Thailand

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

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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".

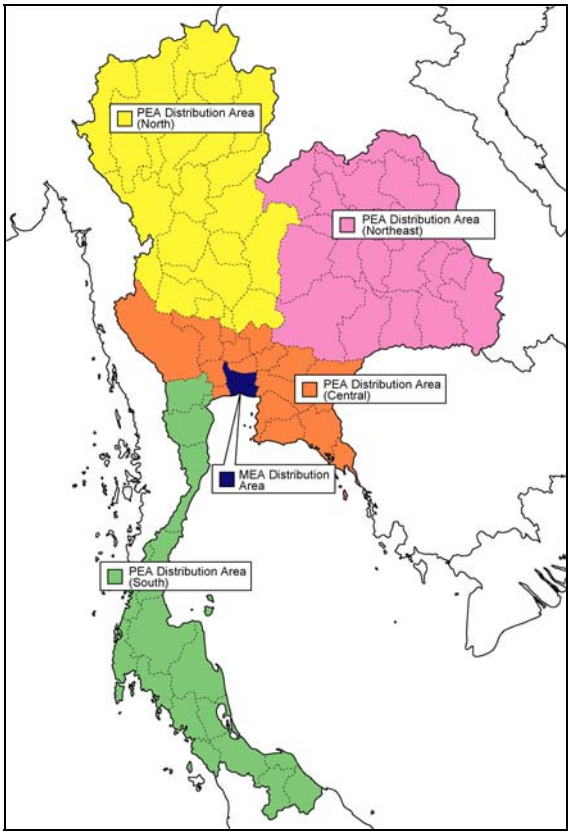

Figure 1: PEA distribution area

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)