No.

Ex-Post Evaluation Report of Japanese ODA Loan Projects 2009
(Thailand)

August 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

OPMAC Corporation

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Preface

Ex-post evaluation of ODA projects has been in place since 1975 and since then the coverage of evaluation has expanded. Japan's ODA charter revised in 2003 shows Japan's commitment to ODA evaluation, clearly stating under the section "Enhancement of Evaluation" that in order to measure, analyze and objectively evaluate the outcome of ODA, third-party evaluations conducted by experts will be enhanced.

This volume shows the results of the ex-post evaluation of ODA Loan projects that were mainly completed in fiscal year 2007. The ex-post evaluation was entrusted to external evaluators to ensure objective analysis of the projects' effects and to draw lessons and recommendations to be utilized in similar projects.

The lessons and recommendations drawn from these evaluations will be shared with JICA's stakeholders in order to improve the quality of ODA projects.

Lastly, deep appreciation is given to those who have cooperated and supported the creation of this volume of evaluations.

August 2010
Atsuro KURODA
Vice President
Japan International Cooperation Agency (JICA)

Disclaimer

This volume of evaluations shows the result of objective ex-post evaluations made by external evaluators. The views and recommendations herein do not necessarily reflect the official views and opinions of JICA.

Minor amendments may be made when the volume is posted on JICA's website.

JICA's comments may be added at the end of each report when the views held by the operations departments do not match those of the external evaluator.

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Thailand “National Metrology System Development Project (I) (II)”

Thailand

Ex-Post Evaluation of Japanese ODA Loan Project
"National Metrology System Development Project (I) (II)"

Nobuyuki Kobayashi, OPMAC Corporation

1. Project Description

Project Site

Calibration Equipment procured by the project

1.1 Background

After the 1980s, the manufacturing sector in Thailand led economic growth. In the last half of the 1990's, however, the sector faced the necessity of producing more high value-added products for competitiveness in the export market. In order to facilitate trade, international quality inspection tended to become more simplified in the last half of 1990s. During this time, national metrological institutes strived to improve the equivalence of national standards[1] and the establishment of internationally acceptable metrological standards for the export of industrial products was urgent. In Thailand, several institutes set and maintained national standards but only in a few categories and the accuracy of calibration services[2] were unsatisfactory. As reliable calibration services were not available in Thailand, calibration laboratories and corporations used calibration services for their equipment outside the country. However, shipping equipment abroad involved high costs and often damaged equipment.

The National Institute of Metrology (Thailand) (thereafter, NIMT) was established under the Ministry of Science[3], Technology and Environment in 1998. The foundation of NIMT aimed at the establishment of an internationally acceptable metrological standard system. NIMT required calibration equipment covering major metrological categories, a laboratory building which could satisfy the testing environment, and the development of human resources to utilize the equipment. This project supported NIMT in the procurement of equipment and a laboratory building over two phases of yen loans. The Project on the Technical Strengthening of the National Institute of Metrology (Thailand) phases 1/2 (thereafter "the coordinated technical cooperation project"), was a technical cooperation project implemented cooperatively, utilizing calibration equipment for human resource development in metrology.

[1] Metrology standards are standards for units to measure length, weight, time, electric current, and so on.
[2] Calibration is a procedure to assess errors of measurement equipment and prove differences from accurate readings and the uncertainty of measurement.
[3] The name of the executing agency at the time of appraisal

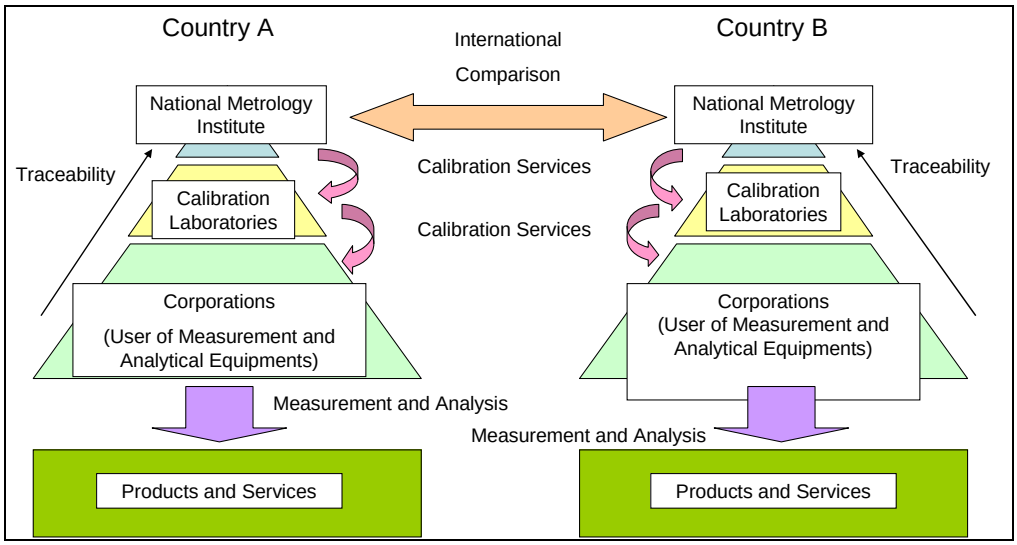
1.2 Project Outline

The objective of this project is to establish national metrological standards by the construction of NIMT's building and the installation of equipment such as meters thereby contributing to the competitiveness of the manufacturing sector in Thailand.

	Phase I	Phase II
Approved Amount / Disbursed Amount	722million yen /691 million yen	2,202 million yen /2,201million yen
Exchange of Notes Date / Loan Agreement Signing Date	September 1999 / September 1999	September 2000 / September 2000
Terms and Conditions	Interest Rate: 0.75% Repayment Period: 40 years (Grace Period: 10 years), Conditions for Procurement: Partial untied (Consulting Service: Bilateral untied)	Interest Rate: 0.75%; Repayment Period: 40 years (Grace Period: 10 years); Conditions for Procurement: Bilateral untied (Consulting Service: Bilateral untied)
Borrower / Executing Agency(ies)[4]	The Kingdom of Thailand /Ministry of Science and Technology[5]	The Kingdom of Thailand /Ministry of Science and Technology[6]
Final Disbursement Date	January 2006	January 2008
Main Contractor (Over 1 billion yen)	-	-
Main Consultant (Over 100 million yen)	Nikken Sekkei Ltd.(Japan)・ PADECO Co., Ltd.(Japan)・ Environmental Engineering Consultants (Thailand)	-
Feasibility Studies, etc.	None	
Related Projects	JICA "The Project on the Technical Strengthening of National Institute of Metrology (Thailand)"	

[4] Name of the executing agency at the time of the ex-post evaluation
[5] NIMT is directly in charge of the implementation, operation and management of this project.
[6] NIMT is directly in charge of the implementation, operation and management of this project.

[Column 1] Overview of National Metrology System



A national metrology institute sets and maintains national standards at the apex of a national metrological system. In 1999, the Metric Convention countries, including Thailand, signed the global mutual recognition arrangement of metrological standards. Under the arrangement, National metrological institutes compare their Calibration and Measurement Capabilities (CMC) and strive to establish an equivalence of national standards among the different countries. In the event that CMC prove the equivalence, the calibration certification of other countries is equally treated with the domestic one.

Using national standards, a national metrological institute provides calibration services such as the calibration of metrological standards, the provision of reference material, and the issuance of calibration certificate. With standard instruments, reference materials, and measurement equipment which are provided by a national metrological institute, calibration laboratories provide calibration services for measurement and analytical equipment owned by end users. The accuracy of measurements and analytical equipment is secured via the chain of calibration services beginning with the national standards; from this, an appropriate metrological standard system is established. If the chain of calibration reaches national standards, it is considered that the equipment has traceability to national standards.

In recent years, manufacturers are required to obtain ISO 9001 (quality management system accreditation) for international trade. ISO 9001 demands that corporations make their equipment traceable to international or national standards. For this reason, the establishment of a national metrological system which maintains traceability is a critical issue for the promotion of exports.

2. Outline of the Evaluation Study

2.1 External Evaluator

Nobuyuki Kobayashi, OPMAC Corporation

2.2 Duration of Evaluation Study

Duration of the Study: November 2009 – August 2010
Duration of the Field Study: February 7th, 2010 – March 4th, 2010 and May 16th, 2010 – May 20th, 2010

2.3 Constraints during the Evaluation Study

None

3. Results of the Evaluation (Overall Rating: A)

3.1 Relevance (Rating: a)

3.1.1 Relevance with the Development Plan of Thailand

At the time of appraisal, the necessity for a metrological standards system was adequately recognized. The National Metrological System Development Act was approved in August 1997. Based on the act, NIMT was established under the Ministry of Science, Technology and Environment. The act defined NIMT's roles including (1) research and studies on metrology, (2) the provision of calibration services and (3) the development of calibration laboratories in the private sector. In order to set policy goals for the development of national metrology standards, the Thai cabinet approved the Master Plan on the National Metrology System Development. The strategy for the development of a national metrology system laid down that NIMT, at the core of the system, would carry out the technological transfer to the private sector.

At the time of the ex-post evaluation, the National Metrological System Development Act in 1997 was still effective and placed NIMT as the main body to develop metrology standards. Reflecting past developments of national metrology standards, the cabinet approved the Master Plan on the National Metrology System Development (Second Phase) in November 2009. The policy goals of the plan include: (1) the development of NIMT and its network (2) the development of calibration and testing laboratories, (3) the expansion of calibration service clientele and (4) the promotion of international activities.

At the times of both the appraisal and ex-post evaluation, NIMT was the main body developing metrological standards and transferring knowledge to the private sector. There has been no significant change in this policy. This project supported the equipment indispensable for NIMT's attainment of knowledge in metrology and the provision of calibration services. Thus, this project has been relevant with the development plan of Thailand.

3.1.2 Relevance with the Development Needs of Thailand

The Metric Convention countries, including Thailand, signed the global mutual recognition arrangement of metrological standards (CIPM MRA) in October 1999. The objective of CIPM MRA is to facilitate trade by the simplification of quality inspection. In order to accept calibration certifications issued in other countries, metrological standards need to satisfy certain requirements. CIPM MRA establishes a scheme to compare the Calibration and Measurement Capabilities among national metrology institutes (international comparison).

There have been minor adjustments to CIPM MRA since its signing. The objective of CIPM MRA, however, remains intact. Following the arrangement, national metrology institutes actively conduct international comparison. At the time of ex-post evaluation, Thailand is still a signatory of CIPM MRA and NIMT participates in international comparison of metrology.

At the time of appraisal, NIMT was required to prove, by participating in international comparison, that it had adequate capabilities. At the time of the ex-post evaluation, Thailand

needs to establish and maintain an internationally acceptable metrological standard system in order to promote international trade. The project has been consistent with the development needs of Thailand as the equipment procured by the project is used for international comparison.

3.1.3 Relevance with Japan's ODA Policy

At the time of appraisal, Japan's Official Development Assistance Charter (1992) referred to the close relationship between Japan and East Asia, including ASEAN, and placed a special emphasis on assistance to the Asian region. It also respected human resource development. Moreover, in the ODA Annual Report for FY 1998, the country assistance strategy for Thailand regarded the establishment of economic infrastructure as one of the priority areas. It paid an attention specifically to (1) the development of human resources in science and technology for more sophisticated industry and (2) the development of supporting industries to cover a wider range of industries.

The project has been consistent with Japan's ODA Policy. It has been implemented cooperatively with the technical cooperation, nurturing specialists who can set and maintain metrological standards. Indirectly, therefore, it also supports human resource development. Calibration laboratories, NIMT clients, provide critical services for standardized products and support economic activities in Thailand.

This project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy, therefore its relevance is high.

