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PROJECT EVALUATION

ASEAN ENERGY CONSERVATION AND ENERGY MANAGEMENT PROJECT

Draft Report

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TABLE OF CONTENTS

Section	Page
SUMMARY	S-1
1.0 **BACKGROUND**	1-1
1.1 Project Overview	1-1
1.2 Trade and Investment Considerations	1-2
1.3 Evaluation Process	1-2
2.0 **PROJECT DESCRIPTION**	2-1
2.1 Building Energy Conservation Component	2-1
2.1.1 Overview	2-1
2.1.2 Training	2-5
2.1.3 ASEAN In-Country R&D	2-8
2.1.4 LBL Research and Support Activities	2-8
2.1.5 Standards Development	2-17
2.2 Training and Coal Utilization Component	2-21
2.2.1 Overview	2-21
2.2.2 Energy Management Training - Malaysia	2-21
2.2.3 Energy Planning Training - Asian Institute of Technology	2-22
2.2.4 Coal Utilization Management Training	2-22
3.0 **PROJECT MANAGEMENT OVERVIEW**	3-1
3.1 Technical Management	3-1
3.2 Program Structure and Mechanics	3-3
4.0 **PROJECT EVALUATION - COMPONENT 1**	4-1
4.1 Achievement of Project Plan Objectives	4-1
4.2 Research Priorities and Impacts	4-2
4.3 Training	4-4
4.4 Standards Development	4-6
4.5 Trade and Investment Linkages	4-7
4.6 Private Sector Involvement	4-9
4.7 Enhancement of National/Regional Cooperation	4-11
4.8 Policy Development Focus	4-12

5.0 **PROJECT EVALUATION - COMPONENT 2** 5-1
5.1 Energy Management Training - Malaysia 5-1
5.1.1 Evaluation Inputs 5-1
5.1.2 Evaluation Results 5-1
5.2 Asian Institute of Technology Certificate Program 5-2
5.3 Coal Utilization Management Training 5-3
5.4 Trade and investment Linkages 5-4

APPENDIX A A-1

TABLE OF FIGURES

Figure		Page
2.1	Overall Project Schedule	2-2
2.2	Overview of Standards Development Process	2-18
3.1	Phase III Funding Flow	3-2

TABLE OF TABLES

Table		Page
2.1	Approximate Budget Allocations for Phase III Project by Task	2-4
2.2	Approximate Budget Allocations for Phase III Project by Regional Activity	2-6
2.3	Training	2-7
2.4	In-Country Research Programs	2-9
2.5	Approximate Allocation of Budget by Research and Policy Topic Area	2-14
2.6	LBL Research and Support Activities	2-15
2.7	Status of ASEAN Standards	2-20
4.1	Example List: Potential Areas of Increased Trade/Investment in Building Energy Technology Equipment and Services	4-8
4.2	Private Sector Involvement	4-10

SUMMARY

Background

The Phase III USAID ASEAN Energy Conservation Project is composed of two components, each of which is evaluated in this report:

- Component 1 - Building Energy Conservation. Under management of the Lawrence Berkeley Laboratories (LBL), training and technical assistance is being provided to Indonesia, Malaysia, the Philippines, Singapore, and Thailand in buildings conservation research oriented towards the development of policies to achieve increased energy conservation in buildings;
- Component 2 - Training and Coal Utilization. Assistance was provided for energy management training in Malaysia, energy planning training at the Asian Institute of Technology (AIT), and for coal utilization management training in the U.S.

The project's purpose was to "foster policies that encourage both public and private sector adoption of energy efficient building design and maintenance and to enhance institutional and human resource development in the field of energy technology management".

Component 1 - Building Energy Conservation

Project Output

Component 1 consisted of four major tasks: 1) training; 2) building energy conservation research; 3) assessment, analysis, and policy studies; and 4) information dissemination.

Eleven separate training activities were carried out relating to building energy analysis, building energy auditing methods, standards policy development, natural ventilation research, and utility production costing. Participants in the training courses were mostly from ASEAN governmental bodies and from universities. The direction of the training evolved in response to specific needs.

Twenty-four ASEAN in-country research projects were initiated in 1987. Roughly 50% of the effort was directly related to standards development, including data base development. About 25% of the effort was related to building solar gain and daylighting effects. The remainder was split between HVAC equipment and natural ventilation research. Most of the projects are on-going. LBL research was largely related directly to standards development, with a significant emphasis on daylighting technologies.

The major tangible output from the project is the development of draft model standards for each of the countries. The Singapore standard is a revision of an earlier document. In the other countries, standards were drafted from a model developed by LBL for Thailand. The standards are expected to be mandatory in Singapore and Philippines; they will probably be implemented as voluntary guidelines in Thailand, Malaysia and Indonesia in the near future.

Information dissemination was primarily in the form of the annual planning workshop meetings. Presentation of the research efforts and results is planned for an ASHRAE meeting in Kuala Lumpur in October, 1989.

Project Management

A complex management structure was adopted. Overall program management and technical support was provided by LBL. An 8a subcontractor in the U.S. (TEM) distributed funds for ASEAN in-country activities to an accounting firm (JST), located in Singapore, which acted as a regional coordinator. Funds were then disbursed by JST to the country coordinating agencies for final distribution to the research teams. The disbursement procedures and policies were established by ~~AID~~. LBL

Country participants indicated that LBL was highly responsive to their technical support needs and maintained a high level of commitment to the project, but that the overall management structure was very cumbersome and resulted in a large financial overhead and significant delays in fundings for in-country research. These delays (about 6 - 9 months) and a shortening of the project by 6 months due to incomplete project funding were felt to significantly reduce the effectiveness of the in-country activities. It is recommended that the technical/management aspects of future similar multi-country projects be simplified to ensure that they do not absorb an inordinate amount of management time and expenses and result in delays which compromise achieving the project objectives.

Evaluation of Component 1

The project accomplished most of its primary goals. Specifically, development of standards documents achieved the objective of promoting policies and enhanced capabilities for increased energy conservation. It is likely that the standards will be implemented as mandatory building codes in at least two countries. Other key policy issues, which were not significantly addressed, are: electric utility tariff structures and the impacts on capacity expansion, import duties as they affect the importation of important energy conserving technologies, and retrofit policies as a means of limiting energy use and demand in the large stock of existing buildings and as a means of enhancing trade/investment opportunities.

Inadequate! Not addressed!

Some degree of coordination between policy makers was achieved, although a greater degree of interchange would have been a desired program focus. Private sector awareness of design alternatives was somewhat enhanced via the participation in the standards development process. The project did not actively seek industry inputs into the selection and implementation of the R&D projects. The project was successful in providing state-of-the-art computer models to universities, government and the private sector. Transfer of the a microcomputer program (ASEAM2) was made to a number of university and governmental agencies.

About 50% of the research projects directly served the objective of developing standards. However, only one of the projects addressed utility policy issues. Limited research relating to HVAC system equipment was carried out. The studies done were focussed on the system design, as opposed to equipment component technologies, and on daylighting technologies.

The training provided was one of the most widely appreciated segments of the project. Content of the auditing courses was effectively tailored for the less experienced trainees. The selection of participants in the training programs was left to the individual countries. In several instances, a large rate of attrition of the trainees occurred due to transfers to other areas or to changes in employment. However, the training helped create a body of personnel in each country qualified to carry on the research necessary to develop and implement energy conservation policies. In the Philippines and Indonesia, in particular, a significant effort was made to enroll private sector participants in the training programs.

The standards implemented in the five countries are likely to similar to the practice already followed by most of the industry. Hence, they are likely to have only a limited impact on energy use in the near term. They will, however, eliminate bad practice. Their presence will also provide a basis for future standards development, or refinement, as additional incentives for energy conservation occur, particularly as governmental awareness grows of the potential role of energy conservation as a means to reduce capital expenditures and environmental problems in the power sector.

The U.S. industry is already well represented in most of the ASEAN countries in the buildings sector. The project has enhanced business opportunities in this sector by virtue of increasing an awareness of energy conservation and by identification of areas for improvement. The potential opportunities offered by retrofit programs were not significantly addressed by the program, although Singapore now has legislation in place requiring upgrades to existing buildings and systems to meet energy standards.

Private sector involvement in the project was largely limited to reviewing the draft standards, and to some participation in the training programs. Added efforts to seek industry involvement would have been useful in defining research areas of more direct interest to the private sector, and could have enhanced identification of possible trade/investment opportunities.

The program enhanced regional cooperation through the common process of developing model standards and through the annual planning workshops. There appeared to be relatively little intra-country interchange between researchers working in similar areas. Possibilities for enhanced cooperation in future programs include peer review of technical reports and creation of technical workshops.

Component 2 - Training and Coal Utilization

Project Output

Three training activities were carried out: a four week intensive course in energy planning held in Malaysia, support for over 30 students in a three month certificate program in energy planning and management at the Asian Institute of Technology, and an eight week training course in lignite/low grade coal utilization at Houston Power and Light.

Thirty four ASEAN mid to senior level planners took park in the training course in Malaysia. The participants worked on group projects in areas relating to utility planning, including conservation and cogeneration, and developed a policy paper. Participants in the AIT energy planning training took regular AIT courses (with other graduate students) with an emphasis on energy planning and

3

renewable energy resources. The coal utilization training program provided eight weeks of classroom instruction by Houston Power & Light and Combustion Engineering Company, followed by eight weeks of field training in two lignite coal fired power plants. The course was directed towards "middle to upper level managers, supervisors, and engineers who are now working with, or planning the development of lignite or sub-bituminous coals for power generation".

Evaluation of Component 2

The energy planning training course held in Malaysia was successful in meeting its objective of training in advanced energy/utility planning methods. A high level of participation was required. Some of the course material was perceived as having only limited relevance to ASEAN countries; however, the course set the stage for policy discussions now underway in several of the countries.

The AIT certificate program was successful in training ASEAN professionals in the areas of energy planning and management. Since the courses were taken with AIT graduate students, the requirements of the participants were high. In several countries, the participants were members of only one organization, rather than spread out over the broad range of organizations having energy planning and policy requirements. Some of the ASEAN coordinators did not feel they had sufficient authority to significantly influence the selection process. Further programs should provide a mechanism to ensure proper allocation of participants over all the important concerned organizations within each country.

The coal utilization training program contributed to an increased knowledge of the utilization of low grade coals. However, the match of program participants and the course material seemed inappropriate. The program announcement, and selection process, focussed on middle to senior level supervisors, managers, and planners. In some instances, the participants had backgrounds in fields far afield from the course content, and had little interest in the actual subject matter. The "hands-on" training in the power plants was considered to be an inappropriate use of senior level professionals, and to be only marginally effective in contributing to the capabilities of the participants. A greater degree of control in the selection of participants and greater clarity in the definition of required backgrounds should be a part of future programs of this type.

1.0 BACKGROUND

1.1 Project Overview

The USAID ASEAN Energy Conservation Project (Phase III), which was the subject of this evaluation process, had two primary components:

- Component 1: Building Energy Conservation
- Component 2: Training and Energy Management

The overall objectives of the program were to "promote policies and enhanced technical capabilities for increased energy conservation in buildings, energy planning, and indigenous energy resource utilization". The primary focus of the program was on component 1 due to the large impact of building energy use on overall energy balances and utility capacity requirements. This component, managed by the Applied Science Division of the Lawrence Livermore Laboratories (LBL) consisted of manpower training (specific to building energy analyses), building systems R&D, and the development of building energy use standards. The expected outputs of this component were to include:

- Greater co-ordination among policy makers at both regional and national levels, along with a stronger policy commitment to energy conservation in buildings in all five participating countries.
- Improved building codes in at least two ASEAN countries.
- Increased private sector awareness of technology and design alternatives for energy conservation in buildings.
- Adoption of microcomputer programs for architects and engineers to use in designing and evaluating energy efficiency in buildings.

