CHAPTER 6
STUDY FOR DISTRIBUTION LINE PROJECTS

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6.1 Candidate Projects

6.1.1 Study for New LV Schemes

(1) Loss Reduction by Small Capacity Distribution Transformers (DT)

The conditions of loss reduction calculation by small DT installation are as follows.

i) A 100 kVA DT is replaced by a 20 kVA single-phase transformer.
ii) Copper losses of DT and the difference of resistive losses on LV line are not considered in the loss calculation.
iii) All system data, including electricity demand provided from each region, will be used for calculation.
iv) The reduced loss value is to be calculated applying typical line constants of the distribution lines.
v) Typical load and no-load losses of small DT are 340 W and 60 W, respectively.

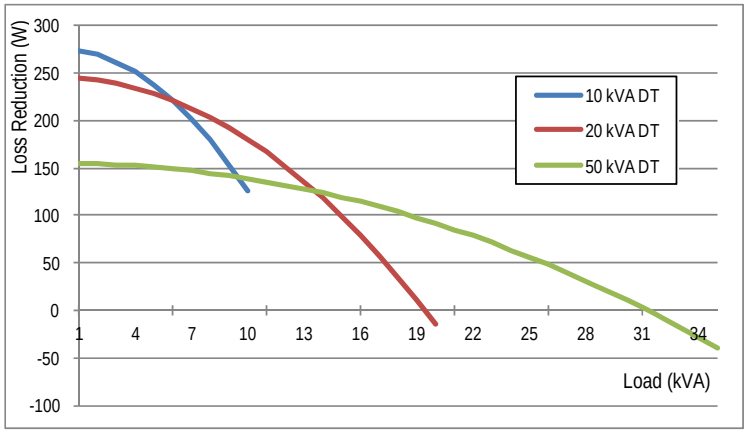
Specifications of the existing transformer are shown in Table 6.1-1.

Table 6.1-1 Specifications of Existing DTs

TR Ratings	Existing Transformer	
	Load loss	Non load loss
100 kVA	305	2,020
160 kVA	415	2,045
250 kVA	545	3,130

(Source: LTL data)

The loss reduction values are shown in Figure 6.1-1 when a 100 kVA DT is replaced to 10, 20 or 50 kVA DT.



(Prepared by the Survey Team)

Figure 6.1-1 Loss Reduction after Replacing to Small DT

Table 6.1-2 shows calculated annual loss reduction value per one unit of small DT.

Table 6.1-2 Loss Reduction by Replacement of Small DT (per one unit)

Before installation	After installation	Reduced losses
2.77 MWh/year	0.94 MWh/year	1.83 MWh/year

(Prepared by the Survey Team)

(2) Loss Reduction by LV Scheme

Conditions of loss reduction calculation by LV Scheme are as follows:

i) Typical line constants of LV line in rural area is used for the calculation.
ii) Peak and minimum loads of DT are assumed as 80 % and 20 % of rated capacity, respectively as shown in Table 4.2-2 in Chapter 4.
iii) After DT installation, load current will be reduced to half of the previous one.
iv) After DT installation, length of LV line is half of the previous one.

Average loss reduction value is 14 MWh/year and no-load loss reduction is 0.5 MWh/year per LV scheme applying directional silicon steel core. However it does not give remarkable difference to load loss.

Table 6.1-3 shows the total amount of loss reduction values.

Table 6.1-3 Loss Reduction by LV Scheme

Region	Area	Required Q'ty	Loss Reduction (MWh/year)	Total Loss Reduction (MWh/year)
Region 1	-	N/A	N/A	0
Region 2	WPN	75	14.5	1,087
	Central	300	14.5	4,350
	Eastern	170	14.5	2,465
Region 3	WPS-2	75	14.5	1,087
	UVA	90	14.5	1,305
	Sabaragamuwa	125	14.5	1,812
Region 4	-	N/A	N/A	0
	Total	835	-	12,106

(Prepared by the Survey Team)

6.1.2 Study for Single-phase to Three-phase Conversion

Conditions of loss reduction calculation by single-phase to three-phase conversion are as follows.

1) Typical capacities of DTs (100 kVA,160 kVA or 250 kVA) are used for the calculation.
2) Amount of losses is calculated by the differences before and after the conversion.
3) Loss reduction values are to be calculated assuming average data with typical system models.

Table 6.1-4 shows the annual amount of reduced losses.

Table 6.1-4 Loss Reduction by Three-phase Conversion

Before conversion	After conversion	Reduced losses
2.91 MWh/year・km	0.48 MWh/year・km	2.43 MWh/year・km

(Prepared by the Survey Team)

Note: Total loss reduction is 2.43 x 3,300 km = 8,019 MWh (≒8 GWh)

When a single-phase circuit is converted to three-phase, the maximum distributed power can be three times that of a single-phase, and load current can be reduced by a third. Accordingly, it is clear that the resistive losses can be reduced by 1/6, considering three wires for three-phase distribution lines. It is necessary to design the consumer's connections to balance the load current on each phase in order to make it effective.

6.1.3 Study for Energy Meters and Remote Data Transmission

CEB's project proposals include provision of energy meters with remote metering at DTs. Considering development of future Advance Meter Infrastructure (AMI), the Survey Team recommends to procure remote metering equipment with extension capability in the future to all consumers, and to apply intelligent smart meters. A typical smart meter in the market is as shown in the right photograph. The smart meters include bidirectional communication facility to be used for future demand response, time of use, and control of load current which are very effective for energy saving and peak-cuts.

(1) Contribution to Distribution Loss Reduction

Generally, energy meters cannot reduce the distribution losses directly but these are very effective to measure energy losses on LV lines. It offers the following advantages for energy management.

1) Possibility to measure the exact energy on LV lines
   It is possible to know the current energy values on LV lines and consequently it is possible to measure the non-technical and technical losses.

2) Real time reading of energy meter at DT from distribution control center
   Providing a communication link, it is possible to send real time reading of energy meters at DTs to the distribution control center.

3) Improved accuracy of energy meters
   The accuracy of the existing electro-mechanical energy meter is class 2.0. Accurate measurement can be obtained by new meters.

4) Recording of past reading

Past reading is recorded in the meters for a month.

5) Reduction of non-technical losses by power theft

Estimating loss reduction by AMR in other country, about 25 % of the non-technical losses can be eliminated as shown in Table 6.1-5. Since power theft is assumed as 2 % of non-technical losses, 0.5 % of loss reduction is expected as shown in Table 6.1-6.

Table 6.1-5 Loss Reduction by AMR

Cause of Loss	Expected effect	Current loss (%)	Reduced loss (%)
Failure of Energy Meter	100%	0.08	0.08
Meter Error	0%	0.03	0.00
Defect of CT/VT circuit	0%	0.14	0.00
Mistake of meter reader	100%	0.23	0.23
Pilferage by manipulation of meter	0%	0.05	0.00
Theft by direct tapping	50%	0.20	0.10
Direct connection by-passing meter	50%	0.18	0.09
Others	0%	1.09	0.00
	Total	2.00	0.50

(Prepared by the Survey Team)

Table 6.1-6 Loss Reduction by AMR in Each Province

Region	Province	Non-Technical losses 2% of total sales (GWh)	Reduction of non-technical losses (0.5%) (GWh)
Region 1	NWP	18.38	4.59
Region 2	WPN	38.08	9.52
Region 3	WPS-2	25.04	6.26
Region 4	WPS-1	17.38	4.35
	Total	98.88	24.72

(Prepared by the Survey Team based on the MV/LV Proposal)

6.1.4 Study for New PSs and Reinforcement of Distribution Lines

Upgrading the system voltage is one of the effective measures to reduce distribution losses. Upsizing conductors or installing additional distribution lines is also one of the effective measures to reduce resistance of distribution lines. Therefore, the Survey Team selected the projects to provide new PSs and the associated new 33 kV distribution line.

The Survey Team evaluated the losses through the following method.

1) In case a new 33/11 kV PS is installed, the related 11 kV line lengths can be shortened. Loss reduction values can be calculated by comparing both losses on 33 kV and 11 kV lines. Typical load pattern is applied to load current on 33 kV and 11 kV lines.
2) In case an 11 kV line is upgraded to 33 kV, the difference of losses between those two voltages can be calculated by the load flows of their typical load pattern.
3) In case a new 33 kV line is provided to prevent overloading, the full load condition (100 %) will be reduced to 50 %, by passing half of full load.

4) In case conductors of 33 kV line is replaced to larger ones, the loss reduction will be calculated under the typical load condition.
5) For a gantry, the loss reduction is considered to be included in the additional new lines.
6) In case of DT replacement, the no-load losses and load losses are considered in the calculation.

Table 6.1-7 shows the loss reduction values in the MV development plans of each region.

