ENERGY CLUSTER EVALUATION

Vietnam - North-South Transmission Line

Cambodia - Oudong District Hospital Technical Assistance Project

Cambodia - Hospital Engineering Project

Thailand - Lignite Mines Development Phase 3

This evaluation was undertaken by external consultants and as such does not necessarily represent Australian Government Policy.

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ABBREVIATIONS

AC	alternating current
AIDAB	Australian International Development Assistance Bureau (now AusAID)
ARC	Australian Red Cross Society
AusAID	Australian Agency for International Development
CRC	Cambodian Red Cross
DIFF	Development Import Finance Facility
EGAT	Electricity Generating Authority of Thailand
EVN	Electricity of Vietnam (responsible for power generation, transmission and distribution)
HEP	Hospital Engineering Project (Cambodia)
LMDP	Lignite Mine Development Project (Thailand)
LMDP3	Phase 3 of LMDP
MoH	Ministry of Health (Cambodia)
MoE	Ministry of Energy (Vietnam)
MOSTE	Ministry of Science Technology and Environment (Vietnam)
NEB	National Environment Board (Thailand)
NGO	Non-Government Organisation
NSTLP	Vietnam North-South 500 kV Transmission Line Project (Vietnam)
ODA	Official Development Assistance
ODHTAP	Oudong District Hospital Technical Assistance Project (Cambodia)
OH&S	Occupational Health and Safety
PCR	Project Completion Report
PDD	Project Design Document
PIDC1	Power Investigation and Design Company 1 (Vietnam)
ppm	Parts per million
SCTQA	State Committee for Technical Quality Acceptance of MOSTE (Vietnam)
SO_2	Sulphur dioxide
TDS	Total Dissolved Solids

UNITS

The units used in this report are joules (J), litres (L), tonnes (t), metres (m), hectares (ha), grams (g), volts (V), and watt-hours (Wh), together with their multiples. Standard metric prefixes are used in this report:

micro (μ)	=	10^{-3} (thousandth)
kilo (k)	=	10^{3} (thousand)
mega (M)	=	10^{4} (million)
giga (G)	=	10^{9} (1000 million)
tera (T)	=	10^{12}
peta (P)	=	10^{15}

CURRENCY CONVERSIONS
May 1997

A$1.00 =	Cambodian riels (CR)	2021
	US$	0.760
	Thai baht (฿)	19.51
	VN dong (Đ)	8932

Average mid-rates for year against Australian $ and US$

Year	Australian dollars (A$)	US dollars (US$)	Thai baht (฿)	Cambodian riels (CR)	Vietnamese dong (Đ)
1990	1.000	0.7734	19.79	na	3879
1991	1.000	0.7599	19.39	na	6900
1992	1.000	0.6873	17.46	871	7704
1993	1.000	0.6775	17.15	1822	7351
1994	1.000	0.7770	19.54	1978	8549
1995	1.000	0.7452	18.57	1826	8214
1996	1.000	0.7968	20.19	2091	8805
1990	1.293	1.0000	25.59	na	5016
1991	1.316	1.0000	25.52	na	9080
1992	1.455	1.0000	25.40	1267	11209
1993	1.476	1.0000	25.32	2689	10850
1994	1.287	1.0000	25.15	2545	11003
1995	1.342	1.0000	24.92	2451	11023
1996	1.255	1.0000	25.34	2624	11050

Source: Asian Development Bank, *Key indicators of developing Asian and Pacific countries*

MAP

EXECUTIVE SUMMARY

As part of AusAID's revised approach to environment review, ex-post evaluations were undertaken of a cluster of four, energy-related projects comprising: the North-South 500 kV Transmission Line Project in Vietnam (NSTLP), the Oudong District Hospital Technical Assistance Project (ODHTAP) and Hospital Engineering Project (HEP) in Cambodia and the third phase of the Lignite Mine Development Project (LMDP3) in Thailand.

All evaluated projects had a substantial focus on institutional strengthening, and included capacity building and training components. NGOs implemented two of the projects and the other two were under bilateral country programs. The sustainability and development impacts of the projects are assessed within the overall development context in which they were designed and implemented. Detailed consideration is given to environmental issues, but within a wider evaluation context which considers social, economic, technical, financial and institutional factors as well as broader policy issues and the key factors governing project success and sustainability.

The Projects

The North-South 500 kV Transmission Line Project in Vietnam (NSTLP) was undertaken in four phases between 1992 and 1994 at a total cost of A$6.5 million. Australian aid funded technical assistance for design and construction checking, commissioning and initial operation of Vietnam's first 500 kV transmission line. Australian involvement in the project was approved rapidly in response to a priority request from the Government of Vietnam, after construction of the line had commenced and it had been made a national project under control of the Prime Minister. The line was built in two years at a cost estimated at A$700 million and represents a significant engineering achievement. Australian assistance ensured that performance standards were achieved. The 1,500 km line is now carrying an average of around 200 GWh per month to Vietnam's central and southern regions and is making a major contribution to the alleviation of power shortages in these areas. Without Australian assistance, it is likely that commissioning would have been delayed and significant additional expenditure required for control equipment. While Australia's quick response was necessary if the assistance was to be effective, it caused some minor difficulties for both AusAID and the Australian contractor in managing the Australian inputs into the project.

The Oudong District Hospital Technical Assistance Project (ODHTAP) in Cambodia provided assistance to the hospital in Oudong district, 40 km north west of Phnom Penh at a cost of A$628,000. The main components were support to District Health Service staff and provision of a solar/diesel power system, a laboratory and water supply. Improvements initiated under the project, such as the tuberculosis ward, helped increase the hospital's outpatient services from 2,000 outpatient days in 1992 to 9,000 in 1995 and lifted the in-patient days during 1995 to 10,000, an increase of 600 percent over 1992. Although the solar system was intended as a pilot project, no replication of the technology has occurred because of the cost and complexity of the equipment. One aspect of the project was to establish a 'mobile technician team' to service hospital equipment. This formed the basis for the follow-on Hospital Engineering Project (HEP) which commenced in March 1995 with an AusAID contribution of A$246,000. The original technician team was to be enlarged and its responsibilities extended to five hospitals. With over half the equipment in many Cambodian hospitals not functioning, the demand for such a service was large.

Overall, the two projects succeeded in increasing the capacity and capability of Oudong Hospital and laying the foundation for an effective hospital equipment repair service. The flexible approach adopted increased the relevance of the projects in a difficult political and economic situation. Despite this, some of the problems experienced and changes required could have been avoided through more detailed project preparation and institutional analysis. The projects could usefully have focused more on issues of sustainability, by identifying long-term institutional needs at an earlier stage.

The third phase of the Lignite Mine Development Project (LMDP3) in Thailand was implemented between 1992 and 1996 at a cost of A$16 million. In addition to continuing operational work commenced under prior phases, LMDP3 focused on environmental management and occupational health and safety. The mine is now operating at, or close to, best international practice, and is among the leaders in Asia in relation to many of its programs, particularly in maintenance and reclamation. Lignite production increased from 11 million tonnes in 1991 to 15.4 million tonnes in 1996 supported by the project's continuous improvements in equipment monitoring and maintenance systems. The steady decline in maintenance cost per plant item, combined with high levels of equipment availability, eliminated the need for the Electricity Generating Authority of Thailand to acquire new earth-moving plant at a cost in excess of A$50 million. The benefits of the maintenance component are estimated to have been 3.6 times greater than its costs, a very high return on investment.

Management and operational capability improved under the project, assisted by technical study awards in Australia and in-country training, and the introduction of a number of computerised systems. The project contributed to an improvement in the operational health and safety (OH&S) status of the mine with personal injury accidents declining from around fourteen per million working hours in 1991 to six in 1996. However, equipment accidents have shown an upward trend and contractor operations still need to be integrated into the mine's OH&S system. Positive impacts of LMDP3 are evident in the land reclamation and environmental areas, though further work on environmental analysis and planning is required.

Lessons Learned

All four projects met most of their objectives and were generally successful, making a positive contribution to the respective implementing institutions and generating positive economic returns. In addition to several project-specific lessons (discussed in the individual project chapters), the projects allow a number of general lessons to be drawn from AusAID's experience in the energy sector.

Institutional strengthening: The factors essential in successful institutional strengthening projects were found to be an understanding of the institutional framework and culture of the target organisation; the need for long-term interventions; existence of operational incentives for acceptance of the assistance; co-location of the advisers and the use of local language.

Sustainability: Earlier and more in-depth investigation of the resources and constraints which promote and hinder project sustainability and replicability after the end of expatriate support and financial inputs would improve the long term benefits from the aid activities.

Transition: The transitional financing mechanism used following the Lignite Mine project is a useful way to assist organisations towards independent operation as it allows project activities to be taken forward in a controlled manner with the organisation taking greater financial responsibility.

Environment: The recognition that environmental issues are an important part of energy sector projects and not just an 'add-on' is vital to the success of these activities. High-level support for environmental management ensures its integration into project activities, adequate funding and long-term sustainability.

Financial and economic analysis: Indicative financial and economic analysis are essential as they force project designers to think about the economic benefits that should result from the intervention and how to maximise them, as well as providing a basis for ex-post evaluation.

Pilot projects: Pilot projects should be carefully monitored and the results publicised, whether or not the pilot project is classed as successful and replicable, so that implementing agencies and other institutions can learn appropriate lessons from pilot project results and conclusions.

Training: When a major and ongoing training program is envisaged, there may be merit in attempting to institutionalise the program. Course reports should be prepared for all training activities.

Evaluation Strategy

This cluster evaluation is the first conducted under AusAID's mainstreaming approach to environmental review which includes an environmental systems audit every third year and a 'cluster' evaluation of environment-related project in the intervening years. This approach establishes a more comprehensive framework for environmental review, better suited to assisting with activity preparation. The scope of the present evaluation is to assess the sustainability and development impacts of four projects within the overall development context in which they were designed and implemented. Detailed consideration is given to environmental issues, but within the usual evaluation approach of considering the key factors for a successful development activity - social, economic, technical, financial, institutional and broader policy factors. Particular attention is paid to analysis of the lessons which can be learned from the projects, to assist in future energy sector and more generally project design.

The Report

The first chapter of the report comprises information on the methodology used in this evaluation, outlines the importance of the energy sector in Asia and in the Australian aid program and gives details of the four projects and a consolidated account of the lessons learned. Following this are three chapters which each comprise a project evaluation report. The first is of the Vietnam North-South Transmission Line Project, the second is an evaluation of the two Cambodian projects and finally the evaluation of the Thai Lignite Mine Development project forms Chapter 4. There are also a number of appendices associated with each chapter, providing further information on each of the activities.

1. INTRODUCTION AND OVERVIEW

1.1 EVALUATION APPROACH

Four completed energy-related projects funded by AusAID were selected for ex-post evaluation:

- North-South Transmission Line Project (NSTLP Vietnam, Bilateral);
- Oudong District Hospital Technical Assistance Project (ODHTAP) and the follow-on Hospital Engineering Project (HEP) (Cambodia, NGO-Bilateral); and
- Lignite Mine Development Project Phase 3 (LMDP3 Thailand, Bilateral).

The projects cover conventional and renewable energy sources and projects implemented by NGOs and under bilateral country programs.

1.1.1 Environmental Review Procedures

This cluster evaluation is the first conducted under AusAID's mainstreaming approach to environmental review. Between 1991 and 1994, AusAID undertook annual environment audits of Australia's overseas aid program. These provided valuable feedback on the extent to which environmental concerns had been incorporated into aid activities and identified areas for improvement and lessons for future practice.

The last review of the treatment and management of the environment in Australian aid activities, *1994 Environment Audit of the Australian Overseas Aid Program*, was essentially a cluster evaluation of seven projects, but was limited to environment-related factors. It recommended that representative samples of AusAID-funded activities should be evaluated periodically from an environmental perspective.

> "AusAID will move to a new environment review cycle in which there will be an environmental systems audit every third year. In each of the intervening years, an evaluation of a cluster of environment related projects will be undertaken. The first of these impact evaluations will examine projects in the energy sector, including renewable energy activities." (Director General's Foreword)

AusAID has revised its environmental review process along these lines. This approach establishes a more comprehensive framework for environmental review, better suited to assisting with activity preparation. The scope of the present evaluation is to assess the sustainability and development impacts of four projects within the overall development context in which they were designed and implemented. Detailed consideration is given to environmental issues, but within the usual evaluation approach of considering the key factors for a successful development activity - social, economic, technical, financial, institutional and broader policy factors. Particular attention is paid to analysis of the lessons which can be learned from the projects, to assist in future energy sector and more generally project design.

The analysis of a range of factors in this cluster evaluation is in keeping with AusAID's wider environmental policy. Sustainable development requires the integration of economic and social as well as environmental considerations in the design and delivery of the development cooperation program. AusAID's environmental policy promotes both a broad range of environmental activities and the mitigation, when appropriate, of possible adverse impacts on the environment. It does not imply that projects must have no adverse environmental impacts. Indeed, non-environmental sustainable development concerns may, in certain circumstances, take precedence in the short term over environmental values. In such cases it is clear that

informed judgements are required regarding possible trade-offs and the longer-term potential for recovery. The examination of energy sector activities in this cluster evaluation provides a perspective on the trade-offs between economic, social and environmental concerns.

1.1.2 Cluster Evaluation

Cluster evaluation, covering a group of projects from the same country or within one sector (energy in this case), allows common themes and issues to be highlighted. Significant cost savings in the evaluation process are also achieved, which may make it cost-effective to evaluate small projects which would otherwise be unlikely to receive detailed ex-post evaluation.

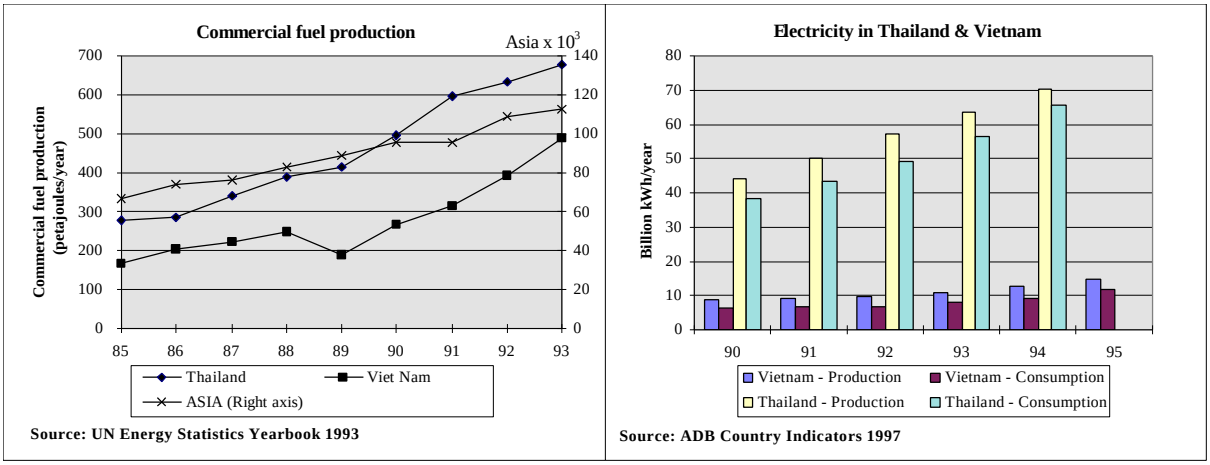
This report focuses on relevant aspects of the four energy sector projects and presents the findings of a post-evaluation mission during May 1997. Assessment is made of the projects' effectiveness in terms of achieving their objectives and sustainability.

The evaluation is based on a review of the Project Completion Reports (PCRs), material in AusAID files, and discussions with staff members of AusAID desks (in Canberra) and posts (in-country), the executing agencies and other in-country agencies. The evaluation was undertaken over a nine-week period between April and June 1997. This included a two-week period planning the field mission and reviewing documents in AusAID's Head Office in Canberra, followed by three weeks in the field with the preparation of field reports. The evaluation report was then finalised in Australia. Copies of the draft report chapters were provided to the executing agencies and relevant AusAID staff for review. Comments received were taken into consideration in finalising the report.

1.2 ENERGY IN ASIA

The Asian region includes the fastest growing economies in the world. The Thai economy has grown rapidly through most of the 1980s and 90s. Vietnam also commenced rapid growth in the early 1990s following the adoption of a market-oriented economic system in 1989. This growth has been reflected in both domestic fuel production and total energy consumption, as shown in Figure 1-1. Cambodia is not identified as producing any

Figure 1-1 Commercial fuel production and electricity production/consumption in Thailand and Vietnam



commercial fuel and was reported to use less than ten petajoules of commercial energy by 1993. While Vietnam's energy production grew steadily from 1989 - due to both coal mine and natural gas development, its consumption only commenced rapid expansion in about 1992, and then at a far lower rate of increase than Thailand. It is likely that Vietnam will have experienced faster growth in energy consumption since 1993 and is expected to closely parallel Thailand over the next few years. This trend is already evident in Vietnam's electricity demand, as discussed in Chapter 2 on the Vietnam North-South Transmission Line project.

1.3 AusAID ACTIVITIES IN THE ENERGY SECTOR

Energy contributes to many aspects of life, from cooking and heating to health services, transport, communications, agriculture and manufacturing. Energy growth and economic growth in developing countries go hand in hand, with higher energy consumption being linked to higher standards of living. The rapid growth in energy demand in developing countries is expected to continue due to population growth, economic growth and expansion in access to electricity supply by urban and rural communities.

AusAID recognises the importance of reliable energy supplies in assisting development. In 1996/97 AusAID is estimated to have provided almost A$50 million to energy sector projects in the Asia-Pacific region (Table 1-1) or 3.4 percent of Australia's total official development assistance (ODA). This is a substantial increase over the early 1990s when energy sector expenditure amounted to around A$5 million annually.

Table 1-1 AusAID's energy sector expenditure and total Australian ODA

	Total ODA (A$ million)	Energy sector (A$ million)	Energy as % of total ODA
1990/91	1311	4.4	0.3%
1991/92	1330	6.9	0.5%
1992/93	1386	23.1	1.7%
1993/94	1411	78.2	5.5%
1994/95	1484	35.6	2.4%
1995/96	1563	8.1	0.5%
1996/97[a/]	1450	49.9	3.4%

Note: a/ Estimated.
Source: AusAID (1997, 1995b)

Energy sector projects tend to be lumpy, contributing to the wide variation in sectoral expenditure over time. The high levels of expenditure on energy projects in 1993/94 and 1994/95 were associated with large Development Import Finance Facility (DIFF) projects in the conventional energy sector. The fall in expenditure corresponds with the abolition of the DIFF, as in 1994/95 50 percent of energy sector expenditure was DIFF-related. The high 1996/97 estimated expenditure relates mainly to two large mixed credit solar energy projects.

The provision of aid money for energy sector development, particularly for conventional energy sources, has its detractors who emphasise the negative environmental impacts of energy use. The major environmental issues associated with energy use include the emission of greenhouse gases; localised air and water pollution; visual impacts; land use conflicts; associated construction and transportation impacts; and waste management and disposal. Although on a global scale, environmental emphasis is currently on reducing greenhouse gas emissions, reducing local pollution is often a higher priority for developing country governments.

Any decision to implement an energy sector project cannot be based purely on environmental grounds, the development benefits of energy supply are large and have to be balanced against environmental concerns. Hence this evaluation is important in that it places the energy-related projects in a wider context than under previous environmental audits.

1.4 PROJECT SUMMARIES

1.4.1 North-South Transmission Line

Objectives

Construction of the North-South 500 kV transmission line in Vietnam commenced in early 1992 as a high priority project promoted at the highest political levels. Vietnam's Ministry of Energy (MoE, later incorporated into the present Ministry of Industry) and a number of other institutions (including the World Bank) had reservations about local capacity to meet the demanding technical requirements of the line. The Vietnamese government, therefore, sought technical assistance in checking the design, commissioning and preparation for operation of the line.

Australian-funded assistance was provided in four phases:

Phase 1 (September 1992 to December 1992) Appraisal of overall design of the transmission line;

Phase 2 (December 1992 to 30 June 1993) Provision of detailed advice on aspects of the design and preparation of a project design document for future project activities;

Phase 3 (1 July 1993 to 30 September 1994) Provision of services to achieve safe and effective operating parameters for the system, including operator and supervisor training in Australia; and

Phase 4 (1 October 1994 to 30 June 1995) Assistance in the commissioning and acceptance of the line and in-country training in line operation.

The overall goal of the project was reasonably clear, if not explicitly stated - to ensure that the transmission line met its objectives in terms of power transmission capacity and reliability.

Implementation Performance and Project Results

The 1500 km north-south transmission line was completed in a little over two years at a cost of around Đ5.5 trillion (A$700 million). It represents a major engineering achievement and is probably a record in relation to construction period for a line of this length and capacity. Commissioning of the line was completed successfully, about one month behind schedule. Subsequent performance has improved steadily and the line is now operating at close to its design parameters in relation to power transmission and interruptions. An average of over 200 GWh per month was transferred to central and southern Vietnam in 1995 and 1996. At an average wholesale value of around A$50 per MWh, this represents imputed earnings of around A$130 million per year. Transmission line outages have fallen steadily to reach an average of two per month in 1996, but are still above the design level of one per month.

The south continues to require power from the north to meet its deficit. However, since the low hydropower production seasons occur at a similar time in both regions, seasonal constraints on electricity supply have not been fully solved by line construction. The duration

of the southern deficit is also likely to be short, and the need for net transfer of power from the north may disappear by about the year 2000. After this, the power line will continue to serve a useful role as the backbone of the national electricity grid, allowing temporary imbalances in generation between regions to be overcome and all regions to purchase from the most economic available power source. A move towards efficiency pricing of electricity and establishment of regional transmission and distribution profit centres will be required before the grid can become fully efficient from an economic perspective.

Australian inputs were most valuable in preparing for operation. In addition to equipment checking, this included the establishment of monitoring and control systems and operating procedures. NSTLP undertook operator and supervisor training in Australia (Phase 3) and Vietnam (Phase 4). In addition, project activities provided the technical foundation for the MoE and the Quality and Technical Acceptance Committee to accept the line and proceed to commissioning. These services were provided for less than one percent of the cost of the line and are considered to have been cost-effective. However, the location of the project team and the lack of formal interaction with Power Investigation and Design Company No 1 (PIDC1, responsible for the design and construction supervision of the line), meant that little transfer of technology was intended or achieved during Phases 1 and 2.

During Phase 3, thirty engineers spent up to three months in Australia studying 500 kV transmission system operation. This training was invaluable in ensuring the smooth commissioning and operation of the line. The engineers who had trained in Australia conducted further in-country training for staff from the sub-stations and load despatching centres under Phase 4 of NSTLP. Because training in Australia had focused on technology and little on training methods and approaches, this in-country training was not fully effective.

Conclusion

NSTLP is considered to have been successful. It contributed substantially to its implicit objective - the successful and timely commissioning of the North-South Transmission Line. The operational performance of the line has improved steadily since commissioning, and it is now meeting close to its design parameters in terms of power supply and interruptions. It has contributed to a marked reduction in power shortages and interruptions in the south and reduced the need to spend hard currency on imported fuel for thermal power generation. The capacity of Electricity of Vietnam (EVN) to operate 500 kV systems has increased greatly, in large part due to the project, and it is expected that future 500 kV lines will be designed, constructed and commissioned with relatively little international technical assistance. After the end of the northern hydropower surplus period in about the year 2000, the transmission line will remain a valuable national asset as the backbone of the national electricity grid.

While the project achieved its objective, and technical assistance inputs were generally cost-effective, the fast-track nature of the project caused a number of problems. In part these related to the highly technical nature of the project, which made it difficult for AusAID to manage the Australian inputs into the activity. They also resulted in the need to make frequent ad hoc decisions and prevented the adoption of a ‘normal’ project design path and tendering procedures. While these were generally accepted by the Australian industry, they can be considered to have led to less than optimal technology transfer, due to the location of the initial phases remote from the designers and project supervisors.

1.4.2 Oudong District Hospital Technical Assistance/Hospital Engineering

Objectives

At the time of project design, AusAID had already provided assistance through the Australian Red Cross (ARC) to Kompong Speu provincial hospital for a number of years. These two activities implemented by ARC continued this stream of assistance. Oudong District Hospital Technical Assistance Project focused on district level activities and was intended to upgrade the medical services provided by the hospital over a two-year period from 1992. It included a pilot component for the introduction of hybrid solar/diesel electricity generation and medical laboratory establishment.

One sub-component of the project was to establish a 'mobile technician team' to service hospital equipment. This provided the basis of the Hospital Engineering Project, which commenced in March 1995. This project was designed to provide long-term improvement in health service systems in curative and preventative health care in selected government hospitals in and near Phnom Penh. In addition to (i) establishing and training a 'hospital engineering team', the project was intended to: (ii) train hospital staff in equipment maintenance; (iii) construct and/or repair water supply, electricity and other systems at five hospitals; (iv) provide and/or manufacture selected, essential equipment for 10 hospitals; (v) provide solar/diesel power units to two remote area hospitals; and (vi) assist the Ministry of Health (MoH) Technology Committee in Phnom Penh with advice concerning hospital equipment.