3.2 Efficiency (Rating: b)

3.2.1 Project Outputs

This project financed NIMT for (1) the procurement of calibration equipment, (2) the construction of a laboratory building, and (3) consulting services. Advisors redefined the categories of equipment, reflecting on technological innovations in calibration equipment, NIMT staff capabilities and the scope of the coordinated technical cooperation project, (see Table 1). The increase in the types of equipment is mainly due to reference materials.

Table 1: Changes in the procured equipment

	Categories under the Project
At the time of appraisal (September 1999)	Items: 329 types The procurement of equipment is for 41 categories as follows: Time & Frequency, DC Voltage, DC Current, AC Voltage, AC Current, Power, Energy, Inductance, Resistance, Capacitance, RF Voltage, RF & Microwave Power, Laser Power Measurement, Mass, Temperature (3 types), Humidity, Length, Diameter, Roundness, Straightness, Angle, Roughness, CMM, Flatness, Sound Pressure Level, Accelerometer, Microphone Sensitivity, Reference Material, Luminous Flux, Luminous Intensity, Spectral Irradiance, Magnetics, Force, Flow, Density, Air Flow, Pressure & Vacuum, Photometry, Distribution Temperature
At the time of ex-post evaluation (May 2010)	Items: 397 types The procurement of equipment is for 36 categories. Changes are following: Add: Wavelength, AC-DC high Voltage, Hardness Regroup: Luminous Flux, Luminous Intensity, and Spectral Irradiance are covered by the equipment in Photometry. Cancel: Energy, Flow, Air Flow, Density, Distribution Temperature*

Source: the appraisal document for the phase 1 project, NIMT

Note: *On Distribution Temperature, NIMT procured the equipment with its own budget.

The laboratory building was constructed in the province of Pathumthani as originally planned. Consulting services covered project management, the detail design of the laboratory building, and construction supervision. The scope of consulting services is almost as planned. In addition, advisors were hired for the selection of equipment and the basic design of the laboratory building. However, the consulting services did not include project management in phase II as NIMT founded a project management unit.

Photo 1: Laboratory

3.2.2 Project Inputs

3.2.2.1 Project Period

The project period was significantly longer than planned (194% of the planned period). The delay was mainly due to construction and the prolonged procurement of calibration equipment. Bilateral ties were applied to the procurement of equipment but the equipment to be procured contained some which were manufactured in countries other than Japan and Thailand. For this reason, International Competitive Bidding (ICB) was applied in principle. At the implementation phase, there was no bid at all for some equipment and some unit price surpassed the price estimate. As a result, other procurement methods such as international shopping and direct contracting were also applied. Long-term experts in the coordinated technical cooperation project supported NIMT in the preparation of the technical specification documents for equipment, the obtaining and comparison of requests for proposal.

Table 2: Details of project period

	Plan	**Actual**
Lion Agreement Signing (Phase I)	September 1999	September 1999
Consulting Services	July 2000 – April 2003	July 2000 – August 2005
Construction of Building	December 2001 – April 2003	September 2003 – August 2005
Procurement and Installation of Equipment	February 2000 – December 2003	May 2001 – January 2008
Project Completion (End of Procurement and Installation of Equipment)	December 2003 (52 months)	January 2008 (101 months)

Source: NIMT, the appraisal document for the phase 2 project

3.2.2.2 Project Cost

The project cost was lower than planned (91% of the planned cost). The cost of equipment increases substantially even when the change of project scope (329 types of item at the appraisal, 397 types of item at the ex-post evaluation) is taken into consideration. This is due not only to an increase in the types of item but also to an increase in unit price. For some equipment, the price estimate at the appraisal did not include additional costs such as shipping and installation fees.

Table 3: Breakdown of project cost

(Unit: million yen)

	Plan*	Plan (Adjusted)**	Actual
Construction of Building	1,118	1,118	899
Procurement of Equipment	1,266	1,528	1,750
Consulting Services	370	370	243
Contingency	170	170	-
Total	2,924	3,186	2,892

Source: NIMT

Note 1: *Given that the yen loan portion is above 70 % and that a fair comparison of other portion is difficult, the above analysis covers the yen loan portion only.

Note 2: **Project cost is adjusted in accordance with the number of item types from 329 to 397 (an approx. 21% increase)

Although the project period was significantly longer than planned, the project cost was lower than planned, therefore efficiency of the project is fair.

3.3 Effectiveness (Rating: a)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

(1) Number of parameters which NIMT can calibrate

The number of parameters which NIMT can calibrate increased substantially during project implementation. In 2008, the scheduled project completion, they reached the target set at the appraisal. Although the project period was prolonged, NIMT meanwhile acquired the ability to provide calibration services in more categories.

Table 4: The number of parameters which NIMT can calibrate

At the time of appraisal (Phase II)		At the time of ex-post evaluation	
Actual (2000)	Target (2004)	Actual (2008)*	Actual (2010)
53	179	250	261

Source: NIMT

Note: * The target in 2004 (project completion in the original schedule) was set for appraisal .For fair analysis, the target is compared with the actual figure in 2008 (project completion in the actual schedule).

(2) Number of ex-house calibration services

As the effect indicator set at the appraisal was not constantly monitored, reliable and comparable data is unavailable. Therefore, an alternative indicator which can allow time series comparison has been selected. The percentage increase of the effect indicator (the number of calibration services) is used as an approximate target. The number of ex-house calibration services grew approximately 200% (see Table 5). For the same period, the number of calibration certificates issued by NIMT recorded a substantial increase. A rigorous analysis on the achievement of the project outcome is difficult. Nevertheless, the before/after analysis clearly shows an increase in calibration services. The calibration services provided by NIMT have strong demand from their clientele.

Table 5: Number of Ex-house calibration services and number of calibration certificates

	Actual (2000)	Actual (2008)	% Increase	Target*	Actual (2009)
Calibration services (Pieces)	1,156	3,465	199.7%	66.8%	3,991
Calibration certificates	1,127	1,765	56.6%	N/A	1,934

Source: NIMT
Note: *The percent increase in the number of calibration services (total of primary and secondary) from 2000 to 2004. This was estimated at the time of the appraisal.

3.3.1.2 Results of Calculations of Internal Rates of Return (IRR)

On both the Financial Internal Rate of Return and the Economic Internal Rate of Return, it is not feasible to estimate the benefit that can be attributed to the project. As the internal rate of return was not calculated at the appraisal, it has not been recalculated at the ex-post evaluation.

3.3.2 Qualitative Effects

(1) Use of Equipment

The use of equipment, mainly expensive equipment[7], is assessed on the basis of interviews with NIMT laboratory staff. The equipment is being used for in-house and/or ex-house calibration services and international comparison or under examination for effective use. Among the equipment, ICP/MS, LC/MS/MS are used for the producing of Certified Reference Materials (CRMs). The time and frequency system has a strong demand as a new regulation requires the companies which charge customers on a time basis to make the measurement of time more accurate. At the time of the ex-post evaluation, the equipment not in use for calibration services was as follows:

Photo 2: Analysis instrument (NOx, SO_2, CO, etc.)

(i) Shore Hardness Testing Machine

There was a methodological change in the measurement of hardness. As clients do not need to measure Shore hardness, opportunities to utilize this equipment have diminished. This equipment, however, will be utilized to provide the calibration service on Leeb hardness by the research work starting in 2013.

(ii) Spectroradiometer

NIMT has been able to provide calibration services for spectral irradiance calibrations of customers' lamps from the beginning of 2008 using the spectoradiometer system. However, there is no secondary laboratory that can provide further calibration service to the end users while there is a lot of demand, especially from the research areas of solar radiation and solar cells. Therefore, NIMT is establishing secondary calibration systems for calibration of radiometers and spectroradiometers and tentatively these two secondary systems will be opened for services by the end of 2011.

(2) Focus Group Discussion for NIMT staff

In order to obtain NIMT staff opinions on the incidence of project effects, a focus group discussion for laboratory staff was conducted (See Column 2).

[7] Price estimate is above 20 million yen; 15 types of item

[Column 2] Results of focus group discussion
Date : February 23, 2010
Place : NIMT headquarters (Province of Pathumthani)
Topic : "How does the equipment provided by the project contribute to the better performance of calibration laboratories and companies?"
Participants : NIMT laboratory staff (one session, 5 persons)

After discussing the above topic, participants were requested to vote for three most agreed-upon opinions. Results were as follows:

Table 6: Results of focus group discussion

Opinion	No. of Votes
NIMT clients can reduce the cost of calibration for equipment and metrological standards	3
NIMT can provide calibratation services to its clients in more parameters.	3
Best Measurement Capability (accuracy) is improved.	3
Traceability is established.	2
Metrologists' knowledge and skills are enhanced	1
Technical knowledge is created.	1
Total (excluding two ineffective votes)	13

Participants regarded cost reductions in calibration services, calibration services in more parameters, and the improvement of accuracy as benefits of the procured equipment. The number of parameters which NIMT can calibrate is shown in "3.3.1.1 Results from Operation and Effect Indicators (1) Numbers of parameters which NIMT can calibrate". NIMT staff consider that the procured equipment has contributed to this increase.

(3) Interviews with calibration laboratories
Interviews with calibration laboratories (three private companies) supposed to have benefitted from the project were carried out in this ex-post evaluation. NIMT directly provides calibration services to all of the laboratories. All interviewees agreed that NIMT can provide calibration services in a much wider range than in the late-90s and that the calibration at NIMT takes less time. Some clients also explained that they do not send equipment to other countries as calibration in Thailand reduces cost. Calibration laboratories expect NIMT to reduce the time needed for calibration. Referring to uneven accuracy (the range of uncertainty) among laboratories, one client expressed a wish that NIMT played a proactive role in guidance for further accuracy in calibration.

This project has largely achieved its objectives, therefore its effectiveness is high.

3.4 Impact

3.4.1 Intended Impacts

(1) Accreditation of ISO/IEC17025
The number of ISO/IEC 17025-accredited[8] calibration laboratories increased from 13 laboratories in 1999 (at the time of appraisal) to 106 laboratories in March 2010[9]. NIMT contributes to the development of calibration laboratories by (1) providing affordable and

[8] ISO/IEC17025 is an international standard for testing and calibration laboratories. The accreditation requirement includes technical capability as well as quality management.
[9] The number of calibration laboratories accredited by Thai Industrial Standard Institute

accurate calibration services in a reasonable period to calibration laboratories and (2) utilizing knowledge of metrology and arranging seminars and comparison among calibration laboratories. An ISO/IEC 17025 accredited laboratory can put an accreditation symbol on its calibration certificate. Companies can then show that they use accurate measurement and analytical equipment in their business operations in the internationally acceptable manner. The increase in accredited calibration laboratories suggests that appropriate calibration services are more readily available.

(2) Number of CMC mutually approved under CIPM MRA
NIMT participates in international comparison as stipulated in CIPM MRA. NIMT's CMC for 8 parameters was approved in 2003. Since then, the number of approved parameters has been gradually increasing (see Table 7).

Table 7: Number of the approved CMC

	2003	2004	2005	2006	2007	2008	2009
Parameters	8	8	8	14	14	14	17
Lines	313	313	313	343	343	343	356

Source: NIMT

At the end of 2009, NIMT's CMC had been approved in 17 parameters. The breakdown of these parameters is 6 parameters in machinery, 8 in electricity and magnetism, 1 in temperature, and 2 in time and frequency. The approval of CMC proves that the national metrology standards in Thailand are equivalent to these in other countries and suggests that the national metrology standards in Thailand are now recognized more widely outside the country.

(3) Interview with calibration laboratory clients
Interviews with calibration laboratory clients (three private companies and one ministry) who are supposed final beneficiaries of the project were carried out in this ex-post evaluation. Several interviewees also agreed that calibration services were available in more categories than in the late-90s and that calibration services took less time. It can be presumed that these project effects are felt by not only calibration laboratories but also final beneficiaries. There was a view that an increase in the number of calibration laboratories had resulted in a decline in the price of calibration services.

