Democratic Socialist Republic of Sri Lanka

FY2018 Ex-Post Evaluation Report of Japanese ODA Loan

"Vavuniya-Kilinochchi Transmission Line Project (Phase I and II)"

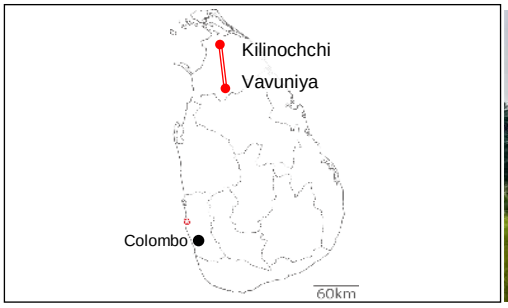
External Evaluator: Hajime Sonoda, Global Group 21 Japan, Inc.

0. Summary

The "Vavuniya-Kilinochchi Transmission Line Project (Phase I and II)" (hereinafter referred to as "the Project") was implemented with the aim of ensuring stable electricity supply to consumers by reconstructing part of the heavily damaged transmission lines due to the civil conflict, which connects the power grid of the northern Sri Lanka to the national grid, thereby contributing to peace building of the northern province through improving the living environment and stimulating economic activities. At the time of both the ex-ante and the ex-post evaluation, the Project is highly consistent with the policies and development needs of Sri Lanka, in terms of recovery from civil conflict, etc. The Project was consistent with Japan's ODA policy at the time of appraisal, which emphasised providing assistance to recovery. Therefore, relevance of the Project is high. Although the project cost was kept within the plan, despite the addition of outputs, the project period far exceeded the plan. Therefore, efficiency of the Project is fair. The electrification rate of target areas has improved dramatically, and by being connected to the national grid, a stable power supply has been achieved. This has contributed to an improvement in security due to the installation of street lights, an improvement in the learning environment for children, and improved living conditions through an increase in activities to improve the standard of living such as home industry and home gardens. The Project has also resulted in improvements in medical, educational and administrative services, which was an important condition for promoting the return of refugees due to the internal conflict, and the reconstruction of Northern Province. Therefore, the effectiveness and impact of the Project is high. No problems have been observed in the institutional/organizational, technical or financial aspects of operation and maintenance of the Project, and there are no problems in terms of the status of operation and maintenance. Therefore, sustainability of the Project is high.

In the light of the above, the Project is evaluated to be highly satisfactory.

1. Project Description



Project Location

Vavuniya-Kilinochchi Transmission Line

1.1 Background

The Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Sri Lanka") had, since 1983, been in the grip of civil conflict which lasted many years between government forces and the Liberation Tigers of Tamil Eelam (LTTE). The LTTE is an anti-government armed group made up of minority Tamils living mainly in the northern and eastern parts of Sri Lanka. It was engaged in activities with a view to achieving the separation and independence of the northern and eastern parts of the country. This resulted in approximately 60,000 deaths and more than 800,000 internal refugees over a 20-year period, in addition to the destruction of a great deal of infrastructure, including power facilities. At a conference concerning the reconstruction of Sri Lanka held in Tokyo in 2003, in response to the ceasefire agreement of February, 2002, *Tokyo Declaration on Reconstruction and Development of Sri Lanka* (hereinafter referred to as "the Tokyo Declaration") was adopted as the decision agreed to by the international community with respect to the promotion of the peace process in Sri Lanka. In this declaration, international aid totalling approximately 4.5 billion USD was announced for the four-year period of 2003 to 2006, and the Japanese government promised support of a maximum of 1 billion USD from 2003 to 2005. The loan agreement for the Project (Phase I) was signed in June, 2005 as a part of this aid. In subsequent months, the ceasefire agreement broke down and fighting intensified once more, resulting in the suspension of the Project, after which the additional loan agreement (Phase II) was signed in March, 2011.

1.2 Project Outline

The objective of the Project is to achieve a stable supply of power by repairing part of the transmission line connecting the power grid of the northern part of Sri Lanka to the national grid, thereby contributing to the reconstruction and recovery of the Northern Province through improving the living environment and stimulating economic activities.

Loan Approved Amount/ Disbursed Amount	(Phase I) 1,278 million yen/1,255 million yen (Phase II) 1,422 million yen/1,364 million yen		
Exchange of Notes Date/Loan Agreement Signing Date	(Phase 1) June 2005/June 2005 (Phase II) March 2011/March 2011		
Terms and Conditions	Interest rate	(Phase I) (Phase II)	0.75%, Main component: 0.65%, Consultant component: 0.01%
	Repayment period (grace period)	Main component: 40 years (10 years)	
	Procurement conditions	General untied	

Borrower/ Executing Agencies	Democratic Socialist Republic of Sri Lanka / (Phase I) Ceylon Electricity Board (CEB), Ministry of Relief, Rehabilitation and Reconciliation (Phase II) Ceylon Electricity Board (CEB)
Project Completion	November 2016
Target Area	Part of Sri Lanka's Northern Province (Vavuniya District, Kilinochchi District)
Main Contractors	Mitsubishi Corporation (Japan) / LTL Projects (PVT) Ltd. (Sri Lanka) (JV)
Main Consultants	Nippon Koei Co., Ltd. (Japan)
Related Studies	Implementation Plan (2004, CEB)
Related Projects	Conflict-Affected Area Rehabilitation Project (Asian Development Bank: ADB, 2003-2011)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda (Global Group 21 Japan, Inc.)

2.2 Duration of Evaluation Study

The ex-post evaluation study for the Project was conducted over the following period.

Duration of the Study: September 2018 to August 2019

Duration of the Field Study: 11th November to 21st December, 2018,
17th to 27th February, 2019

3. Results of the Evaluation (Rating: A[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Consistency with the Development Plan of Sri Lanka

（1） Policy for National Development and Development of the Power Sector

At the time of the appraisal of the Project (Phase I) (2005), the *New Economic Framework*, the economic development strategy announced by the Government of Sri Lanka in July, 2004 cited the promotion of agriculture, livestock farming, fisheries, industry and tourism utilising Sri Lanka's resources, the promotion of small and medium-sized enterprises, the development of nationwide infrastructure (including the power sector) and the development of a safety net to protect the socially vulnerable. Sri Lanka's national development plan, the *Mahinda Chintana: Ten Year Horizon Development Framework 2006-2016* had, as goals to be achieved by 2016, a grid electrification rate of 85%, improved efficiency of power supply, and the deployment of a

[1] A: "Highly satisfactory", B: "Satisfactory", C: "Partially Satisfactory", D: "Unsatisfactory"
[2] ③: "High", ②: "Fair", ①: "Low"

transmission and distribution grid to improve reliability, while the *National Energy Policy* (2008) cited goals with respect to power transmission of: improving energy efficiency; appropriate connection of renewable energies to the national grid; and reduction in transmission and distribution loss. In *Vision 2025*, the economic development plan announced by the government in September 2017, announced: the preparation and implementation of a long-term power generation plan in order to supply inexpensive, highly reliable power in response to the demand for power which would increase in response to the electrification rate reaching 99%; and the active introduction of renewable energies.

（２） Recovery and Reconstruction Plan for Northern Sri Lanka

As already discussed in "1.1 Background", a ceasefire agreement was achieved in February 2002 with a view to ending internal conflict, before the time of appraisal of the Project (Phase I) in 2005. In response, in June 2002 the Government of Sri Lanka formulated *The National Framework for Relief, Rehabilitation and Reconciliation (RRR)*, which aimed to satisfy the basic human needs (BHN) of victims of the civil conflict[3], rebuild living and productive activities and promote ethnic reconciliation. Part of this framework involved rebuilding infrastructure such as roads, power, water supply and sewerage, medical and educational facilities damaged by the civil conflict, in addition to demining operations. However, 2007 saw an intensification of conflict between the Government of Sri Lanka Army and the LTTE, with severe fighting taking place in the northern part of the country. Ultimately, the Government Army overcame all of the LTTE's major bases, bringing an end to the 26-year long civil conflict in May 2009, and bringing the entirety of northern Sri Lanka under government control[4]. *The Northern Sri Lanka Recovery and Reconstruction Plan* (July, 2009) formulated by the Government of Sri Lanka to promote post-conflict recovery and reconstruction cites the connection of the Northern District to the national grid and the construction of power stations and rehabilitation and expansion of the power distribution grid as part of the infrastructure development vital for rebuilding lives, in order to promote the return and resettlement of approximately 300,000 internal refugees.

