PD-AAF-605-81 9365715-2

AGENCY FOR INTERNATIONAL DEVELOPMENT
PROJECT AUTHORIZATION AND REQUEST FOR ALLOTMENT OF FUNDS PART I

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PAF 56p.

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9. EST. PERIOD OF IMPLEMENTATION: YRS. 05 QTRS. -

10. APPROVED BUDGET AID APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE C. GRANT	D. LOAN	E. 1ST FY 79 F. GRANT	G. LOAN	H. 2ND FY 80 I. GRANT	J. LOAN	K. 3RD FY 81 L. GRANT	M. LOAN
1)				500		1,000		1,000	
2)									
3)									
4)									
TOTALS									

A. APPROPRIATION	N. 4TH FY 82 O. GRANT	P. LOAN	Q. 5TH FY R. GRANT	S. LOAN	LIFE OF PROJECT T. GRANT	U. LOAN
1)	1,000		1,000		4,500	
2)						
3)						
4)						
TOTALS						

11. PROJECT FUNDING AUTHORIZED (ENTER APPROPRIATE CODE(S)) 1 = LIFE OF PROJECT; 2 = INCREMENTAL, LIFE OF PROJECT — A. GRANT: 2; B. LOAN:

C. PROJECT FUNDING AUTHORIZED THRU FY 83

12. INITIAL PROJECT FUNDING ALLOTMENT REQUESTED ($000)

A. APPROPRIATION	B. ALLOTMENT REQUEST NO. C. GRANT	D. LOAN
1) FN (103)	500	
2)		
3)		
4)		
TOTALS		

13. FUNDS RESERVED FOR ALLOTMENT

TYPED NAME (Chief, SER/FM/FSD)

SIGNATURE

DATE

14. SOURCE/ORIGIN OF GOODS AND SERVICES: [ ] 000 [X] 941 [ ] LOCAL [ ] OTHER

15. FOR AMENDMENTS, NATURE OF CHANGE PROPOSED

56

FOR PPC/PIAS USE ONLY	16. AUTHORIZING OFFICE SYMBOL	17. ACTION DATE MM DD YY	18. ACTION REFERENCE (Optional)	ACTION REFERENCE DATE MM DD YY

ACTION MEMORANDUM FOR THE DEPUTY ASSISTANT ADMINISTRATOR, DEVELOPMENT SUPPORT BUREAU

AUG 10 1979

FROM: DS/EY, Alan Jacobs

PROBLEM: Approval of the Project Paper for Small Decentralized Hydro-power Project (936-5715) and of the Project Authorization and Request for Allotment of Funds.

DISCUSSION: The Project Paper was reviewed by the Regional Review Committee On July 17 and subsequently discussed by the A.I.D. Energy Coordination Group, July 20.

There is consensus among the geographic bureaus that small, decentralized hydro-power projects offer promising opportunities to meet some developmental requirements for energy. Further, it is agreed that a core funded and centrally managed technical support capability in the field of small decentralized hydro-power should be established in DSB to assist bureaus and missions in identifying, designing and executing hydro-power projects that will be compatible with ongoing and planned developmental strategies of LDCs and missions concerned.

The LAC, ASIA and AFR Bureaus recommended that, while the central technical support capability should reside in DSB/EY, responsiblility for introducing pilot projects, demonstrations or adaptation tests of the technology in LDCs should rest with the appropriate geographic bureaus or their respective field missions. Several regional bureaus stated, in response to a direct inquiry, missions within each of the regional bureaus were already undertaking or planning pilot projects in small hydro-power.

The proposed course of action is that DSB provide funding sufficient to develop a composite team of technical specialists, social scientists and economists who would, with concurrence and cooperation of missions and bureaus concerned, survey interested LDCs to identify potential hydro-power sites and, upon concurrence of all echelons involved, provide technical assistance for the design and implementation of such projects. Ancillary support components such as training and provision for modest technology transfer initiatives by means of workshops and seminars will also be available from the DS core project.

It is agreed that implementation of field projects will be funded by the appropriate mission or geographic bureau. While it is not considered practicable, in the context of this DSB technical support project, to obtain prior commitments of specific levels of funding by the several geographic bureaus to underwrite anticipated implementations, it does seem prudent to obtain bureau concurrence, in principle, of this method of proceeding and, further, to assure that an independent evaluation shall be made between the second and third year of project activity to assure that the actual level of geographic bureau utilization is adequate fully to utilize the technical capacities generated by DSB's initial investment.

Beginning on/or about the 18th month of project activity, the first of a series of evaluations will occur. Continual, planned evaluations at approximately annual intervals thereafter, throughout the life the project, will facilitate adjustments in the composition and numbers of technical advisors in order to keep the operational thrust of the activity field oriented and entirely compatable with LDC, Mission and Bureau energy development strategies, as they evolve.

RECOMMENDATIONS: That you approve the DSB portion of the project, the PAF Part II, attached, which will

- Authorize $1,500,000 of FY 79 and/or FY 80 funds and approve, subject to the conditions specified in the PAF, $4,500,000 over the life of the project for the limited purposes outlined in the PAF.

- Note that regional bureaus have signified by their clearances of the approval instruments, that each expects there will be region and mission requirements for the technical support services being generated by DSB investment in their project.

- Direct that an evaluation is to be conducted in FY 81 and annually in subsequent years of the project to determine the effectiveness of the DS Bureau core component, and to verify the continuing requirement for and availability of DS and geographic bureau funds.

- As requested by the geographic bureaus, direct that attention also will be given to smaller units of 1 to 100 KW capacity.

APPROVED: John D. Bunn

DISAPPROVED: _____

DATE: 8/10/79

Drafted by: DS/PO:LProsser

Clearances:

AFR/DR:LHeilman — Subject to provisions in 8/8/79 memo, attached
ASIA/TR:TArndt — subject to restrictions noted in 9-VIII-79 memo attached
LAC/DR:MBrown
NE/TECH:KMacManus — 3-79
PPC/EY:SKlein — subject to resolution of issues per 7 aug memo
DS/PO:RSimpson

OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

TO : DAA/DS John Bruce

DATE: 9 August 1979

FROM : ASIA/TR/STEP Norman L. Brown NLB

SUBJECT: Small Decentralized Hydropower Project

I have received your August 2nd memorandum requesting Asia Bureau clearance for the DS/EY project on this subject. Your memorandum accurately reflects the substance of the discussion at the Energy Coordinating Group meeting on July 18th.

Attached to your memorandum was the undated DS/EY Action Memorandum to you, recommending approval of the Project Paper and the PAF. This too, accurately reflects the consensus reached at the July 18th meeting. The essence of that consensus is expressed very well in the fourth paragraph of the Discussion section:

> "The proposed course of action is that DSB provide funding sufficient to develop a composite team of technical specialists, social scientists and economists who would, with concurrence and cooperation of missions and bureaus concerned, survey interested LDCs to identify potential hydro-power sites, and, upon concurrence of all echelons involved, provide technical assistance for the design and implementation of such projects. Ancillary support components such as training and provision for modest technology transfer initiatives by means of workshops and seminars will also be available from the core DS project."

The recommendation states that the funding to be authorized for FY79 ($500,000) and approved over the life of the project ($4,500,000) will be "for the limited purposes outlined in the PAF." The PAF, however, contains no inkling of how the funds are intended to be used. Thus, we have no basis on which to make a recommendation except the original Project Paper, on which we commented in my July 17th memorandum to you.

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

In view of the discussion that took place subsequent to that July 17th memorandum, however, the Asia Bureau is pleased to modify its position to support the project as described (briefly) in the paragraph quoted above from the DS/EY Action Memorandum to you, subject to the two provisos previously stated. These are that the terms of reference for the core support be on a scale more commensurate with rural needs in Asia than the "few hundred kW up to several MW" mentioned on page 2 of the Project Paper, and that the core support to be provided be capable of providing a thorough social soundness analysis that takes into account the end use of the electricity to be generated .