Table 6.1-7 Loss Reduction by MV Development Plans

projects	Facilities	Loss Reduction (MWh/year)	Remarks
Region 1			
Colombo City 11 kV Network Development	11 kV line reinforcement with PJT-1	4,605	Refer to Table 6.2-1
North Western	33 kV DL	8,959	
Region 2			
WPN	33 kV DL	2,795	
WPN	33 kV PSs (Augmentation and new PSs)	859	
WPN	Aerial Bundle Conductors (ABC)	280	
WPN	Equipment for Loss Reduction	0	Test equipment
WPN	DTs and 3 phase conversion requirement	1,330	
Region 3			
WPS2	Conversion of OH to UG in Battaramulla	0	Improve reliability
WPS2	33/11 kV PSs	2,111	
WPS2	33 kV UG Aurveda Junc. to Ethulkotte, Rajagiriya	0	Improve reliability
WPS2	Construction and rehabilitation of 33 kV lines	3,847	
Region 4			
Dehiwala Mount Laveniya Under Ground Cabling Project	New 11 kV UG and radial SS 12 locations in Dehiwala and Mt. Lavenia	0	Improve reliability
	Replace to ABC 200 km	446	

(Source: CEB MV Project Proposals of Regions-1, -2,-3 and -4)

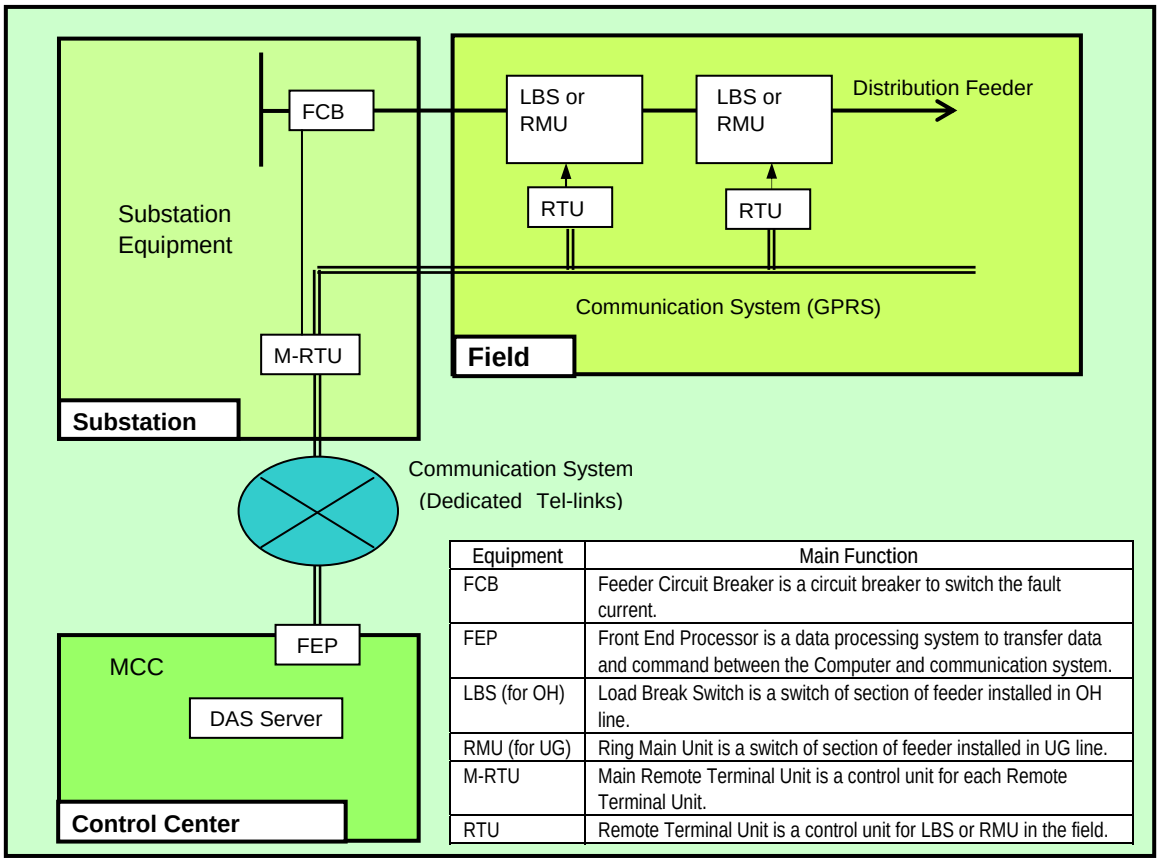
6.1.5 Study for DAS

(1) Outline

Through discussions with each region, the Survey Team was informed that Central Province of Region-2 and the other regions have needs of DAS. In view of loss reduction and automation of the distribution system, the Survey Team nominated this project. The issue to be solved is the communication links between the control center and remote terminal units (RTU). As for this concern, CEB proposed to use exclusive public telephone communication links with important PSs and GSM/GPRS for load break switches (LBSs) at the distribution lines. CEB is developing the GSM/GPRS communication links between the control center and RTUs. They provide firewall and separated local area network (LAN) like virtual LAN in GSM/GPRS.

GSM/GPRS is a very useful communication tool but its speed and security sometimes poses

problems. Acceleration of communication speed and firewall may solve the problems. However, the GSM/GPRS still have several problems such as latency, congestion, security and reliability. Accordingly, the Survey Team proposes to use fiber optic communication links for "Back Bone Communication (BBC)" and radio communication system such as "Zigbee" or "RF Mesh" system for "Last One Mile Communication (LOMC)". The cost of DAS is estimated based on the GSM/GPRS and the estimated cost will be adjusted to use suitable communication system in the later stage. The central unit, RTUs, associated intelligent software, and switchgear such as LBSs are to be included in this project. Figure 6.1-2 shows the necessary components and configuration.



Equipment	Main Function
FCB	Feeder Circuit Breaker is a circuit breaker to switch the fault current.
FEP	Front End Processor is a data processing system to transfer data and command between the Computer and communication system.
LBS (for OH)	Load Break Switch is a switch of section of feeder installed in OH line.
RMU (for UG)	Ring Main Unit is a switch of section of feeder installed in UG line.
M-RTU	Main Remote Terminal Unit is a control unit for each Remote Terminal Unit.
RTU	Remote Terminal Unit is a control unit for LBS or RMU in the field.

(Prepared by the Survey Team)

Figure 6.1-2 Basic Configuration of DAS

In order to draw the maximum ability in DAS, the distribution system should provide the following features:

1) Multiple divisions and multiple interconnections will be standardized.
2) Switch-over LBSs to minimize the shut down at the time of a fault on a line.
3) In order to minimize shut-down section, distribution lines will be inter-connected as much as possible.
4) Automatic reclosing system will be provided to isolate and minimize the shut-down section.

(2) Loss Evaluation

Detailed loss evaluation of DAS is to be done in quantifiable benefits after detailed information of distribution system is available. Here, only unquantifiable evaluation of loss reduction will be highlighted.

1) Rapid switching is available to level the load on distribution lines to suppress the losses.
2) Facilities such as capacitor banks can be switched rapidly when it is necessary to operate and suppress the losses.
3) If voltage drop is caused on distribution lines, the earliest action can be available to compensate it.

As supplemental benefits of DAS, the following unquantifiable benefits may be achieved.

1) Shorten the blackout time
2) Saving manpower
3) Automatic event and disturbance log and report
4) Safety for operator by remote operation

It is possible to reduce losses by the functions of DAS as shown in Table 6.1-8. However, it is very difficult to make exact quantifiable loss reduction of other functions. The total reduced losses in each province are shown in Table 6.1-9.

Table 6.1-8 Loss Reduction by DAS

Cause of losses	Calculation formula	Reduced loss (%)
Loss reduction by balancing load on MV lines	4% (tech. loss) x 18% (Effect of DAS) x (4 hrs/24 hrs)	0.12%
Loss reduction by reactive power compensation	4% (tech. loss) x 27.6% (Effect of DAS) x (4 hrs/24 hrs)	0.18%
(Prepared by the Survey Team)		0.30%

Table 6.1-9 Loss Reduction by DAS in Each Province

Region	Area	Technical losses 6 % of total sales (GWh)	Reduction of non-technical losses (0.3 %) (GWh)
Region 1	NWP	55.1	2.755
Region 2	WPN	114.2	5.710
Region 3	WPS-2	75.1	3.755
Region 4	WPS-1	52.1	2.605
	Total	296.5	14.825

(Prepared by the Survey Team based on the MV/LV Proposal)

(3) System Software and Design

CEB has used the system software such as GE made “ifix”, which is available in the market, to implement the DAS in all provinces. Accordingly, the development of system software and the design of hardware will be carried out by CEB and interfaced to switchgear units which are supplied as loose, using communication interface such as GSM and/or GPRS.

However, the function and data speed/quantity are limited by comparing the so called “full-sized SCADA” instead of “Mini SCADA”. Also, CEB already faces some problems on its communication system. Thus, the Survey Team recommends to apply DAS with superior functions as full-sized SCADA as a total system with reliable communications system.

The system developed by CEB has a single system which has a single personal computer, single human machine interface (HMI), and single power supply. In such a single system, interruption may occur during maintenance or hardware failure. The Survey Team also recommends duplication of the system to increase reliability, dependability and safety considering maintenance and trouble shooting.

On the other hand, if an equivalent DAS used in Japan is adopted into the distribution system of CEB, several supplemental functions such as two shots auto-reclosing system or user programmable software for amendment of the distribution system are available.

(4) Communication System

As for the communication system for DAS/AMR, there are two major parts, the BBC and LOMC. Data from RTUs or smart meters are transmitted to a concentrator where several data are combined and transmitted to a control center. The BBC takes care of the data communication from the concentrator to the control center, while the LOMC takes care of data transmission from RTUs or smart meters to the concentrator.

