Thailand

Metropolitan Power Distribution Project

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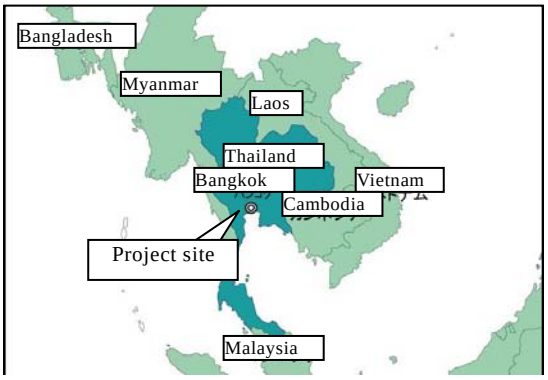
Field Survey: January 2006

1. Project Profile and Japan's ODA Loan



Map of project area: Bangkok Metropolitan area

Site photograph: Substation equipment installed through this project

1.1 Background

Thailand has seen continued rapid economic growth since the latter half of the 1980s, and the demand for electric power has grown quickly along with the economic development. In particular, demand for electric power has increased in the Bangkok Metropolitan area (Bangkok Metropolitan administrative district, Samut Prakan Province, and Nonthaburi Province) which has generated the economic growth, in the wake of factors such as the increase in the population, the development of commerce and industry, the construction of groups of high-rise buildings, and improvements in the living standards. The highest demand for electric power in 1990 of 3,124MW had become 5,637MW by 1996. The yearly average increase in electric power demand for Thailand was 9.2% from 1992 to 1996. For Metropolitan Bangkok in particular, a striking yearly average growth rate of 10.3% was recorded from the years 1990 to 1996. Responding to this demand for electric power was essential for Thailand's sustainable growth.

1.2 Objective

To meet the electric power demand within Metropolitan Bangkok by expanding and improving the substations and power distribution system in this area, thereby contributing to the economic development of the area.

1.3 Project scope

(1) Improving primary substations, (2) newly installing distributing substations, (3) Improving and enhancing distributing substations, and (4) laying down and improving primary power distribution lines, all within Metropolitan Bangkok

1.4 Borrower/Executing agency
Kingdom of Thailand/Metropolitan Electricity Authority (hereafter referred to as the MEA)

1.5 Outline of Loan Agreement

Loan Amount/ Disbursed Amount	14,304 million yen/6,617 million yen
Loan Agreement	September 1997
Terms and Conditions - Interest Rate - Repayment Period (Grace Period) - Procurement	 2.7% 25 years 7 years General untied
Final Disbursement Date	January 2003
Main Agreement	SRI U-THONG CO., LTD, others
Consulting Agreement	None
Feasibility Study (F/S), etc.	JICA Metropolitan Power Distribution System Improvement and Expansion Plan (Master Plan)

2. Evaluation Result

2.1 Relevance

2.1.1 Relevance at the time of appraisal

The priorities in Thailand's Eighth National Economic and Social Development Plan (1997-2001) (Eighth NESDP) were: (1) the promotion and development of the latent potential of the people, (2) the stable development of society, and (3) the promotion of stable and sustainable economic growth.

In Thailand there was no development plan solely for the electric power sector, but development of the electric power sector is touched on in the country's Energy Development Plan, which also incorporates the securing of resources and fuel.[1] The description within the Energy Development Plan focuses primarily on the development of power resources, with no special mention made of setting in place a power distribution system. The Eighth Energy Development Plan set targets for reliability of power distribution for the MEA, which is in charge of power distribution for the metropolitan area, and for the Provincial Electricity Authority

[1] The Energy Development Plan was formulated by the National Energy Policy Office (NEPO) at the time of the Eighth plan. At present it is formulated by the Energy Policy and Planning Office (EPPO), which is what NEPO became after being reorganized under the mantle of the newly created Ministry of Energy (MOEN).

(PEA), which is in charge of regional power distribution[2].

The MEA has a medium-term plan for power distribution, and the Eighth Metropolitan Power Distribution System Improvement and Expansion Plan (hereafter referred to as the Eighth Power Distribution System Plan) plan aimed to: (1) install and expand substations, (2) expand transmission lines, (3) expand the transmission line network, (4) expand and improve distribution lines, (5) coordinate with public projects, (6) boost primary distribution lines to 24kV, (7) and increase the efficiency in management and service of electric distribution projects.