This concurrence is limited to the $500,000 FY79 funding requested, however, since there is no explanation for the requested $4,500,000 life-of-project funding.

cc: AFR/DR: J. Blumgart
LAC/DR: R. Maushammer
NE/TECH: E. Pike
PPC/EY: S. Klein
ASIA/TR: T. Arndt

UNITED STATES GOVERNMENT

memorandum

DATE: August 8, 1978

REPLY TO ATTN OF: AFR/DR/SDP, J. Blumgart JB

SUBJECT: Small Decentralized Hydro-Power Project

TO: DAA/DS, J. Bruce

AFR clears the action memo to you on this project, subject to the following conditions:

1. In addition to larger systems, the project will specifically include hydroelectric generators in the 1-20 kw range.

2. A first function of the contractor will be to prepare a state-of-the-art survey of available hydroelectric technology, including system costs, performance, historical experience, etc. One section of this survey will deal specifically with systems in the 1-20 kw range.

3. The Regional Bureaus will clear the PIO/T (or RFP) to be issued as the basis for a technical services contract. This will give us the opportunity to consider (a) what the contractor is actually to do, and therefore (b) the justification for funding levels proposed. (Available documentation provides essentially no information on either of these points.)

4. In any case, funding is now approved in principle for only FY 1979 and FY 1980. (Amounts will be cleared once justification is provided for them.) We simply know too little now about the project's eventual scope, appropriate contractors, etc., to make any commitments beyond FY 1980.

5. Project approval and funding for years beyond FY 1980 will be contingent upon results of an evaluation to be carried out 18 months into the project. The core participants in this evaluation will be representatives of the Regional Bureaus, PPC, and DSB.

TO:

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

OPTIONAL FORM NO. 10
(REV. 7-75)
GSA FPMR (41 CFR) 101-11.6
5010-112

Project Authorization and Request for Allotment of Funds

Part II

Entity: Worldwide

Project No.: 936-5715

Project Name: Small Decentralized Hydropower Project

I hereby authorize grant financing of one million five hundred thousand dollars ($1,500,000) during FY 1979 and/or FY 80 for the above-named project.

I approve a total level of AID appropriated funding planned for this project of four million five hundred thousand dollars ($4,500,000) including the funding authorized above, during the period FY 1979 through FY 1983, subject to the availability of funds in accordance with AID allotment procedures. However, funding of this project in FY 81, and subsequent years, is subject to the results of the evaluations specified in this PAF.

It is expected that additional funding will be authorized by regional bureaus and selected AID missions for the implementation of particular hydropower project to be assisted by the sources provided under this project.

An evaluation will occur in FY 81, and during the subsequent two years of the project, to determine the effectiveness of the D.S. Bureau core component, and to verify the requirement for and availability of D.S. and geographic bureau funds.

Attachment: Project Paper

John F. Bruce Date: 8/11/79

Clearance:
DS/PO:KSimpson

OPTIONAL FORM NO. 10
JULY 1973 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

TO : DAA/DSB, John Bruce

DATE: August 7, 1979

FROM : AA/PPC, Stephen Klein

Stephen Klein

SUBJECT: Small Decentralized Hydro-Power Project

The importance of small hydro-power suggests that we need to commit resources to build core support for field positions. Accordingly, I concur with the $500,000 in FY 79 funds and a five year project, subject to my comments below. The figure of $4,500,000 appears a very imprecise life-of-project estimate and should be subject to modification as the project moves forward. The details on Table 5 on cost estimates also need some adjustment. The AID/W salaries line should be deleted and the evaluation item should be substantially increased in FY 80 and FY 81.

Two issues are critical to this project and must be resolved in discussions with the Bureaus prior to approval.

1. The definition of small scale hydro-power units. The IDRC has defined small scale hydro-power as 100 KW or less. When we are talking of 200-250 KW and above, I suspect we are discussing hydro-power technologies which are similar in technology and implementation to large units. The technology exists in private sector consulting firms for these technologies. The rationale for the project is to develop expertise and approaches for the smaller units which have been ignored and for which different systems and technologies are required.

2. The selection of the implementor. The whole reason for this project is to develop expertise for support to the field. The selection of the implementor thus becomes the key project decision. The PP mentions only that "the SDH will be managed by a single organization through an appropriate agreement with AID." This leaves totally unclear the process of selection.

Since we have no information in the PP on potential implementors, and selection is so critical to project success, AID should use a competitive selection process to insure we find the most highly qualified entity. Substantial additional thinking needs to be paid to this problem.

Distribution:

ASIA/TR, A. Jacobs
AFR/DR, J. Blumgart/D. French
LAC/DR, R. Maushammer
NE/TECH, E. Pike/K. MacManus
ASIA/TR, N. Brown
AA/PPC, C. Paolillo
PPC/PB, A. Kivimae

5010-110

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

SMALL DECENTRALIZED HYDROPOWER (SDH)

DEVELOPMENT PROGRAM

DS/EY

May 1979

SMALL DECENTRALIZED HYDROPOWER (SDH) DEVELOPMENT PROGRAM

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I. SUMMARY

Recommendation:

It is recommended that AID negotiate an agreement with an institution for the management of a program for the implementation of small decentralized hydropower (SDH) in the LDCs. The total cost of this program would be $9.5 million over a five year period (FY79-FY83) funded on a year by year basis.

Background:

Hydropower is among the most promising renewable energy technologies available to help LDCs meet a substantial part of their energy needs. Electrical power generation from water resources is a mature technology with application going back to 1882 in the United States. Hydropower sites had all but been exhausted in the U. S. until recent price increases in fossil fuels. On the other hand in developing countries, hydropower potential is only beginning to be tapped. As oil and gas prices continue to rise, hydropower is becoming increasingly attractive especially in remote areas where fossil fuel transportation costs are prohibitive.

Hydropower plants utilize natural gravitational energy of falling water to drive a generator producing electricity. Water from a water-course or impoundment is directed by a series of penstocks to turbines or water wheels which convert the velocity and pressure into rotating mechanical energy. Generating potential is dependent on the product of the water flow and the vertical distance it falls or its net head.

Hydropower installations vary in design according to site conditions and expected power output. Of interest to AID are small decentralized units ranging from a few hundred kW up to several MW. Small hydro facilities have been defined to be less than 1.5 MW by various federal agencies. Current capital costs are approximately $1,000/kW for the smallest units exclusive of civil works and $700/kW for larger units including civil works. Delivered energy cost is in the range of 8¢ to 10¢/kWh for small units and 3¢ to 6¢/kWh for larger units. In remote areas, these energy costs are more economical than using diesel electric generators which may produce power at $1.00/kWh. Although capital intensive, once in place, few additional costs will have to be borne since hydropower is a renewable resource. Generally, the most cost effective system is a high head, low flow unit utilizing an upstream intake without the use of a dam. In addition, labor and materials for construction are available locally with the exception of the turbine, generator and switchgear which must be purchased. Environmental considerations also favor hydropower since little disruption at the site will result if proper design procedures are followed.

Project Description

The proposed SDH program is intended to accelerate the implementation of hydropower in the LDCs. Initial activities will focus on studies which will identify hydropower potential in specific countries as agreed upon by the geographic Bureaus and USAIDs. This data base

will serve as required input for the decision making process eventually leading to several demonstration projects.

During the subsequent activity phase, specific sites will be studied in depth to determine suitability for demonstration projects. Complete plants will be designed and built. Standard plant designs will follow suitable for replication at other locations. Consideration will be given to engineering feasibility, environmental impacts and user acceptance. Integration of hydropower into an existing energy infrastructure such as rural electrification or irrigation projects will be stressed. Utilization of electrical power beyond household needs must occur in concert with future development projects. Specifically, these include street lighting, communications, small industry, educational facilities and water pumping.

Field support, information dissemination, seminars and technical training will be provided to foreign nationals. A principal objective is to train a group in various aspects of hydropower which is able to develop its own projects as a result of the SDH program within that country.

Follow up evaluative studies will compare hydropower potential in various LDCs to other renewable energy technologies. Resulting system economics and institutional and social impact will also be assessed.

Administrative Structure:

It is proposed that a single contracted institution carry out program activities under DS/EY supervision, aid in establishing priorities and subcontract component tasks to other institutions and individuals. The managing entity will assemble a team of SDH experts, as well as arrange workshops and disseminate information as specified by DS/EY and in cooperation with Bureaus/USAIDs. The institution will also provide field support as it becomes necessary.

II. PROGRAM BACKGROUND AND DESCRIPTION

A. Background:

Currently, hydropower provides approximately 23 percent of total electricity generation on a worldwide basis. Installed capacity is approximately 375,000 MW which is considered to be only 17 percent of world potential as reported in the 1976 World Energy Conference.(1) Although estimates vary, in South America alone, reported hydro potential is between 212 and 331 GW.(2) Figure 1 shows world hydropower resources, potential, planned, under construction and operating by region. As indicated, outside North America, untapped potential far exceeds systems in operation, planned or under construction. Most installed capacity is from large centralized units in contrast with smaller systems which DS/EY proposes.

