Thailand

Transmission System and Substation Development Project

First Stage, Fourth Stage, Fifth Stage

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Field Survey: December 2004

1. Project Profile and Japan's ODA Loan

Central, North and Northeast Thailand

Mae Lao Substation
constructed under the project

1.1 Background

Thailand's economy took a turn for the better in the late 1980s. Thanks to the increase in direct investment from abroad, the country has been achieving rapid economic growth at an average rate of 10% a year since 1988. However, direct investment from abroad was concentrated in Bangkok and the surrounding area, and consequently the existing income disparity between the Bangkok Metropolitan Area and other regions has widened.

In order to improve the above-described situation, the Thai Government included regional development as important policies in the 6th National Economic and Social Development Plan (1987-1991), and promoted decentralization of industry from the Bangkok Metropolitan Area to the provinces as one of the policies. As a result, power demand sharply increased in regions other than the Bangkok Metropolitan Area where Provincial Electricity Authority (PEA) supplies electric power, recording an increase in power consumption at a rate of 16.8% on an annual average from 1987 to 1991. Although the power demand increase slowed down a little after 1992, power demand was predicted to increase at a high rate around 10% a year on average. Under such circumstances, the important task for the power sector in Thailand was to meet the increase in power demand in the provinces while ensuring a stable power supply and enhancing reliability of the transmission and distribution networks.

1.2 Objective

The project's objective was to cope with the sharply increasing power demand and securing a stable power supply in the Central, North, and Northeast Thailand, by constructing power transmission lines, substations etc., and thereby contributes to economic development, creation of employment opportunities, and promotion of electrification in the provinces.

1.3 Borrower/Executing Agency

Provincial Electricity Authority (PEA) (guaranteed by the Thai Government)/ Provincial Electricity Authority

1.4 Outline of Loan Agreement

	First Stage-1	Fourth Stage	Fifth Stage
Loan Amount Loan Disbursed Amount	7,246 million yen 7,025 million yen	5,292 million yen 5,292 million yen	8,474 million yen 8,004 million yen
Exchange of Notes Loan Agreement	September 1991 September 1991	September 1993 September 1993	September 1995 September 1995
Terms and Conditions - Interest Rate - Repayment Period (Grace Period) - Procurement	3.0% 25 years (7 years) General untied	3.0% 25 years (7 years) General untied	2.7% 25 years (7 years) General untied
Final Disbursement Date	July 2000	January 2001	April 2002
Contractors	ABB Transformers (Thailand) Bangkok Cable (Thailand) Paka Engineering (Thailand) etc.	Bangkok Cable (Thailand) Billiton Marketing (Thailand) Italian-Thai Industrial (Thailand) Panakit Kamai (Thailand) etc.	Hitachi Cable (Japan) Bangkok Technology Engineering (Thailand) BGES Engineering System (Thailand)
Consultant	—	—	—
Feasibility Study (F/S) etc.	Thailand: PEA(1989)	Thailand: PEA (1993)	Thailand: PEA (1995)

2. Results and Evaluation

2.1 Relevance

2.2.1 Relevance at the time of appraisal

At the time of the appraisal of this project, Thailand's "7th national Economic and Social Development Plan" (1992-1996) set the goal of reducing income disparities among regions in the country and emphasized the development of infrastructure in the provinces. In promoting regional development, there arose a strong need to meet the power demand

and ensure a stable power supply. “PEA Power System Development Plan” (1992-1996), which was made in line with the above-mentioned development plan, also set the aim of coping with the sharply increasing power demand. This project was to construct transmission lines, substations, etc. in regions other than the Bangkok Metropolitan Area (central, north, and northeast regions), and therefore was regarded as a high priority project consistent with those policies.

2.2.2 Relevance at the time of evaluation

At the time of this evaluation, the current “9th national Economic and Social Development Plan” (2002-2006) also emphasizes the importance of the development of infrastructure in the provinces. There remains a strong need to cope with power demand and ensure a stable power supply in regions other than the Bangkok Metropolitan Area, and “PEA Power System Development Plan” (2002-2006) also sets the aim of coping with power demand. Therefore, this project, which is consistent with the above-described policies, is of high priority.[1]

2.2 Efficiency

2.2.1 Output

Table 1 shows the plan for the construction of transmission lines and substations under the project and the actual output. As it shows, additional transmission lines and substations were constructed in the first stage (1) and the fourth stage of the project in order to accommodate the increase in power demand at a rate greater than estimated at the appraisal time. The actual output by region is shown in Fig.1.