As outlined above, at the time of the ex-ante evaluation and the time of the ex-post evaluation, the Project is highly consistent with the policy of the Government of Sri Lanka.

3.1.2 Consistency with the Development Needs of Sri Lanka

As discussed in "1.1 Background" above, power-related facilities in the northern part of Sri Lanka sustained heavy damage as a result of the civil conflict. As of 2005, due to the destruction of transmission lines, Kilinochchi and Jaffna districts were not able to be supplied with power

[3] BHN refers to basic human needs, including food, clothing and shelter, education, health and employment.
[4] The implementation of the Project was suspended in November 2006 due to the intensification of civil conflict, but was restarted in May 2009 after the end of civil conflict, and in June 2011 an additional ODA loan (Phase II of the Project) was disbursed (refer to "3.3 Effectiveness and Impacts").

from the national grid, and power needs were covered by expensive independent power producers (IPP) and diesel power generation. In addition, 90% of power distribution facilities sustained damage, and the household electrification rate remained low at 22%. The lack of power facilities made it impossible to use cold storage refrigerators, which was a major obstacle to fisheries, one of the main industries of northern Sri Lanka. Thus, at the time of the appraisal, the restoration of power facilities was an issue which needed to be addressed urgently[5].

Subsequently, with the end of civil conflict in 2009, there were no longer any areas controlled by the LTTE, and the area supplied with power by CEB expanded to the entirety of Northern Province. As a result, demand for power in Northern Province increased. In CEB's *Long Term Transmission Development Plan 2015-2024* at the time of ex-post evaluation, the plan is for transmission lines constructed during the Project to continue to supply power to Northern Province, as part of the national grid. In addition, as will be mentioned below in "3.3 Effectiveness and Impacts", transmission facilities constructed by the Project are vital for the stable supply of power in Northern Province, and the need and importance of these facilities remains unchanged at the time of the ex-post evaluation.

Therefore, the Project is highly consistent with the country's development needs both at the time of planning and the time of the ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

As already mentioned in "1.1 Background" above, the Japanese government announced support of 1 billion USD over three years at the *Tokyo Declaration on Reconstruction and Development of Sri Lanka* (June 2003) in order to promote the peace process in Sri Lanka. The Japanese government's revision of the *Japan's ODA Charter* in September, 2003 placed priority on "Peace-Building", while the *Country Assistance Program for Sri Lanka* (April, 2004) cited assistance to consolidate peace and support recovery. In response to this situation, and in line with the policy of effectively aiding peace-building, JICA has provided support for recovery and reconstruction by expanding target areas for existing ODA loan projects in Sri Lanka and including the northern and eastern parts of the country as target areas for new projects. The Project entails the reconstruction of infrastructure directly destroyed by civil conflict, and is consistent with JICA's policy with regard to supporting reconstruction and recovery. In addition, the *Medium-term Strategy for Overseas Economic Cooperation Operations* (April 2005) positioned "infrastructure development with a view to economic growth" as an important sector, and laid down the policy of providing support for the promotion of economic growth through the development of economic

[5] According to the *Assessment of Needs in the Conflict Affected Areas-Districts of Jaffna, Kilinochchi, Mullaitivu, Mannar, Vavuniya, Trincomalee, Batticaloa and Ampara* jointly implemented by UN agencies, the World Bank and the Asian Development Bank in 2003, in northern Sri Lanka, there was a need for the construction of a 40 MW-60 MW power station, an urgent need for rehabilitation of the transmission lines between Vavuniya, Kilinochchi and Chunnakam, and of Kilinochchi and Chunnakam Grid Substations, along with the rehabilitation and expansion of other substations and distribution grids.

and social infrastructure, including power.

Therefore, the Project is highly consistent with Japan's ODA policy.

In light of the above, the Project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The planned and actual outputs of the Project are shown in Table 1. The original plan was modified when disbursing the additional ODA loan in 2010 (Phase II of the Project) (hereinafter referred to as "the modified plan"), and outputs were achieved in accordance with that modified plan. Moreover, project cost was compressed by competitive bidding and other reasons, and unused ODA loan funds remained, so substation spare parts were procured and Kilinochchi Grid Substation was expanded.

In the original plan, there was a need for demining of substation sites and within 30 meters directly beneath transmission lines. At the time of planning of the project, in Sri Lanka the National Mine Action Centre (Ministry of Relief, Rehabilitation and Reconciliation) was pushing ahead with demining in cooperation with an international NGO, and as there was a need to perform demining of the project site in the Project, a service agreement was concluded with the international NGO. However, with the intensification of civil conflict in 2006, implementation of this agreement was suspended, and the service agreement was rescinded. The implementation was restarted after the end of the civil conflict in 2009, but international NGOs were forbidden from entering the target areas of the Project. As a consequence, demining was performed by CEB with the cooperation of Government of Sri Lanka forces. The civil engineering work of the Project was implemented after obtaining a demining certificate from the UN Mine Action Service.

The modifications to the plan at the time of the additional ODA loan were in response to: the increase in future demand for power due to the expansion of government-controlled areas (areas to which power is supplied) resulting from the end of civil conflict, compliance with higher reliability standard (N-1 standard) due to the increased need for power supply to Northern Province as it entered the reconstruction phase[6], modification to standards in accordance with the standardization of CEB's transmission facilities, and modification to the location of the Kilinochchi Grid Substation (the constraints due to the civil conflict were lifted, and the substation was returned to its previous location, which was more convenient). All of these modifications were deemed appropriate.

[6] N-1 standard refers to the planned standard for "uninterrupted supply of power even if one facility within a power system fails as a result of an accident". For example, if a plurality of transformers is provided, as long as there is not excessive power demand, if one transformer goes out of service, it is possible to continue to supply power using other transformers.

Table 1 Planned and Actual Outputs

Original Plan	Original Plan	Modified Plan (At time of additional ODA loan)	Actual
Reconstruction of transmission line (132kV) Conductor standard/cross section Span length	 ACSR 200 mm^2 66 km	 ACSR 400 mm^2 73 km	 As per the modified plan
Reconstruction of Kilinochchi Grid Substation 132kV transformer bay 132/33kV 31.5MVA transformer 33kV transformer bay 132kV line feeder bay 33kV distribution line feeder bay	 1 1 1 2 4	 2 2 2 4 8	 As per the modified plan
Expansion of Vavuniya Grid Substation 132kV line feeder bay	 0	 2	 As per the modified plan
Transmission facility spare parts	Unplanned	Unplanned	Transformers, circuit breakers, insulators, etc.
Expansion of Kilinochchi Grid Substation	Unplanned	Unplanned	Addition of 1 132kV transformer, etc.
Consulting Service	Detailed design review, support for tender, construction supervision	Detailed design review, support for tender, construction supervision	As planned
Demining	Implemented by international NGO (within scope of ODA loan)	Implemented by executing agency (outside scope of ODA loan)	Implemented by executing agency (outside scope of ODA loan)

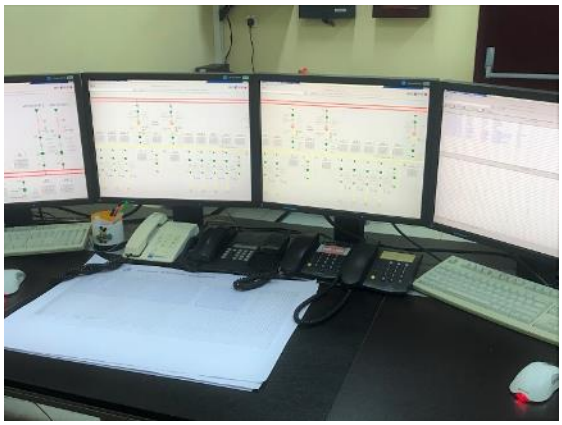
Source: Materials provided by JICA and CEB

The spare parts procured additionally are the standard spare parts used by CEB. Although not restricted to use in the substations and transmission lines of the Project, the spare parts are used to appropriately maintain the function of the national grid, including the Project, and their addition is not deemed to be problematic.