The program was to consider both the reduction of thermal loads on buildings (almost exclusively cooling loads in ASEAN) by appropriate building design and the reduction of energy consumption by incorporation of a range of advanced technologies for serving these building functions (high efficiency air conditioning, advanced lighting , energy management systems, etc.)

The Component 2 activity included a four week course in energy planning in Malaysia, sponsoring of students in a three month certificate program in energy management at the Asia Institute of Technology (AIT), and an eight week training program in lignite/low grade coal utilization at Houston Power and Light. Most of the activities in this component were coordinated by the International Institute of Education (IIE).

1.2 Trade and Investment Considerations

There is increased interest in the issue of U.S.-ASEAN trade and technology development issues as exemplified by the recently announced Private Investment and Trade Opportunities project (PITO). As a result, the evaluation included examination of the potential of activities undertaken in the energy conservation project to contribute to the broader trade and investment issues incorporated in the U.S.-ASEAN dialog. The primary issue considered was the linkage between building efficiency standards and the resultant demand for energy conservation technologies (particularly U.S. technologies). As indicated subsequently, the U.S. industry is already well represented in the ASEAN countries in building energy conservation equipment and U.S. technologies are likely to benefit as building energy conservation measures increase as the result of standards and other government policies.

1.3 Evaluation Process

The team selected for evaluating the project were Dr. William Peter Teagan and Dr. Richard Merriam, both of Arthur D. Little, Inc. Dr. Teagan has extensive experience in energy planning and technology transfer programs in developing countries while Dr. Merriam is highly experienced in the field of building thermal analyses which was a primary focus of the Component 1 program.

The evaluation took place over an eight week period starting on July 24, 1989. The process of information gathering included:

- A meeting with Robert Archer of USAID in Washington, D.C. to discuss the USAID Washington perspective on project history, objectives, and implementation.
- Attendance of the evaluation team at a three day project review meeting held in Bangkok, Thailand on July 24 to 26. This afforded the evaluation team opportunities to interface with the country team coordinators as well as with the principle investigators from LBL.
- Visits to each of the ASEAN countries during the time period of July 27 to August 9, 1989. In each country interviews were held with all or most of the R&D project leaders, the country team coordinators, government personnel, and, in three cases, private sector firms in the building equipment and building management field. Meetings were also held with utility personnel in two countries.
- Interviews in Thailand with key individuals in COST and AIT familiar with the goals and implementation of the Training and AIT course component of the program.

Follow up interviews in the U.S. with:

- LBL on key implementation issues identified during the course of the in country interviews.
- Prof. Mark Bernstein of the University of Pennsylvania on the Malaysia Energy Planning and Management training program.
- Mr. Steven Eben of IIE who coordinated the coal training program

- Prof. Wes Foell who was the resident staff on the AIT energy management program.

A list of the contacts during the course of the evaluation is given in Appendix A.

In addition to the above, the evaluation team read over 50 documents describing the progress in the program, project plans and objectives, and outputs of the R&D and policy studies.

The evaluation team prepared a rough draft report during the field trip which was provided to the USAID mission for initial review upon their departure on August 11th. The final draft, submitted in September, 1989, reflected USAID comments as well as inputs from the follow up interviews in the U.S.

1

2.0 PROJECT DESCRIPTION

A summary of the goals and activities for both components of the project is given in this section to provide a background for the subsequent analysis and evaluation.

2.1 Building Energy Conservation Component

WAS AN EXPANSION OF THE SINGAPORE BUILDING ENERGY CONSERVATION ACTIVITY IN THE EARLIER ASEAN ENERGY COOPERATION IN DEVELOPMENT PROJECT (ASEAN ENERGY II) THAT PRECEEDED THIS PROJECT.

2.1.1 Overview

The ~~Energy Conservation in Buildings project has been conducted in two phases, beginning in~~ BUILDING ENERGY CONSERVATION COMPONENT 1982:[1]

- Phase II - Perform technology transfer relating to building energy analysis methods and perform preliminary determinations of energy conservation potential for commercial buildings in Singapore;
- Phase III - Expand efforts to 5 ASEAN countries with an overall aim of promoting development and implementation of energy conservation policies;

An overall schedule for both phases of the project is given in Figure 2.1.

~~The first segment of the project (ASEAN Energy II) was~~ PRECEEDESSOR SINGAPORE ACTIVITIES INCLUDED a one year study, with a focus on the potential for cost-effective energy conservation. Training in the use of the DOE-2 computer program was accomplished. The program was then used to do the energy conservation studies on a government building. Specific areas of research included lighting systems, window design, daylighting concepts, air conditioning systems and equipment, ventilation, and equipment maintenance. Deficiencies in the then current OTTV equation[2] for capturing the major factors relating to energy use were identified. Various alternative approaches to implementing policies to achieve cost-effective conservation were also briefly examined.

Four specific measures to reducing energy consumption in commercial buildings were identified from the ~~Phase II~~ Singapore study: 1) reduce lighting levels by about 25% from present levels; 2) incorporate daylighting design into new buildings to replace artificial lighting (this was considered the most important strategy resulting from the Phase II work); 3) implement an effective maintenance program for building equipment; and 4) develop in-country OTTV equations taking into consideration local weather parameters and incorporating daylighting to encourage the adoption of daylighting designs as standard practice. These results provided a basis for defining the research activities for the ~~Phase III~~ ASEAN Energy Conservation and Management Project (ASEAN ENERGY III) project which is the subject of this evaluation.

1 The two portions of the project were designated "ASEAN Energy II", and "ASEAN Energy III". Consistent with this designation, they are referred to as Phase II and Phase III throughout this report.

2 The Overall Thermal Transfer Value (OTTV) is an equation which attempts to capture in a simple manner the contribution to the cooling load of the building walls or roof in terms of the building construction and climate parameters. Its use is in demonstrating compliance with the building code.

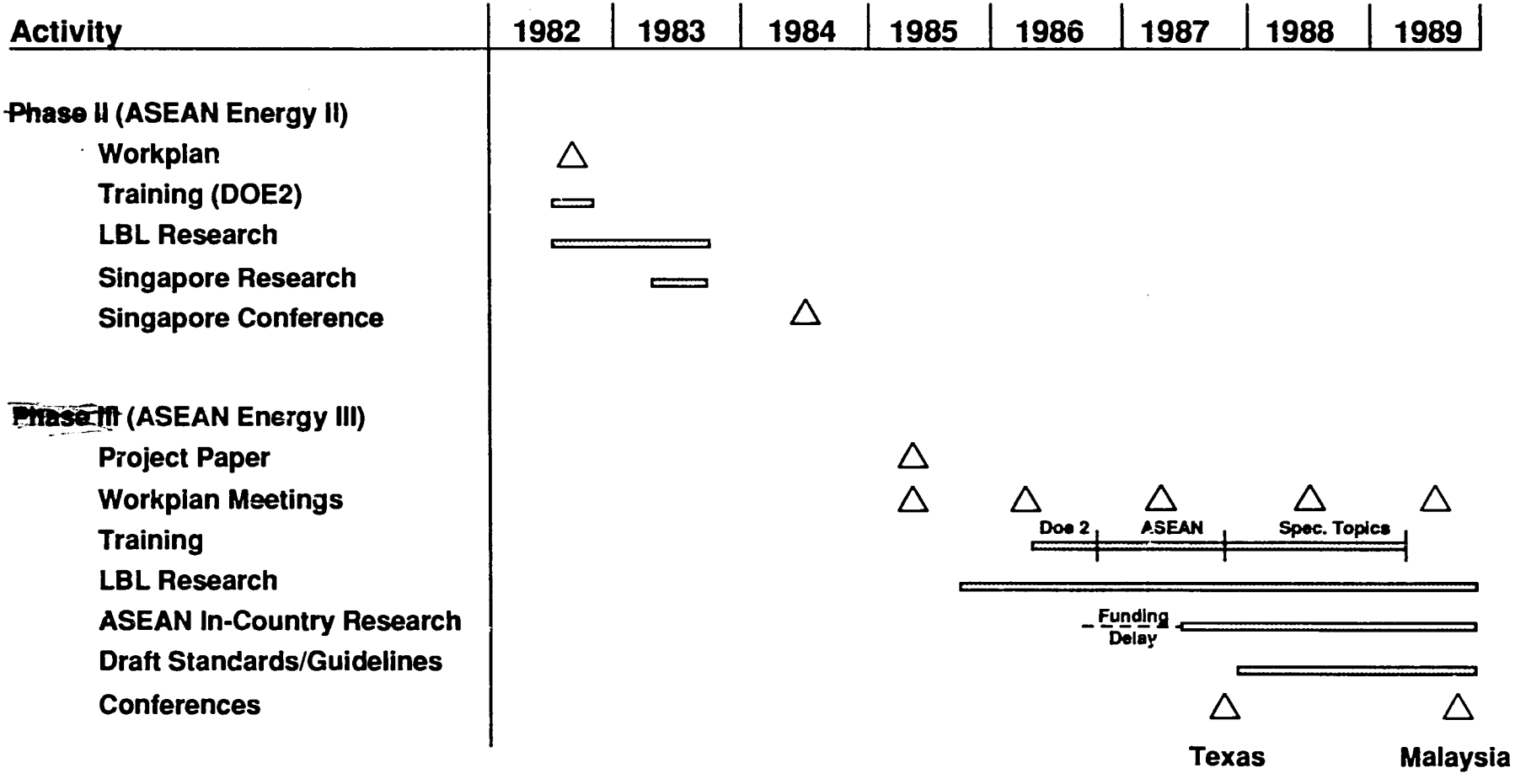

Figure 2.1 Overall Project Schedule

The predecessor Singapore building energy conservation activity

~~Phase II~~ was completed with a conference held in Singapore in May, 1984, to present the results of the research. Additional topics at the conference included papers on energy conservation activities by ASEAN countries, and technical papers by LBL staff on related commercial building energy conservation topics.

~~Phase III of The project~~ Energy Conservation and Management Project (ASEAN Energy III) was initiated with the development of a preliminary workplan in March, 1985, and a project paper in April 1985. It was expanded to include all five of the countries within ASEAN, other than Brunei (not interested in participation), with an overall goal of creating policy to improve energy efficiency of commercial buildings. Four primary tasks were defined:

- Task 1 - Training. The objectives of this activity were to train ASEAN participants to provide the background needed to carry out the research activities, and to provide technology transfer to the ASEAN countries;
- Task 2 - Building Energy Conservation Research. The objective of this task was to provide the research needed to develop policies relating to energy conservation. Four general areas of research were identified: 1) lighting and daylighting, 2) natural and forced convection, 3) air conditioning equipment, and 4) other research as necessary to directly support policy development or to support ASEAN in-country research;
- Task 3 - Assessment, Analysis, and Policy Studies. The objective of this task was to devise and test policies and implementation packages to reduce building energy use. An output of this task was expected to be individual building construction standards or guidelines tailored for each ASEAN country. Subsidiary objectives were to establish the energy use in existing buildings in each of the countries, and to assess the economic potential of the major energy conservation measures for buildings. The policy assessment was intended to yield estimates of impacts of the proposed policies on the national economy, building sector, and other parties in each country;
- Task 4 - Information Dissemination. The objective of this task was to provide a means to share the information developed during the project between the project participants, and with other parties. Five means of accomplishing this were outlined: 1) ASEAN seminars (to be held at the end of each year), 2) local workshops and seminars, 3) publication of the work results, 4) development of a computer data base, and 5) annual workplan meetings. Included in this activity was a planned conference at the end of the project.