Both projects have been followed by new projects: Oudong District Health Service Development and Hospital Engineering Project Extension (HEP Extension) respectively.

Implementation Performance and Project Results

Oudong District Hospital Technical Assistance Project successfully established the solar/diesel system and laboratory. These continue to operate and the solar unit now supplies about twenty percent of the hospital's power requirements. It has been invaluable, particularly during periods when funds are not available to purchase diesel fuel. However, the system supplied proved to be too complex and expensive for Cambodian conditions and no replication has taken place. The unit has provided experience in solar technology for the hospital engineering team and this may be a basis for the future design and supply of low-cost solar units to health clinics. The project was able to support an increase in activity at the hospital, though the planned purchase of drugs was cancelled because of problems experienced in relation to district health service administration. The costs saved were diverted into construction activities, in particular the conversion of a disused warehouse to a tuberculosis ward, which has proved to be an asset for the hospital and district.

The hospital engineering team was established successfully under the Hospital Engineering Project. The team was trained and provided effective support to the five hospitals as planned. Few records of its activities are available however, and it is not possible to quantify its performance. Although it was envisaged that the team would be self-supporting by the end of the project, this was not achieved. However, the value of the team was evident and AusAID supported the expansion of the team under the ongoing HEP Extension.

The remote area hospital power schemes were not proceeded with, following further analysis of the merits of solar and diesel units. This conclusion could probably have been reached

earlier which would have improved the design of the HEP and removed the need for major change in objectives during the project period. Equipment manufacturing was also dropped when it was found that better quality equipment could be imported from regional countries at lower cost than local fabrication. Little training of hospital staff occurred apart from some on-the-job training during maintenance visits.

Conclusion

Both projects made a useful contribution to the establishment of improved hospital services during a difficult period of Cambodia's development. The ARC and its counterpart CRC showing motivation and skill in implementing the two projects evaluated and demonstrating flexibility and rapid response to changing situations. The frequent changes in direction of the projects can be seen at one level as indicating commendable responsiveness to changing circumstances in a difficult institutional and political environment. However, at another level they can be seen as indicating inadequate planning and institutional analysis during project design and early implementation.

The capacity and capability of Oudong District Hospital have increased greatly since the commencement of the project. In large measure, this reflects the inputs and efforts of the project, and also a general strengthening of the Cambodian economy and health service after many years of war and political uncertainty. The hospital has been established as a viable institution, with functioning services and a tuberculosis ward developed by the project. In terms of hospital usage, outpatient days increased from around 2,000 in 1992 to 9,000 in 1995/96. However the Cambodian health service remains severely under-funded and the general level of service at the hospital will not improve greatly until this situation changes. World Bank, Asian Development Bank and AusAID projects are commencing. These will inject much needed funds into the health system. In combination with a restructuring being promoted by the World Health Organisation, the projects will further improve health service delivery through Oudong and other district and provincial hospitals.

The Hospital Engineering Project made a useful contribution to the repair of hospital equipment and laid a foundation for an effective hospital equipment repair service. The project was followed immediately by the HEP extension project that expanded the team and extended coverage to a national level.

Issues mainly relate to the sustainability of both projects. Although the institutional environment in Cambodia makes operation difficult, it is considered that the projects needed to focus more on this issue to ensure the continuation of project benefits after the end of external assistance. More careful analysis during design of the technical and institutional aspects of the projects may have led to greater and longer term impact. Although HEP Extension still has 18 months to run, further efforts are necessary by ARC and the Cambodian Red Cross if the team is to continue to operate effectively after the end of project support.

1.4.3 Lignite Mine Development Project Phase 3

Objectives

Australian assistance to EGAT's Mae Moh lignite mine in north Thailand commenced in the 1970s with geotechnical advice. The first phase of the Thai Lignite Mine Development Project

(LMDP) commenced in 1983. Phase 3, the subject of this evaluation, ran for four years from June 1992.

The project goal for Phase 3, stated in the project design document, was to achieve:

> "successful implementation of each of the annual mining plans for the period 1992-95 in accordance with the medium term mining plan in order to assist in reducing Thailand's dependence on imported energy by cooperatively developing viable indigenous energy reserves, and to contribute to the amelioration of environmental problems associated with coal resource development". (AIDAB 1992)

According to the contract with the managing contractor, LMDP3 was intended to: (i) assist in the efficient planning, operation and management of the Mae Moh lignite mine; (ii) contribute to mine planning, operation and management in accord with the policy objectives of the Thai and Australian governments, particularly in relation to environmental and occupational health and safety policy objectives; and (iii) to assist internationally competitive Australian firms to sell goods and services to EGAT on a commercial basis.

Component objectives included: (i) completion by EGAT of annual mining plans and meeting of operational targets for coal mining and waste removal; (ii) integration of maintenance planning with material and spare parts procurement and achievement of target maintenance and supply measures; (iii) the successful development and implementation of annual and medium-term environment management plans; (iv) Occupational Health and Safety (OH&S) program operative in all divisions of the Mine Operations Department; and (v) professional managerial staff efficiently controlling divisions and sections with information systems in place which support the managerial, administrative and operational functions of the Mine Operations Department.

Implementation was intended to be flexible and responsive to mine development requirements. The detailed activities were, therefore, modified as required in the annual plans prepared by the managing contractor and particularly by the mid-term review of July 1994. This recommended 64 additional short-term technical advisory assignments mainly in the Mine Planning and Operations area, and establishment of a Coal Technology Training Centre and a mine rescue team.

Implementation Performance and Project Results

Between 1991 to 1996, annual lignite production at Mae Moh expanded from 11 million to 15.4 million tonnes. The mine has met the demands of the power station throughout the project period and also added to its long-term stockpile of lignite. Australian assistance played a key role in the efficient development and operation of the mine, under all phases of LMDP and assisted EGAT in meeting its annual and medium-term mine plan production targets.

Occupational health and safety improved under the project, following introduction of a modified version of the Australian 5-star system. Personal injuries per million working hours have fallen by over half since 1987, but a recent upward trend for equipment accidents indicates that problems remain. Further efforts are required, both for EGAT operations and to integrate contractor operations into the health and safety system.

Under the project, work continued on equipment monitoring and maintenance systems. Most of the EGAT trucks and shovels continue to operate effectively despite many being about fifteen years old. Increased levels of preventative maintenance as well as the introduction of

condition monitoring have led to a steady decline in maintenance costs per plant item while maintaining high levels of availability.

Significant training was undertaken under LMDP3 with emphasis on management development, English language and operator/supervisor training. A total of 107 'technical study awards' were made for EGAT staff to undertake study tours and/or attend conferences in Australia. Overall, the impact of the training program under LMDP3 has been very positive, in relation to both formal instruction and to on-the-job technology transfer. However, no evaluation of training activities appears to have been undertaken. In addition to allowing assessment of the training activity, this may have assisted EGAT's training division in the development of the mine's own training program. The Coal Technology Training Centre promoted during Phase 3 has yet to be formally established. The involvement of an outside institution in reviewing courses, setting standards and awarding qualifications would be beneficial and could further increase the effectiveness of training programs. EGAT's in-house training program is well-established and is using several of the initiatives commenced under LMDP, for example in the occupational health and safety training area.

LMDP3 has had a number of positive financial impacts. Notable are the improved maintenance capacity and systems which have reduced the annual cost of maintenance per equipment item and eliminated the need for EGAT to acquire new earth-moving plant at a cost in excess of A$50 million. This, combined with the more efficient use of the mining plant, (largely as a result of operator and supervisor training) has contributed to the major savings in mining and overburden removal cost. Unit cost of coal removal has declined by 2.5 percent per year since 1992 in current cost terms. An analysis of the benefits and costs of the maintenance component indicates a benefit/cost ratio of the order of 3.6:1, a high rate.

In addition to the benefits to EGAT, the project has been instrumental in assisting Australian businesses to sell goods and services to Mae Moh and to other mining and related activities in Thailand. The project team estimated that the value of contracts entered into over the thirteen-year life of LMDP at around A$700 million of which A$400 million related to Phase 3.

The project assisted in establishing the environmental monitoring systems and procedures at Mae Moh. Useful data have been collected and presented. However, the extent of analysis has been limited and efforts are required to interpret and use the data for improved environmental management. Water quality in Mae Moh reservoir continues to deteriorate (though remaining within the national target for dissolved salts) caused mainly by power station effluent, while dust and noise are problems for residents living near the mine.

The reclamation program is proceeding satisfactorily, with a major focus on forestry. The wetland program, assisted by the project, is impressive and achieving useful reductions in pollutants. Since funds are set aside for reclamation at the time of mining, there is every reason to expect that the reclamation program will continue and become a major success. This story, together with other positive environmental achievements (such as the fitting of flue gas desulphurisation systems to the power station units) are at odds with Mae Moh's public image.

Conclusion

The Mae Moh lignite mine achieved its mining targets during the four-year project. Although the postponement of power station expansion has limited the growth in lignite demand and reduced the proportion of coal mined by EGAT (as opposed to contractors), the mine has

operated efficiently and profitably over the project period. Occupational health and safety results have shown improvement, though further commitment is required. Reclamation programs are proceeding smoothly and both wetland development and forestry plantings have shown impressive performance. Further work is considered necessary in the environmental planning area. Overall, the mine is operating at or close to best international practice, and is believed to be among the leaders in Asia in relation to many of its programs, particularly in maintenance and reclamation. EGAT and mine staff are justifiably proud of their performance, assisted by LMDP over a thirteen-year period. LMDP3 component objectives have generally been met and the evaluation team considers the project successful.

1.5 LESSONS LEARNED

Several issues are highlighted by the project evaluations. These are discussed in detail in the chapters on the individual projects. In addition a number of general themes can be identified, from the experience of two or more projects and conclusions drawn relating to energy sector project design and implementation; these may have wider relevance.

1.5.1 Project Design and Management

Three of the four projects evaluated (LMDP3, ODHTAP and HEP) followed from earlier AusAID-supported projects or project phases. The fourth project (the North-South Transmission Line Project in Vietnam) was effectively a 'rapid response' technical assistance project. Of the four, only LMDP3 was appraised by AusAID prior to implementation and had clearly defined objectives. The other projects did not have clearly stated objectives at the outset and changed their objectives during implementation.

- Appraisal by AusAID, independently of the project designers, would probably have assisted the other projects through clarifying their objectives and risks, and resulted in improved implementation performance and outcomes.

During ex-post evaluation, it has been difficult to identify key project data from project records and documents. In some cases the reports required by the LMDP3 contract have not been prepared and in others (as in the case of some PCRs), the reports give limited useful information. Information relevant to project monitoring (such as short-term consultant person-month inputs) is not recorded, while none of the projects collected data on counterpart inputs or costs.

- Managing contractors should ideally review monitoring requirements at design and AusAID should certainly do so during implementation to ensure as far as possible that appropriate monitoring programs are designed and implemented and that records are preserved and accessible.

1.5.2 Institutional Strengthening - Factors for Success

All of the projects had institutional strengthening objectives, though at markedly different levels. Phases 3 and 4 of the Transmission Line Project strengthened Electricity of Vietnam's (EVN's) 500 kV transmission operations, substations and despatching centres but did not attempt to increase its capacity to design and implement similar projects. ODHTAP and HEP in Cambodia both operated under a difficult institutional climate. The Lignite Mine Development Project made a major contribution to EGAT's institutional development, and

assisted in building a much stronger and more competent organisation. Table 1-2 summarises this experience and some of the factors affecting success of institutional strengthening projects.

Table 1-2 Factors affecting success of institutional strengthening projects or components

Factor	NSTLP (Vietnam)	ODHTAP/HEP (Cambodia)	LMDP (Thailand)
Duration	Phases 1-2 - 9 mths Phases 3-4 - 2 years	ODHTAP and successor project 5 years (to date)	13 years (3 phases)
Sector	Government	Government/NGO	Semi-government
Financial / operational incentives	None directly relating to improvement in capacity and capability, but sense of pride probably provided incentive to trainees. Financial incentives to participate in overseas training probably strong	Under-resourced government hospital. External institutional environment not conducive to sustainability	Commercial mine with directly measurable performance gains from the adoption of technology and systems
Objectives	Training objectives specified, but wider institutional objectives not clear	Not clear for institutional strengthening component	Clearly specified
Language	Limited preparation of material in Vietnamese	Up to 12 months language training provided prior to training in Australia	Contracted with specialist institution to conduct English language training
		Little translation of project material into Khmer	Little translation of project material into Thai

A number of conclusions can be drawn from the experience of the four projects:

- institutional development is often difficult to achieve within a short time-span. Projects with institutional strengthening objectives need to take this into account and build in follow-on phases as required. In the case of HEP, the period needed to institutionalise the team and make it self-supporting could have been recognised at the start of the project (for example based on ARC's experience in Thailand) and a longer term intervention planned at the outset. LMDP, which extended over three phases and thirteen years, owed its success at least partly to its long duration.

- 'ownership' of the technical assistance by the implementing agency or the institution being strengthened is essential. Institutional strengthening is easier where financial and/or operational incentives exist, as in a production-focussed entity such as EGAT's Mae Moh mine. It is far harder in organisations that rely on government budget for operation and investment, particularly where these are under-resourced. Ways to build in non-financial incentives need to be found. In the case of the transmission line, the political nature of the project, combined with a pride in the technology and engineering achievement are believed to have contributed to the success of the project.

- Knowledge of local language by advisers assists in maximising technology transfer. All projects were highly technical, and as a result, all chose to use English as the primary working language. This has merit in increasing the capability of counterpart staff and their confidence in dealing with English-speaking advisers and visitors. However, knowledge of local language by project staff and the translation of key project technical reports would

assist in maximising the impact of technical assistance both during the project and after completion.

1.5.3 Sustainability and Rapid Response

The Cambodian and Vietnamese projects involved rapid responses to particular problems. In each case, most targets were met and the projects were generally successful. However, each faced problems through being developed and implemented as a development assistance project with requirements for institutional strengthening and sustainability. The trade-off between achieving rapid results in the field (with expatriates working largely as 'doers' rather than advisers) and institutional strengthening has been widely recognised.

- Earlier and more in-depth investigation of the resources and constraints which promote and hinder project sustainability and replicability after the end of expatriate support and financial inputs would improve the long term stream of benefits from the aid activities.

1.5.4 Dependency and Transition

Projects often foster dependency and this occurred in all four projects being evaluated to a greater or lesser degree. Planning for transition to independent and sustainable operation is thus a key aspect of management. It may be tempting for both managing contractors and in-country agencies to seek to ensure that their project is extended. However, until such an extension is agreed to by AusAID, it is preferable to operate on the assumption that no extension will be forthcoming and to plan for transition.

- AusAID needs to give consideration to the termination or extension of projects in good time. In the case of a complex and long-term institutional strengthening project (such as LMDP), a minimum of two years' notice should be provided and preferably longer in order to allow institutions to adapt to the change and if necessary make budgetary provisions.

Following LMDP3, a Technical Advisory Fund was established to allow EGAT to engage Australian experts on a commercial basis. AusAID contributed A$400,000 towards the A$700,000 cost of the fund. This approach has merit, in requiring the in-country agency to take responsibility for selecting and engaging consultants and should have application in other projects.

- The concept of technical advisory funds, with assistance provided to in-country agencies for the commercial engagement of consultants, may be useful to promote self-reliance and smooth the transition to independent operation at the end of many institutional strengthening projects. However, such an approach should not be used simply to delay the need for independent operation.

1.5.5 Environment

Energy sector projects can have large negative impacts on the environment if important issues are not addressed at an early stage. In the long run, environmental factors can threaten the viability of the entire project. AusAID's original 1991 Environmental Assessment Guidelines require that ODA projects include environmental assessment and the process concerning this have been revised in the 1996 version of the Guidelines.

During the first two phases of LMDP, the main focus in the environmental area was on reclamation. Australian assistance to water quality monitoring was added mid-way through Phase 2. However, much of the activity in relation to environmental monitoring and improvement was undertaken in the last half of LMDP3. The relatively late focus on environmental aspects combined with the lack of immediate and apparent benefits has limited the broader acceptance and support for environmental management. The transmission line project contained no environmental component and the Vietnamese government has yet to provide adequate financial support for necessary remedial activities. In the case of ODHTAP, the most environmental-friendly fuel source was selected but the complex technology involved proved inappropriate and has resulted in a lack of replication.

- For activities with potentially major adverse impact such as mining, effective environmental management plans should be developed from the start.

- The recognition that environmental issues are an important part of energy sector projects and not just an 'add-on' can be integral to the success, or maximising the long term benefits, of these activities. Support for environmental management at the highest policy and management levels is necessary to ensure adequate funding and long-term sustainability.

1.5.6 Financial and Economic Analysis

None of the projects were subjected to financial or economic analysis at the time of design. While technical assistance projects may have less need for sophisticated economic analysis than investment projects, they are nonetheless usually intended to result in economic gains and at least an indicative financial and economic analysis should be undertaken. In addition to providing a basis for ex-post evaluation, such analysis would require the project designers to think about the economic benefits that should result from the intervention and how to maximise them. Both the 'without project' situation and the project boundary are not always easy to identify in technical assistance projects and in some cases 'cost effectiveness' may be a better measure of efficiency than full economic analysis.

None of the projects evaluated made any effort to identify local inputs or costs. While local costs in institutional strengthening projects are often difficult to separate from the wider operating costs of the institution, a basic recording system needs to be put in place to identify counterpart staff, training course and other project-related costs (eg, in the case of LMDP, software purchased to support the technical assistance program). This would not only allow economic analysis to be undertaken on the development assistance inputs, but would also demonstrate the commitment of the in-country agency and identify any problems experienced by the project in relation to counterpart funding and/or staffing.

- Projects should establish monitoring mechanisms for local costs and project benefits. Both cost and benefit monitoring should relate to the scale of the project, ie, should not require the use of project resources at a level that detracts from project efficiency.

1.5.7 Pilot Components

Oudong Hospital Project and the Thai Lignite Mine Development Project had small pilot project components. In neither case was any replication evident. This should not be classed as a failure, since pilot projects are mainly useful in testing the applicability of an idea before it is

developed on a broader scale. In this sense a negative conclusion is as valuable as a positive, and can prevent the waste of resources that full-scale implementation might involve.

- It is desirable that pilot projects are carefully monitored and the results publicised, whether or not they are classed as successful and replicable, so that implementing agencies and other institutions can learn appropriate lessons from the experience.

1.5.8 Training

The training delivered by all projects appears to have been effective and of high calibre. It was however notable that only one training course report could be located from the four projects (on the ODHTAP Management Course, which included an end of course evaluation by participants).

- Course reports, including where appropriate, needs analysis, objectives, course content, participant names and positions and (at least) an end-of-course evaluation, should be prepared for all training courses. In addition to providing a basis for assessing training performance, such reports should be beneficial in designing other courses under the project.

- Where a major and ongoing training program is envisaged, as under LMDP and also NSTLP, there may be merit in attempting to institutionalise the program, eg, by involving an external training institution in course design, accreditation, management, quality control and award of qualifications.

This was planned through the Coal Technology Training Centre concept in Thailand, but, despite strong management support, has yet to be realised. Such a development would mean that: (i) external review of the courses occurs and (ii) the qualifications gained have currency beyond the implementing agency. This should improve the calibre of the courses and their overall economic impact. In Vietnam, sub-station operation, load despatching and line maintenance, for example, could well be included in appropriate vocational training courses.

1.5.9 Technical Advice

Two of the projects (LMDP3 and NSTLP) were technically complex. AusAID has limited in-house capacity to review technical aspects of projects or to assess the quality of technical reports.

- For highly technical projects, the use of a technical advisory group, comprising Australian or international experts in an appropriate field, could assist AusAID and contribute to project monitoring, management and implementation. To take this further, the position of 'supervisory engineer' would allow for changes to the scope of services to be approved on AusAID's behalf.

1.6 EVALUATION RESPONSIBILITIES AND TEAM MEMBERSHIP

The evaluation was carried out by a team consisting of:

Mr Jonathan Cook	Sloane Cook & King Pty Ltd	Team Leader
Dr Robert Hutchings	BHP Engineering Pty Ltd	Energy Sector Specialist

The AusAID Task Manager was:
Ms Emma Ferguson Environment, Agriculture and Physical Infrastructure Section

A high level of support was provided by in-country agencies, government departments and AusAID posts in all three countries visited. This support included the provision of transport, staff time and information and was greatly appreciated by the evaluation team.

BASIC PROJECT DATA

VIETNAM NORTH-SOUTH 500 kV TRANSMISSION LINE PROJECT

Executing Agencies:

State Committee for Technical Quality Acceptance (SCTQA) of MOSTE
Ministry of Energy (MoE)

	Phase 1	Phase 2	Phase 3	Phase 4	Total
Long-term advisers[a/] (person-months)	6	15	33	18	72
Project Costs ($'000)	120.0	1102.5	4012.0	1099.7	6334.2
Contractor contribution	184.2				184.2
Estimated local contribution	na	na	na	na	na
Total project cost	304.2	1102.5	4012.0	1099.7	6518.4

a/ data on short-term adviser inputs not available

Key Dates:				
Feasibility study	-			
Appraisal	-			
Project design document (Phase 3)			Aug 1993	
Phase start	Sept 1992	Dec 1992	July 1993	1 Oct 1994
end	Dec 1992	June 1993	30 Sept 1994	30 June 1995
Mid-term review			14 Sept 1993	

2. VIETNAM - NORTH-SOUTH TRANSMISSION LINE PROJECT

2.1 PROJECT CONTEXT

2.1.1 Background

At the time of formulation of NSTLP in 1992, Vietnam had commenced a program of rapid development and industrialisation. In particular, the introduction of the policy of '*doi moi*' or economic renovation had led to rapid changes in the country's economic structure. Increased electricity supply was an essential ingredient of the program, and high priority was afforded to reducing the constraints posed by power shortages, particularly in the south during the dry season (March-June) when hydropower generation is low.

The completion of the Hoa Binh dam and power station 70 km south-west of Hanoi in the early 1990s, provided surplus power in the north, and presented the potential to transfer electricity to the south. Planning and design for the North-South 500 kV Transmission Line commenced in 1987, and gained momentum as the dam neared completion. The line was adopted as a 'national project' in early 1992, with a two year completion time. The line was afforded high priority and was placed under the direction of the Prime Minister of Vietnam.

The line was designed to: (i) reduce power deficits in the central and southern regions; (ii) act as the basis for a national electricity grid; and (iii) be a national 'link' project to promote a national identity. As a by-product, the project would contribute to foreign exchange cost savings due to the replacement of electricity generated by oil, gas or coal with hydropower. At the time of approval, the line was seen as the most cost-effective and rapid option to augment power supply in the south. The construction of new power stations would have taken longer, and would have involved the import of more equipment, while construction of the line was seen as a labour intensive rather than a technology intensive activity. Excluding the AusAID suport, the total cost of the line has been estimated at around Đ5.5 trillion (in current values) or about A$700 million, which was all funded locally.

2.1.2 Formulation

In early July 1992, when the Vietnamese Government requested Australian input into the transmission line, construction had been underway for about three months and the line was being fast-tracked for initial commissioning in April 1994. A funding vacuum had been created when Belgian aid had not been forthcoming for consultants as advisers to the Ministry of Energy. AusAID was requested to fund an appraisal of transmission line design as a matter of urgency.

Initial Australian support was approved quickly under the Private Sector Linkages program. This provides financial assistance to link Australian firms with organisations in selected developing countries. The support became Phase 1 of what was to be four phases of Australian support to transmission line construction and operation. A major aspect of project formulation was responsiveness; not only in relation to the fast-track construction program, but also in terms of changes in scope as the consultants progressively identified significant issues likely to affect successful completion and operation of the line.

2.2 PROJECT DESCRIPTION

2.2.1 Objectives and Scope

NSTLP provided technical assistance to the design, construction and commissioning of the North-South 500 kV Transmission Line and training in the operation of the transmission system. The in-country agencies for the project were the Ministry of Energy (MoE, later incorporated into the present Ministry of Industry) and the State Committee for Technical Quality Acceptance (SCTQA) under the Ministry of Science, Technology and Environment (MOSTE).

In the period when the line was constructed, commissioned and initially operated, the consultants (a joint venture of Pacific Power International and State Electricity Commission of Victoria International - PPI and SECVI) were to provide the following services for the North-South Transmission Line project:

- **Phase 1 (September 1992 to December 1992)**

  Appraise the overall design of the transmission line and its associated elements - substations, protection facilities, communication and load despatch systems.

- **Phase 2 (December 1992 to 30 June 1993)**

  Maintain support for the project at the same time as defining the scope of services required for completion of the project. The services to be provided included:

  – detailed advice on aspects of the design found to be of concern during the Phase 1 review including liaison with equipment suppliers;

  – provision of a senior adviser to the MoE in Vietnam, supported by a technical specialist in transmission contracts; and

  – preparation of a detailed project design document (relating to future Australian inputs).

