PROJECT ASSISTANCE COMPLETION REPORT

Micro/Mini Hydroelectric Project
A.I.D. Project No. 493-0324
A.I.D. Loan No. 493-T-030

Engineering Division
Office of Project Development and Support
USAID/Thailand

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Project Assistance Completion Report
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The Micro/Mini Hydroelectric (M/M Hydro) Project was completed on September 1, 1989. By that date all inputs (detailed engineering designs, technical assistance, civil works, purchase, installation and testing of electro-mechanical (E-M) power plant equipment) had been completed for four subprojects. The E-M power plant equipment for one subproject had not been installed and tested by the Project Assistance Completion Date (PACD). Under the terms of the loan agreement and the Fixed Amount Reimbursement (FAR) procedures, the National Energy Administration (NEA) will only be reimbursed the costs for those subprojects completed prior to the expiration of the PACD on September 1, 1989.

In sum, the project has achieved its goal of providing the Royal Thai Government (RTG) with the capacity to construct micro (0 - 100 Kilowatts) and mini (100 - 1,000 Kilowatts) run-of-the-river hydroelectric power plants in various parts of Thailand. The purpose to improve the institutional capacity of the implementing agency, the National Energy Administration (NEA), to develop an analytical capacity and methodology to plan, analize, construct and finance micro/mini hydroelectric generating systems has also been achieved.

Goal and Purpose:

This Project was designed to complement a broad strategy to reduce Thailand's dependence on imported fossil fuels used for electricity generation. The specific goal of this project was to provide the Royal Thai Government (RTG) with the capacity to identify economically attractive sites for micro and mini run-of-the-river hydroelectric power development. The purpose was to improve the institutional capacity of the implementing agency, the National Energy Administration (NEA), to develop an analytical capacity and methodology to better their small hydroelectric generation and site selection planning, analysis, construction methods and procedures, and to finance the construction of up to twelve micro/mini hydroelectric generating systems in various parts of Thailand. On-the-job training and technical assistance was provided to improve NEA's skills and methods in engineering, contracting, environmental and socio-economic impact analyses both in management and operational areas.

The Project, which was implemented by NEA, began in 1982 and fell behind schedule due to a variety of delays experienced in its first two years.

The major delays in the implementation of the Project were, inter alia, due to (1) site selection by using the model designed, (2) a one year delay in negotiating the Technical Assistance and Detailed Engineering Design Unit Contract between NEA and the Consultant, (3) a six-month delay in completing written specifications and bid documents needed for tendering the E-M equipment, (4) E-M bid cancellations and rebidding and (5) administrative problems within NEA in approving detailed engineering drawings/design, and delayed approvals by the Royal Forest Department authorities in granting access to the construction sites. As a result, the PACD for the Loan Agreement was extended for two years, from September 1, 1987 to September 1, 1989.

Originally it was anticipated that AID would finance up to twelve micro and mini units. However, it was subsequently decided to install only mini units, and since the mini units were more costly, the total number of units was reduced from twelve to eight in order to stay within the project's funding limitations. The number of units financed by AID was further reduced from eight to five because actual prices tendered exceeded the project's engineering estimates by a substantial amount.

Accomplishments:

The principal achievements of this Project have been:

1. It has improved the institutional setting for the development of mini-hydro within Thailand both at NEA and within the private sector.

2. It has enhanced the ability of the NEA and the Thai private sector to select and assess mini-hydro sites based on economic, financial, and social variables.

3. It has allowed both the NEA and the private sector to develop capabilities for the engineering design of hydropower facilities in the 500 to 1,500 kilowatts range, including the design of civil works, construction supervision and the specification of E-M equipment.

4. It has provided a market for locally fabricated and manufactured E-M equipment for mini-hydro plants.

5. It has provided both the NEA and the local contractors the construction techniques and procedures.

6. It has resulted in the construction of eight mini-hydro facilities in the rural areas of Thailand, four financed by AID and four financed by the RTG. The four completed subprojects are as follows:

(1)	Nam Mae Hat	818	kW
(2)	Khlong Lam Plok	1,182	kW
(3)	Nam Kha Mun	1,032	kW
(4)	Huai Mae Sot	660	kW

The four subprojects being implemented with RTG budget are:

(1)	Huai Lam Sin	958	kW
(2)	Khlong Duson	680	kW
(3)	Lam Pra Plerng	850	kW
(4)	Nam Ya Mo (first phase)	800	kW (the second unit of 800 kW will be installed at later date)

Project History:

The M/M Hydro Project was conceived starting in 1979 following the latest oil price shock (U.S. $32 - 34 per 42 gallon barrel). Governments all over the world were rushing to find and implement renewable energy projects as long as they showed acceptable returns and were proved feasible. This project started in much the same way, but with much higher expectations of what could conceivably be accomplished. When, therefore, oil prices dropped to a low of U.S. $9.00 per barrel in early 1986, the economics of the entire project suddenly were made far less favorable than previously thought. Even now, the cost of oil per barrel is about U.S. $18.00, the economic justification for the project is still far from certain, in almost all cases.