During the period between 1970 and 1975, consumption of electricity in the LDCs grew more rapidly than in the United States. This trend

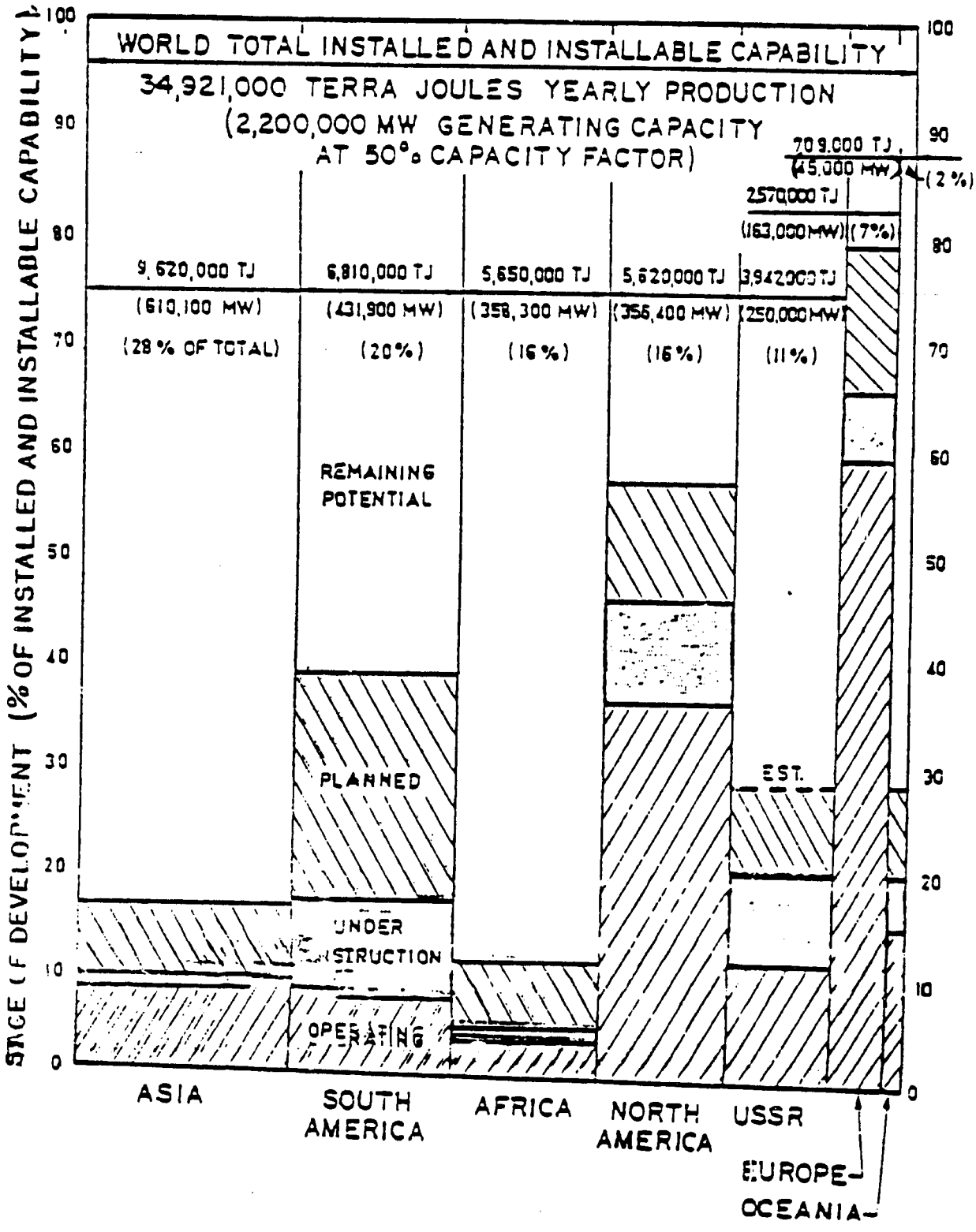


Figure 1. WORLD HYDROPOWER RESOURCES

(from Ref. No. 4)

is expected to continue in the future, with the bulk of the increase coming from hydropower and oil fired plants. In most LDCs, hydropower accounts for 50 percent of the electricity generated. However, further large scale development of centralized hydropower will be restricted by the lack of accessible sites and large initial required capital expenditures. The growth rate of electricity, so vital to economic development, must keep pace with demand. In the period 1970 to 1974, electrical consumption rate increased 9.1 percent in the LDCs, while production increased only 6.2 percent. The major portion of that increase is attributable to hydropower development in Brazil, largely through increased transmission potential. Without this element, the annual production increase is only 2.9 percent.(3)

Moore(5) has forecasted the breakdown in installed capacity for 97 LDCs as shown in Table 1. As the table indicates, hydropower represents one third of forecasted additions by 1990, however, in terms of overall energy capacity, it will be reduced from 40.7 percent in 1976 to 35.5 percent in 1990. This is a consequence of the expected increase in fossil fuel fired generating capacity and the decreasing availability of sites for hydropower generation. Development to date has been at sites which are less costly to exploit near load centers. Remaining sites for large scale development will become more difficult to develop and require

Table 1. 1976-1990 Installed Capacity Breakdown - GW
In 97 Developing Countries

Type	1976	1980	1985	1990	1977-1990 Additions	
hydro	70.4	101.0	149.5	205.8	135.4	(33.3%)
geothermal	0.1	0.4	1.4	2.3	2.2	(0.5%)
nuclear	1.2	4.3	22.1	62.4	61.2	(15.1%)
thermal	101.6	149.6	217.0	308.8	207.2	(51.1%)
total	173.3	255.3	390.0	579.3	406.0	

(from Ref. No. 5)

longer transmission lines. As a result, small decentralized hydropower units are becoming increasingly important. Either high head or low head hydro, depending on the topography, can be developed at reasonable cost in remote areas where alternative methods of generating electricity are prohibitive. Such smaller plants, with capacities to one MW hold significant potential for supplying local villages, small industries and the agribusiness with power which might otherwise not be available or at a high cost using diesel electric sets.

Some positive aspects of hydropower as pointed out by Gladwell are summarized below:[6]

- Hydropower uses a renewable resource.
- Capital expenditure is a one time event and not subject to future inflationary factors.
- Hydropower is a non-polluting energy source.
- The state-of-the art is fully developed.
- Hydropower systems are more reliable than thermal systems and require less maintenance.
- There is less dependence on external sources of fuel.
- For development of small decentralized plants, there exist numerous sites.
- In the LDCs, hydropower may be more economical than alternative sources depending on geographical factors.

Hydropower development is not without some cautionary points which are summarized below:

- Year round stream flows adequate to produce power in significant quantities must be available.
- For low head plants, energy output is extremely vulnerable to stream flows.
- Lead time and construction time are generally long.
- Unit costs of energy may be high because of periodic small energy outputs.
- High initial capital costs.
- A large number of small plants implies coordination and operation problems.

If properly addressed, these cautionary points do not represent serious obstacles. The utilization of water resources for electricity generation in conjunction with other development projects could make a significant impact on development. Power generation supply increases and overall development must proceed concurrently. Institutional and financial barriers need to be overcome, particularly first cost considerations, user acceptance, and a reduction in the long gestation period between initial concept design and final plant start up. The developing countries will need technical assistance and long term assurances that aid in other sectors will be forthcoming.

Reasons for supporting this program encompass humanitarian, economic and security considerations as outlined below:

- Less dependence on foreign oil supplies makes the LDCs less subject to political pressures.
- The economic well being and stability of a region will be enhanced through the availability of electric power.
- Hydropower development will discourage the acquisition of nuclear energy systems.
- U. S. balance of payments will be positively affected through the possible sales of equipment required for hydropower construction.
- Direct involvement in the economic development of the LDCs on a long term basis leading to improved relations in general.

