PD-AAM-244

PROJECT PAPER

MICRO/MINI HYDROELECTRIC PROJECT

(AID Project No. 493-0324)

USAID/Thailand
September, 1982

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ABBREVIATIONS AND ACRONYMS

AID/W	USAID/Washington
CP	Condition Precedent
EGAT	Electricity Generating Authority of Thailand
GWH	Gigawatt-hour (1 million kwh)
IBRD	International Bank for Reconstruction and Development (World Bank)
IEE	Initial Environmental Examination
IFB	Invitation for Bids
KV	Kilovolt
KW	Kilowatt (1000 watts)
MEA	Metropolitan Electricity Authority
KWH	Kilowatt-hour
MSTE	Ministry of Science, Technology and Energy
NEA	National Energy Administration
NESDB	National Economic and Social Development Board
NRECA	National Rural Electric Cooperative Association
PEA	Provincial Electricity Authority
PID	Project Identification Document
POU	Project Operations Unit
PP	Project Paper
RFD	Royal Forestry Department
RFTP	Request for Technical Proposals
RID	Royal Irrigation Department
RTG	Royal Thai Government
TDD	Terminal Disbursement Date
USAID	United States Agency for International Developpment
USAID/T	USAID/Thailand

Terms

Changwat	=	Province
Amphoe	=	District
Tambon	=	Township
Muban	=	Village

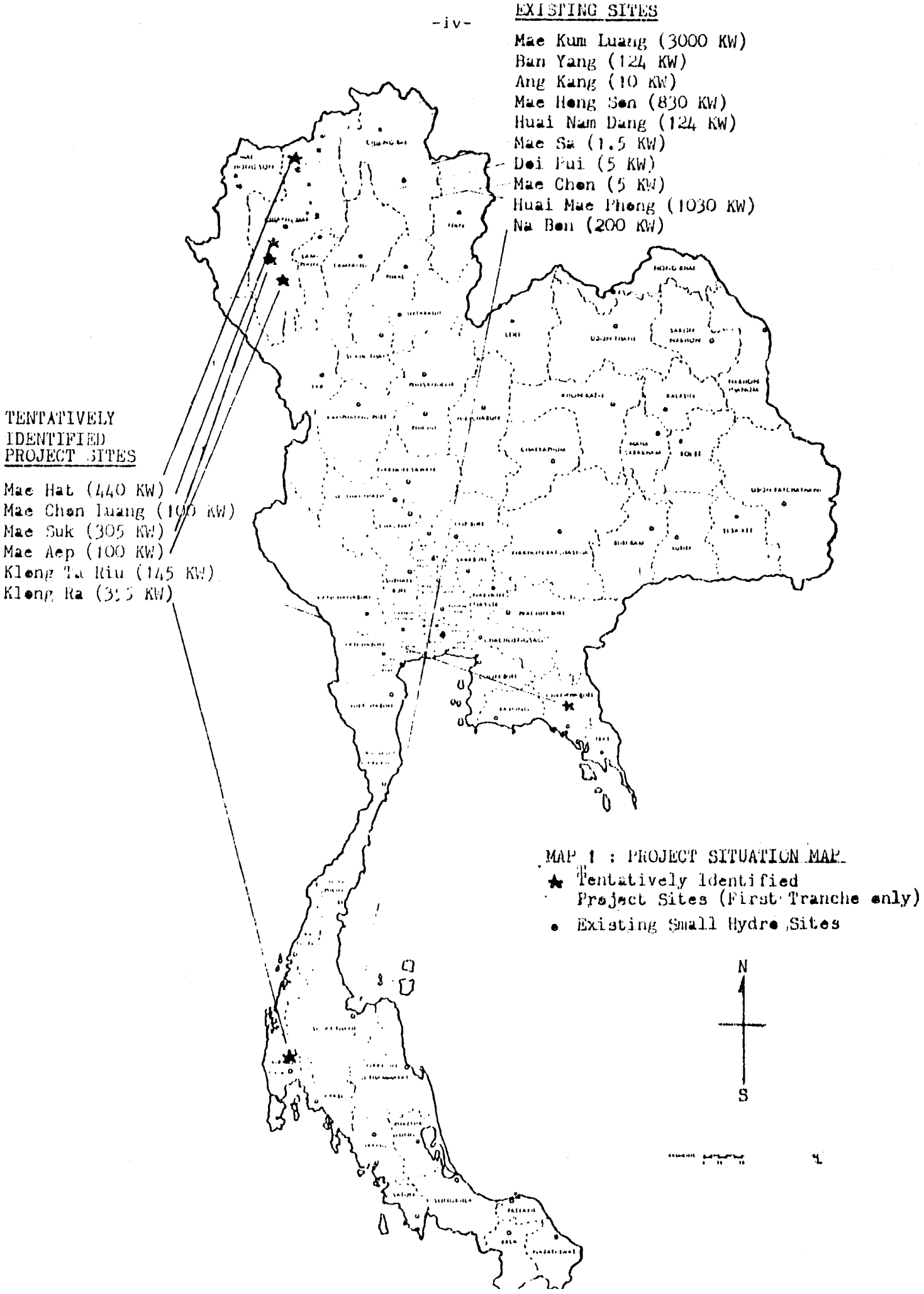
Currency Equivalents

U.S. $1 = Baht (B) 23

Area Equivalents

1 rai = 0.16 hectares

1 hectare = 6.25 rai



MAP 1 : PROJECT SITUATION MAP

★ Tentatively Identified Project Sites (First Tranche only)

• Existing Small Hydro Sites

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

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

DOCUMENT CODE: 3

2. COUNTRY/ENTITY: Thailand

3. PROJECT NUMBER: 493-0324

4. BUREAU/OFFICE: Asia [04]

5. PROJECT TITLE (maximum 40 characters): Micro/Mini-Hydroelectric Project

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 09 DD 01 YY 87

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

8. COSTS ($000 OR EQUIVALENT $1 = Baht 23)

A. FUNDING SOURCE	FIRST FY 82 B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total						
(Grant)	(100)	(-)	(100)	(100)	(-)	(100)
(Loan)	(1250)	(6750)	(8000)	(1250)	(6750)	(8000)
Other U.S. 1.						
Other U.S. 2.						
Host Country		-	-	-	4700	4700
Other Donor(s)						
TOTALS	1350	6750	8100	1350	11450	12800

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	103	062	062	-	-	100	8,000	100	8,000
(2)									
(3)									
(4)									
TOTALS				-	-	100	8,000	100	8,000

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 878 100

11. SECONDARY PURPOSE CODE:

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

A. Code							
B. Amount							

13. PROJECT PURPOSE (maximum 480 characters)

To develop economically attractive, indigenous micro-mini hydropower resources

14. SCHEDULED EVALUATIONS: Interim MM 09 YY 84; Final MM 01 YY 87

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: Robert Halligan

Title: Robert Halligan, Director, USAID/Thailand

Date Signed: MM 09 DD 13 YY 82

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

AID 1330-4 (8-79)

I. PROJECT PROFILE AND RECOMMENDATIONS

A. Project Data Sheet: See previous page.

B. Project Profile: The project described herein is an estimated $12.8 million effort by the RTG and USAID to develop economically attractive, indigenous micro/mini-hydropower resources. USAID will provide $8.0 million of FAA Section 103 loan funds at standard terms of 40 years, including 10 year grace period, at an annual rate of 2% during grace and 3% thereafter, and $100,000 of Grant Funds to cover USAID evaluation requirements.

Project outputs are regrouped into two broad categories: 1) the development of an analytical capacity and method which will permit the RTG to improve small hydro planning, analysis and construction techniques and procedures, and, 2) the construction of up to twelve micro/mini (0-1000 KW) hydroelectric generating systems.

Project inputs include the provision of a range of competitively-bid goods and services; technical assistance, final engineering design and supervision, civil works construction, and power plant procurement.

C. Issues: Major issues identified in the PID approval cable (See Annex J are dealt with individually below.

1. Sub-project Feasibility Studies - In response to AID/W concerns, a detailed, integrated sub-project site selection model has been developed in Annex F of the PP for selection of second tranche (sites 7-12) sites. Furthermore, due to NEA interest in refining the model for standardized use of future small hydro site selection, the PP contains special human and financial resources to assist NEA to develop the model in the course of Project Implementation. First tranche sites (1-6), were also subject to extensive engineering, economic and social analysis and, in fact, provided the experiential base upon which the second tranche model could be built.

2. Maintenance - The Project has utilized a simple, reasonably maintenance-free engineering design for all sites. Past NEA experience in Thailand has shown that maintenance should not be a major obstacle to Project success. A more complete description of this issue is contained in Section III.B.(g).

3. Socio-economic Impact - It is extremely difficult to forecast the exact nature of socio-economic impacts associated with each Project site. Nevertheless, considerable data, anticipating generally favorable impacts, were gathered in the field and are recapitulated in Annex D. Since this topic is crucial to the future development of the small hydro sector, baseline socio-economic data will be gathered on all sites and at least two major impact evaluations will be undertaken during Project Implementation.

4. Institutional Development - As noted in the Project Profile, one of the principal output of the PP is to develop the institutional analytical capacity of the key implementation agent, NEA. The Project will provide technical assistance and on-the-job training of NEA staff so as to improve NEA's skills and methods in a number of engineering, contracting and socio-economic areas. See Section III.A.1. for greater description of this aspect of PP development.

5. Linkages to Non-Conventional Energy Project - The AID-funded Non-Conventional Energy Project (493-0304) includes studies and pilot efforts in a number of energy areas, including micro hydropower. Implementation of the Project's micro hydro activity is still in the detailed planning stage, and may include several small pilot installations of multiple-use application. These micro hydro installations will be slightly more experimental in nature than the units to be installed under this PP and will differ in size and application. Liaison will be continued between the two projects, although no formal linkage is proposed.

6. Other Donors - A number of other foreign donors are involved in scattered small hydroelectric generation projects in Thailand, most notably Finland, Japan, IBRD, and Norway. These projects all basically consist of straightforward construction of small hydro units. Ultimate coordination of donor efforts in this area will lie with the Project implementation agency, NEA.

D. Summary Findings and Recommendations: On the basis of its own analysis of major feasibility issues and given the professional cooperation afforded by the key Project implementation agency, NEA, the PP team recommends that USAID/T move forward with Project implementation as soon as deemed appropriate by USAID and RTG principals.

More specifically, the PP team proposes the following four recommendations as establishing the basic operating framework for the Project.

1. Basic Objective of the Project - Clearly small hydroelectric development is viewed by the RTG as a high priority. The Fifth National Plan calls for early construction of 100 small hydro sites. NEA has estimated that a potential 200 MW of small hydro power generation is currently economically feasible, representing a potential investment of some $400 million, and that number will continue to grow with the spiraling costs of fossil fuels.

This Project, therefore, has been viewed as a crucial starting point of Thailand's small hydro program. It will represent the RTG's first attempt to systematically develop economically attractive, indigenous micro/mini hydropower resources. In consequence, a general theme of this Project is that Project implementors will be expected to act simultaneously as researchers and technicians in their attempts to

develop a credible empirical data base for improving RTG small hydro investment methods. The Project will require an applied research-development-feedback methodology which systematically explores a number of key engineering, socio-economic and operational issues in a real-life "laboratory" setting. Project sites must, therefore, be carefully selected to ensure the maximum flow of relevant sectoral information, while respecting the minimum levels of socio-economic, financial, engineering and environmental feasibility required by the PP site selection model

Given the importance of Project results for future sectoral investment, NEA and AID have underscored the necessity to ensure that sectoral lessons and knowledge generated under the Project are transmitted and "institutionalized" with those Thai specialists and organizations most likely to make optimum use of the information after Project completion (see Section III. A. 1c).

This basic conceptual framework was also important to the determination of the number of sites to be constructed under the Project (see Section III A. 2.b.). The need to establish a statistically relevant data base for the critical variables under investigation and for site selection model calibration will require the construction of an estimated minimum 10 - 15 sites. A larger sample would have been clearly more useful from a statistical point of view, but led the PP team into major funding constraints. The final number of sites has been tentatively established at 12 sites.