1) Back Bone Communication

Since high speed and large capacity are essential for the BBC, fiber optic communication, wide area network (WAN) and GPRS can be used. Considering its reliability, security and cost, fiber optic communication is recommended. If optical fiber cable cannot be installed by some restriction, hard wire public telephone communication is available for the BBC.

Figure 6.1-3 shows the typical connection of the BBC.

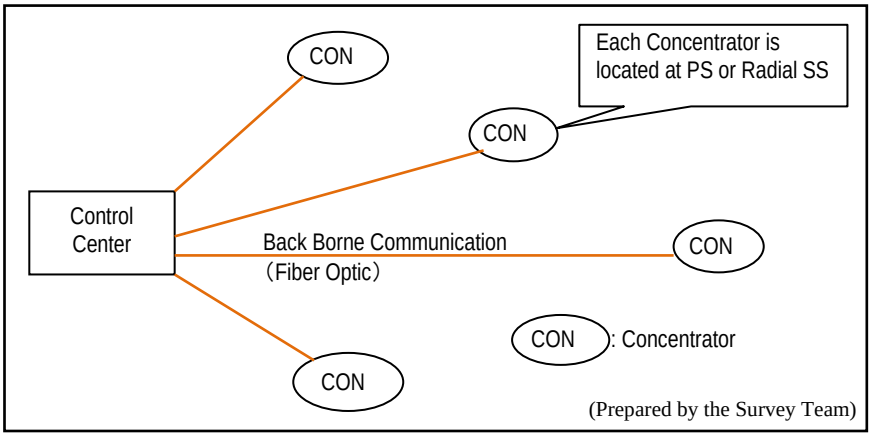


Figure 6.1-3 Back Bone Communication

2) Last One Mile Communication

For the LOMC, it is important to establish the communication network at a very low cost, for there are many terminals in ultimate stage. In the future, optical fiber cable may be available for the LOMC. However, due to cost restrictions at present, radio communication is recommended. For suitable communication system for the LOMC will be the "Zigbee System" or "RF Mesh System" because these can offer economical and reliable communication by "ad hoc" for interactive data transmission. A typical diagram of Zigbee or RF Mesh system is shown in Figure 6.1-4.

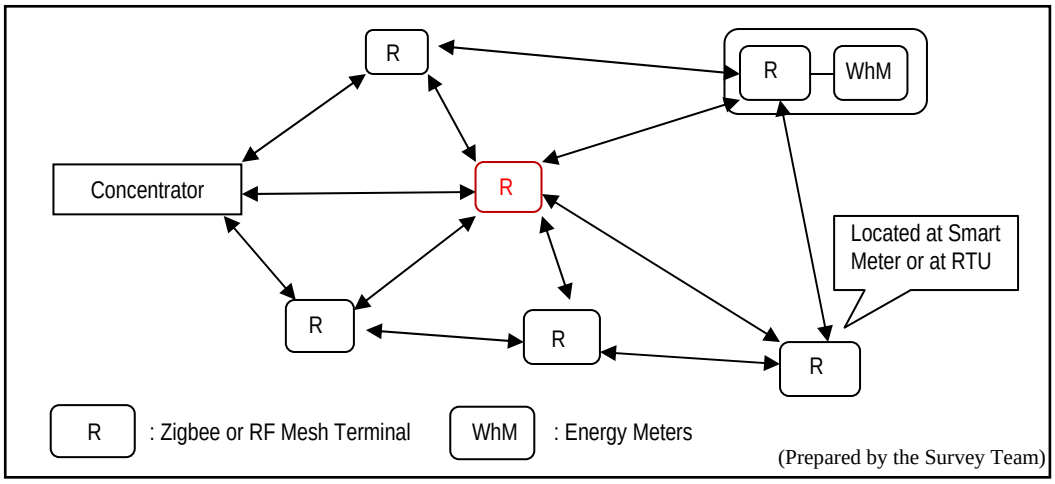


Figure 6.1-4 Last One Mile Communication

The data is transmitted through several terminals as routing action on the internet. If the red marked terminal does not operate for some reason, the data of the other terminal can be transmitted to the concentrator by-passing failure terminal by "ad hoc" function. Using such "ad hoc" functions, radio communication can be extended from terminal to terminal even though the reach of one terminal is very short. This function shall be included in AMR because it is economical to provide this communication facility with energy meters physically.

3) Fiber optic cable network for the BBC

Overhead fiber optic cables with outdoor type splicing enclosure and splicing facilities are suggested for the BBC. The fiber optic cable is hung on each tower and/or pole by fixing accessories and fiber optic cables are spliced at an enclosure. The fiber optic cable can be supported on towers or poles by tension wire. The fiber optic cables can be connected and/or branched in enclosures, which can be fixed at the tower or pole at every 1 km to 2 km depending on cable length or distance between RTUs.

The right photograph shows the installation work of fiber optic cables at pole using specialized vehicle with bucket. Since the installation work can be

carried out effectively and safely using such a vehicle, this is suggested to be introduced to CEB's Maintenance Branch for easy maintenance and safety.

6.2 Candidate Packaged Distribution Projects

As mentioned in Section 4.4, several individual distribution projects are suggested to make some packages by regions. The loss reduction values of packaged projects are summarized in this section.

In the packaged project, several kinds of equipment such as specialized vehicles and testing instruments are commonly used for maintenance works. In order to make system operation more effective by DAS, additional interconnection on the MV distribution system is proposed.

(1) Loss Evaluation for Colombo City 11kV Development (Package 1)

The loss reduction values are calculated by "SynerGEE (USA)" software under the following condition:

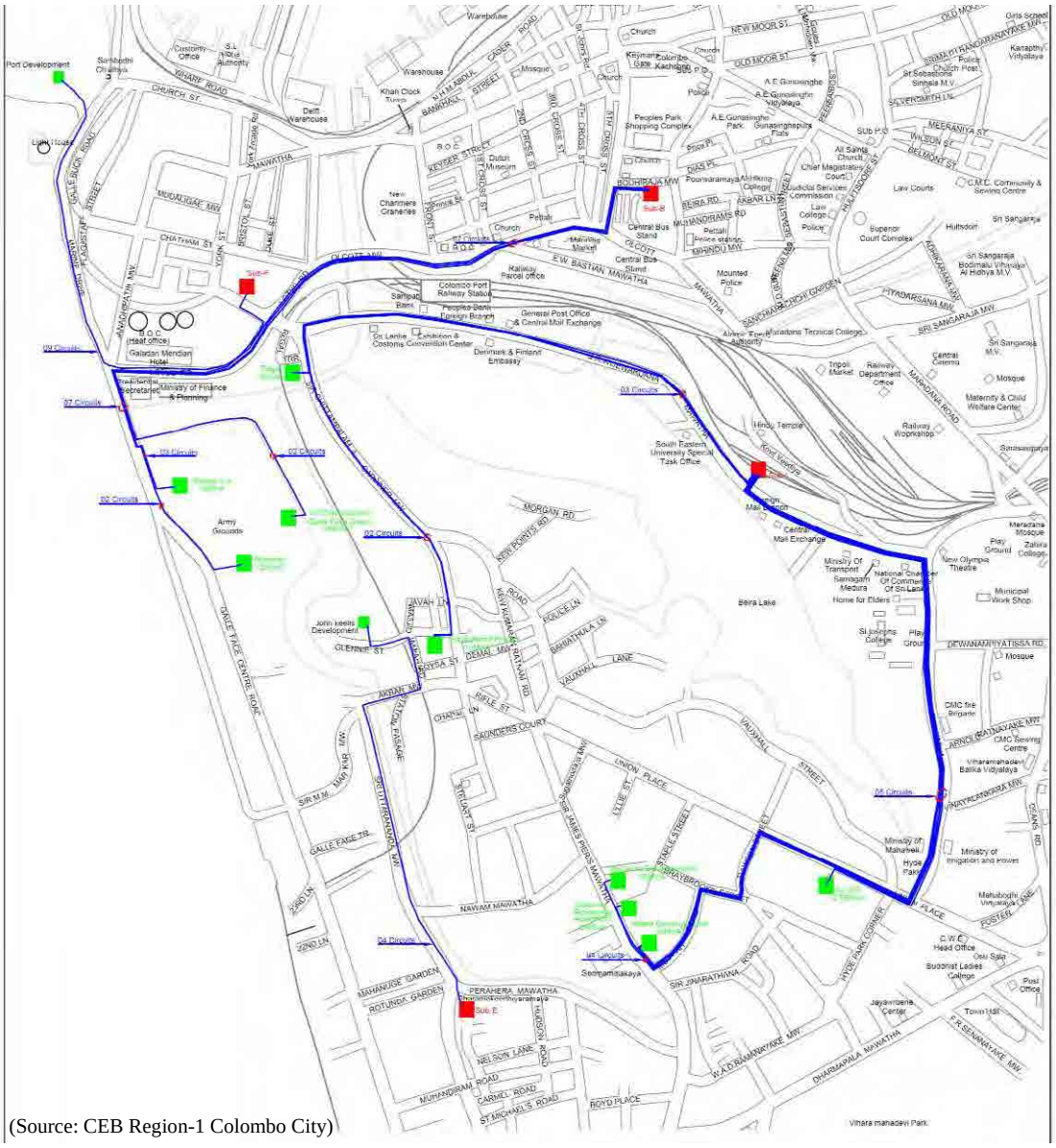
1) Distribution loss values without project are calculated based on the 11 kV network shown in Figure 6.2-1.
2) Distribution loss values with project are calculated based on the 11 kV network shown in Figure 4.2-1 in Chapter 4.
3) Loss difference is calculated between 1) and 2) above.