As this program is being developed in response to fullfill the need for an alternate energy supply infrastructure in the LDCs, similar efforts are under way in the United States at the U. S. Department of Energy through the Small Hydropower Development Program. Objectives of the domestic program are to add some 1500 MW of hydropower by 1985. Private sector commercialization is sought through cost reduction, development at existing dams and reservoirs and through the creation of financial assistance programs. Expectations are that the program will end the previous pattern of plant retirement and re-establish small hydro as a growth industry.(7)

Development of SDH on such a broad basis through central management is a new activity for AID. The advantages of such an arrangement are:

- The ability to marshall an appropriate skills team in a short period of time.
- Direct access by Bureaus/USAIDs to the primary contractor for the use of its services.

- Adaptive research capability across geographic regions.
- Economies of scale provided through central management of all SDH projects, i.e., learning curve effects.

The program must be administered by an umbrella institution familiar with the development process, energy systems design and project management. Direct participation by host nationals in the planning and implementation process in order to develop a local skills base for future hydropower development must be sought. The institution will be charged with disseminating information and technical services to LDCs and Bureaus/USAIDs. The demonstration projects will serve to train local technicians and nationals from other LDCs. Pre-project and post-project efforts will focus on determining the effects of enhanced electrical power availability on the local economy, social and political structures. Better understanding of the supply and distribution infrastructure will result through implementation of demonstration projects and studying subsequent impact.

B. Program Description:

1. Program Goal

The overall goal of the DS/EY energy program is to increase the use of renewable energy resources in order to approach a degree of energy self-sufficiency in the LDCs.

The specific goal of the Small Decentralized Hydro Program is to develop local water resources for electricity production in remote or rural areas of the LDCs.

2. Program Purpose

The primary purpose of the program is to develop a methodology for implementation of SDH systems to provide electrical power in rural areas. Specific program objectives include:

- Definition of specific energy needs in LDCs that can be met through SDH development.
- Identification and demonstration of cost effective application of SDH systems in LDCs.
- Development of a coherent, well structured SDH skills resource composed of institutions and individuals that can provide short and long term expertise to Bureaus, Missions and LDC governments.
- Providing a training program in SDH for LDC technicians.
- Coordination of SDH development with other applicable technologies in a manner as to be most cost effective and successful in the long term.
- Development of repeatable standard designs for a multiplicity of applications.
- Implementation of SDH in such a way as to maximize local participation of labor and materials suppliers.
- User acceptance of SDH systems.

3. Approach

The approach to be followed in the development of this program is a methodology intended to provide electricity to rural areas through

development of water power resources. Five major program phases are outlined below:

Phase I - Resource Assessment

During the initial phase, a coordinated program will be undertaken to identify opportunities for SDH development in the LDCs. A survey, carried out by the prime contractor, will examine flowing water bodies suitable for SDH development which are untapped and near existing or potential future load centers. Selection of specific candidate sites will be carried out with the collaboration of local government agencies, Bureau personnel and USAIDs.

Subsequent analysis will examine existing and future national energy development programs to determine the role of SDH in the country's rural electrification plan and overall energy strategy. A complete technical data base for planning SDH will be assembled for candidate countries. Specifically, data will include hydrologic information, planned and existing electrical loads, capabilities for providing capital equipment locally and available skills base for construction and operation. Coordination with other data collection efforts is stressed. These activities will be carried out by the prime contractor in concert with host country professionals. Final analysis and data base management activities will be coordinated with DS/EY and the regional Bureaus.

Phase II - Planning

Data analysis, final site selection and determination of specific implementation procedures will constitute the planning phase.

Analysis will focus on rural areas where future development projects are expected, where no alternative electricity supply network exists or areas where diesel generators may be the sole source of power. Coordination with rural electrification, irrigation and water resources projects and rural development projects will be stressed.

Site selection criteria will concurrently be developed for use with the data base. The criteria will help to identify possible regions of power demand and local candidate hydropower sites.

Some principal points of a selection criteria are identified below:

- Existence of a current or future local demand for electrical power
- Existence of a local skills base which can be trained to operate the facility
- Existence of a mechanism to pay for the generation costs through sale of electricity
- Cultural acceptance of the concept of hydropower by the community
- Existence of other development projects which could benefit by the availability of electric power
- Host government support and encouragement
- No adverse social, political, economic or environmental impacts

- Suitable physical characteristics such as the availability of stream flow, head and flow duration.
- Existence or possible development of a distribution system such as a rural electric cooperative

With the above points forming the core of the selection criteria, specific sites will be chosen for SDH development and implementation. It is expected that one site in each of the geographic regions will be selected. A team of specialists will then develop specifications and preliminary feasibility studies to be analyzed in the form of Project Identification Documents (PIDs). Site visits will be necessary.

Phase III - System Development

Upon the selection of suitable sites meeting the criteria outlined during Phase I, a prototype project is designed from initial concept to detailed engineering. Phase III will develop the skills of local technicians in the planning, design and engineering of a SDH plant. Missions will be invited to participate in the project design and, after approval by a central review committee, to negotiate a core funded Project Agreement with the LDC government.

Activities will commence with hydrologic and geologic surveys of the area. Initial engineering and design efforts will focus on determining specifications for equipment and the need for special modification to suit the application. It is expected that existing components can be utilized without extensive hardware alterations.

Suppliers of equipment and labor skills will be contacted to determine their capabilities. Whenever possible, it is recommended that components be fabricated locally. A small industry could develop producing turbines and other components, either by license or through local design skills, although formally not part of this program. The project must be a reproducible demonstration in terms of technology and project management. Procedures for building other SDH plants will be developed through this initial experience. It is hoped that with only a minimum of outside technical assistance, a local capability in SDH can be developed within the country.

In addition, during the system development phase, important groundwork must be laid which will create the social, political and institutional structures required to implement and maintain a SDH program. Construction and operating personnel must be trained. Comprehensive planning must occur with the goal of successfully integrating the hydropower produced electricity into the national grid or for local consumption. Sociologists and anthropologists will be consulted to assess cultural impacts. A complete capability will be developed allowing AID technicians to depart with assurances that the system will continue in operation.

Phase IV - System Implementation

During Phase IV, physical construction will begin with site preparation. SDH components will be fabricated, installed and tested. Participation

by local institutions throughout all phases is stressed. The implementation process will follow the approximate sequence outlined below:

- Complete hydrogeologic analysis of the proposed site
- Engineering design of all civil works and selection of mechanical and electrical components
- Site preparation
- Civil works construction
- Mechanical and electrical component procurement
- Equipment installation
- Transmission system construction
- Field testing
- Operation and bringing system on line

It is expected that the first prototype plant will be brought into operation during the early eighties, FY 81 - FY 82, assuming full funding is forthcoming. Institutional infrastructures will be developed intended to remain intact after technical assistance is withdrawn. Planning and implementation methodologies will be designed in anticipation of similar projects at other sites within the same country. All documentation of the implementation process will be made available to USAIDs/Bureaus. Monitorship of project activity and periodic evaluation will be performed by joint teams composed of a cortractor's representative, project manager or region or mission representative. Centralized coordination by DS/EY will facilitate this transfer of information more readily.

Phase V - Technology Transfer

The acquisition and dissemination of information gained in the planning and implementation of SDH systems in LDCs is the principal objective of Phase V. Following an acceptable plant startup period, an overall performance evaluation will be made by the major contractor and the report issued for wide distribution.

Field tests will indicate the success of the overall planning and engineering effort. Impacts on the local community will be identified and in particular any unexpected consequences. Continued operation of the system will point to staff competence or weaknesses with the hope that the institutional infrastructure will be flexible enough to take corrective action. Of prime importance is the need to evaluate social, political and economic changes. Specialists in economic and social science areas will be called upon to assist.

In addition, major problem areas will be addressed and suitable solutions posed prior to initiation of subsequent projects. Specifically, questions of technical management will focus on issues of correct engineering judgment exercised early in the planning process. Determinations will be made of all phases of the project for conformance to plans and to establish if appropriate supporting institutions were in place early in the project. If this was not the case, what actions were taken and what was the result?

User impact will also be assessed in determining the near term costs and benefits of new SDH systems. Issues regarding long term applicability and adaptability in other LDCs will also be addressed. In general, methodological and implementational issues will be examined during the final documentation and technology transfer phase.