Table 1. Planned and Actual Output

Plan (Appraisal)	Actual (Ex-post Evaluation)
＜First Stage-1＞ ①115kV transmission lines: 11 lines (231cct-km)[2] ②115/22kV substations: 9 (560MVA)[3] ③115kV switching station[4]: 3	 ①13 lines (273cct-km) ②17 (1,650MVA) ③As planned
＜Fourth Stage＞ ①115kVtransmission lines: 9 lines (315cct-km)	 ①13 lines (516cct-km)

[1] At present, the sixth stage (1) covering the central region (signing of L/A: September 1997; loan amount: 15,518 million yen) and the seventh stage (1) covering the north region (signing of L/A: March 2002; loan amount: 2,326 million yen) are being implemented.

[2] cct-km: a unit of measurement for the length of a power line (circuit) sending electricity

[3] VA: a unit of measurement for electric energy input in equipment such as transformers. As with W (watt) for workload, VA value is calculated by multiplying voltage V (volt) and electric current A (ampere). W indicates actually consumed energy (active power) whereas VA indicates the total of active and reactive power (the portion not consumed as energy).

[4] Switching station: a facility for sending electricity by opening or closing the circuit.

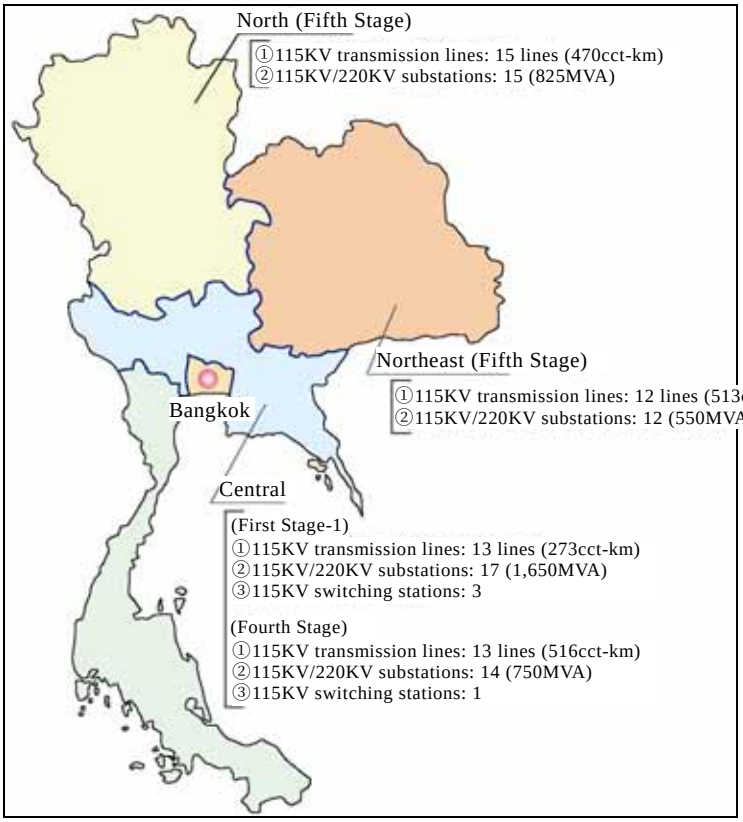
②115/22kV substations: 9 (450MVA) ③115kV switching station: 1	②14 (750MVA) ③As planned
＜Fifth Stage＞ ①115kVtransmission lines: 27 lines(978cct-km) ②115/22kV and 115/33kVsubstations: 27 (1,375MVA)	 ①26 lines (983cct-km) ②As planned

(For information) ＜First Stage-2＞ World Bank (Central Thailand)

＜Second Stage＞ German Development Bank (Kfw)(North and Northeast Thailand)

＜Third Stage＞ Kfw (South Thailand)

Fig. 1. Actual Output by Region



2.2.2 Project Period

The planned and actual project periods are shown in Table 2. As it shows, the periods of the first, fourth, and fifth stages were considerably extended. Main causes of the delay are: ①the time required for the coordination with authorities concerned (Department of Highways, the Ministry of Transportation and Communications, etc.); ②changes in the planned sites for the construction of substations and transmission lines; and ③the decrease in the cash position of contractors that resulted from the Asian economic crisis.