2. Sectoral Analysis and Planning Needs - The PP team concluded that the single, most important sectoral analytical need is to develop a small hydro site selection model which is simple, cost-effective, and localized (using local field data). A preliminary selection model was presented in Annex F of the PP, based on our current understanding of sectoral data. It is expected that this selection process will be challenged and refined by Project specialists with the ultimate objective of reducing financial and personnel requirements to its use, while improving the accuracy of its assessments.

Development of the model in a professional manner will require not only innovative measurement techniques of basic engineering and socio-economic parameters, but of even greater significance, a understanding of the impacts of these electrical generation systems on downstream users, as well as the socio-economic and physical environment in which it is located.

3. Technical Assistance and Training Requirements - The PP recognizes that this Project will place a considerable additional burden on NEA human resources, and has therefore allocated funds to special contracts for technical and support services. NEA staff under the Project will develop and define their skills through their simple association with the Project or through "on-the-job" training undertaken

by Project contract staff. The PP team recommends, however, that the Project take advantage of other closely affiliated, USAID-sponsored resources available to the Project in this area, most particularly the AID/W-funded Small Decentralized Hydropower Program (SDH) and Conventional Energy Training Project (CET).

The SDH Program is run by National Rural Electric Cooperative Association (NRECA) and can provide a wide range of technical, economic, managerial and training services to the Project. NRECA specialists are, in addition, already familiar with this Project, having assisted in the development of the PP.

The CET Project is run by the well-known Intitute of International Education and can offer educational study in the U.S. in engineering, economics or management fields of relevance to the Project as well as special industrial or research internships with U.S. companies or training institutes.

II. PROJECT BACKGROUND

A. Overview at National Power Sector Resources: The primary sources of energy currently consumed in Thailand are graphically illustrated in Figure 1, attached. Worthly of particular note is the heavy reliance on imported petroleum. Of particular relavance to this paper, imported fossil fuel currently (1980) generates some three-fourths of all electrical power in Thailand.

Future developments in this sector include:

1. Natural gas - Several promising gas fields have been discovered in the Gulf of Siam indicating a probable reserve of several trillion cubic feet. These fields are rapidly being developed and an initial pipeline to Bangkok was completed in 1981. EGAT (Electricity Generating Authority of Thailand), the agency responsible for most electrical generation in Thailand, expects to develop or convert some of their plants to natural gas so that by 1991 perhaps 37% of their total generation would utilize this new national resource. The issue of whether to use this gas for electrical generation or for other purposes (such as fertilizer industries) has not yet been resolved.

2. Lignite - Thai lignite reserves are estimated at 770 million metric tons, primarily at the Mae Moh site (650 million metric tons) near Chiang Mai. Large deposits on the Malay border in the South are now being studied for potential joint Malay-Thai development. Some 150 MW of electricity are currently being generated from lignite at Mae Mon and an additional 300 MW generation system is already under construction. A total annual generation capacity of some 1500 MW is expected to be attained over the next decade.

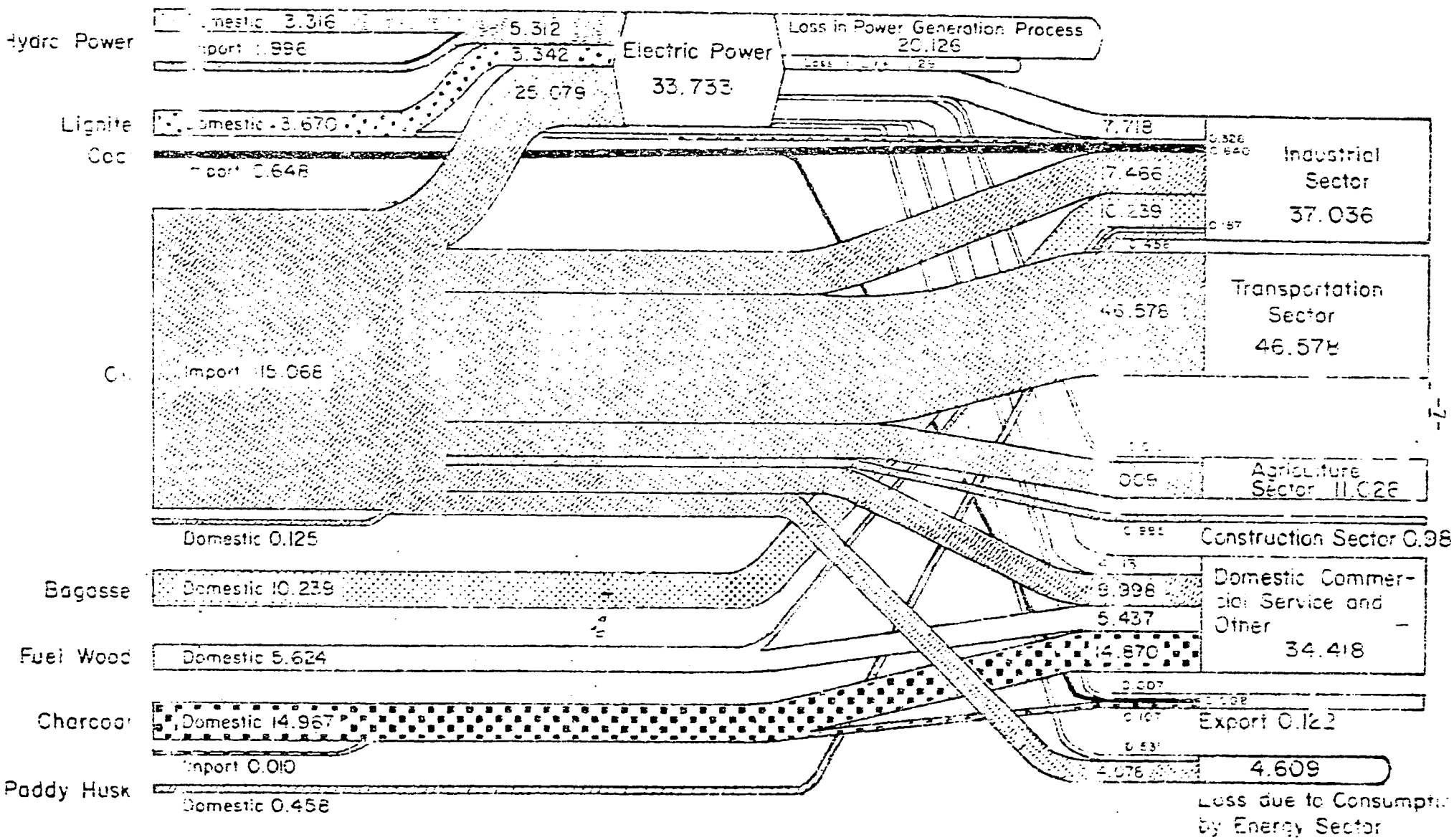
3. Oil - Thailand appears to have a reasonable future in oil production. Current oil production at Fang (406 barrels per day) is small, but recent discoveries in Kamphaeng Phet Province have indicated economical exploration is continuing both in the Northeast and offshore. Finally, large reserves of oil shale (estimated 2,500 million metric tons) are known in Northern Thailand but are not currently economical for exploitation. As domestic oil is ultimately indissociably mixed with imported oils, it is impossible to estimate the amount of local production which will be specifically utilized for energy production in the future.

4. Hydro - As a fairly large country containing considerable differences in topographic relief, abundant rainfall and an extensive river system, Thailand has a good potential for hydroelectric power generation. Of the total estimated hydro potential (9300 MW) some 36% (3370 MW) are either already being exploited or will enter into service before 1991. This does not include the large regional potential offered

FIGURE 1:

ENERGY FLOW CHART (ACTUAL PERFORMANCE IN 1980)

(Unit = 10^{12} kcal)



Source: THAILAND ENERGY SITUATION 1982

by the Mekong and Salween river systems (19,000 MW) which has not been developed due to a need for international political coordination. Clearly, hydropower is Thailand's only currently feasible major source of domestic renewable energy. It is probably also true, however, that the easiest sites may have already been, or soon will be, exploited. Micro (0-100 KW) and mini-hydro (100-1000 KW), the focus of this Project, remains a very new area for development in Thailand*. Although data on global mini-hydro potential is yet incomplete, NEA has conservatively estimated that over 200 MW could be economically generated in Thailand at the present time.

5. Other non-conventional renewable energy - Renewable energy electricity generation is possible in Thailand using such techniques as solar power, bio-gas, wood (dendro-thermal) or other organic matter conversion. Many renewable energies are currently being surveyed and tested through the USAID-sponsored Non-Conventional Renewable Energy Project (493-0304). None of these energies currently appears to hold major promise for electrical generation in the immediate future.

B. National Electricity Consumption: National demand for electricity has grown rapidly over the last decade. NEA statistics reveal that actual sales have gone from 3,805 million KWh in 1970, to 13,136 million KWh in 1980, or a global increase of 245% for that period. Current official forecasts indicate expectations of continued high growth (9-11%/yr.) through 1990.

An event of current importance to electrical consumption is the massive "Accelerated Rural Electrification Program" being developed under the aegis of PEA. Latest estimates for the Program indicate that by 1986 or 1987 some 90% of all Thai villages will be served by the central grid. This program will not only reshape the character of national demand and have a strong impact on the national rural development process, but will also have major implications for the development of this Project as well.

Some key statistics on the nature of the electrical sector are noted below, for reference. Particular note should be made of Thailand's heavy dependence on non-renewable and mostly imported sources of electricity generation (Table 1), of the current strong bias in demand toward industrial/commercial users (Table 2) and of skewed regional consumption patterns, especially toward the Bangkok metropolitan area (Table 3).

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*It should be noted that these definitions of "micro" and "mini-hydro" are those of the United Nations and have been adopted for the PP only following discussions with AID/W. The Thai system formally classified "micro" as 0-200 KW, and "mini" as 200-6000 KW.

Table 1: Supply According to Source (1980)
(Source: Electric Power in Thailand)

Source	GWh	% of Total
Heavy Oil	9,517.3	62.6%
Shengli Crude Oil	1,863.2	12.3%
Lignite	1,364.8	9.0%
Hydro	1,273.0	8.4%
Imported (Laos)	766.4	5.0%
Diesel Oil	407.7	2.7%
	15,192.4	100.0%

Table 2: Consumption by Category (1980)
(Source: Electric Power in Thailand)

Category	GWh	% of Total
Industrial Sales	8,350.0	55.0%
Domestic Sales	3,025.2	19.9%
Commercial Sales	1,665.5	11.0%
Transmission Loss	1,417.7	9.3%
Station Service Loss	617.7	4.1%
Free of Electricity Loss	20.8	0.1%
Other Sales	95.5	0.6%
	15,192.4	100.0%

Table 3: Regional Characteristics (1980)
(Source: Electric Power in Thailand)

Characteristic	MEA (Bangkok)	North	North-east	Central (w/oMEA)	South	Total
Generating Capacity Installed (MW)	1,552.5	991.4	141.8	508.0	254.5	3,448.2
Peak Demand (MW)	1,552.0	516.1	64.3	79.8	167.3	2,379.5
Energy Generation (10^6KWh)	11,151.5	2,000.1	256.3	138.9	879.2	14,426.0
Energy Sales (10^6KWh)	7,872.6	613.0	814.3	2,987.0	849.3	13,136.2

C. National Energy Policy: Thailand's economy, like those of many nations, has become a victim of fossil fuel energy policies which were adopted in the so-called "cheap oil era". With the spiraling national energy costs of the last several years, policy-makers have basically attempted to redirect attention to the tasks of indigenous, (and, if possible) renewable energy development, as well as improving patterns and levels of consumption. Chapter 6 of the Thai 5th National Plan is devoted to the promotion of this strategy. Section 4.2.3.(d) of that chapter calls for an acceleration of the assessment and development of water resources for electricity generation and specifically encourges "exploration and development of small-scale water resources" to help in attaining that objective.