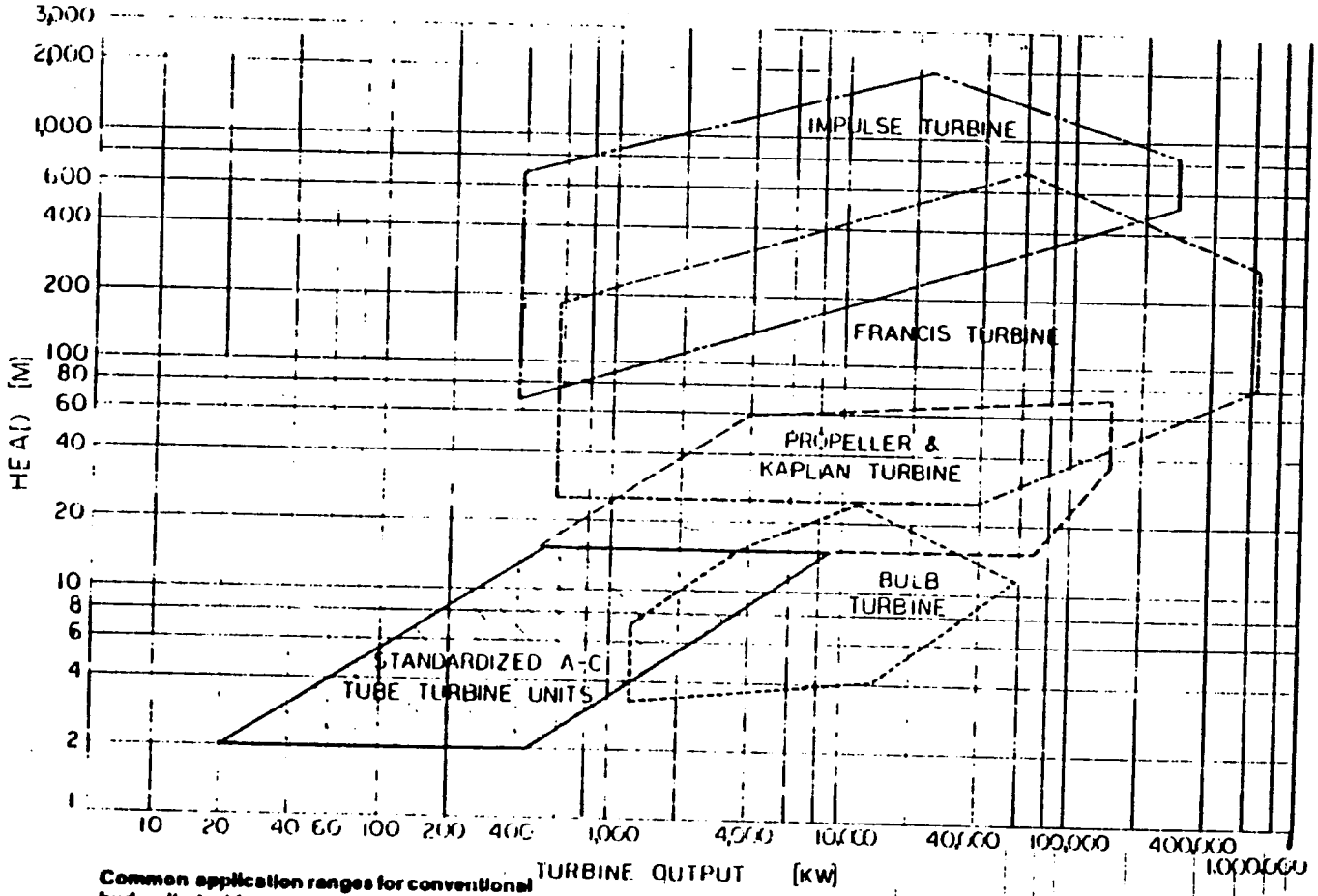
Training of host country nationals by the major contractor will be carried out in order to develop a capability to continue SDH development. A formal training program will be established with in-country and U. S. training assignments. Follow up performance evaluations of training programs are also planned.

III. PROGRAM ANALYSIS

A. Technical

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. Figure 2 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 85 percent. This impulse unit spins at high speed converting the total energy



Common application ranges for conventional hydraulic turbines.

Figure 2
(from Ref. 8)

head into a kinetic energy head, through a contracting nozzle. The water jet imparts kinetic energy on a bucket-like structures which cause rotary motion of the turbine wheel. Figure 3 shows a typical Pelton turbine installation.

For somewhat lower heads, reaction turbines such as Francis or propeller turbines may be used as shown in Figure 4. However, these units run slower, require more flow and are generally located in extensive civil works. 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.

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 the LDCs would surely accelerate implementation of SDH, although not a part of this program.

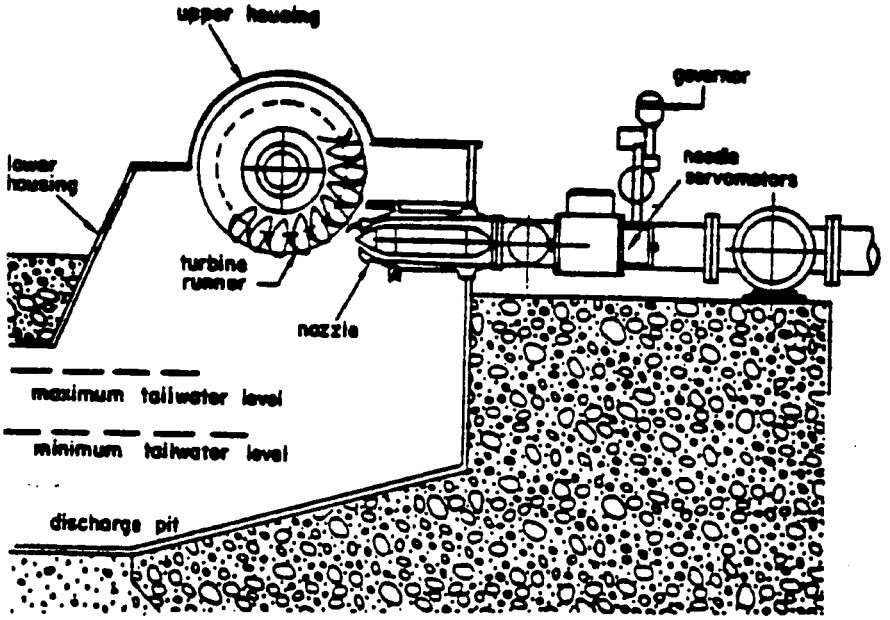


Figure 3

TYPICAL PELTON TURBINE ARRANGEMENT

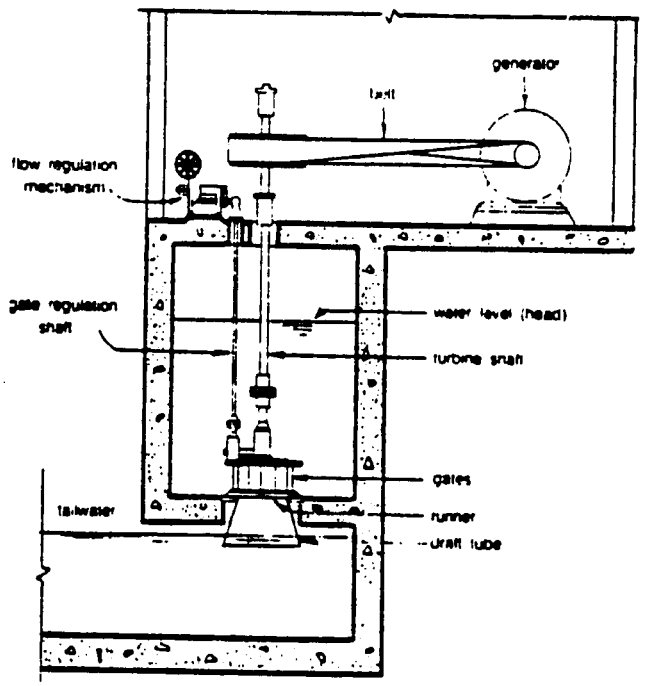


Figure 4

SMALL REACTION TURBINE FACILITY

(from Ref. 9)

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. A governor is generally used to control water flow, thus turbine speed. If there is access to a power grid, an asynchronous generator without governor can be used, since it is self-regulating. However, in either case, 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 and excess power can be stored in batteries. This type of system is only recommended for small installations, generally termed "micro-hydro." The cost of batteries is prohibitive above 6 kW.

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 system development phase, technical and economic decisions will be made regarding a suitable design for the proposed site. At this time sufficient technical expertise must be available

either from local sources or through consultants. Each step of the design process will be monitored by the prime contractor to assure conformance to accepted design practice.

