nominales entre 2,300 y 13,800 voltios. Máxima Demanda(mínimo mensual facturable 60% de la potencia contratada) Energía Activa Energía Reactiva	S/. 1,600.00 KW-mes 7.10 KWh 4.20 KVArh
Tarifa N° 33	Industrial Mayor : Potencia contratada mayor de 999 KW. Suministros con alimentación a tensiones nominales superiores a 2,300 voltios y menores de 30,000 voltios Máxima Demanda(mínimo mensual facturable 60% de la potencia contratada) Energía Activa diurna(consumida entre las 10 y 22 horas) Energía Activa nocturna(consumida entre las 22 y 10 horas) Energía Reactiva	S/. 1,900.00 KW-mes 8.00 KWh 4.70 KWh 3.80 KVArh
Tarifa N° 34	Industrial Mayor : . Potencia contratada mayor de 999 KW . Suministros con alimentación a tensiones nominales de 30,000 a 60,000 voltios: Máxima Demanda(mínimo mensual facturable 60% de la potencia contratada) Energía Activa diurna(consumida entre las 10 y 22 horas) Energía Activa nocturna(consumida entre las 22 y 10 horas) Energía Reactiva	S/. 1,600.00 KW-mes S/. 7.50 KWh S/. 4.25 KWh S/. 4.00 KVarh
Tarifa N° 35	Industrial Mayor : . Potencia contratada mayor de 999 KW Suministros con alimentación a tensiones nominales de más de 60,000 voltios :	

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Resolución Ministerial

Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	1,450.00 KW-mes
Energía Activa diurna (consumida entre las 10 y 22 horas)	S/.	6.70 KWh
Energía Activa nocturna (consumida entre las 22 y 10 horas)	S/.	4.00 KWh
Energía Reactiva	S/.	3.20 KVArh

b.- Tarifas para consumo industrial comprendidas en los Pliegos I-A y III-A:

Tarifa N° 30 — Industrial Menor:

Potencia contratada menor de 50 KW		
Por potencia instalada	S/.	250.00 KW-mes
Energía Activa	S/.	9.00 KWh

Tarifa N° 31 — Industrial Mayor:

Potencia contratada igual o mayor a 50 KW		
Suministros con alimentación a tensiones nominales de hasta 2,300 voltios:		
Máxima demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	1,560.00 KW-mes
Energía Activa	S/.	7.70 KWh
Energía Reactiva	S/.	4.05 KVArh

Tarifa N° 32 — Industrial Mayor:

Potencia contratada de 50 a 999 KW		
Suministros con alimentación a tensiones nominales entre 2,300 y 10,000 voltios.		
Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	1,540.00 KW-mes
Energía Activa	S/.	6.80 KWh
Energía Reactiva	S/.	4.05 KVArh

Tarifa N° 33 — Industrial Mayor:

Potencia contratada mayor de 999 KW
Suministros con alimentación a tensiones nominales superiores a 2,300 voltios y menores de 30,000 voltios:

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	Máxima Demanda(mínimo mensual facturable 60% de la potencia contratada)	S/.	1,800.00 KW-mes
	Energía Activa diurna(consumida entre las 10 y 22 horas)	S/.	7.70 KWh
	Energía Activa nocturna(consumida entre las 22 y 10 horas)	S/.	4.70 KWh
	Energía Reactiva		4.70 KVArh
Tarifa Nº 34	Industrial Mayor : Potencia contratada mayor de 999 KW Suministros con alimentación a tensiones nominales de 30,000 a 60,000 voltios:		
	Máxima Demanda(mínimo mensual facturable 60% de la potencia contratada)	S/.	1,500.00 KW-mes
	Energía Activa diurna(consumida entre las 10 y 22 horas)	S/.	7.20 KWh
	Energía Activa nocturna(consumida entre las 22 y 10 horas)	S/.	4.20 KWh
	Energía Reactiva	S/.	4.00 KVArh
Tarifa Nº 35	Industrial Mayor : Potencia contratada mayor de 999 KW Suministros con alimentación a tensiones nominales de más de 60,000 voltios:		
	Máxima Demanda(mínimo mensual facturable 60% de la potencia contratada)	S/.	1,400.00 KW-mes
	Energía Activa diurna(consumida entre las 10 y 22 horas)	S/.	6.60 KWh
	Energía Activa nocturna (consumida entre las 22 y 10 horas)	S/.	4.00 KWh
	Energía Reactiva	S/.	3.00 KVArh

C.- Tarifas para consumos comercial y de uso General comprendidos en el Pliego Tarifario I.

Tarifa Nº 40	Comercial Menor: Suministros con alimentación a tensiones nominales de hasta 2,300 voltios		
	Consumos de hasta 30 KWh-mes	S/.	757.00 KW-mes
	Consumos mayores de 30 KWh-mes	S/.	25.20 KWh

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Resolución Ministerial

Tarifa N°41	Comercial a Tensión Fija:		
	Mínimo 100 Watts contratado	S/.	3.60 Watt-mes
Tarifa N°42	Comercial Mayor:		
	Suministros con alimentación a tensiones nominales superiores a 2,300 voltios		
	Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	1,200.00 kW-mes
	Energía Activa diurna (de 10 a 22 horas)	S/.	18.50 kWh
	Energía Activa nocturna (de 22 a 10 horas)	S/.	10.00 kWh
	Energía Reactiva	S/.	4.00 kVArh
Tarifa N°50	Uso General a Medidor:		
	Consumos de hasta 30 kWh-mes	S/.	481.00 mes
	Consumos mayores de 30 kWh-mes	S/.	16.00 kWh
Tarifa N°51	Uso General a Tensión Fija		
	Mínimo 100 Watts contratados	S/.	3.00 Watt-mes

D.- Tarifas para consumos comercial y de uso general comprendidos en el Pliego Tarifario I-A:

Tarifa N°40	Comercial Menor:		
	Suministros con alimentación a tensiones nominales de hasta 2,300 voltios		
	Consumos de hasta 30 kWh-mes	S/.	729.00 mes
	Consumos mayores de 30 kWh-mes	S/.	24.20 kWh
Tarifa N°41	Comercial a Tensión Fija:		
	Mínimo 100 Watts contratados	S/.	3.65 Watt-mes
Tarifa N°42	Comercial Mayor:		
	Suministros con alimentación a tensiones nominales superiores a 2,300 voltios.		
	Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	1,150.00 kW-mes
	Energía Activa diurna (de 10 a 22 horas)	S/.	18.00 kWh
	Energía Activa nocturna (de 22 a 10 horas)	S/.	9.00 kWh
	Energía reactiva	S/.	4.20 kVArh
Tarifa N°50	Uso General a Medidor:		
	Consumos de hasta 30 kWh-mes	S/.	452.00 mes
	Consumos mayores de 30 kWh-mes	S/.	15.00 kWh

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Tarifa N°51	Uso General a Pensión Fija Mínimo 100 Watts contratados	S/.	2.60 Watt-mes

E.- Tarifas para consumos comercial y de uso general comprendidos en el Pliego Tarifario II :

Tarifa N°40	Comercial Menor: Suministros con alimentación a tensiones nominales de hasta 2,300 voltios Consumos de hasta 30 kWh-mes Consumos mayores de 30 kWh-mes	 S/. S/.	 695.00 mes 23.10 kWh
Tarifa N°41	Comercial a Pensión Fija: Mínimo 100 Watts contratados	S/.	3.80 Watt-mes
Tarifa N°42	Comercial Mayor: Suministros con alimentación a tensiones nominales superiores a 2,300 voltios Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada) Energía Activa diurna (de 10 a 22 horas) Energía Activa nocturna (de 22 a 10 horas) Energía Reactiva	 S/. S/. S/. S/.	 1,050.00 kW-mes 16.00 kWh 8.60 kWh 3.90 kVArh
Tarifa N°50	Uso General a Medidor Consumos de hasta 30 kWh-mes Consumos mayores de 30 kWh-mes	 S/. S/.	 481.00 mes 16.00 kWh
Tarifa N°51	Uso General a Pensión Fija: Mínimo 100 Watts contratados	S/.	3.00 Watt-mes

F.- Tarifas para consumos comercial y uso general comprendidos en el Pliego Tarifario III :

Tarifa N°40	Comercial Menor: Suministros con alimentación a tensiones nominales de hasta 2,300 voltios Consumos de hasta 30 kWh-mes Consumos mayores de 30 kWh-mes	 S/. S/.	 570.00 mes 19.00 kWh
Tarifa N°41	Comercial a Pensión Fija: Mínimo 100 Watts contratados	S/.	3.80 Watt-mes
Tarifa N°42	Comercial Mayor: Suministros con alimentación a tensiones nominales superiores a 2,300 voltios Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	 S/.	 760.00 kW-mes

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Resolución Ministerial

	Energía Activa diurna (de 10 a 22 horas)	S/.	11.50 kWh
	Energía activa nocturna (de 22 a 10 horas)	S/.	6.65 kWh
	Energía Reactiva	S/.	3.00 kVArh
Tarifa N°50	Uso General a Medidor:		
	Consumos de hasta 30 kWh-mes	S/.	390.00 mes
	Consumos mayores de 30 kWh-mes	S/.	14.50 kWh
Tarifa N°51	Uso General a Tensión Fija		
	Mínimo 100 Watts contratados	S/.	2.65 Watt-mes

G.- Tarifas para consumos comercial y de uso general comprendidas en el Pliego Tarifario III-A:

Tarifa N°40	Comercial Menor:		
	Suministros con alimentación a tensiones nominales de hasta 2,300 voltios		
	Consumos de hasta 30 kWh-mes	S/.	550.20 mes
	Consumos mayores de 30 kWh-mes	S/.	18.35 kWh
Tarifa N°41	Comercial a Tensión Fija:		
	Mínimo 100 Watts contratados	S/.	3.65 Watt-mes
Tarifa N°42	Comercial Mayor:		
	Suministros con alimentación a tensiones nominales superiores a 2,300 voltios		
	Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	733.60 kW-mes
	Energía Activa diurna (de 10 a 22 horas)	S/.	11.20 kWh
	Energía Activa nocturna (de 22 a 10 horas)	S/.	6.45 kWh
	Energía Reactiva	S/.	2.95 kVArh
Tarifa N°50	Uso General a Medidor:		
	Consumo de hasta 30 kWh-mes	S/.	377.00 mes
	Consumo mayores de 30 kWh-mes	S/.	13.80 kWh
Tarifa N°51	Uso General a Tensión Fija:		
	Mínimo 100 Watts contratados	S/.	2.55 Watt-mes

H.- Tarifas para consumos comercial y de uso general comprendidas en el Pliego Tarifario IV:

Tarifa N°40	Comercial Menor:		
	Suministros con alimentación a tensiones nominales de hasta 2,300 voltios		
	Consumos de hasta 30 kWh-mes	S/.	457.00
	Consumos mayores de 30 kWh-mes	S/.	15.25
Tarifa N°41	Comercial a Pensión Fija:		
	Mínimo 100 Watts contratados	S/.	3.80
Tarifa N°42	Comercial Mayor:		
	Suministros con alimentación a tensiones nominales superiores a 2,300 voltios		
	Máxima Demanda (mínimo mensual facturado 60% de la potencia contratada)	S/.	700.00 kW-mes
	Energía Activa diurna (de 10 a 22 horas)	S/.	10.60 kWh
	Energía Activa nocturna (de 22 a 10 horas)	S/.	5.30 kWh
	Energía Reactiva	S/.	3.00 kVArh
Tarifa N°50	Uso General c/ Medidor:		
	Consumos de hasta 30 kWh-mes	S/.	314.00 mes
	Consumos mayores de 30 kWh-mes	S/.	10.50 kWh
Tarifa N°51	Uso General a Pensión Fija:		
	Mínimo 100 Watts contratados	S/.	3.00 Watt-mes

ARTICULO 2°.- Las nuevas tarifas señaladas en el artículo 1° serán aplicadas a todas las facturaciones mensuales, a base de lectura o promedio, que ELECTROPERU efectúe a partir de la vigencia de la presente Resolución.