- **Phase 3 (1 July 1993 to 30 September 1994)**

  The project objectives in this phase were to:

  – establish safe and effective operating parameters for the system;

  – incorporate sub-stations and protection into the transmission system;

  – incorporate load-despatch and communications into the transmission system;

  – incorporate the transmission line into the transmission system; and

  – provide management inputs to the overall 500 kV transmission line project.

- **Phase 4 (1 October 1994 to 30 June 1995)**

  – provide assistance in the commissioning and acceptance of the line; and

  – provide training in 500 kV line operation.

These objectives are mainly statements of activities, with the exception of Phase 3, for which the design document did define project objectives. The overall goal of the project as stated in the Phase 3 PDD was “to construct an effective national electricity supply system” with

Australian assistance intended to ensure that the transmission line met its objectives in terms of power transmission capacity and reliability.

2.2.2 Project Cost

AusAID funded A$6.3 million of the total A$6.5 million cost of the NSTLP, with the difference being the managing contractor's contribution under the Private Sector Linkages Program which formed Phase 1 (Table 2-1). No information was available on local costs as distinct from overall construction costs; however, transmission line construction was well-resourced, and no particular problems or delays were reported due to counterpart funding or staffing. NSTLP costs were less than one percent of the estimated total cost of the transmission line.

Table 2-1 Summary of NSTLP costs

	A$'000
Phase 1 AusAID	120
Managing contractor's contribution	184
Phase 2	1104
Phase 3	3947
Phase 4	1100
Total	6455

2.2.3 Completion

Phase 4 of NSTLP was completed on 30 June 1995, giving a total implementation period of 33 months. Project Completion Reports were prepared by the managing contractor on Phases 2, 3 and 4 activities and include information on the project. However, they do not provide a basis for assessment of project efficiency and give limited information on project activities, inputs or outputs. For example, the Phase 4 PCR indicates that software was purchased, but does not indicate the type of software or its cost while little information is provided on the use of short-term consultants or their activities.

2.3 IMPLEMENTATION PERFORMANCE

2.3.1 Identification and Design

The decision to assist Vietnam was taken after construction of the transmission line had commenced. This, combined with the fast-track, top priority approach being taken to construction meant that decisions relating to Australia's involvement had to be taken rapidly if the consultants were to have significant impact on project implementation. Phase 1 was implemented under AusAID's Private Sector Linkages program and, therefore, did not require the preparation and agreement of a project design prior to project commencement. The implementation of Phase 2 and subsequent phases were awarded to the managing contractors without a requirement for tendering, with the agreement of Austenergy, the peak power sector industry body.

One of the objectives under Phase 2 was to prepare a design document for the balance of the project period. However, the report prepared did not meet AusAID requirements and the terms of reference for the Phase 2 review mission were, therefore, extended to include preparation of a new design document.

Overall there appears to have been a problem in identifying the objectives of the project phases. In part this is attributed to the pressures of the job, with Australia's late involvement in the project appearing to require rapid responses without sufficient time to define long- or short-term objectives. The objectives of the project are generally stated as activities, making it difficult to define the extent to which implicit higher order objectives were achieved. In the

requirement for preparation of a design document for Phase 3, AusAID tried to place the project into a more conventional project mode and thus to gain greater control. However, this objective was not fully achieved and the project continued to react to changing circumstances and required substantial flexibility from both AusAID and the project mangers through to project completion. The highly technical nature of the project also made it difficult for AusAID to monitor the project and ensure that assistance was effective. Consideration was given to mobilising a technical advisory group to assist AusAID, but (apart from the consultants appointed to the review mission for Phases 1 and 2) this was not done.

2.3.2 Construction and Commissioning

The completion of the transmission line in two years represents a major engineering feat. The design and construction supervision company (PIDC1), the equipment suppliers and the construction companies deserve particular commendation for their efforts to ensure the smooth and speedy construction of the line.

Apart from design checking, control and protection system studies and construction quality checking, the Australian advisers did not have a central role in the design and construction process. However, they provided a valuable service to the Vietnamese government through engendering the confidence required to proceed with construction, essentially to the initial design. This occurred at a time when some other institutions, including the World Bank, were criticising Vietnam for attempting such a technical solution to its power problems and many were predicting that the line would fail.

Australian assistance was most valuable in preparing for line operation. In addition to equipment checking, this included the establishment of the monitoring and control systems and operating procedures. Responsibility was taken for most operator and supervisor training which was conducted in Australia (Phase 3) and Vietnam (Phase 4).

2.3.3 Organisation and Management

Organisation and management were complicated by the fast-track nature of the project. As far as can be ascertained, the management of the Australian inputs 'on-the-ground' was efficient, with short- and long-term advisers generally being fielded at appropriate times. However, the consortium was not familiar with the needs of bilateral development assistance projects. Thus the extent and timeliness of documents were often inadequate from AusAID's perspective. Similarly, on several occasions, the managing contractor sought retroactive financing for work undertaken outside the contract and for which approval had not been given. The contractor found difficulty in meeting AusAID's reporting requirements, the resolution of which required considerable effort by both sides. These problems adversely affected the relationship between the managing contractor and AusAID and so also affected the efficiency with which the aid project was carried out.

2.4 IMPACT ASSESSMENT

2.4.1 Operational Performance

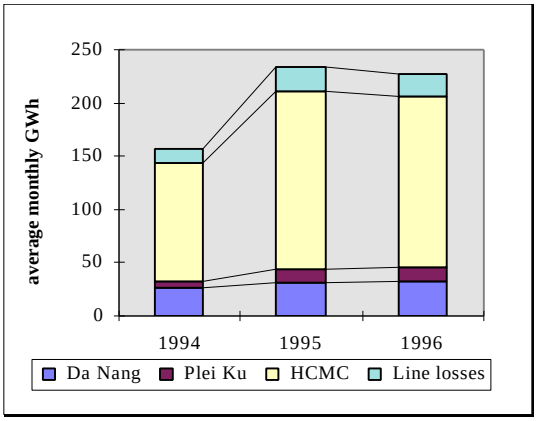
The transmission line was commissioned close to schedule and with few serious teething problems. It is difficult to identify a 'without project' scenario in relation to Australian assistance, but it is likely that, at the least, commissioning would have been delayed and

significant additional expenditure required for control equipment. At the worst, damage to the line may have eventuated. The emphasis given to training under phases 3 and 4 of the project is also considered to have made a substantial contribution to line operational efficiency.

Power Supply

The North-South transmission line was the first 500 kV line constructed in Vietnam. It was a project of national importance with a number of major decisions being made by the Prime Minister. The 1,500 km line was built in record time. It was approved by the Central Committee in February 1992, construction started in April 1992 and the line was commissioned in stages in May 1994 and November 1994. The line has now operated successfully for over three years. The average monthly power transmitted from Hoa Binh to Phu Lam (Ho Chi Minh City), Da Nang and Plei Ku is indicated in Figure 2-1. Detailed monthly data are provided in Figure A-1, Appendix A.

Figure 2-1 Average power distribution from Hoa Binh 1994-96



Source: EVN National Load Despatching Centre

The line was designed to deliver 2,000 GWh of electricity to Ho Chi Minh City per year with a peak power supply of 500 MW and a reliability of 0.8 faults per 100 km per year, or twelve faults annually for the whole line. The line met the design power delivery of 2,000 GWh per annum to Ho Chi Minh City in 1995 and was about five percent below target in 1996 (Table 2-2). Deliveries in the first four months of 1997 averaged 193 GWh per month or forty percent above the average for the same period in 1996. Maximum power transfer to date has been 478 MW at Phu Lam with a maximum of 630 MWh supplied to the line at Hoa Binh power station. Line losses have declined from 10.1 percent of distribution in 1994 to 9.4 percent in 1996 and are at expected levels for a line of this length.

EVN regards the line as successful. Senior management indicated that Australian consultant inputs made a major contribution to the effective operation of the line. They emphasise that it was the first 500 kV line constructed in Vietnam and introduced new methods for system control and data acquisition. The main Vietnamese power design agency (PIDC1) was more reticent about the value of Australian inputs, indicating that they were most useful in evaluating construction quality and in providing assistance with regulations for control and operation of the line, including training of operators.

Table 2-2 Annual electricity received at Phu Lam substation (Ho Chi Minh City) from 500 kV line

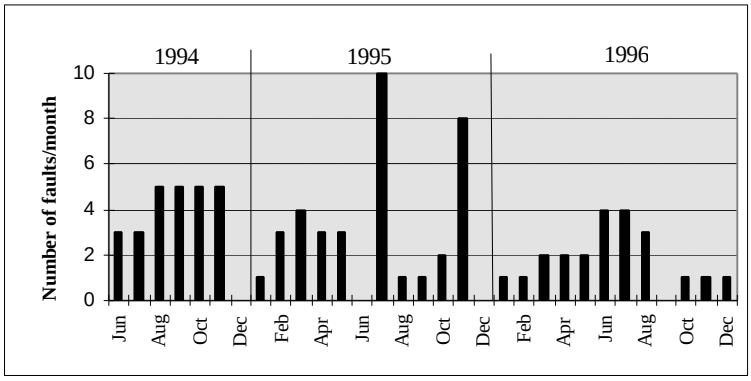
	Total GWh	Average monthly GWh
1994	777	97
1995	2018	168
1996	1904	159
1997 (Jan to April)	772	193
Total	5471	152

Source: Southern Region Despatching Centre

Reliability

The reliability of the transmission line is summarised in Figure 2-2. The line suffered an average of 4 faults per month in 1994, three per month in 1995, and less than two per month in 1996. The downward trend suggests that it may be possible for the line to meet its design target of one fault per month within two or three years if maintenance programs are rigorous.

Figure 2-2 Number of faults per month



Source: EVN National Load Despatching Centre

The relatively high proportion of faults in the wet season is notable. Some thirty percent of trips auto-reclose and do not affect power supply, however outages of around thirty to sixty minutes are required to correct the remainder. Total outage times for the 500 km section Plei Ku to Phu Lam (Ho Chi Minh City) section of the line are given in Table 2-3.

Maintenance for the whole line is scheduled over two periods a year - just prior to the dry season and just prior to the wet. Maintenance outages last for about 48 hours, giving four to five days (or 96 to 120 hours) of scheduled maintenance per annum. The reliability data indicate that the full 1,500 km line had an estimated reliability of around 95.3 percent in 1995 (ie, 4.7 percent forced outages) - however this had improved to around 99.2 percent in 1996 with correction of minor problems and improved operating and maintenance experience.

Table 2-3 500 kV line interruption times

	1995 hours	1996 hours
Forced outages	60.0	9.7
Planned maintenance	120.2	114.0
Total	180.2	123.7

Source: EVN Southern Region Despatching Centre

This line traverses rugged terrain with limited vehicle access. In addition, the automatic fault location equipment is not working, making the identification of faults difficult and time-consuming. It is, therefore, commendable that the transmission companies respond to forced outages as rapidly as they do. Improved fault detection equipment and fault investigation analysis would assist EVN in achieving the design target for line reliability.

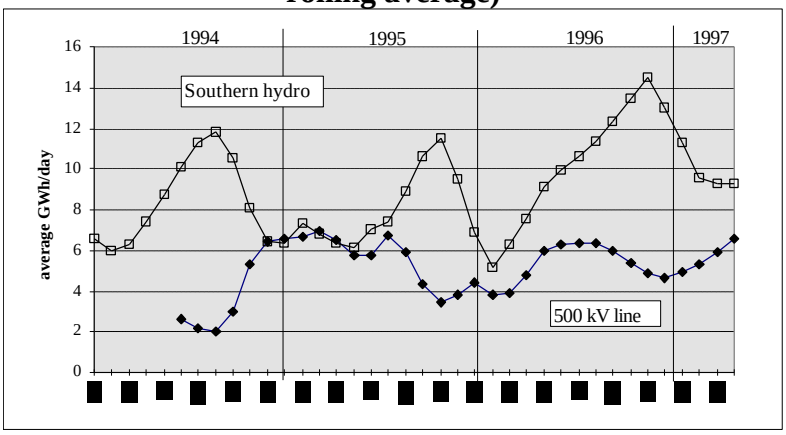
The maximum power transfer is reported to have been limited to date by the amount of reserve generation in the south to cope with load rejection should the line trip out. The line has been subject to extreme storms, particularly north of Hué, but there have been no tower or cable failures to date.

Seasonal Supply

In 1993 Ho Chi Minh City suffered severe power shortages in the critical dry period early March to mid-June, with power supplies often being cut on four out of the five week days. Since commissioning of the line in 1994, this has not occurred. However, power distribution problems in the city mean that interruptions still occur in some areas.

The transmission line was intended to complement southern region hydropower generation and supply to Ho Chi Minh City. As shown in Figure 2-3, the line has succeeded in supplying power at a rate of between four and seven GWh/day from late 1994 to date. However since about November 1995, the peaks and troughs of power supplied from the 500 kV line and the southern hydropower stations have often coincided, and supply from the line has not been sufficient to fill the troughs of southern hydropower production over the past eighteen months.

Figure 2-3 Supply of power to Power Company 2 from 500 kV line and southern hydro stations (three month rolling average)



Source: Southern Region Despatching Centre

Discussion with EVN and the transmission companies indicates that in practice the low hydropower generation capacities tend to be similar in the northern and central regions. In the north, dry season flows are low and restrict generation from about January to June. Red River flows increase in the wet season, but the need to retain unused storage in Hoa Binh dam for flood protection reduces available hydraulic head and power generation until about September. Peak power production from Hoa Binh is thus from about October to January.

2.4.2 Institutional Development

The pressures and timing of the first two project phases did not permit much focus on institutional development. The placing of the Australian advisers in MoE and MOSTE virtually precluded any support to the Vietnamese engineers responsible for design and construction supervision (PIDC1). While institutional strengthening was not among the objectives of the project's initial phases, its absence is considered to represent a missed opportunity which had the potential to increase direct project benefits at little if any cost.

Greater emphasis was placed on institutional development and sustainability issues in the design of Phases 3 and 4. This was achieved through systems development and supervisor/operator training for the staff of the substations and load despatching centres.

Training was conducted both in Australia and in Vietnam. A total of thirty operators and supervisors were trained for periods of between 6 weeks and 3 months in Australia at PPI and SECVI facilities. Training covered both theory and practical work and made substantial use of simulation. All trainees were required to take a written test (in Vietnamese) and a practical test. Management and supervisors at the 500 kV terminal station at Hoa Binh, at the National Load Dispatching Centre in Hanoi and at the switchyard in Da Nang all indicated that the training was beneficial and effective in transferring skills for capable operation of the 500 kV line. However, the focus was on skills transfer, rather than on the training of trainers, which would have required more emphasis on training theory. Again this resulted largely from the immediate needs of the project, but tended to limit the quality of subsequent in-country training and thus long-term institutional development.

An in-country training program was conducted during Phase 4. Some of the engineers and operators who had been trained in Australia were involved in presenting this training. In order to plan and structure this training, a training needs analysis was conducted with many of the operators who had been trained in Australia and other staff. In addition to operator training, the advisers conducted in-country training in systems analysis for EVN engineers. EVN were not greatly interested in maintenance training, raising concerns that line maintenance would not be afforded necessary priority. Operators currently carry out control exercises and tests each month to maintain skill levels.

2.4.3 Financial and Economic Impact

Financial Impact

It is difficult to identify the financial impact of the project. At one level, it can be considered that the project saved the Vietnamese Government costs approximately equal to cost of the assistance or about A$6 million. The government was able to raise the approximately Đ5500 trillion (A$700 million) required to design and construct the line. Given the high priority status of the transmission line, it would probably have been feasible to fund the extra one percent required for monitoring, testing and training, as ultimately undertaken by the Australian-funded project. However, due to budgetary constraints, it was (and remains) difficult to finance the 'softer' parts of project budgets from local or loan funds. Vietnamese agencies, therefore, almost always seek to finance technical assistance through grants. It is thus likely that the responsible Vietnamese agencies would have taken on full responsibility for checking and acceptance in the absence of Australian or other donor support, a task for which the necessary skills and experience were generally not available in Vietnam.

Alternate financing mechanisms, such as international financing or another donor, may have caused substantial delays in commissioning. Reliance on existing domestic skills may have caused a similar delay and possibly damage to the line and equipment if (for example) problems were experienced in synchronisation. Delays in commissioning and hence power transfer to the south would have continued to place foreign exchange demands on Vietnam to import fuel.

Economic Impact

No detailed economic analysis of either the transmission line or of Australian aid inputs was undertaken under NSTLP. Australian inputs made a significant contribution to the commissioning and operation of the line, and may have had substantial positive economic impact compared to the 'without project' situation, through possible prevention of damage to the line and reduction in outage levels.

The transmission line has generated benefits through:

- allowing the sale of electricity surplus to the needs of northern region;
- replacing coal, gas and/or imported oil for fuel generation in central and southern Vietnam; and
- reducing power shortages, particularly in Ho Chi Minh City and thus reducing the impact of outages on local business and domestic electricity consumers.

In general, it appears that the line was at least cost-effective (compared to alternative power sources) and that the transmission line was a suitable candidate for Australian support. Given

Vietnam's economic situation at the time of the project, economic factors were important (ie, the need to ensure that government expenditure showed an adequate return). However, political factors were paramount in relation to both the construction of the line and the assistance requested from Australia.

The line was intended to fill a 25 percent energy shortfall in the south with electricity from the surplus in the north. An alternative solution would have involved building generation capacity in the south, which would have been more costly and taken longer. The duration of the surplus and the amount of power transferred will determine the economic viability of the line based on the objective of surplus transfer.

National power demand grew at over thirteen percent per year in Vietnam from 1990 to 1995 (see Figure 1-1). This suggests that the surplus in the north will be short-lived and there are already plans for increased generation capacity in the north through the development of a new dam and power station at Son La. There has been disagreement over the time for which an energy surplus would exist. In 1993, Vietnam's Energy Minister indicated the north would be in surplus until 1997, while the National Assembly's Science Committee estimated the surplus would be exhausted as early as 1995, only one year after the power line was completed. These projections appear to have been pessimistic, and demand from the south has remained high during 1997, and at least a seasonal surplus is likely in the north to at least the year 2000. However, this uncertainty makes the economics of the transmission line unclear, since the shorter the surplus period, the more marginal the line becomes based solely on the objective of transferring energy. At best a five-year energy surplus is not a good basis for an infrastructure investment decision which would normally be expected to be written off over twenty or thirty years.

The other economic reason for the 500 kV transmission line's construction is to establish a national grid and allow a national electricity market to be formed. This would permit the distribution of the lowest cost energy to consumers and provide security of supply in the event of regional shortages. It was not possible to obtain transfer prices for electricity from generation and transmission companies as their financial aspects are controlled by EVN in Hanoi. This suggests that the line is not currently being used to create a freely operating national electricity market. Without prices being known to the parties involved, an efficient market is not possible. However, the future use of the line in this capacity would help to recoup the large financial outlay on the transmission line. Such a market would provide economic gains to all energy consumers and significant flow-on effects to the Vietnamese economy.

Trade Benefits

A number of Australian firms are now working or have worked in the Vietnamese power sector. The degree to which NSTLP has contributed to commercial flow-on cannot be defined accurately. However, the project generated substantial goodwill towards Australia in the power sector and it is likely that much of the consultancy work that has been won by Australian firms in Vietnam has resulted in large part from these favourable perspectives. The NSTLP managing contractors have subsequently gained a number of contracts in the Vietnamese power sector that they attribute to their demonstrated capacity and the relationships developed under NSTLP. The value of flow-on consulting work is estimated at approximately A$10 million.

Australian contractors and equipment suppliers have also been successful in securing contracts in the Vietnamese power sector. While the link to NSTLP is less direct, it is likely that Australia's involvement in the project made some contribution to the securing of a proportion of the contracts due to the reputation established for Australian design and expertise through NSTLP. The value of these orders to mid-1997 is estimated at around A$10 million, with additional contracts under negotiation.

2.4.4 Environmental Impact

Australian technical assistance did not cover environmental protection. However, ad hoc advice was given by the NSTLP consultants when their help was requested in relation to land subsidence at some construction sites. A request was made by Vietnam following the commissioning of the line for assistance from AusAID to monitor the environmental status of the line, but this was not approved. More attention now needs to be paid to the environment, as without adequate rehabilitation, the physical stability of the line may be threatened in some steep areas.

The negative environmental impacts of the line are predominantly caused by the fast-tracking of construction of the line by the Vietnamese. The schedule for the line's construction and commissioning did not allow for an environmental impact assessment to be completed by the Vietnamese. Emphasis was instead placed on ensuring the accuracy of technical aspects. A small amount of extra care (and time) in construction could have avoided most current environmental problems.

The line crosses mountain ranges and in other areas was purposely built away from the flat coastal land to reduce land purchase costs and increase security. This has led to erosion problems and access difficulties for repair and maintenance teams. Revegetation has not occurred around many of the tower bases in steep areas, as the fast-track construction and inexperience of workers meant that protection measures were not taken. Erosion is also evident along many 'temporary' access roads. In southern region, approximately eighty of the 421 towers have had some remedial work or require repair - ranging from recompacting of soil to major erosion protection. However, necessary work has been undertaken without loss of towers or damage to the line to date.

The environmental impact of any transmission line is mainly within the immediate vicinity of the right-of-way – in this case 36 metres wide. This is narrow for a 500 kV line, with fifty to seventy metres being more common. No assessment has been made of the area of forests, agricultural land or wetlands that have been affected by transmission line construction. In general terms, however, environmental impact is proportional to transmission line length and a 1,500 km line will inevitably have significant impact, with the right-of-way alone extending to some 54 km².

The right-of-way is kept clear of tall growth that may interfere with the line by gangs of Transmission Company employees with about one gang per fifty km of line. EVN cited bamboo growth as a threat to the line and as being responsible for many of the faults. This was disputed by transmission companies responsible for keeping the alignment clear, who claimed the faults were generally technical problems or due to storm damage. The narrow right-of-way has caused problems in that large trees can grow adjacent to the line and so pose a threat, although outside the right-of-way.

Transmission lines induce an electromagnetic field (EMF) which decreases in strength with distance from the line. The cleared right-of-way is an attractive site for agricultural activity or the construction of buildings. However, the Power Transmission companies work with local communities to limit building activities. The placing of lines near settlements also increases the risk of electrocution through for example, children climbing the towers (which have no protection in the form of wire or spikes). However, this is not seen to be a major problem as most people are afraid of the line since it has been energised.

The issue of control over the right-of-way and adjacent activities needs to be addressed urgently. Activities near the right-of-way are unregulated and uncontrolled. Activities within the right-of-way are regulated but not always strictly enforced. The building of metal structures such as fences, roofing and pipelines in parallel with the line could result in induced currents and consequent electric shock.

On a larger scale, the successful completion of the line has allowed hydropower to be used to supply energy demand in the south instead of the development of new thermal power stations or increased use of diesel generators. Hydropower has a lower greenhouse gas content per unit of delivered energy than either of these alternative power sources. Construction of the transmission line has allowed some 5,400 GWh of hydropower to be delivered to Ho Chi Minh City (to mid-1997) potentially reducing CO_2 emission by around 4 million tonnes compared to diesel generation.

2.4.5 Social and Gender Impact

The transmission line has had an impact at two levels - on the lives of those living along the route of the power line and on those who have had their supply of power improved. For the second group the benefits are clear and include a higher standard of living and increased access to income earning activities through a more reliable power supply.

Villagers living along the route of the line have experienced both positive and negative impacts. Initially, people living along the transmission line believed they were going to receive electricity. However, in practice the main beneficiaries have been in urban areas through increased supply reliability. The lack of distribution lines in rural areas is the main constraint to the greater sharing of the potential benefits of the line. According to the World Bank (1996), 78 percent of Vietnam's population have access to electricity, while average per capita consumption is less than 300 kWh per person.

Those affected by the route of the line were not involved in the definition of its alignment or in the location of towers. In one area visited, the line went through a cemetery and several graves had had to be shifted to build the towers. The compensation paid for the relocation of houses, and removal of crops and trees was considered satisfactory by the few affected persons interviewed during ex-post evaluation. EVN staff indicate that many people who had been compensated, and some from non-affected areas, had moved back to the line in the hope of receiving further compensation.

2.4.6 Occupational Health and Safety

The scope of work for the technical assistance did not explicitly include occupational health and safety assistance. However, safe working practices were emphasised in all courses presented under the project. The project advisers were concerned about EVN's safety

practices when working with electrical equipment and emphasised the importance of working with access permits, attaching earth connections and use of safety regulations appropriate for the type and voltage of equipment.

