Ex-Post Monitoring of Completed ODA Loan Project

Sri Lanka

''Kelanitissa Combined Cycle Power Plant Project''

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1． Project Description

Map of Project Area

Kelanitissa Combined Cycle Power Plant

1.1 Project Objective

The objective of this project is to increase base load power sources and stabilize the power supply by building a 150MW grade combined cycle power plant in Kelanitissa district, located in the north of Colombo City, thereby contributing to economic growth in Sri Lanka as a whole.

1.2 Outline of the Loan Agreement

Approved Amount/ Disbursed Amount	13,481 million yen / 13,406 million yen
Loan Agreement Signing Date/final Disbursement Date	October 1996 / June 2003
Ex-post Evaluation	2005
Executing Agency	Ceylon Electricity Board (CEB)
Main Contractor	Marubeni (Japan), Alstom Power Centralle (France)
Main Consultant	Lahmeyer International (Germany), Chuo Kaihatsu

	Corporation (Japan)

1.3 Background of Ex-post Monitoring

When the project was initiated, the demand for electricity was rising in Sri Lanka due to the country's sustained economic growth. It was forecasted that by the year 2000, the nation's output capability would not meet the expected peak demand. To respond to this situation, a 150 MW grade combined cycle power plant was built by this project.

At the time of ex-post evaluation, the efficiency of the project was evaluated as low because the actual project cost and period for building Kelanitissa Combined Cycle Power Plant had exceeded the initial plan. In addition, three concerns were pointed out in the report. The first concern was the future impact on the surrounding area of the power plant since the environmental monitoring system was not fully established and functional at that time. The second concern was the sustainability of the operation and maintenance skills of the staff as the equipment at training center was old and run down. The third concern was the improvement of CEB financial situation and their low profitability. It was point out that urgent measures were need.

As a result, the ex-post evaluation recommended CEB to develop an environmental monitoring system and measure the environmental impact on the surrounding areas; and for the Sri Lankan government to take measures to improve CEB's profitability.

Therefore, this project was selected for ex-post monitoring and reviewed under each criterion with final conclusion being drawn from the findings of the field survey and other research activities.

2. Outline of the Monitoring Study

2.1 Duration of Monitoring Study

Duration of Monitoring Study：April 2011～February 2012

Duration of the Field Study：7 August, 2011～18 August, 2011

2.2 Constraints during the Monitoring Study

None.

3 Monitoring Results

3.1 Effectiveness

3.1.1 Quantitative Effects

3.1.1.1 Results from Operation and Effect Indicators

(1) Comparison to the ex-post evaluation

As can be seen in the following table 1, the operation and effect indicators, namely, power output and plant load factor were lower than the target values of the ex-post evaluation. The reasons for the result are 1) a failure of a major part of the steam turbine in August 2010 and discontinuation of operations since then; 2) and reduction of thermal power generation usage due to increase in annual rain fall from 1,711 mm in 2009 to 1,992 in 2010. The broken steam turbine has already been repaired in India and is awaiting customs clearance and the repairs of other parts have already been completed. If customs clearance is carried smoothly, the steam turbine should be in use by the end of 2011. The operation and effect indicators in 2008, before the steam turbine broke down, were not much different from the ex-post evaluation in 2005. Therefore it is considered that the current situation is only temporary and there will not be a problem in the future.

Table 1: Operation and Effect Indicators (unit: 1000 tons)

	Ex-post evaluation in 2005	Ex-post monitoring in 2011[1]
Maximum output (MW)	168	165
Power generation (GWh)	1043.5	493.3
Plant load factor (%)	72.2	31.9

Source: Data submitted by Kelanitissa Combined Cycle Power Plant

(2) Outage hours

Regarding outage hours of Kelanitissa Combined Cycle Power Plant, until 2009, the total outage hours of gas turbine and steam turbine were lower than the number in 2003; however, the outage hours have largely increased in 2010.

Table 2: Outrage Hours

	Gas Turbine	Steam Turbine	Total Outrage hours
2003	444.40	1826.26	2,270.66
2004	222.45	936.20	1,158.65
2005	299.50	675.37	974.87
2006	468.11	1219.30	1,687.50
2007	448.42	1101.41	1,549.83
2008	187.36	1064.06	1,082.42
2009	259.10	558.56	314.66
2010	340.21	4896.28	5,236.49

[1] The data used was fiscal year 2010, Plant load factor = annual operation hours / annual hours (8,760 hours).