Regístrese y comuníquese

RENE IGNACIO VALLEBUONA
General de División EP.
MINISTRO DE ENERGIA Y MINAS

ES COPIA FIEL DEL ORIGINAL

D. PAUL GAMARRA DIAZ
Secretario General

Electroperu
Gerencia de Explotación

Lima,

GE- 2931-79

Para : Jefe U.E.R. Norte
Jefe U.E.R. Centro
Jefe U.E.R. Sur Oeste
Jefe U.E.R. Sur Este
Jefe U.E.R. Oriente
Jefe de Sistema Interconectado

Asunto : TRANSCRIPCION DE LA RESOLUCION MINISTERIAL N° 0552-79-EM/DGE QUE DICTAMINA LAS NUEVAS TARIFAS DE ELECTROPERU

Ref. : Telex GE-1877-79 del 17.07.79.

Nos es grato dirigirnos a Uds., remitiéndoles adjunto, la copia Oficial de la nueva estructura tarifaria de nuestra Empresa, a fin de que se sirvan difundir en las Oficinas Zonales a su cargo y se proceda a la aplicación de dichas tarifas a partir del pte. mes, tanto a los abonados comunes así como al Sector Industrial Mayor, de conformidad a lo dispuesto mediante nuestro telex de la referencia. Les hacemos nota: que, en las nuevas tarifas, no se han especificado las cuotas mensuales de Alumbrado Público; en efecto, se mantendrán los montos fijados mediante la Resolución Ministerial N° 0533-77-EM/DGE del 21 de setiembre de 1977.

Con relación a nuestro telex de la referencia, les reiteramos que, el Pliego Tarifario I-A sólo es aplicable en las localidades de Pucallpa, Tarapoto y Moyobamba; y, el Pliego Tarifario III-A, sólo es aplicable en la ciudad de Iquitos, de conformidad a la Resolución Ministerial N° 0551-79-EM/DGE, cuya copia adjuntamos. En efecto, en las demás localidades, a nivel nacional, se aplicarán las tarifas N°s: I - II - III y IV de la presente Resolución, según la relación especificada en la Resolución Ministerial N° 0032-78-EM/DGE del 19 de enero de 1978.

En virtud de lo expuesto, agradeceremos se sirvan tomar debida nota de las observaciones señaladas, a fin de que nuestra facturación se efectúe en forma correcta, bajo responsabilidad de cada Jefe de Unidad de Explotación.

Atentamente,

Adj.: Lo indicado (R.M.0552 y 0551-79-EM/DGE)
BEC/AWR/nap.
c. : GG,
Comerc.
Tarifas.

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"Año de Nuestros Héroes de la Guerra del Pacífico"

0502-[illegible]-DGE

CONSIDERANDO:

Que es necesario fijar nuevas tarifas que guarden relación con los costos de los Servicios Públicos de Electricidad;

Estando a lo dispuesto por el Decreto Ley 21781;

Con la opinión favorable del Director General de Electricidad y del Director Superior;

SE RESUELVE:

Artículo Primero: Fíjase las siguientes tarifas Nos. 30, 31, 32, 33, 34, 35, 60 y 61 para la venta de energía eléctrica por Electricidad del Perú - ELECTROPERU - en las localidades comprendidas en los pliegos tarifarios I, II, III y IV:

Tarifa Nº 30	Industrial Menor: Potencia contratada menor de 50 kW. Por potencia instalada Energía Activa	 S/. 182.25 kW-mes S/. 6.65 kWh
Tarifa Nº 31	Industrial Mayor: Potencia contratada igual o mayor a 50 kW. Suministros con alimentación a tensiones nominales de hasta 2,300 voltios: Máxima demanda (mínimo mensual facturable 60% de la potencia contratada) Energía Activa Energía Reactiva	 S/. 1,149.00 kW-mes S/. 5.70 kWh S/. 3.00 kVArh
Tarifa Nº 32	Industrial Mayor Potencia contratada de 50 a 999 kW Suministros con alimentación a tensiones nominales entre 2,300 y 13,200 voltios. Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada) Energía Activa Energía Reactiva	 S/. 1,123.30 kW-mes S/. 5.10 kWh S/. 3.00 kVArh

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Tarifa Nº 33	Industrial Mayor:		
	Potencia contratada mayor de 999 kW.		
	Suministros con alimentación a tensiones nominales superiores a 2,300 voltios y menores de 30,000 voltios		
	Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	1,321.75 kW-mes
	Energía Activa diurna (consumida entre las 10 y 22 horas)	S/.	5.70 kWh
	Energía Activa nocturna (consumida entre las 22 y 10 horas)	S/.	3.45 kWh
	Energía Reactiva	S/.	3.45 kVArh
Tarifa Nº 34	Industrial Mayor:		
	Potencia contratada mayor de 999 kW.		
	Suministros con alimentación a tensiones nominales de 30,000 a 60,000 voltios:		
	Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	1,129.60 kW-mes
	Energía Activa diurna (consumida entre las 10 y 22 horas)	S/.	5.35 kWh
	Energía Activa nocturna (consumida entre las 22 y 10 horas)	S/.	3.05 kWh
	Energía Reactiva	S/.	2.90 kVArh
Tarifa Nº 35	Industrial Mayor:		
	Potencia contratada mayor de 999 kW		
	Suministros con alimentación a tensiones nominales de más de 60,000 voltios:		
	Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	1,016.65 kW-mes
	Energía Activa diurna (consumida entre las 10 y 22 horas)	S/.	4.75 kWh
	Energía Activa nocturna (consumida entre las 22 y 10 horas)	S/.	2.90 kWh
	Energía Reactiva	S/.	2.25 kVArh
Tarifa Nº 60	Electrobombas para Servicio Público de Agua Potable y Desagüe:		
	Mínimo 200 kWh-mes	S/.	716.70 mes
	Exceso	S/.	3.65 kWh
Tarifa Nº 61	Electrobombas para usos agrícolas		
	Consumo entre las 18 y 22 horas	S/.	2.15 kWh
	Consumo entre las 22 y 18 horas	S/.	1.50 kWh.