Table 2.1 provides a breakdown of the relative levels of effort in each of the four tasks ~~in the~~ of the Building Energy Conservation component third ~~phase of the project~~ according to the costs incurred. An additional task (Management) has been added to the four identified above. Activities carried out here included overall project coordination with the ASEAN and technical review, subcontract and overhead functions associated with sub-contract and in-country research activities, travel and overseas coordination of the project.

Table 2.1

Approximate Budget Allocations ($000) for ~~Phase III~~ Project by Task

Project Management		
Management and Review	301	
Subcontract Management and Overhead	145	
Travel by US Team	209	
Overseas Coordination	097	
		752
Task 1: Training		423
Task 2: Research		
Lighting and Daylighting	370	
Natural Ventilation	222	
A/C Equipment	251	
		843
Task 3: Assessment, Analysis, and Policy		
Data	167	
Analysis	155	
Policy	286	
		608
Task 4: Information Dissemination		174
		2800

11

The data listed are based on actual reported expenditures up through July, 1989 and the estimated budget allocation through the end of the project. Roughly equal amounts were expended on project management, Task 2 research, and on Task 3 policy related areas.

Table 2.2 provides a further breakdown of the efforts by five major categories: management and overhead, ASEAN in-country activities relating to the four task areas, US support activities in these areas, equipment provided to ASEAN, and ASEAN travel.

2.1.2 Training

The predecessor project provided

One of the major goals of the ~~Phase II and Phase III projects~~ this project and its predecessor was the transfer, through training courses, of building energy analysis capabilities, and the skills required to carry out building energy audits. ~~Phase II~~ training in the use of the DOE-2 computer program was provided at Singapore in 1982. Table 2.3 summarizes the training activities carried out in ~~Phase III~~ the project. Eleven separate training courses are identified.

Two courses were provided in the use of the DOE-2 computer program to ASEAN personnel, first, in a preliminary training course lasting two weeks at Singapore (30 attendees) and, second, at a 5-week "ASEAN Summer Study" session at LBL (14 attendees). The courses at LBL included a lecture series covering a number of energy conservation topics, as well as policy formulation meetings. The purpose of the policy meetings was to provide a model for the development of in-country standards. All DOE-2 training was designed to support the standards development activities. Attendees were government personnel (country coordinators) and selected university research personnel. It is important to note that the 2 week ~~course~~ preliminary training course in Singapore was taught by Singaporeans who worked on the predecessor project. Seven training courses were provided in the techniques of energy auditing. The specific goals of the audit training were: 1) to transfer the skills and tools required to perform audits; 2) identify cost-effective opportunities for energy conservation retrofits; 3) identify opportunities for improved operation and maintenance in the audited buildings; and 4) support policy development.

Most of the auditing courses (5) were two weeks in duration, ~~and included training~~ were trained under in the use of the ASEAM2 microcomputer program. The course generally included an on-site inspection of a building with identification of energy conservation opportunities. An advanced workshop, of one week duration, was held at LBL for key ASEAN researchers, with presentations by LBL staff on specific topics of interest relating to the ASEAN research and policy development activities. The advanced energy audit training course focussed on the advanced features of the ASEAM2 program, and provided an opportunity to improve on field data collection and analysis skills. The affiliations of personnel attending the auditing training courses were roughly: 54% government, 22% university, 5% utility, and 19% private (largely from Indonesia).

The final two training courses were tailored to meet the specific research needs in the areas of natural ventilation (Indonesia, Philippines and Thailand) and utility production costing analysis (Malaysia). Both courses were provided in response to particular requirements that arose during the course of the ~~Phase III~~ work.

Table 2.2

Approximate Budget Allocations ($000) for ~~Phase III~~ Project by Regional Activity

Project Management		
Management and Review	301	
Subcontract Management and Overhead	145	
Travel by US Team	209	
Overseas Coordination	097	
		752
ASEAN Activities		
Research	235	
Training	30	
Policy Development	203	
Information Dissemination	000	
		468
US Activities		
Research	481	
Training	232	
Policy Development	375	
Information Dissemination	174	
		1262
Equipment Transfer to ASEAN		127
ASEAN Travel		191
		2800

Table 2.3

Training

Course	Year	Duration	Location	Present	Comments
Building Energy Analysis Using DOE-2	1986	2 weeks	Singapore	30	Preliminary Training on DOE-2
ASEAN Summer Study (DOE-2)	1986	5 weeks	LBL	14	Lecture series on related subjects was offered
Auditing (using ASEAM2)	1986	1 week	Jakarta	31	Building walk-throughs demonstrated.
Auditing	1987	2 weeks	Jakarta	30	
Auditing	1987	2 weeks	Bangkok	23	
Auditing	1987	2 weeks	Kuala Lumpur	35	
Auditing	1987	2 weeks	Jakarta	25	
Workshop for Key ASEAN Researchers	1987	1 week	LBL	8	Standards policy, and auditing
Advanced Energy Auditing	1987	2 weeks	Singapore	15	Field data collection Advanced ASEAM features
Natural Ventilation	1987	1 week	LBL	4	Training in the ESP-AIR program for Indonesia, Thailand and the Philippines
Utility Production Costing	1988	1 week	LBL	1	Training in the UPLAN program for Malaysia

14

2.1.3 ASEAN In-Country Research

Twenty four in-country research projects were carried out, beginning in early to mid 1987. Selection of most of the projects was made at the January, 1986 planning workshop based on project proposals from each country and a review of the project goals by an ad-hoc committee of the country and LBL participants.

A summary of each project is given in Table 2.4, listed by country. All but two of the projects are on-going.

Most of the projects are directly related to standards development or to activities in support of standards development ("Energy Use Analysis" and "Data"). One project (Malaysia) focused on utility impacts of load shifting using thermal storage. Three projects studied the efficiency of air conditioning equipment (one project was discontinued).

Natural ventilation studies were initiated in Thailand, the Philippines and in Indonesia. Although not directly related to the standards development work these projects were selected by the countries as being important to their situations due to the current and projected stock of small commercial buildings and schools that normally use ventilation for comfort control. One of the projects (Indonesia) was subsequently discontinued due to personnel issues.

Table 2.5 presents a summary of the research budgets for each of the participating countries, listed by project study area. Other than the natural ventilation work, each of the listed project areas were related to the development of energy conservation standards and lighting/daylighting research. A relatively small fraction of the effort was focussed on equipment and building controls.

2.1.4 LBL Research and Support Activities

A listing of the research and support work carried out by LBL is summarized in Table 2.6. The organization of the table is according to the four primary tasks, and individual subtasks, defined in the Phase III project. Training (Task 1) comprised a major part of the support provided by LBL to the ASEANs. It was carried out early in the Phase III project to provide the background needed by the countries to structure and perform the standards development work. Individualized training was also offered in several areas. The training activities are essentially complete with the exception of one current training of a Filipino researcher at LBL in the DOE-2 program.

The listed Task 2 research work fell in three separate categories with identifiable budgets: a) lighting and daylighting, b) natural and forced ventilation, and c) air conditioning equipment. Daylighting design concepts were considered important potential contributors to energy conservation, and hence received considerable attention throughout the project. The work is on-going in the areas related to development of a simplified design tool and country specific OTTV equations.

Natural ventilation research included modification and delivery of the ESPAIR microcomputer program, wind tunnel testing of air flows around various geometry buildings, computer studies related to natural ventilation flows, and thermal comfort analyses. The natural ventilation research was requested by three of the countries.

Table 2.4

In-Country Research Programs

Project	Title	Description	Status	Util	Stnd	Equip	Energy	Data	Other
I1	Policy	Develop Standards	On-going						
I2	Survey Energy Use in Commercial Buildings	Energy audits of 4-5 buildings in Surabaya. Analysis using ASEAM2. Study DOE-2 program	On-going						Training
I3	Weather and Solar Radiation Data Information	Collect hourly weather data for Bandung and Jakarta. Analyze components of solar data and prepare DOE-2 weather file.	On-going						
I4	Building Control and Monitoring	Monitor buildings. Simulate using ASEAM2. Design retrofit controls and monitor retrofitted building.	On-going						
I5	Natural Ventilation	Develop information related to natural ventilation design principles	Discontinued						Design

Table 2.4, Continued

Project	Title	Description	Status	Util	Stnd	Equip	Energy	Data	Other
M1	Utility Related Study	Determination of impact of thermal energy storage on utility planning	On-going						
M2	Chiller Optimization	Study operation of buildings with energy management systems. Compare with ASEAM calculations	Discontinued						
M3	Energy Audit Studies and Development of Energy Conservation Requirements in Malaysian Buildings	Energy audits on 6 buildings. Revise OTTV equation. Produce energy conservation guidelines document.	On-going						
M4	External Shading of Windows	Define and study effectiveness of shading devices used in Malaysia. Survey buildings using shading.	On-going						Training
M5	Administration and Policy Studies	Survey energy use in government buildings and identify conservation measures. Study effects of implementation of policy in measured buildings	On-going						

Table 2.4, Continued

Project	Title	Description	Status	Util	Stnd	Equip	Energy	Data	Other
P1	Lighting and Day-lighting	Survey lighting conditions in 24 buildings. Study glare problem. Draft lighting manual	On-going						Manual controls
P2	Forced and Natural Ventilation	Correlate worker productivity with comfort. Develop design guidebook for small buildings	On-going						Guide Book
P3	Building Envelope Design and Building Configuration	Computer simulations of the influence of building envelope design on cooling energy	On-going						Training
P4	Performance of Typical Building Insulation and Reflective Materials	Measure thermal properties of typical Philippines build cross-sections	On-going						
P5	Air Conditioning Equipment	Survey air conditioning equipment in buildings. Simulate energy conservation potential for alterations to equipment.	On-going						
P6	Assessment, Analysis, and Policy	Develop guidelines. Study policy approaches	On-going						

Table 2.4, Continued

Project	Title	Description	Status	Util	Stnd	Equip	Energy	Data	Other
S1	Lighting and Daylighting	Survey of lighting intensity and energy use levels in 400 buildings. Develop simplified daylighting analysis tool	On-going						
S2	Energy Analysis	Simplification of OTTV equation. Develop structure for energy consumption index	On-going						
S3	Energy Management	Energy audits. Develop manual on energy conservation measures	On-going						
S4	Energy Standard Revision	Revision of OTTV and lighting load standard. Revise handbook	On-going						

Table 2.4, Continued

Project	Title	Description	Status	Util	Stnd	Equip	Energy	Data	Other
T1	Natural Ventilation	Conduct analyses. Prepare design guidebook	On-going						Manual
T2	Lighting and Daylighting	Audit buildings. Assess daylighting potential	On-going						
T3	Air-ConditioningResearch	Audit 3 buildings. Measure A/C efficiency. Study improvement potential	On-going						
T4	Assessment, Analysis, and Policy	Develop standards and implementation packages	On-going						

