

Thailand

The Sirikit Hydroelectric Project Unit 4

Report Date: September, 2002

Field Survey: February, 2002

1. Project Profile and Japan's ODA Loan



Site Map : Thailand



Site Photo : Control Board of Unit 4

1.1 Background

The Sirikit Dam and Hydropower Plant are located on the Nam River in the Tha Pla district, Uttaradit Province, in northern Thailand, approximately 500 km north of Bangkok. The main dam and saddle dikes were constructed from 1968 to 1972. At the same time, the Electricity Generating Authority of Thailand (EGAT) undertook the construction of a hydropower plant and its facilities. The Sirikit Hydropower Plant started operations in 1974 with three 125 MW hydroelectric generating units. The Plant was built with a fourth bay to accommodate further expansion, ultimately raising generating capacity from 375 MW to 500 MW.

In the context of national development policy emphasized in the Seventh National Economic and Social Development Plan (1992 – 1996), an increase of power generation capacity was given priority. With increasing demand for electricity, it was also necessary to secure appropriate reserves, especially for peak hours.

1.2 Objectives

To meet Thailand's increasing power demand, especially during the peak hours, by installing one hydropower generating unit with conventional type at Sirikit Hydropower Plant. The following benefits were expected:

- (1) Ability to supplement the existing three generating units (each of 125 MW) with an additional 125 MW to generate peak power output of 500 MW at Sirikit Plant;
- (2) Creation of a stand-by plant to fill in emergency situations, as when EGAT's power plants are out of service due to routine maintenance or forced outage

1.3 Project Scope

The project scope consisted of the following works.

- Preliminary works such as construction of administration buildings and temporary utilities facilities
- Civil works for turbine, generator, and switchyard
- Procurement and installation of hydraulic equipment, electromechanical equipment, switchyard and

miscellaneous items
Consulting services

1.4 Borrower/Executing Agency

Electricity Generating Authority of Thailand (EGAT)

1.5 Outline of Loan Agreement

Loan Amount	4,404 million yen
Loan Disbursed Amount	2,600million yen
Exchange of Notes	December 1992
Loan Agreement	January 1993
Terms and Conditions	
Interest Rate	3.0 % p.a.
Repayment Period (Grace Period)	25 years (7 years)
Procurement	General Untied
Final Disbursement Date	May 1998

2. Results and Evaluation

2.1 Relevance

This project matched the policy objectives set out in the Seventh National Economic and Social Development Plan (1992-1996), which was available at the time of appraisal. Those policy goals have been maintained in the current Eighth National Economic and Social Development Plan (1997-2001), which discusses the importance of investing to increase capability to generate reserved electricity, establishing reliability standards for the power system, and improving electricity generation and distribution.

As the Government of Thailand places a high priority on hydropower generation in order to cope with the increasing power demand, especially during peak hours, this project is considered relevant at the time of post evaluation.

2.2 Efficiency

2.2.1 Project Scope

The project was completed without any revision or modification of the original plan.

2.2.2 Implementation Schedule

The project was completed ahead of schedule, and Unit 4 commenced supplying hydroelectric power to the grid in October 1995, one month ahead of schedule.

2.2.3 Project Cost

The actual total project cost was equivalent to 4,323 million yen, compared to the original estimate of 5,873 million yen. This under-run can be attributed to the low procurement cost of Hydro-Electric-Mechanical Equipment, realized through keen competition in bidding.

From the standpoint of the project scope, project schedule and project cost, and considering the performance of the consultant, contractors and suppliers, this project was efficiently executed.

2.3 Effectiveness

2.3.1 Volume of Production

The generation capacity of Unit 4 as 125 MW (Rated Capacity) at commissioning in 1995, a level which has been maintained through proper preventive maintenance and regular inspection up to the time of post evaluation. Unit 4's ability to respond to peak power demand has been maintained.

Note: A power outage lasting 46 hours in 2001 was caused by the malfunction of the hydraulic system. The mechanical trouble was solved by a replacement of mechanical parts.

The volume of actual production from FY1996 to 2001 fluctuated from 120 to 410 GWh/year, and of the plant's utilization factor ranged from 11 to 37%, as shown in Table 1. The relatively low production and utilization factor during FY1997 ~2000 was due to decreased demand by economic crisis, not to matters inside Sirikit Hydropower Station.