The expansion of the Kilinochchi Grid Substation involved the addition of a dedicated transformer for connecting wind power stations (10 MW x 2) in the northern part of the country to the national transmission grid, which was in accordance with the planning criteria for assuring quality of electric power[7]. This expansion contributed to the utilization of the Kilinochchi Grid

[7] Wind power generation, which is affected by meteorological conditions, has considerable fluctuations over the short term in the amount of power generated, and if connected directly to a transformer for distributing limited power demand may cause large fluctuations in voltage. However, if directly connected to the national grid via a dedicated transformer, the impact of such fluctuations is minimized, and problems are less likely to occur.

Substation constructed as part of the Project, and its addition was therefore not deemed to be a problem. However, according to CEB, the wind power stations were still connected to a distribution transformer rather than a dedicated transformer at the time of the ex-post evaluation, as no grave operational impact on the quality of electric power has been seen to date even without using the dedicated transformer.

Kilinochchi Grid Substation: (left) Transformer facilities, (right) Monitoring panel

3.2.2 Project Inputs

3.2.2.1 Project Cost

Planned project cost (Phase I) was 1,704 million yen (1,689 million yen excluding administrative expenses). The planned amount at the time of the appraisal for the additional ODA loan (Phase II) increased as a result of expanded project scope and a sharp rise in materials prices during the project period, to 3,829 million yen (3,733 million yen excluding administrative expenses).

Actual project cost (excluding administrative expenses) was 3,011 million yen, but this amount included 904 million yen for spare parts and the cost of the additional transformer for Kilinochchi Grid Substation. Deducting these expenses gives an actual project cost of 2,107 million yen. This is 418 million yen greater than the planned figure for the Phase I (1,689 million yen excluding administrative expenses), but only 56% of the figure in the modified plan (3,733 million yen excluding administrative expenses). On the other hand, an increase in project costs due to civil conflict (force majeure) was estimated as not exceeding 201 million yen[8], and excluding this

[8] At the time of the appraisal of Phase I of the Project, annual inflation of 1.4% was planned, but the rate of increase in materials prices was an average of 17% annually for the period during which work was suspended due to the intensification of fighting (31 months). In light of the above, the rise in materials prices exceeding that of the plan during this period is calculated as approximately 48%. Therefore, the increase in project cost due to force majeure (increase in cost caused by increase in prices exceeding assumptions during the period during which work was suspended) may be considered not to exceed 48% of 418 million yen, the increase in project cost excluding spare parts, the additional transformer for Kilinochchi Grid Substation and administrative expenses. That is to say, a maximum of approximately 201 million yen.

figure, actual project cost (excluding administrative expenses, and the cost of spare parts and the addition of a transformer at Kilinochchi Grid Substation) was more than 1,906 million yen, more than 51% of the figure in the modified plan excluding administrative expenses (3,733 million yen). As a result, the actual project cost (excluding administrative expenses and the cost of spare parts and the additional transformer at Kilinochchi Grid Substation) was within the range of 51-56% of the plan. Therefore, efficiency of the project cost is high.

Table 2 Planned and Actual Project Cost

(units: million yen)

	Original Plan (2004)		Modified Plan (2010)		Actual	
	Total	ODA Loan	Total	ODA Loan	Total	ODA Loan
Civil works, procurement of materials (of which expenses for the procurement of additional spare parts and for the expansion of Kilinochchi Grid Substation)	1,088	1,088	2,590	2,446	2,514 (904)	2,475 (904)
Demining	104	104	0	0	19	0
Price increase	29	0	124	88	0	0
Physical contingency	122	0	269	0	0	0
Consulting Service	69	69	110	110	101	101
Administrative Expenses	15	0	96	0	Unknown	0
Taxes, customs duties, interest and commitment charge	277	17	640	56	377	43
Total (total excluding administrative expenses) (total excluding administrative expenses, costs for additional spare parts and expansion of Kilinochchi Grid Substation)	1,704 (1,689) (1,689)	1,278	3,829 (3,733) (3,733)	2,700	3,011 (3,011) (2,107)	2,619

Source: Materials provided by JICA and CEB

According to CEB, the main reasons for the project cost (excluding administrative expenses, and the cost of spare parts and the additional transformer at Kilinochchi Grid Substation) being dramatically lower than the plan are as follows.

- At the time of planning, a detailed geological survey was impossible due to land mines, and plans were made assuming the foundations for transmission line pylons were all to be built on soft ground. In practice, however, soft ground was less prevalent than assumed, which meant foundations were constructed more inexpensively than thought.
- Competitive bidding resulted in a dramatic drop in prices.
- The price of steel dropped after peaking in 2008.
- Demining costs were reduced by the direct implementation of the executing agency.

3.2.2.2 Project Period

The Project was planned to be implemented over a 34-month period from the signing of the loan agreement in June 2005 to March 2008. However, the Project actually started operation in September, 2012 (88 months after the signing of the loan agreement), and the additional procurement of spare parts and the expansion of Kilinochchi Grid Substation were completed in November 2016 (138 months after the signing of the loan agreement). The reasons why the duration of the Project was much longer than expected were as follows; after commencing the Project, the intensification of the conflict resulted in the Project being suspended for a period of 31 months (November 2006 to May 2009); and this suspension of the Project meant that the procurement of consultants and civil works took time, delaying the start of civil works by more than 4 years from the original plan. On the other hand, the construction period for the main component of the Project was shorter at 28 months (June 2010 to September 2012) than the 30 months stipulated in the modified plan, and work progressed according to plan without any particular problems.

The delay due to the suspension of 31 months was a direct impact of force majeure (intensification of the conflict), and was therefore not taken into account when determining the efficiency of the project period. Additionally, the Project was completed with the commencement of operation of transmission facilities, so the additional portion (procurement of spare parts and expansion of Kilinochchi Grid Substation) were not taken into account in determining the efficiency of the project period of the Project. Therefore, the effective project period of the Project was 57 months (88 months less 31 months), 168% (57 months divided by 34 months) of the planned period. Therefore, the efficiency of the project period of the Project is low.

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

At the time of the appraisal for the additional ODA loan for the Project (2010), the economic internal rate of return (EIRR) was estimated as 7.8%, based on the following assumptions.

- Costs: Project cost (excluding taxes), operation and maintenance costs
- Benefits: Reduction in alternative power generation costs
- Project life: 25 years

In the ex-post evaluation, EIRR, when recalculated on the basis of the same assumptions, was 17.9%, exceeding expectations at the time of the appraisal. The reasons for this were as follows; the initial investment was only 60% of the planned amount; although the amount of power supplied from Kilinochchi Grid Substation was lower than planned (refer to "3.3 Effectiveness and Impacts"), the construction of a coal-fired power station reduced the power generation cost of those areas connected to the grid, which increased the benefit due to reduced alternative power generation costs (the difference between the power generation cost by heavy oil that would be

required if the Project was not in place, and the cost of supplying power through the national grid as a result of the Project).

Financial internal rate of return (FIRR) was not calculated, since there was no need to independently maintain or ensure the financial return.

In light of the above, although the project cost was within the plan, the project period significantly exceeded the plan. Therefore, efficiency of the Project is fair.

3.3 Effectiveness and Impacts[9] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

The Project (Kilinochchi Grid Substation and Vavuniya-Kilinochchi Transmission Line) started operation in September 2012, re-connecting Kilinochchi and Mullaitivu districts of the Northern Province to the national grid. The Chunnakam Substation and Kilinochchi-Chunnakam Transmission Line constructed by the related project (*Conflict Affected Area Rehabilitation Project* executed using an ADB loan, hereinafter referred to as the "ADB Loan Project") subsequently started operation in September 2013, re-connecting Jaffna district of Sri Lanka's Northern Province to the national grid.

The aim of the Project is to achieve a stable power supply in the target areas. At the time of the appraisal, facility outage time of Kilinochchi Grid Substation (hours/year), transmission losses (%) between Vavuniya and Kilinochchi and maximum demand (MW) of Kilinochchi Grid Substation were set as operation and effect indicators[10]. In the ex-post evaluation, in addition to the above, household electrification ratio (%) of target areas, number of consumers, power consumption (GWh/year), the average number (times/year) and duration (hours/year) of interruption per customer were analysed.

(1) Facility Outage Time

The targets and actual results for facility outage time of the Project are shown in Table 3. The target for the planned facility outage time was the outage time required when implementing the standard maintenance work of CEB. Unplanned outages (outages caused by lightning or accidents such as equipment malfunction) were assumed not to occur.