The objective of this project was to reinforce and improve the reliability in transmission and distribution of power in order to handle the rapid rise in the demand for electric power (average growth rate of 10.3% from 1990-1996) at the time of appraisal (May 1997). The actual result for the demand for electric power from 1996 was 5,637MW, and it was predicted that this would likely rise to 8,290MW in the year 2001 (with an average yearly growth rate of 8% [7.69%]). Based upon these predictions for demand, the improving of one primary substation and newly installing nine power distribution substations, as well as laying down and improving distribution lines were set as the project scope. The substation equipment to be newly installed or improved was chosen with priority given to regions with high increases in their electric power demand. This project contributed to promoting stable and sustainable economic growth and aimed to reinforce and improve the degree of reliability in the country's capacity to transmit and distribute power. As such, it had relevance in terms of both policy and measures.

2.1.2 Relevance at the time of evaluation

The Ninth National Economic and Social Development Plan (2001-2006) (Ninth NESDP) advocated "sustainable development through development that balances human resources, socioeconomic aspects, and natural resources." It mentioned that harmonious and sustainable development can be achieved through the efficient utilization of natural resources and environmental development, as well as increasing the efficiency and economy of energy. This project aimed to increase the efficiency of the Metropolitan Bangkok power distribution system and, as such, was in accord with the sustainable development proposed within the Ninth NESDP. It could be claimed that the project has relevance from a policy aspect even today.

There is no special mention of the Power Distribution System Plan made in the ninth energy plan, but it does draw on the mentality of the Ninth NESDP. As such, limiting the waste of resources and improving the efficiency of energy use was placed as the central thrust of the ninth energy plan, and improving the efficiency

[2] In the eighth plan, the planned value for the System Average Interruption Frequency Index (SAIFI) came to 3.72, and the System Average Interruption Duration Index (SAIDI) was 99.65 for the year 2001.

for power distribution could also be thought of as a policy objective. The strengthening of the power distribution system is conducive to the efficient supply of power, and this project could be termed relevant from the perspective of the policies of the energy sector as a whole.

Since the Asian economic crisis occurred while the Eighth Power Distribution System Plan was being implemented this plan was modified. Investments were substantially reduced for programs for substations and the power distribution system, and the policy shifted toward one that emphasized raising the degree of reliability in the existing installations. The years for the Ninth Metropolitan Power Distribution System Improvement and Expansion Plan (hereafter referred to as the Ninth Power Distribution System Plan), which took over for the Eighth Power Distribution System Plan, are from 2002-2007. Main projects for the first term of the Ninth Power Distribution System Plan from 2002-2003 were projects to improve services and the construction of a 230kV high-voltage power line between Bangkapi and Chitlom. The initial Ninth Power Distribution System Plan was formulated based upon the predicted demand for electric power from August 2002. However, since the growth in the demand for electric power in the year 2003 surpassed expectations (the expected rate of increase in the demand for electric power [MW] for 2003-2004 was 4.5%, while the actual increase was 6.34%), the plan was revised. The two main pillars for the latter half of the Ninth Power Distribution System Plan were set as: (1) projects for improving and expanding the power distribution system and (2) projects to bury the aboveground lines beneath the ground. A policy turnaround occurred during the Eighth Power Distribution System Plan and planning revisions were carried out through the Ninth Power Distribution System Plan. Yet both share the common elements of stabilizing the distribution system and improving services for recipients. Since the project has followed these consistent policies it could be deemed has having relevance.

A re-evaluation was performed on this project since the demand for electric power fell as a result of the economic crisis (at the end of 1997). As a result it was decided that the scope of the project would be altered, and the number of substations to be built would be reduced while the existing power distribution installations and power distribution system would be improved (refer to 2.2.1 Output for details). The MEA has consistently pursued enlarging the power distribution network (volume) and improving the power distribution system (quality) since the time of the Eighth plan up to the present. This project has switched over from expanding volume to enhancing quality to correspond with the changing circumstances of the times. It could be said as a consequence of this, the project has maintained its relevance.

2.2 Efficiency

2.2.1 Outputs

The output of this project is as indicated in Table 1 below. As it was indicated in item 2.1 “Relevance,” the plan for this project underwent alterations owing to the effects of the economic crisis (refer to Table 1). The locations in which substations were to be installed changed considerably between the original plan and the revised plan. These alterations to the project came about as a result of the load factor analyses performed a second time on the substations due to the substantial change in the regional distribution in the demand for electric power caused by the economic crisis. As a specific example, demand predictions from before the economic crisis forecast that growth in demand would be significant for suburb regions relatively far from the central part of Bangkok. However, the result of the analyses from after the economic crisis showed a precipitous drop in demand in the suburbs, while conversely the drop in demand in the central areas of Bangkok was not as steep.