D. Relationship to USAID Strategy: The Project fits well with current AID/W basic policy orientations, addressing the priority sector of renewable small-scale energy and private sector involvement, as well as stimulating general rural development, both agricultural and commercial, through the introduction of local electricity generation.

E. Focus on Micro and Mini-Hydro: By Cabinet decree, NEA is now responsible for all planning and construction of small hydropower (micro and mini-hydro) in Thailand*. NEA has prepared an Accelerated Alternative Energy Development program for the period 1980-89 (to be incorporated in both the 5th and 6th National Development Plans) calling for development of Thailand's considerable micro and mini-hydro potential in order

- to replace existing diesel generation plants in rural areas,
- to feed electric power to the national grid so as to reduce the consumption of fuel oil in thermal power stations, and,
- to supply electric power to new areas under the rural electrification program.

The PP team has located micro-mini hydro sites which have been developed in the Kingdom to date. Those sites are briefly characterized in Table 4, below, and may be located on Map 1. In addition, two new sites, Mae Sariang (2x400 KW) and Huai Nam Khong (2x250 KW), may begin construction in FY 1982.

Although current sites already utilize a fairly wide range of implementation agencies, technologies and power sizes, much still remains to be done in systematically collecting and analyzing the performance, both technical and socio-economic of these diverse systems.

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*Reminder that small-hydro is defined as 0-6000 KW according to current official Thai classification.

Table 4 : Existing Micro/Mini Sites (Thai Definition)

Name	Year Constructed	Installed Capacity	Type of Turbine	
1. Na Bon	1961	200 KW	Pelton	Designed/constructed by RID; used for private rubber processing; net head 90 meters
2. Mae Hong Son	1972	830 KW	Francis	Designed/constructed by NEA; used by PEA to electrify town and districts; net head 28 meters
3. Mae Kum Luang	1980	2 x1500 KW	Francis	Designed/construction supervised by NEA; used to electrify villages and hooked to grid; net head 114 meters.
4. Huai Kum	1980	1000 KW	Francis	Hooked to grid; net head 28 meters
5. Huai Mae Phong	1981	1030 KW	Pelton	Designed by NEA under Swiss supervision and funding; used to electrify district; hooked to grid; storage dam also used for irrigation; net head 327 meters.
6. Huai Nam Dang	1981	124 KW	Cross-flow (Local)	Design NEA, construction RFD, electrified forestry stations and resettlement village, net head 70 meters.
7. Ban Yang	1970	2x50 KW 1x12 KW	2-Cross-flow 1-Francis	Developed by EGAT; utilization PEA; net head 67 meters.
8. Ang Kang	1978	10 KW	Pelton (Local)	Developed and utilized by RID; village electrification; net head 30 meters.
9. Doi Pui	1979	5 KW	Cross-flow (Local)	Developed by WAT; village electrification; head 17 meters.
10. Mae Sa	1979	1.5 KW	Cross-flow (Local)	Privately developed and operated for home use; net head 10 meters.
11. Mae Chon	1979	5 KW	Cross-flow (Local)	Designed by NEA, built and operated by RFD; electrifies RFD station; net head 17 meters.

Recognizing this fact, NEA is attempting to build upon its existing experience base to better understand the limits and capabilities of small hydroelectric development in the Kingdom. When USAID was approached by the RTG with the initial micro/mini hydro sectoral proposal in 1980, the project contained in this PP was seen not only as a means of enlarging the number of sites constructed in Thailand, but also to deal more directly with a number of sectoral issues ranging from technical questions concerning the optimum mix between locally-fabricated and offshore power plants, to sectoral planning concerns relating small hydro to other forms of rural electrification (i.e., grid extension or local diesel generation).

The evolution of the PP since that time has permitted the PP team to grapple with these issues in a more meaningful way. Their conclusions, as are noted in the following section, will require Project implementors to focus basically on immediate, operational issues of small hydro development (site selection feasibility, appropriate power plant selection, efficient consumer utilization).

III. PROJECT ANALYSIS AND DESCRIPTION

A. Technical Analysis Summary

This project proposes to assist the RTG to attain two specific and parallel objectives in their development of national micro/mini hydro potential (1000 KW):

- the development of an analytical capacity and method which will permit the RTG to improve sectoral planning and development (institutional support); and,
- the construction of up to 12 hydroelectric generation systems.

The PP has attempted to deal with both objectives simultaneously in project implementation, for it is felt that the two concepts are mutually reinforcing. The construction of sites is necessary to provide realistic feed-back and field data so essential to the development of any model or other analytical tool, and conversely, appropriate site selection and construction implies the organized analytical capacity to insure informed decision-making. For purposes of clarity, however, each of these objectives will be noted separately below.

1. Institutional Support Component

A key concept of this PP is the creation of a special Project analysis/management group in NEA, the Project Operations Unit (POU). As noted below, the POU will be staffed with Project-funded expatriate and Thai technicians as well as their NEA counterparts. The POU will collaborate on a daily basis with the spectrum of NEA divisions but will be under the supervision of the Deputy Secretary General (see Secton IV.B. for organizational details).

The POU will be responsible for 1) the collection of existing data on Thai and foreign experiences in the micro/mini-hydro section, 2) for proposing, and directly implementing, project-funded analysis, planning, construction and operations, and 3) for the systematic monitoring and evaluating of field activities undertaken by the Project.

The basic analytical themes to be developed by the POU are described below. Additional detail on staffing responsibilities over time are noted in Section IV.B. ("Project Organization and Staffing Responsibilities") as well as in Annex H ("Indicative Terms of Reference for Key Project Personnel").

a. Standard Engineering Analysis: In keeping with commonly accepted practice, all Project sites will undergo full final engineering design (topography, hydrology, geology, etc.) prior to contracting for construction. Appropriate specifications for individual

power plants will also be drawn up prior to initiation of procurement. Once civil works construction has begun, all site construction activities will be supervised and progress evaluated according to the terms of the construction contract. All of these analytical tasks will be carried out by one or several qualified private firms, in close collaboration with POU engineering staff - particularly the Construction Manager and NEA Field Engineer. The POU staff will, on an ongoing basis, record appropriate technical data, suggest innovations in design or construction methods and techniques, and furnish practical, field-related suggestions to other POU staff as they attempt to develop workable analytical models and methods in the small hydro sector.

b. Special Sectoral Analysis: Probably more experimental and hence more difficult to define with precision for local conditions in Thailand, are a wide range of basically socio-economic concerns which have been identified in the course of PP design as critical to the effective development of sites and utilization of downstream power supply. An approximate timeframe for development of these analytical tasks is illustrated in Table 5.

1. Site Selection Analysis

The PP design team has devoted considerable attention to the development of a simple, but reasonably accurate, site selection model. An initial model has been presented in Annex F and will be refined considerably in the course of Project implementation. It is a critical aspect of the Project proposal for several reasons:

- it provides all base data from which future impact evaluations and Project innovations may be drawn,
- it permits an operational framework for integrated analysis of project sites, and
- it will necessitate far ranging, systematic understanding of small hydro systems under a wide variety of site conditions (e.g. different power sizes, management systems, geographic locations, etc.).

Development of the site selection model will be the direct operational responsibility of a Senior Contract Engineer and Socio-Economic Analyst and short-term contract or MEA Specialists, as required. The model will be developed for two parallel objectives. First, it will be the basis upon which USAID determines second tranche site feasibility based on its own standard criteria, and, second, it will

Table 5: Project Monitoring/Evaluation Task Worksheet

Individual	1982	1983	1984	1985
1. Socio-Economic Analyst(s)	Oct.-Dec. - Model development - Literature search - Desk study Tranche II - Define sectoral issues and workplans - Est. basic monitoring/ evaluation methodology	Jan.-June - Tranche II field site selection - Model refinement - Sectoral planning assistance	Sept.-Nov. - 1st field impact evaluation & overall project evaluation (w/AID staff) - Model refinement - Sectoral planning assistance	Sept.-Nov. - 2nd field impact evaluation - Final model refinement - Final sectoral planning suggestion
2. Manufacturing Promotion Specialist(s)		Jan.-Mar. - Small Hydro manufacturing sector assessment for NEA July-Dec. - Direct assistance as required by previous exercise		
3. Consumer Promotion Specialist(s)		Jan.-Mar - Site visits, establish workplan - Identify issues . Productives utilization of local electricity . Local plant operation (Coop or private) . Credit . Hook-up costs . Tariffs . Local training needs	Jan.August - Fieldwork establishing procedures and directing implementation of consumer promotion activities w/ operating agency for both Tranches I and II. - Participate on impact evaluation team.	July-Sept. - Final promotion work on Tranche II sites
4. NEA Geologist/Hydrologist		Jan-August (part-time only) - Standby in case of special field assistance for site selection. - Assist in establishing prerequisite geological/ hydrological reports for model.		
5. Forecasting Specialist		Jan.-Mar (part-time only) - Assist in establishing appropriate demand forecasting technique for model.		
6. NEA Computer Specialist		Jan.-Mar. (Part-time only) - Assist in coding & Collating data from field feasibility studies. - Assist in developing computer program for model.		

be developed so as to provide NEA with a site selection model which best services its internal needs and constraints. A total of 18 person-months have been budgeted per Table 8 (3 person-month of expatriate services and 15 person-month of local services) for this effort. A more complete description of Project staff is provided in Section IV.B.3.

2. Manufacturing Promotion

Thailand already has an manufacturing capability for some power plant components, e.g., generators, transformers and Crossflow turbines of under 100 KW capacity. Although improvements can clearly be made in this area, it is not yet clear what contribution the Project can make to assist in its' development. In an attempt to reduce foreign exchange costs, increase local employment and, potentially, encourage private sector technology transfer through Thai-U.S. joint venture or licensing agreements, a sectoral overview of local small hydro power plant manufacturing potential will be undertaken early in the Project. If that overview can arrive at specific proposals for future analysis or technical assistance which are deemed in accordance with Project objectives and funding capabilities, they will be considered for incorporation into ongoing Project activities under POU supervision. A total of nine person-months have been budgeted per Table 8 (3 p-m of expatriate services and 6 p-m of local services).

3. Consumer Promotion

A number of local, consumer-oriented issues have been tentatively identified by the PP Team for analysis and field development. Contract specialist(s) will be employed early in the Project to visit field sites, assess basic issues and develop a work-plan for action. It is currently anticipated that implementation of consumer-related activities will not take place until construction of first tranche sites well underway. Among the principal issues to be analyzed are:

- productive use of local electricity generation,
- potential for local operation of the Project generation/distribution system (e.g., cooperative or private venture)
- utility of local credit schemes for hook up or appliance costs,
- potential for use of variable hook-up costs,
- potential for use of variable tariff schedules,

- local training needs,
- utilization of local labor for construction or hook-up activities.

A total of 18 person-months have been budgeted per Table 8 (3 person-month of expatriate services and 15 person-month of local services) for this effort.

c. The Concept of Institutionalization: The POU, with its full-time focus on the small hydro sector and its integrated staff and analysis techniques, should move to the forefront of NEA and RTG small hydro sector planning and analysis. It is not clear at this time, however, if POU has the potential for evolving into a specialized line office in its' own right, or if its responsibilities will eventually be re-assigned to other NEA bureaus.

The PP team and NEA have given careful thought, therefore, to formulating a project design which will facilitate maximum "institutionalization" of Project-generated sectoral lessons and knowledge with those Thai personnel and organizations most likely to make optimum use of the results after project completion.

First, and perhaps most importantly, the POU will be under the direct supervision of the NEA Deputy Secretary General's office. NEA top-level management accords high priority to a rapid and intelligent development of the small hydro sector, and will have a direct interest in assuring maximum institutionalization of Project results.

