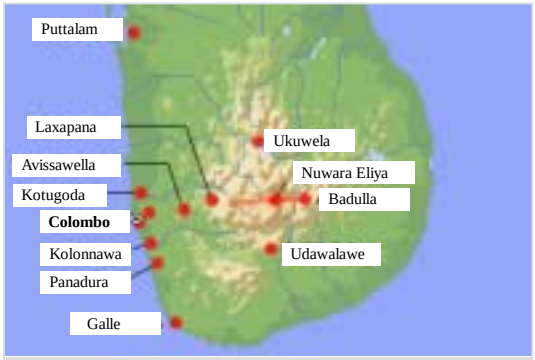
Sri Lanka

Transmission System Augmentation and Development Project (I) (II)

Report date: March 2001
Field survey: February 2001

1. Project Profile and Japan's ODA Loan



Project Area Location Map: Central and Southwest Sri Lanka

Avissawella Substation

1.1. Background

(1.1.1.) Phase I

In Sri Lanka, the loop system was introduced on the power transmission network covering the central region and Colombo the location of many power plants and major substations, while other regions were covered by radial networks.

It became necessary to renew the 66kV transmission lines constructed after 1960 and to expand the transmission capacity to meet the growing power demand. The Ceylon Electricity Board (CEB) was promoting development of transmission networks with the main system voltage of 132kV. At that time, 66kV transmission lines were still in use between the Colombo Substation and Laxapana Substations and between the Laxapana and Badulla Substations. The 75km-line connecting Laxapana Substation and Badulla Substation was an important route forming part of the national transmission network loop system. Despite the fact that 132kV lines had been constructed on part of this section, the transmission voltage was still 66kV or lower due to the low capacity of transmission lines and substations.

In addition, CEB, the agency responsible for power generation, transmission and distribution in Sri Lanka, did not have an appropriate communication systems able to deal with diversification and the increased volume of information caused by the increase in customers. It was therefore necessary to establish a new communication system.

(1.1.2.) Phase II

The cost of Phase I of the project was expected to substantially exceed initial

estimates because the successful tender was higher than projected due to price increases and deteriorating security in the country. In spite of the executing agency's efforts to resolve this situation, the Sri-Lankan side had no prospect of procuring funds to make up the shortfall.

On the other hand, the power supply was insufficient to meet increasing demand due to the above-mentioned problems of low transmission capacity and obsolete facilities. Therefore, there was a growing necessity for the early implementation of the project.

1.2. Objectives

The objectives of the project were to construct 132kV transmission lines and new substations and to expand the existing substations in order to increase the capacity and efficiency of power transmission in Sri Lanka, while establishing a dedicated communications system within CEB as part of efforts to rationalize and enhance the capacity of its system operation (same for Phase I and II).

1.3. Project Scope

The scope of the project was divided into two categories: the transmission network and the communications system. The transmission network project comprised construction of substations and transmission lines to deal with the customer increases, expansion of existing substations (installation of additional transformers and additional 33kV transmission line bays), and improvement of the existing power system protection system. The communication system project included construction of a trunk digital wireless system and expansion of the mobile wireless system. Phase II covered expansion of substations and line bays that could not be covered by Phase I funds. The ODA loan covered all of the foreign currency portion.

*See "Comparison of Original and Actual Scope" for detailed scope of Phase I and II.

1.4. Borrower/Executing Agency

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

1.5. Outline of Loan Agreement

	Phase I	Phase II
Loan amount/Loan disbursed amount	¥4.360 billion/¥3.831 billion	¥918 million/¥658 million
Exchange of notes/Loan agreement	September 1988/ November 1988	June 1993/ August 1993
Terms and conditions	Interest Rate: 2.5%, Repayment period (grace period): 30 years (10 years), Partially untied	Interest Rate: 2.6%, Repayment period (grace period): 30 years (10 years), General untied
Final disbursement date	January 1997	December 1998

2. Results and Evaluation

2.1. Relevance

A high priority was placed on the power transmission project by the Sri Lankan government with the aim of improving the rural electrification rate, which was 20% at the time of appraisal and lower than that in surrounding countries. According to an estimate of power demand, it was deemed certain that the transmission and transformation facilities would be overloaded. The project plan was relevant in terms of facilitating a stable supply of electricity.