3.4.2 Other Impacts
(1) Impacts on the natural and social environment
According to NIMT, the disposal of toxic waste from NIMT's laboratory was outsourced. In addition, resettlement was not carried out because land acquisition was completed before the commencement of the project. Significant negative impacts on the natural and social environment were not observed during the site survey.

While this project contributes to the prevalence of calibration services and the international recognition of the national metrology standards in Thailand, it is presumed that serious negative impacts do not occur.

3.5 Sustainability (Rating: a)

3.5.1 Structural Aspects of Operation and Maintenance
NIMT was under the supervision of the Ministry of Science and Technology at the time of the ex-post evaluation following reorganization of the ministry. No significant change has been made to the National Metrological System Development Act since the appraisal of this project.

Thus, there is no change in NIMT activities as stipulated in the act.

NIMT can be functionally divided into an administrative section (two departments) and a calibration service section (7 laboratories defined by metrological categories). The number of staff is 183 persons including 5 part-time employees. All laboratory staff work on a full-time basis. According to NIMT, staff turnover is low as few employees resign other than those who retire.

3.5.2 Technical Aspects of Operation and Maintenance

NIMT has 18 Ph.D holders, 78 masters degree holders, and 57 bachelors degree holders. Employees with higher education account for more than a half of NIMT staff. After undergoing basic training, a new employee acquaints herself/himself with calibration in the metrology category of which they are put in charge by OJT. Since NIMT offers 30 training courses to external customers, NIMT staff can participate in these courses. NIMT employees have the qualities requisite for the daily operation of the laboratory.

The coordinated technical cooperation project developed human resources in metrology by training for equipment usage in Japan and Thailand, for the assembly of equipment, the establishment of national metrology standards, and for the review of calibration procedure manuals. The technical cooperation project played a vital role in maintaining the effectiveness and sustainability of equipment. In an interview with laboratory staff (9 staff in 6 metrological categories), some staff said that they faced difficulties in understanding the basic concept of metrological standards. Given these difficulties, it can be concluded that the use of equipment does not automatically result in the establishment and maintenance of metrological standards and the provision of calibration services. According to interviewees, training under the technical cooperation project matches the procured equipment. There was one case (freezing point cell) where it took two years between training in Japan and actual use of equipment due to different technical specifications.

Except for the acoustic and vibration laboratory department, all laboratory departments are in the laboratory building financed by the project. As the acoustic and vibration laboratory department requires an anechoic room, the department is located in a building with such a room situated next to the Ministry of Science and Technology. The maintenance of electrical facilities, air conditioning facilities, fire protection facilities and sanitary facilities is routinely conducted in the laboratory building. Temperature is controlled by the use of air conditioners.

3.5.3 Financial Aspects of Operation and Maintenance

The government general budget accounts for approximately 90% of total revenue, though the calibration service fee is increasing (see Table 8). Income adequately covers indispensable expenses for laboratory operation such as personnel expenses and material costs. Depreciation and amortization, a non-cash expense, accounts for a significant portion of total expenditure. Therefore, there is a cushion in liquidity to absorb a reduction of budget allocation. As the cabinet has recently approved the master plan (second phase), financial support for NIMT activities will continue in the foreseeable future.

Table 8: NIMT Income and Expenditure

(Unit: million Baht)

Item	2006	2007	2008
Income	218.9	220.5	332.9
from government general budget	196.6	194.3	301.7
from calibration services	11.4	13.8	16.6
Expenditure	186.0	225.7	253.5
from depreciation and amortization	75.0	88.9	107.8
from personnel expenses	51.3	62.0	74.6
from materials and others	42.4	55.9	52.5
Net Income	32.9	-5.2	79.4

Source: NIMT

3.5.4 Current Status of Operation and Maintenance

The maintenance of equipment, mainly of expensive equipment[10], is assessed on the basis of interviews with NIMT laboratory staff. There is no serious issue preventing the incidence of project effects.

On the inventory management of equipment, the administration department records and maintains the inventory. As each piece of equipment is assigned an ID number, it is easy to distinguish equipment procured by this project from others. On the calibration of equipment, a sticker which shows the calibration date and the effective date is put on every piece of equipment. There is some low-demand equipment which goes beyond its effective date but most of the equipment has calibration in an appropriate cycle (once a year). A repair service is available for all equipment with calibration demand.

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The delay in project implementation was significant. In particular, procurement took much longer period than the original plan had assumed. On the other hand, the project is consistent with the development policy of Thailand, development needs and with Japan's ODA Policy. The incidence of project effects is obvious as the metrological standards system has developed. There are no findings that negatively affect the sustainability of project effects.

In light of the above, this project is evaluated to be (A) highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations for the Executing Agency

The project has contributed to an increase in the number of parameters which NIMT can calibrate and, to some extent, the fostering of calibration laboratories. On the other hand, the uncertainties of parameters widely vary among calibration laboratories.

It is desirable that a comparison among calibration laboratories is promoted, that the accuracy of

[10] Price estimate above20 million yen; 15 types of item

their calibration services is inspected, and that guidance is provided for the improvement of accuracy.

4.2.2 Recommendations for JICA

None

4.3 Lessons Learned

The procurement of this project was bilaterally tied. As the equipment included that which was not produced in Thailand and Japan, the procurement of equipment was based on ICB. There are several types of equipment which surpassed the price estimate and some for which there was no bid. For these reasons, several attempts at tendering resulted in a delay in procurement. For a shorter period for procurement, it is desirable, at appraisal, to assess the size of the procurement package and the procurement procedures. In addition, price estimation needs to include shipping and installation fees. At the implementation phase, the procurement procedure needs to be chosen flexibly, depending on the type of product.

Several performance indicators were selected at the appraisal of this project. During the implementation phase, however, the data for some indicators was not collected due to the cumbersomeness of data collection. It is desirable that performance indicators which are appropriate for the measurement of project effects and can be measured routinely are selected. The use of performance indicators in which the executing agency collects data periodically at appraisal might be appropriate.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	(1) Calibration Equipment: 329 types (41 categories) (2) Construction: Laboratory building (3) Consultanting Services: - Project Management - D/D of Building - Construction Supervision - Advisory services for equipment selection and B/D of bulding	(1) Calibration Equipment: 397 types (36 categories) (2) Construction: Laboratory building (3) Consultanting Services: -Project Management (Phase I only) -D/D of Building -Construction Supervision -Advisory services for equipment selection and B/D of bulding
2. Project Period	September 1999 – December 2003 (52 months)	September 1999 – January 2008 (101 months)
3.Project Cost Amount paid in Foreign currency Amount paid in Local currency Total Japanese ODA loan portion Exchange rate	 1,522 million yen 2,431million yen (857 million Thai Baht) 3,973million yen 2,924million yen 1 Thai Baht = 2.86 yen (As of April 2000)	 - - - 2,892 million yen 2,892 million yen -

Thailand “Power Distribution Reinforcement Project (5-1) / (5-2)”

Thailand

Ex-Post Evaluation of Japanese ODA Loan Project
"Power Distribution Reinforcement Project (5-1) / (5-2)"

Nobuyuki Kobayashi, OPMAC Corporation
Atsushi Fujisawa, TEPSCO

1. Project Description

Project Site

Transforming facilities supported by this project

1.1 Background

When this project was formed in the early 1990s, the Electricity Generation Authority (EGAT) was engaged in power generation and transmission to primary substations in the Thai power sector. Meanwhile, the Metropolitan Electricity Authority (MEA) was in charge of power distribution in the Bangkok metropolitan area and the Provincial Electricity Authority (PEA) in other areas of the country. Since the 1960s, PEA has prepared 5-year development plans corresponding to the National Social Economic Development Plans and has developed a distribution network. Japanese ODA loans have been provided to PEA for the development of the distribution network since 1968.

As a result of PEA's efforts in distribution systems, electrification improved from 20-30% in the late-1970s to above 80% at the late 1980s[1]. More people have benefitted from electrification. In tandem with economic growth in Thailand, electricity demand grew at more than 10% per annum in the late 1980s. However, several issues became apparent in the early 1990s. An increase in industrial demand made users demand a more stable supply of electrify. As a result of the development of distribution facilities, the longer length of distribution line per feeder caused drops in voltage and blackouts more frequently. Moreover, the rapid growth in electric demand was expected to continue in the future. Paying attention to these issues, PEA urgently needed to cope with growing power demand and establish a distribution infrastructure for the stable supply of electricity at the time of appraisal.

1.2 Project Outline

The objective of this project is to improve the reliability of electric supply and realize potential demand by the enhancement and installation of transmission and distribution facilities (the downstream section from PEA or EGAT owned substations), thereby contributing to the stimulation of local economy.

[1] Village basis

	(5-1)	(5-2)
Approved Amount / Disbursed Amount	12,763 million yen / 12,101 million yen	21,223 million yen / 18,196 million yen
Exchange of Notes Date / Loan Agreement Signing Date	December 1992 / January 1993	September 1994 / September 1994
Terms and Conditions	Interest Rate: 3.0% Repayment Period: 25 years (Grace Period: 7 years) Conditions for Procurement: General untied	Interest Rate: 3.0% Repayment Period: 25 years (Grace Period: 7 years) Conditions for Procurement: General untied
Borrower / Executing Agency(ies)	Provincial Electricity Authority / Same as above Guarantor: Government of The Royal Thai Government	Provincial Electricity Authority / Same as above Guarantor: Government of The Royal Thai Government
Final Disbursement Date	November 2000	January 2002
Main Contractor (Over 1 billion yen)	-	
Main Consultant (Over 100 million yen)	None	Mahajak International Electric Co., Ltd. (Thailand), Oriental Electric Industry Co., Ltd. (Thailand)
Feasibility Studies, etc.	None	
Related Projects	Japan International Cooperation Agency (JICA): Power Distribution Reinforcement Project (1)/ (2)/ (3-1)/ (3-2)/ (3-3) / (4-2) /(4-3) World Bank: Distribution Automation and Reliability Improvement Project EU: Electricity Network Upgrading Program	

2. Outline of the Evaluation Study

2.1 External Evaluator

Nobuyuki Kobayashi, OPMAC Corporation
Atsushi Fujisawa, TEPSCO

2.2 Duration of Evaluation Study

Duration of the Study: November 2009 – August 2010
Duration of the Field Study: February 7th, 2010 – March 4th, 2010 and May 16th, 2010 – May 20th, 2010

2.3 Constraints during the Evaluation Study

The project area covered all of Thailand but for this evaluation, a site survey was not carried out

the northeast region. In the second field survey (May 16th, 2010 – May 20th, 2010), site visit was planned for the region. This visit, however, was cancelled due to the political turmoil in Thailand.

3. Results of the Evaluation (Overall Rating: A)

3.1 Relevance (Rating: a)

3.1.1 Relevance with the Development Plan of Thailand

The Seventh National Social Economic Development Plan (1992-1996) placed an emphasis on regional development and promoted balanced development between urban and rural areas. In the power sector, the 7th plan outlined four major policies including (1) to provide an adequate supply of stable power that meets the timely needs of customers at minimum cost and (2) to promote the efficient and economical use of electricity. Corresponding to these major policies, PEA prepared the Transmission and Distribution Development Plan 1992-1996. After being revised in 1994, the development plan recommended 23 projects under 6 categories during the project period. This project was one of the projects under the "Power System Expansion Reinforcement Plan.