Table 2. Planned and Actual Project Periods

Plan (Appraisal)	Actual (Ex-post Evaluation)
＜First Stage-1＞ September 1991 – August 1995 (48 months)	September 1991 – February 2003 (138 months)
＜Fourth Stage＞ September 1993 – February 1997 (42 months)	September 1993 – March 2003 (115 months)
＜Fifth Stage＞ September 1995 – September 1998 (37 months)	September 1995 – May 2002 (81 months)

2.2.3 Project Cost

The planned and actual project costs are shown in Table 3. As it shows, the project costs of the first, fourth, and fifth stages were within the planned amounts. The reasons are ①efficient contracting through competition and ②depreciation of the local currency at a rate greater than the inflation rate.

Table 3. Planned and Actual Project Costs

Plan (Appraisal)	Actual (Ex-post Evaluation)
＜First Stage-1＞ 15,435 million yen (ODA Loan amount: 7,246 million yen)	13,446 million yen (ODA Loan amount: 7,025 million yen)
＜Fourth Stage＞ 11,962 million yen (ODA Loan amount: 5,292 million yen)	10,562 million yen (ODA Loan amount: 5,292 million yen)
＜Fifth Stage＞ 22,093 million yen (ODA Loan amount: 8,474 million yen)	17,322 million yen (ODA Loan amount: 8,004 million yen)

2.3 Effectiveness

2.3.1 Handling of the increase in power demand

Fig.2. Laeme Chabang Substation

Fig.3. Control Room in Substation

As a result of this project, power supply capacity has increased[5] to the level that can cope with the increasing power demand in the regions covered by the project. The maximum power[6] reached 5,906MW in the central region, 1,760MW in the north region, and 1,847MW in the northeast region in 2003 after the completion of the project. These amounts exceed the levels planned for the second year after the completion of the project (2000) at the time of appraisal (5,407MW for the central region, 1,636MW for the north region, and 1,642MW for the northeast region).

The power generation at the sending end increased to 39,063GWh in the central region, 9,900GWh in the north region, and 9,716GWh in the northeast region in 2003 after the completion of the project. As with the maximum power, these amounts exceed the levels planned at the time of appraisal (33,805GWh for the central region, 7,665GWh for the north region, and 7,722GWh for the northeast region), indicating that the project produced satisfactory results (see Fig.4-1, 2 and 3).

The number of beneficiaries of this project[7] is estimated to be approx. 2.09 million in the central region, 2.3 million in the north region, and 2.54 million in the northeast region.

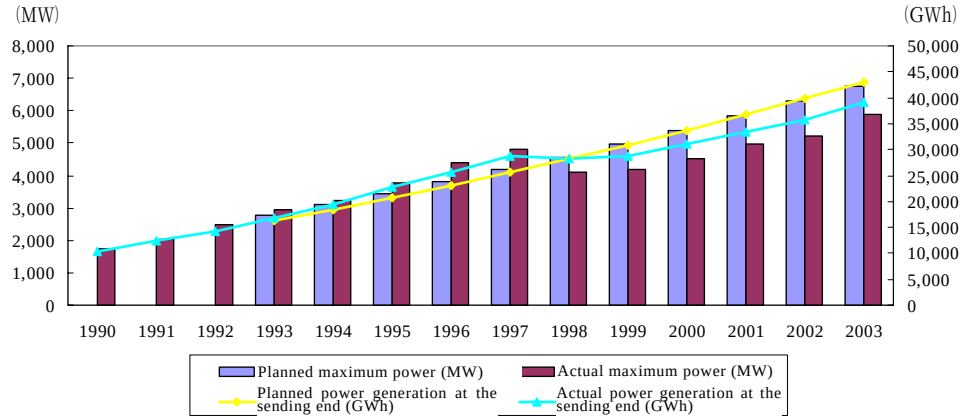
[5] The power supply capacity (the total installed capacity of transformer substations) in the central, north, and northeast regions in 2003 was 11,480 MW, 4,366 MW, and 4,681MW respectively (the installed capacity of the substations constructed under this project is 2,400MW in the central region, 825MW in the north region, and 550MW in the northeast region).

[6] The maximum power is the highest peak demand, or the greatest amount of electricity used in the year.

