Kingdom of Thailand

Ex-Post Evaluation of Japanese ODA Loan Project

"Transmission System and Substation Development Project (Sixth Stage Phase I)"

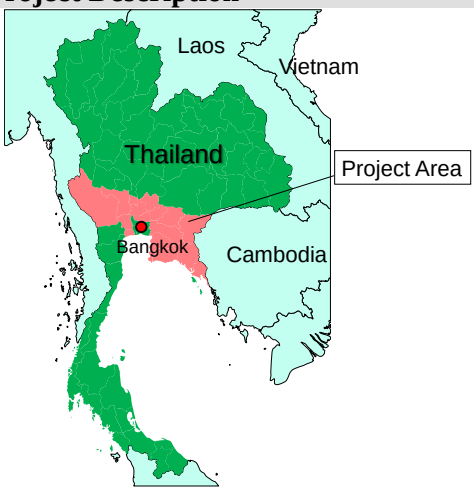
External Evaluator: Keisuke Nishikawa, Japan Economic Research Institute Inc.

0. Summary

This project was implemented to construct substations and extend transmission lines to meet the growing demand for electricity and to stabilize electricity supply in the central region of Thailand. The relevance of this project is high as this project has been consistent with the development plan and needs of Thailand both at the times of appraisal and ex-post evaluation as well as Japan's ODA policy at the time of appraisal. With regard to project effectiveness, it is considered that the effects have sufficiently been observed, as there are no concerns regarding the utilization factor and the voltage drop, outages have improved and the level of user satisfaction is generally high. Positive impacts were observed in terms of stable response to increasing electricity demand, which promoted vibrant economic activities and business establishment; therefore, the effectiveness and impact is also high. In terms of project implementation, the efficiency of the project is fair as the project period was significantly longer than the plan while the project cost was within the plan. With regard to operation and maintenance, no problems have been observed in the institutional, technical, and financial aspects, and the operation and maintenance conditions of the facilities were also favorable. Therefore, it was judged that the sustainability of the generated effects was high.

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

1. Project Description



Project Location

Sub-station constructed under this project
(Nakhon Pathom Province)

1.1 Background

Along with the social and economic development in the first half of 1990s, energy demand in Thailand increased at an annual average of 9.2% during the five-year period between 1992 and 1996. In 1996, the peak power demand in the whole area of Thailand reached 13,905MW, out of which the peak demand of the area covered by the Provincial Electricity Authority (hereinafter referred to as PEA) being 8,268MW. Under the economic conditions of the time, the rate of demand increase was expected to slow, but a stable supply of electricity as well as the improvement in the reliability of transmission networks remained highly important. Moreover, as a consequence of rapid economic growth, regional disparities were expanding, prompting the Government of Thailand to place 'regional development' as one of the priority areas in its national development plan. In response to these circumstances, it was deemed essential to achieve a stable electricity supply and improve the quality of electricity in regions outside the Bangkok metropolitan region so that the development of regional economies through decentralization of industries would be supported.

1.2 Project Outline

The objective of the project was to meet increasing electricity demands, particularly those of middle and large scale industries, and improve the reliability of the electricity supply by constructing new substations and expanding transmission lines in the 16 provinces around Bangkok, thereby contributing to the development of regional economies.

Loan Approved Amount / Disbursed Amount	15,518 million yen / 8,172 million yen
Exchange of Notes Date / Loan Agreement Signing Date	September, 1997 / September, 1997
Terms and Conditions	Interest Rate: 2.70% Repayment Period: 25 years (Grace Period: 7 years) Conditions for procurement: General Untied
Borrower / Executing Agency	Provincial Electricity Authority / Provincial Electricity Authority
Final Disbursement Date	January, 2006
Feasibility Studies, etc.	'The Eighth Transmission and Distribution Development Plan (1997-2001)' (Prepared by the Executing Agency in February, 1997)

Related Projects	[ODA Loan] Transmission System and Substation Development Project ・ First Stage, Phase 1 (L/A signed in 1991) ・ Fourth Stage (L/A signed in 1993) ・ Fifth Stage (L/A signed in 1995) ・ Seventh Stage, Phase 2 (L/A signed in 2002)

2. Outline of the Evaluation Study

2.1 External Evaluator

Keisuke Nishikawa, Japan Economic Research Institute Inc.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: August 2013 - January 2015

Duration of the Field Study: September 3 - 18, 2014 and November 23 - 29, 2014

2.3 Constraints during the Evaluation Study

As stated below, a substantial delay occurred in this project and the last substation was still being constructed at the time of ex-post evaluation. Therefore, the project period was calculated with September 2014, when the first field study was conducted, as the point of completion.

3. Results of the Evaluation (Overall Rating: A[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Relevance to the Development Plan of Thailand

At the time of appraisal of this project, development was underway based on the 8th National Economic and Social Development Plan (1997-2001) in Thailand, which focused on the people-centered development in which human potentials would be nurtured and developed, and the promotion of stable and sustainable economic growth would be its central agenda. Based on the 8th National Economic and Social Development Plan, PEA formulated five plans and eleven projects in its own development plan. This project comprises part of the 'transmission network development plan', which is one of five plans. In the energy policy formulated by the National Energy Policy Office at that time, one of the strategies was to respond to growing electricity demand and improve

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[2] ③: High, ②: Fair, ①: Low

supply reliability and service levels.