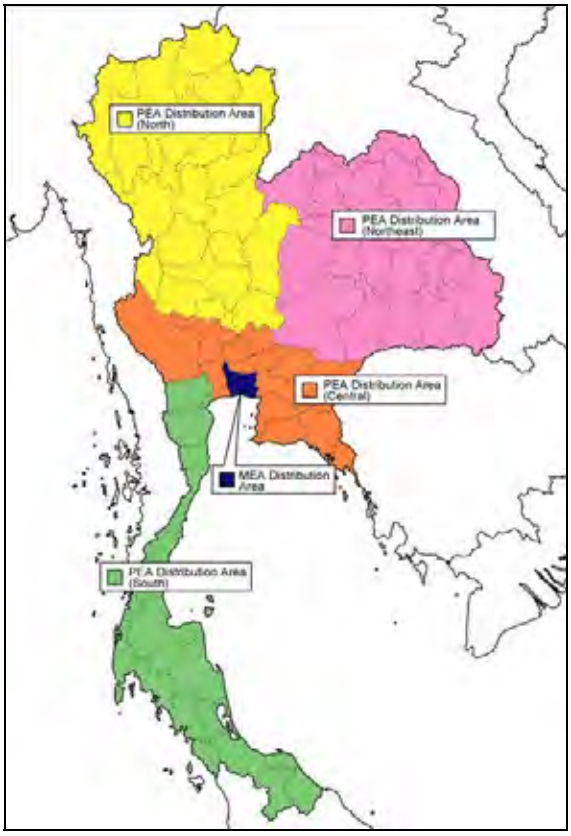


Figure 1: PEA's distribution area

At the time of the ex-post evaluation, The Tenth National Social Economic Development (2007-2011) had five policy pillars; (1) the development of human resources, (2) community oriented development, (3) reform and efficiency in the economy, (4) the conservation of the natural environment and resources, and (5) the improvement of good governance. Aiming at an efficient, stable, and fair economy, the 10th Plan promotes the fair distribution of the benefits of development and infrastructure development spreading over regions in balanced manner. The 10th plan also recommends a reduction in the environmental burden through a change in production and consumption patterns. For reform and efficiency in the economy, the 10th plan also pursues a good investment environment to attract foreign investment. The Transmission and Distribution Development Plan 2007-2011, the latest development plan for the power distribution sector, recommends 8 projects during the project period, one of which is a follow-up of this project.

While the national development strategy promoted balanced development between urban and rural areas at the time of the appraisal, it aims at the fair distribution of the benefits of development. For this policy goal, the current strategy recommends infrastructure development spreading over the regions in more balanced manner.

At both the appraisal and the ex-post evaluation, the reduction of regional disparity remained key for the Thai government. The national development strategy at the ex-post evaluation

weighs the development of good investment environment more than the strategy at the appraisal did. As PEA supplies electricity to all areas except the Bangkok metropolitan area (see Figure 1), this project also constructed infrastructure for power distribution in the same areas. This project has also contributed to the efficiency of energy consumption. For these reasons, in the latest development plan, PEA has promoted a similar type of investment to this project.

3.1.2 Relevance with the Development Needs of Thailand

The electricity demand in Thailand increased at 14% per annum from 1987 to 1991. The demand from the PEA distribution area posted a higher growth, at 15% annually, and this was expected to increase at 11% per year for the 5 years starting from 1991[2]. Therefore, PEA needed to enhance the capacity and efficiency of the distribution systems in order to cope with the growth in demand.

At the time of the ex-post evaluation, power demand was expected to grow continuously. PEA assumes an annual power consumption of 115,868 GWh in 2011(annual growth rate of 6.87% for 2006 - 2011) and a peak demand of 18,461 MW (annual growth rate of 7.15% for 2006 - 2011)[3]. On the basis of the above forecast, PEA is pursuing the improvement of SAIFI (2011 target: 8.94 times)[4] , SAIDI (2011 target: 314 min.)[5], and the restraint of distribution loss (2011: below 5.2%).

The expansion of power demand can be assumed as Thailand has recently experienced steady economic growth. As reliable infrastructure is critical for the further stability of the power supply and the satisfaction of demand, PEA continues investment in order to achieve policy targets. For this reason, the development needs that legitimised this project remain intact at the time of the ex-post evaluation.

3.1.3 Relevance with Japan's ODA Policy

Japan's Official Development Assistance Charter, the preceding charter approved in 1992, referred to the close relationship between Japan and East Asia, including ASEAN, and placed a special emphasis on assistance to the Asian region. The charter made a point of infrastructure development.

At the time of appraisal, Japan's ODA Policy placed importance on both assistance to Asian countries, including ASEAN nations, and infrastructure development. The project has been consistent with Japan's ODA Policy as this project assists Thailand, a member country of ASEAN, in infrastructure development.

This project has been highly relevant with the country's development plan and development needs, as well as Japan's ODA policy, therefore its relevance is high.

Photo 1: Reclosers

[2] Based on the appraisal documents of the "Power Distribution Reinforcement Project (5-1)/(5-2)"
[3] Based on PEA " Transmission and Distribution Development Plan 2007-2011"
[4] Frequency of Interruption per customer
[5] Duration of Interruption per customer

3.2 Efficiency (Rating: b)

3.2.1 Project Outputs

This project supported not only the extension and improvement of distribution lines but also the equipment to stabilize the power supply. Procurement and construction works were adjusted, reflecting the ongoing development of the distribution infrastructure and the changes in development needs (see Table 1).

Table 1: Major changes in outputs and the reasons

Changes	Reasons
An increase in reclosers (from 449 units to 1,234 units)	Electricity demand was stronger than the original forecast. Reclosers can separate accident sections in shorter lengths and improve SAIFI/SAIDI.
A decrease in service meters (from 2,008,000 units to 1,332,100 units)	PEA had the budget to purchase similar equipment outside this project and procured service meters to a certain amount with its own budget. PEA procured the service meters as much as possible with its budget as the meters were available in the domestic market.

Source: PEA

3.2.2 Project Inputs

3.2.2.1 Project Period

The project period was longer than planned (141 % of the original plan).While the original plan assumed 81 months from the signing of the loan agreement for the phase (5-1) to the completion of the phase (5-2), it actually took 114 months. The reasons behind this delay were (1) that procurement was delayed due to the severe shortage of some materials in 1995-1996, (2) that contractors had difficulty in fulfilling their obligations due to a lack of working capital after the Asian financial crisis, and (3) that construction work for roads required the permission of the department highway which took a long period.

Table 2: Details of the project period

(5-1)	Plan	Actual
Loan Agreement Signing	January 1993	January 1993
Survey and Design	January 1993 – December 1995	March 1993 – February 1997
Procurement	January 1993 – December 1996	January 1993 – November 2000
Construction works	July 1993 – September 1997	July 1993 – December 2001
Project completion	September 1997	December 2001

(5-2)	Plan	Actual
Loan Agreement Signing	September 1994	September 1994
Survey and Design	October 1994 – January 1998	October 1994 – November 1999
Procurement	October 1994 – December 1998	January 1995 – June 2002
Construction works	July 1995 – September 1999	January 1995 – March 2002
Project completion[6]	September 1999	June 2002

Source: PEA, the Power Distribution Reinforcement Project (5-1) / (5-2)

[6] The project completion is defined as the end of construction and procurement which were implemented at the end of loan disbursement.

3.2.2.2 Project Cost

The project cost was lower than planned (82 % of the original plan). The reduction in the project cost was mainly due to depreciation of the Thai Baht. The Asian financial crisis resulted in the Thai Baht being depreciated against the Japanese Yen resulting in a decrease in the project cost which was denominated in Japanese Yen.

Table 3: Breakdown of the project cost (total cost of (5-1) and (5-2))

	Plan	Plan (adjusted)*	Actual**
Project cost*	JPY 84,728 mil.	JPY 81,088 mil.	JPY 66,861 mil.
Foreign currency portion	JPY 36,017 mil.	N/A	JPY 30,298 mil.
Local currency portion (in Thai Baht)	JPY 48,711 mil. (THB 10,756 mil.)	N/A	JPY 36,563 mil. (THB 9,967 mil.)

Note 1: * Adjusted with the change of project outputs.
Note 2: ** Based on the project completion reports on the Power Distribution Reinforcement Project (5-1) / (5-2). For the foreign currency portion, a fraction less than JPY one million is disregarded.

Although the project cost was lower than planned, the project period was longer, therefore efficiency of the project is fair.

3.3 Effectiveness (Rating: a)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

(1) SAIFI/SAIDI

PEA started data collection of SAIFI/SAIDI in 1996. Data collection was not conducted for the period immediately after the commencement of this project (1993-1995). As far as data is available, the improvement in SAIFI/SAIDI from 1996 to 2002 (the year of project completion) was notable (see Table 4 and Table 5). An improvement in SAIFI is considered to be the effect of the isolation of cables implemented by this project. It is presumed that the installation of reclosers and switchgears meant the separation of accident sections in a shorter length and an improvement in SAIDI.

The improvement of SAIDI/SAIDI is attributed not only to this project but also the SCADA/DMS introduced by the World Bank and the EU[7]. Nevertheless, it is obvious that this project contributed to the improvement of SAIIFI/SAIDI as (1) the improvement is notable in the northeast region where SCADA/DMS was not introduced and (2) the facilities installed by this project were utilized for the introduction of SCADA/DMS.

Table 4: SAIFI

(Unit: Times)

	1996	2002	% change	2009	% change
PEA	19.12	15.04	-21.3%	9.57	-49.9%
North	19.46	15.73	-19.2%	9.00	-53.8%
Northeast	16.07	14.72	-8.4%	10.02	-37.6%
Central	14.98	11.24	-25.0%	7.27	-51.5%
South	28.91	18.89	-34.7%	12.26	-57.6%

Source: PEA

[7] The World Bank supported the introduction of SCADA/DMS at 7 locations (one in the PEA headquarters and 6 in area offices). EU also supported introduction of smaller scale SCADA/DMS in the province of Phuket.

Table 5: SAIDI

(Unit: minutes)

	1996	2002	% change	2009	% change
PEA	1,611.63	849.76	-47.3%	385.93	-76.1%
North	1,487.20	851.71	-42.7%	313.99	-78.9%
Northeast	1,332.53	849.06	-36.3%	452.35	-66.1%
Central	873.66	543.87	-37.7%	213.95	-75.5%
South	3,122.07	1,179.62	-62.2%	561.49	-82.0%

Source: PEA

(2) Transmission and Distribution Loss

Transmission and distribution loss did not show a notable improvement from 1993 (the time of appraisal) to 2002 (the time of project completion) (see Table 6). The installation of distribution lines spread the load current over the distribution system and reduced the electric current. In addition, it can be presumed that capacitors improved the power factor and reduced technical loss. These factors presumably improved the transmission and distribution loss from 1993 to 1996. However, the Asian financial crisis negatively affected the collection of electricity sales, increased non-technical loss and, thus, hindered the improvement of loss. As the effects of the crisis passed, the transmission and distribution loss again began to improve. In the ongoing sector policy (Transmission and Distribution Development Plan 2007-2011), the target for transmission and distribution loss is below 5.2% in 2011. The current level is in the range of the target.

Table 6: Transmission and Distribution Loss

(Unit: percentage)

1993	1994	1995	1996	1997	1998	1999	2000	2001
5.58	5.45	5.32	5.32	5.70	5.86	5.68	5.67	5.96
2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	
5.64	5.24	4.96	4.91	4.91	4.75	4.66	4.99	

Source: PEA

(3) Number of Customers and Total Sales of Electricity

At the time of appraisal, the number of customer and the total sales of electricity were expected to be 11.95 million and 66,766GWh, respectively, in 2003. The actual results in 2006 surpassed the above forecast[8]. From 1991 (before project implementation) to 2008 (at the time of the ex-post evaluation), the number of customers doubled and the total sales of electricity quadrupled. The Before/After analysis shows a significant increase in both clientele and power consumption.

The Asian financial crisis weakened electricity demand temporarily but electricity demand grew again after the crisis. Through enhancement of the distribution network, this project contributed to the development of infrastructure which achieved both growth in electricity demand and a stable supply of electricity.

[8] At the appraisal, forecasted figures were set for the 4th year after project completion in the original schedule (2003). For a fair comparison, figures in the 4th year after the project completion in the actual schedule (2006) are used for the analysis of achievement.