Second, a number of activities will be organized by POU to disseminate Project concepts and results, on an ongoing basis. a) Periodic progress meetings (see Section IV. D 1 "Project Monitoring") will be conducted by POU to inform interested NEA, AID and other personnel of new ideas and concepts being developed under the Project. Comments and discussion will be solicited of key NEA division chiefs and staff, particularly the Investigation and Planning Division and the Technical Division. b) At least two public seminars on small hydro development will be sponsored through Project funds and coordinated by POU staff in cooperation with relevant RTG and non-governmental interest groups. c) Quarterly Project progress reports will be given wide circulation within NEA as well as to other interested RTG agencies (PEA, EGAT, NESDB, etc.) and interested non-governmental organizations (university staff or private groups).

Finally, NEA and AID will jointly take on the responsibility of re-examining the institutionalization question half-way through Project implementation. A major topic of the major Project evaluation undertaken by AID in 1984 (See Section IV. D. 3.) will be to examine cumulative evidence up to that time and generate concrete proposals, acceptable to the RTG, on the most appropriate ways to ensure broad-based institutionalization of project data analysis and results.

2. Construction Component

a. Technical Description: In the interest of keeping costs to a minimum and simplifying engineering design, all sites proposed for construction under the Project will be "run-of-river" schemes, illustratively presented in Figure 2. No water impoundment is anticipated (e.g., dams, pumped storage) under the project, unless Project technicians are interested and able to make a strong, documented case to the contrary, and such a request is approved by both NEA and USAID. The basic operating principal of the system is the diversion (weir) of a portion of river flow into an open or closed headrace, through a penstock to the power house, where it actuates the turbine and is then directed back into the normal stream bed. Power generated by the turbine is passed through a step up transformer into a 22 KV transmission line to the users where it is then stepped-down, metered and connected to user units. A more detailed description of civil works characteristics may be found in Annex B.

b. Number of Sites: The hydro sites to be constructed under this Project have been viewed as essentially representing the means to attaining the more critical concern of improving sectoral understanding and future investment decision-making. Site construction will provide the "laboratory" setting which will generate the empirical data necessary to systematic resolution of a variety of sectoral technical, socio-economic and operational concerns. The number of Project sites selected for construction under the Project, therefore, was basically a function of the size of the data base required to furnish statistically relevant sectoral information, while fitting within the limits of RTG and AID budget resources. Data from existing small hydro sites, while of general interest to the Project, are of little utility in attaining Project objectives, given their sparsity and the fact that they were not generated within a predefined analytical framework.

Based on the number of variables currently deemed appropriate for study, (see Table 6) NEA and the PP team feel that a minimum of 10-15 sites are necessary for analysis. A larger sample would have been clearly preferable from an analytical point of view (larger samples and greater differentiation of variables), but was difficult to propose, given existing funding constraints.

For purposes of the Project Paper it has been estimated that 12 different sites will be developed under the Project, although the final number of sites will depend on several factors: actual power plant size, actual inflation over time, analytical "quality" of sites (quality of data, representativeness of sites, etc.). Sites have been organized into two separate tranches. As is noted below, a first tranche of six sites has already been tentatively identified through PP team integrated feasibility analysis and will commence construction in 1983. A second tranche of six sites will be determined by POU through use of the site selection model developed in this PP, and will commence construction in 1984.

Figure 2 : Sketch of a Representative Project Hydroelectric Power Plant

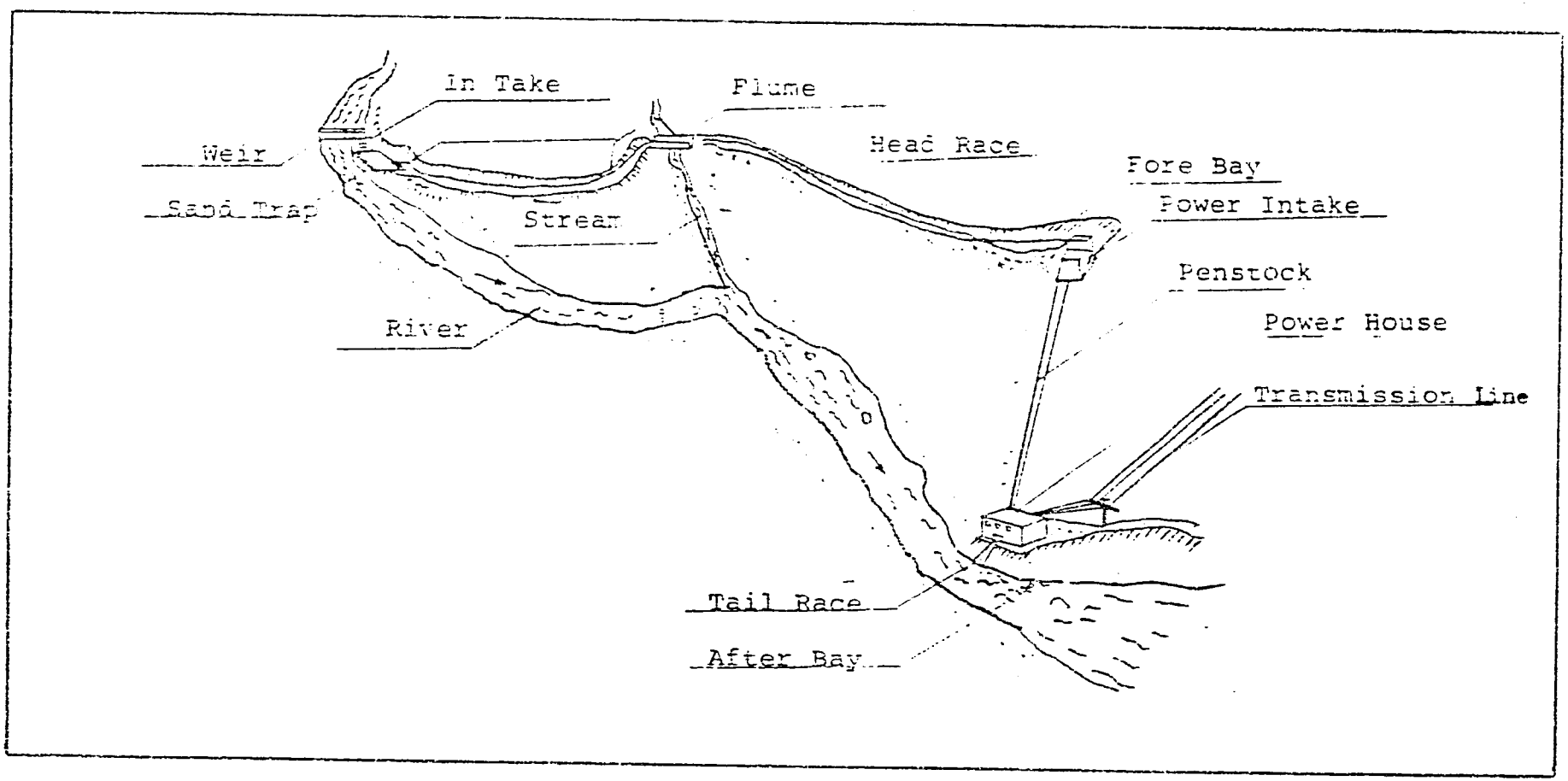

Table 6: Anticipated Project Analysis Matrix

VARIABLES CONSIDERED	FIRST TRANCHE SITES						SECOND TRANCHE SITES
	Site #1	Site #2	Site #3	Site #4	Site #5	Site #6	Sites #7 - 12
- Geographic region	North	North	North	North	East	South	
- Head	High	High	High	High	High	High	
- Generating capacity (KW)	440	305	100	100	145	355	
- Operation Management	EGAT	EGAT	RFD	EGAT	EGAT	EGAT	
- Distribution Management	PEA	PEA	RFD	PEA	PEA	PEA	
- Consumer credit	No	No	No	No	No	No	
- Variable tariffs	No	No	No	No	No	No	
- Country of Power Plant Manufacture	U.S.	Thai	Thai	Thai	Thai	U.S.	- To be developed by PCU -
- Type of turbine	Crossflow		Crossflow	Crossflow			
- Relationship to diesel/ grid generation	---	Hook to grid; Replace diesel	Replace diesel	---	Replace diesel	Hook to grid	

First tranche sites will permit Project staff to better establish the parameters of realistic analysis which can be undertaken by the study. POU will be required to utilize thoughtful advance planning on second tranche sites so as to expand the Project's data base to the maximum extent deemed feasible and of utility, given Project resources. All sites will also be used to calibrate the Project site selection model, as was noted previously.

c. Site location: First tranche sites have been tentatively identified. They are all high-head (over 20 meters) sytems and four of the six sites are located in Northern Thailand. These sites may be situated on Map 1 and are described more explicitly in Table 7, attached. Because of the favorable rainfall and topography of the North, it may be anticipated that several future sites may also be located in the Region, (or other highland areas) although comparably justified sites may located in lowland areas if appropriate low-head systems are developed for use in the Project.*

Future micro-hydro sites will probably all be located outside of grid areas due to anticipated managerial limitations of RTG operating agencies, for such small systems. Mini-hydro sites may be located in either grid or non-grid areas. Finally, the emphasis on future site selection will be to replace existing diesel-generation systems.

d. Site Selection Methodology: Selection analysis of first tranche sites (#1-6) is described in greater detail in Annex B. The basic procedure included pre-field and field screening of a broad range of possible sites as well as specific subsequent field engineering (hydrology, topography, geology), social and economic studies to determine basic feasibility of each of site recommended by the initial screening exercise. The accuracy of initial screening proved to be good, as detailed field study confirmed the feasibility of six out of seven sites. Final review and approval of the Tranche I sites, as with all sites, will be undertaken by NEA/USAID/NESDB prior to moving to construction, however.

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*At least one attractive low-head site was located at Lam Pra Plerng (Nakhon Ratchasima Province). The existence of water impoundment structures at this site potentially implies an interesting cost/benefit ratio for provision of an estimated 3 MW generation capacity. Although exceeding the upper power limit established for this PP, Project staff may wish to consider this site for second tranche selection and compare its economics with those of the smaller sites built under the Project. For further information on low-head systems examined by the PP team, see "Small-Scale Hydroelectric Power Potential in Irrigation Schemes," dated October, 1981 and prepared by Team Consultants.

Table 7 : Initial Sites Recommended for Construction
(First Tranche Only)

Site	Location	Capacity (MW)		Net	Type of	Nature of Average Demand			
		Design	Dependable	Head	Turbine	Resid.	Comm./ Ind.	Ag.	Observations
#1 Mae Hat	Amphoe Chiang Dao Chiangmai Province	440	325	100m.	Crossflow	64%	29%	7%	
#2 Mae Suk	Ban Mae Suk Nok, Amphoe Mae Chaem, Chiangmai Province	333	240	62m.		42%	55%	3%	Will be hooked to grid
#3 Mae Aep	Amphoe Hot Chiangmai Province	100	60	75m	Crossflow	56%	39%	5%	
#4 Mae Chon Luang	Bam Mae Na Chon, Amphoe Mae Chaem, Chiangmai Province	100	60	73m.	Crossflow	58%	36%	6%	
#5 Khlong Ta Riu	Tambon Ta Chian Thong Amphoe Makham, Chantaburi Province	145	[illegible]	90m.		56%	39%	5%	May have potential for capacity expansion.
#6 Khlong Ra	Tambon Song Phraek Amphoe Thap Put Phangnga Province	355	250	125m.		59%	36%	5%	Will be hooked to grid

Future selection of second tranche sites (#7-12) will be undertaken by Project technicians, in collaboration with NEA and NESDB, through utilization of the site selection model detailed in Annex F. This model is the result of the extensive field experience gathered under the first six feasibility studies, and should decrease the time and cost investment required of individual site feasibility work while increasing the accuracy of each assessment. In its current form, the model has also been designed to furnish simple baseline data on each site which can subsequently be utilized for Project evaluation. The model was field tested at the Mae Chon Luang site (#4) and appeared to furnish reliable results. NEA recognizes the model as a potential operational tool of value for standardized use on all RTG small-hydro selection. To assist in attaining this objective, appropriate human and financial resources have been designed into the Project and will be described more fully under the "Institutional Support" component, noted below.

e. Final Engineering Design and Supervision: During the process of screening and basic feasibility determination, each Project site will be subjected to both desk and field studies of local hydrology, geology and topography. Prior to commencement of final engineering, therefore, each site will have a reasonably complete technical dossier, including preliminary engineering and cost estimates of ± 20% accuracy.