[9] Rating of effectiveness was carried out also taking into account impact.

[10] Indicators were set at the time of the appraisal of the Phase I (2005), and revised at the time of the appraisal of Phase II (2011). In the ex-post evaluation, analysis is performed based on the latter. Availability factor was given as one of the indicators, but this is calculated automatically from the outage time and was therefore omitted to avoid duplication.

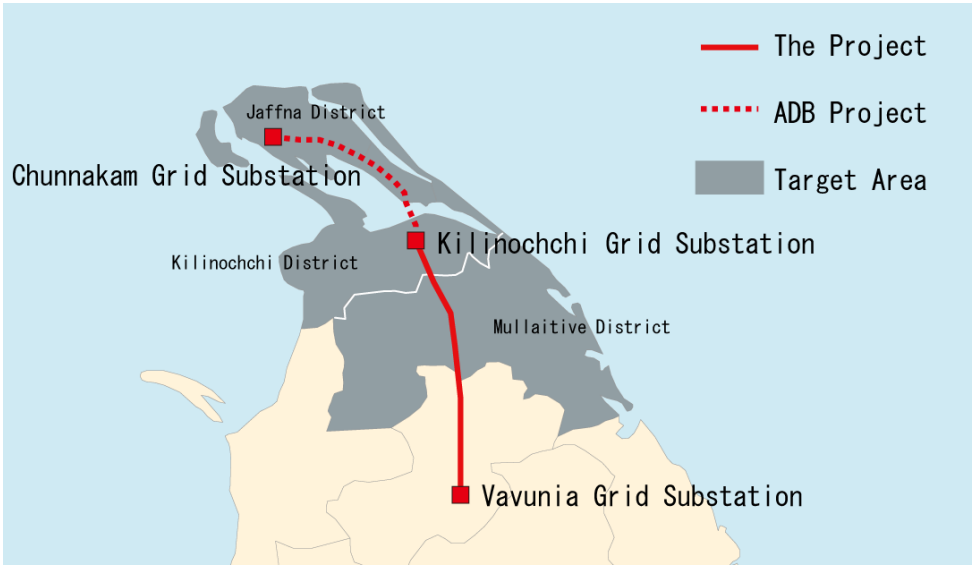


Figure 1　Location of Target Areas and Facilities of the Project

Table 3　Planned and Actual Facility Outage Times

(units: hours/year)

		Target	Actual		
			2016	2017	2018
Transmission lines (Between Vavuniya-Kilinochchi, average of two circuits)	Planned outage	40	14.0	8.0	35.0
	Unplanned outages	0	0.3	0.3	2.0
Transformers (Kilinochchi Grid Substation, average of 3 transformers)	Planned outage	32	86.7	16.0	24.0
	Unplanned outages	0	0.0	0.0	1.9

Source: Materials provided by CEB

The planned outage time of the Vavuniya-Kilinochchi Transmission Line has been less than 40 hours since 2016, achieving the target. Maintenance work is performed by stopping one of the two circuits at a time, so power supply is never stopped. In 2016 and 2017, there were unplanned outages due to the activation of protective systems due to unplanned outages in other transmission lines connected to Vavuniya Substation, and power transmission was stopped for approximately 20 minutes in each of these cases. According to CEB, the protective system has subsequently been improved, and such unplanned outages no longer occurred. In 2018, both circuits were stopped due to lightning strikes, and power transmission was stopped for approximately 2 hours.

Among the transformers at Kilinochchi Grid Substation, rust was found on part of one transformer in an inspection in 2016, and said part was removed and repaired to prevent accidents. As a consequence, planned outage time for 2016 far exceeded the target, but there was no impact on power distribution. According to CEB, this is a rare occurrence, and no similar problems have subsequently been found. The planned outage time since 2017 has been 32 hours or less, achieving

the target. In 2018, a crow came into contact with part of a transformer, causing a short circuit and an outage of one transformer, but there was no impact on power distribution. Aside from that, there were no unplanned outages of transformers. In substation maintenance transformers are stopped one after another, but due to the facility configuration with N-1 standard, as long as demand does not exceed the capacity of other transformers, power distribution is not stopped.

In light of the above, although planned outage times were not achieved for some of the facilities of the Project, and unplanned stoppages due to external factors generated an impact on power distribution, the facilities are generally deemed to be operated appropriately.

(2) Frequency and Duration of Interruptions

As additional indicators of the stable supply of power, data for the frequency (average number of interruptions per customer) and the duration (average duration of interruptions per customer) of interruptions for the areas supplied with power by Kilinochchi Grid Substation and Chunnakam Grid Substation (respectively referred to as "Kilinochchi Area" and "Chunnakam Area") was obtained from CEB (Table 4)[11].

Table 4 Frequency and Duration of Interruptions in Kilinochchi and Chunnakam Areas

	Kilinochchi Area (Area supplied by Kilinochchi Grid Substation)			Chunnakam Area (Area supplied by Chunnakam Grid Substation)		
	2016	2017	2018	2016	2017	2018
Average number of interruptions per customer (per year)						
All causes	40.1	29.2	35.5	55.8	45.7	34.6
Caused by generation	8.4	6.7	0.0	10.0	8.2	0.0
Caused by transmission	10.4	1.1	1.3	12.6	1.4	3.8
Caused by distribution	21.3	21.4	34.1	33.2	36.0	30.7
Average duration of interruptions per customer (hours/year)						
All causes	92.6	44.7	100.6	103.7	56.9	93.6
Caused by generation	20.1	6.0	0.8	24.3	7.6	0.3
Caused by transmission	19.0	0.4	2.8	20.8	0.5	4.4
Caused by distribution	53.5	38.3	97.0	58.6	48.8	89.0

Source: Prepared by evaluator on the basis of materials provided by CEB

Note: Data obtained from CEB for the number and duration of interruptions for each grid substation for each month was missing data for September 2016, January and August to October 2017, and September to December 2018, so the number and duration of interruptions were calculated on the basis of the data obtained.

[11] CEB calculated the average frequency and duration of interruptions per customer in the supply area for each grid substation from 2016, by cause of interruptions, such as power generation, transmission and distribution. However, reference values (target values) are not stipulated.

In Kilinochchi Area, interruptions occurred approximately 36 times in 2018, for a total of 101 hours. Almost all of these interruptions occurred in the distribution grid. Interruptions caused by transmission occurred 1.3 times for a total of 2.8 hours, which was minimal. In Chunnakam Area, there were approximately 35 interruptions for a total of 94 hours in 2018, and similarly the vast majority of these occurred in the distribution grid. As mentioned above, interruptions directly caused by the Project were only approximately 2 hours in 2018 and they were caused by lightning[12].

In 2016, interruptions caused by power generation and transmission occurred for approximately 20 hours in both Kilinochchi Area and Chunnakam Area. This is thought to be because after a large-scale power outage affecting the entire national grid occurred in March 2016, time was required to restart operation of the coal-fired power station which was subjected to an emergency outage and the transmission grid (outside the scope of the Project). The average interruption time per customer in 2016 excluding Colombo was approximately 81 hours, reaching as high as 120 hours in some areas, and the performance of the target areas of the Project (92.6 hours for Kilinochchi Area and 103.7 hours for Chunnakam Area) were not particularly high.

In light of the above, the Project (Vavuniya-Kilinochchi Transmission Line) is considered to be making an adequate contribution to the stable supply of power to the areas supplied by Kilinochchi Grid Substation and Chunnakam Grid Substation.

(3) Transmission Losses (Reference Indicator) [13]

The transmission losses of the Project was assumed to be a maximum of 0.82% two years after project completion, on the basis of numerical values at the time of basic design. Since there is no data obtained by directly measuring this value, a provisional estimate was made on the basis of transmission performance in 2017 and the constructed transmission facilities giving the value at 0.22%, a result which was below target values.