Table 7: Number of Customers and Total Sales of Electricity

	At appraisal		At ex-post evaluation	
	1991 (Actual)	2003 (Forecast)	2006 (Actual)	2008 (Actual)
Number of Customers (thousands)	7,082	11,946	13,844	14,600
Total Sales of Electricity (GWh)	20,812	66,766	83,203	89,602

Source: Appraisal documents and PEA Annual Report (2008)

3.3.1.2 Results of Calculations of Internal Rates of Return (IRR)

On both the Financial Internal Rate of Return and the Economic Internal Rate of Return, it is not feasible to estimate the benefits attributable to the project (such as an increase in electricity sales). Therefore, the internal rate of return was not recalculated at the ex-post evaluation[9].

3.3.2 Qualitative Effects

(1) Beneficiary survey

In the questionnaire survey for manufacturers which was conducted during this evaluation, 60% of the respondents answered that blackouts were 1-2 times or none in 2009 (see Table 8 and Figure 2). Short interruptions are more frequent than blackouts with more than 20% of users experiencing short interruptions 10 times or more per year[10]. This result suggests that short interruptions are a remaining issue in the power supply. More than half the respondents replied that both blackouts and short interruptions had improved in comparison with the early 90s (see Table 9 and Figure 3).

Table 8: Frequency of blackouts and short interruptions in 2009

		None	1-2 times	3-9 times	10-19 times	> 20 times	Total
Short interruptions	Respondents	12	20	57	10	16	115
	%	10.4%	17.4%	49.6%	8.7%	13.9%	100.0%
Blackouts	Respondents	18	53	33	8	3	115
	%	15.7%	46.1%	28.7%	7.0%	2.6%	100.0%

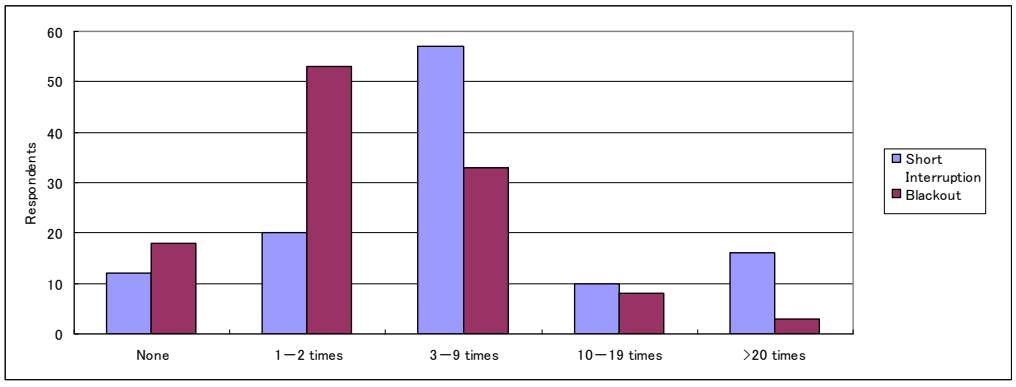


Figure 2: Frequency of blackouts and short interruptions in 2009

[9] FIRR computed at the time of appraisal ((5-1): 12.9% and (5-2): 9.58%). However, the assumptions for benefit do not remain. It is unclear how the increase in electricity sales should be estimated from the given outputs.

[10] In this questionnaire survey, short interruptions are defined as blackouts for a few seconds and blackouts as lasting a few minutes.

Table 9: Blackouts and short interruptions in the early 90s in comparison with the present

		More frequent	Somewhat frequent	Same	Somewhat infrequent	More infrequent	Do not know	Total
Short Interruptions	Respondents	49	39	16	4	0	7	115
	%	42.6%	33.9%	13.9%	3.5%	0%	6.1%	100.0%
Blackouts	Respondents	63	29	13	3	1	6	115
	%	54.8%	25.2%	11.3%	2.6%	0.9%	5.2%	100.0%

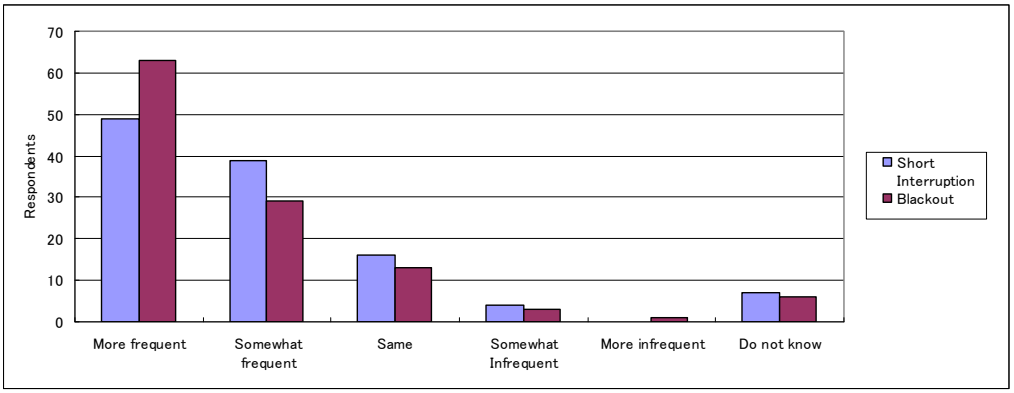


Figure 3: Blackouts and short interruptions (comparison between the early 90s and the present)

The power supply was relatively stable at the time of the ex-post evaluation. Blackouts were 1-2 times or none in more than half the companies, which showed notable progress in comparison with the past. The survey results reflect the improvement in SAIFI/SAIDI and also suggest that users appreciate the stability of the electricity supply. On the other hand, short interruptions are more frequent than blackouts. Given that production facilities are becoming more sophisticated and sensitive to short interruptions, there is still room for improvement here.

[Column] Beneficiary survey

In this evaluation, the beneficiary survey was conducted in order to supplement the operation and effect indicators and various statistics. Since the electric supply affects production activities, electricity users in the manufacturing sector were selected as the population for this survey. The details of the survey are as follows:

Date : March – April 2010
Sample :120 companies (30 samples each for the North, Northeast, Central and South; 115 valid samples and 5 invalid samples)
Location :Areas near the substations improved by this project in the North (Lamphun province), the Northeast (Khon Kaen province), the Central (Ayutthaya province, Chonburi province), and the South (Krabi province)
Population : Electricity users in the manufacturing sector

This project has largely achieved its objectives, therefore its effectiveness is high.

3.4 Impact

3.4.1 Intended Impacts

(1) An increase in manufacturing production

The Manufacturing Production Index and the Manufacturing Production Index for chemical products increased at approximately 15% per annum and 25% per annum, respectively[11]. As a stable supply of electricity is a critical factor for production activities in the manufacturing sector, this increase in manufacturing production implies a stable supply of electricity for the reference period (see Figure2). In particular, the rapid expansion in chemical products, a product which relies on a stable electric supply, also suggests a stable supply of power. As other factors also affect production in the manufacturing sector, this growth is not only attributed to the implementation of this project. Nevertheless, it can be presumed that this project has contributed to the stable supply of power and, consequently, smooth operation in the manufacturing sector.

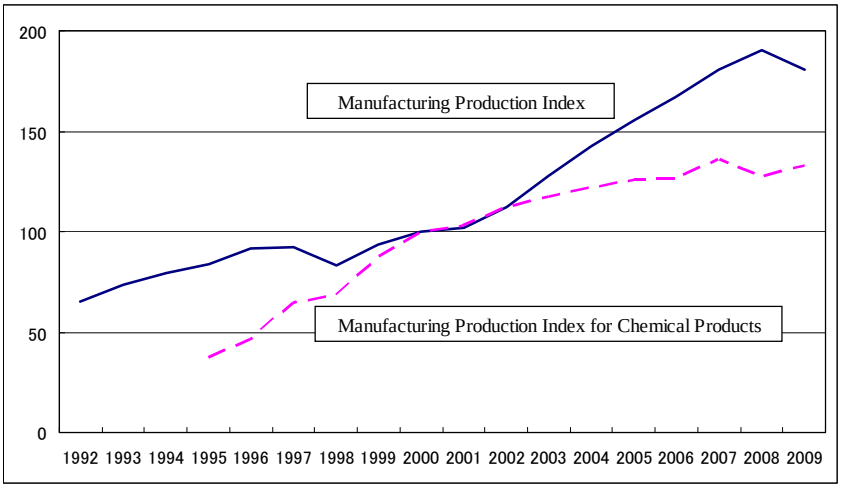


Figure 2: Manufacturing Production Index

(2) Gini coeffcient

Household income per capita by region and the Gini coefficient are estimated on the basis of the Household Socio-Economic Survey published by the National Statistic Office[12]. Regional disparity starts diminishing in the early 1990s while the Gini coefficient has declined since 1992. As other factors also contribute to the decrease in the Gini coefficient, this decrease is not only attributed to this project. However, this project developed distribution systems on a large scale outside the Bangkok metropolitan area and contributed to both the development of the economic infrastructure and, eventually, to income growth in rural areas.

Table 10: Gini coefficient

1990	1992	1994	1996	1998	2000	2002	2004	2006
0.27	0.29	0.25	0.25	0.24	0.25	0.24	0.23	0.22

Source: Kenji Nozaki (2007) “Regional Disparity in Thailand”

[11] The growth rate of the Manufacturing Production Index is for the period from 1992 (at the time of appraisal) to 2009 (at the time of the ex-post evaluation). That of the Manufacturing Production Index for chemical products is for the period from 1995 to 2009. The index for chemical products is available after 1995.

[12] Kenji Nozaki (2007) “Regional Disparity in Thailand” in Setsu, J. and Eguchi, T. (eds.) “Economic Development and Income Disparity in China Proceedings: The 22th Economic Research Center and KITAN International Symposium”, Session 2

(3) Beneficiary survey

The questionnaire survey for the manufacturing sector inquired about effects on production activities. Regarding effects on business performance, more than 90% of the companies considered that the stable supply of electricity had contributed to better performance (see Table 11). The faster response to clients' demand is the most recognized effect of stability of the power supply (see Table 12). Since suppliers are requested to shorten the lead time for inventory management, the stable supply of electricity may well have helped Thai manufacturers to meet more demanding requests from their customers. Less damage to production facilities is valued as the next most important advantage. Automated production facilities have become prevalent but these facilities are often damaged by an unstable supply of electricity.

Table 11: Contribution to business performance

Answer	Yes, very much	Yes, to some extents	No, not so much	No, not at all	Total
Respondents	77	30	8	0	115
%	67.0%	26.1%	7.0%	0%	100.0%

Tables 12: Specific contributions

	Respondents	% of total*
Employees work more efficiently	70	60.9%
Quality of the product is improved	78	67.8%
Customers' demands met more quickly	96	83.5%
No damage of production facilities	80	69.6%

Note: * % of the total respondents (115 respondents)

3.4.2 Other Impacts

(1) Impacts on the Natural and Social Environment

According to the executing agency, the project improved existing distribution systems and did not involve new land acquisition and resettlement. Thus, this project presumably had a negligible impact on the natural environment and local people. In the late-90s, PEA switched to insulation oil which does not contain PCB[13]. Moreover, negative impacts on the natural environment were not observed during the site survey.

It can be judged that this project has contributed to production activities in the manufacturing sector and that negative impact is very negligible.

3.5 Sustainability (Rating: a)

3.5.1 Structural Aspects of Operation and Maintenance

PEA was a state-owned company under the Thai government at the time of the ex-post evaluation as it was at the time of appraisal. The framework of the power distribution sector remains the same with MEA distributing electricity in the Bangkok metropolitan area and PEA in the rest of the country. There is no concrete plan to allow the private sector to enter the distribution business. The status quo of the institutional arrangement does not affect the profitability of PEA.

[13] Polychlorinated biphenyl; the chemical substance has a insulating property but it is harmful to human health.