In the 11th National Economic and Social Development Plan (2012-2016), a national-level development plan of Thailand at the time of ex-post evaluation, there are development strategies such as 'strengthening the agricultural sector, food and energy security' and 'restructuring the economy toward quality growth and sustainability'. As at the time of appraisal, PEA formulated the Power System Development Plan (PSDP) in accordance with this National Economic and Social Development Plan. In PEA's 11th PSDP (2012-2016), nine objectives are set, such as an improvement in the quality, reliability and safety of the power network, and electrification with quality by responding to demand. Concretely, there are five plans listed as priority plans, under which there are 14 projects, such as further stabilization of transmission and distribution networks, as well as the development of a smart grid.

In the Power Development Plan (PDP) 2012-2030, prepared by the Ministry of Energy, priorities are given to the sustenance of power system safety as well as adequate and reliable electricity supply. With regard to electricity generation, it is planned that the generation capacity of 32,395MW as of 2011 will be increased to 70,686MW in 2030. In the plan, the share of renewable energy is targeted to be higher.

As shown above, the National Economic and Social Development Plan listed the need to secure energy at all times, both at the time of appraisal and ex-post evaluation, indicating that electricity supply has always been important in the policy. Also, PEA's PSDP has been formulated in line with the national plan, showing a consistent policy to expand transmission and distribution networks. In PDP, the importance of supplying increasing electricity in a stable manner is also stated.

In light of the above, it can be said that this project has been highly consistent with Thailand's development plan and the electricity sector plan at the time of planning and ex-post evaluation.

3.1.2 Relevance to the Development Needs of Thailand

In the 1990s, a period of appraisal of this project, power demand in the whole of Thailand was rapidly increasing, as recorded in the annual average growth of 9.2% during the five years between 1992 and 1996. It was projected that the demand would keep increasing at an average just shy of 9% from the second half of the 1990s. The rapid growth in demand for electricity was not only seen in the capital area but also in PEA's service areas[3], where the peak demand reached approximately 8,268MW. Based on the

[3] PEA assumes electricity supply in the areas outside Bangkok Metropolitan Region, managed by Metropolitan Electricity Authority.

growth, peak electricity demand was estimated to increase to 10,424MW in 1998 and 15,268MW in 2002.

In addition to these demand increases, promotion of regional economies through decentralization of industries was also a crucial development challenge in the policy of those days, and it was important to achieve a stable electricity supply and improve the electricity quality to indirectly support the promotion of regional economies.

The actual peak demand in the PEA service area from 2006 is as shown in Table 1.

Table 1: Maximum Electricity Demand (Peak Demand) in PEA's Service Area

Year	Peak Demand (MW)	Increase over the Previous Year (%)
2006	13,074	4.11
2007	13,758	5.23
2008	14,309	4.01
2009	14,745	3.05
2010	16,226	10.04
2011	16,223	-0.02
2012	16,952	4.50
2013	17,832	5.19
2014	18,821	5.54

Source: Data provided by the Executing Agency

Note: Actual values for 2006-2012, Estimated values for 2013-2014

The peak demand has been steadily growing except 2011, when large-scale flooding damage occurred in the central area of Thailand, showing an annual growth average of 4.42% between 2006 and 2012. 85% of the electricity consumption is for industrial purposes, indicating that the demand for electricity by industries has always been high.

On the other hand, regarding stable electricity supply and improvement in electricity quality, Table 2 shows outage hours and the number of outages per user.

Table 2: Outage Hours and the Number of Outages per User (Annual)

Year	Outage Hours (minutes)			Number of Outage		
	National	Central	Metropolitan	National	Central	Metropolitan
1997	1,558	702	—	19.6	13.0	—
2000	1,188	623	—	18.1	10.9	—
2005	630	377	—	12.0	10.2	—
2009	386	214	47	9.6	7.3	1.9
2010	350	203	47	8.9	6.8	1.7
2011	319	179	59	8.4	6.3	1.8
2012	281	179	49	7.8	6.2	1.8
2013	249	165	47	7.2	5.7	1.7

Source: Data provided by the Executing Agency
Note: 'National' in the table shows PEA's electricity supply area. 'Central' is identical with the 16 provinces covered in this project.

It can be observed from Table 2 that the outage hours and the number of outages in the project area (16 provinces in the Central Area) have significantly improved since 1997- the time of appraisal. However, a total of 165 minutes and 5.9 outages occurred in 2013, 3-4 times higher than the metropolitan region.

As shown above, electricity demand in recent years has kept increasing while the rate is slower than in 1990s, demonstrating continued needs of securing and enhancing electricity supply capacities. With regard to stable electricity supply, despite substantial improvement in recent years compared to the past, outages in the Central Region have been occurring more frequently and for longer periods in comparison with the metropolitan region, not only at the time of appraisal but also at the time of ex-post evaluation, which indicate high needs of electricity supply enhancement and stabilization. This project can be said to have been implemented in light of such development needs.

3.1.3 Relevance to Japan's ODA Policy

As the appraisal document of this project had no mention of the consistency of the project with Japan's ODA policy, the ODA Charter formulated in 1992 was regarded as the ODA policy at the time of appraisal, and the consistency of the project was checked against the Charter.

