

(On-site Evaluation: June 2006)

Ex-Post Monitoring for Completed ODA Loan Projects

External Evaluator: Atsushi Tokura (IC Net, Ltd.)

Project Name: Myanmar “Gas Turbine Power Station Project (Yangon)” (L/A No. B-P-42)

[Loan Outline]

Loan Amount/Disbursement Amount: 5,000 million yen/4,926 million yen

Loan Agreement: May 1986

Loan Completion: May 1991

Ex-Post Evaluation: FY1996

Executing Agency: Myanmar Electric Power Enterprise (MEPE)

Project Objective

Project Objective: By constructing a gas turbine power station with a capacity of approx. 60MW in the Thaketa district of Yangon (formerly Rangoon), this project aims to accommodate rapidly rising power demand and the need for power supply stability in that city, and thereby contribute to economic development in Myanmar.

Consultant: Electric Power Development International (Japan)

Contractor: Marubeni Corporation (Japan)

[Result Outline]

Item	At time of Ex-post evaluation	At time of Ex-post evaluation
Effectiveness/Impact Effectiveness		Following the ex-post evaluation, power generation has generally been maintained at a level that exceeds targets. Power supply self-sufficiency rate for the target region (including the present power plant, the region has four stations in total) generally

surpassed 100%, and efficiency was high. However, there is still room for improvement in terms of the amount of power generated relative to capacity factor (supply capacity).

(1) Capacity utilization rate

Year	90/91	91/92	92/93	93/94	94/95*
%	6.6	11.9	40.1	59.5	79.8

* The figure for 94/95 are for up to January 1995.

(Source: Responses to a questionnaire)

(2) Power generation

(Initial target: 350GWh/year)

Year	90/91	91/92	92/93	93/94	94/95*
GWh	33.27	59.28	200.43	297.09	334.04

* The figures for 94/95 are up to January 1995.

(Source: Responses to a questionnaire)

(1) Capacity utilization rate

-A capacity utilization rate is being maintained around 95% following the ex-post evaluation. It can be seen that the capacity utilization has been propelled as more than planned, by tight demand and supply conditions.

Year	96/97	97/98	98/99	99/00	00/01
%	99.5	99.57	95.67	97.87	94.3
Year	01/02	02/03	03/04	04/05	05/06
%	96.54	96.51	97.02	98.9	N/A

(Source: Responses to a questionnaire)

(2) Power generation

-Except for 2002-03 and 2005-06, the initial target of 350GWh/yr is being exceeded. The lower power generation figures in 2001-02 and 2002-03 can be attributed to a shortage in the gas supply, resulting in a drop in power generated. The low power generation figure for 2005-06 is due to the fact that large-scale maintenance was undertaken at all the power generators (see below).

Year	96/97	97/98	98/99	99/00	00/01
GWh	352.5	419.9	399.7	400.9	394.9
Year	01/02	02/03	03/04	04/05	05/06
GWh	350.9	338.7	370.9	363.9	290.0

(Source: Responses to a questionnaire)

2005/06 figures derive from MEPE data)

- Units suspension hours, hours of operation, and rate of operating hours to capacity are as shown below. There are no problems in terms of operating conditions.

Year	96/97	97/98	98/99	99/00	00/01
Scheduled suspension hours	1,646	700	4,123	41	703
Unscheduled suspension hours	18	21	12	104	14
Total suspension hours	1,664	721	4,135	145	717
Max. hours of operation annually	26,280	26,280	26,280	26,280	26,280
Rate of operating hours to capacity* (%)	93.7	97.3	84.3	99.4	97.3
Year	01/02	02/03	03/04	04/05	05/06
Scheduled suspension hours	842	1,662	370	343	N/A
Unscheduled suspension	125	212	31	499	N/A