The location for the Nanglern substation was the same in the initial and the revised plans, but aside from that the sites for the facilities were changed. For substation installations which were constructed after the original plan had been altered only the Bangkapi substation was improved, and this was completed in February 2002. Substations other than this are scheduled to be constructed either from the ninth or 10th plan onward. These prove that the change in the plan after the determination that the urgency and level of priority for installing substations in the original plan had declined was, in hindsight, the correct thing to do.

There were a few changes between the revised plan and the actual ouput. Distribution lines were extended and supplies of various types of equipment (transformers, measuring equipment) were increased.

Table 1. Comparison of the Planned Output and Actual

Original plan	Revised Plan	Actual
(1) Improve primary substation: Bangkapi 69kV GIS	(1) Newly install primary substation: Vihavadi 230/69kV 2x300MVA	Same as left
(2) Newly install power distribution substations in 9 locations: Thakwian, Srithanya, Chalongkrung, Prawet, Taiban, Prompong, Nanglerng, Watyeesai, Saorahong	(2) Newly install power distribution substations in 3 locations: Klongmai, Nanglern, Yannawa	Same as left
(3) Improve and upgrade existing power distribution substations in 4 locations: Bangkapi, Dindaen, Thapyao, Klongparapa	(3) Repair existing power distribution substations in 3 locations: Samsen, Prakanong, Mochit	Same as left

(4) Lay down primary distribution lines: new installation of 500cct.km and improvement of 150cct.km	(4) Newly install and improve primary and secondary lines, purchase and install transformers and meters	Same as left, but distribution lines were extended and the amount of equipment was increased

Photograph 1: Substation control board

When taking the plan for this project into account, this project had a sector program-like characteristic. In other words, this project is considered a type of project that institutes numerous sub-projects in accordance with its objectives of enhancing the power distribution system and improving stability. In this project, the construction of substations served as a sub-project for the achievement of its objectives, yet it is not necessary that the locations in which substations are constructed are in accordance with the original plan. Rather, it is preferable that substations be constructed in appropriate locations according to the actual state of power demands. In order to leave deciding upon and altering subprojects to the discretion of the executing agency, as so for a sector program loan, the agency needs to be sufficiently furnished with the capacity to analyze the current conditions and that to alter subprojects accordingly. That the MEA is sufficiently furnished with such capacity for analysis and project planning was effectively demonstrated by the appropriateness of the aforementioned changes to the project scope for this project.

2.2.2 Project period

The plan was revised due to the significant drop in the demand for electric power. The economic crisis occurred after the signing of the loan agreement in September 1997. As a result of the change in the plan, procurement could not be initiated until the beginning of the year 2000. Issues such as compensation negotiation with residents in the vicinity of the Nanglern substation, the removal of the large quantity of buried debris at the construction site for the Yannawa substation, and the construction time to improve the soft ground at the Prakanong substation caused delays in implementation. However, the above issues were not unusual for an infrastructure project in urban area. The MEA coped with these problems by taking appropriate measures.

Table 2. Comparison of the Planned Period with Actual

	Original Plan	Revised Plan	Actual
Loan agreement	September 1997	Same as left	Same as left
Construction/equipment procurement procedures	October 1998-August 1999	September 2000-April 2001	January 2000-July 2000
Construction/equipment installation	April 1999-August 2000	December 1999-December 2001	January 2000-October 2002
Inspection/project completion	January 2000-November 2000	January 2001-December 2001	April 2001-April 2003

2.2.3 Project cost

The project cost changed along with the revisions to the scope of the project. There was an increase in the costs in the revised plan, which was mainly caused by the installation of a secondary power distribution system and the addition of meters and transformers. The project was implemented largely in line with the revised plan, but the actual cost dropped substantially. This was due to the bid price below projections. Intense competition, which might be caused by the sharp decline of public works following the economic crisis, led to the lower bid price.

Table 3. Comparison of the Planned Project Cost with Actual Performance

	Original Plan	Revised Plan	Actual
Total project cost (million yen)	23,954	29,485	10,707
Foreign currency (million yen)	14,304	14,301	6,617
Local currency (million baht)	2,032	4,686	1,486
Loan amount (million yen)	14,304	14,301	6,617

2.3 Effectiveness

2.3.1 Stability of the power supply

(Load Factor)

The average load factors for the seven primary substations and distributing substations which were newly installed, expanded, or improved are as indicated in the following table. The average load factor per year for the seven substations was at the level of 50%-77%, with none of the substations having a load factor that was

extremely high nor low. The substations constructed by this project are maintaining a sufficient rate of operation within a range that did not place an excessive load on their transmission capacity. Due to the above reason, it has been determined that the substations are in a satisfactory state of operation and are providing stable service (refer to Table 4).