In the old ODA Charter approved in 1992, infrastructure development was listed as a priority area, and assistance to infrastructure development, a fundamental condition essential to economic and social development, was deemed important. In addition, considerations to redressing the gap between regions were set as the measures for the effective implementation of ODA. Therefore, this project, which developed infrastructure

facilities in rural areas, can be judged to have been consistent with Japan' ODA policy at that time.

Based on the above, it can be said that this project has been consistent with the national and sector plans which aimed to transform the economy to one of high-quality with sustainable growth, and to supply electricity in a stable manner, both at the time of appraisal and ex-post evaluation. Despite some year-to-year fluctuations, electricity demand has shown significant increases over the long-term. Also, the outage hours and the number of outages in the Central Region, the target area of this project, have remained longer and more frequent than the metropolitan region, despite improvements. This suggests the need to develop electricity infrastructure to achieve a stable supply of electricity with better quality, indicating the necessity of this project both at the time of appraisal and ex-post evaluation. Concerning the consistency with Japan's policy, this project is consistent with the priority area of the ODA Charter at that time as it supported the development of economic and social infrastructure in the rural area.

In light of the above, the relevance of this project is high.

3.2 Effectiveness[4] (Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

Since no indicators to measure project effectiveness, base values, or target values had been set at the time of appraisal of this project, this evaluation study was designed to capture as many indicators set in other related projects as well as basic and auxiliary operation and effect indicators for transmission projects, such as the utilization factor (substations), voltage drop rate, number of outages, outage hours and the volume of electricity supply by province in the project area.

As PEA had a policy to keep the utilization factor of substations below 75% and voltage drop normally under 5%, these indicators were used as target values in this project. The utilization factor of the 43 substations developed by the time of ex-post evaluation was between 25% and 97% (2013), and eight out of 43 substations exceeded the reference value of 75% (2013). However, as 35 substations were below reference and the highest average rate was 55.1% (2012), this criterion can be said to have been generally achieved. According to PEA, when the utilization factor of a certain substation constantly exceeds 75%, other substations are used or a new substation is constructed if at all possible.

[4] Sub-rating for Effectiveness is to be put with consideration of Impact.

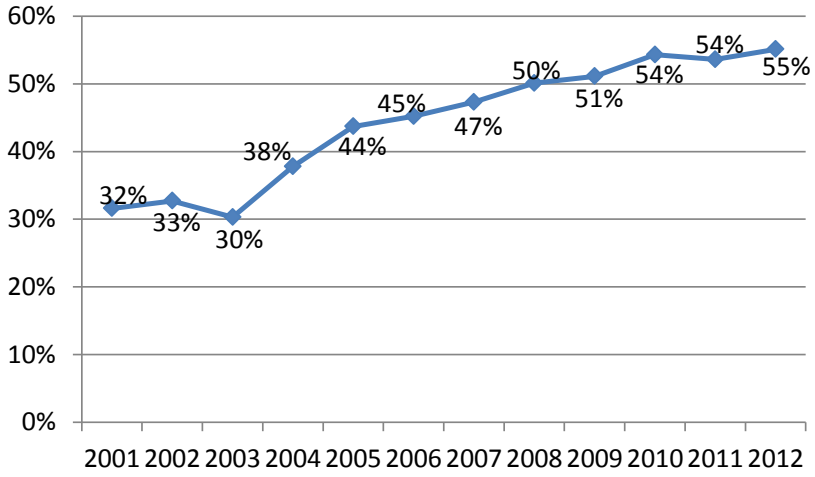


Figure 1: Average Utilization Factor of Substations Developed in this Project

Source: Prepared based on the data provided by the Executing Agency

With regard to the voltage drop, only up to 5% is allowed at PEA under normal operating conditions of 115kV transmission lines and 33kV/22kV distribution lines. When it exceeds the limit, measures are taken by increasing capacitors (condensers). In the project area, no provinces have recorded the voltage drop of more than 5% since 2009, when such data is traceable. Table 3 shows the rate of each province in 2013.

Table 3: Main Operation and Effect Indicators of this Project (2013)

Province	Voltage Drop (%)	Outage Hours (minutes/year)	Outage Times (times/year)	Electricity Supply (GWh)
Ayutthaya	2.65	212.3	6.7	5,194
Ang Thong	3.51	115.6	4.3	1,004
Saraburi	4.35	192.8	6.1	7,332
Pathum Thani	3.91	114.02	4.3	7,846
Nakhon Nayok	4.35	182.7	8.3	539
Prachin Buri	4.76	192.1	6.2	2,109
Sakaeo	4.35	221.1	6.8	630
Chachoeng Sao	3.89	149.0	4.6	4,118
Chon Buri	3.14	99.5	4.7	10,880
Rayong	3.44	166.0	5.7	9,350
Chantha Buri	3.71	349.7	9.8	1,486
Trat	4.39	514.5	15.3	609
Nakhon Pathom	0.97	81.2	3.9	4,664
Samutsakhon	1.21	77.0	3.3	6,731
Suphan Buri	1.39	160.0	6.8	1,419
Kanchana Buri	1.08	220.7	5.9	1,309

Source: Data Provided by the Executing Agency

Table 3 shows some fundamental operation indicators such as outage hours, number of outages and the volume of electricity supply, in addition to the voltage drop rate. Outage hours and the number of outages have decreased to approximately half of 2005, when such data exists, and the volume of electricity supply in 2013 increased by 44% from 2005. It can be said that sufficient and stable electricity supply has been underpinned through implementation of this project.