PEA has five major business units. The Network Business unit is in charge of the Operation and Maintenance (O&M) of the substations and the high and middle voltage transmission/distribution lines which were improved by this project. The unit has staff in area offices (12 offices in total, three each for the North, the Northeast, the Central, and the South).

The institutional framework of the power sector will not be changed in the near future and the responsibilities of O&M are fairly defined. Given the above situation, no issues affecting O&M were found from the institutional aspect.

3.5.2 Technical Aspects of Operation and Maintenance

The Substation Maintenance Division (15 engineers out of 40 staff), the Protection and Relay[14] Division (25 engineers out of 30 staff), the Automation System Division (30 engineers out of 40 staff), and the Network Operation Department (40 engineers out of 100 staff) are engaged in the O&M of the facilities installed by this project.

Training of the employees who are engaged in O&M is conducted mainly via OJT. When new equipment is installed, employees take training courses to familiarise themselves with the new equipment and to brush-up basic knowledge. The training courses relevant to this project are as follows:

Hotline Maintenance Improvement: two courses, once a year, 100 staff in total
Distribution Transformer Maintenance: one course, once a year, 600 staff in total
Power System Protection: two courses, once a year, 60 staff in total
Underground Line Work: one course, once a year, 3 staff in total

Replacement parts for insulated cable and capacitor are readily available as these parts are produced in Thailand. Although switch gears and reclosers are an imported item, PEA can obtain replacement parts and has inventories. It occasionally takes a long time to receive reclosers in the northern region. The branch offices repair and replace low tension distribution lines and service meters.

3.5.3 Financial Aspects of Operation and Maintenance

The financial ratios on liquidity have been stable for the last five years and show that PEA is financially solid. The total debt equity ratio[15] has been declining and suggests less dependence on debt (See Table 10). As profitability has remained at an appropriate level for an electric utility, there is no serious problem in the foreseeable future[16].

While budget allocation covers only preventive maintenance, actual expenses include both preventive maintenance and corrective maintenance. For this reason, actual expense often surpasses budget allocation (see Table 11). Maintenance cost accounts for 0.3-0.4% of electricity sales and this implies that the cost is not a serious financial burden. Thus, it can be concluded that it would not be difficult to continue with a similar amount of expense.

[14] The instrument detects fluctuations in the electric current and voltage and separates a section where an accident has occurred from the rest of the transmission/distribution network.
[15] Total Liabilities divided by Total Equity
[16] Malaysian electric company TNB: ROA 3.7% (2008), Tokyo Electric Power Company: ROA -0.6% (FY2008). ROA at above 2% is considered a sufficient profitability as an electric utility requires large scale investment.

Table 13: PEA financial ratios

	2004	2005	2006	2007	2008
Current Ratio	1.31	1.14	1.22	1,21	1.18
Quick Ratio	1.01	0.98	1.00	1.01	0.95
Total Debt Equity Ratio	1.98	1.81	1.75	1.76	1.64
ROA (%)	2.61	6.67	5.93	4.84	4.15

Source: PEA Annual Report 2008

Table 14: Maintenance Budget

(Unit: million THB)

	2006	2007	2008
Maintenance budget (Allocation)	516.8	641.0	937.2
Maintenance budget (Actual expense) (A)	774.3	1,131.5	701.8
Net electric revenue (B)	245,636.8	252,964.1	257,243.2
(A)/(B)	0.3%	0.4%	0.3%

Source: PEA

3.5.4 Current Status of Operation and Maintenance

According to the executing agency, repair and replacement of the procured equipment is carried out promptly as accidents cause interruptions in power distribution. No broken or unused equipment was observed during the site survey. The frequency of maintenance activities for the facilities installed by this project are as follows:

Inspection and maintenance of various instruments at substations: once a year
Maintenance of relay: once in every three years
Thermal viewer at substations: four times a year
Cleaning of switching substation: twice a year
Patrol of feeder network: once a year
Inspection of insulation oil: once a year

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was delayed due to the Asian financial crisis and the necessity for construction permissions. However, the project is consistent with the development policy of Thailand, its development needs, and with Japan's ODA Policy. This project contributes to production activities in the private sector through a stable supply of electricity. There is no factor that negatively affects the sustainability of project effects.

In light of the above, this project is evaluated to be (A) highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations for the Executing Agency

SCADA/DMS is being introduced with the infrastructure improved by the project as a platform. A more sophisticated operation of the distribution system necessitates the development of

employee skills. Given the automation of the distribution system, it is desirable that PEA continues to further the development of employee skills for the effective use of the infrastructure developed by the project.

While the improvement of SAIFI/SAIDI proves the stabilization of the power supply, the beneficiary survey illustrates that short interruptions occur more frequently than blackouts. As Thai manufacturers cope with more requests from sophisticated clients, the use of automated production facilities becomes increasingly prevalent. Short interruptions have a more serious effect on production activities than before. It is desirable that the isolation of distribution lines is continued and that advisory services, such as advice on UPS capacity, is enhanced as measures against short interruptions.

4.2.2 Recommendations for JICA

None

4.3 Lessons Learned

None

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	Total of (5-1) and (5-2) (1) High voltage distrubution lines: 16,100cct-km (2) Transformers: 1,180,500kVA (3) Capacitors: 498,760kVAR (4) Swithgears: 745 units (5) Reclosers: 449 units (6) Low tension distribution lines: 6,100cct-km (7) Service meters: 2,008,000 units	Total of (5-1) and (5-2) (1) 15,649cct-km (2) 929,500kVA (3) 498,760kVAR (4) 893 units (5) 1,234 units (6) 5,644cct-km (7) 1,332,100 units
2. Project Period	January 1993 – September 1999 (81 months)	January 1993 – June 2002 (114 months)
3.Project Cost		
Amount paid in Foreign currency	36,017 million yen	30,298 million yen
Amount paid in Local currency	48,711 million yen (10,756 million Thai Baht)	36,563 million yen (9,967 million Thai Baht)
Total	84,728 million yen	66,861 million yen
Japanese ODA loan portion	33,986 million yen	30,298 million yen
Exchange rate	THB 1 = 4.53 yen (Weighted Average of (5-1) and (5-2))	THB 1 = 3.67 yen (Weighted Average of (5-1) and (5-2))

Thailand “Distribution System Reliability Improvement Project”

Thailand

Ex-Post Evaluation of Japanese ODA Loan Project
"Distribution System Reliability Improvement Project"

Nobuyuki Kobayashi, OPMAC Corporation
Atsushi Fujisawa, TEPSCO

1. Project Description

Project Site

115kV transmission line constructed by the project

1.1 Background

In the power distribution sector in Thailand, the Metropolitan Electricity Authority (MEA) has been in charge of the Bangkok metropolitan area while the Provincial Electricity Authority (PEA) has supplied electricity to other areas of the country. Since the 1960s, PEA has prepared 5-year development plans corresponding to the National Social Economic Development Plans and has developed a distribution network with a strong emphasis on electrification. Japanese ODA loans have been provided to PEA for the development of the distribution network since 1968. As a result of PEA efforts in electrification, the electrification rate has improved from less than 20 % in the 1970s to 94% in 1995[1].

In tandem with economic growth in Thailand and the progress of electrification, electricity demand grew at approximately 10% per annum in the early 90s, continuing to increase in the last half of the decade. As deregulation of the power generation sector progressed in the 1990s, a power generation market evolved from the monopoly of the Electricity Generation Authority (EGAT) to a competitive market allowing the entry of independent power producers. EGAT investment in power generation facilities and new market entry resulted in the expansion of generation capacity. The expansion of power generation in turn necessitated expansion of the distribution network. Moreover, power users requested a reliable and accident-free power supply because of more industrial demand. PEA was required to cope with the expansion of demand and simultaneously improve the reliability of the power supply. Paying attention to capacity enhancement and the reduction of blackouts, PEA was developing a distribution network at the time of appraisal. Given the background described above, this project has supported the procurement of equipment to stabilize the supply of electricity.

[1] Household basis

1.2 Project Outline

The objective of this project is to improve the reliability of electric supply by the enhancement of transmission and distribution facilities including the instalment of insulated cable and overhead ground wire and the looping of transmission line, thereby contributing to the stimulation of local economy.

Approved Amount/ Disbursed Amount	16,800million yen / 13,025 million yen
Exchange of Notes Date / Loan Agreement Signing Date	September 1996 / September 1996
Terms and Conditions	Interest Rate: 2.7% Repayment Period: 25 years (Grace Period: 7 years) Conditions for Procurement: General untied
Borrower / Executing Agency(ies)	Provincial Electricity Authority / same as above Guarantor: Royal Thai Government
Final Disbursement Date	July 2004
Main Contractor (Over 1 billion yen)	ABB Limited
Main Consultant (Over 100 million yen)	None
Feasibility Studies, etc.	None
Related Projects	World Bank: Distribution Automation and Reliability Improvement Project EU: Electricity Network Upgrading Program

2. Outline of the Evaluation Study

2.1 External Evaluator

Nobuyuki Kobayashi, OPMAC Corporation
Atsushi Fujisawa, TEPSCO

2.2 Duration of Evaluation Study

Duration of the Study: November 2009 – August 2010
Duration of the Field Study: February 7th, 2010 – March 4th, 2010 and May 16th, 2010 – May 20th, 2010

2.3 Constraints during the Evaluation Study

While the project area covered all of Thailand, a site survey in the northeast region was not carried out in this evaluation. A site visit was planned in the region in the second field survey (May 16th, 2010 – May 20th, 2010). However, the visit was cancelled due to the political turmoil in Thailand.

3. Results of the Evaluation (Overall Rating: A)

3.1 Relevance (Rating: a)

3.1.1 Relevance with the Development Plan of Thailand

The Seventh National Social Economic Development Plan (1992-1996) placed emphasis on regional development and promoted balanced development between urban and rural areas. In the power sector, the 7th plan set out four major policies including (1) to provide an adequate supply of stable power that meets the timely needs of customers at minimum cost and (2) to promote the efficient and economical use of electricity. Corresponding to these major policies, PEA prepared the Transmission and Distribution Development Plan 1992-1996. After being revised in 1994, the development plan recommended 23 projects in 6 categories during the project period. This project was one of the projects under the "Power System Efficiency Improvement Plan".

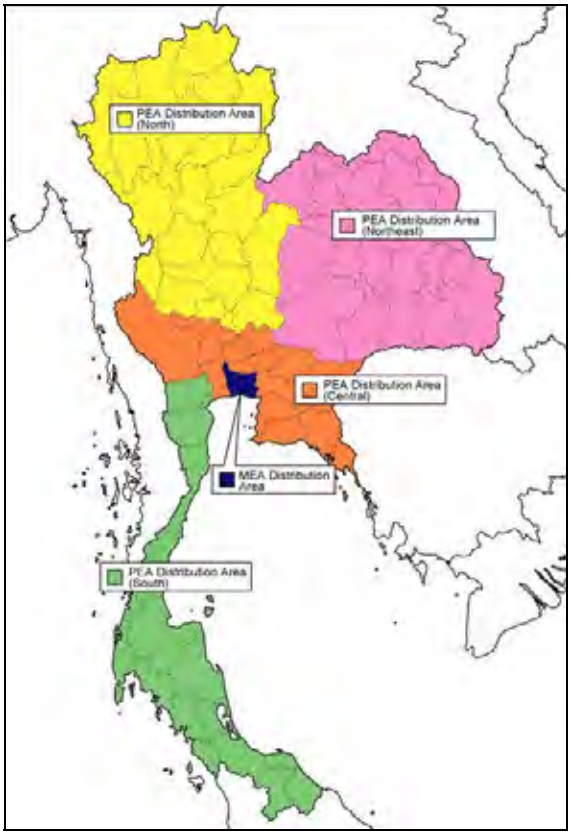


Figure 1: PEA distribution area

At the time of the ex-post evaluation, The Tenth National Social Economic Development (2007-2011) had five policy pillars; (1) the development of human resources, (2) community oriented development, (3) reform and efficiency in the economy, (4) the conservation of the natural environment and resources, and (5) the improvement of good governance. Aiming at an efficient, stable, and fair economy, the 10th Plan promotes a fair distribution of the benefits of development and infrastructure development spreading over regions in a balanced manner. The Transmission and Distribution Development Plan 2007-2011, the latest development plan prepared by PEA, sets several objectives including a stable supply of electricity, the development of distribution systems to meet demand increase, and social development. The development plan recommends 8 projects during the project period, one of which is a follow-up of this project. PEA is installing 115kV loop lines and insulated cables in the follow-up project.