Table 1: Generation and Operation Indicators

Fiscal Year	1994	1995	1996	1997	1998	1999	2000	2001
Unit 4 (this Project)								
1) Generation Capacity (MW)			125	125	125	125	125	125
2) Gross Production (GWh/year)			406.593	147.155	173.731	116.887	233.839	352.048
3) Utilization Factor (%)			37.1	13.4	15.9	10.7	21.3	32.2
4) Outage Hours (hours / year)			0	18	0	0.4	4	46
Unit 3 (existing unit)								
1) Generation Capacity (MW)	125	125	125	125	125	125	125	125
2) Gross Production (GWh/year)	114.330	422.830	308.770	307.470	195.110	113.400	243.460	380.360
3) Utilization Factor (%)	10.4	38.6	28.2	28.1	17.8	10.4	22.2	34.7
4) Outage Hours (hours / year)	0	27	452	0.0	4	0.3	0.1	21
Unit 2 (existing unit)								
1) Generation Capacity (MW)	125	125	125	125	125	125	125	125
2) Gross Production (GWh/year)	99.080	457.880	419.820	217.640	190.100	117.730	236.930	391.970
3) Utilization Factor (%)	9.0	41.8	38.3	19.9	17.4	10.8	21.6	35.8
4) Outage Hours (hours / year)	0	1	9	0	1	3	1	1
Unit 1 (existing unit)								
1) Generation Capacity (MW)	125	125	125	125	125	125	125	125
2) Gross Production (GWh/year)	105.180	446.270	415.840	254.080	159.590	99.800	228.980	356.240
3) Utilization Factor (%)	9.6	40.8	38.0	23.2	14.6	9.1	20.9	32.5
4) Outage Hours (hours / year)	0	0	0	0	0	0	0	0
Sirikit Whole Units								
1) Generation Capacity (MW)	375	375	500	500	500	500	500	500
2) Gross Production (GWh/year)	318.590	1,326.980	1,551.023	926.345	718.531	447.817	943.209	1,480.618
3) Utilization Factor (%)	9.7	40.4	35.4	21.1	16.4	10.2	21.5	33.8
4) Outage Hours (hours / year)	0	28	461	18	5	4	5	68
5) Net Production (Gwh.year)	315.064	1,323.479	1,547.039	922.337	714.869	444.389	939.757	1,476.176

Note: Generation Capacity: Rated Capacity, i.e. 125 MW/Unit

Utilization Factor = "Gross Production" ÷ (Generation Capacity x 24 x 365)

Outage Hour: Outage hours due to troubles

Fiscal Year 2001: from October 1999 to September 2000

Source: Electricity Generating Authority of Thailand (EGAT)

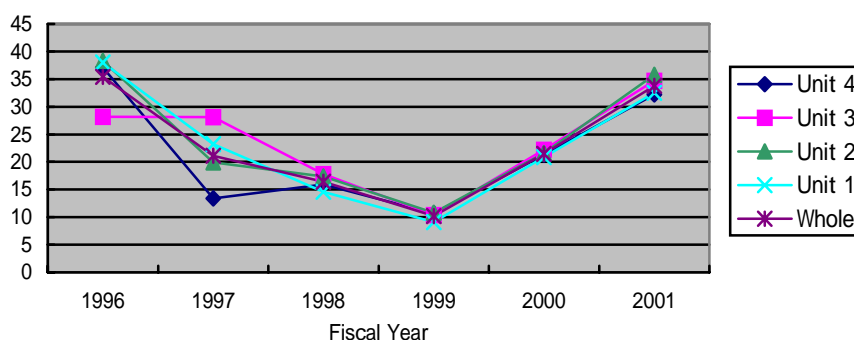
2.3.2 Function of Sirikit Hydropower Plant

The Sirikit Hydropower Plant is generating power under the order of Load Dispatch Center located in Bangkok. There is only one load dispatch center in entire Thailand and it is operated by EGAT.

The power generated at the Sirikit Plant is transmitted to Phitsnulok substation at 230 kV and Uttaradit substation at 115 kV. The transmission distance to each station is 110 km and 60 km, respectively.

Unit 4 is operated in the same manner as Units 1, 2 & 3, all of which have similar yearly utilization patterns, as illustrated in Figure 3.

Figure 3: Utilization Factor (%)



Source: Electricity Generating Authority of Thailand (EGAT)

2.3.3 Recalculation of Financial Internal Rate of Return (FIRR)

Based on data and other information provided by EGAT at the time of post evaluation, the recalculated Financial Rate of Return is 11.2%, compared to 14.3 % at the time of appraisal.