Table 4. Average Load Factor of Targeted Substations

(Unit: %)

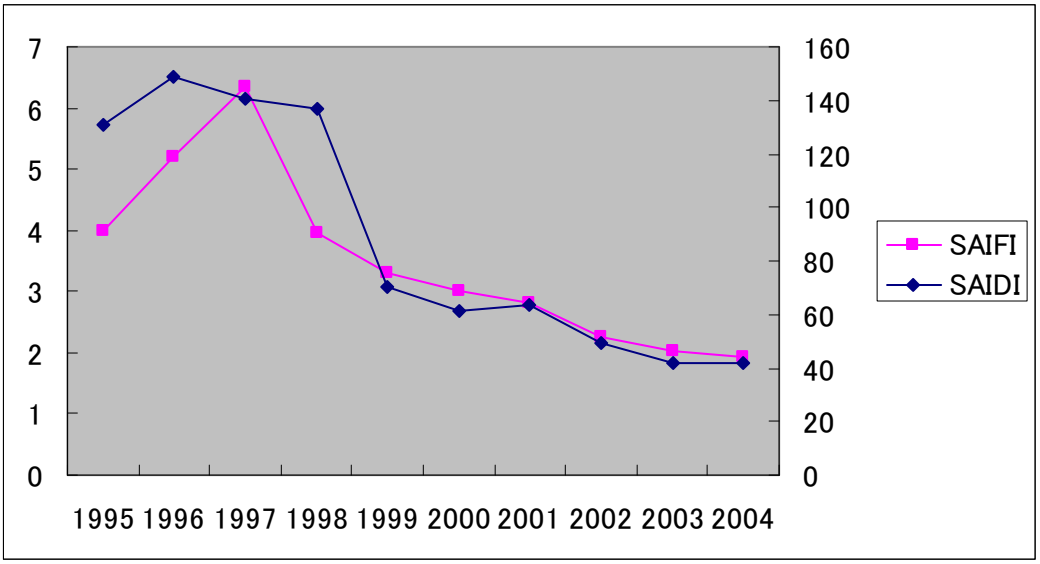
Substation/year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Vibhavadi (230kV)									47.21	49.70
Klongmai	66.58	63.81	63.06	62.82	65.01	59.33	65.49	65.20	71.69	77.23
Mochit	60.88	58.47	57.46	56.53	62.60	46.91	53.19	41.03	48.32	58.64
Nanlerng									59.73	50.08
Prakanong	60.68	61.02	61.04	57.91	55.21	58.89	60.47	56.86	60.62	55.67
Samsen	50.50	53.77	55.62	53.11	53.99	47.15	50.73	51.69	50.85	59.89
Yannawa									35.31	49.10

Source: MEA data

(SAIFI/SAIDI)

The table below indicates trends in the System Average Interruption Frequency Index (SAIFI) per subscriber per year and the System Average Interruption Duration Index (SAIDI) per year for the overall regions in which the MEA provides power distribution services.

Fig. 1 SAIFI and SAIDI Trends



Source: MEA data

Target figures for SAIFI and SAIDI in the Ninth Power Distribution System Plan were 2.831 in 2004 and 2.291 in 2007 for SAIFI, and 62.504 in 2004 and 50.404 in 2007 for SAIDI. The targets for both SAIFI and SAIDI were achieved in 2004.

The overall power distribution capacity of MEA in FY2004 was 14,145MVA. The total amount of transformers that this project installed in primary substations and in power distribution substations was 1,320MVA (9.3% of the total capacity of the MEA). It could therefore be said that this project contributed to achieving the planned targets for SAIFI and SAIDI to a certain extent.

