Sri Lanka

Kelanitissa Combined Cycle Power Plant Project

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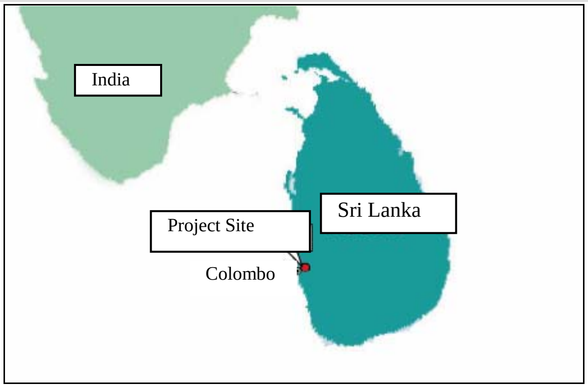
1. Project Profile and Japan's ODA Loan



Map of project area

Power generation facilities built through this project

1.1 Background

The demand for electricity has risen in Sri Lanka due to the country's sustained economic growth. It was forecasted that by the year 2000, the nation's output capability of 1,396MW would not meet the expected peak demand of 1,481MW. Resolving concerns about the tight power supply and demand balance and finding ways to increase the power supply capacity had become critical issues.

A major characteristic of the composition of Sri Lanka's electrical power sources was that 80% of installed capacity is generated hydroelectrically, meaning that Sri Lanka had a kind of "water first, thermal second" structure. This structure had the drawback of being greatly influenced by the weather. For example, in drought years the amount of power generated declined drastically. There was an urgent need to develop thermal base load power sources in order to improve the stability of the power supply.

In addition, the government of Sri Lanka was aiming to improve its electrification rate which, compared to other South Asian countries, had been remarkably low (in 1991, Sri Lanka's electrification rate was 33% compared to India's 74% and Pakistan's 50%). The government had set its target to achieve on electrification for all villages by the year 2000.

From the standpoint of alleviating poverty and developing rural communities, the development of new power sources has become a major issue.

The fact that the power sector occupies a major position in development policy is something common to all developing countries. In the mid-1990s, increasing and stabilizing the electricity supply were important policy issues for Sri Lanka as it sought to resolve the above problems. Sri Lanka allocated 8% of the funds in its Public Investment Plan (1993-1997) to the power sector.

1.2 Objective

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

1.3 Outputs

(1) Combined-cycle power generation facilities (165MW)
1) Gas turbine: one unit with 110MW output
2) Exhaust heat recovery boiler: one unit
3) Steam turbine: one unit with 55MW output
(2) Fuel storage tanks: Two 4,500 ton tanks
(3) Cooling water equipment

1.4 Borrower/Executing Agency

Democratic Socialist Republic of Sri Lanka/Ceylon Electricity Board (CEB)

1.5 Outline of Loan Agreement

Loan Amount/ Disbursed Amount	13,481 million yen/13,406 million yen
Exchange of Notes Loan Agreement	May 1996 October 1996
Terms and Conditions - Interest Rate - Repayment Period (Grace Period) - Procurement	 2.3%/year 30 years 10 years General untied
Final Disbursement Date	June 2003
Main Contractors	Marubeni (Japan), ALSTOM POWER CENTRALES (France), EXCEL BUSINESS (PVT) LTD (Sri Lanka), K.D.A. WEERASINGHE & CO. (PVT) LTD (Sri Lanka), BHEL-GE GAS TURBINE SERVICES PVT. LTD. (India)
Consulting Services	LAHMEYER INTERNATIONAL GMBH (Germany), Chuo Kaihatsu Corporation (Japan)
Feasibility Study (F/S), etc.	Black & Veatch International (US), a JBIC study

2. Evaluation Result

2.1 Relevance

As mentioned in 1.1 above, the major reasons this project was necessary were: (1) Sri Lanka needed to develop its base load power sources so as to alleviate the tight power supply and demand balance brought about by its sustained economic growth and need to increase its electrification rate; and (2) Sri Lanka needed to enhance its thermal power generation plants in order to rid itself of its markedly "water first thermal second" structure and increase the stability of its electricity supply. This is a project addressing urgent issues for Sri Lanka's economy and society, and it is judged that it had sufficient relevance. The fact that Sri Lanka allocated 8% of the funds in its Public Investment Plan (1993-1997) to the electricity and energy sector underscores the importance of this project.