Table 6.2-1 shows the results.

Table 6.2-1 Loss Reduction Values of Package 1

No.	Sub-project Description	Loss Reduction (MWh/year)	Remarks
1	Radial Circuit from N GS to No 320, Union Place to De load Sub. E & I	14	
2	Interconnection from GSS M to GSS N	N/A	Improve reliability
3	33 kV GIS at Kelanitissa Power Station	N/A	Improve reliability
4	Galle Face Green 3 projects	530	
5	Re-development project, Slave Island	104	
6	Development project at Colombo commercial	1,150	
7	Regal Theater site	7	
8	Lotus Tower	N/A	Improve reliability
9	Specialized vehicles	N/A	Efficient Work
10	Port Expansion project	2,000	
11	John Keels hotel, apartment etc. at Slave Island	800	
	Total	4,605	

(Prepared by the Survey Team based on CEB proposal)



(Source: CEB Region-1 Colombo City)

Figure 6.2-1 11 kV Network without the Project

(2) Loss Evaluation for North Western Province of Region 1 (Package 2)

Table 6.2-2 shows the loss reduction values of Package 2.

Table 6.2-2 Loss Reduction Values of Package 2

No.	Sub-project Description	Loss Reduction (MWh/year)	Remarks
1	33 kV distribution lines	8,959	
2	Instrument for loss reduction	N/A	For maintenance
3	Additional LBS for DAS reinforcement	N/A	Associated work for DAS
4	Additional MV lines for interconnection	N/A	Associated work for DAS
5	DAS	2,755	
6	AMR	4,595	
7	Communication infrastructure (1,700 km)	N/A	Associated work for DAS/AMR
8	Construction vehicle	N/A	For safety and efficient work
	Total	16,309	

(Prepared by the Survey Team based on CEB data)

(3) Loss Evaluation of Western Province North of Region 2 (Package 3)

Table 6.2-3 shows the loss reduction values of Package 3.

Table 6.2-3 Loss Reduction Values of Package 3

No.	Sub-project Description	Loss Reduction (MWh/year)	Remarks
1	33kV distribution lines	2,795	
2	Augment of PSs, new PSs and gantries	859	
3	Ariel Bundle Conductor LV Line	279	
4	Instrument for loss reduction	N/A	For maintenance
5	DT and 3-phase conv. requirement	1,130	
6	Additional LBS for DAS reinforcement	N/A	Associated work for DAS
7	Additional MV lines for interconnection	N/A	Associated work for DAS
8	DAS	5,710	
9	AMR	9,520	
10	Communication infrastructure (1,000 km)	N/A	Associated work for DAS/AMR
11	Construction vehicle	N/A	For safety and efficient work
	Total	20,293	

(Prepared by the Survey Team based on CEB data)

(4) Loss Evaluation of Western Province South-2 of Region 3 (Package 4)

Table 6.2-4 shows the loss reduction values of Package 4.

Table 6.2-4 Loss Reduction Values of Package 4

No.	Sub-project Description	Loss Reduction (MWh/year)	Remarks
1	Conversion of OH system to UG Cable System	N/A	
2	33/11 kV PS	2,111	
3	33 kV UG lines	N/A	
4	Construction and Rehabilitation of 33 kV Lines	3,847	
5	Instrument for loss reduction	N/A	For maintenance
6	Additional LBS for DAS reinforcement	N/A	Associated work for DAS
7	Additional MV lines for interconnection	N/A	Associated work for DAS
8	DAS	3,755	
9	AMR	6,260	
10	Communication infrastructure (550 km)	N/A	Associated work for DAS/AMR
11	Construction vehicle	N/A	For safety and efficient work
	Total	15,973	

(Prepared by the Survey Team based on CEB data)

(5) Loss Evaluation of Western Province South-1 of Region 4 (Package 5)

Table 6.2-5 shows the loss reduction values of Package 5.

Table 6.2-5 Loss Reduction Values of Package 5

No.	Sub-project Description	Loss Reduction (MWh/year)	Remarks
1	Dehiwala Mount Laveniya UG cables	N/A	
2	Ariel Bundle Conductor LV Line	446	
3	Instrument for loss reduction	N/A	For maintenance
4	Additional LBS for DAS reinforcement	N/A	Associated work for DAS
5	Additional MV lines for interconnection	N/A	Associated work for DAS
6	DAS	2,605	
7	AMR	4,345	
8	Communication infrastructure (55 km)	N/A	Associated work for DAS/AMR
9	Construction vehicle	N/A	For safety and efficient work
	Total	7,396	

(Prepared by the Survey Team based on CEB data)

6.3 Applicability of Japanese Technologies

(1) DAS and AMR

Although the SCADA system has been supplied to Colombo City by the previous yen loan project, the other provinces, which apply the 33 kV overhead system, have no DAS except simplified remote control facilities named 'Micro SCADA' or Mini SCADA.

In Japan, the DAS system has been developed for overhead lines with self-healing system so-called as step by step energizing method. It has a function of automatic re-energizing, which is very useful in case of large-scale blackout. This is one of the superior technologies as compared with other countries. Operation knowledge of overhead system for more than 30 years in Japan can be very useful and effective to undertake capacity building for CEB engineers, operators and maintenance people. In addition, distribution network connections may change daily adding and/or deleting consumers, distribution lines, etc.; the system configuration data shall be amended timely. In Japanese DAS, such data can be amended by engineers easily.

In addition to the DAS system, the Survey Team suggests introducing AMR systems. For the combined system DAS and AMR, Japanese manufacturers are competitive in technology. This may be a hallmark of the smart grid system in Sri Lanka.

(2) Distribution Transformers

Japanese manufacturers have developed new low-loss type transformers, the so called "Top Runner Transformers" which offer very low no-load and load losses. The transformers have been manufactured according to severe requirements by Japanese laws and regulations. However, there is no such requirement in Sri Lankan laws and regulations. It is obvious that Japanese transformers have smaller no-load and load losses than that manufactured in Sri Lanka. If these techniques are to be introduced in Sri Lanka, it is possible to reduce

much transformer losses in the distribution system.

On the other hand, the Survey Team has recognized the difficulty to apply "Top Runner Transformers" in Sri Lanka, because it is manufactured based on different standards and primary voltage. Considering the situation, the Survey Team investigated the possibility to apply directional silicon iron cores as one of low loss transformer technologies. Transformer manufacturers in Sri Lanka can produce the transformers using this type of cores without changing manufacturing lines.

The cost impact between normal and directional silicon iron core is very small, because the percentage of directional silicon iron is almost 30 % of the total cost. For example, the cost difference in both types of DTs is about US$ 440 in 100 kVA capacity. The loss reduction of 100 kVA DT is estimated as 525.6 kWh/year (78 US$/year saving) (= *60 W (loss difference of new and existing DT) x 24 hours x 365 days*) can be saved without changing load loss. The additional cost can be repaid within 6-7 years as shown in Table 6.3-1.

Table 6.3-1 Loss Reduction and Repaid Years of Each DT

DT Capacity	Difference of No-load loss	Loss Reduction (kWh/Year)	Repaid Year
100 kVA	60 W	525.6	5.6
160 kVA	80 W	700.8	5.6
150 kVA	85 W	744.6	6.8

(Prepared by the Survey Team)

(3) Specialized Vehicles

To confirm the applicability of Japanese specialized vehicles, the Survey Team investigated construction sites and related tenders called by CEB as follows.

1) CEB has experience to use Japanese specialized vehicles and very familiar with them as shown in the right photograph of site work.
2) CEB called the tender for the same type of vehicles financed by ADB and successful tenderer offered Japanese vehicles.
3) Traffic rules are the same in Japan and Sri Lanka, and thus Japanese vehicle is superior to American, European, or Chinese vehicles.
4) Good after care services are available in Sri Lanka, because many Japanese cars are imported and used in Sri Lanka.
5) Japanese specialized vehicles are manufactured based on strict safety rules and regulations of Japan. It can contribute to increase worker's safety in Sri Lanka. Table 6.3-2 shows the safety mechanisms of Japanese specialized vehicles.

Table 6.3-2 Safety Mechanisms of Japanese Specialized Vehicles

Specialized Vehicles	Specific Safety Mechanism	Common Specification for Truck
Pole Installation Trucks	・ Hook over winding check mechanism ・ Auger over winding check mechanism ・ Emergency engine stop device ・ Load meter ・ Angle meter for boom ・ Hydraulic safety devices	・ Right handle vehicle ・ Exhaust gas control ・ Back monitor
Bucket Trucks	・ Hook over winding check mechanism ・ Overload prevention mechanism ・ Multi-layer Insulation bucket ・ Emergency stop device ・ Control switch with boom/jack interlock mechanism ・ Hydraulic safety devices ・ Additional hydraulic jib ・ Multi-layer Insulation	
Cargo Cranes	・ Over load check mechanism ・ Hook over winding check mechanism ・ Stability monitor for preventing turnover ・ Boom/jack interlock mechanism ・ Load meter ・ Angle meter for boom ・ Hydraulic safety devices	

(Prepared by the Survey Team)

Therefore, the very high applicability of Japanese specialized vehicles is confirmed.