Table 2.5

Approximate Allocation of Budget ($000) by Research and Policy Topic Area

Project Area	US	In	Ma	Ph	Si	Th	ASEAN
Energy Audits		26	9	25			60
Standards/Guidelines		10	9	25	40		84
Utility Policy			19				19
Effects of Standards			20				20
Energy Management				8	28		36
	375	36	57	58	68	0	219
Weather/Solar Data		17					17
Building Shading			14				14
Lighting/Daylighting				12	35	25	72
	164	17	14	12	35	25	103
Building Controls		14					14
HVAC Equipment			15	9		32	56
	197	14	15	9	0	32	70
Natural Ventilation	120	19	0	9	0	34	62
Total	856	86	86	88	103	91	454

Note : An additional $14K was allocated to ASEAN project management

21

Table 2.6

LBL Research and Support Activities

Area	Status
Task 1: Training	
Energy Audit Analysis	Complete
DOE-2 Analysis	Complete
Utility Production Cost	Complete
[illegible]	Pending
Task 2: Research on Energy Conservation	
a. Lighting and Daylighting	
Simplified Daylighting Tool	On-going
Study of Window Glazings	Complete
Simulation Studies for OTTV Equation	On-going
Daylighting Guidebook	Complete
Review and Support ASEAN Studies	On-going
b. Natural and Forced Ventilation	
ESPAIR Program Modification	Additional Work Needed
Wind Tunnel Testing	Complete
ESPAIR Training	Complete
Computer Studies	Complete
Thermal Comfort Analysis	Complete
Review and Support ASEAN Studies	On-going
c. Air Conditioning Equipment	
Improve A/C System Performance	Complete
1984 Technical Paper on Equipment Maintenance	Complete
Review and Support ASEAN Studies	On-going

Table 2.6, Continued

Area	Status
Task 3: Assessment, Analysis and Policy	
a. Assessment	
Develop Detailed Building Audit Form	Complete
Supply Field Test Instrumentation	Complete
Develop Microcomputer Data Base of Energy Consumption and Building Design	Complete
Preparation of Weather/Solar Data	On-going
Review and Support of ASEAN Studies	On-going
b. Analysis	
Parametric Analyses Using DOE-2 on Building Envelopes	On-going
OTTV Analyses	On-going
Review and Support of ASEAN Studies	On-going
c. Policy	
Draft Standard for Thailand	Complete
Building Envelope Standard for Malaysia	Complete
Draft Policy Paper Relating to Implementation Strategies	Partially Finished
Review and Support ASEAN Studies	On-going
Task 4: Information Development and Dissemination	
Technical Bibliographies (Natural Ventilation and HVAC Systems)	Complete
Review and Edit ASEAN Technical Papers	On-going
1984 Singapore Conference Participation	Complete
1986 Texas Hot Climate ASEAN Participation	Not Accomplished
1989 ASHRAE Kuala Lumpur Conference ASEAN Participation	Planned
Summary Publications of Project Output	Planned

Air conditioning equipment studies were related to the effects of secondary (air distribution) system design on energy use, and a technical paper delivered at the 1984 Singapore conference. This area was given little emphasis during the course of the project.

Under Task 3 (Assessment, Analysis, and Policy), considerable support was provided in the areas of building audits, development of building design and energy use data. and the preparation of country specific weather data. Analysis work in support of the standards was largely done by the LBL staff. This included the determination of coefficients in the country specific OTTV equations. Draft standards were prepared by LBL for Thailand and for Malaysia. A draft policy paper was partially completed, which dealt with strategies for implementation of the standards.

Task 4, Information Development and Dissemination, activities included preparation of bibliographies on natural ventilation and on HVAC systems, review and editing of ASEAN technical papers, and participation in the 1984 and 1989 Asian conferences. A planned coordination of ASEAN participation in the 1986 Hot Climate conference (Texas) was not successful.

Activities planned over the remainder of the project include:

- Daylighting - completion and delivery of simplified daylighting tool to Thailand, and DOE-2 simulations for development of OTTV equations;
- Natural Ventilation - debug ESPAIR program for use by Thailand and Philippines;
- Standards Development - assist Indonesia in preparation of solar and weather data files, and perform additional DOE-2 simulations on building envelopes for development of OTTV equations;
- Information Dissemination - continue to review and edit ASEAN project reports, prepare summary of research results for dissemination to government and private practice, and coordinate ASEAN participation in 1989 ASHRAE conference in Kuala Lumpur.

2.1.5 Standards Development

Standards development was the primary endpoint of the work in all the five countries. Singapore already had a standard in place with experience in its implementation; this was not the case in Malaysia, Thailand, Indonesia and the Philippines.

Figure 2.2 provides an overview of the process followed to develop standards in these latter four countries. Each started with a "model" standard document developed by LBL, based on the ASHRAE standard. The major part of the work consisted of the country specific modifications to the standards. These modifications, as established by the in-country and LBL supported research, included:

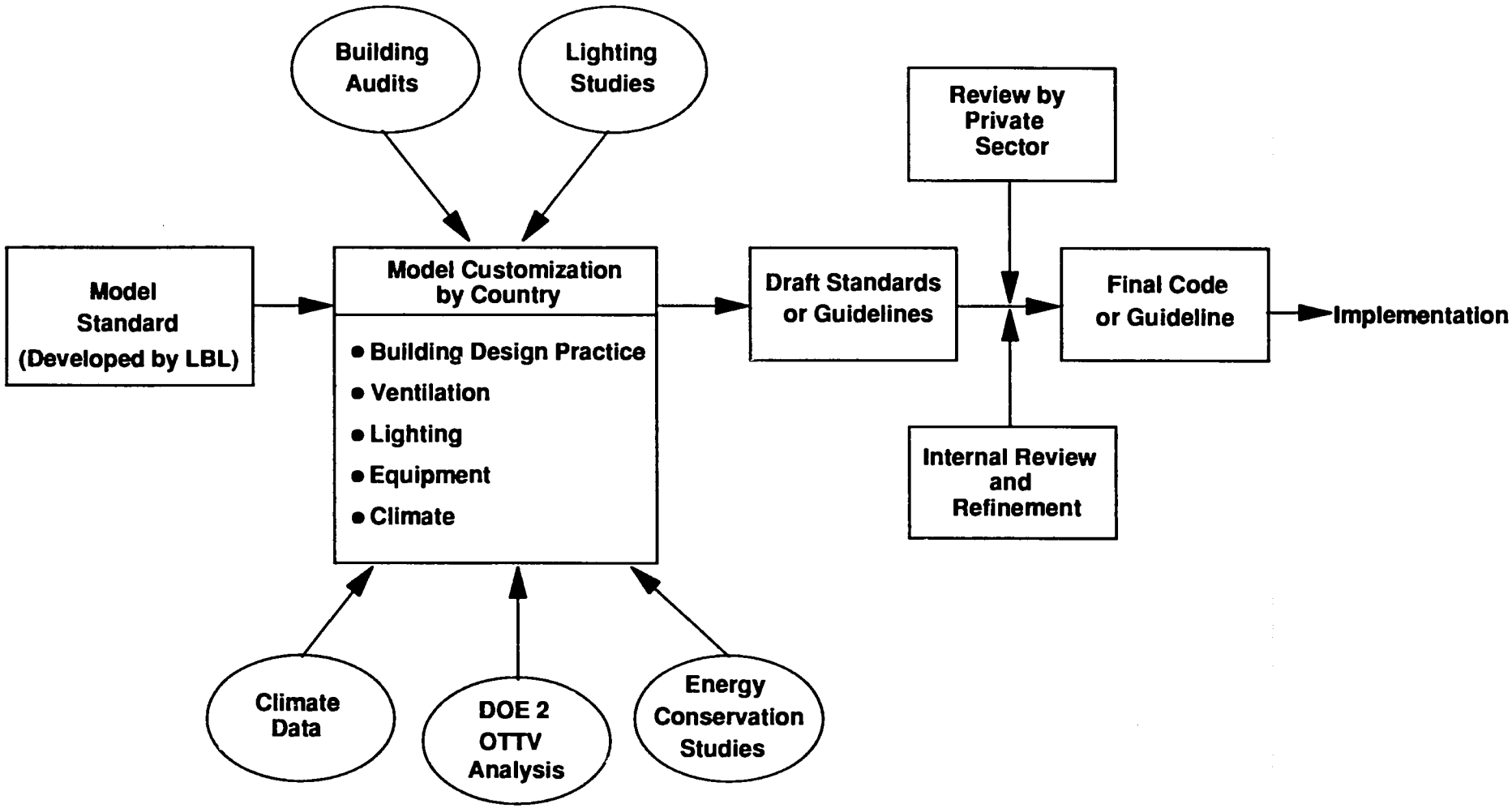

Figure 2.2 Overview Of Standards Development Process

25

- Building design practice. An objective of the standards was to "codify" existing good design practice. It was felt that too stringent standards would not be accepted by private practice. The acceptable level of conservation was very country specific. To support this objective, building audits were carried out to establish the range of design practice in each country.
- Ventilation requirements. Minimum levels of ventilation are being increased in the United States. In ASEAN, however, because of the high humidity levels, this is not being considered.
- Lighting. Audits of existing lighting levels in buildings were carried out to establish current practice. Analyses of the potential for overall energy reduction using daylighting principles were also carried out. Methods for giving a credit for daylighting in the standards differ by country.
- Equipment surveys were carried out to establish current practice. For the most part, the model standard values were accepted.
- OTTV Equations. Slightly different OTTV equations were used by the five countries. Singapore focused on a simplified OTTV and utilized a different definition of the "Solar Factor" (which relates the cooling load to the amount of solar energy incident of the building surfaces). In addition, Singapore is investigating the use of an "Energy Index", which attempts to correlate the actual energy consumption. The Philippines are exploring a modification to the OTTV to account for the cooling load seen by the chiller (as opposed to the envelope load). Malaysia, Thailand, and Indonesia will utilize the form of the OTTV proposed by LBL in the model standard.

Following completion of the draft standards various review activities were carried out, by the in-country technical committee involved with the standards development, by LBL, and, in most instances, by in-country private practice parties. In addition, hearings (presentation of the proposed standards for comment) are planned in most countries. Implementation of the standards will be either as a voluntary guideline or as a regulatory instrument incorporated into existing building codes.

Table 2.7 summarizes the status of the standards in each country.

- Thailand - the draft standard is currently under review. Implementation will be as a guideline;
- Malaysia - the draft standard is under review . Government lawyers have stated that they probably cannot be made mandatory.
- Singapore - the completed standard will be mandatory. Work is continuing on refining parts of the standard. A current mandatory retrofit standard will also be updated.

Table 2.7

Status of ASEAN Standards

COUNTRY	STANDARDS STATUS	IMPLEMENTATION OPTION	COMMENTS
Thailand	Draft Envelope Standard Under Review by NEA	Implementation as a guideline	Based on "Model" Standard by LBL. Work continuing to refine OTTV
Malaysia	Draft standard under review by Ministry of Housing and Local Government	Probably implemented as a guideline due to legal issues. Reduced interest at high levels due to low cost of energy	Similar to Thailand standard.
Singapore	Small revisions in 1979 standards likely. Will modify retrofit code	Changes will become part of the code. Handbook will be revised.	Changes to 1979 standard will be modest. Lighting loads reduced by about 10%. Simplified OTTV equation.
Indonesia	Design guidelines complete. Under review. Future work to refine specific data.	Probably implemented as guideline for 2 years before making mandatory. Must be adopted by 27 provinces.	Intend to hold a conference this year with interested parties to discuss standard.
Philippines	Draft guideline complete. Active participation of private practice. Additional work to refine OTTV.	Some parts may be incorporated into National Building Code. Other part voluntary guidelines.	Based on "model" standard developed by LBL, current practice and country ability to pay first costs of conservation. Public hearing planned.