The objective of Phase II was to fund specific portions of the project that could not be covered by Phase I because of inevitable external factors such as the deterioration of security and rapid inflation in Sri Lanka. Capacity shortages and the deterioration of transmission and transformation facilities covered by the project were serious, while power demand in Sri Lanka was increasing. Under these circumstances, there was a strong need for early completion of the project and the project plan was therefore relevant.

2.2. Efficiency

(2.2.1.) Implementation Schedule

The project was implemented in two phases. The main reason being that increases in bidders' prices due to the social situation in Sri Lanka* and other reasons after the signing of the loan agreement for Phase I resulted in the successful tender price being far higher than projected. However, the Sri Lankan side had no prospect of procuring funds to continue the project. In light of the urgency and necessity of the project, an additional ODA loan was provided for Phase II. The project was completed in December 1998, 7 years and 9 months behind the initially scheduled completion date of March 1991 and 4 years behind the rescheduled completion date of November 1994 which was set at the time of appraisal of Phase II. This delay was unavoidable due to deteriorating security in Sri Lanka as mentioned above. In addition, delays in acquiring land for the Avissawella and Badulla Substations and delay in construction work by the contractor also contributed to the long delays in completion.

* Since the appraisal in 1988, the Liberation Tigers of Tamil Eelam (LTTE) has been stepping up their activities, while in the southern region communist groups began committing acts of terrorism, thereby causing security to deteriorate. In Laxapana, Nuwara Eliya and Badulla areas, in particular, parts of some transmission lines were destroyed by vandalism and were difficult to repair. Tenders were invited in the midst of this difficult situation. It is assumed that bidders offered high prices because the project site covered the northeastern region and central-southern region, which encompass the above-mentioned areas.

(2.2.2.) Project Cost

The price tendered in 1991 was much higher than initially projections mainly

because the bidder added in the extra cost of augmenting security to ensure safety, reserves for delay in completion and additional insurance to hedge against deteriorating security. These circumstances, coupled with inflation, pushed up the local currency portion of the project cost covered by the executing agency's own funds to 456% of the amount estimated at the time of Phase I appraisal (initial plan) and 165% of the amount estimated at the time of Phase II appraisal (revised plan). Phase II was the portion of the project that was not covered by the loan amount provided in Phase I. However, the actual disbursement for Phase I was ¥3.831 billion against the approved loan amount of ¥4.360 billion, and the actual disbursement for Phase II was ¥658 million against the approved loan amount of ¥918 million. In total, the foreign currency portion covered by the ODA loan was ¥4.489 billion, only 3% more than the initially estimated ¥4.360 billion. The reason underpinning this is the rise in the yen exchange rate from $1.00= ¥135 at the time of initial planning to $1.00= ¥95-110 at the time of implementation.

Table 1 Comparison of Estimated and Actual Project Cost

	Phase I appraisal	Phase II appraisal	Actual Cost		
			Phase I	Phase II	Total
Local currency (Rp million)	354.7	979	-	-	1,618
Foreign currency* (¥ million)	4,360	5,278	3,831	658	4,489
Total (¥ million)	5,964	8,008	-	-	7,573

2.3. Effectiveness

Since most power transmission networks in Sri Lanka have a radial structure under which trouble at one point causes power failure at all supply points. The loop system of 132kV and 220kV transmission network in the western region of the country was completed with the construction of the 132kV transmission line between Laxapana and Badulla Substations under the project. As a result, it became possible to transmit power through other routes in the event of trouble in a particular section. Followings are the operation status of each substation.

(2.3.1.) Operation Status of Substations

· Effect of the construction of Avissawella Substation

Before the implementation of the project, 66kV and 132kV transmission lines had already been laid between Kolonnawa and Laxapana Substations. The newly established Avissawella Substation (31.5MVA×2) which connected to the 132kV transmission line was established to replace the substation of the 66kV network.

The maximum load (maximum demand) on the new substation has been increasing since its completion in December 1996 (see Table 2). This is because the power demand in southern Kegalle including Ratnapura and Kahawatta areas has been

increasing with the progress of new town development in Ratnapura. This substation, which recorded an availability factor of 84.1%, has been responding to the sharp increase in demand.

If the power demand continues to increase at present rates, it will exceed the installed capacity of the substation. CEB is constructing Ratnapura Substation as a measure against overload at Avissawella Substation as part of its ongoing "transmission network improvement project" financed by Japan's ODA loan.