Attachment for Chapter 6 Loss Reduction Calculations

1. New MV lines

   1) The typical load curve of Region 3 is used for the loss calculation.
   2) Overload condition is 100 % of rated current of MV line.
   3) 50% of previous load current is by-passed on the new MV line.
   4) Resistance of each type of conductor is as follows:

Conductor Specifications

Conductors	Max Load Current	Rated MVA at 33 kV	Resistance (ohm)
Lynx	350 A	20.00 MVA	0.1576
Raccoon	200 A	11.43 MVA	0.3632
Weasel	95 A	5.43 MVA	0.9077
Lynx (Double)	350 A x 2	40.00 MVA	0.1576 / 2
Raccoon (Double)	200 A x 2	22.86 MVA	0.3632 / 2

(Prepared by the Survey Team)

   5) Calculation formula

$$\text{Loss Reduction (Wh/km)} = \Sigma \{(I^1)^2 \times Rpl - (I^2)^2 \times Rpl \times 2\}$$

Where I^1*: Previous load current before project*

I^2*: Load current after project*

Rpl: Resistance of power wire per km

Σ*: Summation of loss for 24 hours*

2. Re-conduction of MV Lines

   1) Typical load curve of Region 3 is used for the loss calculation.
   2) Peak load condition is 70% of rated current of MV line.
   3) Calculation formula

$$\text{Loss Reduction (Wh/km)} = \Sigma \{(I)^2 \times Rpl^1 - (I)^2 \times Rpl^2\}$$

Where I*: Load current on MV line*

Rpl^1*: Resistance of previous MV line*

Rpl^2*: Resistance of new MV line*

3. Additional PSs

   1) Typical load curve of Region 3 is used for the loss calculation.
   2) The load (10 MVA) on four 11 kV lines is loaded on one 33 kV line.
   3) MV line lengths is 5 km (assumption).
   4) Calculation formula

$$\text{Loss Reduction (Wh/each PSs)} = \Sigma \{(I^{11})^2 \times Rpl^{11} \times 4 - (I^{33})^2 \times Rpl^{33} \times 1\}$$

Where I^{11}*: Load current on 11 kV line*

I^{33}*: Load current on 33 kV line*

Rpl^{11}*: Typical power wire resistance on 11 kV line (0.3632 ohm/km)*

Rpl^{33}*: Typical power wire resistance on 33 kV line (0.1576 ohm/km)*

4. Re-conduction of LV wire from bare aluminum to Arial Bundle Conductors (ABC)
   1) LV wire is replaced to ABC from Fly.
   2) Typical DT (160 kVA) is used for the calculation.
   3) LV line length is 1 km (assumption).
   4) Calculation formula

   $$\text{Loss Reduction (Wh/km)} = \Sigma \{(I^{415})2 \times R^F - (I^{415})2 \times R^A\}$$

   Where I^{415}*: Load current on LV line*

   R^F*: Power wire resistance of Fly (0.452 ohm/km)*

   R^A*: Power wire resistance of ABC (0.443 ohm/km)*

5. Addition of DTs
   1) One DT with same capacity is added between existing transformers
   2) Typical load curve of rural area-2 (as shown in Figure 4.2-2) is used for the calculation
   3) Fly conductor is used for power wire.
   4) Five lines are outgoing from one transformer (160 kVA)
   5) LV line length is reduced to 45 % of previous one (90% in total).
   6) Load current is reduced to 50 % of previous one.
   7) Calculation formula

   $$\text{Loss Reduction (Wh/unit)} = \Sigma \{5 \times (I^{l1})^2 \times Rpll \times L^1 - 5 \times (I^{l2})^2 \times Rpll \times L^2\} - NL + (2 \times (LL - LL^{0.75}) - LL^{0.5})$$

   Where I^{l1}*: Previous load current*

   I^{l2}*: New load current after adding DT*

   Rpll: Resistance of LV Fly line (0.452 ohm/km)

   L^1*: Previous length of LV line*

   L^2*: New length of LV line after adding of DT* ($L^2 = 0.9 \times L^1$)

   NL: No-load loss of 160 kVA DT

   LL: Load loss

   $LL^{0.75}$*: Load loss when load reduced to 0.75 time of previous load*

   $LL^{0.5}$*: Load loss when load reduced to 0.5 time of previous load*

6. Three Phase Conversions
   1) Tree phase LV line is same as previous one (Fly)
   2) Typical load curve of rural area-1 (as shown in Figure 4.2-2) is used for the calculation
   3) Six lines are outgoing from one transformer (100 kVA)
   4) Calculation formula

   $$\text{Loss Reduction (Wh/km)} = \Sigma \{2 \times (I^{l1})^2 \times R^F - 3 \times (I^{l2})2 \times R^F\}$$

   Where I^{l1}*: Previous load current*

   $I^{l2:}$ *New load current on three phase line*

   R^F*: Resistance of LV line (0.452 ohm/km)*

7. Augmentation of 33/11kV Transformers

1) Typical load curve (Region 3) is used for the calculation.

2) Calculation formula

$$Loss\ Reduction(Wh/set) = \Sigma \{L^{n1} - L^{n2} + L^{o1} \times (L/TR1)^2 - L^{o2} \times (L/TR2)^2\}$$

Where L^{n1}*: No-load loss of previous transformer*

L^{n2}*: No-load loss of new transformer*

L^{o1}*: Load loss of previous transformer*

L^{02}*: Load loss of new transformer*

TR1: Capacity of previous transformer

TR2: Capacity of new transformer

L: Load on transformer

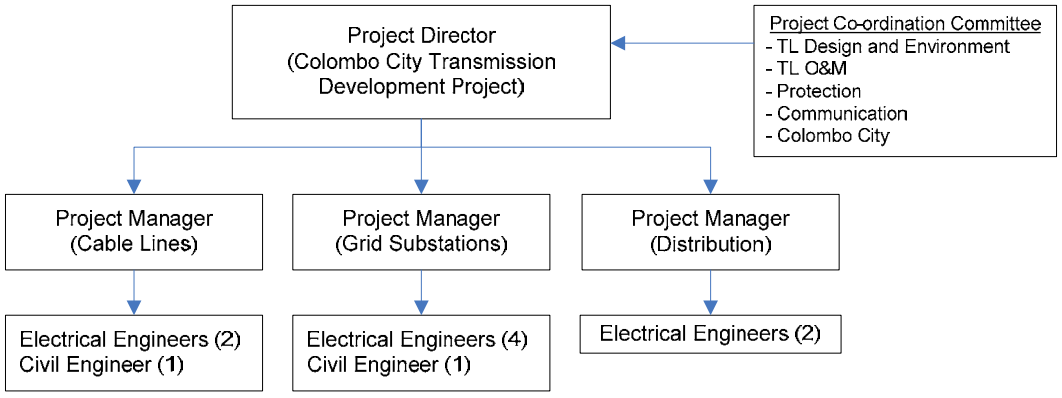
CHAPTER 7
IMPLEMENTATION PLANS FOR TRANSMISSION PROJECTS

CHAPTER 7 IMPLEMENTATION PLAN FOR TRANSMISSION PROJECTS

7.1 Implementation Agency

(1) Project Organization

For the implementation of a transmission line project, CEB generally forms a project implementation unit (PIU), which will be entrusted with the management and supervision of the project. The PIU basically consists of staff from project related branches such as the Transmission Projects Branch. Without exception, a PIU is essential for the selected projects. As an example, Figure 7.2-1 shows the PIU organization for Colombo City Transmission Development Project (PJT-1).



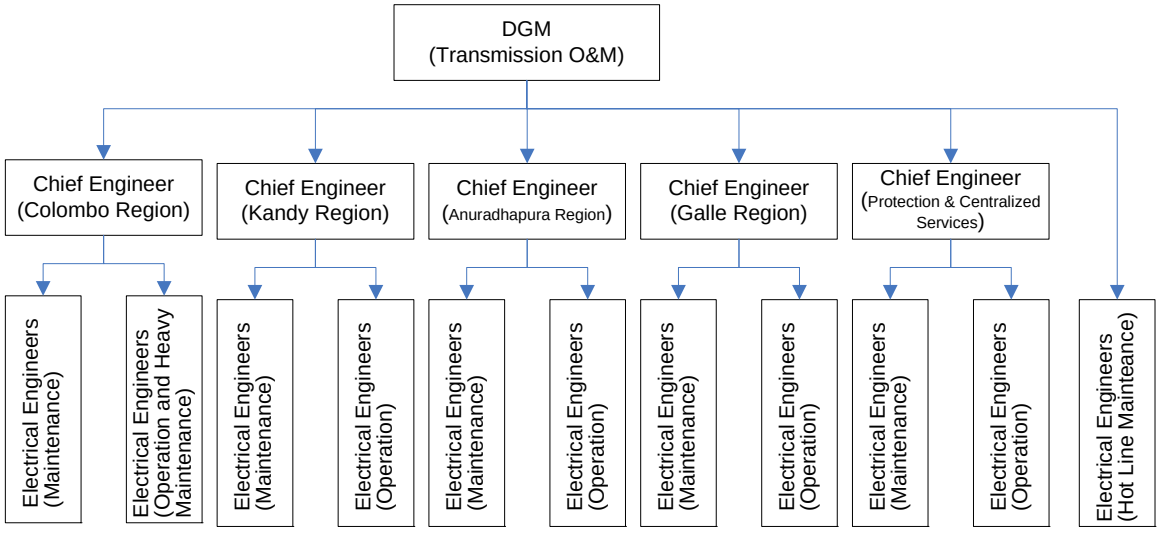
(Source: CEB Transmission Projects Branch)

Figure 7.1-1 PIU Organizational Structure for PJT-1

(2) Maintenance Organization

Once the project is completed, the management, operation and maintenance of the transmission lines/substations will be handed over to the Transmission Operation and Maintenance Branch of CEB.