- Indonesia - A draft guideline is complete and under review. Additional work is needed throughout standard to tighten up on specific data. The draft standard will be made public this Fall.
- Philippines - A preliminary draft is complete and under review by a standing technical committee. Parts of the standard will be mandatory. Additional work being done to tighten up on specific data in the standard.

2.2 Training and Coal Utilization Component

2.2.1 Overview

Component 2 was divided into three main activities:

- A four week intensive training course in Malaysia in energy planning.
- Support for over 30 students in a three month certificate program in energy planning and management at the Asian Institute of Technology.
- An eight week training course in lignite/low grade coal utilization at Houston Power and Light.

In addition, resources from this component were used to support information dissemination activities of the Renewable Energy Resource Center operated by AIT and a highly successful seminar for senior level utility executives in Thailand on cogeneration and private power in 1988. The latter effort provided important inputs for policy initiatives now under discussion.

The following three subsections briefly describe the main activities undertaken as part of this component. The evaluation of these activities is provided in Section 5.

2.2.2 Energy Management Training - Malaysia

This course was administered by the Institute for International Education (IIE) and offered by the Energy Center of the University of Pennsylvania. It was held at the Sultan Ahmed Shah Training Institute, National Electricity Board, near Kuala Lumpur, Malaysia.

There were thirty four ASEAN participants who were mid to senior level planners representing electric utilities, energy companies, government ministries, and universities.

The four week course provided a framework for integrated national energy planning through a series of lectures, computer workshops, and informal evening discussions. The course, which was focused on planning for the electric utility sector, examined private power options, cogeneration, and energy conservation. Topics covered included: planning theory, energy economic interactions, electric utility planning alternatives, and policy modeling.

Participants were presented with the background and tools for developing integrated energy plans. Quantitative tools such as cash flow analyses and energy system optimization were presented. Software packages for these models were provided to the participants.

Participants worked on group projects over the month. There were three group projects which included prototype proposals for conservation and cogeneration, as well as the development of a policy paper which was presented at the end of the course. Participants were also give individual assignments such as computer practice problems and voluminous readings.

2.2.3 Energy Planning Training - Asian Institute of Technology

In this subcomponent a grant was provided to the Asian Institute of Technology for the purpose of "training and related activities to strengthen ASEAN institutional and human resource capabilities in energy planning and renewable energy resources". To this end the grant provided for:

- Training of approximately twenty ASEAN participants in a three month certificate program within the Energy Technology Division of AIT. Participants took 3-4 of the regular AIT courses totalling 9-12 credits with an emphasize on energy planning and/or renewable energy resources. The courses taken were those offered to the regular master degree candidates.
- A long term energy advisor resident at AIT for two years (1987 and 1988) with an expertise in energy planning and technology. Dr. Wes Foell was selected for this position. Dr. Foell served on the faculty of AIT, coordinated the USAID-AIT program, and provided guidance to participants in course selection and special projects which most of the candidates were expected to complete.

Dr. Foell worked with other AIT faculty in expanding the curriculum of the energy department to include more emphasize on energy conservation and energy-environment interactions.

2.2.4 Coal Utilization Management Training

This was a 16 week program given in the U.S., over the period August 25 to December 19, 1986, on the use of lignite and low rank coal in electric power utilities and industry. Twenty four ASEAN participants were trained in topics such as: combustion, boiler design, coal handling, and lignite coal analyses. The course was divided into two phases:

- Eight weeks of classroom training given by instructors from the Houston Power & Light and outside sources, such as Combustion Equipment.
- Eight weeks of hands-on experience working in two lignite coal fired power plants operated by Houston Power and Light.

The application form brochure stated "the course is an intensive, rigorous training program designed to increase the technical competence and job skill of middle to upper level managers, supervisors, and engineers who are now working with, or planning the development of lignite or sub-bituminous coals for power generation".

3.0 PROJECT MANAGEMENT OVERVIEW - COMPONENT 1

3.1 Technical Management

The building energy conservation component of the project was a difficult one to manage. It required identifying and providing technical support for 4 to 6 R&D projects per country (i.e. a total of 24) covering a broad range of subject matters, plus coordinating and participating in multiple training activities. Further complicating the issue, the technical support needs in each country were different and evolved over time. Review of technical and planning outputs and interviews with project participants indicate that the LBL staff did an excellent job in managing the technical support functions. Country participants were nearly unanimous in indicating that LBL staff were highly responsive to their technical support needs and showed a high level of commitment to the project. This high level of responsiveness is exemplified by the special training provided at LBL to meet specific country requests for assistance (e.g., UPLAN training for Malaysia, etc.)

Several concerns raised by some of the participants and noted by the evaluation team were:

- Particularly in the initial stages of the project, LBL planed to do most of the technical analyses and R&D in-house. The ASEAN participants expressed great concern on this issue during the first planning workshop meeting in 1986. As a result of the ensuing discussions the distribution of resources was somewhat modified. As indicated by Figure 3.1, LBL and its direct overhead functions utilized roughly 60% of the budgeted project resources and the ASEAN in-country R&D and expenses only 27%.
- Several of the ASEAN countries already had significant technical and policy formulation capabilities at the initiation of the project as exemplified by the Singapore building energy standards and the ongoing energy auditing activities in Thailand. The effectiveness of the program in promoting regional cooperation would have been enhanced if these capabilities had been shared and more actively built into the program implementation. The evaluation team has a general concern that LBL tended often not to sufficiently utilize these capabilities but to "do it for them". For example, perhaps the Singapore standards could have been used as a model directly to be modified by the other countries via joint discussions among the ASEAN project teams with LBL guidance rather than have LBL prepare the standards on their behalf. This would have had the dual benefits of enhancing the ASEAN in-country capabilities and communications, and of freeing budget resources for other research on policy related studies.

Not withstanding these stated concerns, few organizations in the U.S. have the breadth of analytical and training background in building modeling and technology to have undertaken this support activity relative to building thermal analysis and standards issues addressed in this program.

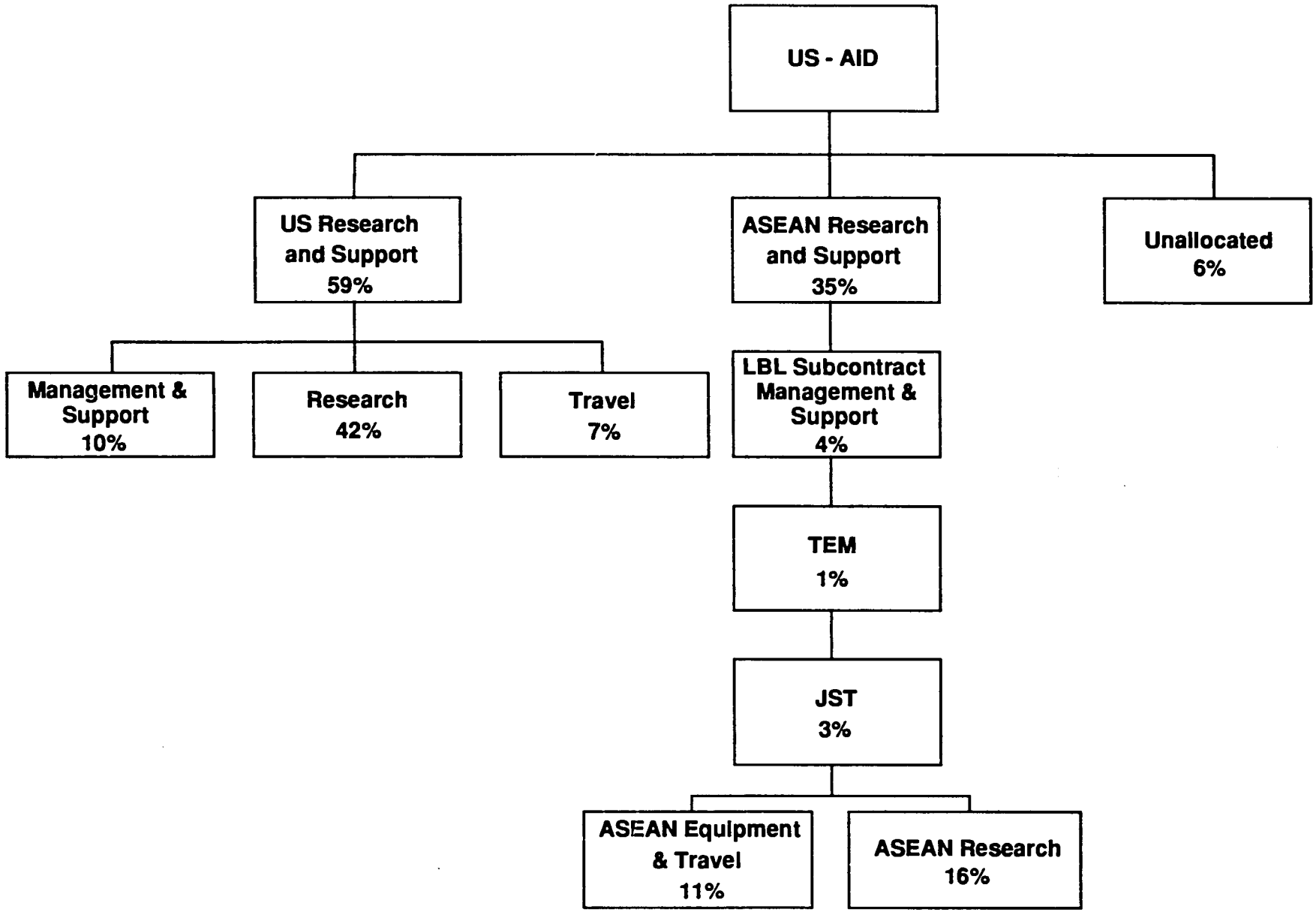

Figure 3.1 Phase III Funding Flow

3.2 Program Structure and Mechanics

The management structure of the building component of the project is indicated in Figure 3.1. The structure consisted of:

- LBL as the prime contractor having broad technical responsibilities and flexibility in assigning resources. Much of the R&D undertaken in the project was undertaken by LBL technical staff and LBL provided technical support and guidance for R&D activities for the ASEAN country teams;
- TEM functioning as a subcontractor to LBL. It was responsible for distributing funds onward to the ASEAN in-country activities per direction of LBL;
- JST, a small accounting firm located in Singapore, acting as a regional coordinator on behalf of LBL. Most funds for ASEAN projects flowed from TEM to JST for regional disbursements. JST also played an active role in supporting LBL in undertaking ASEAN based activities such as travel, meetings, etc.; and
- USAID directly in the approval chain to verify that all disbursement procedures were consistent with USAID policy. USAID played little role, however, in guiding or influencing the course of the technical activities.

This management structure and associated controls on local disbursements was implemented, in part, as the result of political uncertainties in selected ASEAN countries at the time of project formulation and the desire of USAID to ensure that all funds were utilized for their intended purposes.