Note: The reason for this difference cannot be analyzed since the bases for the original calculation are not available.

The expectations for this project, generation, stand-by role and efficient operation, were all realized.

2.4 Impact

2.4.1 Reliability of Electricity Supply

The reserve margin, defined as “system capacity / peak load”, is one of important parameters for measuring the reliability of electricity supply. Under the lower reserve margin, there is a possibility to make a fluctuation of voltage and/or frequency, and sometime raise a black out or brown out of the electricity supply. Therefore, maintaining a certain reserve margin is essential to assuring a quality electricity supply.

Peak load, system capacity and reserve margin figures for the entire country, from 1991 to 2001, are shown in Table 2. And the actual reserve margins in previous years below are more or less bigger than the minimum requirement of 15% in “Recommended Plan” and 20% in “Alternative Plan” as described in the Power Development Plan (PDP) 2001. PDP2001 also forecasts reserve margins, as illustrated in Figure 4.

This project, by adding 125 MW of hydropower generation capacity, is considered to have contributed to improving reserve margins.

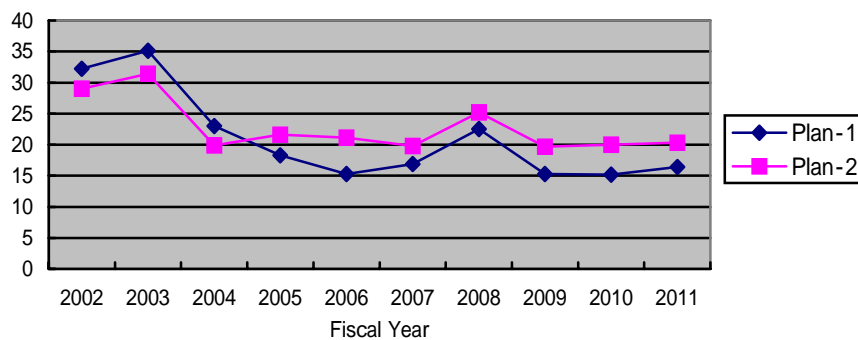
Table 2: Peak Load, System Capacity and Reserve Margin

Fiscal Year	Peak Load (MW)	System Capacity (MW)	Reserve Margin (%)
1991	8,045.00	9,629.56	19.70
1992	8,876.90	11,044.56	24.42
1993	9,730.00	12,185.88	25.24
1994	10,708.80	12,956.15	20.99
1995	12,267.90	14,659.15	19.49
1996	13,310.90	15,725.30	18.14
1997	14,506.30	16,966.90	16.96
1998	14,179.90	17,935.30	26.48
1999	13,712.40	19,097.70	39.27
2000	14,918.30	21,074.00	41.26
2001	16,126.40	22,034.80	36.64

Note: Reserve Margin = (“System Capacity” ÷ ”Peak Load” – 1.00) x 100

Source: Electricity Generating Authority of Thailand (EGAT)

Figure 4: Forecast of Reserve Margin (%)



Note: Plan-1 is Recommendable Plan in PDP2001

Plan-2 is Alternative Plan in PDP2001

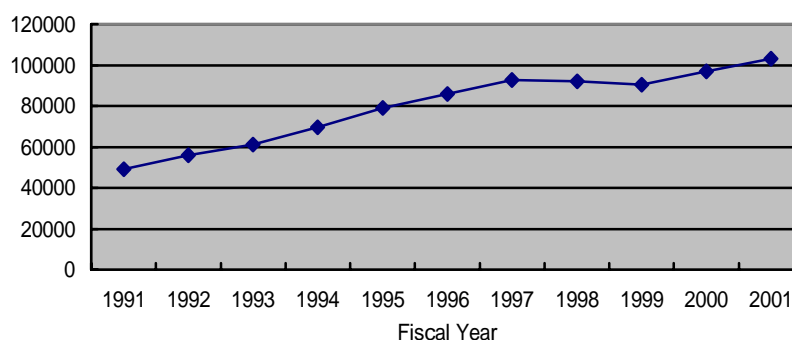
Source: Electricity Generating Authority of Thailand (EGAT)

2.4.2 Growth of Power Demand

The overall economy continued to recover gradually through fiscal year 2000, resulting in a rise in electricity demand at a rate close to that forecast. The trend in power consumption is shown in Figure 5. The gross power generation in fiscal year 2000 grew 7% to 96,780.72 GWh, and the peak generation requirements for that year reached 14,918.30 MW, a 9% increase over the previous year. The country’s installed generating capacity increased 17% that year to 22,269.00 MW, comprising 77% from EGAT’s own generation facilities and 23% from private power producers. The capacity of EGAT’s power plants and private power producers grew 11% and 39%, respectively, from the prior year.