Figure 7.1-2 shows the organization chart of the Transmission Operation and Maintenance Branch.



(Source: CEB Transmission Operation and Maintenance Branch)

Figure 7.1-2 Transmission Operation and Maintenance Branch

7.2 Common Subjects for Project Implementation

For the maximization of project benefits, it is vital to launch the project as early as possible. In addition, during the construction period, it is important to manage the project appropriately with due consideration to quality control, schedule management and safety management under CEB and their consultants.

For the implementation of the candidate projects, the following process needs to be taken:

1) Selection of project consultants
2) Basic and detailed design
3) Preparation of pre-qualification (PQ) and tender documents
4) PQ and tendering
5) Contract with contractors
6) Procurement and installation of equipment and materials
7) Commissioning tests and taking-over

Common subjects that need consideration for the procurement and construction are as follows:

1) Procurement stage

   The origin of the equipment and materials needs to be considered. Specifically, they are the followings:

   The origin of the equipment and materials needs to be considered. Specifically, these include the following items for consideration:

   i) For substation equipments, the country of origin needs to be selected with proper

attention;

ii) The quality of equipments and materials should be the first priority since inexpensive products tend to deviate from global standards and are of lower quality;

iii) Procurement of major equipment is crucial in the management of the manufacturing and transportation schedule;

iv) In case an additional transformer is to be installed at a limited space, it shall be procured considering performance and in line with the functions of existing transformers; and

v) When an additional GIS is to be procured, it should be the product of the same manufacturer or of others that produce types compatible to the existing ones.

2) Construction stage

Special construction methods and tools are not necessary. However, the following needs to be considered:

i) Neighboring residents during construction;

ii) Environmental/social troubles;

iii) In case energized points such as busbars are to be located near the extension area, attention must be mostly given to workers to avoid electrocution;

iv) Existing equipment for sequential control, interlock control, and protection coordination;

v) Planning and pre-warning of power shutdown schedules to ensure the safety of the workers;

vi) Checking of underground objects such as existing water pipes, communication cables, distribution cables, etc. before installation of power cables;

vii) Supervise the cable route during laying works to prevent workers and the public from accidents;

viii) Types of branched tower and route circumstances to avoid heavily populated and traffic congested areas for the construction of overhead transmission line; and

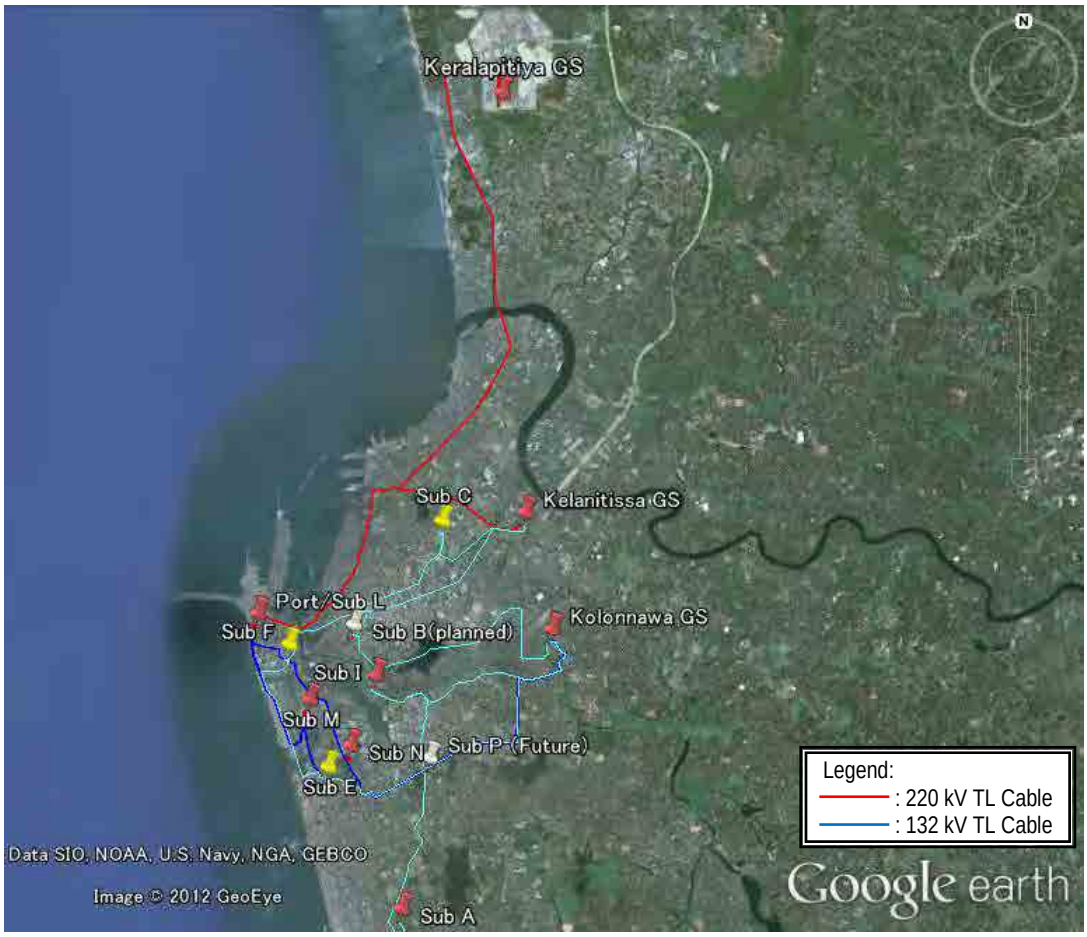
ix) Monitor the tension of the conductor to avoid damage of equipment and harming workers during conductor stringing works.

The implementation plans of each candidate project are described in the following sections:

7.3 Colombo City Transmission Development (PJT-1)

The Survey Team carried out site survey to confirm the existing GSs, new GS sites and cable line routes. In the route survey, obstacles and crossing points of the cable route such as railways, rivers, trunk roads, etc. were examined. Figure 7.3-1 shows the planned GS

locations and line routes of the project.



(Source: Google Earth Pro)

Figure 7.3-1 Location of Colombo City Transmission Development

(1) Substation Site Conditions

1) Port GS and Colombo L GS

- 220/132 kV Port GS and 132/11 kV Colombo L GS are to be located at 6° 56' 14.71'' north latitude and 79° 50' 28.51'' east longitude in Colombo City.
- The site is approximately 6,100 m^2 and located in the premises of the Colombo Port.
- Since the site is located close to the sea, attention should be paid to the equipment design to avoid salt contamination.
- There is enough space for heavy construction machinery intended for installing substation equipment.
- Since the site is sandy, steel plates are required during construction.

2) Colombo M GS

- 132/11 kV Colombo M GS site is approximately 2,400 m^2 and to be located at 6° 55' 32.01'' north latitude and 79° 50' 54.43'' east longitude in Slave Island of Colombo City.
- Since there are residences, shops, railway tracks, etc. around the site, carrying-in route of substation equipment needs to be carefully considered.


Planned Colombo M GS Site

- Since construction works shall be carried out in a limited space, careful formulation of construction plans is necessary such as the arrangement of construction equipment.

3) Colombo N GS

- 132/11 kV Colombo N GS site is approximately 2,400 m^2 and planned to be located at 6° 55' 9.30''' north latitude and 79° 51' 14.74'' east longitude in Hunupitiya of Colombo City.
- Since traffic along Sri James Pieris Mawatha Road in front of the planned site is heavy, attention is necessary to avoid traffic accidents.


Planned Colombo N GS Site

4) Colombo A GS

- Existing Colombo A GS is located at Havelock Town of Colombo City.
- Since the area is limited for installation of third power transformer; it should be installed on a vacant site to save space.


Colombo A GS GIS

- The location for the laying of the 132 kV and 11 kV power cables were identified. Careful planning is necessary to avoid interference with existing power cables.
- Since Colombo A GS is composed of 132 kV power receiving system with pi-

branch circuit, investigation is necessary for the coordination with protective relays, etc. during subsequent stage.

5) Colombo I GS

- Existing Colombo I GS is located in Maradana of Colombo City.
- Since the area is limited for installation of third power transformers, these should be installed on a vacant site to save space.
- Since space for the installation of six sets of 11 kV switchgear is limited, careful planning is necessary.
- Careful design is crucial for Colombo A GS in the next stage so as not to interfere with existing protective relay.