At the both the times of appraisal and ex-post evaluation, the reduction of regional disparity remains a keynote for the Thai government. As PEA supplies electricity to all areas except the Bangkok metropolitan area (see Figure 1), this project also constructed infrastructure for power distribution in the same area. Therefore, the project is consistent with the reduction of disparity between urban and rural areas, a major goal of the development policies at both appraisal and ex-post evaluation. The sector policies consistently pursued a stable supply of electricity at both appraisal and ex-post evaluation. This project aimed for a stable supply of electricity by reducing the frequency and duration of blackouts. In the latest development plan, PEA follows a similar type of investment to this project.

3.1.2 Relevance with the Development Needs of Thailand

In the PEA distribution area, the annual electric consumption grew at approximately 10% in the early 90s[2]. At the time of appraisal, power demand was expected to continuously increase after 1994. It was thought that the annual electricity consumption would increase by approximately 90% from 1994 to 2000 and then would triple in 2006 (see Table 1). Peak demand was expected to grow substantially as well.

Table 1: Electricity demand in the PEA distribution area

	Actual		Forecast at appraisal	
	1991	1994	2000	2006
Peak Demand (MW)	4,253	6,309	11,252	16,327
Electric Consumption (GWh)	22,493	34,303	64,428	96,134

Source: Appraisal documents for Distribution System Reliability Improvement Project

At the time of the ex-post evaluation, power demand was expected to grow continuously. PEA expects that annual power consumption will be 115,868GWh in 2011(an annual growth rate of 6.87% for 2006 - 2011) and that peak demand will be 18,461MW (an annual growth rate of 7.15% for 2006 - 2011)[3]. On the basis of the above forecast, PEA pursues the improvement of SAIFI (2011 target: 8.94 times)[4] and SAIDI (2011 target: 314 min.)[5].

The expansion of power demand is expected as Thailand has recently experienced steady economic growth. In order to further the stability of power supply and satisfy demand growth, a reliable infrastructure is critical. For this reason, the development needs remain intact.

3.1.3 Relevance with Japan's ODA Policy

At the time of the appraisal, Japan's Official Development Assistance Charter, the preceding charter approved in 1992, placed a special emphasis on assistance to the Asian region. The charter referred to the close relationship between Japan and East Asia, including ASEAN, and recognized the importance of the economic growth in the Asian region. The charter regarded infrastructure as the fundamental of social and economic development and made a particular point of infrastructure development.

This project has assisted Thailand, a member country of ASEAN, in infrastructure development and aimed at economic growth via the stable supply of electricity. The aforementioned argument shows that this project has been consistent with Japan's ODA Policy.

This project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy, therefore its relevance is high.

3.2 Efficiency (Rating: b)

3.2.1 Project Outputs

This project supported the construction of infrastructure including the development of the distribution network and the looping of transmission lines. Procurement and construction works were adjusted, reflecting the ongoing development of distribution infrastructure and the changes in development needs (see Table 2).

[2] Based on the appraisal documents of the Distribution System Reliability Improvement Project
[3] Based on PEA " Transmission and Distribution Development Plan 2007-2011"
[4] Frequency of Interruption per customer
[5] Duration of Interruption per customer

Table 2: Major changes in outputs and the reasons for these

Changes	Reasons
Extension of insulated cables (from 16,310cct-km to 25,000cct-km[6])	Economic growth and the boom in the tourist industry necessitated a reduction in interruptions for commercial and tourist areas.
Reduction of underground cables (from 70cct-km to 42cct-km)	When roads and historic sites interfere with construction works, permission from the relevant government offices (Department of Highway, the Fine Arts Department, etc.) is required. The Fine Arts Department did not approve construction works in historic sites. In several sections, permission could not be obtained and this caused a delay in project implementation. It was therefore difficult to achieve the original outputs.
Extension of 115kV loop lines (from 510 km to 1000 km)	In tandem with an increase in substations, 115 kV loop lines connecting substations were extended. In the original outputs, the looping of 115kV transmission lines was carried out in the central region and some areas in the south region. In the actual outputs, these were installed all over Thailand.
Capacitors (from 1,100 units to 150 units)	As newly constructed substations installed capacitors, the installation of capacitors in the feeder network were reduced. PEA procured sufficient capacitors with budgets other than from this project. This situation allowed this project to reduce the procurement of capacitors.
Increase in mobile generators (from 24 units to 48 units)	There was a strong demand for backup generators for emergency cases such as natural disasters and blackouts in hospitals and government offices.

3.2.2 Project Inputs

3.2.2.1 Project Period

The project period was significantly longer than planned (368% of the original plan) (See Table 3). The Asian financial crisis occurred during the implementation of this project. Contractors faced difficulties in fulfilling contractual obligations due to a shortage of working capital. In order to cope with the lack of foreign currency, government agencies were required to obtain cabinet approval when purchasing imported items. This procedure caused delays in procurement.

Besides the Asian financial crisis, a delay in construction permits affected the project period. Construction works over roads and in historic sites require permission from the relevant government offices. It took a long period to go though this process. As this project constructed a distribution network through a vast area, it was difficult to assess all the project sections and identify which sections would require a construction permit.

[6] cct-km is a unit to measure the length of circuit conducting electricity.

Table 3: Details of the project period

	Plan	Actual
Loan Agreement	September 1996	September 1996
Survey and Design	September 1996 – November 1996	September 1996 – April 2004
Procurement	July 1996 – August 1997	January 1997 – March 2006
Construction	October 1996 – September 1999	January 1997 – December 2007
Project Completion[7]	September 1999 (37 months)	December 2007 (136 months)

3.2.2.2 Project Cost

The project cost was lower than planned (60% of the original plan) (see Table 4). Although the expansion of outputs increased the Thai Baht portion of the project cost, the depreciation of the Thai Baht against the Japanese Yen, caused by the Asian financial crisis, resulted in the reduction of the project cost being in Japanese Yen. The Thai government made efforts to restrain loans in foreign currencies. This attempt was applied to all equipment and materials in this project. If substitute products were made in Thailand, procurement was switched to domestic products. If not, the amount of procurement was reduced. As a result, the foreign currency portion of the project costs decreased.

Table 4: Breakdown of the project cost

	Plan	Plan (adjusted)*	Actual**
Project cost	JPY 70,133 mil.	JPY 92,610 mil.	JPY 55,218 mil.
Foreign currency portion	JPY 26,713 mil.	N/A	JPY 13,025 mil.
Local currency portion (in Thai Baht)	JPY 43,420 mil. (THB 10,338 mil.)	N/A	JPY 42,193 mil. (THB 15,337 mil,)

Source: PEA

Note 1: * Adjusted with the change of project outputs

Note 2: ** Based on PEA "The Project Completion Report on the Distribution System Reliability Improvement Project"

Although the project period was significantly longer than planned, the project cost was lower than planned, therefore efficiency of the project is fair.

3.3 Effectiveness (Rating: a)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

(1) SAIFI/SAIDI

As the installation of insulated cables and indoor substations, the enhancement of transforming facilities, and the looping of 115 kV transmission lines progressed with this project, SAIFI/SAIDI in turn improved. SAIFI/SAIDI had achieved targets at the time of appraisal. It is concluded that this project had the intended effect (see Table 5 and Table 6).

The improvement of SAIFI/SAIDI is attributed not only to this project but also to the SCADA/DMS introduced by the World Bank and the EU (see 3.3.2 Qualitative Effects (3) Introduction of SCADA/DMS). Nevertheless, it is obvious that this project contributed to the

[7] Project completion is defined as the end of construction works. The period in parenthesis is from the loan agreement to project completion.

improvement of SAIFI/SAIDI because (1) improvement is notable in the northeast region where SCADA/DMS was not introduced and (2) the facilities installed by this project were utilized for the introduction of SCADA/DMS.

Table 5: SAIFI (Frequency of interruption per customer)

(Unit: times)

	1996	2007	% change	Target*	2009
PEA	19.12	11.32	-40.8%	-23.9%	9.57
North	19.46	10.90	-44.0%	N/A	9.00
Northeast	16.07	10.81	-32.7%	N/A	10.02
Central	14.98	8.90	-40.6%	N/A	7.27
South	28.91	15.77	-45.5%	N/A	12.26

Source: PEA

Note: *PEA has measured SAIFI/SAIDI since 1996 but the data is not directly comparable with the target at the time of appraisal. Therefore, the percent change which was forecasted at the time of appraisal is regarded as the target and compared with the actual percent change at completion (2007).

Table6: SAIDI (Duration of interruption per customer)

(Unit: minutes)

	1996	2007	% change	Target*	2009
PEA	1,611.63	508.27	-68.5%	-20.9%	385.93
North	1,487.20	461.85	-68.9%	N/A	313.99
Northeast	1,332.53	544.38	-59.1%	N/A	452.35
Central	873.66	307.01	-64.9%	N/A	213.95
South	3,122.07	741.10	-76.3%	N/A	561.49

Source: PEA

Note: *The approach used in the analysis of SAIFI was applied to the comparison between the target and the actual figures.

(2) Number of Equipment Accidents

The number of equipment accidents significantly increased between the appraisal and the ex-post evaluation (see Table 7)[8]. However, the increase in equipment accidents did not worsen SAIFI/SAIDI and, thus, did not negatively affect the stable supply of electricity. It is presumed that the reasons that an increase in equipment accidents did not increase SAIFI/SAIDI were earlier detection of accidents and shorter durations of interruption.

Table 7: Number of Equipment Accidents (by cause)

Cause	1995		2008	
	Number	% of Total	Number	% of Total
Insulator	962	29.5%	1,955	13.4%
Conductor	891	27.3%	3,511	24.1%
Fuse	487	14.9%	5,350	36.7%
Arrestor	343	10.5%	603	4.1%
Pole	159	4.9%	96	0.7%
Others	424	13.0%	3,058	21.0%
Total	3,266	100.0%	14,573	100.0%

Source: PEA

[8] Equipment accidents include these that do not cause power interruption.

The reasons for more equipment accidents were the extension of transmission and distribution lines[9] and the installation of equipment for efficient distribution (an increase in "Others")[10]. In addition, more accidents in fuses, equipment which this project did not support, could be attributed partly to the aging of the existing facilities which were outside of the scope of this project. Meanwhile, overhead ground wires installed by this project prevented the burnout of arrestors and resulted in a smaller percentage of accidents in arrestors.

3.3.1.2 Results of Calculations of Internal Rates of Return (IRR)

It is not feasible to estimate the benefits attributable to the project on either the Financial Internal Rate of Return or the Economic Internal Rate of Return. For this reason, analysis on the internal rate of return was not conducted[11].

3.3.1.3 Qualitative Effects

(1) Interview with beneficiaries

Interviews with electricity users (seven private companies, six from the manufacturing sector and one from the service sector)[12] which are beneficiaries of the project were carried out in this ex-post evaluation. All of the users had business operations near substations improved by the project.

Several interviewees stated that blackouts had become less frequent than in the mid-90s. They said that there had been many interruptions caused by accidents where plants or animals had come into contact with non-insulated cables or outdoor substations but these accidents had decreased after implementation of this project. The perceptions of users can be reconciled with the decline of SAIFI/SAIDI and prove the stabilization of the power supply.