Final engineering will be required prior to construction and, in all cases, will be contracted out to qualified Thai engineering consultants. Contracting for design services will take place in two separate tranches as per the Procurement Plan presented in Section IV.D. of this PP. In most cases, it is anticipated that engineering supervision of construction also will be contracted for.

All final engineering design and supervision will be the responsibility of a special Project Operations Unit (POU) and most explicitly, the Project-funded Construction Manager and the NEA Field Engineer (see Implementation Plan for details).

f. Site Construction: It is anticipated that the first six sites (constituting tranche one) will be constructed by contract(s) with qualified Thai, U.S. or Thai-U.S. joint venture firms. Future sites (second tranche) may utilize contract or force account methods, or both, depending largely on Project experience on the first six sites. The contractor(s) will build all civil works, including transmission and main distribution lines. The procurement and installation of the power plant will remain a POU responsibility, allowing the procurement process to begin at an earlier date than actual site construction. Actual hook-up and metering of power to individual users will be the responsibility of PEA or whatever operational agency eventually responsible for power distribution and revenue collection for the system (see next paragraph). Hook-up costs will be paid by the individual consumer. It is anticipted that electricity will generally be

sold to users at standard PEA rates. An exception to this is the Mae Aep site (#3) which should be entirely operated by the RFD and electricity distributed free of charge to local hill tribe villages and to the local Forestry Center.*

Upon completion of construction it is tentatively anticipated that all first tranche site electrical generation will be distributed, and revenues collected, by PEA (with the exception of the Mae Aep site). To ensure proper break-in of the generation system, NEA will run all power plants for a period of one year, at the end of which it is anticipated that operational responsibilities will be turned over to EGAT. Final plant operation and electricity distribution responsibilities will be clearly enunciated by NEA prior to final site selection (see Site Selection model - Annex F) and commencement of construction. Because of the underlying Project objective of exploring various management options, POU will be encouraged to utilize other potential operating and distribution groups (e.g., PEA, cooperatives, private sector, RFD, RID) wherever deemed appropriate.

The engineering design contractors will in all cases be encouraged to develop low-cost, simple systems which are as maintenance-free as possible. As the current quality of local design firms is generally good, little problem is anticipated in this area.

g. Power Plant: Appropriate power plant (turbine, generator, switchgear, control equipment, step-up transformer) technology is known for the full range of effective head and generating options being considered under this PP. Final decisions of the exact type of equipment to be utilized for each project site can only be made upon completion of relevant final engineering, topographical and hydrological studies, however. This is especially true of the turbine, and for the purposes of the PP, we have assumed that all turbines will be of the Crossflow, Francis or Pelton design for first tranche sites.

Crossflow turbines are already manufactured in Thailand at acceptable standards and other turbines could be manufactured locally with appropriate assistance from qualified U.S. firms. The PP has anticipated that sites 2, 3, 4 and 5 will equipped with turbines of Thai manufacture and sites 1 and 6, of U.S. manufacture.

A detailed power plant analysis is contained in Annex B.

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*While clearly not in agreement with the PP and RTG policy of ensuring financial viability of each site this system appears to be warranted by local conditions. It should not be considered as setting a precedent for other sites, therefore, but, rather, one of a number of management options being explored by the Project.

h. Maintenance: Appropriate selection and construction of various elements of each project site will be the key to determining the frequency and intensity of maintenance. Quality of design and construction of the diversion works, head race, penstock, and tail race can provide civil engineering works which are relatively free of routine maintenance problems. The sand trap will require periodic flushing, but this is an operational expense rather than a true maintenance expense.

NEA policy requires that they operate, maintain and "shake down" new hydroelectric project sites (both civil works and power plant) for a period of not less than one year after the plants are put in service. This should permit any design or construction miscalculations and minor break-in problems to be expeditiously rectified. The NEA has a skill training center, where local Thai personnel are given the training required to successfully maintain all segments of hydroelectric installations. They now perform this training for individuals working for many Thai line agencies and can provide necessary trained technicians to carry out the required maintenance and operational program for those sites included in the Project.

When the hydroelectrical installations are commissioned after the one year operational phase, the operating agencies will take over total responsibility for overhead and maintenance and associated costs. Given an appropriate design and careful construction, the annual cost of maintenance should be in the neighborhood of 1% of project construction costs. This is not a large financial burden, and should be easily accommodated from returns through the sale of electricity. Financing of this activity will be through normal budgets where the fees collected are deposited in the national account, (which is the case under the PEA operation), or from fees actually collected where electrical cooperatives operate the plant.

During the life of a hydroelectric Project, miscellaneous equipment and facilities will wear out and require replacement. This replacement is in addition to those routine replacements covered in normal plant maintenance. A sinking fund should be established for these interim replacements.

Hardware to be installed under the Project will most probably be procured from the United States, or from Thailand, and is not expected to result in problems with spares or lack of manufacturer's support. While the maintenance of facilities often proves to be a troublesome part of many infrastructure projects, the history of small scale hydroelectric operations in Thailand does not show failure due to lack of maintenance, and the PP team has concluded that it should not prove to be a constraint.

B. Financial Analysis Summary

1. Project Budget Analysis

The details of the Project budget analysis may be found in Annex C. A Project Financial Plan (Table 8) has been attached for reference, and indicates a total life of project cost of $12,800,000, composed of an estimated 91% local costs and 9% foreign exchange costs.*

The anticipated projection of expenditures by donor and by fiscal year is noted in Table 7. USAID will finance some 63%, and the RTG some 37%, of total Project costs.

Table 9: Projection of Expenditures by Source and by Fiscal Year**
($000)

Source	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	Total	(%)
USAID	470	2,316	3,861	1,384	67	8,100	(63%)
RTG	213	1,366	2,375	731	15	4,700	(37%)
TOTAL	689	3,682	6,236	2,115	82	12,800	(100%)
(%)	(5%)	(29%)	(49%)	(17%)	(1%)		

*This is simply an estimate of the type of currency which will actually be used to procure Project goods and services, not an assessment of the foreign exchange component of the procurement. For example, a locally assembled Japanese vehicle procured in Baht with a 50% foreign exchange component would be registered as a 100% local cost. It should be noted that the 91% local cost figure cited above could be reduced considerably, depending on the competiveness of local Thai contractors vis-a-vis their U.S. competitors

**Assumes linear annual cash outflows (e.g. FY 84 calculated as 75% of CY 84 plus 25% of CY 83). An exception, FY 82 was calculated as 25% of CY 82, leaving the other 75% for FY 83.

Table 8: Project Financial Plan (US$000;

ITEM	1982 AID FX	1982 AID LC	1982 RTG	1983 AID FX	1983 AID LC
A. Final Engineering					
1) Sites 1-6					135
2) Sites 7-12					180
B. Construction					
1) Site #1: Mae Hat					
- Construction contract					294
- Power plant (est. U.S.)				206	
2) Site #2: Mae Suk					
- Construction contract					268
- Power plant					170
3) Site #3: Mae Aep					
- Construction contract					106
- Power plant					57
4) Site #4: Mae Chon Luang					
- Construction contract					84
- Power plant					29
5) Site #5: Khlong Ta Rru					
- Construction contract					198
- Power plant					85
6) Site #6: Khlong Ra					
- Construction contract					180
- Power plant (est. U.S.)				223	
7) Sites 7-12 (estimate)					
- Construction contract					
- Power plants					
C. Project Staff					
1) NEA Project Manager					
2) NEA Field Engineer					
3) Senior Engineer/Coordinator				90	30
4) Construction Manager					30
5) Soc-Econ Analyst(s)	6	6		16	27
6) Manufact. Promotion Specialist(s)				22	24
7) Consumer Promotion Specialist(s)				22	8
8) NEA Geologist/Hydrologist					
9) Forecasting Specialist				22	8
10) NEA Computer Specialist					
11) Secretary		1			2
12) NEA Accountant					
13) NEA Drivers					
D. Equipment					
1) Minor Support Equipment				20	
2) NEA Vehicles					5
E. Seminar Support					
F. Special AID Evaluation (Grant)					
Sub-Total	6	7	-	621	1,920
+ Physical Contingencies (10%)	-		-	-	
+ Inflation (15%/yr.)					
TOTAL	7	8	-	786	2,429

1982 Base Year Prices; CY Only; Tax-Free Only)

	1984			1985			1986			TOTAL		
	AID			AID			AID			AID		
RTG	FX	LC	RTG	FX	LC	RTG	FX	LC	RTG	FX	LC	RTG
135												
180												
294												
268												
106												
84												
198												
180												
		1,854	,854									
		899										
5						5			5			
5						5			4			
	90	30		90	30		75	25				
		30			30			8				
		8			8							
	22	13			8							
13												
8												
2		2			2			1				
5						2			2			
						5			3			
41											1	
	69											
1,524	181	2,886	1,871	90	78	17	75	34	14			
-	-		-			-		-	-			
1928	263	4,118	,,71	150	130	28	144	65	27	1,350	6,750	4,700

GRAND TOTAL = $12,800,000

2. Taxation and the Project Budget

As a U.S. Government agency offering public funds under grant or concessional loan conditions, USAID can not finance Project-related taxes, nor can it recognize RTG payment of taxes as a host-country contribution to the Project. Although not yet formally confirmed by the RTG, it is anticipated that payment of certain taxes will be required of this Project. Included in this group are import duties (10-30%) and importer business tax (10-20%) on imported power plants, manufacturer's business tax (7-10%) on locally-made power plants, contruction contractor business tax (3%), and income and other taxes on foreign technical assistance personnel. The difficulty in estimating these taxes has precluded the PP team from attempting a detailed assessment of their magnitude. The total value of these taxes are estimated in the $300,000 to $500,000 range, and could be higher, if eventual POU detailed studies indicate the necessity to import greater numbers of foreign power plants. The implications of this for the above-noted Project budget are two-fold: 1) The U.S. contribution does not include, and may not be utilized to finance clearly visible tax items. This indicates the necessity for an early meeting of USAID/T and interested RTG parties to record their mutual understanding on this matter. 2) The RTG contribution noted above ($4.7 million) has been calculated as a tax free contribution. If the Thai Government requires the payment of taxes under this Project those taxes will be funded by additional RTG funds, and NEA should undertake careful advance financial planning prior to each fiscal year so as to ensure coverage of this taxation, as required, in its annual budget.

3. Project Financial Feasibility

Following the rationale presented in Annex G, second tranche sites will all be required to demonstrate a financial rate of return on capital investment of at least 8%, per general RTG guidelines for electric power sector investments. The methodology proposed for derivations of financial rates of return is outlined in Annex F. First tranche sites were exempted from this analysis, given the extensive cost-benefit economic analysis undertaken for these six sites.

4. Project Recurrent Costs

Although a public sector project, each of the hydro-electric sites should generate sufficient revenues from electricity sales to consumers to cover all recurrent costs (overhead, regular and periodic maintenance) over the useful life of each site.

The site selection model (Annex F) utilized by the Project for second tranche sites will build in additional safeguards in this respect through its financial analysis. The 8 percent of return on capital investment should ensure auto-financing of each site, not only for basic operating costs but also for future site expansion (e.g., new transmission, second phase generator, etc.)

C. Social Soundness Summary

1. Social Profile

First tranche sites all tend to be located in fairly isolated areas and also tend to demonstrate low levels of existing "modern" economic development. The average site is expected to contain some 5,000 inhabitants within its zone of influence.

Targeted populations tend to be traditional rice farmers and are only occasionally involved in small commerce or highly localized activities (e.g. mining in the South, RFD wage laborers). Most have had no experience with past electrical utilization although the majority appeared to have an interest in utilizing electricity at current PEA rates.