(4) Maximum Demand (Peak Power)

The maximum demand of Kilinochchi Grid Substation increased from 10 MW in 2013 immediately after commencing operation (September 2012) to 17 MW in 2018. This represents an increase of 70%, an increase far exceeding the nationwide increase in maximum power for this period (17% increase from 2013 to 2016). However, compared to the maximum demand (56 MW) in 2018 for the Kilinochchi Grid Substation projected at the time of the appraisal of Phase II of the Project, the actual figure of 17 MW was only 30% of the projected value. According to CEB,

[12] The reason why there were more interruptions due to power transmission in 2018 in Chunnakam Area than Kilinochchi Area is (Table 4), according to CEB, that in February 2018 the Kilinochchi-Chunnakam transmission line sustained an unplanned outage of several hours due to a kite.

[13] Transmission losses were set as an indicator to see whether facilities are being operated appropriately. However, as this is not an indicator that is directly related to the objective of the Project, and there is no actual measurement data for this indicator, it is only used as a reference indicator in the analysis of effectiveness.

this is attributable to the delay in the realization of large-scale demand such as factories which were assumed at the time, and low power utilization by resettled refugees. It is also possible that the accuracy of demand projection at the time of the appraisal was not high[14]. Although outside the scope of this indicator, maximum demand for Chunnakam Grid Substation in 2018 was 47 MW (61% of the projected figure) compared to the projected 77 MW.

Table 5 Maximum Demand by Substation (Peak Power)

(units: MW)

		2013	2014	2015	2016	2017	2018
Kilinochchi Grid Substation	Projected	37	40	44	48	50	56
	Actual	10	14	14	14	16	17
Chunnakam Grid Substation	Projected	48	53	58	65	71	77
	Actual	42	36	32	38	44	47
(Reference) Nationwide	Actual	2,164	2,152	2,283	2,453	2,523	Unknown

Source: Materials provided by CEB

Note: The actual figures for 2018 was the figures up to the end of October. Projected values were the estimation at the time of the appraisal of Phase II of the Project.

(5) Household Electrification Rate and Number of Benefiting Households

The Government of Sri Lanka was promoting electrification by pushing ahead with the construction of the distribution network and exempted resettled refugees from fees for connecting to the power service in a bid to achieve rapid reconstruction and recovery after the civil conflict. As a result, the household electrification rate of the three districts benefiting from the Project, Jaffna, Kilinochchi and Mullaitivu, reached 95% or more by the end of 2017 (Table 6). Among these, the household electrification rate of Kilinochchi and Mullaitivu Districts mainly supplied by Kilinochchi Grid Substation improved dramatically from 18% in 2010 to 95% in 2017.

Table 6 Trends in Household Electrification Rate of Target Areas

	2010	2011	2012	2013	2014	2015	2016	2017
Jaffna District	66%	72%	82%	84%	89%	96%	98%	99%
Kilinochchi District	18%	25%	40%	40%	85%	84%	92%	95%
Mullaitivu District	18%	25%	40%	40%	85%	87%	92%	95%

Source: Materials provided by CEB

[14] Details on the method used by CEB in making this demand projection was not obtained. In the most recent demand projection by CEB (*Long-term Transmission Plan*, December 2015), the maximum demand for Kilinochchi Grid Substation and Chunnakam Grid Substation in 2018 were estimated as 18.3 MW and 45.5 MW respectively, which represented dramatic downward revisions. In this demand projection, maximum demand for each substation was estimated based on past tendencies for increased demand and specific forecasts for large-scale demand (industry, medical institutions and educational/research institutions, etc.). The target areas of the Project were subject to the specific situation of being in the immediate aftermath of civil conflict, and with an absence of past demand data and difficulty of making forecasts for the achievement of large-scale demand, it was impossible to adapt similar methods at the time of the appraisal. The maximum demand for Kilinochchi Grid Substation in 2018 was able to be covered with one transformer (one transformer can handle a maximum demand of approximately 25 MW), but two transformers are required to ensure reliability according to N-1 standard.

Through the Project, power services were expanded and improved in areas supplied with power by Kilinochchi Grid Substation and Chunnakam Grid Substation. This is attributable to a synergy between the related project involving the construction of a transmission line to Chunnakam Grid Substation (ADB Loan Project), expansion of the distribution grid by CEB, and the Project.

In Kilinochchi District (having a population of 113,000 in 2012) and Mullaitivu District (having a population of 92,000 in 2012), before the Project, power was only supplied to some areas along arterial roads from Vavuniya Grid Substation which was connected to the national grid. As a result of the Project, almost all areas of both districts are supplied with power from Kilinochchi Grid Substation through the national grid. In Jaffna District (having a population of 580,000 in 2012), before the Project, power was supplied to approximately half of the areas, but after Chunnakam Grid Substation was connected to the national grid, power was supplied to all areas. In Kilinochchi District and Chunnakam District, approximately 70,000 households (38,000 households in Kilinochchi District and 32,000 households in Chunnakam District) are estimated to have been newly connected over the four-year period from 2013 to 2016.

Jaffna is the capital of Jaffna District while at the same time being the capital of Northern Province, and from the colonial era to until the outbreak of Sri Lanka's civil conflict in 1983 was Sri Lanka's second-largest city, with a population second only to that of the Colombo Metropolitan Area. Before the Project, approximately half of the areas of Jaffna District, centring on Jaffna itself, had an independent power grid that was not connected to the national grid, and in 2013 some 141,000 households were supplied with power. Power was obtained from multiple small-scale thermal power plants (belonging to CEB and independent power producers) in Chunnakam, but due to power shortages, the city centre was subjected to planned power outages during peak times, and in the outskirts and in rural areas, power was only supplied for several hours per day. As a result of the Project, Jaffna's power grid was connected to the national grid via Chunnakam Grid Substation, enabling the abovementioned 141,000 households to receive a stable supply of power[15].

(6) Power Consumption

Power consumption in Northern Province over the seven-year period from 2010 to 2016 increased by approximately 110%. Power consumption in the areas supplied by Vavuniya and Kilinochchi Grid Substations (which more or less coincide with Kilinochchi, Mullaitivu and Vavuniya districts) increased by approximately 150% from 2010 (57 GWh) to 2017 (144 GWh). Power consumption in the area supplied by Chunnakam Grid Substation (which more or less

[15] Chunnakam Grid Substation, which was newly connected to the national grid by the Project and related projects, is at the terminal of the national grid and had a lack of voltage. To address this situation, CEB constructed Uthuru Janani Power Station (24 MW) in 2013 to replace the existing aging power station, and connected this to Chunnakam Grid Substation. Judging from the generating performance of this power station, in 2016 approximately half of Jaffna District's power consumption is deemed to be supplied by this power station and the remaining half from the national grid.

coincides with Jaffna District) increased by approximately 80% from 2010 (107 GWh) to 2017 (197 GWh). National power consumption increased by approximately 40% over the same period, so target areas of the Project saw growth in power consumption exceeding that level.

In summarizing the above, the Project is being operated appropriately, and by being connected to the Kilinochchi-Chunnakam Transmission Line and distribution network constructed separately from the Project by the ADB Loan Project and CEB respectively, is being used for the supply of power to areas centring on Kilinochchi, Mullaitivu and Jaffna Districts. The electrification rate of these areas was improved dramatically, and the connection to the national grid has provided a stable power supply. Therefore, effectiveness of the Project is high.


(Left) Vavuniya Grid Substation, (Right) Example of residential wiring (Mullaitivu District)


Distribution network constructed by CEB (Left: Jaffna District, on the left is a tsunami warning loudspeaker, Right: Kilinochchi District, at the rear is a mobile phone antenna tower)

