



Action(s) Required	Name of Officer responsible for Action	Date Action to be Completed
<p>financial performance incentive by limiting the total funds made available, these benefits do not outweigh its negative features. This system requires the RTG to provide funding during the construction period from funds which would otherwise be allocated to other economic development activities.</p>		
<p><u>Action:</u> At this juncture, impractical to change system. No action required.</p>		
<p>3. The current effort to resolve the bid evaluation procedure for electrical and mechanical equipment should set as its primary objective choosing the bid which represents the least economic cost to Thailand. The current efforts to not count taxes and duties paid to the government is a necessary step to meet this goal. It also takes into account the competitiveness of local and foreign suppliers.</p>		
<p><u>Action:</u> Resolved in favor of not counting taxes and duties in bids.</p>		Completed.
<p>4. Future efforts by AID to form a POU should benefit from the experience in this project and should utilize existing organizational structures to the maximum extent possible so as to insure a sustainable activity within the institution.</p>		
<p><u>Action:</u> Acknowledged.</p>		
<p>5. In addition, NEA should focus its efforts more on project management and less on design and construction supervision. This would resolve what the evaluation team perceives as a shortage of experienced technical staff to undertake the range of projects which NEA should consider. In this regard, the collaborations between NEA and both the public and private sector participants in the mini-hydro project and the renewable energy project represent good models to be followed.</p>		
<p><u>Action:</u> USAID will continue to discuss this issue with the top management of NEA in order to encourage NEA to move toward emphasis on project management in lieu of design and construction engineering.</p>	USAID and NEA	On-going through project life

Action(s) Required	Name of Officer responsible for Action	Date Action to be Completed
<p>6. Priority should be given to producing an agreement between NEA and EGAT on the terms under which the latter will assume responsibility for the mini-hydro facilities once they are operational. This agreement should set the basis for NEA's further work in the development of grid-connected mini-hydro and should contain the basis for establishing a revolving fund or other financial mechanism to fund an on-going program of mini-hydro construction.</p>	NEA and PEA	On-going through project life
<p><u>Action:</u> It has been determined the EGAT does not plan to participate and that the agency willing to assume responsibility will be the PEA.</p>		
<p>7. The size of the market does not justify the development of a domestic capability for fabrication of complete mini-hydro scale turbines. The current emphasis on a mix of domestic and imported components should be encouraged.</p>		
<p><u>Action:</u> No action necessary as market is responding in a manner consistent with recommendation.</p>		
<p>In addition to the above recommendations, the evaluation team suggested a few more activities during the final phase of the project which should receive special attention. These include:</p>		
<p>1. Geotechnical and brief environmental surveys beyond simple checklists, should be made of the first six micro-hydro sites to determine any potential problems which might arise from the operation of these sites. Also environmental surveys should be made of the last two sites under consideration and their findings should be incorporated into the design process. Thai consultants can be used for both these efforts.</p>	NEA	On-going through project life
<p><u>Action:</u> The NEA has conducted both geotechnical and environmental surveys of all eight subprojects under consideration and has made allowances and changes to the designs for those not yet built. NEA has introduced anti-erosion measures and</p>		

Action(s) Required	Name of Officer responsible for Action	Date Action to be Completed
<p>made structural and geotechnical changes (especially to the foundations of the powerhouses) in those subprojects under construction at the present time. Please see Mission comments on page 10 of this evaluation summary (Block L).</p>		
<p>2. Foreign technical assistance should be provided to perform an engineering review of plant design and operation after two mini-hydro sites have been operational for a few months. Potential problems which would warrant such a review are problems with deteriorating concrete, penstock joint integrity, erosion along the headrace and access roads, equipment vibration, water hammer and cavitation.</p>		
<p><u>Action:</u> The NEA is presently performing engineering reviews of the subprojects in the areas pointed out by the evaluators. At this writing, only one subproject is in operation, but the NEA plans to conduct continual reviews of all the subprojects for at least one year after their completion. The NEA is capable of undertaking the reviews, has the desire and the budgetary resources to accomplish them as well. No foreign technical assistance is required.</p>	NEA	On-going through project life
<p>3. The design of an appropriate site selection model should be completed. This model would include separate components for micro-hydro, isolated mini-hydro, grid-connected mini-hydro and grid extension. The latter should incorporate the methodology being used by the consultants in the development of the National Mini-hydro Plan. The first two would require revisions in the economic and financial evaluation techniques proposed in the Project Paper.</p>		
<p><u>Action:</u> The NEA prefers to undertake the revisions with its own resources. They have the capacity, the desire, and are performing almost weekly changes to the model in conjunction with TEAM Consulting Engineer, Ltd., NEA's ongoing Thai consulting engineering firm for hydroelectric projects and programs.</p>	NEA	On-going through project life