No overall information was available on safety performance during line construction. However, as an example, the record of Power Construction Company Number 3 in Central Region was reviewed. The company is based in Da Nang and was one of three MoE construction companies engaged to construct the line, with responsibility for the 524 km from Ha Tinh to Plei Ku substation. Employment during construction totalled 4,500 employees plus casual village labour. Construction labour inputs totalled some 120,000 person-months. Personal protection equipment used included safety helmets, boots and safety belts for work at heights. Special allowances were paid for work at heights over three metres. Over the eighteen month construction period for this section of line, three people were reported to have been killed and three severely injured. An average of two lesser injuries is estimated by company management to have occurred per month. Based on these data, the injury frequency rate was about two per million hours worked - a commendable level. However, no formal attempt was made to measure construction safety and appropriate recording and safety enhancement systems could usefully be institutionalised in the construction companies.

The Australian advisers carried out spot checks on the quality of the work performed. Deficiencies were reported to the contractors, corrected and then rechecked by the advisers. These checks contributed to the safe commissioning and operation of the line.

2.5 SUSTAINABILITY

The 500 kV line appears fully sustainable, ie, able to continue to transmit power from north to south and/or to form the basis for Vietnam's national power grid. It has operated successfully for the last three years and EVN, the despatching centres and the transmission companies have sufficient expertise to operate the line. Most performance indicators (eg, fault occurrence and duration) are improving over time as staff become more familiar with the line's operating requirements. As a key component of the national grid, the government is expected to ensure that sufficient resources are made available to maintain and operate the line. As additional generation capacity is linked into the line and for example, a parallel 500 kV line is developed, initially from Plei Ku to Phu Lam, the stability and robustness of the line will improve. The energy source for the line - the Hoa Binh reservoir, is likely to have a long life, estimated at around 100 years. This may be exceeded, since a larger dam (with 3,600 MW generation capacity, the first 600 MW due to come on line in 2007) is planned at Son La, upstream of Hoa Binh, on the Black Da river, thus reducing the sediment load reaching the latter dam.

To the extent that the Australian-funded inputs contributed to the successful commissioning and operation of the line, the Australian technical assistance project can also be considered sustainable. Most staff who received training remain in EVN employment, due perhaps to the technical nature of their skills and qualifications.

2.6 LESSONS LEARNED

2.6.1 Timing

The construction of the 1,500 km line was a notable engineering feat. However, it is unfortunate that MOSTE only concluded that there were potential problems with the project (for example in relation to potential line stability) after construction had commenced.

- Earlier assessment of the requirement for technical assistance by MOSTE and MoE and its agencies would have allowed a more controlled approach to be taken to the assistance and increased project effectiveness.

2.6.2 Fast-Track Projects

It is difficult to incorporate fast-track projects into the Australian aid program. Decisions need to be made rapidly and limited attention can be paid to planning, design and monitoring. Frequent changes may be required which make it difficult for AusAID to manage Australian inputs into the project. In the case of NSTLP, normal tendering procedures could not be followed and contracts were awarded directly to the contractors who initially proposed the project. This 'issue' was resolved by including a peak industry body (Austenergy) in the decision-making process. Nonetheless, at least one major Australian energy sector consulting firm did not support the approach taken. Problems of this nature have the potential to limit the effectiveness of such fast-track projects, particularly in sectors where there are several technically qualified potential bidders.

In the case of the NSTLP, the assistance may have been more effective in relation to transmission line design, if it had been provided to, or through, the design and engineering supervision company. While it is appreciated that the government, in part, wanted the technical assistance as a check on the capacity of the Power Investigation and Design Companies, the effectiveness and sustainability (of the technical assistance inputs) could have been improved if undertaken through permanent institutions rather than through a specially formed committee. Institutional strengthening could have occurred if this had taken place.

- Fast-track projects can achieve institutional strengthening objectives if adequate institutional analysis is undertaken.

Where projects are highly technical and, in particular, where rapid decisions need to be made, project management and control is demanding. In this situation, a technical advisory group would be able to assist AusAID through providing objective assessment of project implementation performance and requirements. This system has been adopted in the ongoing My Thuan Bridge project in Vietnam (with experts from the United States and Germany) and could have wide application in technical projects. The use of the formal position of 'supervising engineer' would take this process further, allowing changes in the scope of services to be agreed to on AusAID's behalf by the supervising engineer.

- For 'fast-track' and/or highly technical projects, the establishment of a technical advisory group (or more formal 'supervising engineer' who could certify amendments to the scope of services on AusAID's behalf) may assist in ensuring that inputs are appropriate and advise AusAID on the direction of the project.

No documents were available on NSTLP's short-term staffing inputs, on local costs or counterpart inputs or on training outcomes. While improving the level of analysis, recording and reporting would not have been easy in the context of this project, it is considered that in general it is desirable that an attempt is made to record such aspects, even in fast-track projects. This would assist in the monitoring of implementation and provide the basic data required for assessment of project effectiveness.

- As far as possible, projects should record local counterpart staffing inputs, local costs and data to identify and record any implementation issues and assist in assessing project efficiency. Project completion reports should include an analysis of project efficiency.

2.6.3 Environmental Factors

NSTLP did not have any specific environmental objectives. Overall, the transmission line has resulted in environmental benefits through maximising the use of existing hydropower and thus reducing the need for new thermal generation. However, there have been localised environmental problems, at least partially caused by the fast-track nature of the project which limited the ability of the construction companies to rectify problems at the time of construction. Continuing effort needs to be made to rehabilitate areas adjacent to the towers and their access tracks. Power Construction Company 2 is undertaking some of this work in the south, particularly where the stability of towers is threatened.

- It is preferable to undertake environmental protection measures at the time of construction, rather than trying to remedy problems later. Necessary plant and equipment is on hand and access tracks are trafficable. If correction measures need to be taken subsequently, erosion problems are likely to be more severe and access to the towers more difficult.

Where Australian assistance is provided to projects with potentially significant environmental impacts, environmental planning and management elements should be included in the project design. Under the updated 1996 AusAID Environmental Assessment Guidelines, this approach is required.

2.6.4 Training

All EVN staff with whom discussions were held believed that the training was valuable and contributed to the standard of operation of the line. It would be helpful if a report on the training, including the objectives, program, module notes and results could have been prepared. In addition to assisting in evaluation, it would be a valuable reference document for future training programs in Vietnam or elsewhere in the region. While the manuals prepared during and after the training fulfil this role to some degree, there is benefit in providing wider training information to assist in planning future courses.

- Course reports should be prepared for all training activities.

The thirty trainees who went to Australia generally received one year's English language training. However, many continued to experience difficulty with English, despite the use of a translator.

2.7 CONCLUSION

NSTLP is considered to have been successful. It achieved its implicit objective, with the North-South Transmission Line being commissioned successfully, and close to schedule. Operational performance has improved steadily since commissioning, and the line is now achieving close to its design parameters in terms of power supply and interruptions. It has made a major contribution to improved power supplies in Ho Chi Minh City and central regions and reduced the expenditure of hard currency on imported fuel for thermal power stations. The capacity of EVN to operate 500 kV systems has increased greatly, in part due to the project, and it is expected that future 500 kV lines such as that to be constructed from Plei Ku to Ho Chi Minh City could be designed, constructed and commissioned with relatively little international technical assistance. Although the northern hydropower supplies will all be required in the north by about the year 2000 (at least until the future construction of Son La dam), the transmission line will remain a valuable national asset as the backbone of the national electricity grid.

CAMBODIA
OUDONG DISTRICT HOSPITAL PROJECT (ODHTAP)
HOSPITAL ENGINEERING PROJECT (HEP)

Executing Agencies:

ODHTAP	Oudong District Health Service
HEP	Cambodian Red Cross

	ODHTAP		HEP	
	Planned	Actual	Planned	Actual
Technical Assistance				
Long-term advisers (person-months)		49		13
Project Cost (A$):				
Total project cost	571000	626800	246000	264167
AusAID contribution	571000	611800	246000	246000
'Interest allocation'		10800		11167
Local in kind contribution (est)		15000		7000
Key Dates:				
Design document/assistance request		February 1992		September 1994
Appraisal		na		na
MOU signed		na		na
Project commencement		1 March 1992		24 March 1995
Project completion	31 March 1992	30 June 1995	December 1995	April 1996

3. CAMBODIA - OUDONG DISTRICT HOSPITAL AND HOSPITAL ENGINEERING PROJECTS

3.1 PROJECT CONTEXT

The Oudong District Hospital Technical Assistance (ODHTAP) and Hospital Engineering Project (HEP) formed part of a long-term program of assistance by AusAID and the Australian Red Cross (ARC) to the Cambodian Health Sector. Both projects have been followed by new projects - the Oudong District Health Service Development Project and the Hospital Engineering Project Extension (HEP Extension) respectively. It is difficult to separate all long term impacts of individual projects, therefore, the conclusions reached on each project are influenced by the outcomes of subsequent, and ongoing, projects.

3.1.1 Oudong District Hospital Technical Assistance Project

The Australian Red Cross has been active in the Cambodian health sector since 1985, when a program of reconstruction and refurbishing of the Kompong Speu Provincial Hospital was commenced. Since the completion of reconstruction, ARC had maintained an expatriate medical and technical presence at the hospital. The successful integration of solar electric and water heating technology into the provincial hospital formed the basis for the extension of the technology to the district level and the ODHTAP project proposal in February 1992.

Oudong District Hospital, and two other district hospitals in Kompong Speu Province had received small-scale assistance from the ARC as part of its involvement with the provincial hospital. In common with almost all Cambodian district hospitals at that time, the hospital lacked many basic facilities including electricity and water supply.

The Cambodian Ministry of Health (MoH) operates the national, provincial and district public hospitals and commune health clinics. Under current restructuring plans assisted by the World Health Organisation, it is planned that there will be approximately one 'referral hospital' and ten health centres per 100,000 population. Oudong District Hospital has recently been classified as a referral hospital, representing an upgrading in status and extending the size of its 'operational' district.

3.1.2 Hospital Engineering Project

The project proposal for the Hospital Engineering Project stated that most hospitals:

> "struggled to provide even the most basic levels of curative medicine due to poor management, poor training in many of the health professions, low salaries and overstaffing, among other problems. Common problems [include] unreliable water supplies, sanitation, sterilisation, lighting, vaccine and blood refrigeration, power for laboratory appliances and other physical infrastructure services.
>
> MoH has very few technicians or tradespeople on staff. It is overstaffed with minimally trained medical personnel...Many aid organisations have brought equipment into Cambodian hospitals with little or no plan for maintenance. There remain substantial amounts of broken-down equipment scattered through hospitals." (PDD)

A three-person 'mobile technician team' had been developed under ODHTAP and provided valuable support to hospitals in Kompong Speu. HEP planned to expand the team and constitute it as a hospital engineering team to provide a wider service to hospitals in the provinces near Phnom Penh.

3.1.3 Formulation

Both projects were formulated by the ARC. A project design document was prepared for ODHTAP (February 1992) and a project proposal for HEP (September 1994). No formal appraisal of either project was carried out by AusAID.

The Project Design Document for ODHTAP indicates that "in concept the project was developed by staff of the Oudong District Hospital, members of the Kompong Speu Provincial Health Committee, Oudong District Health Committee, Murdoch University Energy Research Institute and the ARC ".

The Hospital Engineering Project built on the experience of ODHTAP which had confirmed that adequate electricity and water supply were vital ingredients in improving the capacity of the district hospitals. The project, therefore, intended equipping two remote area hospitals with power systems and expansion of the three-person mobile technician team established during ODHTAP.

3.2 PROJECT DESCRIPTION

3.2.1 Objectives and Scope

Oudong District Hospital Technical Assistance Project

ODHTAP was intended to assist the people of Oudong District by providing appropriate technology, drugs and diagnostic supplies and support personnel to the District Hospital to facilitate improved health service delivery. Although not explicitly stated as an objective, "ARC viewed the operation as a pilot project for the trialing of solar technology in the rural Cambodian setting. The expected success of the project may ultimately lead to deployment of units in other districts and even in other regional countries" (ODHTAP PDD page 5).

As designed, the project was intended to:

1. supply and install a hybrid solar-diesel electric generator system, to provide power for essential services;
2. supply vaccine refrigeration, basic laboratory and clinic instrumentation, a submersible well pump and emergency lighting to provide the machinery for essential services;
3. monitor the performance of the generator unit and associated equipment over a three-year period;
4. support District Health Service staff by providing an Australian Project Coordinator to work in collaboration with national counterparts toward the extension of community health services;
5. provide supplementary drugs, dressings and essential diagnostic supplies;
6. support District Health Service Staff by providing Australian expert personnel (Scientific Support Officer) to work in collaboration with national counterparts toward the development of laboratory-based diagnostic, public health and epidemiological services with emphasis on tuberculosis and malaria programs; and
7. determine the impact of the project on the provision of health services in the district.

The ARC, together with Murdoch University Energy Research Institute (MUERI), would supply and install the hybrid solar-diesel system and associated instruments. An Australian engineer was appointed to oversee the installation and develop and implement protocols for monitoring system performance.

Hospital Engineering Project

HEP was intended to provide long-term improvement in health service systems in curative and preventative health care in selected government hospitals in and near Phnom Penh. This was to be achieved through six main activities:

1. Identification and commissioning of local technician teams, ensuring institutional security.
2. Provision of technical training and support to the technician teams to undertake nominated work.
3. Identification and nomination of hospital staff to undertake maintenance training.
4. Construction and/or repair of water supply systems, sterilisers, incinerators, electricity systems and hospital appliances and equipment with a view to providing five hospitals with complete physical services of appropriate technology including training for their continued maintenance.
5. Provision and/or manufacture of selected essential equipment for ten hospitals including necessary training for maintenance and upkeep.
6. Facilitation, advice and support for the establishment of a MoH Technology Committee with responsibility for improving hospital services infrastructure, continued maintenance of systems and its financing.

The project would provide to selected MoH hospitals:

- running cold water and safe drainage in examination, surgery and delivery rooms;
- sterilisation equipment for medical instruments;
- thermostatically controlled vaccine refrigeration and ice-making capacity for vaccine transport;
- 24-hour electric lighting for minor surgery and delivery tables and to power various items of equipment;
- hospital equipment such as minor surgery and delivery tables and traction beds produced in local factories; and
- one solar and one diesel electric power supply in two district hospitals.

The project was to fund five Khmer technicians, a team leader and administrator together with a four-wheel-drive vehicle, tools, equipment and materials.

Objective five was deleted when it was found that equipment could be imported from regional countries at substantially lower cost and of better quality than local fabrication.

A ‘no-cost’ extension of the project was approved by AusAID in February 1996 to allow all project activities to be completed, extending the project completion date from 31 December 1995 to 30 April 1996. In part, this was required because of a delay in initial mobilisation and also from the need to put in place the follow-on HEP Extension, to ensure continuity of employment for the technicians.

3.2.2 Project Cost

ODHTAP was expected to require an input by AusAID of A$571,000. The budget was increased by A$42,500 in a contract amendment of June 1993 and there was some reallocation between cost sectors. Final expenditure was close to the amended budget supplemented by A$10,500 of interest earned on bank deposits. The estimated, revised and actual costs of ODHTAP are shown in Appendix C Table C-1.

No information is available on local costs or on ARC head office costs. For the Oudong District Hospital Project, it is not possible to separate counterpart funds for the project from general hospital operating and administration costs. In general local costs are believed to have been minimal, both through the project period and subsequently. The present hospital director reported that only about one-third of the approved monthly budget of around CR6 million ($3,000) for the entire district (one hospital and nine clinics) was normally received.

The HEP proposal indicated that the total project cost would be A$267,600 including A$6,900 contributed by ARC and A$14,700 by CRC (Appendix C, Table C-2). No record of ARC's contribution to the project in addition to that funded by AusAID is available. CRC did not make any cash contribution, but did provide staff support, estimated by ARC staff at the equivalent of 1.5 people full-time and one vehicle and running costs for a year (estimated at A$6,000 annually). The value of the staff contribution would be of the order of A$1,000 at local salary rates. Total actual project cost was thus A$264,200 as in Table C-3. In addition, the World Bank contributed A$6,800 to HEP operating costs in compensation for completion of an inventory of equipment makes, models and state-of-repair in 22 Cambodian hospitals.

3.2.3 Completion

ODHTAP was completed on 30 June 1995 compared with the completion date of 31 March 1995 envisaged at the time of design. HEP commenced on 1 January 1995 and was completed on 30 April 1996 compared to the planned 31 March 1996 completion date. Project Completion Reports (PCRs) were prepared by the managing contractor on both projects. The PCRs provide an assessment of the achievement of planned activities and provide limited information on project implementation and outcomes.

3.3 IMPLEMENTATION PERFORMANCE

3.3.1 Identification and Design

The design document for ODHTAP was prepared by ARC and submitted to AusAID in February 1992, following consultation with the Provincial Health Committee, Oudong District Hospital Committee and a number of NGOs. While Oudong District Hospital clearly needed support, the design did not fully analyse the institutional requirements for operational sustainability, or consider the possibility of lower-cost options for solar power generation. Such analysis may have increased the replicability of project technology and project sustainability.

The Hospital Engineering Project was designed by ARC in mid-1994, with a project proposal (in practice the design document) submitted to AusAID in September focussing mainly on the establishment of the hospital engineering team. The inclusion of the solar/diesel units was surprising, given the experience of ODHTAP. More detailed analysis of the pros and cons of

diesel and solar power during ODHTAP and/or HEP design (as subsequently undertaken in two studies commissioned under HEP) may have resulted in an improved design for the second project.

3.3.2 Organisation and Management

The implementing agency for ODHTAP was the Oudong District Health Service. It is difficult to assess the capacity of the health service before, during or after the project or the impact of the project on its capacity and capability. In common with other bureaucratic institutions in Cambodia, it was to a large degree political in nature and not highly effective. In this situation ARC was forced to take a dominant role in implementing the project, providing the drive that the implementing agency lacked. This resulted in a lack of capacity building in the health service.

Apart from the problems faced by the Cambodian bureaucracy in general, the project faced difficulties relating to the head of the health service at that time. As a consequence, the project switched investment from the purchase of drugs to construction and renovation. While effecting this change, and ultimately the transfer of the officer, took some time, this shift in project direction is assessed as generally positive, and the development of the tuberculosis ward in particular is an asset to the district.

3.4 IMPACT ASSESSMENT

3.4.1 Operational Performance

The operational performance of the two projects is assessed, firstly in relation to the physical infrastructure developed and maintained, and then in terms of hospital health care delivery.

Oudong District Hospital

The physical infrastructure aspects of the project were completed in a competent manner and fulfil their design functions well. Facilities such as the laboratory, vaccine refrigeration units, water supply and emergency lighting have been installed and are performing satisfactorily. Various models of 220V AC water pump have been trialed for improved capacity to supply the increased hospital water demand.

As described in the PCR and project progress reports, funds were diverted from short-term supplementary medical supplies to fund the renovation of hospital buildings. These works included conversion of a derelict warehouse into a tuberculosis ward, meeting area and store rooms. Other buildings including the latrine block, the administration offices and mortuary were renovated or constructed. While these funds appear to have been well accounted for, and the decision was sound given the circumstances, no formal process was followed by ARC to gain approval for this change.

The hybrid solar-diesel power unit has supplied power reliably for five years, receiving regular maintenance from the HEP technical team based in Phnom Penh. Modifications were made to the hybrid solar-diesel unit at site to make it easier to maintain locally. These included disconnecting the auto-control function but retaining the data logging capability. In addition the diesel generator has been housed in a separate small building remote from the laboratory to reduce noise levels. It is reported that the solar panels now supply around twenty percent of

the electrical energy used by the hospital. Although the hospital could not function without the diesel generator to supply most of its power needs, staff expressed appreciation of the reliability of the solar power. Funds to purchase diesel fuel are often not available and medical staff stated that "it is clear that at times the availability of solar power has saved lives". Growth in power demand at the hospital has seen the role of the solar unit change from being a major to a minor power source.

Monitoring the performance of the solar-diesel unit has occurred over an extended period through the in-built data logger. However, analyses of the data were not readily available, beyond those presented in Bryce's evaluation of the technical transfer associated with the project in 1994. The constraints faced by the hospital in relation to low salaries for hospital staff and lack of MoH funds to meet approved operating budgets result in the hospital being effectively staffed for about three hours per day. General assessment of hospital power requirements cannot, therefore, be made from the monitoring data.

As indicated by Bryce (1994) and other studies, the hybrid solar-diesel unit is not now considered to be an ideal model for wider application. However, valuable lessons have been learned and the conclusion not to replicate the unit at other district hospitals can be viewed as a positive outcome in terms of knowledge gained. The high cost of power supplied, output limitations (especially to supply an expanding hospital demand) and local maintainability are key factors which have led to this conclusion. The optimal power sources for typical Cambodian health centres and hospitals have not yet been fully defined. The experience and skills of the hospital engineering team are being applied to this issue under HEP Extension.

Prior to ODHTAP, Oudong hospital was functioning at a low level. In 1992 there were on average four non-tuberculosis hospital patients and one tuberculosis in-patient per day. Few outpatient consultations were undertaken. The hospital is now relatively large in terms of bed numbers for a district hospital and has recently been upgraded to a referral hospital. With over 10,000 in-patient days during 1995, the average daily in-patient population averaged 28-an increase of 600 percent over 1992. Comparison is made with Kompong Speu provincial hospital and eight other district hospitals in Table 3-1. The 28-bed tuberculosis ward at Oudong makes comparisons with other district hospitals difficult in that patients in this ward are long-stay and have a comparatively lower mortality rate than is experienced in the other wards. This is reflected in a high bed occupancy rate compared with the average of other district hospitals.

A survey of nineteen district hospitals in five provinces was undertaken in August 1995 under the ADB Basic Health Services project. The results provide a basis for comparison with Oudong Hospital and are summarised in Table C-4 of Appendix C. The hospitals surveyed had an average bed occupancy of around sixty percent (on the day of survey, much higher than MoH data) giving annual in-patient days of about 7,500, or about 75 percent of Oudong District Hospital's 1995 level. The majority (89 percent) of the nineteen hospitals surveyed were receiving NGO assistance, with 71 percent receiving assistance with building renovation or new construction, 41 percent technical advice and the same level for equipment, supplies and drugs. Training was provided to 24 percent of hospitals.

Table 3-1 District health service operational performance, 1995

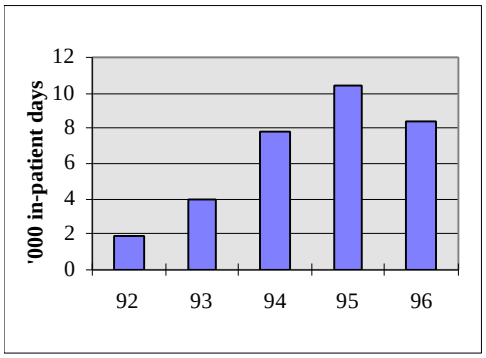
District Hospital	Beds	Admissions	Deaths	Mortality rate (%)	In-patient days	Average stay (days)	Bed occupancy rate (%)
Kompong Speu	165	3168	118	3.7	24077	7.6	40.0

(Provincial)							
Oudong[a/]	**60**	**1101**	**5**	**0.5**	**10369**	**9.4**	**47.3**
Baset	14	114	2	1.8	1015	8.9	19.9
Kong Pisey	33	428	4	0.9	3039	7.1	25.2
Samrong Tong	9	110	n/a	n/a	1034	9.4	31.5
Thpong	20	160	2	1.3	1568	9.8	21.5
Phnom Sruoch	20	476	18	3.8	2428	5.1	33.3
Oral	5	173	2	1.2	1107	6.4	60.7
Chbar Mon	6	64	n/a	n/a	288	4.5	13.2
Chung Ruk	29	139	1	0.7	459	3.3	4.3
Average	36	593	15	2.6	4538	7.2	34.4

Notes: a/ Oudong hospital data was supplied by the ARC. Bed figures comprise 32 beds for general, paediatric, surgical and maternity purposes and 28 tuberculosis beds.
n/a not available.
Source: Cambodian Ministry of Health 1995.

Figure 3-1 highlights the rapid expansion in Oudong hospital's capacity to treat in-patients over the project period. In addition, the hospital has continued to carry out pathology tests following the end of the ODHTAP. In 1996, over 1,500 pathology tests and nearly 400 blood smears were conducted by Oudong District Hospital. The blood smears were tested for malaria while the pathology tests were primarily full blood count (38 percent), hematocrit (for dengue fever and other conditions such as dehydration 23 percent) and acid-fast bacilli (for tuberculosis diagnosis, 21 percent).

Figure 3-1 In-patient treatment, Oudong District Hospital 1992 to 1996



Note: December 1996 estimated
Source: Healy and Dy 1993 and unpublished data.

All measures point to heightened hospital performance both in terms of quality of care and quantity of service over the period since the beginning of the Oudong District Hospital Project. This increase in the level of service provision has extended beyond the life of the project, though a decline in in-patient numbers is evident in 1996 (the reasons for which may be unrelated to the availability of hospital services).