Source: Data submitted by Kelanitissa Combined Cycle Power Plant

It is because the main part of the steam turbine broke down and needed replacement. Although outage of either the gas turbine or the steam turbine occurred frequently, it is confirmed that Kelanitissa Combined Cycle Power Plant has been trying hard to maintain the generation of a certain volume of power and to minimize the outage hours at the facility.

3.1.1.2 Financial and Economic Internal Rate of Return (FIRR)

The Financial Internal Rate of Return (FIRR) and Economic Internal Rate of Return (EIRR) at the time of ex-post monitoring, were both negative as it is shown in the table 3. The increase in maintenance costs and the lowered electricity unit pricing could be the main reasons for the results. Even in this situation, it is important to keep operating the plant in order to maintain sustainable power supply in Sri Lanka.

As it will be discussed later in this document the sustainability and financial situation of CEB are not favorable; however, some positive factors were observed. These were 1) the financial structural reform including amendment of the electricity bill by revision of Electric Utility Law had been active since 2009; and 2) the maintenance cost of specially the Steam turbine could be reduced after 2012 by completing the current major repairs of it. Thus, the internal rates of returns could be improved in the future. Regarding, the conditions assumed when calculating the Internal Rates of Return see the following Table 4.

Table 3：Internal Rate of Return

	Ex-post evaluation in 2005	Ex-post monitoring in 2011
FIRR	14.5%	Negative
EIRR	14.2%	Negative

Table 4：Conditions Assumed when Calculating the Internal Rates of Return

Project life	Twenty years from when the facilities begin operation
Fiscal year	Same as the calendar year
Fixed price calculation method	Costs are converted to fixed prices by taking the year of project completion as the base year and discounting for the consumer price indices for both the local and foreign currencies. Fixed prices expressed in foreign currencies are converted using the exchange rates of the base year.
Cost breakdown	Project cost, operation and maintenance cost

Breakdown of FIRR	i) Income from sales of the electricity generated by the power plant ii) Fuel savings
Breakdown of EIRR	Same as above

3.1.2 Qualitative Effects

It is not identified.

In summary, although the internal rate of returns of the project are negative due to the increase in the maintenance cost and the lowered sales price; from the viewpoint of maximum output, power output and plant load factor, it is concluded that the project is mostly effective as was expected at the time of ex-post monitoring.

3.2 Impact

3.2.1 Intended Impact

3.2.1.1 Stabilization of the Power Supply

The amount of electricity generated by the Kelanitissa Combined Cycle Power Plant (493.3GWh) accounted for 4.6% of total electricity generation (10,714GWh) in Sri Lanka in 2010. In the same year, Sri Lanka's potential output (2,818MW) exceeded peak demand (1,955MW), thereby securing a supply reserve of 863MW. Considering the supply reserve was 766MW at the time of the ex-post evaluation in 2005, the power supply in Sri Lanka has become more stabilized than it was in the past. Table 5 shows the composition of power sources in Sri Lanka. Although the percentage of hydroelectric power has slightly increased in 2010 in comparison to 2004 because of the increase in rainfall, it is evident that the over dependence on hydroelectric power as was the case in the 1990s has been reduced.

Table 5：The Composition of Power Sources (%)

	Hydroelectric Power	Thermal Power
1992	82%	18%
2004	50%	50%
2008	48%	52%
2009	48%	52%
2010	53%	47%

Source：CEB

3.2.1.2 Impact on the Surrounding Environment

It was pointed out in the ex-post evaluation that it was difficult to know the effect of the project on the surrounding environment. In response to this, the manager of Kelanitissa Combined Cycle Power Plant assigned an Environmental Officer in 2006 and since then, the officer has been carrying out monthly monitoring of effluent discharge, noise and vibrations. In addition to this, the plant has then commissioned a quarterly environmental inspection by a third party inspection body that has been in carrying out inspections since 2006 in accordance with the Environmental law of Sri Lanka. All inspections have been conducted using inspection equipments brought by the third party inspection body to the power plant. The subjects of the inspections are noise, vibrations, and concentration of contaminant emission from smokestacks.