Incomes of this group tend to be low, with perhaps one-half having incomes under the current IBRD poverty line.

2. Institutional Overview

Development of the individual site power supply will clearly be the responsibility of NEA. The demand side of the Project could be orchestrated by a wide variety of actors, including PEA, EGAT, RFD, RID, cooperatives or private groups. Clearly, the current most active rural electricity agency in the country in PEA. The PP has therefore anticipated that the front-line candidate for power sales and distribution for five out of six first tranche sites is PEA. Future sites, (second tranche) may prove to be candidates for cooperative or private sector management and such experimentation with local alternative management options should probably be encouraged.

On the basis of its field analysis (see Annex D) the PP team has deemed construction of the first tranche sites socially sound, with the caveat that user demand should be the object of more intensive analysis in the course of Project implementation, so as to ensure optimal distribution of site-generated revenues while promoting a productive, rational utilization of electricity at the consumer level.

D. Economic Analysis Summary

1. Macro-ecoromic Consideration

As noted in the "Background" section of this PP, Thailand relies heavily on foreign oil imports to meet the country's fast-rising demand for electrical power. This external dependance impacts on the national economy in two important and related ways: reducing foreign exchange availability and rendering the economy vulnerable to be spiraling costs of foreign fossil fuels.

Of all developing nations, Thailand is the fifth largest importer of petroleum. The current monthly value of petroleum imports is now close to 6 billion Baht ($260 million), of which some 20%, or $626 million per year is utilized in generation of electricity.

Thailand has been running a trade deficit the last several years, which has seriously widened with continuing increases in imported petroleum costs. For 1981, the trade gap is estimated at some 80 billion Baht.*

If successful, this Project will not only actually install an aggregate physical plant capacity of some 4000 KW, but of greater macro-economic significance, will develop a series of analytical methods and procedures which should help in developing the entire small hydro sector.

Promotion of micro/mini hydroelectric generation to replace existing or projected small diesel units and/or to feed the existing (petroleum-fueled) grid should help reverse these balance of trade tendencies from two different directions:

- by reducing the necessity for oil imports through indigenous, renewable electricity generation, and,

- by stimulating local production and exports through provision of electricity to rural producers and through the loosening up of foreign exchange and national funds (previously spend on imported fossil fuels) for priority RTG rural development activities.

In the long-term, if oil prices continue their current tendency as expected, use of renewable local power should also reduce the relative cost of supplying electricity to the consumer and induce a more favorable rate structure, ultimately engendering further secondary effects in the form of increased production, lower production cost and higher individual incomes.

2. Micro-economic Analysis

Seven site possibilities were analyzed using the economic cost-benefit methodology described in Annex E. Of these seven sites, six were deemed economically feasible in all but the most unfavorable conjuncture of circumstances, and, therefore, retained for first tranche construction. The internal rates of return for the reference scenarios and all sensitivity tests have been recapitulated in Table 10 below.

*Exports 160 billion Baht. Imports 240 billion Baht, of which 28% is in petroleum and petroleum products.

Table 10: Economic Rates of Return for Individual Project Sites
(IRR's in %)

Site	Base IRR	Sensitivity Tests* #1	#2	#3	#4	#5	#6
1. Mae Hat	17.4	14.8	14.5	12.3	14.3	11.3	10.0
2. Mae Suk	10.7	8.4	8.2	6.3	8.6	6.4	4.6
3. Mae Aep	15.5	12.2	12.1	9.6	12.5	9.7	7.5
4. Mae Chon Luang	22.4	14.8	18.5	14.7	14.9	14.8	11.6
5. Khong Ta Rui	13.0	10.2	10.0	7.6	10.3	7.7	5.9
6. Khlong Ra	45.6	17.8	18.5	14.7	17.9	14.8	11.6

*Test #1 Capital costs rise by 33%
Test #2 Demand falls by 25%/year
Test #3 Both #1 and #2
Test #4 Indirect benefits fall by 33%
Test #5 Both #2 and #4
Test #6 Both #1 and #5

While felt to be reasonably accurate in assessing Project economic worth, this method will not be utilized for the selection of second tranche sites. These sites will be chosen through use of the model presented in Annex F, which, for methodological reasons made explicit in the Annex G, prescribes an economic least-cost analysis in place of the cost-benefit approach utilized for first tranche sites.

E. Environmental Analysis Summary

An Initial Environmental Examination (IEE) was prepared on 9/23/80 and submitted with the Project Identification Document (PID). AID/W concurred in a negative determination for the Project in STATE 327974 (1980). Special environmental analysis required of each Project-funded site may be found in the integrated site selection model presented in Annex F.

IV. IMPLEMENTATION PLAN

A. Implementation Schedule

A reasonably detailed Project Implementation Schedule is proposed in Figure 3 for use by Project Implementation personnel. All details of the implementation planning selection have been organized, and budgets have been calculated, on the basis of this Schedule. It should be underscored at the outset that the timeframe for tranche one contracting has been deliberately planned tightly, in response to NEA and AID concerns for expeditious implementation of the first six sites. Project implementors should be forewarned that a special effort will be required in CY 1982 if this timeframe is to be adhered to.*

B. Project Organization and Staff Responsibilities

1. Sector organization:

In broadest terms, energy sector coordination is the responsibility of NESDB's Energy Planning Section. Specific coordination of small-scale hydroelectric planning and construction was formally delegated to MSTE and NEA in 1980, however.** This Project and the AID-sponsored Non-Conventional Renewable Energy Project should play an important role in assisting NEA to undertake small hydroelectric sector coordination.

In the course of feasibility work on individual project sites, it is expected that NEA will need to coordinate its activities with a number of other interested RTG agencies (including NESDB, PEA, RFD, RID, and EGAT)

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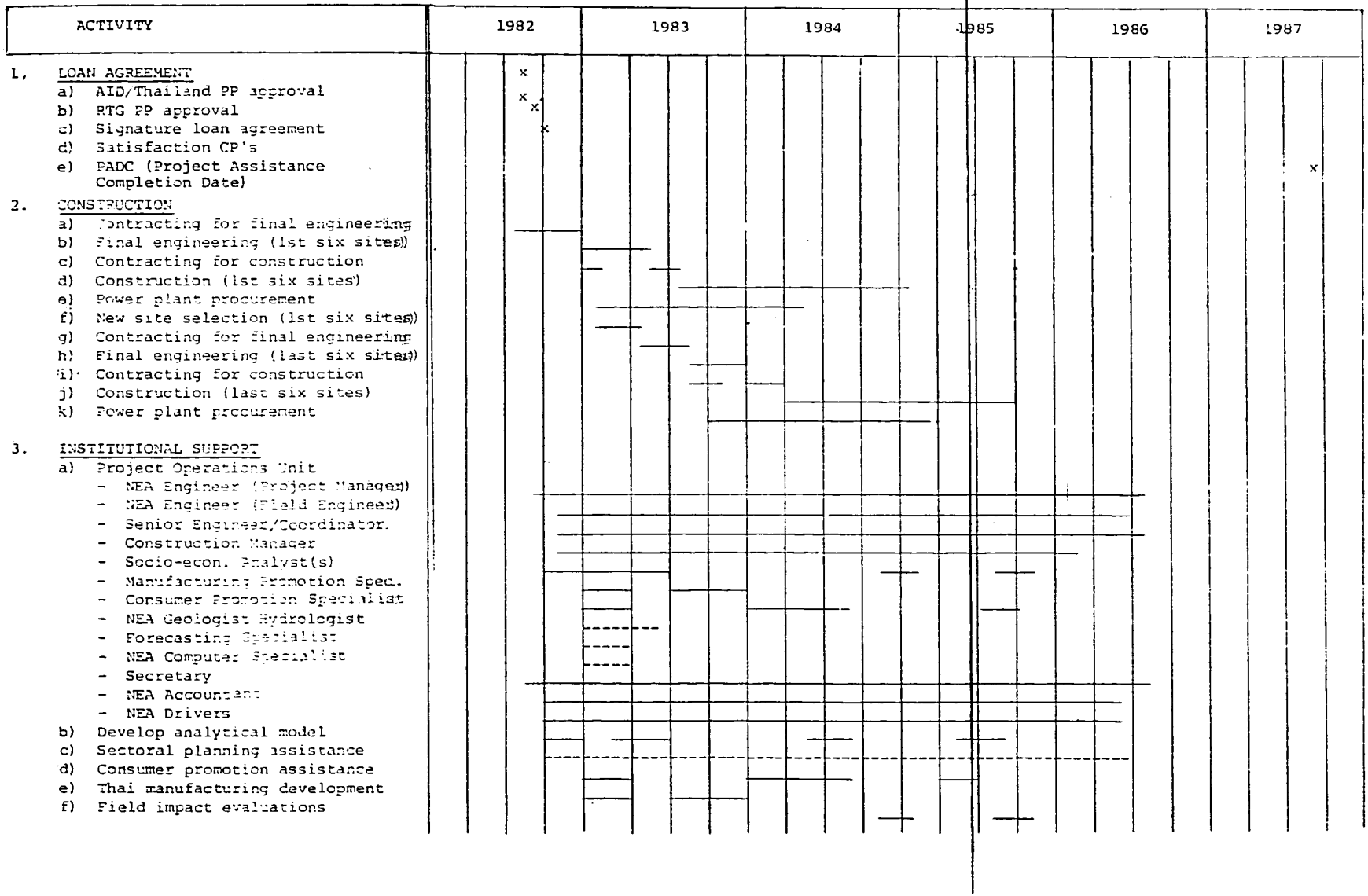
*Of particular importance will be the contracting of the Senior Engineer and assignment of NEA staff as early as possible.

**See Cabinet decision recorded in Letter No. 0202/31595, dated 12/12/80 from Secretary of the Cabinet to the Minister of MSTE.

Figure 3 : Indicative Project Implementation Schedule (CY only)



Any critical, systematic cooperation required for successful project development has been incorporated in the Project Site Selection Model contained in Annex F.

NEA is, (both for the Project and for the small hydro sector in general), therefore, the critical implementation agent for successful Project realization. The internal organization of NEA is in the process of being modified although most references to its structures contained in this PP are along existing rather than the future organizational lines.

Because the small hydro sector is a new area of analysis for NEA, the Secretary General's Office has deliberately establised POU outside of existing divisions in order to focus full-time NEA and contract skills to the specialized task placed before it. Indeed, based on existing NEA structures, no line office would have the total breadth of skills (planning/analysis, design, construction, contracting, etc.), nor the time, to focus on the experimental field of small hydro development.

POU still will, however, necessarily work and liaison on a regular basis with other intra and inter-agency specialists for the unit. This will be most particularly true of the Investigation and Planning Division (NEA's field analysis branch) and of the Technical Division (NEA's project design and implementation branch). NEA is not a large government organization and its technicians commonly cut across Division structures to cooperate with each other on an ad hoc basis. It is expected that POU will enter into a similar relationship.

Figure 4 contains the current operational framework of NEA and Figure 5 contains the proposed new administration structure approved by Cabinet 8/7/81.

7. USAID/T Staffing Requirements

In response to both Mission and AID/W concerns, the project has been staffed with contract and NEA personnel so as to reduce USAID/T administrative and managerial requirements to a minimum. It is anticipted that all Mission backstopping activities for the Project can be coordinated by a Project Manager who will devote 30-40% of his time to the Project.