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Artículo Segundo: Fíjase las siguientes tarifas Nos. 30, 31, 32, 33, 34, 35, 60 y 61 para la venta de energía eléctrica por Electricidad del Perú - ELECTROPERU - en las localidades comprendidas en los pliegos tarifarios Nos. [illegible]

Tarifa Nº 30	Industrial Menor Potencia contratada menor de 50 kW Por potencia instalada Energía Activa	S/. S/.	177.55 kW-mes 6.40 kWh
Tarifa Nº 31	Industrial Menor Potencia contratada igual o mayor a 50 kW. Suministros con alimentación a tensiones nominales de hasta 2,300 voltios: Máxima Demanda (pliegos mensual facturable 60% de la potencia contratada) Energía Activa Energía Reactiva	S/. S/. S/.	1,111.15 kW-mes 5.50 kWh [illegible] kVArh
Tarifa Nº 32	Industrial Mayor. Potencia contratada de 50 a 999 kW. Suministros con alimentación a tensiones nominales entre 2,300 y 10,000 voltios. Máxima Demanda (pliegos mensual facturable 60% de la potencia nominal) Energía Activa Energía Reactiva	S/. S/. S/.	1,0[illegible].50 kW-mes [illegible] kWh [illegible] kVArh
Tarifa Nº 33	Industrial Mayor. Potencia contratada mayor de 999 kW. Suministros con alimentación a tensiones nominales superiores a 10,000 voltios y menores de 50,000 voltios: Máxima Demanda (pliegos mensual facturable 60% de la potencia contratada) Energía Activa diurna (consumida entre las 10 y 22 horas) Energía Activa nocturna (consumida entre las 22 y 10 horas) Energía Reactiva	S/. S/. S/. S/.	1,177.60 kW-mes 5.50 kWh 5.65 kWh 5.35 kVArh

Tarifa Nº 34	Industrial Mayor: Potencia contratada mayor de 999 kW. Suministros con alimentación a tensiones nominales de 30,000 a 60,000 voltios. Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	1,042.11 kW-mes
	Energía Activa diurna (consumida entre las 10 y 22 horas)	S/.	5.15 kWh
	Energía Activa nocturna (consumida entre las 22 y 10 horas)	S/.	2.95 kWh
	Energía Reactiva	S/.	2.30 kVArh
Tarifa Nº 35	Industrial Mayor. Potencia contratada mayor de 999 kW. Suministros con alimentación a tensiones nominales de más de 60,000 voltios. Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	982.20 kW-mes
	Energía Activa diurna (consumida entre las 10 y 22 horas)	S/.	4.50 kWh
	Energía Activa nocturna (consumida entre las 22 y 10 horas)	S/.	2.50 kWh
	Energía Reactiva	S/.	2.15 kVArh
Tarifa Nº 60	Electrobombas para Servicio Público de Agua Potable y Desagüe: Mínimo 200 kW-mes	S/.	716.70 mes
	Exceso	S/.	3.65 kWh
Tarifa Nº 61	Electrobombas para usos agrícolas Consumo entre las 12 y 22 horas	S/.	2.15 kWh
	Consumo entre las 22 y 12 horas	S/.	1.50 kWh

Artículo Tercero: Fíjase las siguientes tarifas Nos. 10, 11, 20, 21, 22, 30, 41, 42, 50 y 51 para la venta de energía eléctrica por ElectroMéldico del Perú – ELECTROPERU – en las localidades comprendidas en los pliegos tarifarios I, I-A, II, III, III-A y IV:

PLIEGO TARIFARIO I

Tarifa Nº 10	Alumbrado Público o Particular	S/.	3.50 kWh
Tarifa Nº 11	Alumbrado Público a Tarifa Fija	S/.	5.80 lámpara
Tarifa Nº 20	Residencial Menor: Tarifa social para consumos de hasta 30 kWh-mes	S/.	55.25 mes

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Tarifa Nº 21	Residencial a Medidor:		
	Consumos mensuales mayores de 30 kWh		
	Tope al consumo:		
	Primeros 200 kWh	S/.	7.55 kWh
	Exceso	S/.	3.05 kWh
Tarifa Nº 22	Residencial a Pensión Fija:		
	Mínimo 100 Watts contratados	S/.	1.40 Watt-mes
Tarifa Nº 40	Comercial Menor:		
	Suministros con alimentación a tensiones nominales de hasta 2,300 voltios		
	Consumos de hasta 30 kWh-mes	S/.	542.00 mes
	Consumos mayores de 30 kWh-mes	S/.	17.97 kWh
Tarifa Nº 41	Comercial a Pensión Fija:		
	Mínimo 100 Watts contratados	S/.	2.70 Watt-mes
Tarifa Nº 42	Comercial Mayor:		
	Suministros con alimentación a tensiones nominales superiores a 2,300 voltios		
	Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	853.66 kW-mes
	Energía Activa diurna (de 10 a 22 horas)	S/.	10.15 kWh
	Energía Activa nocturna (de 22 a 10 horas)	S/.	7.05 kWh
	Energía Reactiva	S/.	0.05 kVArh
Tarifa Nº 50	Uso General a Medidor:		
	Consumos de hasta 30 kWh-mes	S/.	299.75 mes
	Consumos mayores de 30 kWh-mes	S/.	12.00 kWh
Tarifa Nº 51	Uso General a Pensión Fija:		
	Mínimo 100 Watts contratados	S/.	2.05 Watt-mes
	PLIEGO TARIFARIO [illegible]		
Tarifa Nº 10	Alumbrado Público a Medidor	S/.	3.55 kWh
Tarifa Nº 11	Alumbrado Público a Pensión Fija	S/.	3.60 Watt-mes