This project was implemented to develop transmission lines to respond to increasing electricity demand. At the time of ex-post evaluation, the enhancement of substation equipment capacities was 3,550MW through the implementation of this project (excluding one uncompleted substation). Once the last substation is completed, the supply capacity will be increased by another 100MW. As the installed capacity of substations in the Central Area is 13,330MW, this project would constitute 27% of the entire substation installed capacity, once the whole project is completed. It can be said that this project contributed to the realization of capacity enhancement and stable supply to respond to the growing demand.

3.2.2 Qualitative Effects

As a qualitative effect of this project, an improvement of customer satisfaction through improved electricity supply capacities and the realization of stable supply was expected. In order to verify this expectation, an interview survey was conducted with a total of 16 large users and the chambers of commerce and industry (commerce and manufacturing) in the four provinces of Chon Buri, Rayong, Nakhon Pathom, and Ayutthaya, all of which were in the project area.

As a result, all interviewees responded that power outages decreased dramatically compared to the past and the outage hours became shorter while they sometimes occur even at the time of ex-post evaluation. It was also heard from the interviews that while voltage fluctuations had not been a major problem and electricity supply had never been suspended on a large scale, the supply became much more stable in recent years compared to the past, confirming that the interviewees were satisfied with the electricity supply as a whole. While some of the manufacturing firms requested further improvement stating that an installation of their own backup generator was required since even a momentary blackout would affect their operations, all the interviewees commented that the electricity supply was more stable than in neighboring countries, indicating a higher level of satisfaction. Among the interviewees, two were Japanese firms located in an industrial park, and it was heard from them that stable supply of electricity and water was a big factor for their decisions for investment.

3.3 Impact

3.3.1 Intended Impacts

The impacts of this project expected at the time of appraisal was the promotion of regional industry and economy through improved electricity supply capacities and supply reliability, and the employment generation and the improvement of living standards associated with it.

While it is difficult to verify direct causal relationships between these macro-level changes and the electricity supply as the changes are not brought about by the improved electricity supply alone, provincial economic data (average annual growth rate) and the rate of increase in electricity demand of the target provinces were obtained to see the expectations.

Table 4 shows the annual real economic growth rates (Gross Provincial Product: GPP) of each province, classified by agricultural and non-agricultural sectors for 1997 - 2012.

Table 4: Real Economic Growth Rate (GPP) of Each Province in the Project Area

	Real GPP Average Annual Growth Rate (1997-2012)			Ratio of Non-Agricultural Sector in GPP (2012)
	Real GPP	Agriculture	Non-Agriculture	
Ayutthaya	4.15%	2.41%	4.19%	98.2%
Ang Thong	1.72%	1.66%	1.84%	88.9%
Saraburi	3.95%	5.22%	3.88%	95.8%
Pathum Thani	0.87%	1.72%	0.87%	98.9%
Nakhon Nayok	3.86%	4.54%	3.49%	73.5%
Prachin Buri	9.07%	2.28%	9.33%	97.7%
Sakaeo	3.40%	2.21%	3.86%	78.2%
Chachoeng Sao	6.70%	1.81%	7.05%	95.9%
Chon Buri	4.40%	2.67%	4.43%	97.4%
Rayong	4.71%	2.02%	4.81%	96.8%
Chantha Buri	2.16%	1.22%	2.99%	52.3%
Trat	2.43%	2.54%	2.14%	45.3%
Nakhon Pathom	3.22%	2.57%	3.27%	93.2%
Samutsakhon	3.62%	9.25%	3.31%	92.0%
Suphan Buri	2.13%	1.93%	2.30%	75.2%
Kanchana Buri	1.39%	3.66%	0.95%	81.2%
All 16 Provinces	4.01%	2.88%	4.09%	94.0%

Source: Calculated from the Gross Regional and Provincial Product, published by the National Economic and Social Development Board

Table 5 shows the average annual electricity demand growth rate of each province for 2003 – 2012.

Table 5: Average Annual Growth Rate of Electricity Demand of Each Province

	Electricity Demand by Province Annual Average Growth Rate (2003 – 2012)		
	Household	Industrial	Total
Ayutthaya	5.27%	2.89%	3.16%
Ang Thong	4.24%	5.30%	4.86%
Saraburi	5.51%	3.25%	3.45%
Pathum Thani	7.13%	1.06%	2.04%
Nakhon Nayok	5.22%	6.82%	6.19%
Prachin Buri	5.09%	8.89%	8.25%
Sakaeo	5.52%	11.91%	8.96%
Chachoeng Sao	5.73%	8.04%	7.75%
Chon Buri	7.57%	8.55%	8.36%
Rayong	7.07%	4.60%	4.79%
Chantha Buri	4.06%	10.80%	7.24%
Trat	4.72%	10.55%	7.77%
Nakhon Pathom	5.70%	4.64%	4.83%
Samutsakhon	5.27%	4.34%	4.41%
Suphan Buri	5.40%	8.37%	6.92%
Kanchana Buri	5.83%	3.27%	3.80%
All 16 Provinces	6.10%	4.83%	5.02%

Source: Calculated from the Data Provided by the Executing Agency

As indicated in Table 4, economic growth rates of the 16 provinces over 15 years from the time of project appraisal (1997) till 2012 recorded an annual average of 4.0% as a whole with the growth of the non-agricultural sector which comprises 94% of GPP (2012). While it is difficult to measure the extent to which this project contributed to this growth, it assumes 27% of the entire installed capacities of substations as described above, and it is presumed that the project has made a certain degree of contribution.