From the viewpoint of the ASEAN participants, however, the structure was viewed as being very cumbersome resulting in delays and leading to excessive use of funds for overhead functions rather than for useful project purposes. More specific problems arising from this arrangement included:

- Delayed disbursements of funds through the chain placing hardships on both JST and the ASEAN teams.
- Delays in implementing the in-country R&D projects due to inflexibility in the system to allow advanced funding of researcher activities and planning activities. The delay in starting in-country activities combined with a shortening of the project by 6 months due to funding shortfalls will significantly reduce the effectiveness of these in-country R&D activities.
- A planning oversight which resulted in a delay of the approval for participation of the ASEAN teams in the ASHRAE conference on hot, humid, climates held in Houston, Texas in 1986. As a result, the ASEAN researchers were not able to participate in this important meeting.

The project evaluation team is cognizant of the need for careful accountability in projects of this type. However, it is recommended that more attention be given to the technical/financial management aspects of such multi-country projects during their initial planning stages to help ensure that these functions do not absorb an inordinate amount of key management time (both U.S. and recipient country) and result in delays which compromise achieving important project objectives.

4.0 PROJECT EVALUATION - COMPONENT 1

4.1 Achievement of Project Objectives

On balance the evaluation team determined that the project achieved most of its primary objectives - particularly as measured by the outputs stated as goals of the project. Specifically, relative to the Project Plan objectives and output goals:

1. Did the project achieve the stated objective to "promote policies and enhanced technical capabilities for increased energy conservation in buildings ..."?

   The evaluation team determined that this objective was generally achieved through a combination of standards development process and effective training courses. However, the program output goals resulted in a rather narrow definition and focus of policy studies so that only standards preparation received significant policy attention. As a result, important policy issues of utility tariff, import duties, and retrofit incentives received relatively little attention. Consideration of government policy actions to promote implementation of energy conservation in buildings was initiated but not completed.

   Also, as indicated in Section 4.2, the technology focus was on architectural design issues (daylighting, natural ventilation, etc) almost to the exclusion of the broader range of technology options being developed and implemented in the industrialized countries to reduce energy use in both new and existing buildings. Examples of these are energy management systems, variable speed drives for the pumps and blowers of large chiller systems, and heat recovery for ventilation air.

2. Did the project " lead to greater coordination among policy makers at both the regional and national levels, along with a stronger policy commitment to energy conservation in buildings an all the participating countries"?

   The program was partially successful in achieving this goal. In all the countries the issue of building energy use standards and policy is being discussed at the policy level of government. There has been sufficient coordination to result in a common structure for the building energy efficiency standards which will enhance the potential for further cooperation in this field. As indicated in Section 4.7, however, several of the country coordinators and the evaluation team feel that the program could have been more effective in promoting intra-country discussions and sharing of research results outside the work plan meetings.

3. Did the project lead to implementation of "improved building codes in at least two ASEAN countries" ?

The project has been very successful in developing building energy efficiency standards which are likely to be implemented eventually in all five ASEAN countries. With the exception of Singapore, the issue of whether the standards will be implemented as guidelines or integrated into the codes is still not defined. It appears, however, that they will be integrated as codes at some time in at least three of the countries, the Philippines, Singapore, and Indonesia. Even where they are implemented as guidelines they will tend to be followed by much of the professional community similarly as they now tend to follow the ASHRAE standards. Even in these countries they will have a beneficial effect. If stronger policies towards energy conservation are ultimately adopted in these latter countries the guidelines will provide a basis for development of regulatory codes.

4. Did the project "increase private sector awareness of technology and design alternatives for energy conservation in buildings" ?

The project was somewhat successful in this area as exemplified by the role of the industry trade groups in reviewing draft standards in most of the countries and their participation in some of the training programs. As indicated in Section 4.6, however, the program did not seek to engage the industry in the selection and implementation of R&D projects. Also, most of the technology trends of primary potential interest to industry in areas of improved equipment technology and building management were not emphasized in the program.

5. Did the project lead to "adoption of microcomputer programs for architects and engineers to use in designing and evaluating energy efficiency in buildings" ?

The project was successful in providing training for use of state-of-the-art computer models (ASEAM2) to university, government, and, to a lessor degree, private sector professionals. The skills learned are being effectively used by many of the program participants. The training program was particularly useful in Indonesia and the Philippines, where less experience resided in building energy conservation analysis methods.

4.2 Research Priorities and Impacts

To meet the project goals, the research activities carried out within the ASEAN countries and by LBL were selected to serve several functions:

- Develop basic information needed to develop building energy efficiency standards.
- Relate building efficiency/load management technologies to a broad range of key policy and macroeconomic issues such as utility tariff structures and incentive programs (taxes, import duties, etc.) for high efficiency retrofits.
- Train manpower in key analytical and technology areas required to institutionalize a broad based capability in government, universities, and private industry.
- Develop in-country awareness of and capabilities in advanced energy conservation/load management technologies which go beyond the standards in their potential impact.

Figures 2.4 and 2.6 summarize the R&D projects undertaken in ASEAN and at LBL. Observations of the evaluation team on how the R&D projects addressed these various goals follow:

- About 50% of the projects directly served the high priority objective of developing information required to prepare energy efficiency standards. These included the audit programs which developed an overview of current building practice with which to compare proposed standards and the weather/solar data collection and analyses efforts needed for calculating building envelop heat gains as part of the OTTV calculations. The high percentage of projects in support of standards formulation is consistent with the initial project intent.
- Only one project, in Malaysia, deals with the broader policy issues of the impact of building energy efficiency on utility operations and vice versa i.e. the impact of utility rate structures and policies on the market for building energy efficiency equipment and services. Experience in the U.S. and elsewhere indicates that building energy conservation policies are tightly interwoven with electric utility and environmental policies; to wit:
  - The primary national benefit of building energy conservation in some countries might be to reduce the need for capital expenditures for new generation and transmission capacity.
  - Reduced need for generation capacity favorably impacts on a broader range of environmental issues (acid rain, global warming, etc.)
  - Utility rate structure and other policies greatly impact on the zeal with which energy conservation measures are implemented.

  It is the understanding of the review team that the limited attention given to the broader spectrum of policy issues, as exemplified by utility rate structure policies, reflected a combination of factors including the lack of familiarity and interest of most country team members with these issues, the relatively little importance given to this issue by LBL, and, possibly, a lack of interest from utility organizations in participating in the program at this time.

- "Daylighting" technology was given a very high priority by both LBL and the national R&D teams. The analyses of daylighting concepts serves a function in helping to train technical staff in the intricacies of building thermal analyses and efficient lighting design. This technology is one of several which might have an important impact in the future in reducing energy use and impacting building standards. The application of the technology in hot, humid, climates is still in early R&D stages relative to such basic practical issues as human factors, implementation options, and thermal impacts. Daylighting technology is judged by the evaluation team not to be an important factor in the *near term* development of building energy efficiency standards nor is it considered by most of the industry to be one of the advanced technologies most likely to have important impacts in both new and existing buildings in reducing energy consumption over the next decade.
- The natural ventilation projects is useful in training manpower in building thermal analyses. In temperate climates ventilation air cycles (forced convection) can be a significant operational tool for reducing loads on air conditioning equipment in commercial buildings. It should be noted, however, that this technology cannot be used in commercial buildings which are actively cooled in the hot, humid, climates prevalent in the ASEAN countries. The benefits of this technology might be to improve the design of smaller buildings (such as school houses) in rural areas where active cooling would not normally be employed and to reduce the incentive to convert to active cooling in such areas. The priority given this subject area is probably not warranted by its potential given the primary goals of this project.

The primary thrust of the project was to develop building standards leading to improved energy efficiency in commercial buildings. As stated previously, much of the R&D activity was directed in support of this standards development effort.

An additional objective of the program was to help create a better understanding of the broad range of more advanced technology options which might allow further tightening of standards in the future and/or encouraging building owners to further reduce energy use in response to market forces. Table 4.1 indicates examples of a range of technologies which are increasing being used to this end in the U.S. and which may have special applicability in hot, humid, climates. The project management put its focus only on those technologies related to daylighting. The high degree of focus on this technology, however, diminished the ability to achieve the project objective of creating a broad awareness of energy conservation technology options having potential for major impacts in both new and existing construction and for identifying policy initiatives to accelerate their use.

4.3 Training

As indicated in Section 2, the training took four primary forms within the Building Energy Conservation Component of the project:

- Energy audit training in each of the participating countries

- Use of DOE-2 and ASEAM computer models to support building thermal analyses activities
- Specialized training at LBL in such diverse fields as utility planning, natural ventilation, and standards development
- Direct interaction between LBL staff and individual researchers on an as needed consultive basis

Many of the researchers interviewed by the evaluation team had participated in one or more of the formal training courses. Also, interviews were held with several private sector professionals who took the formal audit courses. Based on the above the following observations can be made:

- Both the formal and informal training functions provided by the program were commented on enthusiastically by most of the participants, particularly those from countries which had little experience in the field. In some cases they felt the courses might be "too short" - this, however, always in the context that the courses were useful and well presented. One private sector firm in the building energy management business commented that they were using some of the course material as part of their internal training program.
- There were a few comments that the selection process for course candidates (particularly the highly prized courses given at LBL) might not have been as effective as hoped for as indicated by a relatively high attrition rate from the program upon return to the participating country. This is always a concern with programs of this type. Unfortunately, there was no formal attempt made to determine to what extent the training provided was being utilized professionally - even if not in the capacity originally envisioned. For example, two individuals were identified who left government employment for private sector energy management firms where the training was used.
- There were about 20 participants from private sector companies enrolled in the various in-country courses. This reflects the active solicitation of private sector participation in several of the countries, particularly Indonesia and the Philippines. This participation of private sector interests is consistent with program goals.
- There was a strong emphasis on the use of DOE-2 which was the focus of the LBL training and the advanced training program in Singapore. DOE-2 is primarily a research tool which is difficult to use without extensive training and is only effective when utilized on a regular basis by R&D personnel. Most of the candidates to the course will probably not utilize DOE-2 directly but will elect to use simpler models such as ASEAM2. The program probably gave too much emphasis to DOE-2 to the detriment of more practical tools and policy training.

- In all countries except Singapore and, possibly, Thailand, the training in energy auditing and use of computer based thermal models provided to government/university staff was essential for implementing other aspects of the program - particularly the development of standards. Singapore is a possible exception due to their having a core capability in part as the result of prior USAID programs (e.g., Phase II).

Review of the reports resulting from the in-country R&D programs and interviews with the participants indicate that the training provided by this program has been effective in helping to develop a cadre of highly trained professionals which can lead to institutionalizing the ability for government and industry to work on policies and technologies leading to more efficient building energy use.

4.4 Standards Development

Before describing the role of the project in standards development it is useful to provide a brief background discussion on two issues:

- The factors impacting on whether standards are mandatory (built into the codes) or voluntary (guidelines)
- The probable impact of energy standards on building energy use

When the program was initiated in the early 1980's the specter of rapidly rising energy prices inhibiting economic growth provided for a strong political backing in most of the ASEAN countries for energy conservation policies. In large part the reduction in international energy prices has diminished this enthusiasm - particularly since several of the ASEAN countries are now net exporters of energy. The pursuit of energy conservation in buildings is now viewed by some as being desirable to "remain modern and competitive" or as a hedge against future price increases. As a result there is still interest in the program and a commitment for standards development in all the countries. The perception of plentiful, low cost, energy supplies, however, has probably contributed to the view that the standards in most countries should be implemented as "guidelines" rather than legally binding codes - at least in the early years.

