Thailand

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

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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.

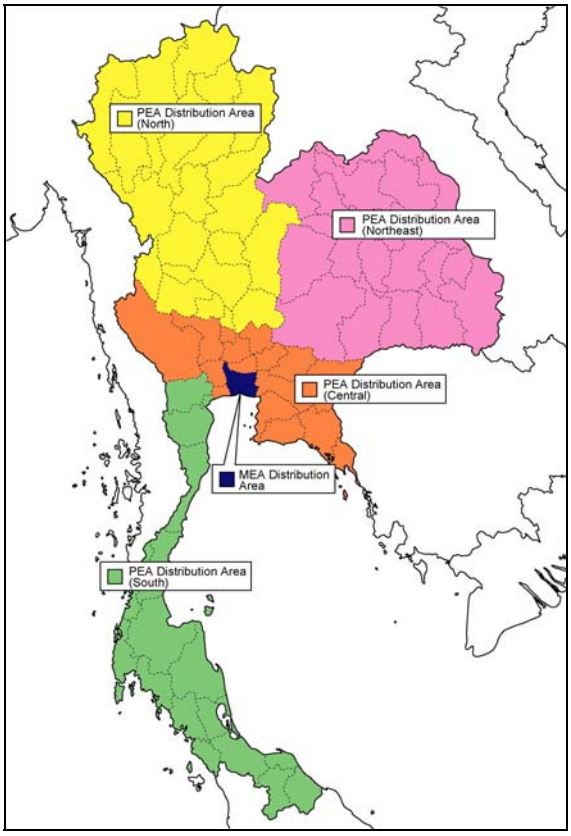

Figure 1: PEA's distribution area

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%

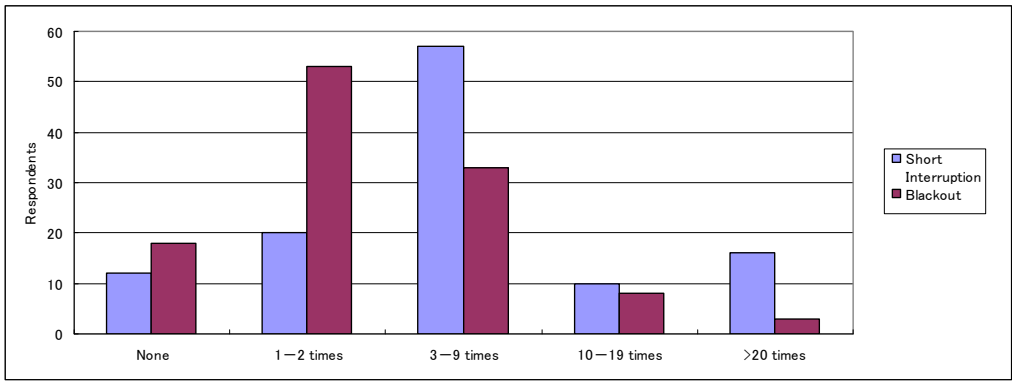

Figure 2: Frequency of blackouts and short interruptions in 2009

[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%

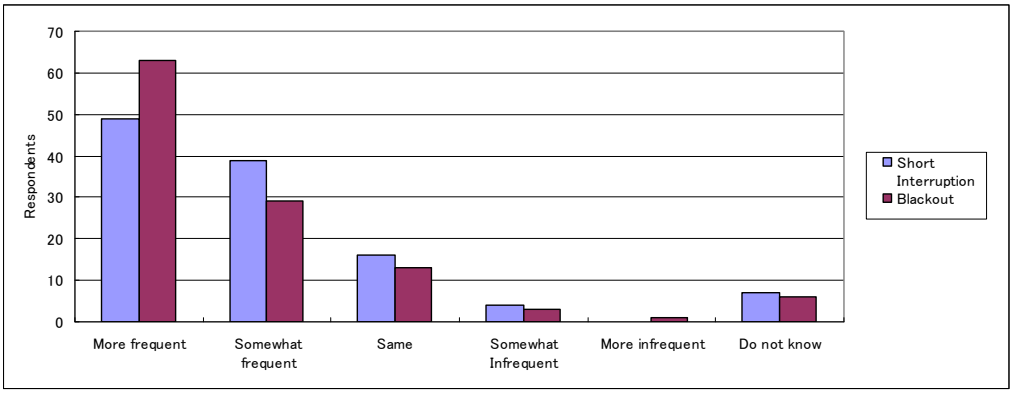

Figure 3: Blackouts and short interruptions (comparison between the early 90s and the present)

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.

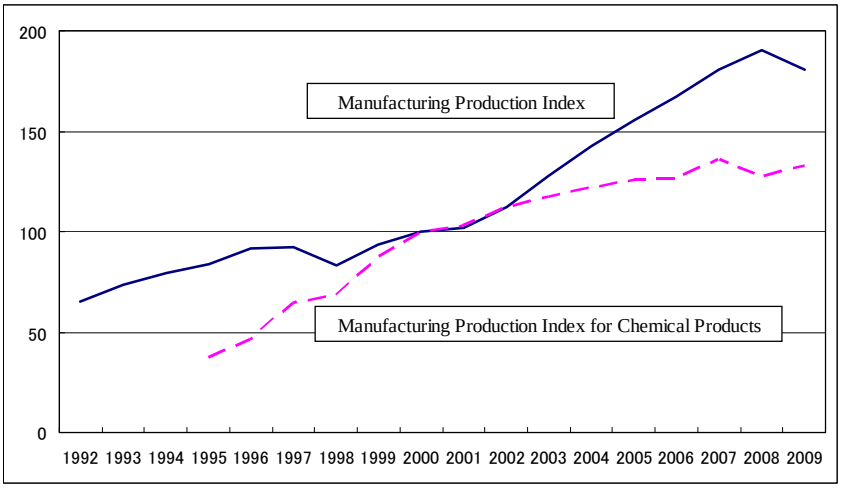

Figure 2: Manufacturing Production Index

(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))