Hospital Engineering Project

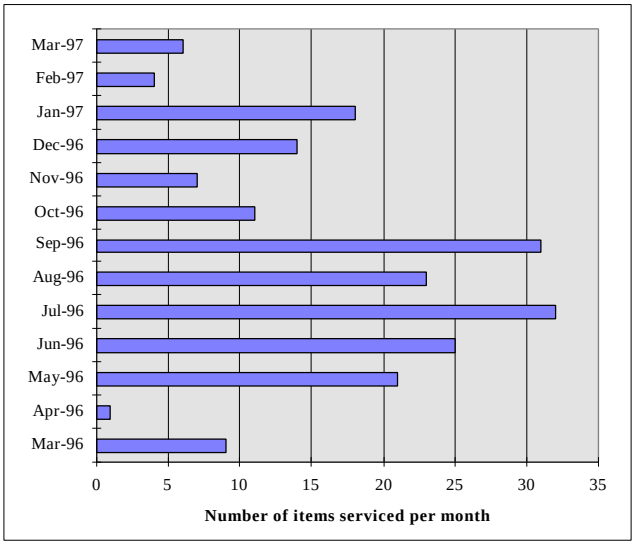
It has been difficult to assess the operational performance of the engineering team over the thirteen month project period. Few detailed records were maintained of the equipment repaired and wiring work carried out. However, monthly reports prepared by the ARC engineering adviser and the summary of achievements in the project completion report indicate that the team of five was used constructively and performed needed and worthwhile services.

It is reported that over fifty percent of the electrical/electronic equipment in the five hospitals serviced by the engineering team were out of service or malfunctioning at the time of first visit. In addition only ten percent of the equipment was in good working condition with the balance needing adjustment, cleaning or minor repair. In some cases, equipment had not operated for over two years. Depending on the grade of hospital, typical equipment serviced included x-ray machines, ultrasounds, suction pumps, sterilisers, centrifuges, microscopes, several types of lights, dental equipment and infrastructure items such as generators, solar systems and water pumps.

Following the initial repair campaign, routine service visits typically revealed a further failure rate of the order of ten to twenty percent of the equipment. Few failures are reported, it being a cultural characteristic to accept that equipment will malfunction and that little can be done to prevent or mitigate failure. The engineering team under HEP Extension is gradually changing this attitude through positive results in the hospitals serviced.

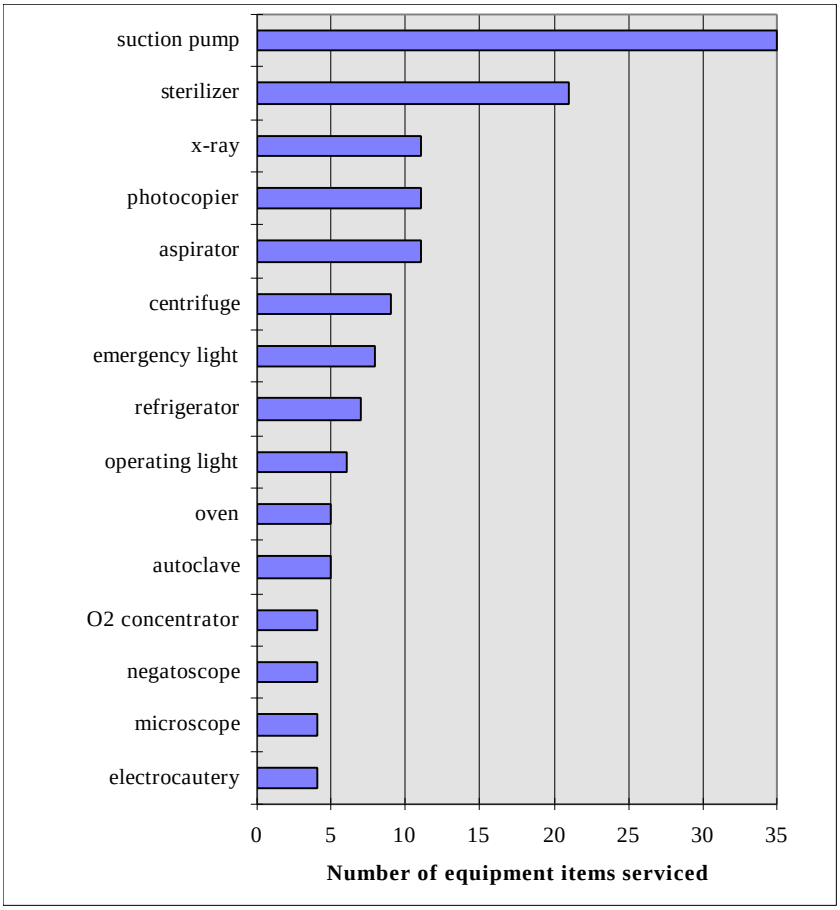
Data are available on the repair of twelve items of equipment during the last two months of the project. In addition, a significant portion of the services supplied early in the project were for hospital rewiring to provide safe and reliable distribution of power. Once commenced, this collection of data on services supplied has continued under the extension project. Service delivery data under this project are given in Figures 3-2 and 3-3, since to a large degree the impact of HEP is reflected in the performance of the Extension project. In terms of equipment items serviced per month, project activity peaked during May to September 1996, and has subsequently shown a downward trend.

Figure 3-2 HEP Extension Project - number of equipment items serviced per month 1996/97



Source: HEP Extension

Figure 3-3 HEP Extension Project - number of equipment items serviced by type 1996/97



Source: HEP Extension

3.4.2 Institutional Development

Skills development under ODHTAP was largely limited to improving the laboratory skills of technicians and the practical skills of the three-person engineering team. A mid-term review (Hill 1994) indicated that the effectiveness of laboratory technician training under the project had been limited by high staff turnover. The project also provided management training to some fifteen hospital management and senior staff, and eight personnel from district, provincial and national health areas. The approach taken was participatory and included training course evaluation. Participants rated the course highly with respect to: work direction and communication skills; development of team-work; management skills development; and problem solving. The workshop report (ARC 1994) was the only detailed training course report that could be located for the four projects included in this evaluation report.

In terms of the overall development of the capacity and capability of the staff at Oudong District Hospital, it is clear that significant improvement has occurred. The level of activity at the hospital has increased substantially since project inception. However, because of the minimal level of government salaries, staff spend little time working at the hospital and most operate private medical practices from their homes. As reported by a survey of government and private health service provision under another project (Healy and Dy 1993), some eighty

percent of health service provision in Oudong District is through private practice, both traditional and modern.

Skills development under the HEP concentrated on the computer, biomedical engineering, electronic engineering and English language skills of the five-person team. However, limited basic electrical and electronic engineering training was also provided to fifteen MoH technicians. The amount of training provided was expanded over that originally planned following the reallocation of funds from the hospital equipment manufacturing component.

The project was also intended to promote the training of hospital staff in minor equipment maintenance. While some of this training was undertaken on-the-job during service visits, there is no evidence of significant skills transfer. This program would have benefited from more detailed planning and program structuring. Some simple manuals are reported to have been produced in Khmer which should assist in reducing operator error and improving basic maintenance.

Training effectiveness reviews were conducted for the biomedical engineering training provided by the Austin Hospital in Melbourne, but were not available to the evaluation team, nor had they been seen by the ARC. The two course members from the Hospital Engineering Team later delivered training in Cambodia to MoH technicians. There is no evidence that similar reviews were made of training provided in Cambodia, although the plan for the basic training for MoH technicians indicated that the courses would be evaluated after three months for usefulness and the information used during HEP Extension.

The engineering team does not yet have all the skills necessary for self-management. Future training under the HEP Extension should thus have a strong component of both formal management training and on-the-job management skills development. Management training commenced in May 1997 and will need to continue over the remainder of the project period. HEP Extension design provides for 'broad management support' from the ARC Country Program manager after the expatriate position expires in September 1997. Continuing management training over the remainder of the project period could be considered, perhaps including short workshops conducted by local consultants as well as courses and activities conducted by other institutions.

3.4.3 Financial and Economic Impact

Oudong District Hospital Project

Health sector projects are often difficult to assess from an economic perspective. While economic costs are easily measured, the benefits pose more of a problem, relating largely to reduced disease incidence and mortality and to increased labour productivity. Analysis requires detailed assessment of the health 'environment' and of the labour force and economic activities in the area. Many of the gains relate to 'quality-of-life' effects which are hard to quantify. The required information is not often available in countries such as Cambodia, and its collection is seldom warranted, particularly for small projects.

In Oudong, the hospital is now providing medical services at a level reported to be above those available in most other districts and provinces and much above pre-project levels. In-patient days in 1995 and 1996 for example averaged nearly five times their 1992 levels. Information on other indicators (such as out-patient days) is not readily available, but overall quality of

service has clearly improved. These gains would have economic benefit, through improving the working capacity of the population, though data are not easily available to quantify this.

Technical assistance inputs were generally cost-effective. However, the solar power unit and laboratory were expensive (estimated at around A$100,000) and the envisaged replication of the system has not occurred, though several other hospitals and clinics have installed solar power units. While the system has been a valuable resource to Oudong Hospital, it would have been possible to provide a similar level of service for substantially lower cost. This would probably have led to a substantial increase in the development outcomes of the project.

Hospital Engineering Project

HEP has had a number of positive economic and financial outcomes. These have included the rehabilitation of broken down equipment and providing the confidence for hospitals to purchase (or accept donations of) second-hand equipment - reducing the need to buy new equipment. In some cases, the availability of a local professional bio-medical equipment repair capability has removed the need to send machines overseas for repair or to bring in foreign technicians. The (follow-on) HEP Extension was reported by the Director of the Centre of Hope Hospital in Phnom Penh to have played a major part in equipping of the hospital, at a saving of several hundred thousand dollars over the purchase of new equipment.

3.4.4 Environmental Impact

The project design documents for the Oudong District Hospital and the Hospital Engineering projects did not make explicit mention of environmental objectives. However, there have been two areas of environmental impact from these activities.

ODHTAP made substantial use of local resources for roofing, general building restoration and maintenance of wells. The project also involved the installation of energy technology in the form of a solar system. At the time of installation, this was seen as the best technology for the required purposes. Experience has proved that, although having certain environmental advantages over diesel, the particular solar system installed was not economically or technologically appropriate to provide the capacity required for the growing demands of the hospital. In this situation both these factors far outweigh any environmental considerations.

The development of the hospital engineering team has had a further environmental impact. The increased availability of hospital equipment leads to a commensurate increase in the use of chemicals, plastics, paper and glassware, some with special disposal requirements. The need for waste disposal training of staff using these pieces of equipment (as with occupational health and safety needs) has not been addressed by the project managers or implementers. There may be merit in including hospital training on safe waste disposal in the HEP Extension training program if budgetary resources permit.

3.4.5 Social and Gender Impact

In developing countries, projects which provide services to the health sector can be expected to indirectly improve the situation of women and children as major users of hospitals and health clinics. In Cambodia, where health services are rudimentary and receive limited financial support from the government, any improvements in service availability could be expected to be reflected in improved mother and child health statistics. However, the collection of statistics

by the projects, the MoH and the hospitals and clinics themselves has not been undertaken on a systematic and comparable basis. Anecdotal evidence suggests that women and children comprise a large majority of patients at Oudong District Hospital and thus are the main beneficiaries of the improvement in the hospital's power supply and infrastructure from the low pre-project level, however, gender-based statistics are not available.

ARC recognised the possibility of the hospital engineering team contributing directly to the status of women through providing equal access to training. However, the requirement for team members to have a tertiary qualification in an engineering or biomedical field, restricted the possibility of female involvement as few Cambodian women have such qualifications. However, midway through the HEP the need for an administrative officer was recognised and a woman was appointed to this position.

3.5 SUSTAINABILITY

The sustainability of both projects is at risk. While the physical infrastructure and skills development will live beyond the projects, the institutional framework in which they exist is starved of funds. In the absence of continued donor support it is likely that Oudong hospital will become dysfunctional and the engineering team dissipate; with their skills being diverted to the repair (for example) of computers and photocopiers in the private sector. Ensuring as far as possible that the hospital and engineering team continue to function effectively after the end of the current projects represents a major challenge for the implementing agencies and the managing contractor.

While HEP Extension will not end until late 1998, it is highly desirable that the engineering team, the Cambodian Red Cross and the ARC plan activities to ensure the sustainability of the team. The key requirement is to make the team self-funding as rapidly as possible. While it is appreciated that this to some degree runs counter to Red Cross philosophy (of providing free help to the poor and needy), it is considered that the work of the team is so important that the dominant consideration should be its survival. It should be possible to strike a balance between income earning activities and providing a free or subsidised service to poorer hospitals. The team has earned income in the past; with the ODHTAP mobile technicians team (the forerunner of the hospital engineering team) "spending 43 percent of its time on paid work and the balance on CRC activities" up to about March 1994.

Management skills development and optimal team location are other issues to be considered. There are strong arguments for the team to operate independently of both CRC and the MoH. This would reduce the political problems of being associated with a particular NGO, while it would not be possible to operate effectively under a government department because of difficulties finding funds for salaries and an operating budget. The MoH has indicated it is considering setting its own medical engineering workshop to service government hospitals.

One of the most promising aspects promoting project sustainability is the increasing involvement of multilateral agencies in the Cambodian health sector. The World Health Organisation is currently in the third stage of its Health System Strengthening Project, while World Bank (US$30 million) and Asian Development Bank (US$20 million) loan projects are getting underway. These projects will provide support to hospitals and health centres for construction and provision of equipment in fifteen provinces including Kompong Speu in which Oudong is located. Oudong hospital has been designated as a referral hospital and will thus be supported under the World Bank project. In addition, AusAID is funding a A$14

million initiative in Cambodia's health sector, aimed at reinforcing health promotion and primary health care at national, provincial, district and commune level, which began in late 1996 and will run to 2001.

The engineering team also has the potential to benefit from the multilateral projects, since the provision and maintenance of equipment to the referral hospitals is among the projects' major objectives. This offers the potential for the engineering team to develop maintenance contracts or service agreements with the hospitals which would provide a guaranteed income after the end of AusAID assistance to the HEP Extension. Team management should also be able to develop commercial arrangements with the private hospital sector which is rapidly gaining strength, particularly in Phnom Penh. It was indicated that an approach may be made to the ADB and World Bank Projects, as well as to private hospitals in the Phnom Penh region, with a view to drawing up service agreements or maintenance contracts for medical equipment.

Among its commercial activities, the engineering team could develop a range of solar energy or solar-diesel packages, particularly for health centres of different sizes. These may be marketed by the engineering team on the basis of cost plus design and installation fees. In addition to providing a valuable service to the Cambodian health sector, this activity should provide a further source of income for the team, thus promoting its continued viability.

3.6 LESSONS LEARNED

3.6.1 Project Design and Implementation Systems

One of the strengths of the two projects is that they met basic needs and were responsive to the requirements of beneficiaries. The flexibility demonstrated in implementation is commendable, but does not remove the need for the projects to have their objectives clearly specified. In addition to assisting in the evaluation of the project, it is helpful to managers, counterpart and funding agencies if all parties know what the project is intended to be doing and achieving at any given time. In the case of the projects being evaluated, it would have been helpful if both the reasons for changes in direction and AusAID approval for these changes could have been documented.

- Project objectives need to be clearly specified during design and any changes during implementation documented and approved.

In relation to project activities, ODHTAP Objective 7 required the implementing agency to "determine the impact of the project on the provision of health services in the district". In practice, few useful data are available from the project (or pre-project) period, making analysis of the 'with and without project' situation difficult. The project design documents contain virtually no data on the baseline situation in the project areas in terms of either data or the institutional framework of the project. This may have contributed to difficulties in designing the most appropriate interventions and to some of the difficulties experienced during implementation. The current ARC project in Oudong is collecting comprehensive data on hospital activities and will ensure that they are permanently recorded and accessible.

Project records are incomplete. Thus only one training workshop report could be located (ARC 1994). Others may have been prepared but could not be located in Melbourne, Canberra or Phnom Penh.

- It is important that training course reports are prepared and available, as otherwise much valuable experience is lost and new staff have to organise training courses with little knowledge of prior activities. It is similarly desirable that every training activity is subject to some degree of evaluation, at the least an end of course evaluation by participants, in order to provide feedback to the project and course organiser on ways to improve future training activities.

- A full set of project documents should ideally be available both in AusAID and in the implementing agency.

Some implementing organisations may feel that the requirement for management and recording detracts from their ability to work effectively. However, it is believed that NGO projects, in common with most other forms of complex economic activity, benefit from 'management' in its broadest sense which includes monitoring of performance and the orderly maintenance of records.

- Managing contractors and AusAID should review project and benefit monitoring requirements at design and during implementation to ensure as far as possible that monitoring programs are designed and implemented and that records are preserved and accessible.

3.6.2 Sustainability Issues

Both projects met major needs. However, they were designed as development projects and not as rapid responses to particular problems. In order to achieve development objectives, sustainability is essential. Thus, at the least, the projects needed greater assessment of the institutional environment and analysis of how the projects would fit into this environment and continue to operate at a reasonable level once foreign support ceased. Both projects have been sustained in the periods post-completion by follow-on projects (Oudong District Health Service Development and HEP Extension). While the follow-on projects are certainly beneficial, earlier consideration of sustainability issues (from design onwards) may have resulted in the development of systems which would promote project effectiveness after the end of expatriate support and financial inputs.

If analysis had indicated that there was no prospect of achieving sustainability (at an acceptable level), then the project designers could have considered either:

- a longer-term project focussing on the development of institutional capacity and, in the case of HEP, self-funding mechanisms; or
- an emergency relief type intervention, aiming to address a particular need for a limited period.

The suggested level of institutional analysis may also have indicated the extent of the political problems which existed in the Oudong District Health Service in the early 1990s and led to modifications in project design.

- Institutional factors play a key part in the effectiveness and sustainability of technical assistance and institutional strengthening projects. Adequate attention to the institutional and baseline situation is essential in project design to maximise the potential for sustainability.

3.6.3 Replication

Both projects had explicit or implicit aims to have some of its technology replicated in other hospitals or health centres. These were not achieved, partly because the Oudong Hospital solar plant was too expensive and complex for Cambodian conditions. Given its pilot nature, more analysis of the economics of the system (and more viable alternatives for power generation) could have been undertaken during the project. A secondary benefit of this analysis would have been a more focussed design for the follow-on health engineering project. The solar/diesel units planned under HEP were not constructed. However, the HEP Extension Project is developing low cost solar units of differing sizes which could be relevant to a range of health centres and may even prove to be a source of commercial earnings for the team.

- The results of pilot projects should be written up and publicised to maximise learning from the experience.

3.7 CONCLUSION

Both projects made a useful contribution to the establishment of improved hospital services during a difficult period of Cambodia's development. Overall it is considered that the NGO approach was appropriate for the implementation of health sector projects in Cambodia. The ARC and its counterpart CRC have shown motivation and skill in implementing the two projects evaluated. They have generally maintained excellent relationships with other institutions and have demonstrated flexibility and rapid response to changing situations.

Issues mainly relate to the sustainability of both projects. Although the institutional environment in Cambodia makes operation difficult, it is considered that the projects needed to focus more on sustainability and the continuation of project benefits after the end of external assistance. Neither project resulted in the intended replication of solar power supplies. More careful analysis during design of the technical and institutional parameters of the projects may have resulted in greater (or more sustainable) outcomes.

THAILAND AUSTRALIA LIGNITE MINE DEVELOPMENT PROJECT PHASE 3

Executing Agency: Electricity Generating Authority of Thailand (EGAT)

	Phase 1 Post-evaluation	Phase 2 PDD	Phase 3 PCR
Technical assistance (person-months)			
Long-term advisers	*	235	328
Short-term advisers	0	111	192
Total		346	520

Key Project Data ($'000)

	Phase 1	Phase 2	Phase 3
Planned[a/]			
AusAID contribution	*	4784	11560
Actual			
AusAID contribution			16485

Note: a/ Excluding escalation

Key Dates			
PDD		September 1987	January 1992
Project start	October 1983		July 1992
Project implementation document			1992
Mid-term evaluation	September 1986		1993
Project completion	October 1987		June 1996
Ex-post evaluation	April 1988		May 1997

4. THAILAND - LIGNITE MINES DEVELOPMENT

4.1 PROJECT CONTEXT

The Mae Moh Lignite Mine is located in Mae Moh District, Lampang Province, some 640 km north of Bangkok and 75 km south-east of Chiang Mai. The mine is run by the Electricity Generating Authority of Thailand (EGAT), the semi-government organisation responsible for most national power generation and coal mining in Thailand.

The Mae Moh valley is surrounded by rugged limestone outcrops but remains a fertile area used for pineapple growing and other small cropping. The Mae Moh lignite basin is some 32 km² in area, with a present level of coal reserves of 1.14 billion tonnes. Large-scale mining commenced in 1978 and has expanded to reach 15.4 million tonnes in 1996. Lignite from the mine is used to power thirteen generators with a total generation capacity of 2, 625 MW which currently provide some nineteen percent of Thailand's fast-growing electricity demand. This level is down from 24 percent in 1991 due to increasing use of natural gas for electricity generation. As further 'Small Power Producer' and 'Independent Power Producer' plants are commissioned in Thailand and power purchasing from Lao PDR expands, Mae Moh's proportion will fall further.

4.1.1 Rationale

Australia's involvement in the Thai lignite mining sector began in the late 1970s. According to the evaluation report of for Phase 1 of LMDP (AIDAB 1988):

> "Australia has a strong comparative advantage in the delivery of development assistance for coal and lignite production. It is one of the largest and most efficient producers of these commodities in the world and for several years has been the world's leading exporter...
>
> ...The oil price rises [of 1973 and 1979] also had an impact on Thailand's energy sector and the country subsequently sought to cut its oil import bill by adopting a strategy of developing indigenous energy resources that could be substituted for imported oil as fuels for electricity generation. Chief among these are lignite and natural gas...
>
> ...Australian assistance was initially provided for geophysical surveys of lignite reserves in the Mae Moh and Krabi basins in Thailand, commencing in 1979. In 1980, EGAT sought Australian help to develop the Mae Moh mine, an activity for which the World Bank was the major source of funds."

Phase 1 of LMDP commenced in October 1983, Phase 2 in 1987 and Phase 3, the principal focus of this evaluation, in July 1992. By the time Phase 3 commenced, production at the mine had expanded greatly, from around 1.3 million tonnes in 1983 to almost 10 million tonnes in 1991.

In the early 1990s, lignite mine development was being undertaken within the context of EGAT's National Power Development Plan, with the rate of development largely determined by the construction and commissioning schedules for the power plants in the Mae Moh valley. Planning at this stage was based on the production level increasing to around 30 million tonnes per year by 1998. Due to the planned rapid expansion, mine management saw a need for continuing technical assistance from Australia, particularly in the areas of environment/ reclamation, occupational health and safety and computer systems for information and management.

4.1.2 Formulation

As the third phase of LMDP, design was straightforward. Following a request by EGAT in October 1990, a feasibility study was prepared in February 1991. The project was appraised in September 1991 and a draft project design document completed in July 1991. The draft PDD was submitted to the then Department of Arts, Sport, Environment, Tourism and Territories which indicated that Australian involvement "was expected to make an environmentally positive contribution to EGAT's operations" (PDD p 10).

An 'appraisal/design' team reviewed the situation of the Mae Moh lignite mine in September/October 1991. The project design document was finalised in January 1992 and Phase 3 commenced in July of that year.

4.2 PROJECT DESCRIPTION

4.2.1 Objectives and Scope

The project goal as stated in the design document was to promote: "successful implementation of each of the annual mining plans for the period 1992-95 in accordance with the medium-term mining plan".

Australian assistance to EGAT was intended to "assist in reducing Thailand's dependence on imported energy by cooperatively developing viable indigenous energy reserves, and to contribute to the amelioration of environmental problems associated with coal resource development" (PDD p 14). The six detailed component objectives identified in the PDD (p 36) are outlined below. The activities/outputs required to meet these objectives were numerous. Those in the environmental area are summarised in Appendix D.

- **Mining Plan and Operations**

  Completion of annual mining plans and meeting of operational targets for coal mining and waste removal.

- **Maintenance and Materials Management**

  Integration of maintenance planning with material and spare parts procurement as well as operational plans. Achievement of target maintenance and supply measures as detailed in the annual mining plans.

- **Environmental Management**

  Successful development and implementation of annual environment management plans. Development and integration of a medium-term environmental management plan with the medium-term mining plan.

- **Occupational Health and Safety** (OH&S)

  '5-star' OH&S Program operative in all divisions of the Mine Operations Department. EGAT OH&S policies reflected in contracts with private site operators.

- **Management and Administration**

  Professional managerial staff efficiently controlling divisions and sections. Information systems in place which support the managerial, administrative and operational functions of the Mine Operations Department.

- **Project Management/Administration**

  Completion of long-term work programs which complement the functions and objectives of the Mine Operations Department. Efficient management of short-term advisory inputs.