Table 2 Operation Status of Avissawella Substation

	1996	1997	1998	1999
Maximum load (MW)	5.3	32.9	40.4	48.2
Availability factor (%)	9.2	57.3	70.5	84.1

Source: CEB data

* Availability factor =maximum load (MW)÷installed capacity of substation (MVA)×power factor (0.91)

・Effect of the construction of Nuwara Eliya Substation

Nuwara Eliya Substation is a 132/33kV substation (31.5MVA×2) that was constructed to replace the 66/33kV substation along with the construction of 132kV transmission line to replace the existing 66kV transmission network (completed June 1996).

The availability factor of Nuwara Eliya Substation has been increasing as shown in Table 3. It meets the power demand from the milk plant in Nuwara Eliya, a bulk power customer, and 39,731 customers* in the city. If the ever-increasing maximum load were charged on the 66/33kV substation (3MVA×4) which was abolished when this substation started operating, planned outages ("load shedding") would be inevitable due to overload. In this regard, the construction of this substation has been highly effective.

* As of June 1999

Table 3 Operation Status of Nuwara Eliya Substation

	1996	1997	1998	1999
Maximum load (MW)	16.0	25.9	25.3	31.8
Availability factor (%)	27.9	45.2	44.2	55.5

Source: CEB data

・Effect of the construction of Panadura Substation

Panadura Substation (31.5MVA×2) was completed in December 1995 along the 132kV transmission line between Pannipitiya and Matugama Substations.

The operation status of transformers is shown in Table 4. This substation supplies electric power to Colombo. As the power demand in Colombo is increasing every year, the maximum load on the substation is also increasing. Consequently, the availability factor of the substation is rising every year. As a measure to prevent

overload, CEB is planning to install an additional 31.5MVA transformer in the future*.

* Long-term Transmission Line Development Plan (2000-2010)

Table 4 Operation Status of Panadura Substation

	1996	1997	1998	1999
Maximum load (MW)	16.5	17.6	19.7	28.1
Availability factor (%)	28.8	30.7	34.4	49.0

Source: CEB data

・Effect of the installation of additional transformers at Kolonnawa Substation

At Kolonnawa Substation, the existing 132/33kV transformer (installed capacity: 120MVA) was expected to be overloaded in 1999. As a result of the installation of additional transformers (completed 1996), the maximum load on the existing transformer in 1999 was confined to a reasonable level of 61.1MW and the availability factor was 56.0%.

This is because 22.7MW of the maximum load was shifted to the newly installed 132/33kV transformers (31.3MVA×2) under the project with the change in the distribution system. The maximum load on the additional transformers has been increasing as shown in Table 5, contributing to the stable power supply to commercial and industrial sector customers and to households in Colombo.

Table 5 Operation Status of Kolonnawa Substation

(only for newly installed transformers)

	1996	1997	1998	1999
Maximum load (MW)	1.5	6.8	17.0	22.7
Availability factor (%)	2.7	11.9	29.7	39.6

Source: CEB data

* Operating rate=maximum load (MW)÷installed capacity of substation (MVA)×power factor (0.91)

・Effect of the installation of additional transformers at Puttalam Substation

Before the implementation of the project, Puttalam Substation had only two 132/33kV transformers (10MVA). Two 31.5MVA transformers were installed under the project (completed 1996). The availability factor of the newly installed transformers has been rising gradually except in 1997 when the rate increased sharply to 37.7% due to a failure of the existing transformer. This substation meets the demand from a cement plant consuming 72GWh a year with a maximum load 10MVA, as well as from other customers in the Puttalam area.

Table 6 Operation Status of Puttalam Substation

(only for newly installed transformers)

	1996	1997	1998	1999
Maximum load (MW)	10.1	21.6	12.4	13.9
Availability factor (%)	17.7	37.7	21.6	24.3

Source: CEB data

(2.3.2.) Quantitative Effectiveness

Since the project was targeted at the improvement of the power transmission network system without targeting particular regions, it is difficult to identify its costs and benefits. Quantitative effectiveness has not therefore been evaluated.

(2.3.3.) Effect of Improvement of CEB's Dedicated Communication System

The improvement of CEB's dedicated communications system rendered the hitherto impossible communication between substations and the head office possible. The former communication system was mainly designed as a power line carrier system with a small-capacity communication line that often necessitated call restrictions, however, expansion was impossible because of signal quality. These problems have been solved by the establishment of a digital wireless system under the project. The new system is used for various purposes such as communicating information on the control of power generation, transmission and transformation, ordering spare parts necessary for facility maintenance, communicating information on charge collection and customer information, and trouble reporting. CEB intends to use the new communication system to connect each office to an online system which will enable data transmission and information communication. The information technology section of CEB is now working on the construction of such system.