3.3.2 Impacts

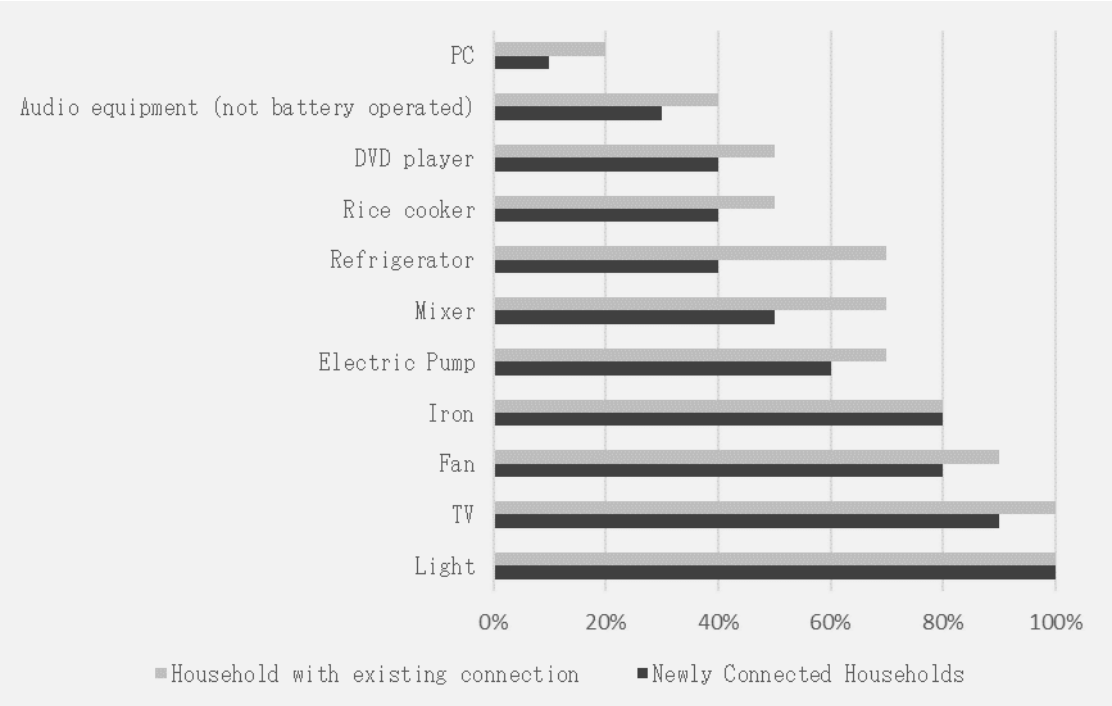
3.3.2.1 Intended Impacts

It was expected that the Project would improve the living environment of residents and stimulate economic activities. In the ex-post evaluation, the impacts on residents' lives,

administrative services, economic activities, resettlement and rebuilding lives of refugees were analysed through interviews with local residents, public institutions and commercial entities in areas newly connected to power services through the Project and areas in which power services were improved by the Project[16].

(1) Impact on Lives of Residents

Almost all newly-connected households (residents who were newly connected to the power supply service after the Project) had been using kerosene lamps as a source of light before being connected to the power supply. Although there were a small number of households which were using battery-operated lighting, 80% of households were not using any electrical appliances (including radios or mobile phones) at all. Approximate ownership rates of electrical appliances after the Project (at the time of the ex-post evaluation) according to interviews with local residents are shown in Figure 2. Although tendencies for the electrical appliances owned are similar, the ownership rates among households with existing connections are slightly higher.



Source: Group interviews of residents

Figure 2 Ownership rates of main types of electrical appliances

[16] In the ex-post evaluation, group interviews were performed on residents (10 locations, total of 110 residents: 45 males and 65 females, 69 new connections and 41 existing connections). Almost all newly-connected households were residents who returned from where they had taken refuge in 2010-2012. Interviews were also carried out in two hospitals, two educational institutions, administrative facilities (one town hall and one police station), two chambers of commerce, three stores, two hotels, one factory, two religious institutions and two NGOs supporting resettled refugees in the target areas.

The following impacts of electrification were noted among newly-connected households:

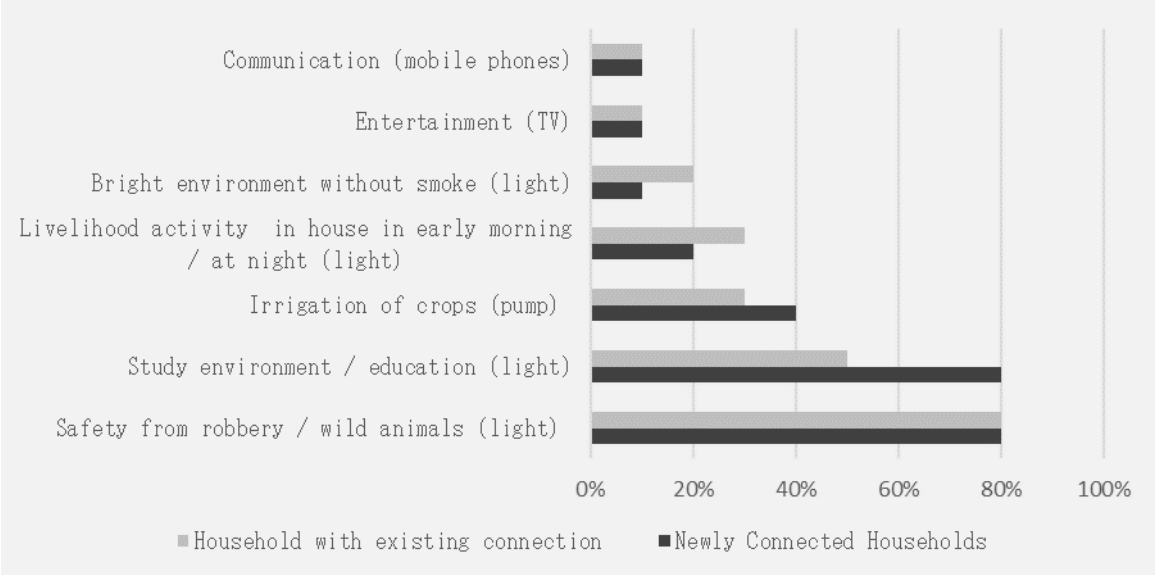
- Electric Lighting: In two-thirds of newly-connected households, the usage of electric lighting resulted in a reduction in sleeping hours of one to two hours. Electric lighting is used for housework in early-morning or at night, children's studying and family time at night. In a small number of households, electric lighting is also used for economic activities such as home industry. Advantages of electric lighting that were cited by 80% of households included safety from robbery (mainly targeting livestock and personal property) and wild animals (elephants, etc.) and children's studying.
- Advantages of television that were cited included being able to relax by watching entertainment programs (90%), being able to watch the news (80%), and being able to access practical information (20%) such as education, health and economic information.
- Mobile phones are mainly used for talking to family and friends, but approximately one-third of households also use them for work and/or business.
- Approximately two-thirds of households draw water from wells using electric pumps to irrigate home gardens and crops in fields (apart from rice). Some 30% to 40% of households cited as advantages of electric power that they no longer had to buy vegetables, fruits and spices, or that they are now able to sell these products.
- With regard to other electrical appliances (refrigerators, rice cookers, mixers, irons and fans), two-thirds of residents cited the advantage that they were able to perform housework efficiently and comfortably (ironing is necessary mainly for school uniforms). One-third of households reported that they were able to reduce food waste by using a refrigerator. In some cases, cows' and goats' milk were stored in refrigerators before sale.
- The use of power in industrial activities is limited, but there were reports of use in welding, woodworking, raising poultry and in flour milling.

Almost all households with existing connections responded that before the Project, the lengthy and frequent interruptions and dramatic fluctuations in voltage were problematic. Power was previously only supplied for two hours in the morning and at lunchtime respectively, and four hours in the evening. At the time of the ex-post evaluation, 24-hour power supply had basically been achieved, and there are no voltage fluctuations.

The main benefits cited of new connections to the power supply and the stabilization of the power supply included: improved safety; children's studying; irrigation of crops by electric pumps; and late-night and early-morning livelihood activities (Figure 3). The following advantages were also cited: street lighting in the neighbourhood has made it possible to walk

around at night with peace of mind; shops now stay open later; Hindu and Buddhist temples have been made brighter with illumination, making it easier to worship until late at night in well-lit conditions. Some also expressed the opinion that although they were grateful for street lighting, the number of street lights is inadequate[17]. There were also voices of discontent that when electricity bills come irregularly, it becomes difficult for residents who are living hand to mouth while considering their monthly incomings and outgoings to pay their bills. They would therefore like electricity bills to be issued regularly.

Although there were no particular negative impacts due to electrification and electric power cited by residents, according to NGOs providing assistance to resettled refugees, there are some households headed by women, such as women who lost their husbands in the civil conflict, who are having difficulties making monthly instalment for electrical appliances.



Source: Group interview with local residents

Figure 3 Main advantages of electric power

Overall, 80% of households are extremely satisfied with the electric power service. Some 10% of responses indicated dissatisfactions, and the main reason for this was that electricity charges are too high. Few respondents cited interruptions as a reason for dissatisfaction.