In the period from 1994 to 2004 peak demand for electricity increased rapidly at an average of over 5.5% per year, from 910MW to 1,563MW. This again demonstrates the relevance of the aspects in (1) above. At the same time, conversion of the composition of power sources has been steadily progressing and as of 2004 the relative amounts of power generated from hydroelectric and thermal sources had more or less equalized. The fact that this conversion of the energy structure could proceed so swiftly highlights the importance of the aspects in (2) above, and is a further evidence of the relevance of this project.

The power sector accounted for 6% of the Public Investment Plan in 2006, and as before has been given highest priority among infrastructure categories. The government of Sri Lanka formulated a number of reform plans for the power sector in cooperation with the international aid community. These included the Power Sector Government Policy guidelines of 1997, and the Power Sector Reform and Public Utilities Committee Bills of 2002. At the time of the field survey, these plans had come to a halt due to changes of governments and other factors, and so it was unclear in which direction power sector policy was moving. Later on the situation took a turn for the better, and in April 2006 a bill pertaining to reform of the power sector (revised version) was introduced to parliament and was submitted in government communiques. So a certain degree of improvement is currently expected in the power sector.

2.2 Efficiency

2.2.1 Outputs: The modifications which were made are described below.

(1) Combined cycle power generation facilities

The facilities were modified from the initially planned 150MW to 165MW. This modification was a result of consideration being given to the ease of procuring power in the market and the tight supply and demand balance. Specifically, the number of gas turbines and their output, the number of exhaust heat recovery boilers, etc., were modified.

Table 1.

	Original Plan	Post-Modification
Gas turbines	Two or three units with an output of 37-67MW	One unit with an output of 110MW
Exhaust heat recovery boilers	Two or three units	One unit

(2) Fuel storage tanks

Fuel storage capacity was modified from the original plan of two 17,000 ton tanks to two 4,500 tons tanks. It is ordinarily possible to pump fuel in from the refinery. Moreover, private power generation facilities were being built on the grounds of the power plant, and as a result there was no longer enough space for the originally planned tanks.

2.2.2 Project period

The project period lasted 78 months (from October 1996 to March 2003), or 186% of the originally planned period of 42 months (October 1996 to March 2000). The major causes of the prolonged delay are as follows:

(1) Extension of the tendering period: This was a result of the modification of the specifications for the combined cycle power generation facilities from 150MW to 165MW and the modification of the design.

(2) Worsening security: Imposition of a nighttime curfew and attacks on the airport hampered the movement of personnel and the transport of raw materials.

(3) Delay in trial operation: Due to the tight electricity supply-and-demand situation, there was no choice but to prioritize commercial operation, and so initially there was no time for the trial operation. In addition, an accident occurred with the steam turbine during trial operation, and it took time to restore the facilities to working order.

2.2.3 Project cost

The actual project cost (17,812 million yen) only exceeded the initial estimate (16,214 million yen) by just over 10% so it can be seen as having basically remained within the planned scope. We should add that increasing the output of the combined cycle power generation facilities (from 150MW to 165MW) was not merely a factor that just drove up costs. This is because it is necessary to also take into account the cost saving factors such as 1) improvement to the ease of procurement, and 2) a reduction in the number of gas turbines and exhaust heat recovery boilers.

2.3 Effectiveness

2.3.1. Status of operation of the power plant

(1) Operation and effect indicators: comparison with targets set at the time of appraisal

As can be seen in the following table the operation and effect indicators, namely, maximum output, power output, and plant load factor, all exceeded the target values set at the time of the appraisal. For one of the indicators, thermal efficiency, no target was set at the time of the appraisal, but when comparing it with the design efficiency for rated output at the time of operation, it fell only slightly short. In practice, rather than operating constantly at its rated output, the plant sometimes operates at partial load, resulting in a drop in efficiency. Given that fact, the slight discrepancy (0.59%) shown in Table 2 should not be deemed a problem.

Table 2

	Target values set at the time of the appraisal	Actual values achieved in 2004
Maximum output	150MW	169MW
Power output	985.5GWh	1,107GWh
plant load factor	75%	76.6%
Thermal efficiency	None Design value: 48.65%	48.06%

(2) Outrage hours

At the time of the appraisal, there were no targets set for outrage hours. Outrage hours for gas turbine facilities declined steadily, registering 298 hours in 2003, 239 hours in 2004, and 126 hours in 2005. Problems initially encountered at the startup of operations were overcome, and the overall trend can be seen as moving towards ever smoother operation.