		hours					
		Total suspension hours	967	1,847	401	842	N/A
		Max. hours of operation annually	26,280	26,280	26,280	26,280	N/A
		Rate of operating hours to capacity* (%)	96.3	92.9	98.5	98.1	N/A
		<p>*Rate of operating hours to capacity= annual hours of operation/max. possible hours of operation (i.e., 24 h x 365) (Source: Responses to a questionnaire)</p>					
	<p>(3) Meeting the demand for power The power station in the project in question accounts for 7.6% of Myanmar's facility capacity, and 9.7% of annual power generation.</p>	<p>(3) Meeting the demand for power -The power station in the current project now accounts for 5.75% of Myanmar's total annual power generation. The figures may be broken down as 4.85% generated by gas turbines and 0.9% generated by combined cycle operation. Because the amount generated by steam generation has increased, the power generation from this power station has fallen slightly as a percentage of Myanmar's total power generation relative to the time of the ex-post evaluation.</p> <p>-As shown in the table below, the power demand (power consumed) across the whole of Myanmar is at present less than supply. It was not possible at the time of this evaluation to obtain data on demand for the period following 2004, but</p>					

demand is assumed to have increased following 2003, and the difference between average power generation and consumption is becoming insignificant. Average power generation fell in 1998-99 because of a prolonged drought and an accompanying fall in steam power generation. The fall in 2001-02 was attributable to an insufficient gas supply and a resulting fall in gas turbine power generation.

Unit: MW

Year	96/97	97/98	98/99	99/00	00/01
Max. demand (A)	277.8	305.5	310.1	332.2	373.1
Facility capacity (B)	1033.0	1036.0	1031.0	1171.0	1171.0
Power supply capacity (C)	492.2	530.6	447.9	502.3	559.1
Supply-demand gap					
(B)-(A)	755.2	730.5	720.9	838.8	797.9
(C)-(A)	214.4	225.1	137.8	170.1	186
Year	01/02	02/03	03/04	04/05	05/06
Max. demand (A)	347.1	535.5	NA	NA	NA
Facility capacity (B)	1160.0	1190.0	1256.4	1370.1	1491.4
Power supplied (C)	506.1	544.1	573.7	625.6	681.0
Supply-demand gap					
(B)-(A)	812.9	654.5	NA	NA	NA
(C)-(A)	159	8.6	NA	NA	NA

(Source: Maximum demand and facility capacity were extracted from the Statistical Yearbook 2003. Power supplied came from MEPE data.)

*Facility capacity for the period following 2004 was estimated from average power generated, using the fact that for 2002-03 the ratio of facility capacity to power supply was 2.19. Average power generation in MW was calculated from MWh across one year.

(4) Stabilization of the power supply

-At present, the four power stations in Yangon City have sufficient facility capacity to cover power demand for the city. The table below gives cumulative data for the four power stations.

Year	2001/02	02/03	03/04	04/05	05/06
Power demand (GWh)	1357.1	1605.4	1774.5	1835.2	2075.2
Facility capacity (GWh)	4073.4	4073.4	4073.4	4073.4	4073.4
Power supply coverage rate (power self-sufficiency rate) (%)	300.2	253.7	229.6	222.0	196.3

(Source: MEPE data)

-On the other hand, if comparing power generation with demand, in 2005-06 the power self-sufficiency rate fell below 100%, meaning that the power stations within the city were not sufficient to meet the demand for Yangon. According to MEPE, in order to ensure that power generation for each power station approaches the facility capacity, it would be necessary to secure a sufficient gas supply and conduct thorough maintenance.

-According to the draw below, power generation (GWh) of Thaketa gas turbine power station accounts for around 15% in the total power generation of Yangon city, even in 2005/2006 when the large-scale maintenance was conducted and its power generation

decreased. Thus, the Thaketa gas turbine power station contributes on the stabilization of power supply in Yangon city.

Year	2001/2002	2002/2003	2005/2006
Power demand (GWh)	1357.1	1605.4	2075.2
Power generated (GWh)	1822.37	2098.03	1952.6
Power supply coverage rate (power self-sufficiency rate) (%)	134.3	130.7	94.1
Power generation(GWh) of Thaketa gas turbine power station (*from (2))	350.9	338.7	290.0

(Source: Data for 2001-02 and 2002-03 came from the Statistical Yearbook 2003. Figures for 2005/2006 came from MEPE data.)

-Yangon City electrification rate

Following 2001, the electrification rate has decreased slightly. As mentioned above, there are three other power stations besides the Thaketa gas turbine power station, but the causal relationship between each power station and the electrification rate is unclear.