B. Social:

The need for cheap electrical power in rural areas from the social system standpoint is self-evident. Energy consumption and income generally go hand in hand. With electricity, necessities such as refrigeration for food and medicine can be provided. In addition, opportunities will be enhanced for small industry development and job creation. Educational institutions can be established which can operate in the evenings in conjunction with various forms of communication and street lighting.

The cumulative effects of available electric power can fundamentally alter community structures in a positive manner. Activities which were never possible before can be pursued after the sun has set. Genuine social development will not begin without the necessary infrastructure such as the availability of cheap electric power.

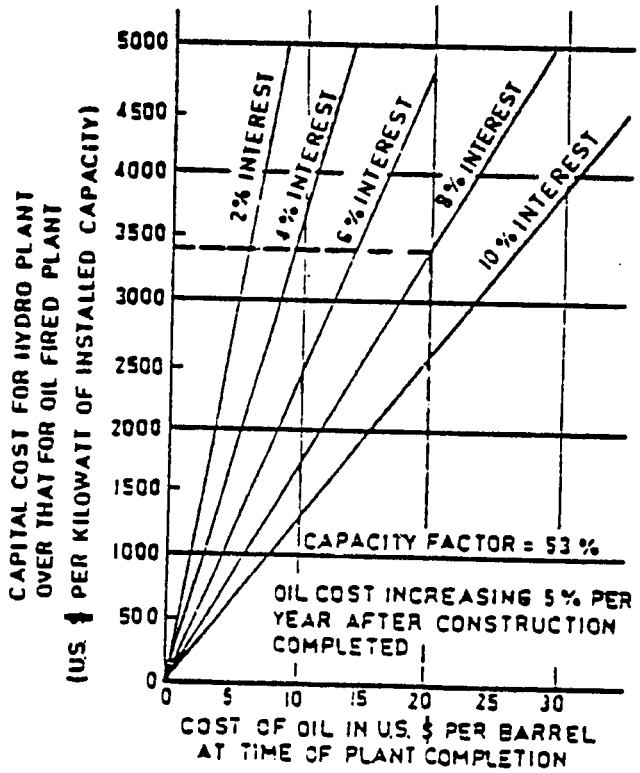
C. Economics

The economic facts of concern are the high initial capital cost and low operating costs. Prior to 1973, the low cost of fossil fuel generated electricity made most hydropower plants uneconomical on the basis of life cycle costing. In the United States, thermal plants tended to replace hydro facilities as they were retired through obsolescence.

Currently, in the United States a large oil or gas fired plant being completed today will cost approximately $400 per kW. Plants which are now in the planning stages will cost $900 per kW by the time construction is complete in the eighties. Small diesel-electric sets, with backup, range from $1200 to $2100/kW.

Since hydropower is so capital intensive, the energy costs are very sensitive to interest rates. Armstrong has presented Figure 5 which indicates the value of hydroelectric over the value of a kW from a thermal plant.(4) Citing his example, if the cost of oil were to be $20 per barrel at the time the thermal plant started operations, and assuming a 5 percent per year increase in the cost of oil, then the value of hydro kW would be $3400 more than that of the oil fired kW. A 35 year life span was used for the thermal plant and a 50 year life span for the hydro plant along with an 8 percent interest rate. The key element making thermal electricity uneconomical in the long run is the ever increasing cost of fossil fuels.

A further comparison is noted by Moore in which system capital costs were compared in 97 LDCs. Table 2 gives installed cost per kW of generating capacity:



Additional capital costs economically justified for a hydroelectric plant over that of an oil-fired electric plant with different oil costs and rates of interest for financing.

Figure 5

(from Ref. No. 4)

TABLE 2

Average System Costs per kW of Generating Capacity in 97 Developing Countries ($US) (from Ref. 5)

Hydro	$1,296
Geothermal	1,564
Nuclear	1,436
Thermal	863

Although the hydro costs are higher than the thermal, it must again be noted that the hydro has a built-in check against inflation. Only maintenance and labor costs will increase annually depending on the local inflation rate. In addition, where a fossil fueled system exists, the marginal cost of expanding electrical power capacity must be examined. In most cases, increased use of fossil fuels will not be readily accepted by a nation whose balance of payments is already strained by imported oil costs. Overall social, economic and political circumstances may make hydropower increasingly attractive.

Capital cost reduction opportunities exist in LDC applications of SDH. By using local resources, standard components and repeating the same project implementation methodology at other sites, significant cost savings can be effected. Where a choice exists between capital expenditure and increased labor, the labor intensive technique should be adopted. The use of earth dams instead of concrete dams is another way to save capital expenditures. Proper maintenance and training will also lead to reduced O & M costs.

Apart from the grants recommended by this program, future development of SDH in the LDCs will depend on financing opportunities and arrangements. Unlike in the United States, complex environmental and regulatory roadblocks to hydro development do not exist in the LDCs, therefore making implementation easier when financing has been arranged. The large capital sums required for future development will have to come from international lending institutions. To a large extent, it will depend on the individual LDC's economic performance and participation to establish a favorable lending climate.

D. Application

To demonstrate the application of SDH, two cases are presented to show the magnitude of investment required and subsequent benefits. Costs are estimates only and may be different depending on actual site characteristics.

Case A is a 100 kW, high head facility using a Pelton turbine with a powerhouse, upstream water intake, canal and penstock. This type of facility is suitable for mountainous regions with small streams having steady flows. As shown in Table 3, capital costs are estimated to be $77,000 or $770/kW installed, exclusive of the distribution network. The lighting, household and communication needs of a village of 500 families could be served around the clock. Most of the load would be used during the dark hours with light industrial loads taking up the daytime slack since battery storage

TABLE 3

SDH FACILITY COSTS: CASE A

Basic Data:

Generic Type - High head installation using Pelton wheel with a powerhouse, upstream water intake, canal and penstock. Suitable for mountainous regions with small streams with year round flows.

Baseload Power Output - 100 kW

Net Head - 500 ft.

Flow Rate - 3 cfs

Efficiency - 80%

Facility Costs (in thousands of 1978 dollars)

• Turbine - Generator(1)	25
• Power Station(2)	15
• Intake, Canal, Penstock(3)	20
• Electrical, Mechanical Equipment(4)	10
• Fees/Contingencies/Eng.(5)	7
Total or $770/kW	77

Notes

1. $250/kW, Johns Hopkins Study, (10)
2. $150/kW, A. E. Allen, (11)
3. $200/kW,
4. $100/kW, Verplanck, et al., (12)
5. 10%

or pumped storage are not considered. Such daytime loads could be irrigation pumping, daily water pumping for potable water supplies and various small processing industries. However, induction loads would have to be kept at a minimum so as not to overtax generator capacity.

Case B is a 500 kW facility using a low head Francis turbine with a powerhouse, impoundment and spillway as outlined in Table 4. This type of facility is suitable for a lower elevation topography with broader slow moving waterways. Costs are estimated to be $523,000 or $1050/kW exclusive of the distributing network. A community of approximately 2,000 families plus some small industries could be served. With the installation of an impoundment, flood control and irrigation benefits could accrue.

These two estimates are based on U. S. experience and will be somewhat different in an LDC context. Specifically, it is expected that all civil works will use labor intensive techniques and locally available materials thereby reducing the cost of a dam, powerhouse, sluices, etc. Equipment, on the other hand, will in all probability have to be imported, thereby adding extensive transportation expenses to hardware costs. Final costs can only be developed when a specific site has been chosen for development.

TABLE 4

SDH FACILITY COSTS: CASE B

Basic Data:

Generic Type - Low head Francis turbine with a powerhouse, impoundment and spillway. Suitable for planar areas with broad and slow waterways.

Baseload Power Output - 500 kW

Net Head - 20 ft.

Flow Rate - 400 cfs

Efficiency - 75%

Facility Costs (in thousands of 1978 dollars)

• Turbine - Generator(1)	150
• Power Station(2)	75
• Dam, Spillway, Reservoir(3)	200
• Electrical, Mechanical Equipment(4)	50
• Fees/Contingencies/Eng.(5)	48
Total or $1050/kW	523

Notes

1. $300/kW, Verplanck, et al., (12)
2. $150/kW, A. E. Allen, (11)
3. $400/kW, A. E. Allen, (11)
4. $100/kW, Verplanck, et al., (12)
5. 10%

E. Environment:

In general, SDH will cause only a minor disruption to the environment in contrast to traditional large hydropower installations. However, environmental impact of small plants has not been studied in detail and any proposed facility will be subject to a comprehensive evaluation.