2.3.2 Financial and economic internal rates of return

Table 3 compares the estimates that were made at the time of appraisal of the Financial Internal Rate of Return (FIRR) and Economic Internal Rate of Return (EIRR) (based on data from JBIC) with the actual figures calculated in the ex-post evaluation. The FIRR showed a slight improvement. Among the positive indicators following project completion are 1) a rise in electricity charges, and 2) a decline in local currency expenses denominated in yen due to the depreciation of the rupee. There was no significant difference in EIRR between the estimate at the time of appraisal and the actual value recorded. Regarding the conditions assumed for calculations, see Table 4.

Table. 3

	At time of the appraisal	Ex-post evaluation results
FIRR	12.6%	14.5%
EIRR	14.5%	14.2%

Note: Benefits include income from electricity sales and fuel savings; expenses include the project cost and operation and maintenance cost.

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 rate of the base year.
Cost breakdown	Project cost, operation and maintenance cost
Breakdown of FIRR benefits	1) Income from sales of the electricity generated by the power plant 2) Fuel savings
Breakdown of EIRR benefits	Same as above.

2.4 Impact

2.4.1 Contribution to increases and stabilization of the power supply

The amount of electricity generated by this project (1107.4GWh) accounted for 13.8% of total electricity generation in Sri Lanka in 2004. In that year, Sri Lanka's potential output (2,329MW) exceeded peak demand (1,562MW) thereby securing a supply reserve of 766MW. This project has contributed to an increase in electricity supply capacity, something which was a major development issue for Sri Lanka.

In 1992, the composition of power sources was 82% hydroelectric power and 18% thermal power. By contrast, in 2004 thermal and hydroelectric power each accounted for 50%, showing that Sri Lanka has overcome its lopsided "water first, thermal second" power generation structure. Together with the increase in private thermal power generation facilities primarily since 1997, this project has contributed to the stabilization of the power supply by overcoming the "water first, thermal second" power generation structure.

2.4.2 Impact on the regional economy and local residents

The target area for this project was all of Sri Lanka, and at the time of the appraisal there was no mention of the impact on any one particular region. The greater Colombo area, which includes the city of Colombo and the southern part of the Western Province, is a region of high power demand. In an interview survey of consumers in that region, since 2003, the year in which the project was completed, the vast majority of respondents (82% of large companies, 98% of small and medium-sized companies, and 82% of individual consumers) said that power supply conditions had improved. This suggests that the project had a positive impact on the regional economy and local residents.

2.4.3 Impact on the surrounding environment

The environmental impact assessment (EIA) of this project was approved by the Central Environmental Authority (CEA) on March 11, 1996. At the time of the appraisal, it was made compulsory for the project to get its EIA approved and undergo the monitoring prescribed by the CEA and it was decided that the CEB would implement that monitoring.

In this ex-post evaluation several variables were measured, including a) the concentration of airborne contaminants (outside power plant premises), b) the concentration of contaminants from smokestacks, c) noise levels at plant boundary lines, d) vibrations at plant boundary lines, and e) drainage water quality.

Meters to monitor the concentration of contaminants from smokestacks have been installed, but the position of environmental monitoring manager became vacant, and for this and other reasons the meters are not operating properly and the prescribed data cannot, therefore, be obtained.

Environmental monitoring of the concentration of airborne contaminants outside of plant premises was conducted in November and December of 2002 based on the EIA. At that time, it was confirmed that concentrations of contaminants had already reached the maximum level permissible under Sri Lankan environmental laws[1]. Therefore the state of the air pollution in the area surrounding the power plants was perceived as something of a problem. It has been difficult to accurately grasp the impact of this project on the surrounding environment for the following reasons:

1) The concentration of contaminants from exhaust gases from the power plants are not being measured in an appropriate form.

2) The traffic on nearby roads is heavy, and the neighboring Sapugaskanda power plant (which was expanded to 80MW during 1997-1999) is also in operation there. The impact of the exhaust gases from these sources is not being measured.

On the other hand, variables c), d), and e) are satisfactory with respect to regulated standard and there is no problem in these areas.

2.5. Sustainability

The sustainability of this project was studied from five perspectives: technical capacity, structure, operation and maintenance, fuel supply, and financial status. Apart from the financial aspects, no problems appear to have materialized.

2.5.1 Technical capacity

The operational status of the power generation facilities was closely examined. As the facilities were operating at an appropriate technological level, no problems were seen.

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[1] NOx: Max. permissible level 0.1 mg/m^3; actual values 0.165-0.285 mg/m^3.
SOx: Max. permissible level 0.08 mg/m^3; actual values 0.013-0.143 mg/m^3.