2001/02	2002/03	2003/04	2004/05	2005/06
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	<p>(5) Implementation of combined cycle operations Two years following the completion of the project, plans were devised to expand facility capacity, improve thermal efficiency, and implement combined cycle operations.</p> <p>(6) Environment SOx: None (because the station uses natural gas) NOx: Approx. 60 ppm</p>	<table border="1" data-bbox="1330 229 2011 268"> <tr> <td>57.52%</td> <td>57.34</td> <td>57.08</td> <td>56.98</td> <td>56.87</td> </tr> </table> <p>(Source: YESB data. The number of households was estimated based on population figures, setting the ratio of people to households at 4.84, and electrification rates were derived based on this.)</p> <p>(5) Implementation of combined cycle operations¹ Combined cycle operation commenced in 1997. The installed capacity was 35MW with three generators. According to plans, combined cycle operation would generate 28MW, but as of June 2006, one generator only is producing only 7MW. Gas turbine power generation has been too low on account of a gas supply shortage, and it has not been possible to obtain enough steam needed for the combined cycle. Thermal efficiency is 50%.</p> <p>(6) Environment Sox: None NOx: None, during the period where combined cycle operations are being employed. (*this description is being reconfirmed now)</p> <p>(7) Financial Internal Rate of Return 14.27%</p>	57.52%	57.34	57.08	56.98	56.87
57.52%	57.34	57.08	56.98	56.87			
Impact	Impact	<p>(1) Economic impact - It is difficult to identify the project's impact from the table below. However, providing the underlying support for the</p>					

¹ The main advantages of this power generation method are its high thermal efficiency and low levels of circulating (cooling) water and thermal effluent. Using the method, steam power generation can be performed using the waste heat from internal fuel combustion.

stabilization of the power supply in Yangon city, it is believed that this project makes a certain degree of contribution to the base for industrial and economic activity.

Table (Reference): Changes in Myanmar GDP

(million dollars)

Year	1996	1997	1998	1999	2000
GDP	4.956	4.657	6.932	9.253	9.764
Year	2001	2002	2003	2004	2005
GDP	7.736	8.727	8.559	6.891	5.922

(Source: IMF data)

- Nearby to the Thaketa gas turbine power station, there is an industrial park that was established in 1993; this is connected to the fact that the stable power supply has provided an incentive to factories to relocate there. In recent years, however, power outages at the park have occurred on a chronic basis.

Sustainability
Project
sustainability

Although there are concerns, including lack of spare parts and training, the operation and management capacity and financial status of the executing agency have not been an issue. This was also the case at the time of the ex-post evaluation. The effect of the organizational restructuring conducted in 2006 remains unclear. Although the gas fuel supply was not enough at the time of the ex-post monitoring, it is hereafter expected to become more stable due to the installation of a pipeline.

	<p>(1) Technical capacity The executing agency has constructed and owns six gas turbine power stations as of 1985, and in terms of capability there are no particular issues. Moreover, while the project was being conducted, a consultant was providing the executing agency with training.</p> <p>(2) Structure There are no particular problems with respect to the executing agency's organization. The Thaketa gas turbine power station, which is responsible for operation and maintenance, has 110 employees (Of those, 70 are in charge of operation and maintenance).</p>	<p>(1) Technical capacity -The executing agency has been conducting power generation projects using gas turbines for many years, and has no special issues in terms of capability. Although opportunities to receive training are few, there have been no difficulties in the performance of day-to-day maintenance.</p> <p>(2) Structure -In 2006, the Ministry of Electric Power was restructured by dividing it into two ministries, the first primarily in charge of hydroelectric power generation, and the second primarily in charge of all other types of power generation. The Myanmar Electric Power Enterprise (MEPE) belongs to the jurisdiction of the second ministry.</p> <p>-The Thaketa gas turbine power station has a total of 119 employees. The breakdown of employee roles in operation and maintenance is as follows: 25 in charge of gas turbines, 25 in charge of steam turbine power generation, 12 in charge of water treatment, 11 in charge of electrical maintenance, 19 in charge of mechanical maintenance (these latter are broken down into 12 for gas turbines and 7 for steam turbines).</p> <p>-The Ministry of Electric Power has a personnel pool system so that whenever new personnel are needed at any of the power stations to make up a shortfall, they can be promptly provided.</p>
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(3) Financial status

The executing agency's budget is included in the national budget, and accordingly is treated as part of the government accounting, rather than as an independent entity. For that reason, although financial statements have been put together independently, periodic losses are automatically compensated for using government expenditure allowances. On the other hand, periodic profits are paid into the national treasury (See the table below).