  The contract with Kinhill Engineers Pty Ltd, the LMDP3 managing contractor, indicated that:

  > "the fundamental objectives of the [project were]: (i) to assist in the efficient planning, operation and management of the Mae Moh lignite mine; (ii) to contribute to mine planning, operation and management in accord with the policy objectives of the Thai and Australian governments, particularly in relation to environmental policy objectives and occupational health and safety policy objectives; and (iii) to assist internationally competitive Australian firms to sell goods and services to EGAT on a purely commercial basis."

  An additional objective introduced during project implementation covered support to environmental management in EGAT, Bangkok.

Implementation was intended to be flexible and responsive to mine development requirements. The detailed activities were modified as required in the annual plans prepared by the managing contractor and particularly by the mid-term review of July 1994. This recommended 64 additional short-term assignments, mainly in the Mine Planning and Operations area, establishment of a Coal Technology Training Centre and a mine rescue team. The additional assignments recommended are summarised in Appendix D.

4.2.2 Project Cost

The project was completed for an approved cost to AusAID of A$16.4 million compared to the original budget of A$11.2 million (Table 4-1). The increase was due to cost inflation (escalation) and to an increase in the work done in the third and fourth years of Phase 3 as outlined above. The total cost of Australian inputs over all three phases amounted to A$35.5 million or some nine percent of AusAID's Thai program over the period since LMDP commenced in 1983.

Table 4-1 Thailand Lignite Mine Development - summary of project costs

Component	Budget[a/] A$'000	Actual A$'000
Phase 1	-	7520
Phase 2	6892	11560
Phase 3		
1. Long-term personnel	4245	5480
2. Short-term personnel	3948	5702
3. Direct costs	1858	4029
4. Procurement	1182	1215
Total Phase 3	11233	16426
Total project		35506

Note: a/ Excluding escalation due to inflation
Sources: PDDs and PCRs for Phases 1 to 3

Table 4-2 Mae Moh mine investment 1990-96

Year	Investment costs	
	฿ million	A$ million
1996	4078	203.9
1995	5145	257.3
1994	4502	225.1
1993	4433	221.6
1992	3611	180.6
1991	3284	164.2
1990	2303	115.2
Total	27355	1367.8

Source: EGAT

Counterpart funds were provided by EGAT to complement project inputs, though no details are available. Additionally, EGAT provided funds for the development of the mine from its own or loan resources. Total capital and development expenditure at Mae Moh over the

period since 1990 as reported by EGAT totalled almost A$1.4 billion (Table 4-2), indicating that the mine has been well-resourced.

4.3 IMPLEMENTATION PERFORMANCE

4.3.1 Identification and Design

Unlike the other projects being reviewed under this Energy Sector Cluster Evaluation, LMDP's design followed a traditional path. This, and the large scale of the project, is reflected in the quality of the design documents which are concise and clear. The objectives of the project are well-specified and the boundary of the project and the obligations of the advisers defined. The process was conducted in good time, and the transition from Phase 2 to Phase 3 was smooth despite a change in managing contractor.

The mid-term evaluation conducted towards the end of the second year of Phase 3 was a useful exercise. It reviewed and extended the objectives of the project. In addition to recommending additional short-term adviser inputs and changes in long-term staffing arrangements, it made a number of suggestions for improving the management of technical assistance inputs, most of which were adopted and proved beneficial.

4.3.2 Organisation and Management

As designed, the project involved locating nine long-term advisers at the mine site and one in Bangkok. Regular visits were made by some 100 short-term advisers expert in their particular fields. Initially these visits were scheduled for a fixed four-week term at site, but as a result of the July 1994 mid-term review, the duration of visits was varied to match the specific issues to be addressed and shortened to an average of three-weeks.

During Phase 3, around 300 technical reports and short-term assignment reports were published by the managing contractor. These represent a substantial body of technical work. It is estimated that about one third of the reports will be of enduring value and interest, both to the mine and also across a range of industries facing similar issues. It would be helpful if EGAT management could identify these significant documents and ensure that they are filed and available.

The project's use of short- and long-term advisers appears to have been well directed. A few of the short-term advisers were not as focused on technology transfer and involvement of mine staff as desired. However, in general the involvement of local staff appears to have been well managed. The excellent reclamation and maintenance management programs that are being implemented effectively by EGAT staff one year after project completion testify to the success of the programs in these areas. As with the training awards, the short-term adviser inputs and the preparation of reports tended to bunch towards the end of the project, with two-thirds of the reports received in the last half of the project period. This would suggest that the change in managing contractor resulted in some loss in project momentum.

Despite the change in managing contractor, the entire long-term team remained on site under the new management arrangements. During the implementation of Phase 3, changes were made to some of the long-term adviser arrangements. This included changeover of the environmental adviser at the mine site (following the July 1994 mid-term review) and placing a long-term adviser with EGAT's Environmental Division in Bangkok.

Review of the documents prepared under Phase 3 indicates that the managing contractor and the on-site project team were efficient and effective in project organisation and management. Although some delays occurred, annual plans and other key documents appear to have been prepared in a timely manner and to have presented the information required by AusAID and EGAT. On-site management deserves particular commendation for the effective management and coordination of a complex range of tasks.

4.3.3 Project Completion

LMDP3 was scheduled to commence in July 1992 and end on 30 June 1996. The project was commenced and finished on schedule. However, revisions to scope, principally in the areas of environmental management, computerised systems and management advice and delays in implementation of some aspects, meant that not all elements of the project were completed to the extent originally planned. The two-volume PCR prepared by the managing contractor discusses the design, scope, implementation and operational aspects of the project and provides detailed project information.

The main incomplete elements related to the cost management system, maintenance and materials management and computerisation of investment data. These elements were all affected by delays in acquiring the new VAX computer. Other areas where less progress was made than planned, included some environmental aspects, particularly long-term strategies for dust and water emissions. In these areas there are some sustainability risks which could largely be attributed to the environmental program being mostly a Phase 3 activity and expectations by EGAT (and to some extent the managing contractor) that there was likely to be a follow-on Phase 4.

Annexes 1-9 of the PCR present a summary of major findings for the nine major project areas and summarise further challenges facing EGAT. If studied carefully by EGAT management, this information should be valuable for future improvements in mine management.

EGAT has the opportunity to address incomplete elements of the program during the A$700,000, two-year Technical Advisory Fund jointly contributed by AusAID and EGAT at the end of Phase 3. This provides a transitional mechanism to full EGAT funding and self-management of technical consulting support. The provision of this transitional mechanism will allow for some of the Phase 3 initiatives to be brought to a conclusion and others built upon.

4.4 IMPACT ASSESSMENT

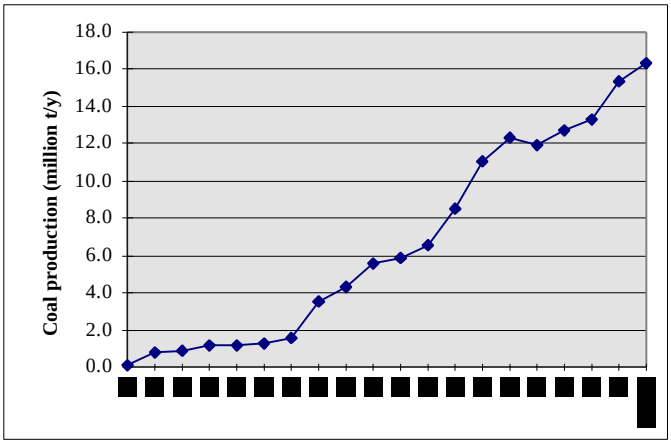
The effectiveness of LMDP3 in assisting EGAT to achieve significant improvements in mine output and efficiency in operations is assessed in this section. The extent to which the project met its objectives in relation to environmental effects, and improved health and safety and reclamation performance is also reviewed.

4.4.1 Mine Planning and Operations

From a low base in 1979, coal production at Mae Moh expanded steadily to reach eleven million tonnes in 1991 and 15.4 million tonnes in 1996 as shown in Figure 4-1. The mine was able to meet the power stations' demand for lignite which increased by an average of nineteen percent per year over the period 1983-96. The complex geological conditions, geotechnical constraints and coal quality issues applying make the achievements notable. With current and

planned power station development limited to retrofitting flue gas desulphurisation plant to Units 4 to 7 and replacement of Units 1 to 3 early next century, little growth in coal demand is expected over the next five to ten years. In the longer term, it is possible that the next six power stations will be developed as anticipated at the start of LMDP3. This would increase power generation capacity to around 4,700 MW (compared to the present capacity of 2,625 MW) requiring annual lignite production to rise to about thirty million tonnes.

Figure 4-1 Annual coal production Mae Moh mine 1978-96



Source: EGAT, Mae Moh and Bangkok

In the years since 1989 the progressive introduction of contracting to remove overburden and supply coal has made a major contribution to productivity growth and at the same time has permitted the mine's operating costs per tonne of lignite to decline. The mine has produced sufficient lignite to meet power station requirements and all annual production targets have been met, in practice with room to spare, due to the need to stockpile high sulphur coal. The activities of LMDP 3 have contributed significantly to the attainment of the mine's overall goal.

The lignite mine development project assisted the achievement of this growing coal demand in a range of significant ways. The mine planning and operational achievements in Phase 3 included:

- clearly defined annual mine plans using computer aided design and drafting systems;
- better geological definition with an updated computerised database;
- innovative geotechnical solutions to critical slope problems involving steeper batters and reduction in excavation volume of some forty million bank cubic metres (a measure of volume of coal or overburden 'in the ground');
- a master plan for in-pit and surface drainage; and
- improved cooperation between mine and power station on coal quality, coal blending and water management.

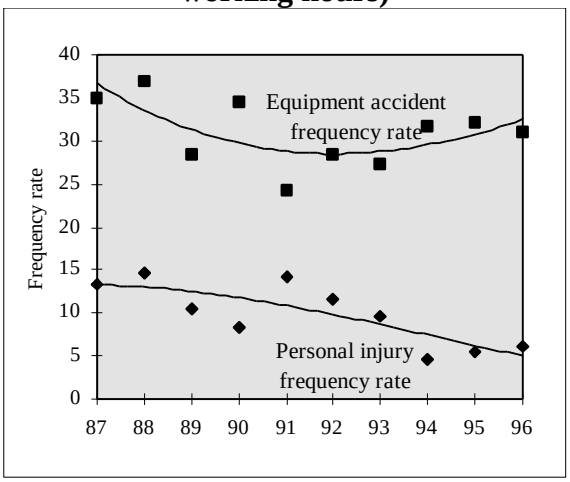
Disappointments included the failure to resolve performance issues relating to the COALSCAN coal quality monitoring equipment.

Since 1993, coal demand growth has been lower than predicted. At the same time, it has been necessary to excavate more coal by contract from upper levels in the pit to balance coal quality and coal reserves. These factors have led to a reduction in the amount of lignite mined by EGAT's own plant from around eight million to an average of 5.6 million tonnes/year. To some extent this explains the somewhat low utilisation of Terex trucks (37 percent) and P&H shovels (55 percent) over the period.

4.4.2 Occupational Health and Safety

Occupational health and safety improvement was included as a specific objective in Phase 3 of the project and considerable advice and training was supplied. A modified version of the Australian 5-star system was adopted by the mine and assessments made against this system. The mine progressed from three silver stars in 1994 to one gold star in 1995 and two in 1996. The 5-star system is a quality-management-based system focussing on policy and management accountability, prevention, response and standards.

Figure 4-2 Mae Moh health and safety performance, accidents and injuries, (per million working hours)



Source: EGAT

As indicated in Figure 4-2, Mae Moh has a trend of fewer personal injuries per million working hours over the last ten years. However, the recent upwards trend for equipment accidents and marginal increases in personal injury rates in 1995 and 1996 give cause for concern.

In a November 1995 progress report, the project's short-term adviser recommended that:

- mining sections should prepare health and safety action plans;
- safety division should move away from a safety maintenance function and fill a consultant role;
- accident analysis should focus on risk control; and
- health and safety assessment should include contractor accidents.

These issues still need addressing by mine management. The annual safety plan for the Health and Safety Division largely comprises safety maintenance activities such as better lighting, traffic signs, fire-fighting trials and clean up; all activities which should be the responsibility of operating sections and divisions. The Division, however, runs a commendable safety training program involving eight courses, run one to three times per year with an overall course attendance of around 600. Job safety analysis planning is now being provided.

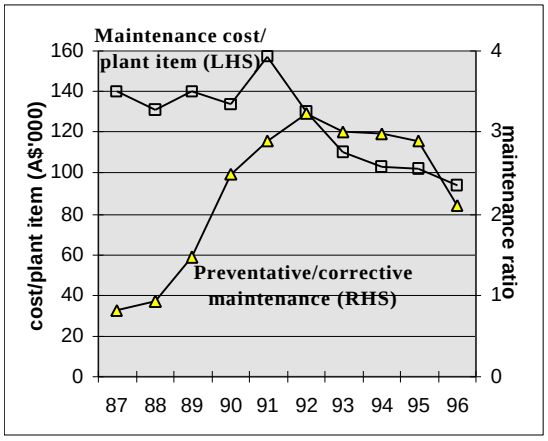
A new safety management system is now being introduced in the mine. Entitled 'modern safety management', it focuses on some twenty elements and is being introduced in all EGAT operations. The system is being introduced in phases, with five elements: leadership and administration, inspection, investigation, personal protective equipment, and organisational roles being addressed first. To be successful, any OH&S system requires total management

commitment, which was not evident in relation to the 5-star system. If management fully embraces the 'modern safety management' system, safety is likely to improve. However, management should be cautious about partially implementing too many new systems.

4.4.3 Maintenance and Materials Management

EGAT has improved the maintenance and operation of its truck and shovel mining equipment significantly. The fleet of 41 Terex 33-11C, 85 tonne, rear dump trucks has accumulated an average of some 45,000 hours use and average fleet availability has increased from some 58 percent in the mid 1980s to an average of 73 percent over the past five years. The average availability of the five P&H 2100BL electric shovels has been maintained above eighty percent over the past ten years. These shovels have operated for over 70,000 hours on average. Benchmark availability figures for such equipment would be around eighty and ninety percent for trucks and shovels respectively with plant some ten years old. The EGAT plant is over fifteen years old and is being maintained in good condition at reasonable cost as indicated in Figure 4-3 by the declining maintenance cost per major equipment item. The improvement in the ratio of planned maintenance to corrective (breakdown) maintenance and the expenditure on maintenance per equipment item over the last ten years is also shown. It is noticeable that maintenance expenditure per item has fallen while equipment availability has improved.

Figure 4-3 Terex availability and maintenance program



Source: EGAT

The improvement in truck availability and consistent shovel availability has been almost entirely due to the implementation of improved maintenance strategies, improved skills of the maintenance workforce, improved metallurgical failure analysis and repair techniques and hydraulic trouble-shooting skills. The technical assistance program was instrumental in introducing these improved strategies and skills. The results form a textbook case for the benefits of preventative maintenance and condition monitoring over breakdown maintenance. Improved methods of inventory control and stores management have reportedly resulted in a reduction in inventory and improvement in supply. The supply of rapid turnover spare parts has improved through the establishment of a store dedicated to these items. These benefits have been largely the result of the introduction of new systems, (such as the Mine Information Management System and Auslang cataloguing) and procedures to EGAT by the short- and long-term advisers.

4.4.4 Institutional Development

Management

The four-year duration of LMDP3 coincided with a period of organisational change within EGAT. In common with state-owned utilities in many countries, privatisation became a goal. While this process has recently been put on hold by the Thai parliament, during the time of the project the prospect led to intense interest and focus on management development within both the Mine Operations Department at Mae Moh and the Mine Engineering Department in Bangkok. LMDP3 assisted the management development process with advice on organisational structure, task descriptions and the installation of a performance assessment system. In addition a new cost management information system was provided and partially implemented. EGAT will need to do further work to gain full benefit from this system.

The management development program has been largely successful with individual management performance now being assessed on an objective basis against pre-agreed performance plans. Annual bonus payments are scheduled to be made on the basis of achievement of these plans; however, at the time of evaluation the first test of the system with respect to bonus payment was six months away. While the organisation structure of the mine had been revised on the basis of project advice, further rationalisation of management reporting at the mine is desirable. This has been put on hold while the government further considers long-term ownership and operational structures for EGAT.

Training

Substantial training was undertaken under Phase 3, though at a lower level than during the first two phases. The focus was on management development training, English language training and continuation of the operator and supervisor training commenced earlier in the project. A total of 107 'technical study awards' were made for EGAT staff to undertake study tours and/or attend conferences in Australia. This aspect of the project and its prior phases has been instrumental in fostering good will between EGAT staff and the Australian mining industry as well as showcasing Australian systems and technology. The number of person days of study tour and the gender balance are summarised in Figure 4-4, which indicates that the number of women given training awards was similar to the overall balance of employment in the mine.

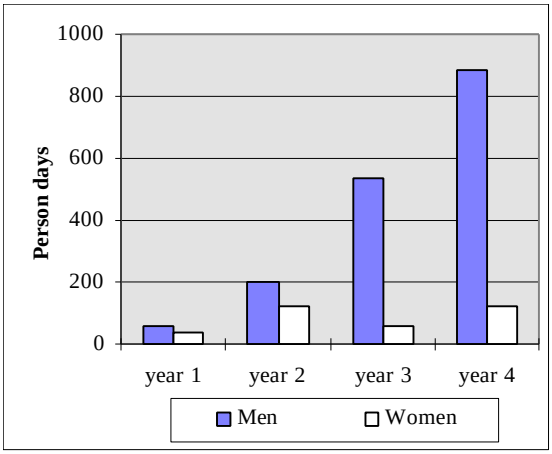
Analysis of employment records maintained by EGAT allowed some assessment of the degree to which the benefits of the training have been sustained, based on the proportion of participants who remain in EGAT employment. Overall, seventy of the 107 trainees are currently employed at the mine, giving a retention rate of around 65 percent, a reasonable level as summarised in Figure 4-5. The retention rates for women and men have been similar.

English training was provided by the English Language Centre of Australia, in Bangkok. Some 700 staff participated in courses in Mae Moh and 300 in Bangkok. The average standard of English among middle to senior management is now high and the training over the total project period has been beneficial to the company and to the project. It has permitted

improved interaction between consultants and their counterparts and the ability of the Thai staff to review reports prepared under the project, which were almost all in English.

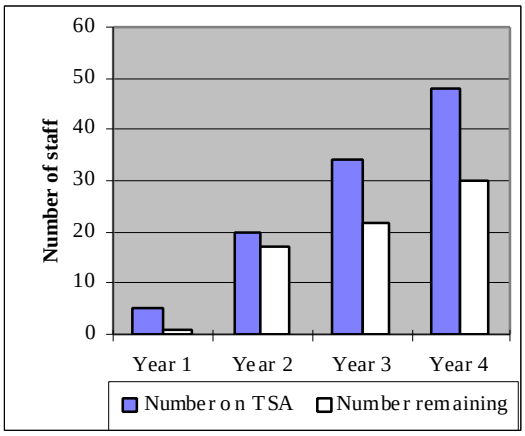
The Mae Moh Training Department has a staff of eleven and is conducting a range of courses with little external assistance. A comprehensive training program is being implemented for 1996/97 with a total of 58 courses planned. Of these, eight are in the occupational health and safety area. Substantial work was undertaken to develop the concepts for the Coal Technology Training Centre during Phase 3. The Centre has wide support from management but has made little progress to date.

Figure 4-4 LMDP Technical study awards by gender, project years 1-4



Source: PCR

Figure 4-5 Technical study awards (TSA) by year and awardees remaining at Mae Moh in 1997



Source: EGAT Mae Moh Personnel Dept

Overall, the impact of the training program under LMDP has been very positive. This relates to formal instruction, as in the case of plant operator and supervisor training, and to on-the-job technology transfer through the development of working relationships between the short- and long-term advisers and EGAT staff. It is notable that EGAT's in-house training program is well-established and is using several of the initiatives commenced under LMDP, for example in the occupational health and safety training area.

No training course reports or evaluations have been located. The only indicators of training outcomes are performance statistics. EGAT reported that, as a result of the program of operator training initiated and initially supported by LMDP, their operators were more efficient and plant damage had been reduced by thirty to forty percent. P&H shovel loading was routinely above their standard of 750 tonnes/hour and for the wheel loader, 992C, above the standard of 450 tonnes/hour. For the acceptance test of a new loader in ideal digging conditions, they had doubled the guaranteed output. About 200-250 operators receive training each year - some attending several courses.

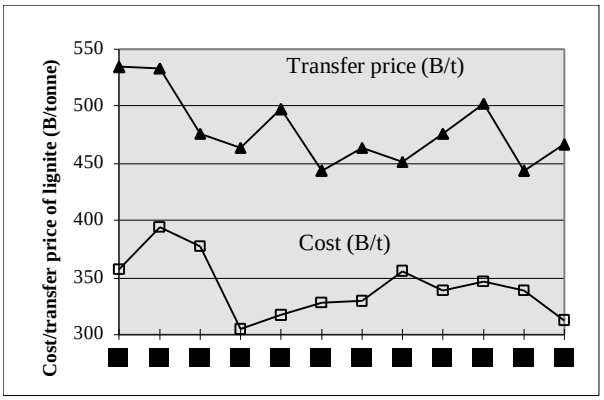
4.4.5 Financial Impact

The financial impact of the project on EGAT has been positive. LMDP Phase 3 continued the operator training and maintenance programs commenced under earlier phases and thus substantially improved plant availability. Plant life has been greatly extended, with many trucks and shovels exceeding 60,000 hours of use. This has almost eliminated the need for EGAT to acquire new earth-moving plant during LMDP. Since replacement of all of the EGAT trucks

and excavators would cost in excess of A$50 million, even part of this would represent a substantial saving.

The project has contributed to a more or less steady fall in lignite production cost by an average of 1 percent per year since 1985. Since 1992, the rate has accelerated to reach 2.5 percent per year in current baht terms. This has been due in large measure to an increase in the proportion of coal won by contractors whose coal mining and overburden removal costs are lower than EGAT's. Lignite production cost in 1996 averaged ฿317 per tonne. This cost includes provision for reclamation (฿6.8 per tonne) and for land compensation and resettlement (฿7.3 per tonne). In each category the total provision exceeded ฿100 million (A$5 million). The transfer price of lignite to the power station has also fallen (erratically) from 1985. Based on these data, Mae Moh mine has had an operating margin averaging 40 percent of gross revenue.

Figure 4-6 Lignite production cost and transfer price 1985-96



Source: EGAT Bangkok

The mine and associated power stations are a major economic enterprise, with total investment by EGAT reported to exceed A$2 billion. Due to Australia's experience in lignite mining and power generation and at least partly due to LMDP, Australian companies have succeeded in winning many of the tenders for equipment and services. The LMDP3 PCR estimates trade benefits to Australian firms as follows:

Table 4-3 Estimated purchases of Australian goods and services by Thai mining sector

(A$ million)

	EGAT Mine & contractors	EGAT Power station	Other	Total
Prior to LMDP	4.9			
Phase 1	78.2	46.6	28.5	153.3
Phase 2	40.0	25.6	77.2	142.8
Phase 3	96.8	248.3	65.4	410.4
Total	219.9	320.4	171.0	706.4

Source: PCR p 5-9

4.4.6 Benefit/Cost Analysis

The feasibility study for LMDP3 undertook a basic benefit/cost analysis of Australian inputs. However, this was not referred to in the project design document, which stated that "a formal cost-benefit analysis could not be undertaken within the time available to the appraisal team". The project design consequently included a requirement for cost/benefit analysis to be

undertaken within six months of project commencement. The required study was undertaken in December 1994 (eighteen months after commencement), but the report was not finalised and was not made available to AusAID or the evaluation team. This omission is unfortunate as the document should have included an indication of the parameters which should be monitored to allow the economic impact of the project to be measured. In the absence of necessary project monitoring data and prior assessment of project economic performance, detailed economic assessment of LMDP or of the lignite mine has not been undertaken.

Some attempt can be made to assess the economic performance of the mine as a whole by estimating the import parity price of black coal as an alternative fuel source and estimating the 'equivalent import parity price' of lignite at Mae Moh based on heating value. Based on Australian coal exports to Japan with an average export value of A$49 per tonne in 1996, it is estimated that the equivalent heating value of black coal delivered to Bangkok was approximately ฿584 per tonne of lignite, or 25 percent higher than the present transfer price to the Mae Moh power stations. Since about 30 percent of Mae Moh's electricity is sold in northern Thailand, the economic value of lignite in Mae Moh is higher than in Bangkok and is estimated at ฿764 per tonne. At this level, Mae Moh's mining and overhead costs (฿312 per tonne in 1996) represent only 45 percent of economic lignite value (Appendix F, Table F-1). If the economic value of the mine is estimated at A$1.5 billion (as at 1997) and annual coal production is kept constant at 16 million tonnes per year over thirty years, the mine's internal rate of return would be of the order of 25 percent.