[7] These numbers were calculated by multiplying the population of each region (as of 2002) by the ratio of the installed capacity of the substations constructed under the project against the total installed capacity of all substations in the region.

Fig. 4-1. Changes in Maximum Power and Power Generation at Sending End (1990-2003)

Central Thailand



Source: PEA (same for the following figures)

Fig. 4-2. Changes in Maximum Power and Power Generation at Sending End (1990-2003)

North Thailand

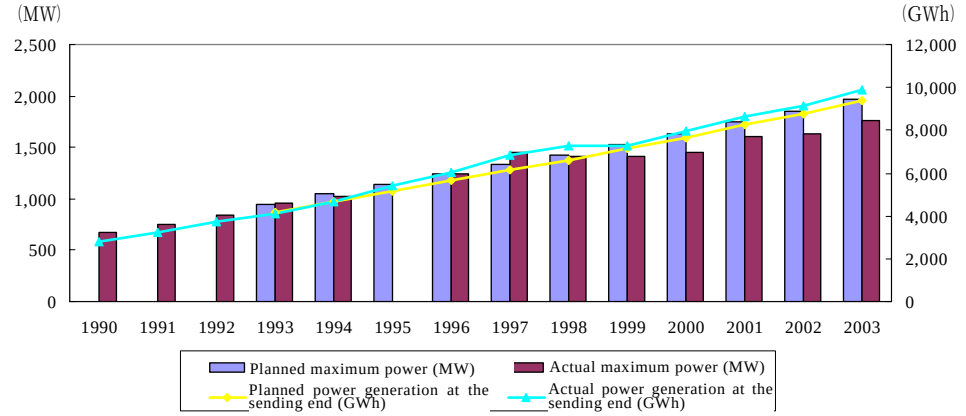
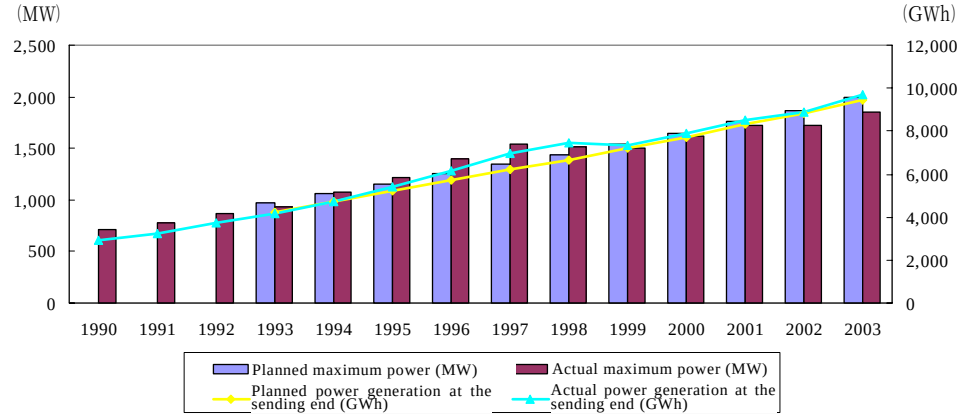


Fig. 4-3. Changes in Maximum Power and Power Generation at Sending End (1990-2003)

Northeast Thailand



On the other hand, the capacity utilization rate is lower than the planned 75.0% in all

regions due to the decline in power demand caused by the Asian Economic Crisis: 67.3% in the central region; 47.5% in the north region; and 46.7% in the northeast region. However, as the power demand started to pick up recently, the capacity utilization rate is expected to increase in the future.

2.3.2 Stabilization of power supply

As shown in Table 4, reliability of the power supply improved after the implementation of this project, and both the number and duration of power failures (per user) were reduced.

Table 4. Number and Duration of Power Failures (per user)

Year	Number of Power Failures (cases/year-user)			Duration of Power Failures (minutes/year-user)		
	Central	North	Northeast	Central	North	Northeast
1996	15.0	19.5	16.1	873.7	1,487.2	1,332.5
2001	10.8	17.2	15.3	544.8	958.5	846.5
2002	11.0	15.7	14.7	543.9	851.7	849.1
2003	12.8	13.2	14.5	606.1	738.8	910.1
2004	10.0	12.7	12.7	419.6	615.4	740.5

Source: PEA

Also, as shown in Table 5, the transmission and distribution loss rate is on the decline, almost achieving the value planned at appraisal for the second year after the completion of the project (2000) (4.7% for the central region, 7.3% for the north region, and 9.0% for the northeast region).