(FIRR)

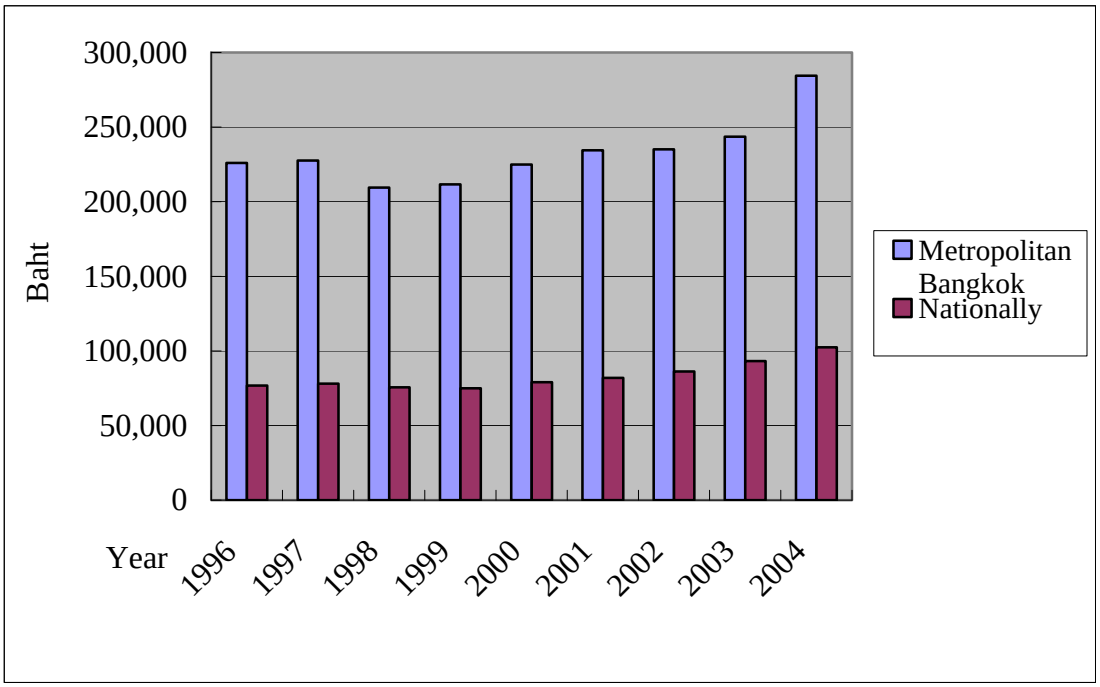
At the time of appraisal, a Financial Internal Rate of Return (FIRR) of 7.3% was calculated for this project. It is not possible to calculate returns from this project alone. As this project is a part of the power distribution system, it is impossible to calculate the Internal Rate of Return that is comparable with the FIRR in the appraisal, based on the cash flow solely of this project. In consideration of the aforementioned points, in this evaluation the rate of return was expediently calculated, using procedures described below. The investment cost was set as the total project cost, which is a sum of the ODA loan and counterpart funding (local currency). This investment cost comprised 5.35% of the MEA's fixed assets in 2003. As a result, 5.35% of the MEA's ordinary revenue (excluding depreciation) was assumed as returns generated by this project, and the return on investment was calculated under the premise that returns would be made consistent over a 30-year period. In other words, it had the same meaning as the calculation of the MEA's fixed asset rate of return, and the rate of return was 10.0%. Since the current interest rate for 10-year Thai government bonds was approximately 5.5%, it is reasonable to conclude that the investment in this project has produced adequate returns.

2.4 Impact

2.4.1 Contribution to economic growth

From 1999 to 2004, the per capita gross domestic product (GDP) of the Bangkok Metropolitan area rose from 211,609 baht to 284,447 baht (a 34.4% increase). The economic crisis of 1997 has been overcome and economic growth has continued, and it can be said that this power distribution system project also contributed to such growth.

Fig. 2 Trends in Per Capita GDP



Source: MEA data

2.4.2 Improvement of scenery

Implementation of the project to improve the scenery in Bangkok's downtown areas (Mahboonkrong and Suriwongse areas) was completed. All utility poles were removed and this has improved the scenery (in Mahboonkrong). In the Suriwongse area electric lines were buried, but since the telephone lines are still above ground it cannot be said that the scenery has been improved substantially.

2.4.3 PCB treatment

The treatment of Polychlorinated biphenyl (PCB) has been implemented every two to three years since 1991 at substation installations on machinery (transformers, etc.) contaminated with PCBs which are harmful for human. As of 2001, 335.7 tons of PCB had been treated. Currently tendering is being conducted on treatment work for the approximately 22 tons of transformers and capacitors which became unnecessary and were scrapped following the implementation of this project. Heretofore, the treatment contractor for all treatment has been determined by tendering. The treatment contractors are foreign contractors from the UK, Germany, and France who transport the PCB from Thailand and incinerate it. There are no special incinerators in Thailand.