2.4. Impact

(2.4.1.) Stabilization of Livelihoods and Promotion of Local Industry

If the construction and expansions to existing substation facilities mentioned above had not been made under this project, it is likely that load shedding would have become a frequent occurrence. The project is contributing to the stabilization of livelihoods and to the promotion of local industry by securing a stable power supply through effective measures to prevent overload on substations and transmission lines based on accurate forecasts.

(2.4.2.) Environmental Impact

The environmental law of Sri Lanka requires environmental impact assessment (EIA) to be performed prior to construction of transmission lines measuring 10km or more with a voltage of 50kV or more. The 132kV, 75km transmission line between

Laxapana, Nuwara Eliya and Badulla Substations under this project is subject to the above requirement. However, according to CEB, EIA has not been conducted because the transmission was constructed along the existing 66kV line and there were no particular problems involved.

CEB states that construction and expansion of substations have not had any particular impact on the environment on the ground used for new construction of substations on sites adjacent to existing substations, and that existing substations were expanded within their premises.

2.5. Sustainability

(2.5.1.) Operation and Maintenance

Maintenance of communication and power transmission facilities is performed by the power transmission and transformation facilities construction and maintenance department (207 employees) and the communication department (7 employees) of CEB. Periodic inspections are conducted in accordance with the maintenance manual provided by the contractor. Maintenance of the protection system is the duty of the facility protection department (11 employees) which conducts monthly visual examinations and annual performance tests.

CEB is planning to separate its organization into a hydraulic power generation company (Hydro Genco), a thermal power generation company (Thermal Genco), a power transmission company (Transco) and several distribution companies (Discos) and is considering the privatization of the thermal power generation company and distribution companies. The operation and maintenance of the project will be taken over by the power transmission company, which will remain public. Therefore, there will not be any significant changes in the operation and maintenance system.

(2.5.2.) Financial Status of CEB

Table 7 shows CEB's profit and loss statement for 1994 to 1998. Profits shrank in 1996 and 1997 when the availability factor of hydraulic power plants declined due to drought, and thermal power plants which use imported heavy oil were operated for longer periods. In addition, large sums were necessary to purchase electricity from IPP thermal power plant. CEB again started turning a profit in 1998. The fuel expenses and electricity purchase expenses, which were around Rp.900 million in 1994 and 1995, increased sharply to Rp.5.718 billion in 1996 and Rp.8.071 billion in 1997, squeezing the profit margin.

The financial cost rate, which was 21.8% in 1994, has gradually declined to 14.2% in 1998. The receivables turnover period is about 3 months and involves no particular problems.

Table 7 Profit and Loss Statement of CEB

(Rp million)

	1994	1995	1996	1997	1998
Electricity sales income	12,553	13,708	14,100	15,932	19,787
Other income	1,408	1,644	2,834	3,086	1,331
Total incomes	13,961	15,352	16,934	19,018	21,118
Fuel expenses, electricity purchase expenses, etc.	912	987	5,718	8,071	5,132
Operation and maintenance expenses	1,989	2,248	2,937	3,655	4,263
General and administrative expenses	1,147	1,102	1,600	2,003	1,891
Depreciation	3,362	3,694	4,223	4,815	4,872
Interest paid	2,741	2,324	2,360	2,464	2,806
Total expenses	10,151	10,355	16,838	21,008	18,964
Current pre-tax profits	3,810	4,997	96	(1,990)	2,154

Source: CEB data

(2.5.3.) Establishment of Transmission Network Development Plan

In Sri Lanka, most investment in power facilities was concentrated on power generation facilities and there were no medium or long-term plans for the development of transmission networks. In 1997, the Japan International Cooperation Agency (JICA) drew up a "Master Plan for the Development of a National Transmission Network" in which a development plan for 2015 was suggested.

The transmission planning bureau of CEB reviews JICA's master plan every year according to its estimate for power demand based on the government's projection for the GDP growth rate and the long-term power source development plan in order to establish a 10-year plan for the development of transmission networks. The current transmission network development plan for 2000-2010 consists of 56 projects with the total project cost estimated at Rs17.3 billion (including foreign currency portion Rs11 billion)*.