Table 5. Transmission and Distribution Loss Rate (%)

Year	Central	North	Northeast
1996	5.1	10.4	10.3
2001	4.3	7.6	8.4
2002	4.4	7.4	8.5
2003	4.0	7.4	8.3

Source: PEA

2.3.3 Recalculation of Financial Internal Rate of Return (FIRR)

At the time of appraisal, Financial Internal Rate of Return (FIRR) was calculated based on the income from the sale of electricity as the benefits, and the project cost, investment in associated distribution facilities, and operation and maintenance cost as the cost. Recalculation of FIRR for ex-post evaluation based on the same assumptions resulted in values exceeding the planned values for all of the first, fourth, and fifth stages (Table 6). The main reasons for the increase in FIRR are that ① the project cost was reduced, and that ②a greater amount of electricity than planned was sold.

Table 6 FIRR Estimated at Appraisal Time and Actual Results

	Estimation (Appraisal)	Actual (Ex-post Evaluation)
First Stage-1	8.6%	21.5%
Fourth Stage	10.6%	19.6%
Fifth Stage	10.5%	18.0%

2.4 Impact

2.4.1 Promotion of regional development (other than the Bangkok Metropolitan Area)

This project contributed to facilitating economic development in regions other than the Bangkok Metropolitan Area by stabilizing the power supply. The project also contributed to the improvement of business activities in these regions by addressing the increase in power demand and improving reliability of the power supply.

In the eastern coastal area of the central region where the first stage (1) and fourth stage of project were implemented, the maximum power increased from 789MW in 1993 to 2,723MW in 2003. As evidenced by the fact that the installed capacity of the substations constructed under the project accounts for 19.5% of the total in the central region, the project contributes significantly to meeting power demand.

Fig.5 The interviewed company in the eastern coastal area

In the interview with companies in Laeme Chabang and Maptaphut Industrial Estates located in the eastern coastal area, they expressed their view that the improvement and expansion of power supply facilities including that of this project supports economic development in the eastern coastal area. Actually, while Thailand's average economic growth rate from 2000 to 2003 was 4.5%, Chachoengsao, Chon Buri, and Rayong Provinces, where the eastern coastal area extends, recorded high growth rates varying from 6.5% to 8.7% during the same period.

In the north region where the fifth stage of the project was implemented, the interviewed small and medium size enterprises said that the frequency and duration of power failures decreased significantly after the completion of the project, and the environment for business has been improved considerably.

2.4.2 Creation of employment opportunities

With the growth of the regional economy described above, additional employment opportunities were created in these regions. The unemployment rates in the eastern coastal industrial areas in the central region (as of 2003) were between 0.7% and 1.5%,

lower than the national average of 1.5%[8].

2.4.3 Contribution to regional electrification

Construction of transmission lines, substations, etc. under this project helped facilitated electrification in rural areas. As shown in Table 7, the village electrification rates and household electrification rates in each region increased after the completion of the project. According to the PEA's branch office in the central region, which we visited for this evaluation, there is a case where the expansion of regional electrification led to the development of tourism to an island.

Table 7. Changes in Village Electrification Rate and Household Electrification Rate (%)

Year	Central Region		North Region		Northeast Region	
	Village Electrification Rate	Household Electrification Rate	Village Electrification Rate	Household Electrification Rate	Village Electrification Rate	Household Electrification Rate
1991	97.4	—	92.2	—	95.8	—
1994	98.6	89.1	94.5	84.3	99.5	89.7
2004	99.7	98.5	97.9	96.1	99.9	96.3

Source: PEA

2.5 Sustainability

2.5.1 Executing Agency

2.5.1.1 Technical Capacity

The executing agency PEA is equipped with the technical capacity required for the operation and maintenance of the project and has no problem. With the objective of having the operation and maintenance staff acquiring technical knowledge and an enhanced technical level, PEA provides training programs on the power transmission and transforming techniques, computer software techniques, safety management, and other fields.