The Project was formally initiated on September 16, 1982 when the loan agreement was signed between AID and RTG. The stated objective of the project was to develop the institutional capacity of the implementing agency, the National Energy Administration, and to plan and construct up to 12 micro/mini hydropower plants over a five year period. Funding of $12.8 million for the project was to be provided jointly by USAID and the RTG. USAID's share was to be a loan of $8.0 million and a $100,000 grant for evaluation purposes and the RTG agreed to provide the remaining $4.7 million. USAID funding was provided in accordance with the Fixed Amount Reimbursement (FAR) procedures. Under this method, the RTG would only be reimbursed after the hydropower plants began operation. The funds for construction would have to be borne through NEA sources until the first plant produced power.

'Under this project, USAID agreed to provide 50% of the cost of civil works, transmission and distribution and 100% of the cost of the electro-mechanical equipment. This approach, it was thought, would encourage efficient and rapid implementation by NEA.

The mini hydro plants were to be built in remote areas to service rural energy consumers. Some plants would be grid-connected while others would serve remote villages. Also, NEA would build the plants, operate them for one year and then turn them over to the Provincial Electricity Authority if the plants were isolated, or to the Electricity Generating Authority of Thailand if they were connected to the national grid.

Plans called for twelve plants were to be constructed in two phases. The initial six would be used to develop the site selection methodology with the assistance of foreign consultants. Of the original six subprojects selected for project funding at the time of Project Paper (PP) was prepared, three were constructed, two were dropped when more detailed feasibility work revealed unfavorable economics and one (Nam Mae Chon Luang, 80 kW) was built by villagers under NEA supervision.'

The subproject built by the villagers with NEA assistance was located in an isolated area. The unit's capacity was planned for 130 kW. However, it was determined that this size unit was not cost effective to build and NEA later reduced the capacity to 88 kW. Costs were further reduced by community participation and for promotion by the productive use of electricity.

To assist NEA in implementing the USAID supported project, professional services were solicited. The winner of the competition was the Association of TEAM Consulting Engineer Co., Ltd., K. Engineering Consultants Co., Ltd. and Stanley Consultants, Inc. (TEAM-KEC-SCI). TEAM was to design the plants, KEC was to carry out the survey work and SCI was to assist NEA in site selection and training of the Project Operation Unit (POU).

The Project Paper proposed that the POU be made up of 5 to 6 people. These were professionals drawn mainly from construction ranks but also included specialists in hydrology, geology, economy, etc.

During the course of implementation of this project, five NEA engineers in electrical, mechanical, and civil field were offered by the equipment suppliers to go to the States to observe small hydropower turbines and generators manufacturing techniques; witness performance and efficiency tests of the turbines and generators. They also visited some small scale hydropower plants using new technologies where all the sites belong to private companies.

There were several major bureaucratic reasons for slow implementation of this project in the beginning. There were disagreements between NEA and the Ministry of Finance over such issues as contractor overhead. There was also some weakness in the initial project design and a clear lack of built-in flexibility on technical issues such as the number and scale of plants to be constructed. Most of the subprojects were to be located in national forests, reserved forest, or wildlife sanctuaries and failure to consider the associate environmental issues during project design caused further implementation delays.

Currently eight units have been completed, are under construction or installation of E-M equipment. They are geographically distributed, four in the North, three in the South, and one in the Northeast. They range in size from 660 kW to 1,182 kW.

All the sites are located in remote, forested, hilly areas having little direct environmental impact on villagers and wildlife in the immediate vicinity. Although some of the sites are located in national parks, forest reserves, and wildlife sanctuaries have not been detrimentally effected because seven out of the eight units constructed utilize the "run-of-the-river" method whereby no dam or river impoundment occurs to create a reservoir. Therefore, the damage to the environment is substantially less than would otherwise be the case. The eighth unit is utilizing the power of an older existing dam. The most significant environmental impacts occurred during the construction phase at the initial stage. To build the weirs, headrace, penstock, powerhouse and access roads, wide swaths of land have to be cleared. However, the soil erosion was later controlled through improved construction techniques. Thailand is a tropical country and the exposed areas were 70 - 90% covered with natural grass and weeds within a rainy season, if not mitigated by man-made ways, e.g. sodding, rip rap, etc. In short, the environmental impacts of this project are minimal.