The electricity demand of general households and industries in the entire project area (Table 5) increased by an annual average of 6.10% and 4.83% respectively between 2003 and 2012, when the data were available, making the total average of 5.02%. It can be observed that the electricity demand has increased with economic growth.

As briefly stated in '3.2.2 Qualitative Effects', it was uniformly heard in the interviews with large electricity users and chamber of commerce and industry that stable electricity supply was an indispensable factor for manufacturing and commercial activities, and that the increase in the establishment of firms over the last 15 years was led by the secure supply in the project area. Moreover, it was heard from large electricity users and chamber of commerce and industry in each province visited that sufficient and stable electricity supply promoted 'employment generation → income improvement → increase in consumption → economic growth' through smooth economic activities and new establishment of firms. It is considered that this project was one of the contributing factors.

Based on the above, 'the promotion of regional industry and economy through

improved electricity supply capacities and supply reliability, and the employment generation and the improvement of living standards associated with it', expected at the time of appraisal, can be evaluated to have been realized to substantial extent.

3.3.2 Other Impacts

3.3.2.1 Impacts on the Natural Environment

At the time of appraisal, no particular negative environmental impact was estimated as this was a project to construct a small-scale transmission network. According to the environmental law of Thailand, it was confirmed that no environmental impact assessment would be required.

According to the executing agency, no negative impact on natural environment during or after the construction has been observed, and no reports or news on any particular environmental problems were identified. Therefore, it is considered that there were no negative impacts on the natural environment.

3.3.2.2 Land Acquisition and Resettlement

When a section of land for substations is going to be secured, PEA has adopted a method to 'determine the site for substations → implement a tender process to accept applications (bidding) from land owners → sign a purchase agreement'. Therefore, it was expected during the planning that the process could take much time in some cases. However, this project was said to have already been in the process of bidding by land owners at the time of appraisal and the sites were basically selected in the area with abundant supply of land, and it was reported that no change of sites or of the scope of substations had been required in the past due to problems with land purchases.

A land area of 384,000m^2 was scheduled to be purchased in the initial plan for the construction of substations, but 568,400m^2 was actually purchased. The main reason for this change is that the land owners of the candidate sites were often reluctant to sell the area of land PEA needed, for the reason that the remaining piece of land after it is divided would not be utilized. As a result, PEA purchased a larger area of land. Also, there were some sections of land whose market prices were actually higher than the purchase prices planned based on the values assessed by the Land Development Department, which required securing more finances causing delays in purchasing the land that led to the delay of the project. However, according to PEA, no issues occurred regarding land acquisition in this project as the purchases were made based on the market prices with consents from land owners.

With regard to transmission lines, as they were constructed along the existing roads, no land acquisition took place.

No resettlement of residents was observed for the construction of substations and transmission lines, according to PEA, and it is assumed that there were no problems.

While no indicators to measure the project effects had been set at the time of appraisal of this project, there were no concerns on the utilization factor and the voltage drop, fundamental indicators of a transmission project. Power outage situations improved and customer satisfaction levels were also generally high. Therefore, it can be judged that the effects of this project have been sufficiently achieved.

Impacts were observed in that stable economic activities evolved and the establishment of firms was promoted as this project underpinned steady economic growth and the increase in electricity demand in the project area. No negative impacts on the natural environment were observed, and the purchases of land were implemented based on market prices under the consents from landowners. It can be judged to have no problems in this regard.

In light of the above, the effectiveness and impact of this project is high.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

Table 6 compares the original and actual outputs of this project.

Table 6: Comparison of Original and Actual Project Outputs

	Original	Actual
Project Area	16 provinces around Bangkok	16 provinces around Bangkok
Construction of 115kV Transmission Line	39 sections, 780cct-km	43 sections, 731.1cct-km
Construction of 115kV-22kV Substations	44 locations, Total transformer capacity : 3,500MVA	43 locations, Total transformer capacity : 3,550MVA
Construction of 115kV Switching Station	1 location	1 location

Source: Project Appraisal Document, Information provided by the Executing Agency
Note: The last substation (in Nakhon Pathom) was being constructed at the time of ex-post evaluation, and it was scheduled to be completed during the first quarter of 2015.

As indicated in Table 6, this project, a project in which a number of substations and transmission lines were going to be constructed, was generally implemented as planned. Due to the change of project sites of some substations, the number of transmission lines increased and their distance decreased. However, it is assumed that there were no problems as these changes did not seem to have affected the generation of project effects.

43 substations had been completed at the time of ex-post evaluation as it took a long time for land acquisition, with the last one uncompleted. While a number of substations had construction delays, there were no cases where the electricity supply volume became short due to these delays and incompletion as the electricity supply was secured by the entire transmission network. It is important to note, however, that the volume of electricity required at that time was supplied by the substations as the construction was gradually completed despite the project delay, since the supply capacity had been designed based on the long-term plan, and there were some years when the demand growth fell below initial expectations due to economically negative factors such as the Asian Economic Crisis, Lehman crisis, and the flooding in 2011.