Environmental effects of SDH development are complex and must be evaluated on a project specific basis. Of principal importance is to keep watercourse disruption at a minimum in spite of its inevitability during construction.

Of the two types of facilities proposed, the high head Pelton unit is most environmentally benign, principally because of the possible absence of a dam. The requirement to keep fish from entering the penstock leading to the turbine is of prime importance. High head installations cause sudden pressure changes in passages leading to fish mortality. However, a periodically cleaned trashrack and fish screen may be used to keep fish and debris from entering the watercourse.

Environmental disruption may be more severe at a low head site caused by the need for an impoundment. Some negative effects may be upstream valley flooding, possible downstream water shortages, reduced wildlife mobility, alteration of both upstream and downstream habitats and creation of a drawdown zone. Both water

quantity and quality are affected. Oxygen content in the impoundment may be low and thermal stratification may set in leading to eutrophication.

A reservoir acts as a settling basin for the accumulation of sediments altering the character of the bottom, thereby affecting its suitability for various organisms. Silt and other fine particles tend to accumulate in the forebay, reducing reservoir storage capacity. Serious downstream modification may occur through the reestablishment of equilibrium conditions leading to scouring. In many developing areas, the bed load naturally transported by the river is necessary to fertilize downstream agricultural lands during periodic flooding.

Spillways generally associated with dams also adversely affect fish and wildlife. Water plunging over dams can become supersaturated with atmospheric gas, such as nitrogen at levels up to 140 percent. Fish exposed to supersaturated water are subject to gas bubble disease, believed to be a major cause of juvenile and adult mortality.

The impoundment may also be a breeding ground for mosquitos and schistosomiasis.

Some measures to counter these problems do exist and include:

- Spillway deflectors - prevents deep plunging of water thereby avoiding supersaturation. A well-known technique.

- Screens and trashracks - intended to keep fish and debris from entering penstock
- Water regulations - controls pool level and downstream water flow
- Aerators - motor driven device to keep the impoundment from becoming stratified and anaerobic.
- Fish ladders - intended to provide upstream mobility for fish.

From an environmental standpoint, high head SDH systems without a dam structure are preferred. However, such opportunities may not be available. At each candidate site, regardless of configuration, a complete environmental impact assessment will be required so as to include ecological consideration in any decision making process.

IV. IMPLEMENTATION PLAN

A. Administrative Structure:

The SDH program will be managed by a single organization through an appropriate agreement with AID. The program will be funded by AID with overall program management responsibility resting in DS/EY. The contractor will carry out the activities for AID subject to centralized supervision by a DS/EY energy officer in collaboration with the regional Bureaus.

Program activities will be jointly formulated based on AID's mandate, recommendations of USAIDs/Bureaus and contractor. The contractor will be chosen on the basis of previous relevant experience and current capability for carrying out project activities. The contracting

entity will formulate subprogram priorities, subcontract specific components of the work to other institutions, arrange workshops and seminars, identify and work with individual consultants and carry out field support activities as required.

The supervising entity, with subcontracting institutions, will form a SDH program support group that will assist the Bureaus/USAIDs/LDCs in development, implementation and evaluation. It will be the responsibility of the managing entity to formulate and carry out a program that is well conceived, both technically and economically feasible to LDC development involving host country nationals in all activities.

The field support structure is envisioned to consist of several specialties, such as geohydrologists, engineers, anthropologists, sociologists and economists. Program funds will support a variety of arrangements from single individuals in regional Bureaus to small staffs temporarily assigned to USAID regional centers. Advisors will assist LDC personnel, USAID Missions as well as oversee project development work. Bureaus will be requested to identify locations and subtasks. The advisors will arrange seminars, workshops and meetings for the purpose of exchanging information regarding SDH development. It is also expected that the advisors will seek opportunities for SDH development by encouraging the construction of demonstration units. Possible research areas and other renewable energy demonstration projects will be additional responsibilities.

Procedures will be established to keep DS/EY and the regional Bureaus informed of all activities being carried out in the field and at the support level within the U. S. Documentation will outline up to date progress, the need for decisions and adjustments in funding and technical information. DS/EY will monitor the program for conformance to AID's development goals.

The approach to contractor participation will be structured in such a way as to guarantee equal opportunity to small, minority owned, as well as large businesses. Small business setasides for small project activities will be considered. Government procurement and subcontracting policies will be strictly adhered to by the managing entity. RFP conferences and pre-proposal meetings for subtasks will be held to outline the program to prospective contractors.

B. Implementation Plan

The SDH program is a five year, $9.5 million program. The focus of early efforts (years 1 through 2) is to identify and plan opportunities for SDH development. Later phases (years 3 through 5) will concentrate on design and implementation of demonstration units concurrently with host country national training. After the five year time frame, the entire program will be evaluated to determine performance and assure continuation.

The proposed schedule will be flexible to allow for DS/EY and regional Bureau review and for redirection of efforts, if necessary, according

to requests by specific USAIDs. All major decisions will involve Bureau/USAID participation so as to insure responsiveness to LDC needs. A program manager from DS/EY will be assigned to the program throughout its activity span.

Funding is summarized in Table 5 according to the rationale given below and the schedule is shown in Table 6.

DS/EY/USAID/Bureau Reviews - It is anticipated that DS/EY, USAIDs and the regional Bureaus will review the program and make a recommendation according to their specific needs. Missions will be asked to propose projects identifying possible sites which meet the criteria outlined. This activity will involve only AID personnel for an approximate six month period beginning in early Y1.

Major Contractor - A major managing entity is chosen second quarter of Y1 and briefed according to the AID program plan.

Team Visits - Visits to specific LDCs will take place during the third quarter of Y1. Participants will be specialists representing the major contractor, DS/EY and regional Bureaus. During these visits, initial assessments of all reviews will be made and future program plans will be firmed up.

Field Consultants - During the last quarter of Y1, the managing entity will place several field consultants in USAIDs and regional Bureaus to begin in depth SDH assessments for specific LDCs or geographical regions. Field consultants will provide services

Table 5
SMALL DECENTRALIZED HYDROPOWER
DEVELOPMENT AND SUPPORT PROGRAM

BUDGET SUMMARY

(in thousands of dollars)