Lessons Learned:

Quite a few lessons have been learned from this project. First, the schedule laid out in the PP was not realistic since the timing for many actions was exceedingly tight. Furthermore, the PP was overly optimistic regarding the accomplishments the project was supposed to achieve. AID/Washington insisted the Fixed Amount Reimbursement procedure be used even though the project was not particularly suited to this method of financing. FAR is most appropriate when identical structures are being built and only slight modifications are anticipated.

The M/M Hydro Project lacked every element needed for the FAR procedure to work. Hydroelectricity is one of the most complicated and difficult projects in terms of site location (remote and mountainous) and scope of activities (including roads, housing, weir, water delivery system/headrace and penstock, powerhouse, electro-mechanical equipment,

transmission line, etc.). Each subproject was totally different, with site conditions varying considerably, and subelements, such as the weirs, sand sluices, headraces, flow control structures, penstocks, powerhouse, and even the style of the headraces were different i.e. some were buried and some elevated. The FAR was designed as a "hands-off" program, to limit the involvement of Mission personnel but this also limited the Mission's ability to monitor the actions and processes of the NEA, the implementing agency, since we did not control the funds and were not consulted until after major decisions had been made and implemented. Consequently, some mistakes were made that could have been avoided.

One subproject, Huai Lam Sin, was not completed by the PACD. The estimated costs of this subproject was $1,134,800.00 and AID agreed, under the FAR arrangement, to reimburse the Government for 50% of the total construction costs and 100% of the cost for equipment and material upon completion of the subproject. The civil works were completed but, due to a contractual dispute, the equipment was not installed and tested before the PACD. Since it is unlikely the contract dispute will be resolved in the near future, a decision was made not to extend the PACD. Therefore, we advised the Government that, in accordance with the FAR procedures, AID could not reimburse the Government for any of the costs incurred on this subproject since it has not been completed. Consequently, the Government must finance all the costs incurred to date and the cost to complete the project, i.e. installation of the equipment which is estimated at $122,800.00, with their own resources.

The E-M bid cancellation and rebidding was one of major project delays. The E-M equipment for each subproject was tendered more than three times and each bid took more than 60 days. Owing to the lowered cost of oil and environmental concern, the development of hydropower had slowed down and many E-M equipment manufactures were closed down because of limited demand. Yet, the cost estimates for equipment were still set at very low price and even the lowest bid was much higher than the budgeted costs. According to the RTG regulations, after three times of infavorable bids, the "special method" procurement can be applied, i.e., the bid price can go beyond the cost estimates. The delay in E-M equipment procurement consequently delayed the construction of the powerhouses since the equipment contractor or manufacturers had to submit the floor plan for the powerhouse. The resulting delays were compounded by the consequent deterioration of conditions at the sites, i.e. once the foundations for the powerhouses had been started but not completed, rains caused mud slides, erosion, etc. There were also serious disputes between the equipment supplier and the implementing agency (the employer of powerhouse contractor) at Huai Lam Sin site which resulted in a long delay. The dispute still has not been resolved and the subproject was not completed by the PACD. The delays at the beginning of the project also resulted in under utilization of the expatriate and local specialists who had already been on board since the commencement of the project. By the time the work was fully underway, the contract for the major technical assistance had already been terminated!

'In short, from the principal lessons learned from this Project and the implications for future project design are:

1. Project design must take into account existing government regulations and procedures.

2. Project design should include a more careful assessment of institutional capacity so that the requirements for technical assistance will complement existing institutional capabilities and be coordinated with the activities of other donors.

3. In design of energy projects, a certain flexibility must be built in. As economic, financial and natural resource constraints change, project implementors should have some flexibility to change project goals. Negative criticism of a project because its original goals were not met is not an appropriate response in situations where the underlying economic conditions and the resulting rationale for a project have been altered during the life of the project.

4. The basic economics of micro-hydro, isolated mini-hydro and grid-connected mini-hydro as applied to rural electrification should be established and methods for quantifying their benefits should be agreed upon.

5. Project evaluation of energy projects should allow for a closer examination of the viability of a project as a function of changes in energy costs, capital costs and discount rates. The project design should consider the marginal benefits and costs for different levels of capacity and for different sets of capacity expansion over time. The analytical capacity of existing micro-computer software have greatly reduced the labor required for such analysis.

6. USAID needs to develop a more effective approach to contracting and monitoring of technical assistance to insure that the personnel provided and their scope of work will provide useful inputs given that these requirements may change over the life of a project.

Sustainability of the Project

The replicability of this project has never been in doubt. The successful subprojects have demonstrated the feasibility of constructing mini-hydro plants in Thailand. The RTG plans to continue the micro/mini hydroelectric program with its own resources by constructing approximately 5 - 7 micro and 3 - 5 mini hydro plants a year depending on the size of installation and the budget allocation.