Interview results show that most factories have back-up generators for interruptions of power supply. Nevertheless, due to the lack of generation capacity, these are limited to critical production lines that significantly affect the quality of products. Therefore, blackouts still influenced production activities at the time of the ex-post evaluation.

Moreover, prompt information sharing with users in the case of interruptions was referred to as an issue. Users want to know the timing of resumption earlier for the arrangement of production lines.

(2) Focus Group Discussion for the Staff in the Executing Agency

A focus group discussion for PEA staff in the distribution dispatching centres was conducted on the project effect of the looping of 115 kV transmission lines, a component among the facilities constructed by this project (see Column). While they acknowledged that the looping of 115kV transmission lines increased the operational burden, for example through more numerous and complex procedures, they recognized a decrease in the duration of blackouts.

[9] PEA's total distribution network increased at 79% from 1995 (254,559cct-km) to 2008 (456,754cct-km).
[10] An increase in the sophisticated equipment resulted in more equipment accidents.
[11] Due to the difficulties in conducting a precise analysis, the internal rate of return was not taken into consideration in the appraisal.
[12] Interviews were held in the central region (Ayutthaya province, Chon buri province) and the south region (Phuket province).

[Column] Results of focus group discussion

Date : February 22, 2010
Participants : PEA staff in (two session, 18 persons)
Topic : "What are the effects from the looping of 115kV transmission line constructed by the project?"

After discussing about the above topic, participants were requested to vote for the three most agreeable opinions. The voting results are as follows:

Table 8:Voting Results of the Focus Group Discussion

First Session (11 participants)

Opinion	Number of Vote
A decrease in the duration of blackouts	11
Improvement in customer confidence	9
An increase in maintenance works	5
More operational procedures	5
Supply of electricity specific to blackout areas	3

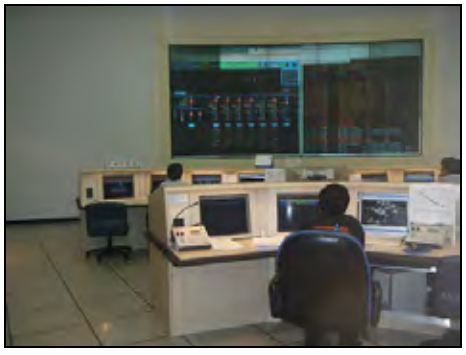
Second Session (8 participants)

Opinion	Number of Vote
A decrease in the duration of blackouts	9
More investment in safety equipment	3
Voltage drop in the extension of transmission lines	3
Better corporate image	2
More complicated operational procedures	2
Wider coverage of service area	2
Maintenance which does not affect the power supply	2
Quality improvement	1

(3) Introduction of SCADA/DMS

The World Bank supported the introduction of SCADA/DMS at 7 locations in Thailand. In addition, EU also supported the introduction of smaller scale SCADA/DMS in the province of Phuket. Remote terminal units were installed at the substations improved by this project. The introduction of SCADA/DMS allows the distribution dispatching centres to figure out the status of distribution systems and open/close distribution sections from distant places. As a result, PEA can cope with accidents more promptly and the stability of power supply has improved. This project became a platform for the introduction of SCADA/DMS and contributed to the further stability of the power supply through collaboration with other projects.

Photo 1: Distribution dispatching centre



This project has largely achieved its objectives, therefore its effectiveness is high.

3.4 Impact

3.4.1 Intended Impacts

(1) Manufacturing Production Index

The Manufacturing Production Index increased over the period from pre-implementation to the ex-post evaluation. Moreover, for chemical products, where blackouts affect product quality, the production amounts showed a significant increase. As other factors also affect production amounts in the manufacturing sector, this growth cannot only be attributed to the implementation of this project. However, a stable supply of electricity is a critical factor for production activities in the sector. It can be presumed that this project has contributed to the smooth operation of the sector to some extent. In particular, a rapid expansion in the chemical products, products which rely very much on a stable electric supply, implies a stable supply in the period from the appraisal to the ex-post evaluation.

Table 9: Manufacturing Production Index

	Manufacturing Production Index	Index on Chemical Product
1996	91.39	46.68
1997	91.95	64.39
1998	83.40	68.26
1999	93.69	86.88
2000	100.00	100.00
2001	102.00	102.94
2002	112.01	111.97
2003	127.73	117.25
2004	142.62	121.76
2005	155.56	126.07
2006	166.98	126.56
2007	180.66	135.98
2008	190.20	127.71
2009	180.33	132.92
Annual % growth	15.2%	21.9%

Source: Bank of Thailand

3.4.2 Other Impacts

(1) Impacts on the Natural and Social Environment

According to the executing agency, the project improved existing facilities and did not involve new land acquisition and resettlement. This project presumably has had a negligible impact on the natural environment and on neighbours. PEA did not acquire new land for the compact substations as these facilities are used as temporal substations. The compact substations were installed at (1) property owned by PEA and (2) land leased from government agencies, municipalities, and land owners. Moreover, a negative impact on the natural environment and road traffic was not observed during the site survey.

Photo 2: Temporary substation

It is can be inferred that this project has contributed to production activities in the manufacturing sector and that the negative impact is very negligible.

3.5 Sustainability (Rating: a)

3.5.1 Structural Aspects of Operation and Maintenance

PEA was a state-owned company under the Thai government at the time of the ex-post evaluation as it was at the time of appraisal. The framework of the power distribution sector remains the same, with MEA distributing electricity in the Bangkok metropolitan area and PEA doing so in the rest of the country. There is no concrete plan to allow the private sector to enter the distribution business. The status quo in the institutional arrangements does not affect the profitability of PEA.

PEA has five major business units. The Network Business unit is in charge of the Operation and Maintenance (O&M) of the substations and the high and middle voltage transmission/distribution lines which were improved by this project. The unit has staff in area offices (12 offices in total, three each for the North, the Northeast, the Central, and the South).

The institutional framework in the power sector will not be changed in the near future and the responsibilities of the O&M are fairly defined. Given the above situation, no issues affecting the O&M have been found in the institutional aspect.

3.5.2 Technical Aspects of Operation and Maintenance

The Substation Maintenance Division (15 engineers out of 40 staff), the Protection and Relay[13] Division (25 engineers out of 30 staff), and the Automation System Division (30 engineers out of 40 staff) and the Network Operation Department (40 engineers out of 100 staff) are engaged in the O&M of the facilities installed by this project.

The training of employees engaged in O&M is conducted mainly via OJT. When new equipment is installed, the employees take training courses for familiarization with new equipment and to brush-up basic knowledge. The training courses relevant to this project are as follows:

Hotline Maintenance Improvement: two courses, once a year, 100 staff in total
Power System Protection: two courses, once a year, 60 staff in total
Underground Line Work: one course, once a year, 3 staff in total

Replacement parts for insulated cables and capacitors are readily available since these parts are produced in Thailand. Although switch gears are an imported item, PEA can obtain replacement parts and has inventories.

3.5.3 Financial Aspects of Operation and Maintenance

The financial ratios on liquidity have been stable for the last five years and show that PEA is financially solid. The total debt equity ratio[14] has been declining and suggests less dependence on debt (See Table 10). As profitability stays at an appropriate level for an electric utility, there is no serious problem in the foreseeable future[15].

While budget allocation covers only preventive maintenance, actual expenses include both preventive maintenance and corrective maintenance. For this reason, actual expenses often surpass budget allocation (see Table 11). Maintenance costs account for 0.3-0.4% of electricity sales and this implies that the cost is not a serious financial burden. Thus, it can be concluded that it would not be difficult to continue with a similar level of expense.

Table 10: PEA financial ratios

	2004	2005	2006	2007	2008
Current Ratio	1.31	1.14	1.22	1,21	1.18
Quick Ratio	1.01	0.98	1.00	1.01	0.95
Total Debt Equity Ratio	1.98	1.81	1.75	1.76	1.64
ROA (%)	2.61	6.67	5.93	4.84	4.15

Source: PEA Annual Report 2008

[13] The instrument detects fluctuations in electric current and voltage and separates a section where there has been an accident from the rest of the transmission/distribution network.

[14] Total Liabilities divided by Total Equity

[15] Malaysian electric company TNB: ROA 3.7% (2008), Tokyo Electric Power Company: ROA -0.6% (FY2008). ROA at above 2% is considered enough profitability as an electric utility requires large scale investment.

Table 11: Maintenance Budget

(Unit: million THB)

	2006	2007	2008
Maintenance budget (Allocation)	516.8	641.0	937.2
Maintenance budget (Actual expense) (A)	774.3	1,131.5	701.8
Net electric revenue (B)	245,636.8	252,964.1	257,243.2
(A)/(B)	0.3%	0.4%	0.3%

Source: PEA

3.5.4 Current Status of Operation and Maintenance

According to the executing agency, the repair and replacement of the procured equipment is carried out promptly as accidents cause interruptions in power distribution. Although the Neutral Grounding Registers (NGR)[16] installed at substations near industrial areas were overburdened and often burned, these parts were replaced after accidents. No broken and unused equipment was observed during the site survey. The frequency of maintenance activities are as follows:

Inspection and maintenance of various instruments at substations: once a year
Maintenance of relay: once in every three years
Thermal viewer at substations: four times a year
Cleaning of switching substation: twice a year
Patrol of feeder network: once a year

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was significantly delayed due to the Asian financial crisis and construction permissions. Meanwhile, the project is consistent with the development policy in Thailand, its development needs, and with Japan's ODA Policy. Since blackouts were reduced considerably between project appraisal and project completion, the effectiveness of this project is high. There is no factor that negatively affects the sustainability of project effects and, thus, the suitability of project effects is high either.

In light of the above, this project is evaluated to be (A) highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations for the Executing Agency

SCADA/DMS is being introduced while infrastructure improved by the project becomes a platform. A more sophisticated operation of the distribution system necessitates the development of employees' skills.

Given the automation of the distribution system, it is desirable that PEA continues to further the development of employees' skills for the effective use of the infrastructure developed by the project.

[16] The equipment prevents strong electric currents in ground faults and does not interfere with protection relays in substations.

4.2.2 Recommendations for JICA

None

4.3 Lessons Learned

The construction of aerial and underground cables often interfered with historic sites and roads and required permission from other government departments. Obtaining permission is one of the reasons for delays in the project implementation.

As the sections under the project were quite long, it was not feasible to assess all sections, identify the sections which required permission, and redefine the project scope at appraisal. As PEA had a long experience in the implementation of the distribution system, it was feasible to review the implementation schedule in the light of the on-going projects and assess counter measures to shorten delays[17].

[17] Possible countermeasures include rerouting of a delayed section in the case that a delay surpassed a certain period.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	(1) Partial insulated cables and aerial cables: 16,310cct-km (2) Underground cables: 70cct-km (3) 115kV transmission lines 510km (4) Overhead ground wires 8,300cct-km (5) Switch: 2000 units (6) Switching capacitors: 1,100 units (7) NGR: 30 units (8) Mobile substations: 10 units (9) Mobile generators: 24 units (10) Power transformers: 5 units (11) Mobile transformers: 4 units (12) Line post insulators: Intalled at 15,500cct-km	(1) 25,000cct-km (2) 42cct-km (3) 1,000km (4) As planned (5) As planned (6) 150 units (7) As planned (8) Compact substations: 12 units (9) 48 units (10) As planned (11) As planned (12) As planned
2. Project Period	September 1996 – September 1999 (37 months)	September 1996 – December 2007 (136 months)
3. Project Cost		
Amount paid in Foreign currency	26,713 million yen	13,025million yen
Amount paid in Local currency	43,420 million yen (10,338 million Thai Baht)	42,193 million yen (15,337 million Thai Baht)
Total	70,133 million yen	55,218million yen
Japanese ODA loan portion	16,800 million yen	13,025 million yen
Exchange rate	THB 1= 4.2 yen (As of April 1996)	THB 1 = 2.75 yen (Average between February 1999 and July 2004)