Figure 4

CURRENT ORGANIZATION CHART OF NATIONAL ENERGY ADMINISTRATION (NEA)

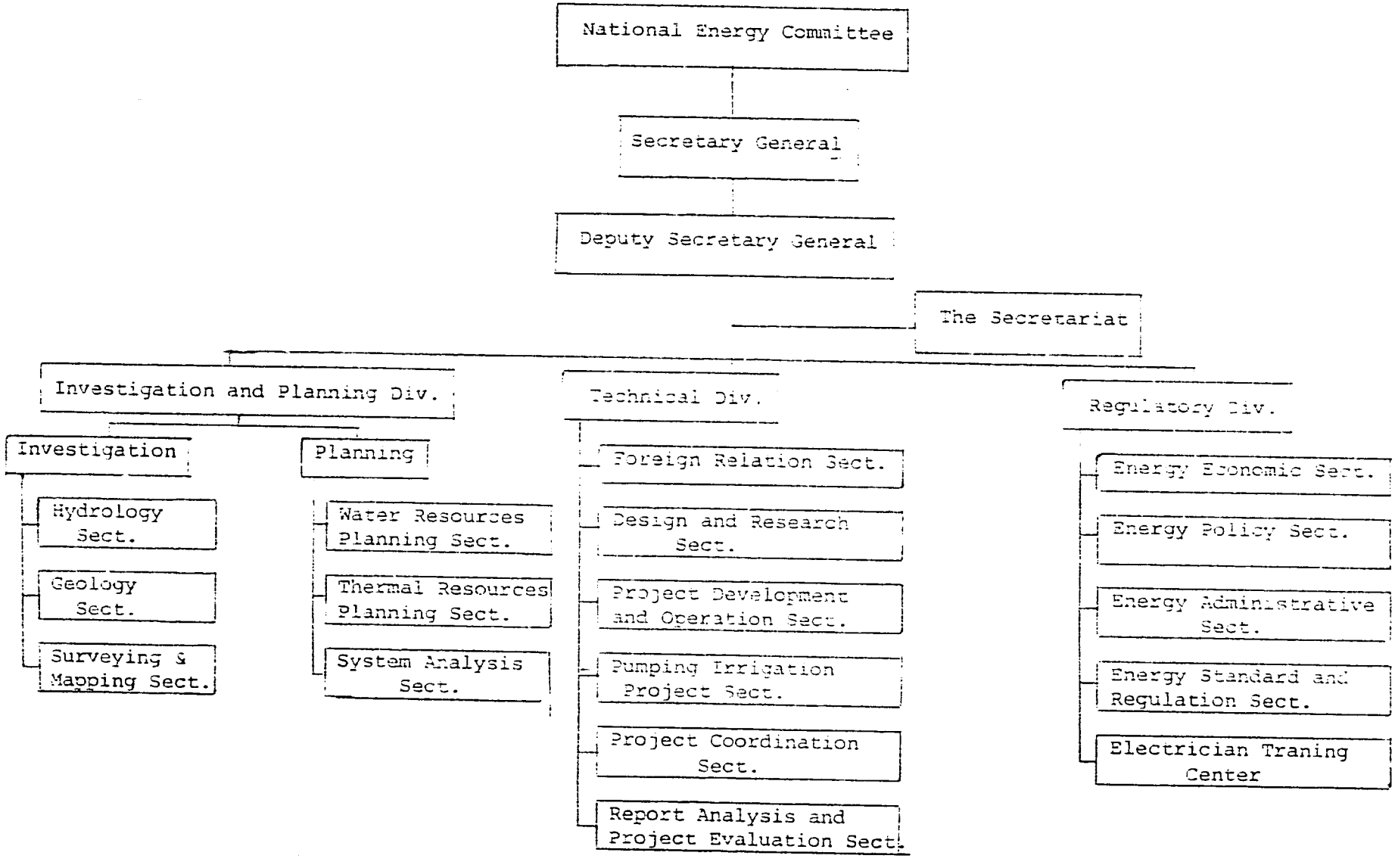
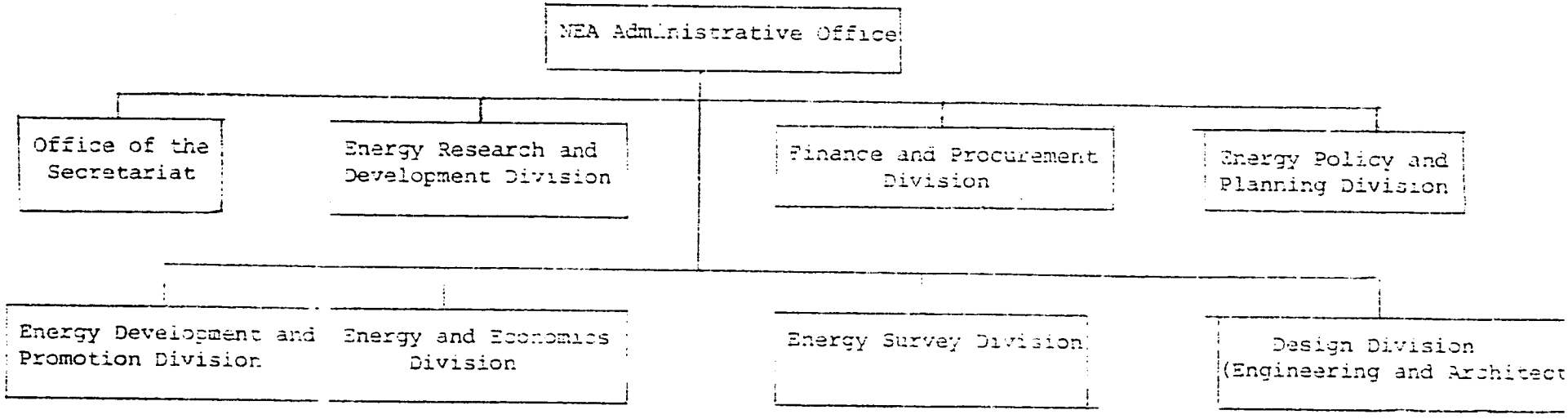


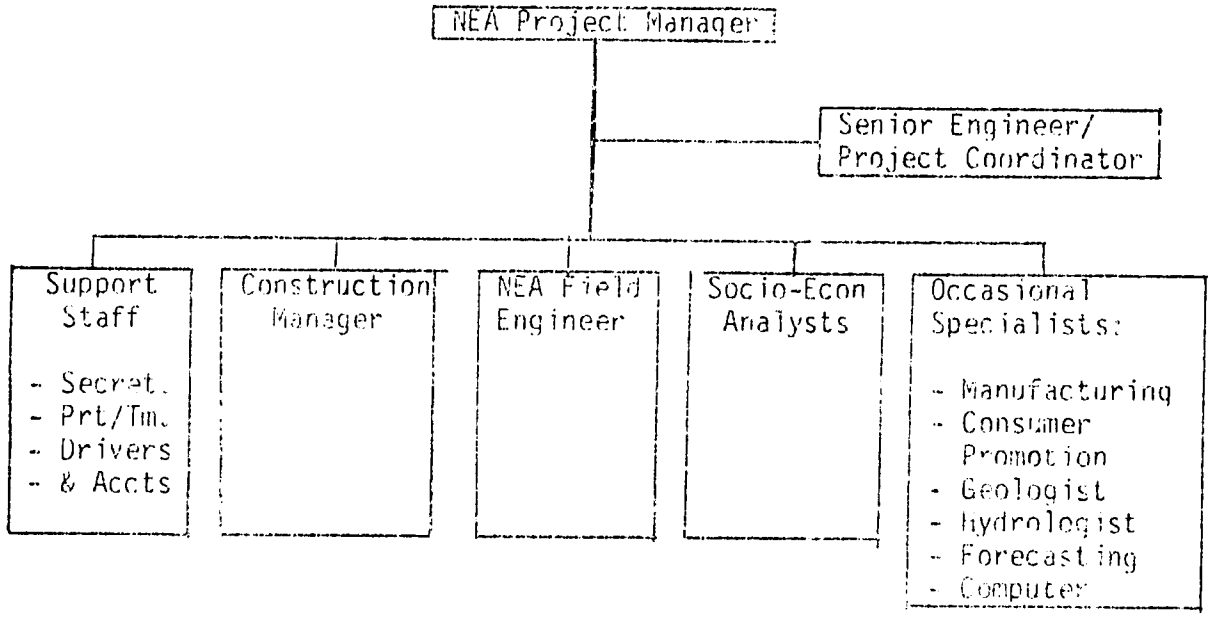
Figure 5

PROPOSED ORGANIZATION OF NATIONAL ENERGY ADMINISTRATION (APPROVED 3/7/81)



3. Project Organization

All Project activities will be coordinated by a special Project Operations Unit (POU), located in NEA and under the direct supervision of the NEA Deputy Secretary General. The chart below indicates the organization of Project technical staff envisaged to undertake these responsibilities.



Broadly speaking, the POU Project Manager (an NEA line employee) will be responsible for all managerial decisions related to the Project and will be actively involved in all aspects of Project analysis and construction. He will be assisted in all of these managerial activities by the expatriate Senior Engineer/Project Coordinator, who will be involved in orchestrating the analytical activities of POU (model development, monitoring/evaluation, site selection, consumer promotion, manufacturing promotion, etc.) as well as coordinating specific engineering design, construction and contracting efforts on a daily basis.

The contract Construction Manager will monitor all field operations including, most importantly, supervision of final engineering design and site construction. He will coordinate his field work closely with his NEA Field Engineer counterpart in order to ensure high standards of construction and engineering throughout.

The contract Socio-economic Analyst will be resonsible for the refinement and adaptation of socio-economic analytical models and concepts promoted by the PP and the POU Project Coordinator. His focus will be highly operational and as such he will often work in close collaboration with field personnel and Project-funded specialists. He will establish regular contacts with the "Report, Analysis and Project Evaluation Section" of the Technical Division and the "Water Resources Planning Section" of the Investigation and Planning Division of NEA.

An indicative terms of reference for each key Project employee has been noted in Annex H for reference.

C. Procurement Plan

1. Generalities

As virtually all Project funds will be spent on the procurement of goods or services, the PP team has dwelled at considerable length on an appropriate procurement plan. Authorized source/origin for all procurement will be U.S., Thai or Code 941*. All procurement of goods and services will be coordinated by the Project Operations Unit (POU) in collaboration with the NEA Deputy Director-General and NEA secretariat and with the concurrence of AID/Thailand (O/EST, O/PPD, RPO). Based on past Mission experience in this area, it is recommended that due consideration be given to contracting of a procurement agent for offshore commodity procurement, if deemed appropriate by both RTG and USAID. It is also recommended that contracting be undertaken using host country procedures. If, however, the RTG and the AID decide, prior to the signature of the Loan Agreement, that significant time and cost savings are possible through AID direct contracting, this option should remain open. Whichever conclusion is reached, the contracting mode selected should be clearly indicated in the Loan Agreement.

Procurement under the Project can be grouped into four broad categories (Design/Supervision, Construction, Power Plant Procurement, Technical Assistance). Each category is discussed below. For greater clarity, key contracting actions have been represented over time in Figure 6, assuming an availability of Project funds by October, 1982.