(2) Impact on Administrative Services

In interviews with personnel at hospitals, educational institutions and administrative institutions, the following positive impacts on administrative services due to connections to electric power service or improvements to the electric power service were observed.

[17] Installation of street lighting is an obligation of municipalities.

- Before the Project, Kilinochchi General Hospital was supplied with electricity only in the evening by means of a generator, and there were three doctors. After the Project, ICU, surgery department (operating theatre), emergency department and a dialysis room were opened, making it a general hospital that boasted 86 doctors and 300 beds in 2018. Before the Project, Mullaitivu General Hospital had five doctors, and was operating ICU and emergency department while being power-supplied 24 hours a day by a generator. After the Project, an operating theatre, a blood bank and a dialysis room were added using the stable power supply, and the number of doctors increased to 43 by 2018. It became possible to use examination equipment, thus improving the efficiency of various types of examination.

- With the electrification of elementary and junior high schools, computer classes were started, and school principals are now able to manage their schools using computers. There is electric lighting but it is very rare that it is used during classes. In Kilinochchi, a vocational training school was founded in 2016 with the assistance of Germany, bringing together several hundred students, not only from the local area but from throughout the country, to be educated in machinery, electrics and electronics, automobiles, IT, cooking and construction. Power is essential for practical training.

- Maritimepattu Town Hall (Mullaitivu District), as a local agency of the central government, provides a range of administrative services, including issuing of certificates, social welfare services, and coordination of development projects. During the civil conflict, the town hall provided a traveling service, and a generator was only used during the daytime. The town hall had no PCs, with all communications being made by mail (postal services), and emergency communications were carried out by radio. Currently there are 40 staff, each of whom use PCs and is connected to the Internet. It has also become possible for personnel to use telephones, and the efficiency of administrative services has significantly improved.

- According to the Mullaitivu Police Station, the electrification of households is extremely important for communications in the event of emergencies. In addition to the emergency number 119, residents know the landline numbers of the police station and the mobile numbers of the police officers in charge of their areas, and in the event of an emergency, notify the police from their own mobile phones.

(3) Impact on Economic Activities

According to the Chamber of Commerce, factory managers and hotel managers in Jaffna, after the end of civil conflict, electric power and electrical communications were rapidly deployed,

which were important conditions for recovery and reconstruction. Atchchuvely Industrial Estate in the suburbs of Jaffna which had been shut down was reopened, and occupancy is gradually increasing. The increase in power demand centring on the tourism industry has been intense, with at least 15 new business plans for hotels alone. There are also business plans for the machinery industry, ice factories and cold storage warehouses for agricultural produce.

According to business managers in Kilinochchi (stores, hotels, restaurants and ice-cream factories), construction of stores, hotels and the like started along arterial roads in Kilinochchi in around 2008-2010, around the end of the civil conflict. Initially these operations were using generators, but with the completion of Kilinochchi Grid Substation in 2012, power is now supplied in a stable manner, enabling business activities to be carried out efficiently.

According to business managers from both cities, there are no problems in terms of the quality of power, but many are of the opinion that electricity charges are expensive.

3.3.2.2 Other Positive and Negative Impacts

(1) Environmental and Social Impacts

According to CEB, the Project did not cause displacement of residents. Moreover, there was no site acquisition, with only compensation being paid for trees which needed to be felled. This compensation was made appropriately in accordance with Sri Lanka's regulations. As the existing route of power lines destroyed by the civil conflict was used, an environmental impact assessment was not required. In the on-site visits, no particular environmental impact was observed.

(2) Other Impacts

According to Maritimepattu Town Hall, electrification is an important condition for resettlement of refugees, and as there was progress in electrification, refugees were now able to be resettled with peace of mind. Therefore, along with the abovementioned impacts, the Project promoted the resettlement of refugees, making a great contribution to the reconstruction and recovery of northern Sri Lanka.

The Project (Phase I) was adopted against the backdrop of the Tokyo Declaration in 2003, and was expected to contribute to the promotion of the peace process between the Government of Sri Lanka and LTTE, and to the recovery and reconstruction of the northern part of the country. After the Tokyo Declaration, fighting between the two parties intensified, with the civil conflict ending in 2009 with government forces taking all of the major bases of LTTE, so the peace process was not concluded. It is therefore difficult to clearly identify the contribution of the Project to the promotion of the peace process.

In light of the above, the Project has achieved its objectives. Therefore effectiveness and impacts of the Project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional/Organizational Aspects of Operation and Maintenance

The Project is operated on a 24-hour framework by CEB's System Control Centre (Colombo) as part of the national grid[18]. The System Control Centre was transferred to a new building in August 2018, all generation and transmission facilities were connected to SCADA (Supervisory Control and Data Acquisition) system, a remote management system which uses telemeters, and management software was updated to enable stable transmission. In order to maintain the frequency of the national grid at a constant level, the Centre issues generation commands according to fluctuations in demand for power. When power generation capacity is insufficient, power distribution is stopped to part of the grid automatically or manually in some cases.

Maintenance of the Project is performed by the North-Central Office (Anuradhapura Region) of CEB's Transmission Operation and Maintenance section. Four engineers, 10 electricity supervisors and 100 other staff are stationed at said office, and these personnel perform maintenance work in accordance with an annual schedule for 16 grid substations and 1,300 km of transmission lines in five of Sri Lanka's nine provinces, including Northern Province. The maintenance of each grid substation and transmission line facility is carried out for 30 days once a year. The management of trees under and around transmission line routes is carried out twice or three times per year, and takes approximately five months. In several locations throughout the country, there are also specialist teams who are able to remove kites and other foreign objects that have become caught on power lines while keeping them energized.

The operation and maintenance of the distribution networks of Northern Province, Colombo, North Western Province and North Central Province is the responsibility of CEB's Power Distribution Division 1. Several supervisory offices are situated under the responsibility of each of approximately 30 area engineers, and these offices perform meter reading, new connections and maintenance of distribution facilities. When an interruption occurs, a call is received by the call centre, and information is transmitted to the responsible supervisor using a mobile phone. In Kilinochchi and Mullaitivu districts, the addition of meter readers has been unable to keep up with the sudden rise in the number of connections, and at one time electricity bills were being sent out for several months at a time or irregularly. According to CEB, this situation has improved considerably, but the number of meter readers is still inadequate. In addition, more than 90% of interruptions are able to be dealt with within two hours, but there are occasions in which accidents and the like mean that there is a need to replace electric power poles, which takes more time. According to the supervisor for Mullaitivu District, as the area for which they are responsible is extensive, the personnel (eight people) and vehicles (three vehicles) are inadequate.

[18] CEB is under the jurisdiction of the Ministry of Power and Renewable Energy. Founded in November 1969, CEB transmits power from power stations, supplying power to all categories of consumers, and earns revenues from electricity charges.

In light of the above, no problems were observed in the institutional/organizational aspect of operation and maintenance of the Project (substations and transmission lines). With regard to the distribution network, while the organizational framework is clear, there is scope for strengthening personnel at supervisory offices.

3.4.2 Technical Aspects of Operation and Maintenance

CEB is a government owned company founded in 1969, and has power generation, transmission and distribution facilities throughout the country. It has the technical capacity to be able to provide a practical power supply without problems. CEB has a training centre equipped with accommodation facilities in suburban Colombo, and training including practical and on-site training is implemented for all levels of personnel, from senior engineers to field workers.

The substations and transmission lines constructed in the Project were to CEB's standard specifications and therefore do not require special technology for operation and maintenance. There are adequate stocks of spare parts at CEB's Asset Management section, including those procured in the Project, and these spare parts are supplied as necessary. Regular maintenance work is implemented by referring to CEB's manuals and the manuals of equipment manufacturers. No particular problems were reported in the technical aspect from staff responsible for maintenance.

In light of the above, no problems were observed in the technical aspect of operation and maintenance of the Project.