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Tarifa N° 20	Residencial a Medidor Tarifa social para consumos de hasta 30 kWh-mes	S/.	65.25 mes
Tarifa N° 21	Residencial a Medidor Consumos mayores de 30 kWh Tasa al costo Primeros 200 kWh	S/.	7.20 kWh
	Exceso	S/.	7.75 kWh
Tarifa N° 22	Residencial a Potencia Fija Mínimo 100 Watts contratados	S/.	1.35 Watts-mes
Tarifa N° 40	Comercial Menor Suministros con alimentación a tensiones nominales inferiores a 2,300 voltios Consumos de hasta 30 kWh-mes	S/.	624.00 mes
	Consumos mayores de 30 kWh-mes	S/.	17.30 kWh
Tarifa N° 41	Comercial a Potencia Fija Mínimo 100 Watts contratados	S/.	3.25 Watts-mes
Tarifa N° 42	Comercial Mayor Suministros con alimentación a tensiones nominales superiores a 2,300 voltios. Máxima Demanda (máximo anual facturable 100% de la potencia contratada)	S/.	825.30 kW-mes
	Energía activa diurna (de 18 a 22 horas)	S/.	12.70 kWh
	Energía activa nocturna (de 22 a 18 horas)	S/.	4.00 kWh
	Energía reactiva	S/.	2.95 kVAr/h
Tarifa N° 50	Uso Comercial a Medidor Consumos de hasta 30 kWh-mes	S/.	209.75 mes
	Consumos mayores de 30 kWh-mes	S/.	11.60 kWh
Tarifa N° 51	Uso Comercial a Potencia Fija Mínimo 100 Watts contratados	S/.	1.95 Watts-mes

PLIEGO TARIFARIO II

Tarifa N° 10	Alumbrado Público a Medidor	S/.	2.80 kWh
Tarifa N° 11	Alumbrado Público a Potencia Fija	S/.	0.50 Watts-mes
Tarifa N° 20	Residencial a Medidor Tarifa social para consumos de hasta 30 kWh-mes	S/.	65.25 mes

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Tarifa Nº 21	Residencial a Medidor: Consumos mensuales mayores de 30 kWh Todo el consumo: Primeros 200 kWh Exceso	 S/. S/.	 7.13 kWh 7.35 kWh
Tarifa Nº 22	Residencial a Pensión Fijo: Mínimo 100 Watts contratados	S/.	1.40 Watt-mes
Tarifa Nº 40	Comercial Menor: Suministros con alimentación a tensiones nominales de hasta 2,300 voltios. Consumos de hasta 30 kWh-mes Consumos mayores de 30 kWh-mes	 S/. S/.	 501.35 mes 16.40 kWh
Tarifa Nº 41	Comercial a Pensión Fijo: Mínimo 100 Watts contratados	S/.	2.70 Watt-mes
Tarifa Nº 42	Comercial Mayor: Suministros con alimentación a tensiones nominales superiores a 2,300 voltios Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada) Energía Activa diurna (de 10 a 22 horas) Energía Activa nocturna (de 22 a 10 horas) Energía Reactiva	 S/. S/. S/. S/.	 745.25 kW-mes 11.40 kWh 6.10 kWh 2.80 kVarh
Tarifa Nº 50	Uso General a Medidor: Consumos de hasta 30 kWh-mes Consumos mayores de 30 kWh-mes	 S/. S/.	 249.75 mes 12.00 kWh
Tarifa Nº 51	Uso General a Pensión Fijo: Mínimo 100 Watts contratados	S/.	2.05 Watt-mes
	PLIEGO TARIFARIO III		
Tarifa Nº 10	Alumbrado Público a Medidor	S/.	2.70 kWh
Tarifa Nº 11	Alumbrado Público a Pensión Fijo	S/.	0.80 Watt-mes
Tarifa Nº 20	Residencial a Medidor: Tarifa social para consumos de hasta 30 kWh-mes	S/.	65.25 mes

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Tarifa Nº 21	Residencial a Medidor:		
	Consumos mensuales mayores de 30 kWh		
	Todo el consumo:		
	Primeros 200 kWh	S/.	7.15 kWh
	Exceso	S/.	7.45 kWh
Tarifa Nº 22	Residencial a Paralón Fijo		
	Mínimo 100 Watts contratados	S/.	1.40 Watt-mes
Tarifa Nº 40	Comercial Menor.		
	Suministros con alimentación a tensiones nominales de hasta 2,300 voltios		
	Consumos de hasta 30 kWh-mes	S/.	406.50 mes
	Consumos mayores de 30 kWh-mes	S/.	13.55 kWh
Tarifa Nº 41	Comercial a Paralón Fijo		
	Mínimo 100 Watts contratados	S/.	2.70 Watt-mes
Tarifa Nº 42	Comercial Mayor		
	Suministros con alimentación a tensiones nominales superiores a 2,300 voltios		
	Máxima Demanda (mínimo mensual facturable 60% de la potencia contratada)	S/.	547.00 kW-mes
	Energía Activa diurna (de 10 a 22 horas)	S/.	8.25 kWh
	Energía Activa nocturna (de 22 a 10 horas)	S/.	4.75 kWh
	Energía Reactiva	S/.	2.15 kVAr
Tarifa Nº 50	Uso General a Medidor		
	Consumos de hasta 30 kWh-mes	S/.	299.73 mes
	Consumos mayores de 30 kWh-mes	S/.	11.20 kWh
Tarifa Nº 51	Uso General a Paralón Fijo		
	Mínimo 100 Watts contratados	S/.	7.05 Watt-mes

PLIEGO TARIFARIO 115 - A

Tarifa Nº 10	Alumbrado Público a Medidor	S/.	2.70 kWh
Tarifa Nº 11	Alumbrado Público a Paralón Fijo	S/.	2.80 Watt-mes
Tarifa Nº 20	Residencial a Medidor		
	Tarifa social para consumos de hasta 30 kWh-mes	S/.	85.25 mes
Tarifa Nº 21	Residencial a Medidor		
	Consumos mensuales mayores de 30 kWh		
	Todo el consumo		
	Primeros 200 kWh	S/.	6.95. kWh
	Exceso	S/.	7.30 kWh.