Although the rated capacity of Unit 4 represents only 0.7% of the EGAT’s own installed generating capacity as of 2000, this project is considered to have contributed to respond to the rapid growth of power demand.

Figure 5: Growth of Power Consumption (GWh)



Source: Electricity Generating Authority of Thailand (EGAT)

2.4.3 Importance of Hydropower

With regard to fuel used in Thailand, fuel oil-based generation was reduced by 28% and diesel oil-based generation by 78% due to oil price hikes. More natural gas and hydropower were utilized instead. Energy mix in fiscal year 2000 consisted of 37% from natural gas, 16% from lignite, 5% from hydropower, 12% from fuel oil, and 0.16% from diesel oil. 30% of electricity was purchased from private power sources. Compared with the prior year, energy portion from natural gas and hydropower increased 9% and 54% respectively whereas the portion from fuel oil, diesel oil and lignite decreased 28%, 78% and 1% respectively.

From the above, the importance of hydropower generation should be noted.

2.4.4 Impact on Environment and on Local Residents

This project expanded the production capacity of the existing Sirikit Hydropower Plant by one unit. No negative impacts on the environment or on local residents have been reported from either the head office of EGAT or the Sirikit Hydropower Plant.

2.5 Sustainability

2.5.1 Operation and Maintenance

The Electricity Generating Authority of Thailand (EGAT), a government organization, is the agency responsible for the operation and maintenance of the Sirikit Hydroelectric Power Station. Actual management of operation and maintenance is taken care of by the Sirikit Dam Division, headed by a division manager who reports to the deputy governor for hydro plant in EGAT. The dam division, with a total of 143 personnel, consists of an Operation Department, with 45 people (5 engineers, 9 chief operators and 31 operators), and a Maintenance Department, with 97 people (7 engineers, 40 skilled workers and 50 technicians).

Sirikit Dam Division manages operation and maintenance works in accordance with the operation and maintenance manuals and holds training programs for both operator and maintenance staff.

To maintain the performance of hydropower generation as well as plant reliability, large-scale renovation and inspection are carried out in accordance with EGAT standards from the beginning of Unit 1 operation according to the following schedule:

	Start	Finish
Renovation of Unit 3	01/10/2001	31/08/2002
Replacement of Runner Vane in Unit 4	03/05/2002	07/05/2002
Renovation of Unit 2	01/09/2002	30/06/2003
Minor Inspection Unit 4	04/01/2003	18/01/2003
Renovation of Unit 1	01/07/2003	30/04/2004
Warranty Inspection of Unit 3	01/08/2004	30/08/2004
Warranty Inspection of Unit 2	01/06/2005	30/06/2005

Preventive inspection is carried out on a minor scale every two months, when plant operations are stopped for three hours, and the inside of two inlet water pipes are inspected every year.

Major, minor and consumable spare parts are stocked in a warehouse near the plant site, and the division has its own maintenance shop near the plant site.

2.5.2 Technical Capacity

EGAT established a Center of Excellence for Hydro Plant (CEHP), the first such center inside EGAT, at the Bhumibhol Power Plant in January 2000. Its mission covers the operation and maintenance of all hydroelectric generation plants managed by the deputy governor of hydro plant.

The objectives of this center are to collect data, spread knowledge, improve technology and experience relating to the operation and maintenance of hydroelectric generation plants and to establish knowledge, improve training courses and increase manpower to strengthen EGAT.

The following specific targets were given to the center :

- (1) Development of manpower for operation and maintenance of hydro plant in order to support the energy production from 1999-2002.
- (2) Collecting and gathering knowledge and experiences as well as development of a knowledge storing system in operation and maintenance to be completed within the year 2001.
- (3) Improvement of the international level instructor of the Hydro Plant Technology from 1999-2001 to be promoted for the training service in operation and maintenance of hydro plant in 2002.
- (4) Proceeding the project for development of Center of Information, Skill and Knowledge for Energetic Industry to be completed all system including analysis of the training need for the provincial level to be completed within 2000.
- (5) Establishment of a research and development unit within the center to promote research work, establish the knowledge of operation and maintenance of hydro plant from the year 2002 forward.