No external consultants were employed in this project and PEA managed all the project implementation by itself. According to PEA, there were no particular problems observed by not hiring any consultants.

Gas Insulated Transformer


Rojana 2 Substation


Transmission Line Constructed under This Project

3.4.2 Project Inputs

3.4.2.1 Project Cost

The planned project cost was 43,115 million yen (foreign currency portion: 15,518 million yen, local currency portion: 27,597 yen), and the entire foreign currency portion of 15,518 million yen was to be financed through ODA loan.

Table 7 summarizes the original and actual project costs on a comparable basis.

Table 7: Comparison of Original and Actual Project Costs

(Unit: million yen)

Item	Original		Actual	
	Total	ODA loan portion	Total	ODA loan portion
Transmission Line	7,862	2,048	7,417	1,900
Substation	18,508	11,354	17,013	6,272
Land Acquisition	4,047	0	1,725	0
Labor Cost	1,354	0	579	0
Transportation Cost	565	0	18	0
Equipment Cost	1,612	0	365	0
Engineering and Supervision	406	0		0
Price Escalation	3,019	705	0	0
Contingencies	3,920	1,411	2,230	0
Tax	1,822	0	425	0
Total	43,115	15,518	29,772	8,172

Source: Project Appraisal Document, Project Completion Report

Note 1: The original cost was calculated based on 1 baht = 4.75 yen, and the actual cost was calculated based on 1 baht = 2.89 yen, the average between 2001 and 2014, when the local currency portion was spent.

Note 2: The actual project cost includes the cost of the 44th substation being constructed at the time of ex-post evaluation, etc.

While there were few increases or decreases in the project outputs, the government at that time set a policy recommending domestic procurement of materials with the local currency portion, which resulted in a substantial reduction in the disbursement of ODA loan. The project components for the ODA loan portion were completed in 2006, during the project implementation, leading to the end of disbursement. In Table 7, while the local currency portion decreased in yen terms, it was a 29% increase based on Thai baht. As the project cost decreased substantially in yen terms with the exchange rate of stronger Japanese yen, the total project cost ended in 29,772 million yen. Therefore, the total project cost was 69% of the plan, within the planned amount.

3.4.2.2 Project Period

The original and actual periods of this project were as shown in Table 8.

Table 8: Comparison of Original and Actual Project Periods

Original	Actual	Actual / Original
September 1997 – December 2001 (51 months)	September 1997 – September 2014 (204 months)	400%

Note: 'September 2014' in 'Actual' indicates the timing of the first field study.

While the duration of the project initially expected was 51 months, the project was substantially delayed mainly due to the following reasons.

- Expenditures by government organizations were restrained due to the change in the policy after the Asian currency crisis occurred, which led to the stagnation of land acquisition processes. It was gradually started from 1999.
- Permission from the Ministry of Industry was required for government organizations to procure imported goods and it took a long time for these processes.
- Land prices of the project sites often exceeded the values assessed by the Land Development Department, and additional time was required to secure the budget again.
- More time was required to obtain permissions from related organizations such as the Department of Highways and the State Railway of Thailand to construct transmission lines.
- Much time was required for land acquisition particularly for the construction of the last 44th substation.

As a result, the 44th substation was being constructed at the time of ex-post evaluation of this project, and this timing was deemed as the end of the project period in this study. Therefore, the project duration was 204 months, which was 400% of the plan.

Although a substantial delay occurred due to the reasons above, no supply shortage was brought about in the whole electricity network and the electricity was supplied without problems. While significant delay occurred, it was possible to respond to the increases in electricity demand as the facilities were gradually developed. It can be judged that the delay did not cause any negative effects in particular to the generation of project effects.

3.4.2.3 Results of Calculations of Internal Rates of Return (Reference only)

At the time of planning of this project, the Financial Internal Rate of Return (FIRR) based on the entire plan which was based on PEA's eighth plan was calculated to be 15.43%. The FIRR calculated specifically for this project in the ex-post evaluation survey was 18.25%, indicating a sufficient rate of earning.

The outputs of this project were confirmed to be almost the same as the plan though the last substation was still under construction. With regard to the project cost, while the local currency portion virtually increased, the ODA loan portion was significantly reduced with the change of policy of the Thai government to restrain borrowings in foreign currencies.

With this background, the total project cost was within the plan (69% of the plan). The project period was 400% of the plan as substantial delays occurred for land acquisition and the processing within the government organizations.

In light of the above, although the project cost was within the plan, the project period significantly exceeded the plan. Therefore, the efficiency of the project is fair.