After the completion of this project, ODA loans were also provided for the "Transmission and Substation Development Project" and "Transmission and Substation Development Project II" in line with CEB's transmission network development plan, making a substantial contribution to the stable operation of the electric power system in Sri Lanka. There are plans to establish a nationwide transmission network including the section covered by this project under the

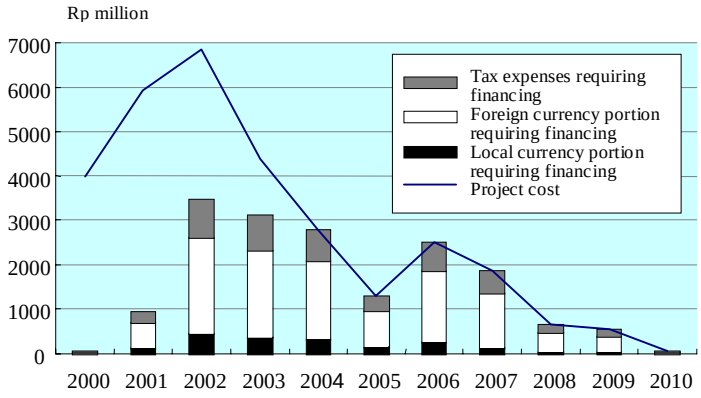


Figure 1 Project Cost Required for Transmission Network Development Plan

transmission network development plan. Therefore, the project is expected to further maintain its effectiveness.

* Based on prices as of 1999

Comparison of Original and Actual Results

	Plan	Results	
		Phase I (SL-P17)	Phase II (SL-P34)
1. Project scope	Construction of 132kV transmission lines		
	Laxapana-Nuwara Eliya Substations: 36km, double circuit	As planned	–
	Nuwara Eliya-Badulla Substations: 39km, double circuit	As planned	–
	Existing line-Panadura Substation: 7km, double circuit	As planned	–
	Existing line-Avissawella Substation: 0.5km, double circuit	As planned	–
	Inginiyagala-Ampara Substations: 38km, single circuit		Excluded due to deteriorated security
	Construction of 132/33kV substations		
	Panadulla: 2×31.5MVA	As planned	–
	Inginiyagala: 2×10MVA	Cancelled due to change in plans	–
	Avissawella: 2×31.5MVA	As planned	–
	Nuwara Eliya: 2×31.5MVA		As planned
	Ampara: 2×10MVA		Excluded due to deteriorated security
	Expansion of 132/33kV substations		
	Badulla: 132kV line bay, etc.	As planned	–
	Kolonnawa, Puttalam: 2 transformers	As planned	–
	Thulukiriya: 2 transformers		Separately implemented at expense of the executing agency
	Laxapana: 4 transformers		Separately implemented at expense of the executing agency
	Wimdasrendra: 2 transformers		Separately implemented at expense of the executing agency
	Trincomalee, Matugama: 2 transformers		Separately implemented at expense of the executing agency
	Improvement of system protection system		
	Katuyanake		Separately implemented at expense of the executing agency
	Pannipitiya		As planned
	Kolonnawa	As planned Puttalam was added	– Matugama and Polpitiya were added
	Installation of additional 33kV line bays		
	Matugama		Separately implemented at expense of the executing agency
	Biyagama		As planned
	Ukuwela		As planned
	Kilinochchi		Excluded due to deteriorated security
	Chunnakam		Excluded due to deteriorated security
	Galle	As planned	–
	Kotugoda		As planned
	Udawallawe		As planned
	Bolawatte		
	Total 25 circuits		
	Establishment of communication systems		
	CEB dedicated trunk digital wireless system	Completed in Phase I with no substantial change from initial plan	–
	CEB dedicated mobile wireless system		
	Consulting services: total 140M/M	Total of Phase I and II 168.7M/M	
2. Implementation schedule	April 1989 to March 1991 (24 months)	February 1993 to December 1998 (71 months)	

Item	Plan	Actual		
		Phase I (SL-P17)	Phase II (SL-P34)	Total
3. Project cost				
Foreign currency	¥4.360 billion	¥3.831 billion	¥658 million	¥4.489 billion
Local currency	Rp354 million	–	–	Rp1.618 billion
Total	¥5.964 billion	–	–	¥7.573 billion
ODA loan portion	¥4.360 billion	¥3.831 billion	¥658 million	¥4.489 billion
Exchange rate	Rp1.0= ¥4.515 (1987)	–	–	Rp1.0= ¥1.906 (1995)