3.4.3 Financial Aspects of Operation and Maintenance

The financial performance of CEB from 2013 to 2017 is shown in Table 9. CEB's profits are affected by power generation costs. When the proportion of hydroelectricity, with its inexpensive unit cost, increases, profits tend to increase. In 2015, a year in which water resources were abundant, a significant profit was recorded, but in 2016 and 2017, years in which drought resulted in a greater reliance on thermal power generation, losses were recorded. The Government of Sri Lanka has the policy of strengthening the price-setting framework to appropriately reflect expenses, in order to stabilize the finances of CEB[19]. The current ratio cannot be described as adequately high at around 100%, but in 2014 the debt ratio was dramatically improved by the government taking over almost half of long-term debt. Electricity charges can be paid by bank

[19] In 2011 the Government of Sri Lanka introduced a charge framework taking into account power generation costs. Under this framework, CEB applies to the Public Utility Commission of Sri Lanka for charges taking into account expenses which have actually been incurred each six months, and after the Commission assesses the appropriateness of the expenses, grants approval to CEB. However, it is difficult to rapidly reflect increased expenses during times of drought in these charges, making it impossible to completely cover expenses. In addition, in some cases price rises were curbed due to political judgment. The Government of Sri Lanka, which has started to clean up the management of state-operated enterprises with the support of the IMF, introduced an automated pricing mechanism for fuel in May 2018. A similar system was to be introduced for power in the course of 2018, but as of March 2019 the system had still not been introduced.

payments, credit cards, internet and mobile phones (SMS), and in 2015 the charge collection ratio had reached almost 100%.

Table 9 Financial Results of CEB

(units: million Rs)

		2013	2014	2015	2016	2017
Sales	a	194,147	202,645	188,684	206,811	218,450
Cost of goods sold	b	-165,508	-213,646	-168,308	-222,097	-259,991
Gross profit	c=a+b	28,638	-11,001	20,376	-15,286	-41,541
Administrative expenses	d	-2,556	-3,146	-4,092	-4,441	-4,555
Other operating revenues	e	5,107	5,871	8,292	9,845	7,444
Operating profit/loss	f=c+d+e	31,190	-8,277	24,576	-9,882	-38,652
Financial revenue/expenses	g	-8,924	-6,726	-4,700	-4,312	-8,415
Income/loss before taxes	h=f+g	22,266	-15,003	19,876	-14,194	-47,068
Corporate tax	i	-1,325	900	126	-263	-232
Current net income/losss	j=h+i	20,939	-14,102	20,002	-14,457	-47,068
Operating profit margin		16%	-4%	13%	-5%	-18%
Current ratio		102%	91%	123%	66%	96%
Debt ratio		229%	102%	89%	126%	95%

Source: Documents provided by CEB
Note: 1 rupee (Rs.) equals approximately 0.73 yen (as at the end of 2017)

The maintenance budget for grid substations and transmission lines is allocated to each Transmission Operation and Maintenance Office on the basis of annual maintenance plans, taking into account increases in prices and reserve funds. According to the Transmission Operation and Maintenance North-Central Office, there are no budgetary constraints which restrict maintenance work.

In the light of the above, no major problems were observed in the financial aspect of operation and maintenance of the Project.

3.4.4 Status of Operation and Maintenance

According to the Transmission Operation and Maintenance North-Central Office, the grid substations and transmission lines of the Project have not required major repairs. In the on-site visits, no particular problems were observed.

Spare parts procured through the Project are managed by CEB's Asset Management section, and are used as necessary. Among the spare parts, two transformers were used to replace transformers damaged by fires in two other substations in 2017 and 2018. According to CEB, having spare transformers which could be used right away was extremely useful in maintaining the function of the national grid. CEB plans to procure new spare transformers which could be used to replace of the transformers that were used.

Thus, no problems have been observed in the organisational, technical or financial aspects of the operation and maintenance of the Project. Therefore, the sustainability of the effects of the Project is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The Project was implemented with the aim of ensuring stable electricity supply to consumers by reconstructing part of the heavily damaged transmission lines due to the civil conflict, which connects the power grid of the northern Sri Lanka to the national grid, thereby contributing to peace building of the northern province through improving the living environment and stimulating economic activities. At the time of both the ex-ante and the ex-post evaluation, the Project is highly consistent with the policies and development needs of Sri Lanka, in terms of recovery from civil conflict, etc. The Project was consistent with Japan's ODA policy at the time of appraisal, which emphasised providing assistance to recovery. Therefore, relevance of the Project is high. Although the project cost was kept within the plan, despite the addition of outputs, the project period far exceeded the plan. Therefore, efficiency of the Project is fair. The electrification rate of target areas has improved dramatically, and by being connected to the national grid, a stable power supply has been achieved. This has contributed to an improvement in security due to the installation of street lights, an improvement in the learning environment for children, and improved living conditions through an increase in activities to improve the standard of living such as home industry and home gardens. The Project has also resulted in improvements in medical, educational and administrative services, which was an important condition for promoting the return of refugees due to the internal conflict, and the reconstruction of Northern Province. Therefore, the effectiveness and impact of the Project is high. No problems have been observed in the institutional/organizational, technical or financial aspects of operation and maintenance of the Project, and there are no problems in terms of the status of operation and maintenance. Therefore, sustainability of the Project is high.

In the light of the above, the Project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency (CEB)

CEB needs to take the following measures with a view to ensuring the appropriate operation of the Project.

- The dedicated transformer additionally procured for the Kilinochchi Grid Substation is to alleviate the negative impact of wind power generation, which is subject to major short-term voltage fluctuations, to voltage of power distributed from the substation. But at the time of the ex-post evaluation, wind power generators are still connected to the distribution transformer, as no grave operational impact on the quality of electric power has been seen to date. However, there is no guarantee that no serious impact will occur in the future. It is therefore necessary to connect the dedicated

transformer of Kilinochchi Grid Substation to wind power generation as soon as possible.

- In Kilinochchi and Mullaitivu districts, the increase in numbers of meter readers is unable to keep pace with the rapid increase in the number of connections, with electricity bills being out once every several months or on an irregular basis in some areas. Therefore, there is a need to station adequate numbers of meter readers and to endeavour to issue electricity bills on a regular basis.

4.2.2 Recommendations to JICA

In order that the dedicated transformer added at Kilinochchi Grid Substation would be connected to the wind power stations, JICA should monitor the relevant situations and remind CEB as necessary.

4.3 Lessons Learned

Demand Forecast in Areas Subject to Special Circumstances

In areas in which it is difficult to follow past trends in demand for public services due to being in special circumstances such as being in the aftermath of civil conflict, it is necessary to examine project plans that reserve the room to accommodate significant major fluctuations in demand, taking into account the fact that it is possible that the accuracy of demand forecasts may not be adequately high. It is also desirable to set indicators of project effects which are not affected by demand, such as increased access to public services. In the Project, the executing agency made forecasts for power demand for areas in which resettlement of internal refugees with the termination of civil conflict was starting, and the maximum demand (peak power) for the substations calculated on the basis of these forecasts were made to serve as an indicator of project effect, but delays in economic recovery after civil conflict and the lack of growth in power usage meant that actual maximum demand was only 30% of that which was forecast, making the achievement rate of said target low.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
① Outputs*	< Plan at time of additional ODA loan>	
	Reconstruction of transmission line	
	(132kV) ACSR	
	Conductor standard/cross section 400 mm^2	As planned
	Span length 73 km	As planned
	Reconstruction of Kilinochchi Grid Substation	
	132kV transformer bay 2	As planned
	132/33kV 31.5MVA transformer 2	As planned
	33kV transformer bay 2	As planned
	132kV line feeder bay 4	As planned
	33kV distribution line feeder bay 8	As planned
	Expansion of Vavuniya Grid Substation	
	132kV line feeder bay 2	As planned
	Consulting Service Detailed design review, support for tender, construction supervision	As planned
	Demining (not for ODA loan)	As planned
		<Additional Outputs>
		Transmission facility spare parts; transformers, circuit breakers, insulators, etc.
		Expansion of Kilinochchi Grid Substation; addition of 1 132kV transformer, etc.
② Project Period	June 2005-March 2008* (34 months)	June 2005 - September 2012* (88 months)
③ Project Cost*		
Foreign Currency	2,008 million yen	2,069 million yen
Local Currency	1,820 million yen	942 million yen**
Total	3,829 million yen	3,011 million yen**
(ODA loan amount)	2,700 million yen	2,619 million yen
Exchange rate	1 US$ = 87.0 yen = 113.5Rs (November 2010)	1 US$ = 96.8yen = 126.0Rs (Average during 2010-2016)
④Final Disbursement	July 2016	

Notes: * Commencement of operation of the transmission facility
** Amount excluding administration expenses