If the rationale for building energy conservation were primarily "saving energy" the above perception might be valid - particularly given that the current design practice in most of the countries is quite good compared to the standards. The concept that an important rationale for building energy conservation is to reduce capital expenditures and environmental problems in the power sector was not emphasized in the program at either the country or overall management level. The absence of consideration of this factor might have reduced the political support for more vigorously promoting the standards for inclusion within the code structure.

An explicit assumption of the program is that energy conservation standards in commercial buildings would lead to substantial energy savings in the ASEAN countries and expansion of business opportunities. It should be noted, however, that most engineering firms already follow some form of standard in their design work - most prominently the relevant ASHRAE standards of the U.S. The design of the HVAC systems commonly is based on Carrier guidelines. The standards resulting

from the project are quite similar to those de facto followed by most of the industry. The impact of the standards will vary from country to country but will most likely be modest. They will, however, serve the important functions of eliminating bad practice, highlighting the government commitment to encourage energy efficiency, and forming a basis for policy extension - for example, into retrofit policies.

Both project audit activities and discussions with private sector energy management firms verify that most larger commercial buildings are already designed with practice which approaches that specified in the proposed standards (or existing standards in the case of Singapore). The energy management firms indicate, however, that there is still opportunity for energy savings of 10% to 30% by both good operational practice and modest capital improvements. This preliminary information supports the view that large reductions in energy consumption in commercial buildings in ASEAN countries will require moving beyond the standards as currently envisioned.

4.5 Trade and Investment Linkages

The U.S. industry has a strong position in the equipment and services associated with building energy conservation in hot, humid, climates. This reflects, in part, the fact that few of the industrialized countries have large building concentrations in hot climates with the associated need to develop building designs and air conditioning equipment to deal with the unique comfort condition problems presented. Also, the U.S. has been active in developing a policy environment (utility pricing, standards, etc.) which favors accelerating the use of energy conserving and load management technologies.

As a result of the above, the U.S. industry is already well represented in most of the ASEAN countries in building sector equipment and materials. Examples include the major market share positions of Carrier, Trane, and York in air conditioning systems, Honeywell and Johnson Controls in HVAC control systems, and Emerson and Reliance in pump and fan motors.

The evaluation team met with several of these firms to assess their views on the impact of building energy conservation standards on their business opportunities in ASEAN countries. These interviews supported the assessment of the evaluation team that the project has enhanced the prospects for increased trade and investment by U.S. firms in this area by virtue of accelerating the development of building efficiency standards and enhancing an awareness in government and industry of the potential for large improvements. The equipment and energy management firms indicated, however, that the largest opportunities were often found in upgrading the existing inventory of equipment or in proper maintenance. By and large the project did not focus on policies to accelerate retrofit programs.

Example technology areas/service areas which might benefit from the program and its follow-on activities are indicated in Table 4.1.

Table 4.1

Example List: Potential Areas of Increased Trade/Investment in Building Energy Technology Equipment and Services

Lighting Equipment

- Advanced Lighting Technology (fixtures, reflectors, etc,)
- Lighting Controls (including those for "daylighting")
- Advanced Glazing Materials and Processes

Energy Management

- Energy Management Systems
- Building Management Controls and Services
- Ice Storage System
- Energy Audit Equipment and Instrumentation

Air Conditioning Equipment

- High Efficiency Chillers and Packaged Air Conditioners
- High Efficiency Compressors and Heat Exchangers
- High Efficiency Motors, Pumps, and Blowers
- Variable Speed Drives

- Desiccant Dehumidification Systems
- Ventilation Air Energy Recovery (enthalpy wheels, etc)
- Absorption Air Conditioning

Packaged Cogeneration Units

4.6 Private Sector Involvement

There are multiple reasons for wanting to involve private sector interests in the process of accelerating the use of energy conservation design and equipment in commercial buildings. These include:

- Creating an increased awareness of energy conservation policies, technologies, and business opportunities within the private sector companies which ultimately must use and design the buildings.
- Engaging private sector interests in the development and review of proposed standards to both benefit from their experience and gain support for their implementation.
- Identifying areas where the private sector would most benefit from possible government program initiatives.
- Identifying possible trade/investment opportunities which might result from building energy conservation initiatives.

Table 4.2 is an overview of the project interaction with the private sector. Several observations follow:

- The primary involvement of the private sector in the program has been to review draft energy conservation standards as developed by the designated government agency with LBL support. The private sector organizations involved included professional trade organizations (local ASHRAE chapters, Institute of Architects, etc.) and prominent HVAC and architect design firms. The standards developed are generally quite similar to the U.S. ASHRAE standards which are widely familiar to the professional community. The process of proposing standards to this community for review and comment (rather than attempt to actively engage the organizations directly in their formulation) was a reasonable approach given the tight schedules involved.
- There was some involvement of private sector companies in the in-country training courses. The evaluation team interviewed one participant from a private building management firm who was very favorably impressed with the energy audit course. In Indonesia the second round of energy audit training held in 1987 was open to participants from private sector firms via a public notice and over 10 firms participated.
- The evaluation team met with several private sector firms including U.S. manufacturers of air conditioning equipment, energy management firms, and HVAC consultants. These interviews combined with discussions with country coordinators indicated that there was relatively little interaction with the private sector relative to such issues as R&D project selection, technology trends, and policy issues. There are multiple reasons for this including:
    - The project was executed primarily by university and government researchers with few contacts in the private sector.

Table 4.2

Private Sector Involvement

Country	Mode of Private Sector Involvement	Organizations Involved	Comments
Malaysia	Review of draft standards.	Institute of Engineering Association of Architects Consulting Engineers Housing Development Association Local ASHRAE	Draft standards presented to professional societies in 3 separate meetings
	Enrollment of private sector professionals in energy audit course.		
Singapore	Minimal involvement.	Institute of Engineers	No interaction with private sector in R&D or standards discussions
Indonesia	Seminar to review draft standard (planned for Fall 1989)	Professional societies Engineering firms Equipment suppliers	No involvement of private sector during standards development
Philippines	Technical Review Committee for standards review and development	Professional societies Engineering firms	No private sector energy management firms identified
	Participation in training course		
	Inputs into one of the R&D projects		
Thailand	Review of draft standards	Professional societies Energy Institute of Thailand	No private sector energy management firms identified

- In none of the countries was a formal mechanism implemented (professional meetings, mailings, etc.) to make the private sector interests aware of the overall project and associated R&D subprojects.
- The project did not focus on the spectrum of building energy conservation technology trends of primary practical interest to industry (energy conservation economics, advanced lighting, variable speed drives, etc.).

4.7 Enhancement of National/Regional Cooperation

One of the goals of the program was to foster increased cooperation among researchers and policy makers in the field at the national level (i.e. within the countries) and among the ASEAN countries. The primary modes within the project contributing to this goal were:

- Annual planning meetings of key participants from all the countries which afforded the opportunity to review programs and discuss issues of common interest.
- Training courses conducted in each country which enhanced communication among the country researchers and the associated potential for increased cooperation among different government, university, and private sector organizations.
- Training courses in Singapore and LBL attended by key participants from the different countries provided for enhanced communication and cooperation among the countries based on the personnel relationships established.

Participants interviewed indicated that the program improved communication among the countries - certainly more so than if no integrated ASEAN program were in place.

The program further enhanced cooperation by promoting the development of a model standards format so that the structure of the standards in each country will be similar thereby facilitating increased cooperation in the future relative to building design and equipment design, use, and manufacture. The model format and its agreed upon use by the ASEAN countries was one of the important contributions of the project.

There are a number of project subject areas which were undertaken separately in multiple countries. These included OTTV research and analyses (5 countries), natural ventilation (3 countries), and daylighting (3 countries). There appeared to be little cooperation among researchers in these similar (or identical) fields. They did not have meetings or engage in direct communications on a periodic basis to share findings and avoid duplication of effort. Several participants interviewed indicated that more cooperative efforts in similar R&D efforts would be desirable and increase the effective utilization of limited resources. Future programs should have built-in formal mechanisms to share in the research results. Possibilities include the joint review of technical reports and active participation in workshops related to specific research areas.

4.8 Policy Development Focus

The focus of the building energy conservation program was on developing energy conservation standards which would ideally be incorporated into legally binding codes. This focus is consistent with the overall project objectives. Standards development is, however, just one of several major policy issues impacting on the form and rate of implementation of energy efficiency design and operation into commercial buildings. Other key policy issues include:

a. Electric Utility Tariff Structures and Impacts on Capacity Expansion

A policy to accelerate the introduction of energy conservation in both new and existing commercial buildings requires a supportive utility rate structure combining economically rational energy charges, time of day rates, and demand charges which reflect the *true* cost to society of electric utility capacity expansions needed to serve the growing loads. The characteristics of the rate structure provides price signals to the building owner/operator that will greatly influence the type and degree of energy conservation undertaken. Conversely, the impact of building energy conservation and load management technologies and market penetration rates is important in assessing utility load growth characteristics.

Only one R&D activity in the project dealt with this key issue (project M3 in Malaysia)

Preliminary information gathered by the evaluation team indicated that the current rate structures are only marginally supportive of energy conservation in buildings - an observation which was seconded by interviews with the private sector energy management firms.

Also, of major policy importance is the fact that several of the ASEAN countries, such as Thailand and the Philippines, are already or will shortly be capacity constrained in achieving economic expansion. For example, it was reported that some industrial park projects in Thailand are being delayed by up to two years due to lack of power. Power not utilized inefficiently in buildings will be "released" for economic expansion in such cases. The resultant national benefits are an important policy consideration and one which, if properly addressed, might increase the political support for aggressively implementing standards within a code structure rather than as guidelines.

b. Import Duties

Discussions with industry indicated that in some countries import duties greatly increased the cost of imported equipment which might be considered in energy conserving building design. For example, it was reported that the cost of heat absorbing glass and specialized equipment for use in VAV air conditioning distribution systems was increased by up to 40% in the Philippines as the result of such duty policies. Clearly such policies will greatly inhibit the use of such advanced equipment and materials.

As a practical matter there is not a critical mass of market in individual ASEAN countries to allow for the economic manufacture of much of this equipment and specialized materials. The accelerated use of many energy conserving technologies will, therefore, require import duty policy changes in some of the ASEAN countries - most importantly the Philippines, Indonesia, and Thailand. By contrast, Singapore has almost free trade of such equipment.

c. Retrofit Policies

The background material for the project refers to the large annual energy cost savings resulting from only a 10% reduction in energy use (about $200 million) and the potential for 20%, 30%, and, in the longer term, 40% savings. In the near term (next 5 to 15 years) achieving of even the more modest of these energy savings goals across the building sector will require that policies are implemented which encourage improving the equipment and operation of the existing building stock. This observation derives from the fact that about 80% of the load in 1995 and 60% in 2000 will still be due to buildings now in place (assuming an average growth rate in commercial building stock of about 4%)

Singapore has recognized this issue and has implemented policies which encourage building owners to upgrade their facilities using the energy standards as a guide. These policies include a combination of tax incentives for doing so and a utility surcharge if no action is taken.

In general the standards being developed as part of this program will not address this issue one way or another since they will apply only to new construction.