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Tarifa Nº 22	Residencial a Pensión Fija Mínimo 100 Vatios contratados	S/.	1.35 kW-mes
Tarifa Nº 40	Comercial Menor: Suministros con alimentación a tensiones nominales de hasta 2,000 voltios. Consumo de hasta 30 kWh-mes	S/.	392.00 mes
	Consumos mayores de 30 kWh-mes	S/.	13.10 kWh
Tarifa Nº 41	Comercial a Pensión Fija Mínimo 100 Vatios contratados	S/.	2.00 kW-mes
Tarifa Nº 4[illegible]	Comercial Mayor Suministros con alimentación a tensiones nominales superiores a 2,000 voltios. Medida mensual (mínimo mensual facturable 60% de la potencia contratada)	S/.	324.00 kW-mes
	Energía Activa diurna (de [illegible] a 22 horas)	S/.	9.70 kWh
	Energía Activa nocturna (de 22 a [illegible] horas)	S/.	[illegible].68 kWh
	Energía Reactiva	S/.	1.[illegible] kVArh
Tarifa Nº 50	Uso General a Medidor Consumo de hasta 30 kWh-mes	S/.	289.[illegible] mes
	Consumos mayores de 30 kWh-mes	S/.	[illegible].60 kWh
Tarifa Nº 51	Uso General a Pensión Fija Mínimo 100 Vatios contratados	S/.	1.95 kW-mes

ALUMBRADO TARIFARIO [illegible]

Tarifa Nº 10	Alumbrado público a medidor	S/.	[illegible].71 kWh
Tarifa Nº 11	Alumbrado público a Pensión Fija	S/.	0.80 kW-mes
Tarifa Nº 20	Residencial a Medidor Tarifa social consumos de hasta 30 kWh-mes	S/.	35.25 mes
Tarifa Nº 21	Residencial a Medidor Consumos mensuales mayores de 30 kWh Todo el consumo Primeros 200 kWh	S/.	5.30 kWh
	Exceso	S/.	5.90 kWh

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Tarifa Nº 22	Residencial - Facultad Fija		
	Mínimo 100 kwh contratados	S/.	1.40 Nuevos
Tarifa Nº 40	Comercial Menor		
	Suministro con alimentación a tensiones nominales de hasta 2,200 voltios		
	Consumos de hasta 30 kwh mensuales	S/.	123.20 [illegible]
	Consumos mayores de 30 kwh mensuales	S/.	16.85 [illegible]
Tarifa Nº 41	Comercial - Facultad Fija		
	Mínimo 100 kwh contratados	S/.	[illegible] Nuevos
Tarifa Nº 42	Comercial Mayor		
	Suministro con alimentación a tensiones nominales superiores a 2,200 voltios		
	Máxima Demanda (mínimo mensual facturable 50% de la potencia contratada)	S/.	[illegible]
	Energía Activa diurna (de 16 a 22 horas)	S/.	7.45 [illegible]
	Energía Activa nocturna (de 22 a 10 horas)	S/.	[illegible]
	Energía Reactiva	S/.	[illegible]
Tarifa Nº 50	Uso General a Medidor		
	Consumo de hasta 30 kwh mensuales	S/.	[illegible]
	Consumos mayores de 30 kwh mensuales	S/.	3.05 [illegible]
Tarifa Nº 51	Uso General a Facultad Fija		
	Mínimo 100 kwh contratados	S/.	2.05 Nuevos

Artículo Cuarto.- Los precios pactados por concepto de Servicios Domiciliarios a que se refieren las tarifas Nos. 21, 31, 33, 34, 35 y 41 de los Artículos Primero, Segundo y Tercero de la presente Resolución, tendrán un recargo del treinta por ciento (30%) para aquellas localidades que se abastecen mediante plantas de su respectiva Potencia Contratada del suministro correspondiente.

Artículo Quinto.- Las tarifas fijadas por la presente Resolución se aplicarán según los montos de facturación mínima establecidos en la Resolución Ministerial Nº 625-75-EM/DGE de fecha 27 de Julio de 1975 en los localidades de Olmos para cada pliego tarifario en el artículo tercero de la Resolución Ministerial Nº 0072-78-EM/DGE del 19 de enero de 1978 y disposiciones complementarias.

Artículo Sexto.- Las tarifas fijadas para el consumo de alumbrado público se aplicarán con sujeción a las disposiciones de los artículos 8º, 15º, 16º y 18º del Decreto Ley 22012.

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Artículo Sétimo: A los consumidores destinatarios de los usuarios del consumo industrial mayor, con carga conectada superior a 10,000 kW, que reciben energía eléctrica directamente desde un Centro de Transformación 138/13.8 kV, se les aplicará la Tarifa MT-33, más un recargo de S/. 0.21/kw h.

Artículo Octavo: Lo dispuesto en la Resolución Ministerial Nº 0413-77-EM/DGE de fecha 08 de julio de 1977 se aplicará, a partir de la vigencia de la presente Resolución, considerando el nuevo valor de la Tarifa MT-30 fijado en el artículo primero.

Artículo Noveno: Las tarifas fijadas en la precedente Resolución y el recargo a que se refiere el artículo cuarto de la misma, serán cobradas a todas las facturaciones mensuales efectuadas por Electroperú del Perú - ELECTROPERU - a partir del 1º de julio de 1977.

Artículo Décimo: Derógase las disposiciones que se opongan a la presente Resolución, excepto la Resolución Ministerial Nº 0142-77-EM/DGE del 11 de marzo de 1977.

Regístrese y comuníquese.

C.VG./C.M.S./lk.

PERU's ENERGY RESOURCES AND CONSTRUCTION

1. Fossil Fuels

PETROPERU's (the Peruvian State Oil Company) estimate of Peru's total petroleum reserves in 815 million barrels, broken down as follows: measured reserves[1/] 560 million barrels, indicated reserves 160 million barrels and inferred reserves 95 million barrels. United States Geologic Service (USGS) specialists who participated in the DOE's Cooperative Energy Assessment estimated identified reserves at 1 billion barrels, the difference being accounted for principally by USGS's higher estimates of the potential for secondary recovery in the Talara Basin. Peru shifted from a net oil exporter to a net oil importer in the late 1960's, however, with the discovery of the new fields and the completion of the trans-Andean pipeline and the northern branch pipeline, domestic production once again exceeded domestic consumption in mid-1978. Unless additional new discoveries increase output, it is expected that Peru's oil production will peak at 81.9 million barrels per year (bbl/yr) in 1981, level off at 70 million bbl/yr by the mid 1980s and drastically decline to approximately 10 to 15 million bbl/yr by the year 2000. Because the normal lag time between exploration and production is 3 to 5 years, the USGS specialists consider that the predicted decline in production through the early to mid 1980's is irreversible. However, exploratory ventures in the next 10 years could reverse the anticipated low production rates by 1990's.