An approximate cost/benefit analysis for the LMDP plant maintenance program is undertaken in Appendix F, based on the improvement in serviceability of EGAT's mining plant. This improvement is considered to have resulted from activities under all phases of LMDP. It is estimated that the procedures introduced have permitted the winning of an additional 1.1 million tonnes of lignite and removal of around 1.9 million tonnes of overburden annually. At current contract rates, the value of these achievements would be around ฿88.5 million (A$4.2 million) per year. It is further estimated (conservatively) that one third of the total project cost (A$12 million) related directly or indirectly to increasing mining efficiency, thus providing a basis for benefit cost assessment. With benefits estimated to last 10 years, and discounted at 8 percent, the projects benefit cost ratio would be approximately 1.9:1. If additional savings in investment in stocks of parts and materials amount to ฿100 million (A$5 million) and operator efficiency is assumed to have increased by twenty percent due to the operator/supervisor training program, benefit cost ratio increases to around 3.6. While the analysis is approximate, it does demonstrate that LMDP made a significant contribution to the profitability of the mine and to EGAT's economic performance.

4.4.7 Environmental Impact

The main focus in the environmental sector during Phase 2 was on spoil dump reclamation. However, midway through Phase 2, water quality management planning was initiated. Environmental management assumed greater importance during Phase 3 with 2 long-term and 11 short-term advisers working with mine staff to mitigate environmental impacts relating to water and air quality and land reclamation. The relatively late focus on environmental aspects appears to have contributed to water and air quality being viewed as an 'add-on' and not integral to the long-term success of mine operations. Spoil dump reclamation is in a much better position as it was begun in earlier phases, is now subject to a performance bond and is highly visible. In common with other sectors, most activities in the environment sector took place late in the project period with 29 of the 42 Phase 3 reports being completed in the final

18 months of the project. In many cases, this left insufficient time to ensure that they were fully understood and implemented. When Phase 3 ended, not all work had been completed, including preparation of comprehensive water and dust management plans, and these areas in particular were not sufficiently advanced to be self-sustaining.

The mine's six-person environmental unit was established in 1995 as part of a broader restructuring program. Previously, an environmental section, located at the power station, was responsible for all EGAT's Mae Moh operations. This change has allowed a greater understanding of the environmental issues specific to the mine. The mine and power station's environmental units still work closely together on issues that are of importance to both.

The mine's environmental staff have a good understanding of the air and water monitoring procedures as designed by the advisers. EGAT Bangkok recognised the excellent collection of data on the environment by mine staff. However although data collection is efficient, the purpose of and economic rationale for environmental monitoring seem less clear to management. Analysis, the next stage of this process, is not undertaken systematically either at Mae Moh or in Bangkok.

EGAT Bangkok has a ninety-person Environment Department which is mainly concerned with environmental policy at a broad level and particularly with the environmental issues associated with new EGAT projects. EGAT's environmental policy is to meet, and when possible do better than, the industrial standards of the National Environment Board (NEB), although, as a government agency, this is not a legal requirement. There are no specific NEB standards (or specific EGAT environmental policies) relating to mining environmental standards. The Bangkok Environmental Department is not involved in the day-to-day environmental issues associated with Mae Moh although records are kept of the data collected at the mine. There is no annual follow-up by the EGAT board on the environmental performance of the mine.

No environmental plan for the mine has been completed. Ideally there should be both annual and medium-term environmental plans and these should be incorporated into the annual and medium-term mining plans. This was one recommendation of the advisers which has not yet been acted upon by mine management. The use of this planning procedure would enable EGAT to build on the environmental work begun by the AusAID advisers. A high-quality Environmental Report was completed by the Environmental Department of EGAT (January 1996) with the assistance of an AusAID environment adviser. This document covers all EGAT operations, but could form a useful basis for a mine environmental plan.

An indicator of the success and acceptance of environmental monitoring and management systems developed with EGAT staff at Mae Moh, would be their replication and use in other Thai mines. This apparently has not occurred to date. There are requirements that private mines take air/water samples every three months; a generally ineffective system used by Mae Moh mine prior to Phase 3 advice, which does not provide sufficient information for accurate trend projections and hence remedial and mitigating actions. Public sector mines have no such legal requirements. The NEB does make random checks on major environmental indicators, but these are no substitute for regular monitoring. EGAT, through its Mae Moh programs, would be able to take on a leadership role on mine environmental management systems in Thailand if it wished to do so.

Water quality

LMDP3 assisted EGAT to develop the necessary water quality models, drainage plans and monitoring systems for sustainable improvement in water management at Mae Moh. The mine plans to build a further reservoir above the Mae Moh reservoir to allow pit water to be held when its salt content is high, for release during periods of high water flow.

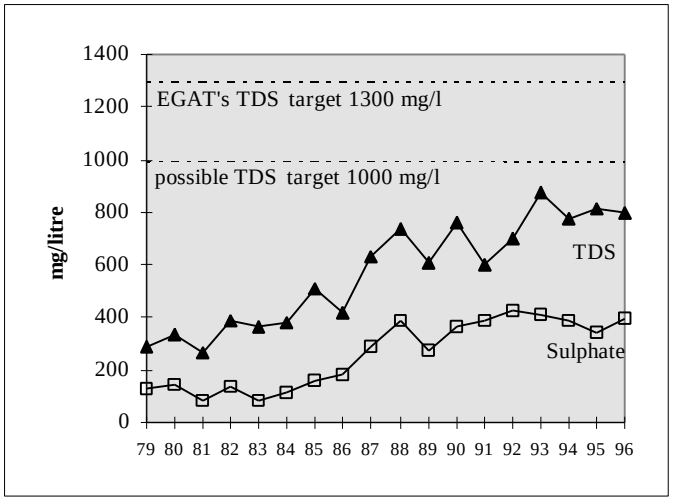
Despite the efforts of the mine and power stations to control water pollution, total dissolved solids (TDS) levels in the Mae Moh reservoir have risen since 1981 by an average of 7.1 percent per year and sulphate levels by 11.5 percent (Figure 4-7). While the annual average salt content of the Mae Moh Reservoir is currently around 800 ppm TDS, at times the reservoir and discharges from it have a TDS as high as 1500 ppm. However, the downward trend in TDS from 1993 is encouraging and average annual TDS levels remain below the Thai Royal Irrigation Department reference standard for irrigation canals of less than 1300 ppm. This standard is an approximation as there is no Thai standard for TDS in natural water systems. The mine uses water which already has a relatively high salt content at entry (TDS ranging from 50 to 500 ppm). The water in the Mae Moh reservoir is currently Class 3:

> "medium clean fresh surface water resources used for: (1) consumption, but passing through an ordinary treatment process before use and (2) agriculture"

The joint environmental committee of the mine and power station is working to lift this to Class 2.

> "very clean fresh surface water resources used for: (1) consumption which requires ordinary water treatment processes before use (2) aquatic organism conservation (3) fisheries (4) recreation."

Figure 4-7 Water quality in the Mae Moh reservoir



Source: EGAT Environmental Division

Mae Moh

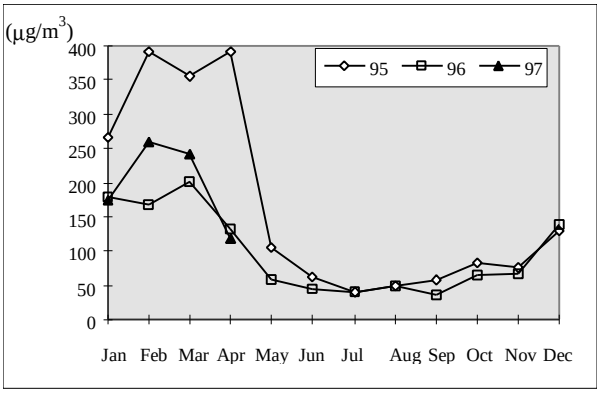
Further work remains to be done by both the power station and the mine to develop robust strategies to achieve long-term improvement in water discharge quality. The power station is investigating the use of dense-phase pipeline transport of conditioned ash, as used at the Stanwell power station in Queensland, to replace the current conveyor/stacker system of disposal. Such a system would provide potential materials handling benefits, provide a means to dispose of highly saline water from the power station and thus assist in reducing the salinity of overall water discharge. The current wetland trials are showing encouraging results and removing up to fifty percent of the sulphate from mine water. By adopting such measures, it should be possible for EGAT to target for less than 1000 ppm TDS for all Mae Moh reservoir discharges and a similar improvement in sulphate content.

Air quality

The predominant air quality concerns from mining operations relate to dust levels. These are measured at 20 sites using instruments supplied under LMDP. The advisers worked with EGAT staff to develop a model to predict patterns of dust fall-out. However, when Phase 3 ended this model only included data on the mine's dust emissions. To be able to predict actual dust patterns, the model needs to be expanded to include dust emissions from the power station and meteorological data. This task is being worked on by mine staff and is a job of considerable size and complexity. There is also a recognised need for more monitoring equipment and for recalibration of existing instruments.

The monitoring program, together with testing to determine the source of the dust, has indicated that seventy percent of mining dust is from the roads in the mine. Over the last twelve months, roads have been sprayed with water to suppress dust, particularly during the dry season when dust is of most concern. This program has made a great difference to dust emissions from the mine. However it is difficult to persuade some contractors to comply, as those on older contracts have no clause compelling them to spray roads. Although dust levels continue to be regularly above the 330µg/m^3 standard at three of the monitoring stations, the overall situation has been improved following monitoring, analysis of the collected data, and the determination of a plan of action. Figure 4-8 gives the average daily dust deposition rates on a monthly basis. Improvement is evident between 1995 and 1996, followed by a marginal deterioration in February and March 1997. The great impact of seasonal conditions on deposition rates is evident, with the dry season levels in January to April averaging over four times wet season levels (June to September).

Figure 4-8 Dust deposition levels average of 12 monitoring sites, Mae Moh 1995-97



Source: EGAT, Mae Moh mine

One further environmental issue that has been widely reported and which is the level of sulphur dioxide (SO_2) emissions from the power stations. The high (average three percent) sulphur content of Mae Moh lignite causes emissions of SO_2 from the power station to be correspondingly high. Improving the mine's performance, eg, through the blending of coal and the burning of relatively low sulphur coal during high risk periods, has had a positive impact on the environmental performance of the power station. The close links between the environment departments of the mine and power stations, established during Phase 2 of LMDP, has allowed good cooperation between the parties in relation to lignite quality. Power station management believes that coal quality, as measured by the heating value and moisture content, has improved over the last two years. Coal is blended at the stockpile which belongs to the mine, but the power station can request low sulphur coal for particular times. For example, high quality coal is brought in from outside Mae Moh to blend with the local coal in the winter months when the SO_2 problem is at its peak. Through these measures, the mine is able to assist the power station in reducing SO_2 emissions.

Reclamation

Substantial work was undertaken under LMDP3 in relation to detailed planning of reclamation and the provision of advice on reclamation activities on the north-east and western spoil dumps. Short-term advisers were engaged to look at soil conservation and reclamation, wetlands development and water management. In addition, several environmental reports covered aspects of reclamation. The geology and spoil characteristics at Mae Moh are complex, while there are many areas of toxic material which complicate reclamation. For the north-east dump for example, only five percent of the spoil to be placed in the dump in the final three years was estimated to be non-toxic by project advisers as quoted in the North East Dump Reclamation study, which would be insufficient to provide a five metre deep cover over the entire dump. EGAT geotechnical staff however believe that toxic material volumes will be far lower and do not envisage any major problems. Further analysis may be required.

The North-East Dump Reclamation study analyses the design and approach to reclaiming an area of about 600 ha. It defines the requirements for contractors to model the land-form to minimise the requirement for EGAT to undertake final reshaping - a potentially costly exercise. A new 25-household village is included in the plan and appears well-designed and likely to meet residents' requirements as stated by village leaders in the area. Detailed analyses have been undertaken of the optimal species mix for trees, understorey and pasture, with teak and other species thriving under the soil and climatic conditions of the spoil dumps. The commercial timber plantations in particular offer the potential to resettling large numbers of local residents in the long-term, mainly after the end of mining in around 2050, by which time the plantations will be near maturity and highly valuable.

The final reclamation document produced under the project was a Reclamation Manual. This document is highly professional and reflects well on its authors and on EGAT.

One aspect of open-cut mines which can cause major environmental impact is the final void - the pit that remains after the end of mining. In the case of Mae Moh the pit is likely to be large, based on current long-term mining plans - with an area of 19 km² and a maximum depth of around 400 metres. Final void volume is likely to exceed 2.5 billion cubic metres which will take considerable time to fill with water from ground or surface flows. Little analysis has been undertaken to date of the final void issue, which is understandable given that it will not arise until the conclusion of mining in the middle of the 21st century. However, detailed analysis of how to minimise final void problems will be desirable in any revision of the long-term mining plan.

4.4.8 Social Impact

The lignite mine has had a significant impact on the lives of people in the local area. EGAT's activities have included the relocation of 12,000 people over the life of the mine and the development of new housing, farming land, income earning activities and infrastructure. The environmental impacts on air quality and Mae Moh River water quality and flow rate by the mine (and more importantly the power station) activities have adversely affected people inside and outside the relocation boundaries. The situation with respect to SO_2 emissions from the power stations and acid rain is improving but local residents still complain about respiratory tract infections which they attribute to the plant.

The project has contributed to the positive social impacts of the mine. The contribution to increased mine production has impacted directly on job creation. In one resettlement village of nearly 7000 people, 50 percent of those of working age held jobs with EGAT. The increased level of production has also substantially improved the ability of the mine to contribute to the community financially - in 1996/97 the mine budgeted around ฿20 million (A$1 million) to local social and cultural facilities and activities. The Mae Moh mine also pays ฿54 million (A$2.7 million) per year in local property taxes. During 1995/96, the mine made provisions of ฿112 million (A$5.6 million) for land compensation and resettlement. A mobile medical service has also been provided to local communities.

The project has also assisted EGAT in mitigating the negative social impacts of mining. The project provided the basis for the mine's mitigation plan for environmental (hence social) impacts, although long-term success depends on the cooperation between mine and power station management and the priority this work is given by senior EGAT management. The development of a 'Land Reclamation Handbook' and its use by EGAT has resulted in forestry and public recreation areas being created on former mining land.

Some 2000 people living close to the mine's northern boundary are affected by dust and noise levels and wish to be resettled. To the south, complaints about water quality are received from up to 8 km downstream from the Mae Moh reservoir outlet to the Mae Moh river. Although within NEB standards, mine management is working to address these concerns (see Section 4.4.7).

The SO_2 problems of the power station, highlighted by the incidents of October 1992 which were widely reported, are no longer a major issue within the community. Improved environmental management was believed by local government officials to have reduced the requests for compensation to one or two cases in the last year. These management practices include: (i) the installation of real time SO_2 monitoring devices within the Mae Moh Valley linked to the power station control room; (ii) the development of safety procedures if SO_2 levels pass a critical level; (iii) coal blending and stockpiling of high quality coal (including import of low-sulphur lignite by rail) for use in unfavourable weather conditions; and (iii) the installation of flue gas desulphurisers on Units 12 and 13 of the power plant to directly reduce SO_2 emissions. Units 4 to 11 will have this equipment installed by the year 2000.

Past problems appear to have created a long-term problem for EGAT - including Mae Moh mine - in terms of its ability to deal with the public. While no survey has been undertaken of community attitudes, they are reported by local leaders to be largely negative. In addition to its work on environmental improvement, the mine needs to work to generate more positive attitudes as it is through public support for the mine's activities, such as environmental management, that these will be replicated by other government agencies and private companies.

During phases 1 and 2 of LMDP in particular, the project team identified community relations as an area in which Australia could make a significant contribution to planning and development, due to its experience in community development and urban/rural development planning. Requests for the inclusion of community development activities in the scope of the project were rejected by AusAID on the grounds that the project should retain a technical focus.

4.4.9 Gender Impact

Women comprise 10.4 percent of EGAT's Mae Moh mine workforce of 2,300, which is a fall from 12.3 percent in 1991. The PDD for Phase 3 identified that women were concentrated in the then Mine Controller's and Administration Divisions, mostly in office and personnel management and financial or accounts. A similar situation still exists with women concentrated within the newly created Mine Planning and Administration Division, in departments such as General Services (46 percent female), Accounting and Finance (61 percent) and Statistics and Analysis (44 percent). In the Production Division, women are only strongly represented in the divisional administration area (58 percent). The restructuring has broadened the areas in which women are represented to include reclamation, safety and operational planning.

Technical study awards were deemed important for advancement by the PDD and were then limited in areas where women were concentrated. During Phase 3, women received study awards at a rate equivalent to, or higher than, their proportion of the workforce (see Figure 4-5 and Figure E-3, Appendix E). Additionally, women were given the opportunity to attend English language training which has improved their fluency and confidence in use and aided those recieving technical study awards.

4.5 SUSTAINABILITY

As a commercial undertaking, lignite mine sustainability for EGAT as a whole relates to its ability to continue to supply the power station with lignite for power generation. At this stage, there is no reason to believe that Mae Moh mine will not be able to complete its long-term mining objectives, despite the difficulties involved in deep mining towards the end of the mining period. Under all normal circumstances Thailand's electricity demand is likely to increase, and in this situation, electricity from Mae Moh should continue to be demanded. In the longer term, with the possibility that Thailand's electricity sector will be fully or largely privatised, the mine and power station may face significant pressure from hydropower (for example, purchases from Laos will reach 3000 MW by the year 2000) and from power stations using low-cost imported black coal. However, by that stage Mae Moh itself may have been privatised and thus better equipped to withstand pressure on its electricity price.

Sustainability in the context of LMDP has narrower boundaries. It essentially relates to the continued ability of EGAT staff to operate the systems and implement the procedures developed under the project. This in turn requires that sufficient skilled staff remain at the mine. While some activities initiated under LMDP have not been continued or fully institutionalised, most activities under LMDP appear likely to be sustained, particularly in the key production related areas such as Geotech, Mine Planning, Maintenance and Reclamation. Further management support is needed in areas such as environmental planning and computer applications if the initiatives commenced under LMDP are to be sustained.

4.6 LESSONS LEARNED

4.6.1 Institutional Strengthening

LMDP3 contributed to the strengthening of the mining and associated operations at the Mae Moh lignite mine. It achieved this through the use of detailed front-end planning to ensure institutional needs were comprehensively addressed and in a way that would not cause delays

in the mining process. This traditionally structured project still afforded the flexibility for changes to be incorporated as necessary. This success may not have been so pronounced without the pre-existing strong relationship between EGAT and Australia which had been developed prior to the project's commencement. The dedication and skills of the EGAT counterpart staff and EGAT's willingness to implement the advisers' suggestions and recommendations also contributed to the success of the project.

The success of LMDP3 was in part due to the expertise of the Australian advisers. Over the project period, mine management's confidence in their advice was confirmed. For example implementation of maintenance advice along textbook lines has provided savings of the order of A$50 million through avoiding the need to purchase replacement equipment. Providing of high calibre technical advice in areas in which Australia is seen to be a world leader contributed to the success of the project through increasing the acceptance, implementation and incorporation into work practices of the advice.

The project involved some nine permanent staff and periodic visits by about 100 short-term experts. Such projects can be difficult to manage given the range of personalities and pressures involved. Management both in Australia and on-site was effective and managed most project inputs efficiently contributing substantially to the successful project outcome. In terms of impact on the institution and the flow on of trade benefits to Australian firms, LMDP has been highly positive.

The key factors contributing to the success of the project's institutional strengthening components included:

- the length of the project, extending over three phases lasting thirteen years;
- the high calibre of Australian technology in open cut lignite mining (and power generation)
- the expertise of the long- and short-term advisers; and
- the operational and technical focus of the mine, with technical improvements often translating directly into productivity gains or cost savings.

4.6.2 Dependency

In part because of this success, EGAT came to depend on Australian consultancy inputs. While the company's cashflow since the end of the project has been sufficient to purchase consultancy services, little such contracting has occurred. When EGAT has hired consultants, as for example to assist it in planning for privatisation, it has not always been successful. The main difficulty is reported to have been in getting approval for such hiring through the budgetary system, which can take up to two years. Despite reported advice to the contrary from AusAID's Thai desk, there was apparently expectation that Australian assistance would continue after the end of Phase 3, and no action was taken to include provision for consultancy budget in the annual budget request for 1996/97. Planning for the end of the project and transition to independence should have been given more emphasis during say the last two years of the project. The external review of Phase 3 in May 1994 could for example have confirmed that the project would end after Phase 3 and required all relevant activities to be directed towards transition. With an outputs based contract, it would have been desirable for the managing contractor to have been required to complete all activities planned under the project, which would have reduced problems faced by EGAT, for example, from incomplete systems development.

- Care needs to be taken to minimise dependency. Project planning must take adequate account of the requirements for transition to independent operation with project extensions must approved (or rejected) in sufficient time for implementing agencies to make necessary adjustments.

- The establishment of a 'technical assistance fund' as introduced at the end of LMDP3 can be of great assistance in smoothing the path to independent operation, but should not be used to defer progress towards independent operation.

4.6.3 Technology Transfer and Training

While most aspects of the technical assistance were successful and contributed greatly to strengthening EGAT's capability in many areas, impact could have been improved in a number of ways.

- Effort is needed to prevent the 'bunching' of activities near the end of a project's life, when there is little time left to promote their sustainability.

English was selected as the LMDP3's working language. This was considered to be necessary given the technical nature of many of the project's activities.

- Translation of key reports into local language would often be cost-effective and contribute greatly to the understanding and impact of the reports and recommendations.

While the training delivered appears to have been effective, no formal evaluation of the training has been located.

- All training courses should be written up (selectively including needs, program, participants, evaluation and follow-up) so that adequate information is available to assist in the design of future courses.

The trades and other training courses were not integrated into the wider Thai educational system. This means that: (i) no external review of the courses takes place and (ii) the qualifications gained have no currency outside EGAT. There would be advantage to the trainees and probably in the longer term to EGAT in such integration. The Coal Technology Training Centre concept is considered to have substantial merit, and should be promoted. This will require the involvement of an appropriate external institution to ensure recognition of the courses.

- Where appropriate, the integration of project training activities into the wider national vocational education and training system can improve course effectiveness and maximise training benefits.

4.6.4 Public Relations and Community Development

The press reports on Mae Moh mine and power stations have been almost uniformly negative. Both have success stories to tell, for example in relation to the wetlands areas, general reclamation activities and to the SO_2 flue gas desulphurisation program. Other areas in which EGAT's public relations appear not to reflect the positive aspects of development include its relationship with government agencies with responsibility for the environment such as the

Office of Environment Policy and Planning, which continues to consider Mae Moh as a major environmental problem.

Many of the studies prepared under LMDP are of wide interest, particularly those in the environment and reclamation areas. Their dissemination could contribute greatly to improving EGAT's PR image.

- Consideration could be given by EGAT to the wider distribution of key project reports in the Thai government and mining sectors, and for example placing them in key libraries.

Community development and relations are important in large industrial projects. The lack of trust of EGAT by some local communities, predominantly arising from environmental issues connected with the power station and also the process of resettlement, has meant that the mine has not been integrated well into the local culture and society.

Improvement of community relations and public perceptions can be achieved through: (i) continuing to promote community development, with support from all levels of management and the workforce; (ii) providing assistance to resettled villagers, for example in the resolution of their land title dispute; (iii) assisting in organising villager/local government/EGAT meetings to discuss problems and disseminate information; and (iv) making a particular effort to keep the community advised of the environmental situation and the measures being taken by the company to improve the local environment.

- Industrial-scale energy (and other) projects need to make particular efforts to minimise distrust in the local community, to promote community development and to improve community relations.

AusAID support to such projects may be able to make a positive contribution to community development and relations, taking account of socio-cultural differences, which make community consultation difficult in many developing countries. Particularly for projects with potential adverse environmental impacts, adequate community consultation at the design stage is highly desirable.

4.6.5 Environment

Mining can have significant impacts on the environment. An effective environmental management plan is essential from the start. Although individual environmental activities at Mae Moh are carried out thoroughly (such as air and water monitoring and land reclamation) an integrated environmental plan which forms part of mine operating plan would go some way to relieving community concerns regarding the environmental impacts of the mine.

- Integration of environmental aspects into mine planning needs to be commenced early in a project's life and should be seen as integral to the mine's success rather than as an 'add-on'.

- Community involvement would be desirable in the development of the plan and the resulting draft document could be made available for public comment and discussion prior to publication.