## H. EVALUATION ABSTRACT (do not exceed the space provided)

A Micro/Mini Hydroelectric Project (USAID/Thailand Project No. 493-0324) was evaluated over a five week period during May-June 1987 by the Hagler, Bailly & Company, Inc.

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 is to provide the Royal Thai Government (RTG) with the capability to identify economically attractive sites for micro and mini run-of-the-river hydroelectric power development. This was to be done through the design and construction of up to twelve plants which would provide electricity to local villages or to the national grid. The project, being implemented by the National Energy Administration (NEA) began in 1982 and fell behind schedule due to a variety of delays experienced in its first two years. However, six sites are currently well along in construction and scheduled for completion over the next year and a half. Additional sites are under design. It is anticipated that as many as three sites will be operational by the early part of 1989.

This evaluation was a broad review to determine if and how the project should be extended beyond the completion date of September 1987, to allow for construction of approximately eight mini-hydro sites. The evaluation team, consisting of two foreign consultants (an engineer and an economist) and one Thai social scientist, spent two weeks visiting the six sites under construction, reviewing the quality of design and construction, and interviewing the residents in the proposed service area. An additional two weeks were spent interviewing NEA and private sector personnel directly involved in the project, government officials working in the energy sector and local manufacturers of small-scale hydroelectric equipment. An extensive review was also made of the site selection model developed for the project and of the financial and economic constraints which existed at the time of the project's conception, as well as today.

The project's objectives include (1) providing a broad institutional setting for the development of mini hydropower, (2) developing a site selection model based on economic, financial and social variables, (3) developing capabilities for the engineering design of hydropower, (4) providing the Thai fabrication and manufacturing sector the opportunity to provide electromechanical equipment for minihydro plants, and (5) constructing six mini-hydro facilities in the rural areas of Thailand, with planning underway for additional sites.

ABSTRACT

## I. EVALUATION COSTS

1. Evaluation Team		Contract Number OR TDY Person Days	Contract Cost OR TDY Cost (US\$)	Source of Funds
Name	Affiliation			
Hagler, Bailly & Co., Inc.		IQC-PDC-5730-I-00-7022-00	\$63,808	Project Fund
Dr. Sangkom Suwannarat		493-0324-S-00-7022-00	\$4,263	Project Fund

2. Mission/Office Professional  
Staff Person-Days (estimate) 25

3. Borrower/Grantee Professional  
Staff Person-Days (estimate) 75

COSTS

# A.I.D. EVALUATION SUMMARY PART II

J. SUMMARY OF EVALUATION FINDINGS, CONCLUSIONS AND RECOMMENDATIONS (Try not to exceed the 3 pages provided)  
Address the following items:

- Purpose of activity(ies) evaluated
- Purpose of evaluation and Methodology used
- Findings and conclusions (relate to questions)
- Principal recommendations
- Lessons learned

Mission or Office: USAID/Thailand

Date this summary prepared: July 22, 1988

Title and Date of Full Evaluation Report: Micro/Mini Hydroelectric Project Evaluation, January 1988

## 1. Purpose of Activity(ies) Evaluated

The project activities aim to assist the RTG to improve the institutional capacity of the implementing agency, the National Energy Administration (NEA), to develop an analytical capability and methodology to improve their small hydroelectric generation and site selection planning, analysis, construction methods and procedures.