Based on present operations and existing knowledge of petroleum reserves in Peru, the country should be self-sufficient in oil until 1985. Currently, domestic demand is approximately 45 million barrels per year, and for the past decade it has been growing at an average annual rate of 4.6%. Expected domestic consumption by the year 2000 is estimated at 117 million barrels per year.

Natural gas plays a much smaller role as an energy source, supplying 6.4% of Peru's total energy needs. Gas production in Peru is expected to remain relatively high with current production at about 72 billion cubic feet per year, and an estimated 5% decline per year. Peru's natural gas, produced mainly from the Talara Basin, is used primarily for fertilizer production.

1/ Measured Reserves: That part of the identified resource which can be economically extracted using existing technology, and whose amount is estimated from geologic evidence supported directly by engineering measurements.
Indicated Reserves: Reserves that include additional recoveries in known reservoir (in excess of the measured reserves) which engineering knowledge and judgement indicate will be economically available by application of fluid injection whether or not such a program is currently installed.
Inferred Reserves: Reserves in addition to demonstrated reserves eventually to be added to know fields through extension, revisions, and new pays.

Coal deposits are reported to occur in 18 of Peru's 24 departments and include coal ranging in quality from lignite to anthracite. Although the coal found in most areas is of little economic value, in central (Oyón Cerrona and Jatunhuasi) and northern Peru (Alto Chicama and Santa Valley) coal beds thicker than one meter are reported in many localities. Some of these areas are currently under active exploration and others are sites of former mines. These coal fields would appear to have considerable potential as sources of coal for use directly as fuel and for processing into metallurgical (cooking) coal.

No attempt has been made to classify coal reserves on a national basis according to commonly accepted standard procedures. One unverifiable estimate calculates over one billion tons of coal reserves; however, the figures cannot be interpreted as to their significance in terms of economically recoverable coal at current prices. The lack of basic data points to the great need for a well-planned, exploration program to determine what economically recoverable coal deposits exist. Current coal production is of an artisan nature and is carried out by over 40 small firms, whose technical and financial capacity do not allow for further expansion. Thus very little of Peru's coal resources are currently being exploited. The last coal mined on a large scale for commercial purposes was in 1973, when a small amount of anthracite was produced. In April of 1976 [illegible] and MINEMPEH signed a contract in a joint venture with Kopex of Poland and Universal Engineering of Switzerland to carry out a technical economic study of the Alto Chicama coal and oil energy complex. The first stage of the proposed project includes the construction of a thermal steam plant to generate 200 megawatts of power and a mine [illegible] to produce 2,000 tons of coal per day. The project's second stage will produce [illegible] megawatts of electricity, requiring [illegible] tons of coal per day. The plant would provide energy for the proposed Michiquillay copper project and the Bayovar fertilizer petrochemical complex, which is currently under construction and is expected to be operational by 1983.

2. Renewable energy

Geothermal power - At present, there is no installed geothermal power capacity in Peru, despite the fact that the country is located in a highly volcanic, [illegible] zone. The Geologic, Mineral and Metalurgical Institute (INGEMMET) is charged with evaluating, developing and utilizing geothermal resources and has identified six regions of geothermal interest. To economically utilize geothermal energy for the production of electricity, it must be at temperatures between 170°C to 200°C and at depths [illegible] than [illegible] are required. INGEMMET, with assistance from the Latin American Energy Organization (OLADE), is carrying on a study to detect usable sources of geothermal energy in the volcanic cone chain of southern Peru. According to the referenced Peru-USA Energy Assessment, the development and implementation of a geothermal energy option would require exploration and resource evaluation beginning quite soon in order to have a demonstration plant operational by 1988.

Solar Energy - No comprehensive summary exists of Peru's solar energy resources by season and/or geographic location. The National Metereologic and Hydrologic Service (SENAMHI) has maintained records on bright sunshine duration at 78 sites, but these data inadequately describe the potential solar energy resources because of the following: (1) the easter and north-central regions are no sufficiently represented; (2) the data do not describe day-to-day or year-to-year variations; and, (3) the data, in order to be useful, must be convered into energy units. Preliminary information suggests that the Sierra has the highest potential for solar energy resources exploitation followed by the jungle and coastal areas.

Although, solar photo-voltaic systems could be used to provide small-scale electrical generation for pumping water and powering communication equipment in rural areas which do not have small hydro energy resources, the basic limitation of current photo-voltaic applications is the high production costs of solar cells and the need for expensive battery storage. This option will become attractive as cell production costs decline to a level at which the cost of photo-voltaic generated electricity is competitive woth the cost of isolated diesel or hydro-generated electricity.

Wind Power - Wind turbines may be used to generate electricity for uses similar to those in which solar photo-voltaic cells are used. Additionally they can be used directly for pumping water. A difficulty in evaluating wind energy potential is that a proper national resource evaluation locating windy areas does not exist, although some coastal areas, such as Piura, have been using small wind-powered water pumps for several years.

Biomass - This general title encompasses a large variety of potential resources including vegetable and animal products and residues. Peru has fairly abundant forest resources, most of which are located in the jungle region where the population density is low. Approximately 70 million hectares of natural forest and 106 thousand hectares of tree plantations (99% of the latter is eucalyptus) exist in the country. An estimated 99% of the native forests and 60% of the lumber mills are in the jungle region. The potential use of biomass on the coast is limited because of the lack of sufficient agricultural wastes, poor soils, desert conditions and the great distances between the needed sources of vegetable wastes and the industrial and population centers. In the Sierra the eucalyptus could be used to produce additional fuel for domestic use through the commercial production of charcoal and gas, although the remaining residues will not provide for bio-fuel conversion.