2.5.2 Structure

No problems have materialized with respect to the structure. As was explained in the section on relevance, power sector reform was in the air at the time of the evaluation and the decision-making that could be carried out under the current system was limited. There was concern that if this state of affairs continued, the necessary decision-making would be postponed and sustainability might be affected. Fortunately, things took a turn for the better, and in April 2006, a bill pertaining to reform of the power sector (revised version) was introduced to parliament and was submitted in government communiques. Thus, the situation is expected to improve somewhat.

2.5.3 Operation and maintenance

Because guidance is being received from technicians from overseas manufacturers as needed, there are basically no problems with operation and maintenance. Although there is a training center (constructed with grant aid from France) which is supposed to shoulder the burden of maintaining skill levels in the field, because its facilities are old and in a state of marked deterioration, the center is not fulfilling its anticipated functions.

2.5.4 Fuel supply

In the original plan, naphtha was the fuel to be used. Later this was switched to combined use of diesel oil (53%) and naphtha (47%) because these two fuels can substitute for each other and there was a relative change in their prices.

2.5.5 Financial status

The CEB’s pretax profit fell into the red starting in FY2000. Under a financial restructuring plan based on the ideas of the international aid community and the government, electricity charges were raised by 25% in March 2001, and another 36% in April 2004. Despite the increase in revenue, the CEB’s profit and loss situation continued to worsen. At the time of the evaluation, pretax losses of 15.7 billion rupees were forecast for FY2004, which is equal to 30.7% of net sales. The government also has financial issues, and is demanding that the CEB cover a portion of its deficit through bank borrowings. As a result, the increase in the CEB’s monetary costs is striking (2.42 billion rupees in FY2000 and 6.64 billion rupees in 2004).

Adding to the increasing severity of the CEB's financial status are structural problems that include the following external constraints.

(1) The government is demanding that the CEB covers a portion of its deficit through bank borrowings.

(2) In order to handle peak demand, the government is demanding that the CEB purchase electricity through short-term contracts with private independent power producers (IPPs).

(3) An increase in various import costs due to the depreciation of the rupee.

The CEB's low profitability leads to budget shortfalls, and there is the concern that it will gradually undermine the CEB's ability to carry out operations. Particular attention needs to be paid to the budget allocation to various areas such as operation and maintenance, training, and environmental management. Fortunately, recently things have taken a turn for the better, and in April 2006, a bill pertaining to reform of the power sector (revised version) was submitted to parliament and was published in government communiques. Moreover, the CEB and the Ministry of Finance have been discussing options for restructuring the CEB's debt, and they have decided to defer repayment on the conditions of a debt-equity-swap for 50% and a reduction or exemption of interest on the remaining 50%. It thus appears that there is a sign of an improvement in financial sustainability.

3. Feedback

3.1 Lessons learned

Environmental Monitoring System

During the appraisal stage, JBIC expected that "once the EIA is approved, the prescribed environmental monitoring will be carried out." Based on that assumption, JBIC did not set up any system to assess the state of monitoring after completion of the power plant, and as a result, verification of deficiencies in the air pollution monitoring system was delayed.

These circumstances could have been avoided if 1) at the time of conclusion of the L/A the implementation of environmental monitoring had been set as a condition, and 2) an obligation to submit the results of monitoring had been included.

3.2 Recommendations

3.2.1 Recommendations for the CEB

(1) Environmental monitoring system

An environmental monitoring system should be developed. This includes the appointment of a new person to, and appropriate budgetary provisions for, the management position that was vacant at the time of the evaluation.

(2) Mechanism for the improvement of skill levels

Improvement of the capabilities of technicians is important for the smooth implementation of electricity generation, transmission, and distribution. However, the equipment at the training center responsible for that task is seriously run down, and morale at the training site itself is low. Drastic improvements are needed.

3.2.2 Recommendations for JBIC and the government of Sri Lanka

Despite an across-the-board increase in electricity charges, the CEB's worsening profitability has become very serious. The reason for this is that the CEB's structural constraints are too severe to be resolved through self-help efforts by the CEB itself. Recently, there was a progress in discussions among people regarding CEB's debt restructuring. That said, the formulation of comprehensive countermeasures is an urgent matter. For example, there needs to be an examination of burden-sharing for improving the CEB's profitability among the government, the CEB, and consumers.

Comparison of Original and Actual Scope

Item	Plan	Actual
(1) Outputs 1) Combined cycle power generation facilities	150MW	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 Loan Portion	13,481 million yen	13,406 million yen
Exchange rate	1 rupee = 1.93 yen	1 rupee = 1.377 yen