When the past environmental inspection reports were reviewed; the Kelanitissa Combined Cycle Power Plant had never received warnings about an environmental problem up to today. It is also confirmed that an environmental license has been issued to the plant by the Central Environmental Agency (CEA).

As for the concern of the concentration of contaminant emission from the smokestacks shown in the ex-post evaluation report, the results from environmental test report conducted by an independent third party are shown in the table 6. From this results, all the contaminants including Nitrogen Oxide (Nox), sulfur dioxide (SO_2), Suspended Particulate Matter (SPM) are much less than the national standard of Sri Lanka, therefore, it is concluded that the impact of this plant gives on the natural environment will be limited.

Table 6: Concentration of Contaminant Emission from Smokestacks

	NO_x (mg/Nm^3)	SO_2 (mg/Nm^3)	SPM (mg/Nm^3)
2009	85	27	8
2011 (July)	71	41	85
Environmental Standard of Sri Lanka	3,000	250	300

Source: Test report of Industrial Technology Institute

The continuous monitoring system to measure the concentration of contaminants from smokestacks, which was installed when the plan was constructed, has never been operational since the start of operation of the power plant, due to problems associated with the monitoring equipment and its installation. At the time of the ex-post monitoring, CEB had decided to replace the entire equipment and been processing to prepare and review.

3.2.1.3 Contribution to the Economic Development

As shown in Table 7, real economic growth rate of Sri Lanka is quite positive except during the Lehman Shock period in 2009. The high growth rate of around 8.0% is expected also in 2011.

Table 7: Real Economic Growth Rate (%)

	2005	2006	2007	2008	2009	2010
GDP growth rate (%)	6.2	7.7	6.8	6.0	3.5	8.0

Source：World Bank, World Indicators, 2010

With the composition of the gross domestic product, as shown in Table 8, industrial sector and service sector percentages have been increasing against the agricultural sector. The development of the industrial and service sectors require stable electricity power supply and thus the project had met such needs. It can be also said that the project had a positive impact on the economic development of the Sri Lanka

Table 8: Composition of Gross Domestic Product in Sri Lanka (%)

Sector	1999	2008	2009
Agriculture	20.7	13.4	12.6
Industry	27.3	29.4	29.7
Manufacture	16.4	18.0	18.0
Service	52.0	57.7	57.7

Source：World Bank, World Indicator, 2010

In summary, it is confirmed that the project has still been playing an important role in the sustainable electric power supply and the economic development of Sri Lanka at the time of ex-post monitoring. As for the environmental impact concerns highlighted at the time of ex-post evaluation, it is also confirmed that internal and external third party monitoring for the environment has been undertaken since 2006, and these report proved that the amount of contaminated waste from the project is within the national standard of Sri Lanka. Further, the project has never caused any problems till today.

3.3. Sustainability

3.3.1 Structural Aspects of Operation and Maintenance

No particular problem had been identified at this time with respect to institutional structures including decision-making process, human resources management, facility management, legal system, and operation and maintenance system.

3.3.2 Technical Aspects of Operation and Maintenance

No particular problem had been identified at the time. In the field survey, it is confirmed there are many engineers who work at the Kelanitissa Combined Cycle Power Plant and have been working there since its establishment. And those engineers contribute to the maintenance and improvement of the facility. Furthermore, according to the facility manager, the technical levels of the young engineers have improved compared with the past, as a result of the CEB's training systems and daily on-the-job training.

3.3.3 Financial Aspects of Operation and Maintenance

As pointed out in 3.1.1.2 Financial and Economic Internal Rate of Return, the financial situation of CEB has been the constant budget shortfalls over a long period and the situation is still not good at present. The cumulative losses reached to 10.5billion rupees at the end of 2008. To this situation, the government of Sri Lanka took the following actions to fundamentally change the financial structure of CEB.

- With the enactment of Sri Lanka Electricity Act in 2009, Public Utilities Commission of Sri Lanka (PUCS) became the economic regulator of the electricity industry.
- The government took over payment of interest on borrowings for the period from 2011 to 2014.

Furthermore, the CEB Finance Office targets to make CEB profitable by 2015 by implementing the following plans. These plans have been progressing well, CEB should in the black and profitable around 2013 according to these plans.