Profit and loss statement (million kyat)

Fiscal year	1988	1989	1990	1991
Payment to national treasury	-	84.9	33.5	-
Net profit or loss (government expenditure)	▲40.7	0	0	▲32.7

Electric power development is a high priority in Myanmar. So long as financial allocations are secured based on a national development plan, there should be no problem with treating power development as a part of the government budget, as is the case at present. On the other hand, there are also grounds for considering granting financial independence to this sector, as doing so is likely to contribute to operating efficiency and securing of investment capital.

(3) Financial status

-As of the time of the ex-post evaluation, losses were compensated for through government expenditure allowances, and profit was paid into the national treasury. According to the profit and loss statements, for the past three years the station has enjoyed a profit.

Profit and loss statements (kyat)

Fiscal year	2003-04	2004-05	2005-06
Profits	1,075,685	1,796,825	233,600

<p>Operation and maintenance</p>	<p>(Operation and maintenance) -No significant problems have arisen with respect to breakdowns. In addition, more than three years' worth of parts have been procured.</p> <p>-During field inspections made in 1994, it was reported that there were no problems with operation and maintenance. As planned, all three generators were used as a base load. An operation and maintenance manual has been established, and periodic inspections are also being conducted in accordance with standards prescribed by the manufacturer.</p> <p>-Several years following the start of operations, because there was a shortage in the natural gas fuel supply, the amount of power generated fell far short of initial target figures. At the time of the evaluation, the requisite natural gas supply had been secured.</p>	<p>(Operation and maintenance) -Operation and maintenance is being conducted in accordance with the manual. The machinery is inspected and cleaned daily. Lubricating oil is replenished and cleaning water inspected and replenished on a weekly basis. Large-scale maintenance was completed in January 2006, and further large-scale maintenance is not expected to be needed for another five years.</p> <p>-Employee training was conducted at the time the power stations were constructed as well as in 1997, when combined cycle operations were implemented. Since then, training has not been conducted due to budget shortfalls; however, in 2006 six engineers were given training in Dubai. However, as next year's budget has not yet been decided, improving the technical expertise of young engineers could be an issue.</p> <p>-There are no spare parts. Moreover, because the facilities are old, obtaining spare parts itself is difficult.</p> <p>-Regarding the gas supply, currently 5 million metric standard cubic feet per day (MMSCFD) of gas is being supplied from an inland gas oil field, and 7 MMSCFD of gas is being supplied from a coastal gas oil field. (*this description is being reconfirmed now) According to the Myanmar Oil and Gas Enterprise, starting in August 2006 gas will flow through a pipeline from Kanbauk, a coastal gas oil field. The field is expected to provide a stable supply of 22.5 MMSCFD.</p>
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<p>Lessons Learned, Recommendations, Information Resources and Monitoring Methods</p> <p>(1) Follow up on lessons learned and recommendations made in ex-post evaluation report and as part of evaluations made following the post-post evaluation</p> <p>(2) Proposals for securing sustainability and instructions given at time of follow-up monitoring</p>	<p>(1) Because there were shortages in the supply of natural gas, which was expected to serve as the fuel source, the power station has not operated at a sufficiently high level for several years following the start of operations. At the time of the appraisal, information should have been gathered directly from the natural gas supplier, while taking measures (conditioning) to ensure that natural gas is supplied in a reliable manner.</p>	<div data-bbox="1279 268 2013 427" style="border: 2px solid black; padding: 5px;"> <p>To maintain sustainability, improving the technical training of the power station staff is indispensable. To that end, it is worth considering matter such as technical support.</p> </div> <p>(1) At the time of follow-up monitoring, power station operations are still being hindered by a shortage in the gas supply. However, this problem is expected to be resolved through the commencement of operations of a gas pipeline scheduled for December 2006.</p> <p>(2) The technical capabilities of the power station staff need to be improved. Training to that end is indispensable. Since the training that the power station supplies do not exceed minimal levels, hereafter certain steps need to be considered, which the MEPE considers the power station's needs and then plans the training programs, for the purpose of improving the technical level of their staff. Based on need, JBIC should execute its side support.</p>
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