## 2. Purpose of Evaluation and Methodology Used

The evaluation was a broad review to determine if and how the project should be extended beyond the completion date of September 1987, to allow for construction of about eight mini-hydro sites. Specific proposed evaluation tasks were to describe the status of the progress made to date indicating reasons for delay in implementation. Indicate the changes made in response to delays and project schedule for completion of the project. Lastly, to provide recommendations to assure completion of the project and attainment of objectives. The evaluation team, consisting of two foreign consultants (an engineer and an economist) and one Thai social scientist, spent two weeks visiting the six sites under construction, reviewing the quality of design and construction, and interviewing the residents in the proposed service area. The Team spent another two weeks interviewing NEA and private sector personnel, government officials, and local manufacturers of small-scale hydroelectric equipment.

## 3. Findings and Conclusions

The six sites visited showed an evolution in the quality of design, construction techniques and management indicating that the NEA and Thai consultants have continued to refine their capabilities as the project evolved. The replicability of this effort is clearly established and demonstrated by parallel efforts to develop mini-hydro facilities with funding from other donors. This project and the Renewable Non-Conventional Energy Project which preceded it, have demonstrated the ability of the NEA working together with the Thai private sector to develop energy systems with sustainable benefits for the country. Specific findings are:

- (1) The revised economic and financial analysis indicate that the viability of the minihydro projects is questionable given current fuel prices. However, taking into account the marginal costs to complete the projects versus the marginal benefits, it is clear that the six sites currently under construction should be completed. The remaining two sites which are being designed should be reviewed for economic and financial viability. While it is likely that both the financial and economic internal rate of return from these projects will be below the hurdle rate of 12 percent, this does not mean that they would not be financially justified given the terms of the loan for USAID financing.

SUMMARY

- (2) The foreign technical assistance provided under this project was in general appropriate but not crucial to meet the requirements of the project or the NEA. This is partly due to the scope of work which was defined in the Project Paper. Monitoring was encumbered by having to deal with administrative matters instead of technical substance. Also, the difficulties of the USAID Mission in Thailand in providing good technical assistance is in part due to the high quality of technical input required as well as the difficulties of replacing experts who do not perform well.
- (3) The site selection model as presented in the project paper and as executed by the TAG is insufficient because it does not distinguish between mini and micro hydro and between isolated and grid connected systems. The grid connected mini-hydro model should compare this type of facility with other grid connected methods of power generation. The isolated micro-hydro model should examine the hydropower operation with other local generation systems including diesel generators. The isolated mini-hydro model should take into account the limitation on output equal to the dependable capacity and should compare this system with other multiple-village generation and distribution systems and with the extension of the grid. Since the project placed special emphasis on this development and implementation of this model, it seems appropriate that some effort be made to finalize the model.
- (4) The NEA is currently limited in its approach to the development of isolated power systems. A more general strategy is needed in which the NEA can respond to the needs of isolated enclaves with several alternative isolated power systems depending on which is more financially viable.
- (5) NEA's institutional role has shifted from being primarily an engineering organization to being a project management organization. The different managerial skills implied by that transition need to be addressed through development of the managerial capabilities of and the supporting staff for the project managers.
- (6) The sustainability of the mini-hydro program in NEA faces a serious problem. While there is no question that NEA has the technical capability to manage these projects and to deliver working systems, there is a serious financial question as to the source of funds for continuing this program. At present most of the funding for this project comes from off-budget funds and in particular from foreign aid and central government funds. The cash flow analysis in Appendix I indicates that the sites will produce sufficient revenues to meet the debt service and provide a small surplus. However, a similar analysis assuming no USAID loans but rather commercial loans indicates that the projects would not generate a surplus until 15 years into the project. 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.
- (7) The RTG is currently in the process of revising its procedures for energy planning. This revision is most obvious in the transfer of responsibility for preparing the energy component of the five year plan from the NESDB to the Office of National Energy Policy. However, the government needs to develop a more rational approach to the selection among alternatives for electricity generation which takes into account the uncertainties related to the relative

costs of fuel and labor over time and the real costs of exploiting domestic energy resources.

- (8) Little environmental analysis was carried out at the six sites. There is some negative environmental impact which can be noticed during the construction phase. Permission from the Royal Forest Department to proceed with construction has also been slow in coming, in part due to an initial lack of concern for environmental issues. More recently however, both USAID and the NEA have given new attention to this issue and it is expected that some sort of environmental analysis will be done at the remaining two sites.