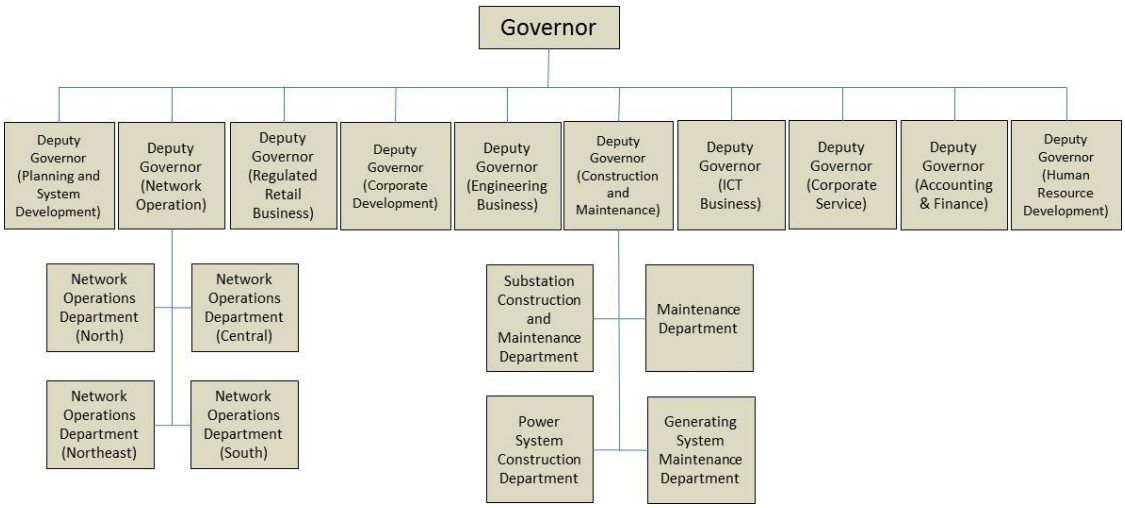
3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

The executing agency of this project is the Provincial Electricity Authority (PEA), as already stated above. PEA is a state-owned enterprise wholly owned by the Thai government, and it is under the supervision of the Ministry of Interior. It undertakes power transmission and distribution in all the regions except for the Bangkok metropolitan region with 915 offices and 28,060 staff members (2012). PEA has four regional offices (North, Northeast, Central and South) under the Deputy Governor in charge of network operations, and these regional offices have three area offices each.

Daily operation and maintenance activities of the transmission lines and substations are implemented by the staff in the Network Operations Department and the Substation Construction and Maintenance Department assigned to each area office (three offices in the area of this project). While 20 - 30 engineers and technicians are stationed at each area office, a maintenance team from a division in charge at the headquarters will be dispatched in the case of major breakdown (Substation Maintenance Division: 50 staff), and attend to the repair together with the area offices.

PEA has been in the process of shifting from a 24-hour manning system to an unmanned system at each substation by remotely supervising the network operation status with the use of an electricity network supervising and controlling system called SCADA.



Source: Information provided by PEA

Figure 2: Organizational Structure of PEA

3.5.2 Technical Aspects of Operation and Maintenance

PEA has set the years of experience and requirements for operation managers and staff in charge regarding the maintenance capacity of substations. Normally, On-the-Job-Training is employed to improve technical capacities through routine maintenance activities, but the Substation Maintenance Division has been implementing a week-long lecture-workshop and training on substation maintenance techniques at a substation for 100 - 150 technicians, in cooperation with the High Voltage Training Center. Also, it was confirmed that PEA had formulated a maintenance manual of facilities. According to them, it has been utilized at training workshops and in actual activities.

In addition to the formulation of the maintenance manual and the periodical implementation of training for capacity development in this way, the substations and transmission lines in the project area have been in operation without any problems as they were repaired when problems arose. Therefore, it is considered that there are no particular issues in terms of the knowledge and skills of PEA technicians on maintenance activities.

3.5.3 Financial Aspects of Operation and Maintenance

Financial conditions of PEA over the last four years have been sound and, as seen in Table 9: Income Statement of PEA, a surplus has consistently been recorded. The gross profit margin has been approximately 10%, the return on asset (ROA) has been 4.0% - 5.3% and the return on equity (ROE) has been 11.5% - 13.8%. The current ratio is also more than one, demonstrating that the financial status has been stable.

Table 9: Income Statement of PEA

(Unit: million baht)

	2009	2010	2011	2012
Sales	288,961	322,662	323,535	385,839
Cost of Sales and Services	255,930	285,783	287,681	347,528
Gross Profit on Sales	33,031	36,879	35,854	38,311
(Gross Profit Rate)	(11.4%)	(11.4%)	(11.1%)	(9.9%)
Sales and Administrative Expenses	17,766	20,229	21,869	22,644
Operating Profit / Loss	15,266	16,650	13,986	15,667
Non-operating Income	1,541	1,049	1,224	2,329
Non-operating Expense	2,807	2,936	3,039	3,234
Current Profit	14,000	14,763	12,171	14,761
Profit for the Year Before Tax	14,000	14,763	12,171	14,761
Net Profit for the Year	14,000	14,763	12,171	14,761

Source: Prepared based on the PEA Annual Report (2009 - 2012)

Table 10: Balance Sheet of PEA

(Unit: million baht)

	2009	2010	2011	2012
Current Asset	56,210	67,865	75,631	66,105
Fixed Asset	205,826	216,132	228,178	243,037
Total Asset	262,037	283,997	303,809	309,142
Current Liability	47,493	49,437	61,553	58,850
Fixed Liability	113,406	126,127	136,176	137,908
Total Liability	160,899	175,565	197,729	196,758
Capital	101,137	108,432	106,080	112,384
Total Capital and Liabilities	262,037	283,997	303,809	309,142

Source: Prepared based on the PEA Annual Report (2009 - 2012)

The maintenance expenditure of the entire PEA has shown that the actual amount normally exceeds the budget as a whole, though the provincial data was not developed, making it impossible to obtain. Costs for repair are not appropriated at the beginning of the financial year and they are recorded afterwards. While sufficient maintenance has generally been conducted, the financial burden is not considered large as the maintenance expenditure has been 0.2% of the revenue from electricity sales and 4.0% - 5.6% of the net profit for the year.