2.5.1.2 Operation and Maintenance System

Power generation and transmission to primary substations are controlled by Electricity Generation Authority of Thailand (EGAT). PEA purchases electricity from EGAT and transmits and distributes it to each region[9] other than the Bangkok Metropolitan Area[10]. PEA is under the control of the Ministry of Interior, and it must obtain the Ministry's

[8] The data on unemployment rate by National Statistical Office Thailand do not include laid-off workers and therefore the unemployment rate tends to be lower than those of other countries.

[9] PEA's supply area is 510,000 km^2, occupying 99% of entire Thailand. The supply area is divided into 4 service areas of north, northeast, central, and south each of which is operated and maintained by 3 branch offices, 12 branches in total.

[10] Power transmission and distribution in the Bangkok Metropolitan Area are carried out by Metropolitan Electricity Authority (MEA).

approval in determining important matters such as the capital investment plan.

In the electric power sector in Thailand, marketing reform is now being considered. There is a plan for PEA as well as EGAT and MEA to offer shares to the public, though it has yet to proceed as of May 2005.

2.5.1.3 Financial Status

Although the sales in the years from 2001 to 2003 after the completion of the project are over 3 times as much as those in 1991 and 1992 before the project was implemented, the operating income and the net income remain almost unchanged (Table 8). The equity ratio is maintained at a satisfactory level. Thus, there is no problem with the sustainability of the project in terms of finance.

Table 8. Financial Indicators (unit: million bahts)

	Sales*	Operating Income*	Net Income*	Equity Ratio
1991	35,304	4,549	5,807	30.5%
1992	40,201	6,339	7,661	35.8%
2001	132,772	5,174	5,715	34.1%
2002	148,751	4,939	6,064	34.3%
2003	164,364	6,817	6,013	34.5%

Source: PEA

2.5.2 Operation and Maintenance Status

As confirmed with the executing agency for evaluation, there is no problem with the operation and maintenance of transmission lines, substations, or switching stations constructed under the project.

3. Feedback

3.1 Lessons Learned

None

3.2 Recommendations

None

Comparison of Planned and Actual Scope

Item	Plan	Actual
①Output		
First Stage (1)	①115kV transmission lines: 11 lines (231cct-km)	①13 lines (273cct-km)
	②115/22kV substations: 9 (560MVA)	②17 (1,650MVA)
	③115kV switching stations: 3	③As planned
Fourth Stage	①115kVtransmission lines: 9 lines (315cct-km)	①13 lines (516cct-km)
	②115/22kV substations: 9 (450MVA)	②14 (750MVA)
	③115kV switching station: 1	③As planned
Fifth Stage	①115kVtransmission lines: 27 lines (978cct-km)	①26 lines (983cct-km)
	②115/22kV and 115/33kV substations: 27(1,375MVA)	②As planned
②Project Period		
First Stage (1)	Sep. 1991 – Aug. 1995 (48 months)	Sep. 1991 – Feb. 2003 (138 months)
Fourth Stage	Sep. 1993 – Feb. 1997 (42 months)	Sep.1993 – Mar. 2003 (115 months)
Fifth Stage	Sep. 1995 – Sep. 1998 (37 months)	Sep. 1995 – May 2002 (81 months)
③Project Cost		
First Stage (1)		
Foreign Currency	7,246 million yen	7,025 million yen
Local Currency	8,189 million yen (1,545 million bahts)	6,421 million yen (1,618 million bahts)
Total	15,435 million yen	13,446 million yen
ODA Loan Portion	7,246 million yen	7,025 million yen
Exchange Rate	1 baht＝5.3 yen (as of January1991)	1 baht＝3.97 yen (1991-2003 average)
Fourth Stage		
Foreign Currency	5,292 million yen	5,292 million yen
Local Currency	6,670 million yen (1,509million bahts)	5,270 million yen (1,509million bahts)
Total	11,962 million yen	10,562 million yen
ODA Loan Portion	5,292 million yen	5,292 million yen
Exchange Rate	1 baht＝4.42 yen (as of June 1993)	1 baht＝3.49 yen (1993-2003 average)
Fifth Stage		
Foreign Currency	8,474 million yen	8,004 million yen
Local Currency	13,619 million yen (3,762million bahts)	9,318 million yen (3,148million bahts)
Total	22,093 million yen	17,322 million yen
ODA Loan Portion	8,474 million yen	8,004 million yen
Exchange Rate	1 baht＝3.62 yen (as of May 1995)	1 bath＝2.96 yen (1995-2002 average)