6) Kerawalapitiya GS, Kelanitissa GS and Kolonnawa GS

It was confirmed that there is enough space to install additional 220 kV and/or 132 kV GIS TL bays in Kerawalapitiya GS, Kelanitissa GS, and Kolonnawa GS.

(2) Power Cable Route Conditions

The following points are to be noted about the cable routes:

1) Kerawalapitiya – Port 220 kV Cable Route

- The narrow canal road that has heavy traffic. This is located at about 800 m west from Kerawalapitiya GS and about 4 km to the 220 kV cables.

The Mattakkuliya Bridge over the Kelani River. This is about 4 km south to Kerawalapitiya GS and about 150 m long. The 220 kV cables are to be installed

along the bridge sites or on a cable bridge which is to be constructed beside said bridge.

- Aluthmawatte Road and H. J. Perera Mawatha Road, which are both subject to heavy traffic in the morning and evening.
- The cargo railway where the 220 kV cables shall cross shall extend to about 3 km north-northwest from Port GS.


Canal Road


Mattakkuliya Bridge & Kelani River

2) Kelanitissa – Port 220 kV Cable Route

- New Kelani Bridge Road along Kelanitissa GS since it has heavy traffic; however it is wide enough to accommodate the installation of cables.
- The port access road between Barge Power Plant in Colombo Port and Kelanitissa GS since this is where the new 220 kV cables are to be constructed. Thus, it is necessary to check the conditions of the existing cable before laying new cables.

Existing Power Cable Warning Board


Port Access Road

3) Port – Colombo F – Colombo N - Kolonnawa 132 kV Cable Route

- The condition of existing cables buried around Colombo F GS since new 132 kV and 11 kV cables are to be laid between Colombo N and Kolonnawa, and between Colombo E GS and Kolonnawa GS.


132 kV Cable Route around Colombo F GS


132 kV Cable Route around Colombo N GS

4) Port GS – Colombo E GS via. Colombo M GS Route

- Special attention shall be taken to avoid traffic accidents and disturbance along the Galle Road, where new 132 kV cables are to be laid.
- Since there is a railway track at the planned cable route between Colombo M GS and Colombo E GS, appropriate consideration for construction methods in the next stage is necessary.

(3) Implementation Schedule

Table 7.3-1 shows the planned implementation schedule for the project. Construction period for the project is planned to be 24 months.

Table 7.3-1 Implementation Schedule: PJT-1

Work Items	1st Year												2nd Year											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Package 1 - Cable Lines (24 months)																								
1) Design and documentations	●															●						●		●
2) Manufacturing and factory tests	●														●									
3) Other materials					●											●								
4) Transportations						●		●			●		●			●								
5) Civil and installation works						●																		●
6) Commissioning																	●							●
Package 2 - Grid Substations (24 months)																								
1) Design and documentations	●															●		●				●		●
2) Manufacturing and factory tests	●																		●					
3) Other materials					●														●					
4) Transportations						●		●			●		●			●			●		●			
5) Civil and installation works								●																●
6) Commissioning										●														●

(Prepared by the Survey Team)

The Survey Team suggests that the project be divided into three packages, namely, (1) construction of 220 kV and 132 kV cables, (2) construction and augmentation of 220 kV and 132 kV GSs, and (3) 11 kV distribution development. Hence, consideration shall be taken with respect to scale of the packages and boundaries of construction contracts. Construction schedule for the distribution package is presented in Chapter 8.

(4) Revised Project Costs

The Survey Team estimated the costs for the candidate projects by applying revised unit rates, which have been prepared based on records of previous projects carried out in Sri Lanka. Table 7.3-2 shows the revised base costs of PJT-1.

Table 7.3-2 Revised Project Costs: PJT-1

Scope of the Project	CEB's Estimate (MLKR)		Survey Team's Estimate (MLKR)	
	FC	LC	FC	LC
1) 220 kV cable: Kerawalapitiya – Port (14.9 km)	3,480.0	648.0	3,555.7	752.6
2) 220 kV cable: Kelanitissa – Port (7.2 km)	1,686.0	624.0	1,728.9	363.7
3) 220 kV Junction 1,200 mm2 with end terminal (0.3 km)	-	-	88.9	15.2
4) 132 kV cable: Port – Kolonnawa (9.7 km)	1,598.7	297.0	1,344.4	426.6
5) 132 kV cable: Port – Colombo E (4.7 km)	760.1	141.2	650.3	206.7
6) 132 kV Junction with end terminals (0.9 km)	-	-	286.3	39.6
7) Miscellaneous, communication and river crossing	-	-	710.5	386.6
8) Dispute board fee for TL project	-	-	19.2	0.0
9) Construction of 220/132/33 kV Port GS	1,572.6	188.7	2,103.6	215.3
10) Construction of 132/11 kV Colombo-L GS	983.1	137.7	1,370.5	148.8
11) Construction of 132/11 kV Colombo-M GS	959.4	135.6	1,039.8	119.3
12) Construction of 132/11 kV Colombo-N GS	763.0	118.8	1,002.5	107.8
13) Extension of 132/11 kV Colombo-A GS	243.7	35.2	297.5	36.7
14) Extension of 132/11 kV Colombo-I GS	243.7	35.2	297.5	36.7
15) Extension of 220 kV & 132 kV GIS for line bays	233.3	9.9	339.4	13.0
16) Dispute board fee for GS project	-	-	19.2	0.0
Total of 1) ～ 16)	12,523.6	2,371.3	14,854.2	2,868.6
Total (FC+LC) in MLKR		14,894.9		17,722.8
Total in MJPY equiv.		8,817.8		10,491.9

(Prepared by the Survey Team)

7.4 Construction of Kappalthurai GS (PJT-2)

(1) Site Situation

The Kappalthurai GS site is located at 8° 34' 1.87" north latitude and 81° 10' 29.63" east longitude in Eastern Province, which is about 7 km away from Trincomalee to the west. As shown in Figure 7.4-1, the site is located beside Kandy Road and estimated to have an area of 2,400 m^2 considering the planned Kappalthurai GS scale.

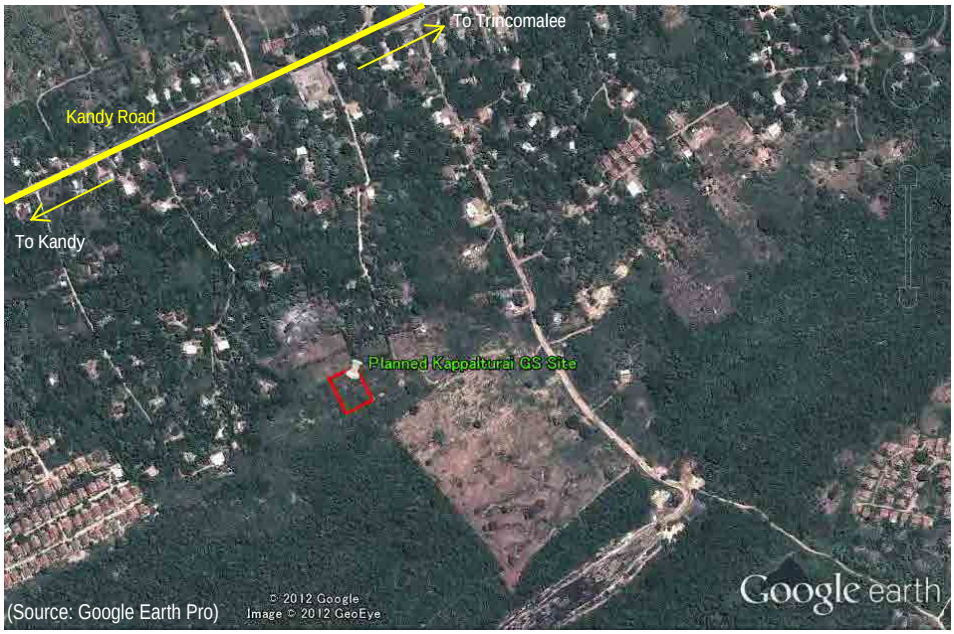


Figure 7.4-1 Kappalthurai GS Location

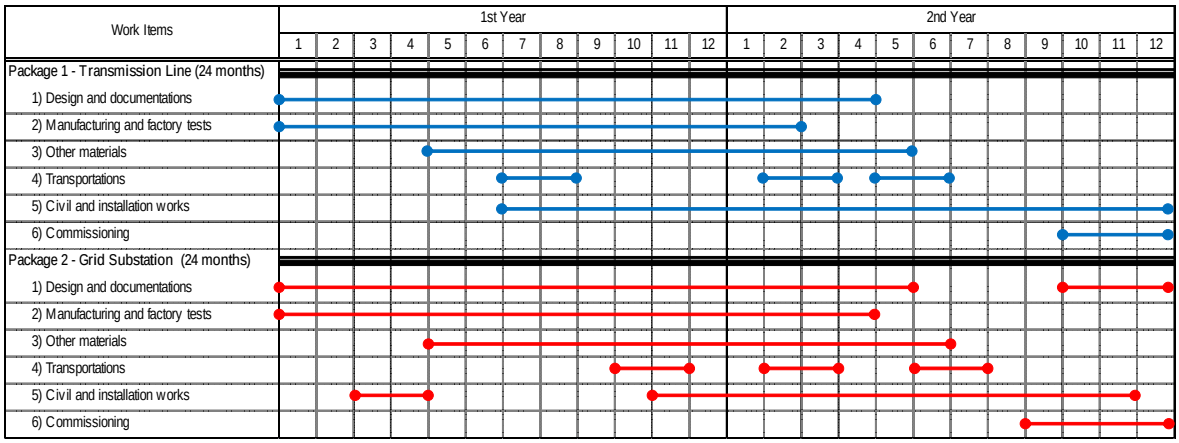
According to the CEB proposal and planned site condition, confirmation, and hearings were carried out. Corresponding results obtained are as follows:

1) There is enough space for the project site. However, a service road is required for the installation of large-sized substation equipment and heavy construction machinery; and
2) Density of residence within the site is not high.