Table 11: Maintenance Expenditure of PEA

(Unit: million baht)

	Maintenance Cost		(A) / Revenue from Electricity Sales	(A) / Net Profit for the Year
	Budget	Actual (A)		
2009	581.1	597.1	0.2%	4.3%
2010	588.0	597.0	0.2%	4.0%
2011	567.0	685.9	0.2%	5.6%
2012	604.0	736.3	0.2%	5.0%

Source: Data provided by PEA, PEA Annual Report

3.5.4 Current Status of Operation and Maintenance

During the ex-post evaluation study, site visits were conducted in the provinces of Chon Buri, Rayong, Nakhon Pathom and Ayutthaya in the project area. All the substations and transmission network developed in this project were never left broken for a long period of time and were operating normally. According to PEA, one switching station installed has been operating without any problems.

With regard to the maintenance plan of these facilities, the maintenance team of the Substation Construction and Maintenance Department at the headquarters has been inspecting each substation in the three areas in the Central region once a year, in addition to the cases of large-scale breakdowns. Moreover, the Network Operations Department of regional offices has been supervising the network with the use of the SCADA system, and the staff of the Department has been implementing monthly visual inspections of transmission lines.

Therefore, the substations and transmission lines developed in this project have been maintained in good condition, and a regular inspection has been systematically implemented, leaving no major concerns on operation and maintenance. It can be said that there are no issues as a whole.

No concerns were observed in terms of the institutional aspects of operation and maintenance, operation and maintenance conditions, and the techniques on inspections and repairs. Financial conditions have always been sound and stable.

In light of the above, no major problems have been observed in the institutional, technical and financial aspects of the operation and maintenance system. Therefore, the sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was implemented to construct substations and extend transmission lines to meet the growing demand for electricity and to stabilize electricity supply in the central region of Thailand. The relevance of this project is high as this project has been consistent with the development plan and needs of Thailand both at the times of appraisal and ex-post evaluation as well as Japan's ODA policy at the time of appraisal. With regard to project effectiveness, it is considered that the effects have sufficiently been observed, as there are no concerns regarding the utilization factor and the voltage drop, outages have improved and the level of user satisfaction is generally high. Positive impacts were observed in terms of stable response to increasing electricity demand, which promoted vibrant economic

activities and business establishment; therefore, the effectiveness and impact is also high. In terms of project implementation, the efficiency of the project is fair as the project period was significantly longer than the plan while the project cost was within the plan. With regard to operation and maintenance, no problems have been observed in the institutional, technical, and financial aspects, and the operation and maintenance conditions of the facilities were also favorable. Therefore, it was judged that the sustainability of the generated effects was high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

4.2.1.1 Construction of Uncompleted Substation

As a result of significant delays in land acquisition for substation construction in this project, the last substation was still being constructed even at the time of ex-post evaluation, 17 years after the loan agreement was signed. While the entire supply has been secured by power interchanges from other substations in the transmission network, it is important to implement the construction of the last substation in line with the schedule without any further delay and start operations at an early date so that an optimal transmission network will be established and burdens on existing substations will be reduced.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

4.3.1 Improvements in the Project Site Decision Process

The project was delayed due to the change in the government policy to restrict the purchase of imported goods and restrain expenditure due to the occurrence of the Asian currency crisis soon after the loan agreement of this project was signed. Furthermore, as the project was commenced without decisions on the land sections for substations, there were problems observed in terms of the long time required for site selection and the escalation of land prices during that period causing budget shortage to purchase the land.

Despite substantial delays, electricity was supplied to users smoothly in this project through existing substations in the transmission and distribution network, and there were no significant issues. However, in a future transmission and distribution project with the construction of many substations, it is considered that candidate sites need to be pre-selected to the extent possible, as in the efforts currently made by PEA, so that the

project period falls within the plan, leading to the prompt generation of project effects.

(End)

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	1) Construction of 115kV Transmission Line (39 circuits, 780cct-km) 2) Construction of 115kV-22kV Substations (44 stations, with a total installed capacity of 3,500MVA) 3) Construction of a 115kV switching station (1 station)	1) Construction of 115kV Transmission Line (43 circuits, 731.1cct-km) 2) Construction of 115kV-22kV Substations (44 stations, with a total installed capacity of 3,650MVA) 3) Construction of a 115kV switching station (1 station)
2. Project Period	September 1997 - December 2001 (51 months)	September 1997 - September 2014 (204 months)
3. Project Cost Amount paid in foreign currency Amount paid in local currency Total Japanese ODA loan portion Exchange rate	15,518 million yen 27,597 million yen 43,115 million yen 15,518 million yen 1 Baht = 4.75 yen (As of September 1997)	8,172 million yen 21,600 million yen 29,772 million yen 8,172 million yen 1 Baht = 2.89 yen (Average between 2001 -2014, when the local currency was disbursed)