4.7 CONCLUSION

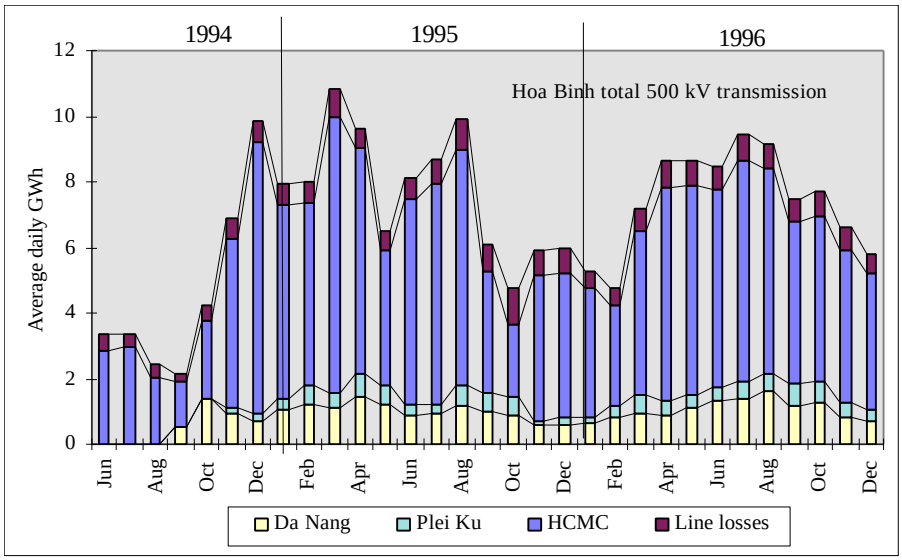
The Mae Moh lignite mine achieved its mining targets during LMDP3. Most of the individual project component objectives were also achieved in large measure and overall the project is classed as successful. Although the postponement of power station expansion has limited the growth in lignite demand and reduced the proportion of coal mined by EGAT (as opposed to contractors), the mine has operated efficiently and profitably over the project period. Occupational health and safety results have shown improvement, though further commitment is required. Reclamation programs are proceeding smoothly and both wetland and forestry plantings have shown impressive performance. Further work is considered necessary in the environmental planning area. Overall, the mine is operating at or close to best international practice, and is believed to be among the leaders in Asia in relation to many of its programs, particularly in maintenance and reclamation. EGAT and mine staff are justifiably proud of their performance, assisted by LMDP over a thirteen-year period. Work is now required to market this message and to improve the public image of the mine and power station.

APPENDIX A VIETNAM - STATISTICAL DATA

Table A-1 North-South 500 kV Transmission Line Project - summary of project costs

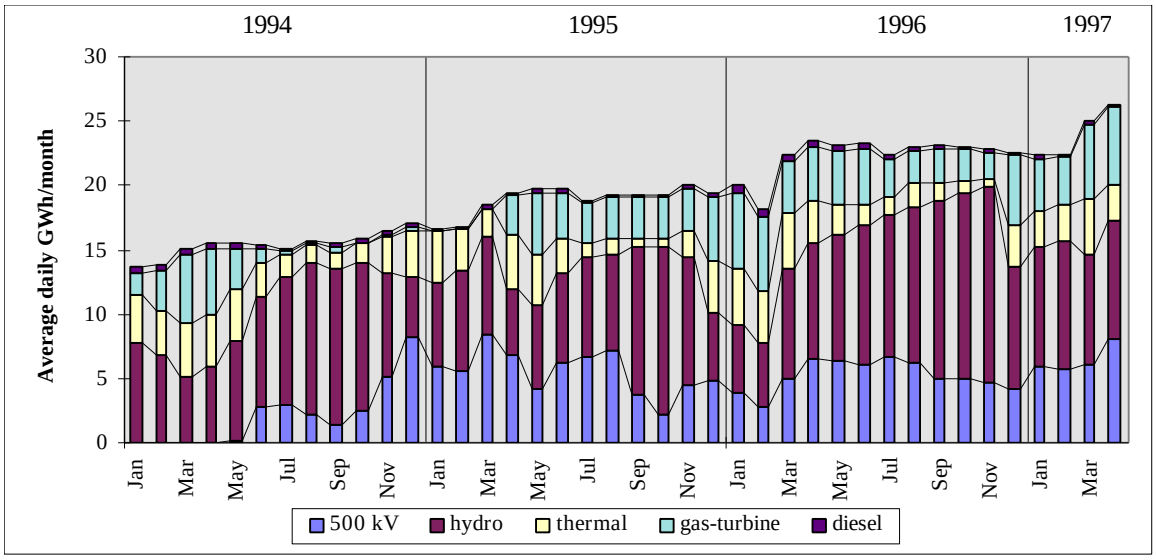
Component	Original budget	Actual cost
Phase 1		A$
1. Personnel + Direct		120000
2. Contractor contribution		184181
Total Phase 1	120000	304181
Phase 2		
1. Personnel + Direct		596959
2. Training course		505500
Total Phase 2	1103951	1102459
Phase 3		
1. Personnel		3714371
2. Direct costs		65000
Phase 3a		232659
Total Phase 3	3947030	4012030
Phase 4		
1. Personnel + Direct		904715
2. Software		195000
Total Phase 4	1099754	1099715
Total	6270735	6518385

Figure A-1 Power transmitted from Hoa Binh to Phu Lam, Da Nang and Plei Ku



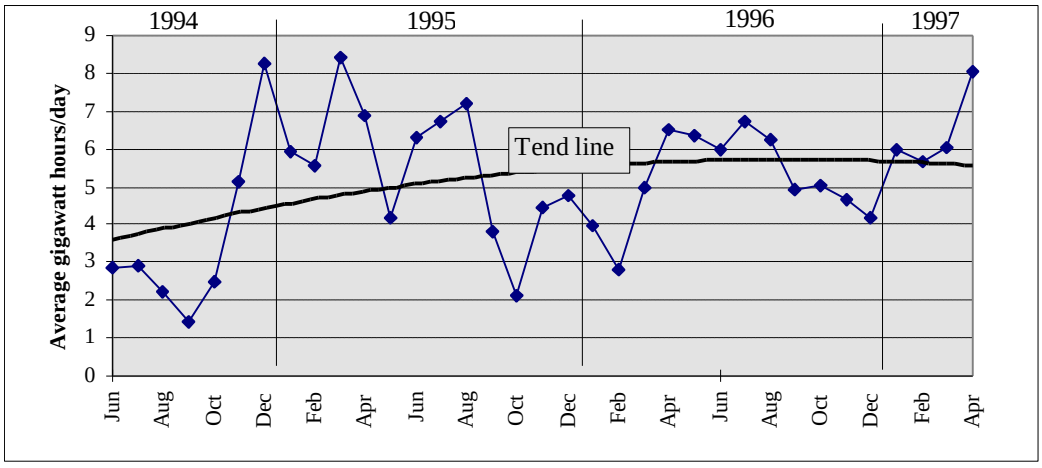
Source: EVN National Load Despatching Centre

Figure A-2 Monthly power supply to Power Company 2 by source



Source: EVN Southern Regional Load Despatching Centre

Figure A-3 Average daily receipt of electricity from 500 kV line atPhu Lam



APPENDIX B ELECTRICITY GENERATION IN VIETNAM

STRUCTURE

In January 1995, the government issued Decree No. 14/CP to establish Electricity of Vietnam (EVN), a state holding corporation for the different power sector entities engaged in generation, transmission, distribution, and associated service functions. The formation of EVN represented a pilot experiment in state enterprise reform based on the Enterprise Group concept. (This section is summarised from World Bank 1995).

EVN comprises 34 separate business units, each with its own charter and each reporting to EVN's Director General. The business units fall into three categories:

- Those engaged in generation and transmission are subject to dependent accounting, and consolidation of accounts takes place only at the level of EVN as a whole (General EVN). There are seventeen business units involved in these activities - twelve for generation and five for transmission (the national load despatching centre and four transmission companies). They report to EVN's Director General, through the Deputy-Director General for production.

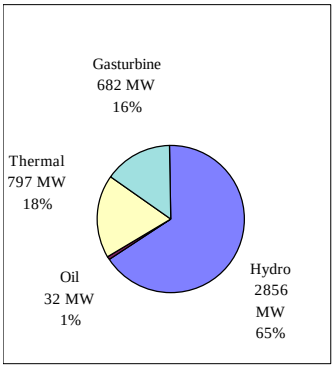
- Those responsible for distribution and supply are independent accounting enterprises (profit- or cash-generating canters), which are accountable directly to EVN's Director General. There are five distribution units: Hanoi, Ho Chi Minh City, PCl, PC2, and PC3.

- Those involved in providing services, including finance, design (PIDCs 1 and 2), construction (three power construction companies), and planning have either independent or dependent accounting status.

GENERATION CAPACITY

In early 1997 the installed power generating capacity in Vietnam was 4400 MW (Figure 2.3). Total generation was some 17,000 GWh in 1996. Hydropower is the dominant source of electricity with almost two-thirds of supply capacity. Ho Chi Minh City and Hanoi, with 1996 consumption of 378 GWh and 1,618 GWh respectively, constitute over 30 per cent of the total demand. Growth in EVN supply to Ho Chi Minh City was some 400 GWh per year from 1995 to 1996, and it is predicted by the government that overall demand will increase at an average rate of 16 to 18 per cent per year to the year 2000.

Figure B-9 Electricity generation capacity Vietnam 1997



Source: EVN

The transmission line has delivered surplus electricity generated by the Hoa Binh (1,920 MW) hydro power plant located some 72 km west of Hanoi to the central and southern parts of the country which have suffered power shortages. The Hoa Binh plant was completed in 1994 when the eighth 240 MW unit was brought on line. Without construction of the north-south line, the surplus power would have been taken up steadily by growth in power demand in the north, it being estimated that demand would have been matched by supply by around 1999 to 2000.

Construction of the line is estimated by EVN to have provided a saving of some U$120 million in the first full year of operation through avoided generation using diesel fuel.

APPENDIX C CAMBODIAN HEALTH SECTOR PROJECTS

Table C-1 Oudong District Hospital Project - summary of budgeted and actual project costs

Component	Budget			Actual
	Initial A$	Amendment A$	Total A$	A$
1. Hybrid generator	100000		100000	95250
2. Vehicle	36000		36000	30300
3. Laboratory & clinic equipment	25000		25000	13000
4. Drugs & supplies	90000	-53000	37000	49750
5. Project personnel	280000	0	280000	261100
6. Accommodation	10000	30000	40000	42500
7. Operating budget	30000	0	30000	50500
8. Building works		36000	36000	51150
9. Mobile unit		19500	19500	11000
10. Review/evaluation		10000	10000	7250
Total	571000	42500	613500	611800
Funding				
1. AusAID			601000	601000
2. Interest allocation			12500	10800
3. Local currency expenditure (est)			15000	15000
Total			628500	626800

Source: ARCS

Table C-2 Hospital Engineering Project - summary of project budget at design

	AusAID A$	ARC A$	CRC A$	Total A$
1. Improve hospitals				
Project personnel	81000	1000		82000
Non-personnel costs	64000	1400	2200	67600
Project support costs	38000	1000	12200	51200
2. Support MoH Committee				0
Project personnel	21600	300		21900
Non-personnel costs	2000			2000
Project support costs	2200	400	500	3100
3. Project management				0
Project personnel	28000	2200		30200
Non-personnel costs				0
Project support costs	9200	600		9800
Total	246000	6900	14700	267600

Source: Project design document

Table C-3 Hospital Engineering Project - Budgeted and actual costs by category

	Budget A$	Actual A$
In-Australia		
Personnel	14000	17600
Support costs	2000	2000
In Cambodia	0	0
Australian personnel	91600	93100
CRC engineering team	25200	23100
CRC admin and vehicle support	14700	7000
Training costs	3000	18200
Tools, equipment and components	23300	44700
Remote area power supply components	39000	21400
Vehicle purchase and operation	34500	15400
Communications, office furniture etc	5900	18300
Review and evaluation	7500	3400
Unallocated	6900	
Total	267600	264200
Funding		
1. AusAID	246000	246000
2. ARCS/interest allocation	6900	11200
3. CRC	14700	7000

Source: ARCS

Table C-4 General characteristics of district hospitals

General:		**Facilities:**	
Mean district population	75,900	- Outpatient clinic	100%
Mean distance to district hospital	11 km	- Small surgery	47%
Mean age of hospital building	18 years	- Dental service	58%
Hospital electricity source		- Laboratory	100%
- Own generator	42%	- Surgery	5%
- Other source of supply	32%	**Hospitals receiving NGO assistance:**	89%
- No source of electricity	26%	of which	
		- Building renovation or new bldg	71%
Hospital with ambulance	16%	- Technical adviser	41%
Staff		- Equipment or supplies	41%
- Hospital staff	24	- Drugs	41%
- Health clinic staff	10	- Training	24%
Average beds per hospital	35	**Median outpatient consultations/month**	433
Mean bed occupancy ratio on day of visit	59%	**Median annual hospital admissions**	477
		Mean monthly referrals to provincial hospital	10

Source: Preliminary findings of Health Facilities and Services Survey ADB MoH Basic Health Services Project August 1995

APPENDIX D THAILAND LMDP TERMS OF REFERENCE

ENVIRONMENTAL ACTIVITIES PLANNED UNDER LMDP3

Activities planned in the environmental area were intended to develop:

- medium-term and annual environmental plans and integrate them with the medium-term and annual mining plans;
- annual reclamation and rehabilitation plans in conjunction with the annual mine plans;
- procedures for the management of overburden dump surfaces including soil profiling and revegetation;
- procedures and techniques for erosion control, of drainage systems for reclamation dumps and steep slopes and of techniques for the revegetation of steep slopes;
- a comprehensive water flow and water quality model;
- a water quality monitoring system;
- a water management strategy for the mine and its reclamation areas
- a strategy for the safe long-term disposal of power station ash;
- plans for the design, construction and biological management of wetlands and the final void lake;
- a dust control model for the mine;
- a dust monitoring system;
- a dust suppression strategy; and
- a water treatment plant at a contaminated seep (construct and commission).

These programs were to be implemented by the Mae Moh Environmental Management Coordination Committee (established in February 1991) through a number of sub-committees assisted by long- and short-term Australian advisers.

ADDITIONAL CONSULTANCY INPUTS RECOMMENDED BY MID-TERM REVIEW

- **Mine Planning and Operations**: 41 additional short-term assignments, mainly in mine planning, technical and geology, establishment of the Coal Technology Centre and stockpile management;
- **Maintenance and Materials Management**: 9 additional assignments
- **Environmental Management**: 5 assignments focussing on water management engineering and spontaneous combustion;
- **Occupational Health and Safety**: 4 additional assignments including establishment of a mine rescue team;
- **Mine Management and Administration**: 15 assignments related to computer based management systems and management development training.

The engagement of a long-term adviser in computerised maintenance systems was recommended and several other minor components added, mainly relating to the provision of equipment and software.

APPENDIX E LMDP DATA

Table E-1 EGAT budgeted and estimated actual counterpart funding of LMDP3, ($'000)

Project Year:	Budget	Actual
Office Space at Mae Moh	350	
office maintenance	12	
Counterpart Staff inputs	500	32918
Lignite & geotechnical analyses	45	
Training facility expenses	60	245
Equipment support & spares	36	
Internal communications costs	4	
Vehicle registration & insurance	40	
Copy Paper	16	
Engineering/drafting materials	25	
Computer maintenance	30	
VAX 11/750 & other software.	416	
Seismic survey equipment	300	
Geological support facilities	96	
Three Silicon Graphics (SG) Workstations and System Software	57	
SG Hardware & Software Maintenance	19	
Darkmaster Plotter (provisional)	20	
Mincom MIMS3 Software and Modules	75	
Total	**2100**	

Figure E-1 Number of reports received/year

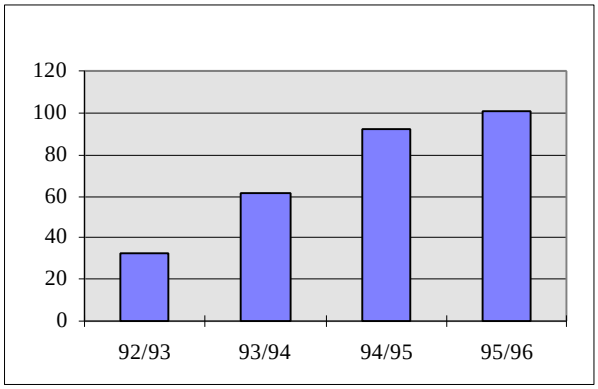


Figure E-2 Preparation of reports under LMDP Phase 3

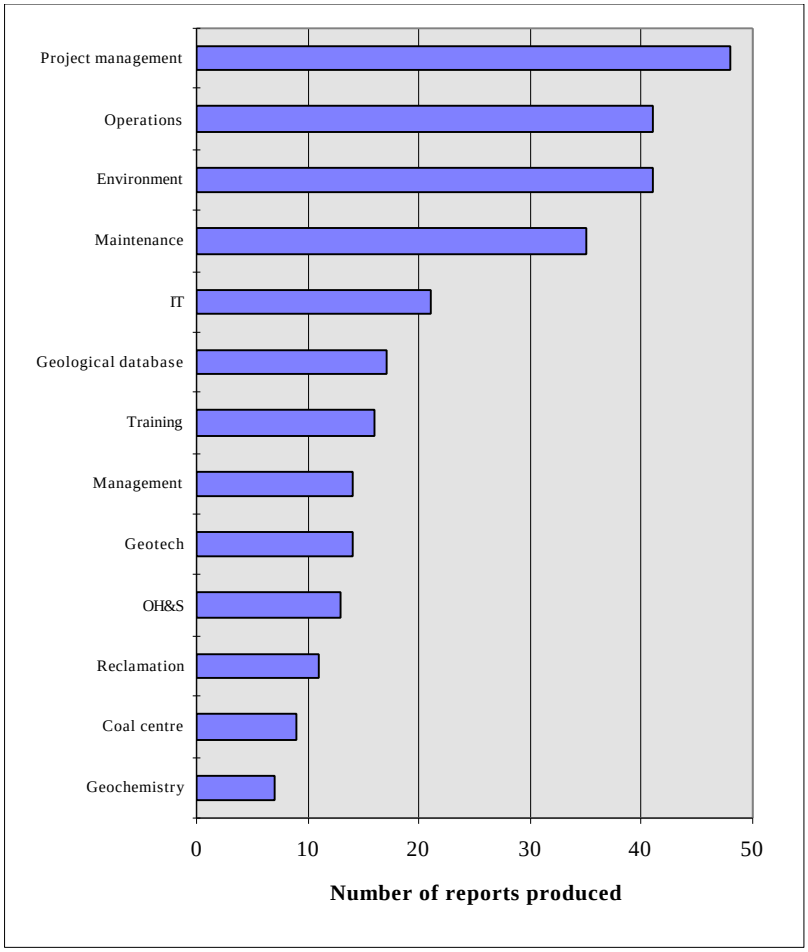
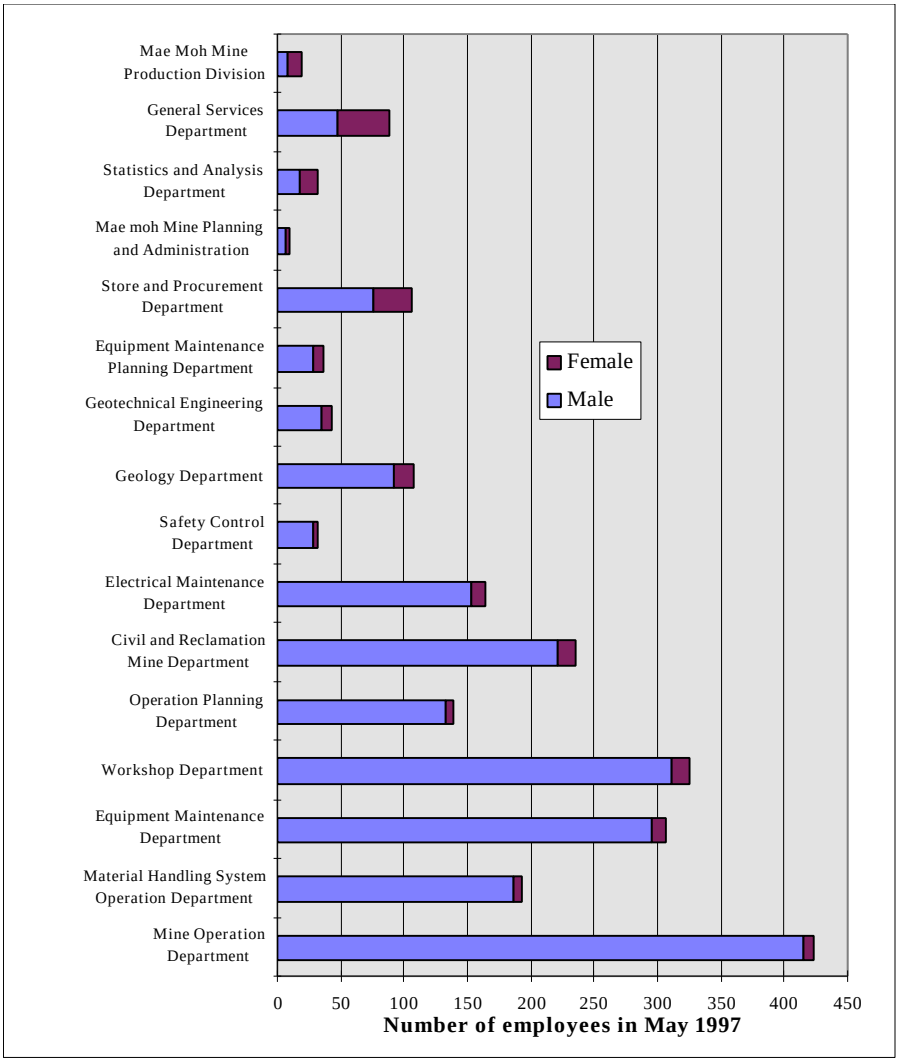


Figure E-3 Employment on Mae Moh mine by division and gender - May 1997



APPENDIX F LMDP3 - PARTIAL COST BENEFIT ANALYSIS

Table F-1 Estimate of economic value of lignite at Mae Moh

Export value of Queensland black coal 1996	A$/t	49 +
Est shipping cost (Gladstone to Bangkok)	A$/t	15
CIF price Bangkok	A$/t	64 +
Delivery to Bangkok power station	A$/t	3
Power station black coal cost	A$/t	67
Lignite/black coal heating ratio	ratio	0.4315
Equivalent lignite value (heating ratio * cost black coal)	A$/t	28.9
Currency conversion rate	฿/A$	20.19
Lignite value	฿/t	584
Freight to North Thailand (by barge)	฿/t	600
Proportion of power sold in north	%	30%
Average equivalent lignite value (lignite value * proportion of power * freight to north)	%	764
Allowance for higher capital cost of lignite power station	%	10%
Average economic value of lignite	฿/t	687
Average present lignite transfer value	฿/t	466
Average mining and mine overhead cost	฿/t	312
Operating margin as proportion of economic value		55%

Table F-2 Partial cost benefit analysis of LMDP3 maintenance program

Average annual lignite production 1991-96	million tonnes	12.4
Coal mined by EGAT plant (1995 and 1996)	million tonnes	5.6
Estimated coal mined by contractor[a/]	million tonnes	6.8
Availability of Terex fleet		
Current average (over 5 years)		72.7%
Estimated availability prior to AusAID project		58.0%
Prior/current availability		0.80
Estimated Mt coal/annum mined by EGAT without improved plant availability	million tonnes	4.5
Estimated annual increase in coal mining due to project	million tonnes	1.1
Annual contact mining cost @ 25 ฿/t	฿ million	28.3
Estimated average annual overburden removal by EGAT	MBm^3	9.6
Estimated MBm^3 overburden/annum removed by EGAT without improved plant availability	MBm^3	7.7
Estimated MBm^3/annum increase in overburden removal due to LMDP3	MBm^3	1.9
Extra annual cost to remove this overburden by contract mining @ 31/m^3	฿ million	60.2
Average total annual benefit	฿ million	**88.5**
	A$ million	**4.4**
LMDP cost (all phases)	A$ million	**32**
Estimated cost of maintenance program	฿ million	**211**

a/ Actual average 1995/96 = 8.4 million tonnes

Assuming benefit accrues over five, ten and twenty years and a real discount rate of eight percent applies and cost of maintenance materials management and operator training component was around 33 percent of AusAID costs (฿211 million)

This analysis only considers improvement in plant availability - if improvement in operator performance (with training) is estimated to result in a conservative twenty percent improvement in excavated material per hour, and the ฿100 million reduction in stores holdings due to improved stores and materials management practice is taken into account the table becomes:

	5 years	10 years	20 years
PV Benefits (฿ million)	240	404	591
Benefit/cost ratio	1.14	1.91	2.80
PV Benefits (฿ million)	456	766	1121
Benefit/cost ratio	2.16	3.63	5.31

The benefits of the project are likely to be accrued over a long time (greater than ten years and probably twenty years), and the above assumptions are considered conservative. That is the likely need for additional capital expenditure by EGAT on their truck and shovel fleet under the 'No AusAID assistance' scenario has been ignored, as have the less tangible benefits of improved health and safety, mine planning and environmental performance. On this basis it is estimated that benefits of the AusAID assistance exceeded costs by more than 2:1.

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