The two main non-commercial energy resources utilized in Peru are wood and animal dung. Of the total amount of energy consumed in the country energy produced from wood represents approximately twelve percent. While the information on the amount of energy produced from agricultural wastes and dung is scarce, during 1976, approximately 43% of the population utilized wood and dung for cooking. The use of these

non-commercial energy resources declined between 1965 and 1976 with respect to commercial energy resources, i.e. their growth rates during this period have been 1% and 4.2% respectively. An explanation for this relatively low rate of growth of non-commercial energy is related in part to rural-urban migration and to the increased use of kerosene as a fuel by rural populations.

ANNEX II
Exhibit H

PROJECT DESIGN SUMMARY

LOGICAL FRAMEWORK

Life of Project:
From FY 81 to FY 85
Total U.S. Funding $10.0 million
Date Prepared: _____

Project Title & Number: Mini-Hydroelectric Centrals

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objective to which this project contributes. To improve the quality of life of the rural poor by increasing their productivity through the use of hydro-electric power and to contribute to Peru's lessened dependence on petroleum.	Measures of Goal Achievement: - Installation of agro-industry and development of cottage industry due to availability of electricity. - Employment generated due to expansion of business frontiers. Higher and more productive employment levels with positive opportunity costs. - Cultural advancement due to more generalized use of electrical appliances and communication devices. - Mini-hydroelectric plants substituting for petroleum fed systems.	- Regional statistical reports of the Ministry of Industry and Tourism. - Employment statistics published by the National Office for statistics. - National Accounts prepared by the Central Reserve Bank. - Project evaluations. - Visual inspections.	Assumptions for achieving goal targets: - The GOP continues recognizing the need for better productity levels as well as for the redistribution of income in favor of the rural poor. - Sufficient budgetary allocations are provided by the GOP for analyzing and carrying-out projects oriented towards substitution of petroleum for domestic and industrial use. - An efficient use of electricity is promoted through a multiple stage price scheme. - Labor intensive production processes are favored by the GOP. - Political stability prevails.
Project Purpose: To promote rural and regional socio-economic development through the development of an institutional base capable of providing reasonably priced hydro-generated electrical energy for social and productive uses in rural towns in the sierra and high jungle.	Conditions that will indicate purpose has been achieved; End of project status: - Institutionalization of the Mini-hydroelectric Development Program. OPTA actively engaged in project development & implementation. - Hydroelectric plants in operation in rural areas of San Martin, Junin and Cajamarca with a total capacity of 8.4 MWs. - 100% of total energy available for sale is consumed by domestic and industrial units. - Approximately 53,000 families using electric lighting.	- OPTA's Mini-hydro Development Plan for the long-range. - Enlargement of the technical staff of OPTA and increased budgetary allocations. - Project Manager monitoring reports. - Annual joint evaluations. - Visual inspections.	Assumptions for achieving purpose: - A core of OPTA and ELECTROPERU technicians are appointed to work at full time in the Project. - Timely acquisition of equipment and machinery. - Technical assistance available on a timely basis. - Construction is finished on schedule. - Effective demand for electricity - Possibility for industrial development.
Outputs: 1 - Installation of mini-hydroelectric plants. 2 - Studies outlines for idenfitication of sub-projects. 3 - Promotion Campaign 4 - Maintenance Plan 5 - Trained Personnel	Magnitude of Outputs: 1- 28 plants distributed principally in the Departments of San Martin, Junin and Cajamarca and with an average capacity of 300 KW. 2- Pre-feasibility and Feasibility methodology designed to identify those sub-projects which meet minimum technical, economic, social and environmental criteria. 3- An on-going educational program designed to inform and train the target communities on how to take advantage of electricity to increase their economic activity and productivity. 4- An on-going plant staff with four (4) turbine generator preventive maintenance mechanics. 5- 48 man/months of local training for rural promotors and maintenance engineers.	For (1) to (6): - Records of ELECTROPERU, OPTA and USAID. - Publication of Pre-feasibility and Feasibility Methodology for ELECTROPERU technicians. - Progress Reports submitted by ELECTROPERU/OPTA. - Project Manager monitoring reports. - Visual inspections. - Publication by MEM of Mini-hydroelectric Development Plan for Peru	Assumptions for achieving outputs: - Project Plan is implemented as scheduled. - AID and GOP counterpart funds are disbursed as planned. - Project procurement is delivered within expected time frame. - Technical assistance is provided on a timely basis. - GOP interest is maintained in the search and execution of projects which constitute an alternative to conventional energy sources.
Inputs:	Implementation Target (Type and Quantity)	- USAID and ELECTROPERU accounting records. - Project financial reports. - Project audit reports.	Assumptions for providing inputs - ELECTROPERU complies with conditions precedent. - The GOP provides ELECTROPERU with the required budgetary allocations to implement the Project.

Investment Category	A.I.D. Loan	A.I.D. Grant	GOP	Total
	(Thousands of U.S.Dollars)			
I. Studies				
- Pre-feasibility	-	-	200	200
- Feasibility	-	-	500	500
II. Implementation Support for Promotion Campaign				
- Operation Expenses	-	100	100	200
III. Construction				
- Civil Engineering Works	2500	-	2090	4590
- Equipment and Machinery	6500	-	1030	7530
- Supervision	-	-	240	240
IV. Technical Assistance 1/	-	870	-	870
V. Maintenance				
- Operation Expenses	-	30	30	60
- Spare parts	-	-	210	210
Grand Total	9000	1000	4400	14400
	69%		31%	100%

1/ Includes: 60 m/months of Project Advisor, 8 m/months of Economist, 4 M/months of Environmentalist, 4 m/months of Curriculum Specialist. 6 m/months of Energy Planner, 6 m/months of Administrative Specialist, 4 m/months of Maintenance Specialist, 6 m/months of Procurement Specialist and 4 m/month of Evaluation Technician (total of 102 m/months).