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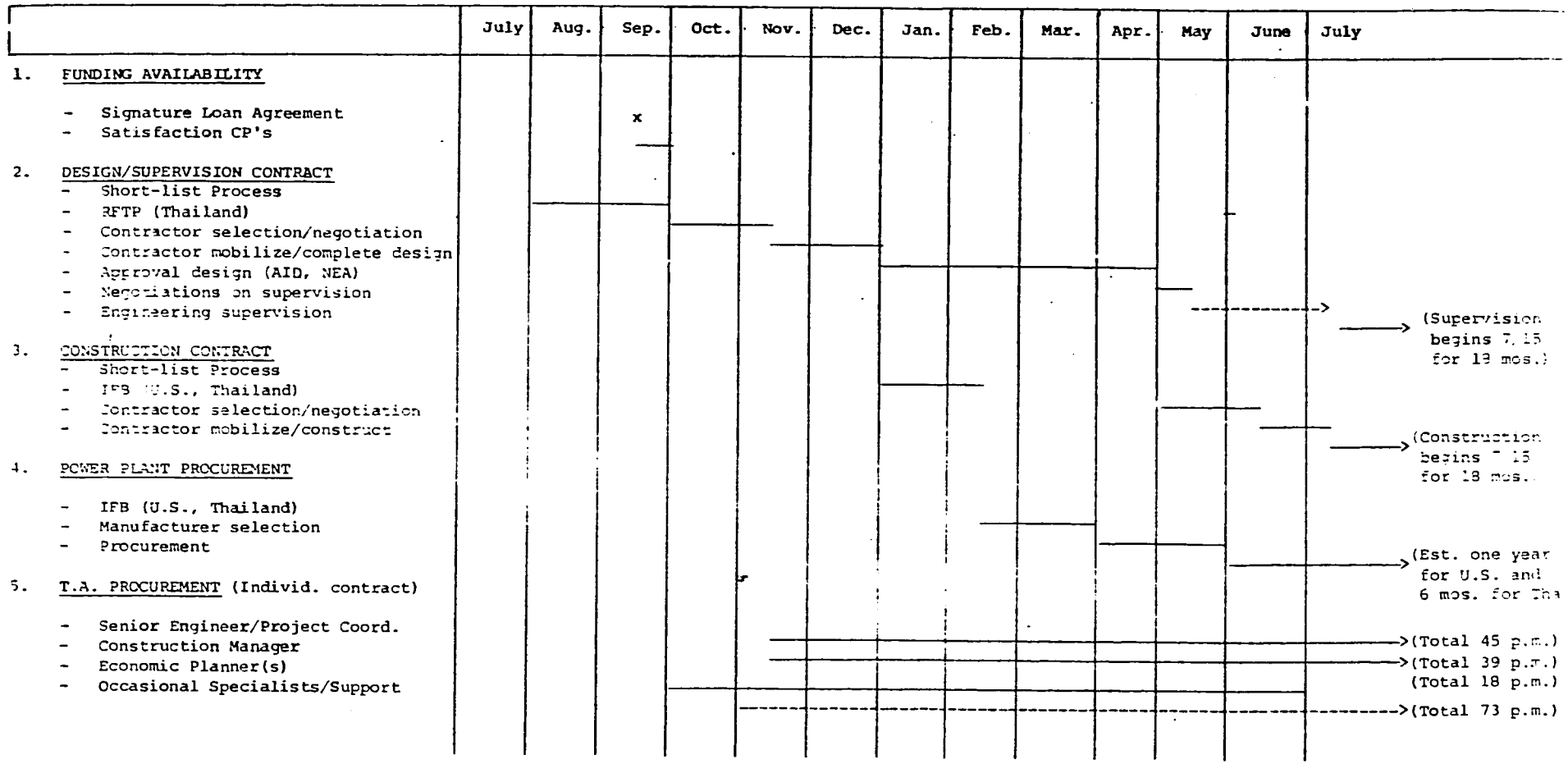
*Developing Free World. See AID Handbook for most recent listing.

Figure 6 : Indicative Contracting Schedule (First Tranche, CY 1982/ 1983 Only)



2. Design/Supervision Contracting

All final engineering design (plans, specifications and bid documents) will be contracted to qualified local A & E firms following authorized host country competitive procedures. Upon completion of final design, the RTG may exercise the option of retaining A & E firms for supervision of actual construction, should it so desire. Selected A & E firms will be expected to submit indicative rate schedules for supervisory engineering services at the time of award of design contracts.

After considerable study of the question by the PP team, it was determined that the size of this contract was clearly too small to attract U.S.-based companies. A Request for Technical Proposals (RFTP) will therefore only be advertized locally and according to standard NEA practice. Firms will be selected on the basis of their technical proposal alone and final contract negotiations and cost estimates will only subsequently be requested of the firm (s) selected. The contract will be awarded by NEA using standard host country contracting procedures (which procedures will first be reviewed and approved by the USAID Regional Contracting Officer). As the contract will be entirely in local costs, no USAID special clauses will be added to the NEA contract.

3. Construction Contracting

It has been decided to contract out all civil works construction (including transmission lines, step-down transformers and major distribution lines to villages) for the first tranche, (sites 1-6), to qualified local construction firms. Only the responsibility for power plant procurement, as is noted below, and user hook-up, will be excluded from the civil works contract. Tranche two sites will either be constructed by private firms or by NEA through force account, depending on private sector and NEA construction capabilities at the time.

Immediately upon receipt of the final engineering design, an Invitation for Bids (IFB) will be published in the CBD and Small Business Opportunities Journal in the U.S. and in appropriate Thai publications. Bidders may be disqualified if they do not meet minimum technical qualifications. The firm (s) selected will enter into a host country contract with NEA, financed jointly by NEA and USAID. NEA will follow its standard contract procedures (advance to contractor, payment according to monthly progress statement of costs) but USAID will only reimburse NEA a fixed amount upon satisfactory completion of each site construction as certified by an authorized USAID engineer. USAID may authorize appropriate advances to NEA upon completion, to the satisfaction of AID, of agreed-upon milestones in the site construction plans. The Mission considers this approach to be a legitimate utilization of the FAR (Fixed Amount Reimbursable) method suggested in AID Handbook 3, Appendix 3F.

Firms will be selected on the basis of their cost proposal and the contract will be awarded using standard NEA civil works contracting procedures (following review and approval by the USAID Regional Contracting Officer, including insertion of appropriate AID clauses). If possible, the Loan Agreement should contain specific directives outlining the manner in which USAID will conduct its reimbursement of civil works construction.

4. Power Plant Procurement

The contract engineering design firm will be responsible for drawing up final power plant specifications and plans. Once their design has been approved by NEA and AID, POU will advertize an IFB for power plants in the U.S. and Thailand. As with the civil works construction contract, bidders may be disqualified if they do not meet minimum standard technical qualification. As NEA does not currently have appropriate local testing facilities, fulfillment of contract manufacturing standards will be judged by NEA on the basis of adherence to design specifications (physical measurement) for Thailand manufacturers and on operational efficiency (performance specifications) for U.S. manufacturers.

As with previous contracting, procurement of individual power plants (turbine, generator, control equipment, switchgear, step-up transformer) will take place in two distinct tranches. NEA will be responsible for contracting and will negotiate directly with the manufacturer for actual procurement. In the double objective of testing the presumed higher quality of U.S. manufacture in the high power range and of encouraging the nascent Thai power plant industry, it is tentatively anticipated that the two largest units (Mae Hat and Khlong Ra) will be of U.S. origin and that the four remaining units will be of mixed Thai/US/Code 941 origin. Installation of the power plant may be either undertaken by NEA or sub-contracted to the civil works prime contractor or other firms.

As each power plant will be virtually custom made and, furthermore, given that final head data will not be determined until completion of the final engineering survey, no procurement specifications beyond those indicated in Section II.B. can be advanced at this time.

5. Technical Assistance Procurement

A number of short and long-term specialists will be in contracted for under the project as stipulated in Section II. B. of this PP*. The PP team feels that individual contracts between NEA and each specialist is probably more appropriate than blanket contracting with one

*For anticipated country of origin of each contract position, see Annex C.

or two companies for these services. The primary disadvantage of individual contracts is the greater time and paperwork required by multiple documents - this appears to be outweighed, however, by the elimination of high company overhead costs, and the fact that much of the additional work gen rated by this approach can be delegated to the POU and particularly the Senior Engineer/Project Coordinator, who will be hired early in the development of the Project. A final technical assistance procurement proposal will be established by NEA and the Regional Contracting Officer prior to the drawing up of the Loan Agreement and after detailed discussions of this topic. All known rural electrification and relevant specialist groups in Thailand and the U.S. will be contacted in NEA's attempts to contract for the services of these individuals.

Finally, technical staff working on the Project will have some $20,000 of funds available for procurement of minor equipment which is directly supportive of their activities, primarily in the context of field basic feasibility work. This equipment (e.g., desk-top programmable calculator, soils kits, simple surveying or hydrological instruments, etc.) will be procured by the POU with the concurrence of NEA and AID.

D. Monitoring/Evaluation Plan

As repeated at several points in this PP, the very essence of this Project is to introduce a range of interesting supply and utilization options for ongoing monitoring and evalation. The results of these exercises will hopefully provide considerable assistance to the RTG in advancing its understanding of the small hydro sector and improving the quality of its investment decisions. A reasonably detailed monitoring/evaluation plan should be drawn up by the Project Manager, Senior Engineer and Socio-Economic Analyst during the period October-December, 1982 (see Table 5). This plan should include a proposed measurement methodology, timeframe and personnel requirement for overall Project monitoring and evaluation activities. The plan should be developed in cooperation with the NEA Deputy Secretary General's Office, the NEA Section for Report Analysis and Project Evaluation, the NEA Water Resources Planning Section and the USAID Project Manager, and submitted in final form by mid-CY 1983. Three types of activities should be included in this plan: project monitoring, impact evaluations, external evaluation.

1. Project Monitoring: - It is anticipated that POU will submit to NEA and USAID a quarterly progress report on the status of all major Project activities proposed in this PP. This includes primarily, but is not necessarily limited to:

- final engineering design/supervision
- civil works construction

- technical assistance contracting
- power plant procurement
- site selection model development
- manufacturing promotion
- consumer promotion

Appropriate, on-going monitoring and periodic (probably quarterly) discussions among key POU, NEA and USAID personnel is intended to provide a mechanism for safeguarding the integrity of Project design, while building-in flexibility to adjust the Project activities and requirements according to updated information and constraint during that future timeframe.

2. Impact Evaluations: - Two point-in-time impact evaluations of Project sites are planned during the life of this Project (see Table 5). The first evaluation will measure the impact of first tranche sites just before and after actual electrification of those sites. The second evaluation will measure second tranche electrification impacts and will furnish a longitudinal comparison (one year later) for first tranchesites. The information gathered during these exercises should be compared with baseline data gathered in the course of initial site selection (see Annex F). The information gathered and conclusions reached should 1) enhance RTG knowledge of the various technical, socio-economic and environmental impacts of each generation system developed under the Project, and, 2) feed-back in the site selection model (Annex F) so as to improve its assessment capacity while reducing its human and financial resource requirements.

3. External Evaluation: - While the POU is undertaking its first field impact evaluation in mid-1984, USAID will undertake a comprehensive mid-stream evaluation of the overall Project. The evaluation will examine normal USAID concerns of progress on physical works and appropriate use of funds as well as all of the sectoral analytical concerns studied through the Project. Both USAID and external contract personnel will be utilized for this evaluation. Grant funds, up to $100,000 will be allocated to this effort. A final evaluation is also scheduled for the second quarter of FY 1987.

E. Conditions Precedent, Covenants and Negotiating Status

Planning for the Micro/Mini Hydroelectric Project is already at an advanced stage. USAID has been collaborating closely with the RTG and there is a general understanding and agreement with respect to shared financial and managerial responsibilities under the Project. Conditions precedent to initial disbursement of Project funds will therefore be kept to a minimum.

Prior to the first disbursement under the Project, or to the issuance by USAID of documentation pursuant to which disbursement will be made, the Cooperating Country will furnish to AID in form and substance satisfactory to USAID

a. Specimen Signatures

b. Legal Opinion

c. Evidence of the source and availability of funds for the RTG contribution to the Project (estimated $4.7 million equivalent in Thai Baht).

d. Evidence that NEA has undertaken all actions necessary to authorize establishment of the Project Operation Unit (POU) and that the Project Manager has been assigned full-time to that Unit.

In addition the following general covenants conditions will be included in the Project Loan Agreement:

a. Prior to the release of funds civil works construction costs NEA and AID will reach a written agreement describing procedures and requirements necessary to AID reimbursement of Project civil works construction costs using the Fixed Amount Reimbursable (FAR) methods.

b. Project site selection will be undertaken in accordance with engineering, socio-economic, financial and environmental criteria established in the PP site selection model (ANNEX F), or as subsequently amended by joint approval of AID and NEA.

c. The RTG will agree to contract with a procurement agent or allow USAID to assist with procurement of offshore commodities whenever both parties deem appropriate.

d. The RTG will take such steps as are necessary to ensure orderly and timely allocation of responsibilities for power plant operation and electricity distribution of Project-funded sites.