NEA has received a budget allocation of approximately $16 million for the construction of 6 - 7 micro and 3 mini hydro systems in 1990. However, most of the funding for this program comes from central government funds. No operational budget exists to support similar projects in the

future. The only apparent option for NEA, given the declining interest of donors in hydropower, is to develop a revolving fund which would receive the value of the asset at the time it is transferred to the operating agency, presumably EGAT, and make those funds available for further investments.

The report on "Master Plan of Mini Hydropower Development in Thailand" has recently been done. The report will be useful for the future development of small scale, run-of-the-river or existing irrigation dam type, hydropower. Watershed management is also of vital concern to the development of micro and mini hydro units since almost all the micro and mini hydro installations are utilizing the run-of-the-river method. Year round flow is the critical factor to the successful and sustainable development micro/mini hydro power.

Beneficiaries: Direct and Indirect

At the end of the project, several thousands families have directly benefited from the supply of electric power, particularly those in newly developed rural areas.

The systems of the completed subprojects have replaced some existing diesel generation plants in rural areas, provided additional power to the national grid which will help offset the projected EGAT shortage in the spring of 1990 and reduced oil consumption at large thermal power plants.

As a result of this project, the NEA has decided to maintain the POU to replicate the process used to develop the completed subprojects. Today, micro/mini hydro systems development has become the NEA's second largest activity in terms of its budget and staff.

The indirect benefits will be in the form of employment generation, reduction of migration rates, and improved security in the subproject areas.

In sum, the project goal and purpose have been achieved, i.e., by successfully completing four mini hydroelectric systems the NEA has developed the analytical capacity and methodology to select sites, analize, supervise construction of micro/mini hydroelectric generating systems. NEA received on-the-job training in engineering, contracting, environmental and socio-economic impact analysis. The incomplete subproject provided valuable lessons for future planning.

Therefore, we conclude that this project has been successfully completed. No further monitoring or evaluation requirements have been identified. AID can be proud of the role it played in developing this project and the capacity it has created for the RTG to carry on with similar projects based on the experience and knowledge gained from this Project.

'Summary Financial Statement

a. Life-of-Project Funding

USAID Grant	$ 0.10	million
USAID Loan	8.00	
RTG Budget	5.75	
Total	$ 13.85	million

b. USAID Contribution

Project Title/ Element Description		Total Obligations	Total Expenditures	Deobligation
GRANT:				
Evaluation		$100,000	$67,931	$32,069
LOAN:				
1. Personnel	1/	935,509	906,503	29,006
2. Construction	2/	2,178,615	1,862,414	316,201
3. Power Plants	3/	4,774,476	4,139,756	634,720
4. Contingency		111,400	0	111,400
Totals		$8,000,000	$6,908,673	$1,091,327

1/ technical assistance, engineering design, and supervision.

2/ civil works (weirs, sand sluices, headraces, flow control structures, penstock, and powerhouse) and transmission lines.

3/ electro-mechanical equipment, installation, and tests.

c. Host Country Contribution

The resources provided by the RTG for the M/M Hydro project included costs borne on an "in cash" basis and are estimated to have been around $5.75 million and will total at least $8.0 million.

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
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ACTION MEMORANDUM FOR THE MISSION DIRECTOR

DATE: January 11, 1990

THRU: O/PDS: Mr. B. Donald Reese, Director
O/DIR: Mr. Steven P. Mintz, Deputy Mission Director

FROM: PDS/ENG: Mintara Silawatshananai, Chief Engineer

SUBJECT: Micro/Mini Hydroelectric Project Completion Report

Background:

The Micro/Mini hydroelectric Project (A.I.D. Project No. 493-0324) was completed on September 1, 1989. A.I.D. Handbook 3, requires the preparation of a "Project Assistance Completion Report".

Discussion:

The attached Project Assistance Completion Report follows the guidance for preparing such reports as contained in Handbook 3, Chapter 14, Appendix 14 A. It includes, among other things, a brief review of project accomplishments, a statement of lessons learned in implementing the project, and a summary of donor contributions.

Recommendation:

That you signify your acceptance of this completion report by signing below:

Accepted: John R. Eriksson

Rejected: _____

Date: 1-28-90

PDS/ENG:Mintara:sc:1/11/90:#6726I

Clearance:PDS:BDReese:dft:12/6/89
PDS/PSD:THammann:dft:12/12/89
PRO:PThormann:dft:12/26/89
FIN:DFranklin::dft:1/10/90

DIST:O/PDS
PDS/PSD ✓
O/PRO
O/FIN

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