- The operation of Coalfired power plant in Puttalam will be started in 2011 and the second plant will be fully operational by 2014.
- Upper Kotmale hydro energy plant will be operational in 2012 and Broad Land Hyro energy plant will be operational in 2015.
- Supply amount from costly West Coast plant will be expected to diminish from 2014.

PUCSL considers if CEB implements all the above-mentioned plans and the country maintains high economic development, the CEB's targets will be achievable. In addition, it was confirmed that the budget for operation and maintenance of the Kelanitissa Combined Cycle Power Plant was appropriately allocated because the fine operation of the plant is directly related to the electricity sales to utilities revenue of CEB.

3.3.4 Current Status of Operation and Maintenance

A concerned highlighted in the ex-post evaluation report was that the future quality of operations and maintenance could be degraded due to the aging of Piliyandala training center. When the evaluator visited and studied the training center, the facility was entirely renewed, the number of trainees had been increased, and the inside facility was also filled with positive spirit. Moreover, the reputation of the training participants is good, and these days, the center had been receiving trainees not only from CEB but also from independent power industry companies. Therefore all of the identified issues pointed out at the time of ex-post evaluation have been solved. Table 9 shows the number of trainees at promotion training program in this training center.

Picture 1: Lecture at Piliyandala Training Center

Table 9: Number of Trainees
at Promotion Training Programs in Piliyandala Training Center

	2007	2008	2009	2010
Number of Trainees	254	405	831	2,029

Source: Piliyandala Training Center

In summary, no particular problems on the capacity of the implementation agency and operation and maintenance system were identified, and the financial situation concerned at the time of the ex-post evaluation showed signs of improvement. Therefore, the sustainability of the project does not have a problem.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

It is confirmed that the project has still been playing an important role for the sustainable electric power supply and the economic development of Sri Lanka at the time of ex-post monitoring. As for the concerns on the environmental monitoring system pointed out in the ex-post evaluation report, CEB has assigned an Environmental Officer of the power station and the undertaking of monthly inspections, and in addition, the environmental inspection includes the measurement of contaminants from smokestacks

undertaken regularly by an independent third party since 2006. Therefore it is concluded that the issues on the environmental monitoring system has been mostly solved

As for the sustainability of the project, there is no visible problem on capacity and operation and monitoring system of the implementing agency.

The financial challenges of CEB, have remained. However, there are signs of improvement in the CEB's financial management and the budgets for operation and maintenance of the Kelanitissa Combined Cycle Power Plant have been appropriately allocated due to the importance of the plant for this country. Therefore, the sustainability of the project does not have a problem at this time.

The aging of CEB's training center, buildings and training equipment has been addressed and there has been tremendous improvements, thus the concerned issues at the time of the ex-post evaluation has been solved.

4.2 Recommendations

To implementation agency:

As for the environmental monitoring system pointed out in the ex-post evaluation of JICA, it was confirmed that CEB had been putting continuous efforts to improve the situation. The replacement of the monitoring equipment for the measurement of concentration of contaminants from the smokestacks considered by CEB should be well examined from the aspect of necessity, usefulness; and then most appropriate approach taken for CEB.

4.3 Lessons Learned

It is not identified.

Comparison of Original and Actual Scope

Items	Plan	Actual
(1) Outputs		
1) Combined cycle power generation facilities	150 MW	165MW
a) Gas Turbines	Two or three units with an output of 37-67MW	One unit with an output of 110MW
b) Exhaust heat recovery boilers	Two or three units	One unit
c) Steam turbines	One unit with an output of 37-67MW	One unit with an output of 55MW
2)Fuel Storage tanks	Two 17,000 ton tanks	Two 4,500 ton tanks
3) Cooling water equipment	Direct cooling or a cooling tower	As planned
(2)Project Period	October 1996 - March 2000 (42 months)	October 1996 - March 2003 (78 months)
(3) Project Cost		
Foreign currency	10,926 million yen	12,613 million yen
Local currency	5,288 million yen	5,199 million yen
Total	16,214 million yen	17,812 million yen
ODA Lon Portion	13,481million yen	13,406 million yen
Exchange rate	1 rupee ＝1.9 yen (October 1996)	1 rupee＝1.4 yen (Average between May 1996 - June 2003)