4. The general recommendations of this report are:

- (1) USAID should continue its involvement in this project through the completion of at least the first six mini-hydro sites, since the benefits far outweigh the marginal cost necessary for completion. The two remaining sites currently being planned should be reviewed by the Thai government. While it is unlikely that their financial or economic rates of return are acceptable, they are marginally financially viable given the conditions of the USAID loans and they may meet social and political objectives which are important to the Thai government.
- (2) The present system used by USAID to fund this project, the FAR system, should be reviewed. While it offers incentives to rapid project implementation by limiting the monitoring requirements of USAID and provides some form of financial performance incentive by limiting the total funds made available, these benefits do not outweigh its negative features. This system requires the RTG to provide funding during the construction period from funds which would otherwise be allocated to other economic development activities.
- (3) The current effort to resolve the bid evaluation procedure for electrical and mechanical equipment should set as its primary objective choosing the bid which represents the least economic cost to Thailand. The current efforts to not count taxes and duties paid to the government is a necessary step to meet this goal. It also takes into account the competitiveness of local and foreign suppliers.
- (4) Future efforts by AID to form a POU should benefit from the experience in this project and should utilize existing organizational structures to the maximum extent possible so as to insure a sustainable activity within the institution.
- (5) In addition, NEA should focus its efforts more on project management and less on design and construction supervision. This would resolve what the evaluation team perceives as a shortage of experienced technical staff to undertake the range of projects which NEA should consider. In this regard, the collaborations between NEA and both the public and private sector participants in the mini-hydro project and the renewable energy project represent good models to be followed.
- (6) Priority should be given to producing an agreement between NEA and EGAT on the terms under which the latter will assume responsibility for the mini-hydro facilities once they are operational. This agreement should set the basis for NEA's further work in the development of grid-connected

mini-hydro and should contain the basis for establishing a revolving fund or other financial mechanism to fund an on-going program of mini-hydro construction.

- (7) The size of the market does not justify the development of a domestic capability for fabrication of complete mini-hydro scale turbines. The current emphasis on a mix of domestic and imported components should be encouraged.

#### 5. Lessons Learned

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. An individual familiar with these regulations and procedures should be retained to identify potential conflicts and to estimate the length of the delays which will result.
- (2) 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. This issue continues to plague the development community.
- (3) 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 capabilities of existing micro-computer software have greatly reduced the labor required for such analysis.
- (4) Project design should include a more careful assessment of institutional capability so that the specification of technical assistance will complement existing institutional capabilities and be coordinated with the activities of other donors.
- (5) 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.
- (6) In the 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.

K. ATTACHMENTS (List attachments submitted with this Evaluation Summary; always attach copy of full evaluation report, even if one was submitted earlier)

Evaluation report titled: Micro/Mini Hydroelectric Project Evaluation, January 1988.

ATTACHMENTS

L. COMMENTS BY MISSION, AID/W OFFICE AND BORROWER/GRANTEE

Many improvements and accomplishments have already taken place within NEA and USAID/Thailand as a result of the evaluation. As indicated in our comments in Block E., some recommendations resulting from the evaluation have been implemented, while others need continuous discussion and others, by their nature, need no action. Overall, the Mission is satisfied with the results of the evaluation and recognizes its value in our dealings with the NEA and other players involved with this Project.

Contrary to one finding of the evaluation, Mission believes that the Technical Assistance furnished was crucial to the success of the Project. Although the NEA has an abundance of exceptionally well-qualified engineering and technical expertise to supervise the engineering design and construction, they did not have the requisite qualified personnel needed to develop the integrated, analytical site selection model which was the heart of the endeavor. The NEA's continued development and refinement of the model will also address (over time) insufficiencies in the model high-lighted by the evaluation.

One of the major helping hands given by the evaluators was the emphasis placed on environmental issues. The Mission personnel associated with the Project were able, with the help of the evaluation, to focus the NEA on the proper pre- and post-management of the natural resources at the individual sites, in terms of narrowing the excavation area to confine the clearing to only that absolutely necessary. Previously, the areas had been cleared without regard to forest destruction, with the idea being that those areas would eventually be restored (especially in a tropical environment). Erosion had been especially severe in earlier subprojects, and the attention devoted to the environmental issues later largely resolved these problems.

MISSION COMMENTS ON FULL REPORT