2.5.3 Financial Status

As shown in Table 3, electricity sales revenue of EGAT increased during the 1996-1998 period, when net incomes were positive. In 1999, net profit decreased sharply, turning negative. This was due to foreign exchange losses and a decrease in electricity sales revenue from the industrial sector, which was heavily affected by the economic recession. Net profit, however, became positive again in 2000 as revenues increased.

Table 3: Highlight of Financial Indicators

(Unit: Million Baht)

	1996	1997	1998	1999	2000
Operating Revenue	108,835	125,376	146,572	134,335	160,992
Operating Expenses	81,742	112,548	126,262	158,596	140,817
Net Income	27,093	12,828	20,310	-24,261	20,175
Total Assets	295,976	316,060	358,445	396,362	434,411

Comparison of Original and Actual Scope

Item	Plan	Actual
Project Scope (1) Preliminary Works (2) Civil Works (3) Procurement of Equipment (4) Installation Works (5) Consulting Service	(1) Works prior to the start of project (2) Pit for turbine and generator (3) Hydraulic, electro-mechanical and switch yard and others (4) Major equipment and others (5) Relating to engineering works	(1) - same as Plan - (2) - same as Plan - (3) - same as Plan - (4) - same as Plan - (5) - same as Plan -
Implementation Schedule (1) Tender Document (2) Preliminary Works (3) Civil Works (4) Procurement and Installation (5) Commissioning	Dec.1991 – Mar.1993 Jul. 1991 - Jun 1993 Jan 1994 - Nov. 1995 Apr.1993 - Sep.1995 Aug.1995 - Nov.1995	Feb.1991 - Oct.1991 Jul.1991 - Jun 1993 Mar.1993 - Jul.1995 Apr.1993 - Jul.1995 Jun 1995 - Oct.1995
Project Cost Foreign Currency Local Currency Total ODA Loan Portion Exchange Rate	4,427 Million Yen 1,446 Million Yen (283 Million Baht) 5,873 Million Yen 4,404 Million Yen 1 Baht = 5.1 Yen (as of June 1992)	3,219 Million Yen 1,104 Million Yen (257 Million Baht) 4,323 Million Yen 2,600 Million Yen 1 Baht = 4.3 Yen (average from June 1993 to March 1996)

Indepent Evaluator's Opinon on The Sirikit Hydroelectric Project Unit 4

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1. Relevance

The project is relevant to the national policy goals. Due to rapid increase of electricity demand, the unit 4 generates additional 125 MW of hydropower to meet the peak demand and to maintain the reserve margin as required by the Power Development Plan

2. Impact

The project capacity to secure the reserve margin is considered to have positive contribution to reliability of power supply. Even though no negative impact on the environment or on local residents due to the expansion of production capacity of the Sirikit Hydropower Plant by Unit 4 was reported, a study on quality of life of the relocated people and of those who live in the original area after 25 years of construction of the Sirikit Dam was conducted in 1998. It is important to point out about the findings that both groups are satisfied with the physical aspects of their households and their life. About 55 percent of people who continue living in the original area and only 26 percent of the relocated people reported that they have their family members living in the same village. The relocated people have a higher and more secure income whereas those who live in the original area earned their extra income from working temporarily for EGAT forest growing project until the project ended in 2001. Of the 39 government's basic need indicators in the year 1997, people in the original area met the minimum requirement on 16 items, whereas those relocated people met on 18 items. Therefore the quality of life of both groups was not much different.

At the time of the study, EGAT has been working on several projects to improve their quality of life. Examples of the projects are : water supply system for both domestic consumption and irrigation, fishery project, forest planning project, career training project and monthly community medical service in order to establish interaction with local people, to learn about their problems and to help solving the problem by giving advice, providing thinking and demonstrating so that the local people can do it by themselves.

However, those who live in the original area feel happier because of close family relation and possibility to seek help from their relatives who live in the same village whenever needed. Similarly the relocated people feel lonely and lack social safety net, although they are economically better off.

3. Sustainability

Technical capacity for operation and maintenance can assure reliable performance of the project despite the growth of power demand following the economic recovery in the next few years.

4. Recommendation

Improvement of quality of life of the local people should be continued. The projects carried out by EGAT are justified to help increasing income of the poor and solving problems of both groups.