Several of these policy issues were identified in a 1988 rough draft report prepared by LBL. They were not, however, given significant attention during the course of the program. The evaluation team recognizes that the program had limited resources and time available and could not effectively deal with the full range of policy issues involved. It should be recognized, however, that the standards alone will not have the desired impact on building energy use without supporting policies in the above and other areas.

5.0 PROJECT EVALUATION - COMPONENT 2

5.1 Energy Management Training - Malaysia

5.1.1 Evaluation Inputs

The evaluation observations of this section are based on the following inputs:

- Interviews with 5 participants in the course
- Review of the course evaluation provided by the participants (Report on ASEAN Energy Planning Training Course, Kuala Lumpur, Malaysia, October 12 - November 6, 1987)
- Review of the course curriculum
- Discussions with the course coordinator in ASEAN and the organization responsible for giving the course (Energy Center at the University of Pennsylvania).

There was good agreement from these diverse sources, which facilitates the evaluation process.

5.1.2 Evaluation Results

The course was successful in its primary objective of providing effective training in advanced energy/utility planning methods and concepts to mid and senior level professionals in each of the participating countries. A review of the attendance list indicates that the selection process was effective in identifying candidates having planning responsibilities in their normal working environment.

In general the participants were satisfied with the course and felt that it focused on the subject matter indicated in the initial descriptive literature; i.e. it accomplished the stated objectives as far as content was concerned.

The course was felt to have been well taught by highly qualified professionals who showed a genuine interest in the subject matter and in ensuring that the participants were engaged in the process.

Several of the participants interviewed felt the highlight of the course was in their learning how to use LOTUS spreadsheet analytical tools to undertake financial analyses. This capability has widespread utility even for those participants no longer engaged in energy sector planning.

The group projects were considered useful as both a way of utilizing the knowledge gained from the formal lectures and as a way of directly interacting with participants from the other countries. These direct contacts might facilitate future cooperative activities among the countries.

The primary complaint was that the course might have been too intense with conflicting demands of attending formal lectures, voluminous reading assignments, evening discussion sessions, and the group project. This level of intensity exemplifies the commitment of the teaching staff to ensure an effective learning experience - however, there seems to be a consensus that it reached a level of diminishing returns.

Another observation indicated in the written evaluation report was that some of the course material was perceived by the participants as having limited relevance in most of the ASEAN countries - examples cited were the focus on private power and cogeneration. However, events in Thailand and elsewhere have shown that the course was setting the stage for policy trends. In some cases participants in this course are now involved in cogeneration/private power deliberations now underway in their respective countries.

In summary, the Malaysia Energy Planning Course was considered by almost all concerned to have been successful in achieving its objectives and has contributed to the ability of the ASEAN countries to consider energy sector policy in a more integrated fashion than was heretofore the case. It would be useful, however, to follow up on the current status of the participants to determine the extent to which they use the knowledge gained.

5.2 Asian Institute of Technology Certificate Program

Information for the evaluation of the AIT certificate program was obtained from:

- Interviews with 3 participants in the course
- Discussions with the AIT coordinator for the ASEAN training program (Dr. Prida Wibulswas)
- Phone discussions with Dr. Wes Foell, the resident advisor/coordinator on the project under contract with USAID.

There is good agreement that the program was successful in helping to train ASEAN professionals in the areas of energy planning and management and that most of the participants are utilizing their knowledge in both university and government organizations having energy planning/policy responsibilities. Dr. Foell was considered to be an important contributor to the program in that he brought in "new ideas" to the AIT program which led to expanding the curriculum in the areas of energy conservation and energy-environment interactions. Dr. Foell also received a consistently high ranking from the students as a teacher.

The primary concerns raised were:

- The AIT is a very prestigious institution accepting only about 10% of applicants who must have graduated in the upper 5% or so of their classes from good universities. Some of the USAID-ASEAN participants found it difficult to work within this highly competitive environment since they were taking the same classes as the M.S. and Ph.D. students.
- The above issue, in turn, relates to some concerns relative to the selection process. In one or two countries there was a tendency to restrict nominations to only one organization rather than spread them out over a broader range of organizations having energy planning and policy responsibilities. This clearly compromised achieving project objectives. The ASEAN coordinators did not feel they had the authority to significantly influence this

48

process. In future programs of this type USAID should consider specifying in the agreement the general guidelines governing the nomination process - including the need to allocate nominations to all the important organizations concerned.

Notwithstanding the above observations, the program has been generally successful and the quality of the nominees in general quite good as evidenced by the six participants in the three month certificate program who are now or will shortly be pursuing an advanced degree at AIT on full scholarships.

5.3 Coal Utilization Management Training

The evaluation of this activity is based on discussions with program coordinators at AIT/COST in Thailand, the evaluation report prepared with participant inputs in September of 1987, an interview with one of the participants, and discussions with the U.S. program coordinator, IIE.

The above sources indicated that the participants gained an increased knowledge of the utilization of low grade coals and lignite and the U.S. experience with these fuels. Specifically, the course was perceived to be reasonably effective imparting knowledge on coal preparation, handling, and environmental technologies and weak in combustion and boiler design issues. The participants and ASEAN based coordinators were also in agreement that this training activity had several problems in its concept and implementation which detracted from the positive aspects of the training experience. Specifically:

- The announcement for the course stressed that the participants should be mid to senior level supervisors, managers, and planners. The participants felt the course was, in practice, much more geared to more junior level and plant personnel. As such there was perceived to be a fundamental mismatch between program content and the targeted audience. This was attributed to poor communications between ASEAN and U.S. organizers of the program.
- In some cases the selection of candidates was inappropriate. The course and field experience was of primary use to professionals responsible for the planning, design, and operation of lignite/low quality coal power plants. A background and interest in power plant design/operation was essential for effective participation. Several of the participants had backgrounds in such fields as geology and chemistry and came from university or research institutes. As such they had no, or little, knowledge or in interest in much of the subject matter.
- The "hands-on" training in the power plants was generally considered to be an inappropriate use of mid to senior level professional time, of unnecessary duration, and only marginally effective in contributing to the capabilities of the participants. Reportedly, the activity was not well coordinated with other aspects of training and participants could not generally ask questions during this eight week period of knowledgeable engineers about details of plant functions; i.e. the only people available for discussion were usually plant operational staff having a narrow view of their particular activity.

It appears that this aspect of the training component requires considerable review so that future programs will be more effective.

5.4 Trade and Investment Linkages

The component 2 activities have helped train mid and senior level staff in many of the organizations involved in ongoing policy discussions on cogeneration, private power, and expanded use of lignite and coal. The implementation of these policies will have important trade/investment ramifications for the U.S. industry. Specifically, the U.S. industry has a strong competitive position in many of the equipment and service technologies associated with the above areas. Examples include engineering of cogeneration facilities, advanced metering and switchgear technologies, environmental instrumentation, coal handling and cleaning technologies, and power plant environmental control equipment.

The strong position of U.S. firms in environmental equipment and engineering should be of particular importance over the coming years due to increased worldwide concerns on such issues as acid rain, deforestation, and global warming.

9

APPENDIX A

PERSONNEL INTERVIEWED DURING EVALUATION

A list of the personnel interviewed during the course of the evaluation is provided here, sorted by country and affiliation category.

INDONESIA

Government

Ir. Noer Saijidi, Director of Public Buildings, Public Works Department

Ir. Atayanto Mochtar, Directorate of Public Buildings, Public Works Department

Ir. Tony Wisnu, Directorate of Public Buildings, Public Works Department

Ir. Noraya, Directorate of Public Buildings, Public Works Department

Private Sector

Ir. Rana Jusif, Consultant

Utility

Irzal Chatab, Directorate General for Electricity and New Energy

MALAYSIA

Government

En. Mohd. Annas Hj. Mohd. Nor, Head, Energy Unit, Ministry of Energy, Telecommunications and Post

Mr. Chin Shih Loon, Assistant Secretary, Ministry of Energy, Telecommunications and Posts

Mr. Nizar, Public Works Department, Ministry of Works

Mr. Satkunanathan, Public Works Department, Ministry of Works

University

Prof. K. S. Kannan, Universiti Teknologi Malaysia

Dr. Masjuki Hassan, Department of Engineering, University of Malaysia

Private Sector

Ng. Yong Kong, Carrier (Malaysia)

Gerard B C. Tan, Marketing Manager, Cofreth

Utility

Dr. Salim Sairan, Senior Research Engineer, Research and Development Dept., National Electricity Board

51

PHILIPPINES

Government

Benjamin T. Damian, Executive Director, Philippine Council for Industry & Energy Research & Development

Renato P. Olegario, Chief, Science Research Specialist, Philippine Council for Industry & Energy Research & Development

Ms. Charise B. Tablante, Chief, Conservation Division, Ofiice of Energy Affairs

Alberto R. Dalusung, III, Director, Planning Services. Office of Energy Affairs

University

Geronimo Manahan, College of Architecture, University of Philippines

Private Sector

Jose A. Hilario, Director, Engineering Services, RNFA Consulting Engineers

Laurentino R. Punsalan, L. R. Punsalan and Associates

Irineo R. Amante, President, Amante Air Balance Co. Incorporated

Val S. Abeng, President of Philippine Association of Building Administrators

SINGAPORE

Government

Wong Wai Ching, Higher Executive Engineer, Building Control Division, Ministry of National Development

University

Peter Woods, School of Architecture, National University of Singapore

Wong Yew Wah, Senior Lecturer, School of Mechanical & Production Engineering, Nanyang Technological Institute

Dr. M B Ullah, School of Building & Estate Management, National University of Singapore

Dr. Chou Siaw Kiang, Mechanical & Production Engineering Dept., National University of Singapore

Private Sector

John Lim Hwee Chiang, Manager, Econoler Singapore Pte. Ltd.

Clarence Chung, System Engineer, Econoler Singapore Pte. Ltd.

Alex Adam Nangoy, Regional Manager, Trane Company, Singapore

THAILAND

University

Dr. Pibool Hungspreung, Rector, King Mongkut's Institute of Technology (KMITT)

Krissanapong Kirtikara, Vice President and Chairman, Materials Technology Programme, KMITT

Dr. Surapong Chirarattananon, School of Energy & Materials, KMITT (also, Division of Energy Technology, Asian Institute of Technology)

Prof. Prida Wibulswas, School of Energy & Materials, KMITT (also, Division of Energy Technology, Asian Institute of Technology)

Pattana Rukhamsuk, School of Energy & Materials, KMITT

Jinda Kaekiew, School of Energy & Materials, KMITT

Dr. Piyawat Boon-Long, Dept. of Mechanical Engineering, Chiang Mai University

Dr. Chutchawan Tantakitti, Dept. of Mechanical Engineering, Chiang Mai University

Utility

Khien Vongsuriya, Director, Thermal Power Engineering Department, Electricity Generating Authority of Thailand

Chaya Jivacate, Associate Director, Thermal Power Engineering Department, Electricity Generating Authority of Thailand

UNITED STATES

Government

Robert Archer, Energy Officer, Bureau for Asia and the Near East, USAID

Robert T. Dakan, Deputy AID Representative to ASEAN, USAID

Mark D. Levine, Head, Energy Analysis Program, Applied Science Division, Lawrence Berkeley Laboratory

University

Prof. Mark Bernstein, University of Pennsylvania

Mr. Steven Eben, International Institute of Education

Prof. Wes Foell, resident staff of Asian Institute of Technology

Private Sector

Joseph Deringer, the Deringer Group