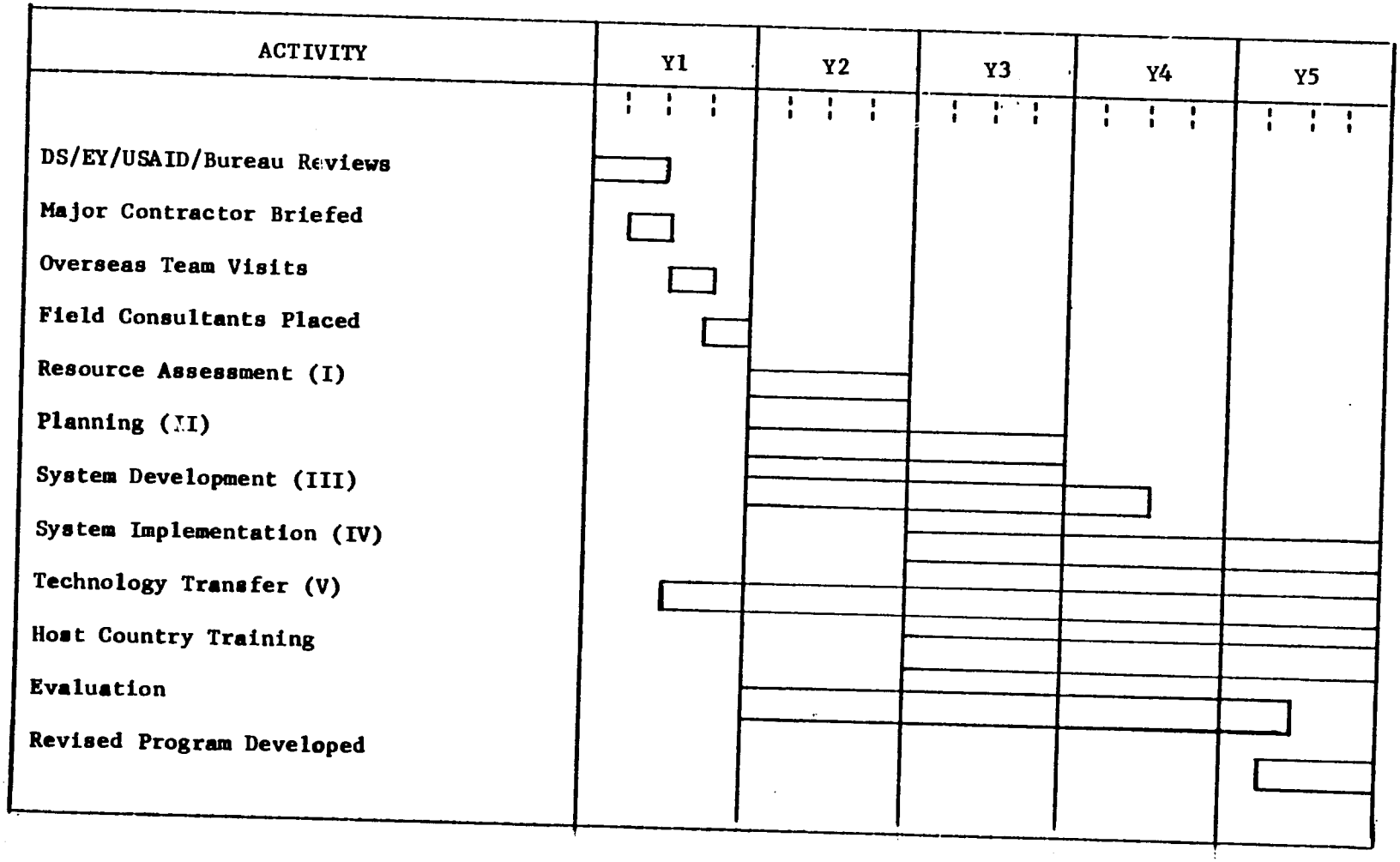
	FY 79	FY 80	FY 81	FY 82	FY 83
Major Contractor Salaries	160	220	250	250	300
Field Consultants	150	220	250	300	400
Travel	50	60	70	70	80
State of The Art Study and Field Manuel	40	-	-	-	-
Resource Assessment (I) (Data Gathering)		100	50	50	
Planning (II) (Site Selection)		100	50		
System Development (III) (Engineering & Design)		100	100	100	
System Implementation (IV) (Demonstration Units)			(1000)	(1700)	(1800)[1/]
Technology Transfer (V) (Seminars, Workshops, Publ.)	100	70	70	50	50
Host Country Training			100	100	100
Evaluation		130	60	80	70
TOTAL	500	1000	1000	1000	1000

1/ Estimated geographic bureau contributions.

Table 6

SMALL DECENTRALIZED HYDROPOWER DEVELOPMENT AND SUPPORT PROGRAM

ACTIVITIES, YEAR 1 THRU 5



throughout the program. The geographic regions may share a team of specialists or two persons will be permanently assigned to each region.

Resource Assessment - Beginning in Y2, field consultants in conjunction with major contractor personnel will conduct data collection efforts. These are followed by studies of SDH potential in specific LDCs to include technical, economic, social and environmental considerations. This assessment will continue into Y3 as part of the overall energy planning process for developments expected beyond Y4.

Planning - After careful screening by specialists, DS/EY/USAID/Bureaus, final selection of sites is made, followed by feasibility studies. System development and implementation efforts will be firmed up.

Systems Development - Engineering and design of demonstration facilities will begin in Y2 under contract to the managing entity. The objective is to design several demonstration units for subsequent construction.

System Implementation - Under supervision of the managing entity, host country firms and U. S. contractors, demonstration plants will be constructed beginning in Y3 or possibly earlier. This phase of the project will last three years and be funded $4.5 million. At this level of funding, at least one plant can be realized in each of the geographic regions, with the possibility of several more.

Technology Transfer - The process of documentation, holding seminars and workshops will begin mid Y1 and continue to the end of the program. The bulk of this activity will be carried out by the principal contractor and consists of keeping AID and subcontractors informed of field activities.

Host Training - The training of host country nationals will proceed from Y3 until the end of the program. Training activities will be carried out by the prime contractor. It is expected that host country nationals will come to the U. S. for specialized types of training and in other circumstances, the contractor will carry out training programs in country.

Evaluation - Determination of program effectiveness will begin in Y2. Performance will be evaluated by an independent subcontractor such as NSF on the basis of overall impact on the local community and resulting energy economics as described in a subsequent section.

Revised Programming - As a result of program evaluation, modification will be made in the overall SDH program so that AID goals and objectives are continuously met.

C. Program Validation

A continuous flow of information from field personnel to the principal contractor, DS/EY and Bureaus will occur at regular intervals. Status and progress reports will be developed periodically and reviewed by all participants.

The details of an evaluation plan include the following:

1. Periodic reviews of progress at the end of each of the five major phases constitutes the basis for the evaluation plan. These reviews will be documented and made available to Bureaus and other appropriate representatives for their comments.

2. Evaluations will be carried out by independent groups, such as research foundations.

3. Phase I evaluations will focus on the quality of the survey assignments to assure they were carried out in accordance with the goals of the program. Reports will be examined and the missions will be contacted.

4. Phase II evaluation will assess the planning efforts of all participants.

5. Phase III evaluations will determine the effectiveness of system development efforts. Activities will determine the performance on technical and economic feasibility studies, conformance to budgets, timetables, commodity purchases, overall project coordination and problem reporting. If problem areas exist, they will be addressed during the evaluation period.

6. Phase IV evaluation activities will closely follow the construction of the demonstration facilities to determine conformance to plans and accepted operating procedures pertaining to procurement, construction and start-up activities.

7. Phase V evaluation will focus on the overall performance of the program. Specific economic and technical indicators will be developed such as the final installed cost of the demonstration plant and resulting busbar energy costs. In addition, a summary environmental impact statement will be prepared. User acceptance of the facility will be assessed as will the local availability of trained personnel. Readiness of local nationals to carry out a program of SDH development will be determined. Mechanism used to report all activities back to AID and the Bureaus will be evaluated. Questions of procedures and organization during the various program phases will be answered.

Based on these findings, future programs will be adjusted to ensure increased implementation of SDH. Finally, recommendations will be made which will accelerate SDH development by better employing AID/Prime Contractor skills base.

AID 1010-1 (10-71)

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Project Title & Number: SMALL DECENTRALIZED HYDROPOWER (SDH) 936-5715

Life of Project:
From FY 79 to FY 83
Total U. S. Funding 9,500,000
Date Prepared: 30 Apr 79

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objective to which this project contributes: To increase the utilization of renewable energy technologies in the developing countries.	**Measures of Goal Achievement:** Increased use of SDH at the operational level in the LDCs. Greater use of SDH by other development assistance donors	o AID Project Paper o World Bank Reports o UN Reports	**Assumptions for achieving goal targets:** Renewable energy resources are necessary for development, both from the standpoint of balance of payment and the need to generate more employment.
Project Purpose: To demonstrate the application of small decentralized hydropower to provide energy to meet rural needs	**Conditions that will indicate purpose has been achieved: End of project status.** 1. Trained nationals in SDH 2. Purchase of U. S. components or existence of local industry manufacturing components 3. Enhanced development resulting from the existence of inexpensive electricity.	o Information Request Summaries o Progress Report o Final Reports	**Assumptions for achieving purpose:** Proven technical and economic feasibility of SDH for LDCs. Need for energy in the rural sector to enhance development.
Outputs: 1. Trained nationals in SDH. 2. Operating units in the field. 3. Technology Transfer Information 4. U. S. capability in SDH development for LDCs.	**Magnitude of Outputs:** 1. Studies 2. Demonstration Units 3. LDC Personnel	o Reports and Reviews o Field Trips o Trip Reports o General AID Participation	**Assumptions for achieving outputs:** o LDC cooperation o Suitable application for SDH were chosen o Studies and reports objectively demonstrate performance of program.
Inputs: 1. AID Funding 2. Principal Contractor Participation 3. Subcontractor Participation 4. LDC Participation	**Implementation Target (Type and Quantity)** $9,500,000 (FY 79-FY 83	o Vouchers o Requests for Proposal o Travel Plans	**Assumptions for providing inputs:** o PASA with major contractor o LDC support of activities

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