2.4.4 Other impacts

While the project was being implemented, the MEA responded appropriately to the removal of neighboring houses and other building at the substation construction sites and to the compensation for residents. It also responded effectively to the issues of removing debris buried underground and improving the ground.

2.5 Sustainability

2.5.1 Executing agency

As a state-run enterprise under the Thai Ministry of Interior (MOI), the MEA distributes power to the districts under the Bangkok Metropolitan Administration and the two adjoining provinces (Samut Prakan Province and Nonthaburi Province), which is a region with a total surface area of 3,192km^2. The operation, maintenance, and management of facilities are carried out by the MEA's Operation Department, which is one of the company's five current divisions.

2.5.1.1 Technical capacity

The MEA has acquired sufficient experience in the maintenance and operation of distribution and transmission facilities. There have been no technical problems since the time the project was planned and no problems have arisen after the completion of the project. The MEA periodically and systematically conducts training aimed at engineers and is working to maintain and improve their technical capabilities.

2.5.1.2 Structure

The Operation Department has the Power System Control Department (PCD) operating the facilities, and the Power System Maintenance Department (PMD) maintaining them. Operation and maintenance of the facilities are carried out as planned.

The PCD has 594 employees, versus the 669 employees that were planned. The PMD has 368 employees, versus the 432 that were planned. The numbers of engineers and technicians do not meet the planned targets. While this is the result of the revisions to the plan due to the fall in the demand for electric power, no problems regarding operation and maintenance have been found, nor have there been any reports from the MEA to the effect of being short-staffed.

2.5.1.3 Financial status

The MEA has continued to post stable sales and operating income, and earnings before interest and tax (EBIT) stayed at a level in the range of three to four times that of interest fees. Due to this, it is readably concluded that there is sufficient earning to bear the debt service and that the financial status is highly stable. Moreover, a stable capital-to-asset ratio at around 40% continues. The balance

sheet also supports the conclusion that the financial status is healthy.

Table 5. Financial Status of the MEA[3]

(Unit: million baht)

	Sales	Operating Income	EBIT[4]	Interest Payment	Capital-to-Asset Ratio
2002	91,389	5,192	6,138	1,625	36.8%
2003	98,011	4,788	4,638	1,051	37.4%
2004	109,901	6,224	6,829	1,267	39.5%

Source: MEA Annual Report

2.5.2 Operation and maintenance

It has been confirmed through this evaluation that the maintenance and operation of the facilities and machinery installed through this project is well-conducted, and no problems have arisen.

3. Feedback

3.1 Lessons Learned

None

3.2 Recommendations

None

[3] The accounting period for the year 2002 was from October 1, 2001 to September 30, 2002, the accounting period for the FY 2003 was from October 1, 2002 to September 30, 2002, and the accounting period for 2004 was from January 1 to December 31.

[4] Earnings before interest and tax

Comparison of Original and Actual Scope

Item	Plan	Actual
(1) Output The power distribution system in Metropolitan Bangkok was improved	1) To improve a primary substation (1 location) - Bangkapi 69kV GIS 2) To newly install distributing substations (9 locations) - Thakwian, Srithanya, Chalongkrung, Prawet, Taiban, Prompong, Nanglerng, Watyeesai, Saorahong 3) To improve and upgrade existing distributing substations (4 locations) - Bangkapi, Dindaen, Thapyao, Klongparapa 4) To lay down or improve primary distribution lines - newly install 500cct.km and improve150cct.km	1) Primary substation improved (1 location) - Vihavadi 230/69kV 2x300MVA 2) Distributing substations newly installed (3 locations) - Klongmai, Nanglern, Yannawa 3) Distributing substations improved and upgraded (3 locations) - Samsen, Prakanong, Mochit 4) Primary and secondary distribution lines were laid down or improved, and transformers and meters were purchased and installed
(2) Project Period Loan agreement Construction/equipment procurement procedures Construction/equipment installation Inspection/project completion	 September 1997 October 1998-August 1999 April 1999-August 2000 January 2000-November 2000	 Same as left January 2000-July 2000 January 2000-October 2002 April 2001-April 2003
(3) Project Cost Foreign currency Local currency Total ODA Loan Portion Exchange rate	 14,304 million yen 9,650 million yen (2,032 million baht) 23,954 million yen 14,304 million yen 1 baht = 4.75 yen	 6,617 million yen 4,090 million yen (1,486 million baht) 10,707 million yen 6,617 million yen 1 baht = 2.75 yen

The exchange rate for actual performance is the average exchange rate from 2001 to 2003 (from MEA data).