(2) Implementation Schedule

Table 7.4-1 shows the planned implementation schedule for the project. Construction is planned to be 24 months.

Table 7.4-1 Implementation Schedule: PJT-2



(Prepared by the Survey Team)

(3) Revised Project Costs

Table 7.4-2 shows the revised base costs of the Kappalthurai GS Project.

Table 7.4-2 Revised Project Costs: PJT-2

Scope of the Project	CEB's Estimate (MLKR)		Survey Team's Estimate (MLKR)	
	FC	LC	FC	LC
1) 132 kV TL for New Anuradhapura – Trincomalee double in & out connection (2.0 km)	32.9	19.0	59.0	11.7
2) Transformers 132/33 kV 2 x 63 MVA & E.TR & Aux. TR.	143.6	17.6	372.3	19.0
3) 132 kV D/B transformer bay	56.0	10.1	240.3	5.6
4) 132 kV D/B line bay	98.1	20.8	116.7	2.8
5) 132 kV D/B arrangement with bus coupler	42.6	3.9	66.2	1.5
6) 33 kV S/B transformer bay	26.5	0.3	24.3	0.6
7) 33 kV S/B feeder bay	102.3	0.9	112.1	2.2
8) 33 kV S/B arrangement incl. bus section	14.4	0.1	9.3	0.3
9) Common items for grid with spare parts	204.7	96.5	470.6	143.9
10) Substation automation	46.6	0.5	99.4	5.2
Total of 1) ～ 10)	767.7	169.7	1,570.2	192.8
Total (FC+LC) in MLKR		937.4		1,763.0
Total in MJPY equiv.		554.9		1,043.7

(Prepared by the Survey Team)

7.5 Construction of Kerawalapitiya GS (PJT-3)

(1) Site Situation

Through the site survey, the following have been confirmed:

- The existing Kerawalapitiya is located within the premises of Kerawalapitiya CCGT Power Plant;
- Two sets of transformers are located inside the gurard house;
- 33 kV switchgears are to be extended to the 220 kV switchgear building located at the north side;
- There is enough space for the construction of a service road for large-sized substation equipment and for installation of heavy construction machinery; and
- New power cable routes with the existing protective relay, etc. shall be carefully designed during the next stage.

(2) Implementation Schedule

Table 7.5-1 shows the planned implementation schedule for the project. Construction period is planned to be 24 months.

Table 7.5-1 Implementation Schedule: PJT-3

Work Items	1st Year												2nd Year											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Package 1 - Grid Substation (24 months)																								
1) Design and documentations	●											●										●		●
2) Manufacturing and factory tests	●															●								
3) Other materials						●											●							
4) Transportations							●	●				●	●				●	●						
5) Civil and installation works							●																●	
6) Commissioning																				●				●

(Prepared by the Survey Team)

(3) Revised Project Costs

Table 7.5-2 shows the revised base costs of the Kerawalapitiya GS Project.

Table 7.5-2 Revised Project Costs: PJT-3

Scope of the Project	CEB's Estimate (MLKR)		Survey Team's Estimate (MLKR)	
	FC	LC	FC	LC
1) Transformers 220/33 kV 35 MVA & E.TR. & Aux. TR	325.0	39.9	299.7	19.0
2) 220 kV D/B type for transformer bay	-	-	167.7	8.0
3) 33 kV S/B transformer bay	31.5	0.3	24.3	0.6
4) 33 kV S/B feeder bay	102.3	0.9	112.1	2.2
5) 33 kV S/B arrangement incl. bus section	14.4	0.1	9.3	0.3
6) 4 x 5 MVar capacitor banks incl. SC bay	76.6	6.3	118.2	3.8
7) Common items for grid with spare parts	204.8	100.2	292.5	152.8
8) Substation automation system	46.6	0.5	82.3	1.3
Total of 1) ～ 8)	801.2	148.2	1,106.1	188.0
Total (FC+LC) in MLKR		949.4		1,294.1
Total in MJPY equiv.		562.0		766.1

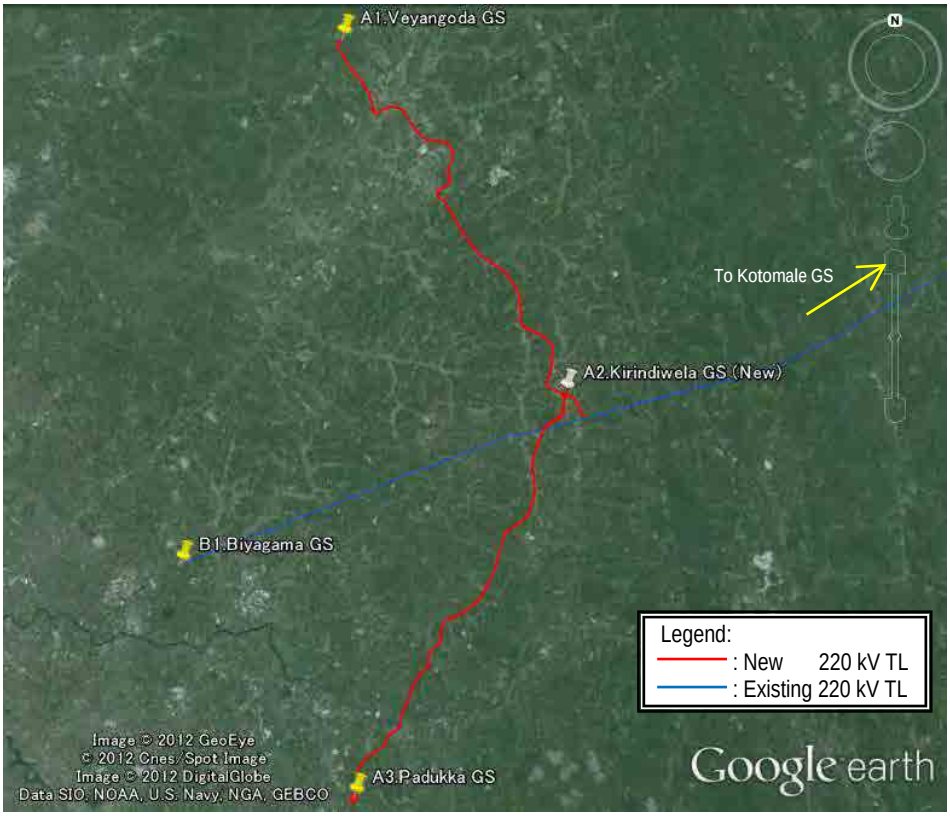
(Prepared by the Survey Team)

7.6 Construction of Veyangoda – Kirindiwela – Padukka 220 kV TL (PJT-5)

(1) Site Situation

The Survey Team carried out site survey to confirm the existing Veyangoda GS, new Kirindiwela and Padukka GSs sites and new transmission line routes.

Figure 7.6-1 shows the planned location of the Veyangoda – Kirindiwela – Padukka 220 kV TL Project.



(Source: Google Earth Pro)

Figure 7.6-1 Veyangoda – Kirindiwela – Padukka 220 kV TL Route

1) Veyangoda–Kirindiwela–Padukka 220 kV TL route

- Veyangoda - Padukka via Kirindiwela 220 kV TL route avoids residential and plantation areas, and is planned to be mainly constructed along pastoral land.
- The 220 kV TL shall cross railway tracks, which shall extend to about 4 km south-southeast from Veyangoda GS. There is no overhead line along the tracks.
- The Kelani River is about 5 km north-northeast from Padukka GS, and is about 100 m wide. Thus, the 220 kV TL route plan does not require special consideration.


Railway Crossing


River Crossing

2) Kirindiwela – Kosgama 132 kV TL route

- Similar to Veyangoda – Padukka 220 kV TL, the Kirindiwela – Kosgama 132 kV TL route avoids residential and plantation areas, and is planned to be mainly constructed along pastoral land.
- The Kelani River, which is about 4 km north-northweast from Kosgama, is about 100 m wide. Thus, the 132 kV TL route plan does not require special considerations.


River Crossing

3) Veyangoda GS

- The existing Veyangoda GS site is located in the Western Province, which is about 36 km away from Colombo City in the north-northeast direction.


Veyangoda GS 220 kV TL Bay


Veyangoda GS
Control & Protection Panel Room

- For the Veyangoda GS, which needs to extend its TL bays, no particular consideration is necessary for the space required for extension of existing busbar.

- The area of the existing control room is sufficient for the installation of the control and protection panels etc.

4) Kirindiwela GS

- The site for 220/132/33 kV Kirindiwela GS is located at 7° 2' 14.16'' north latitude and 80° 7' 48.74'' east longitude in the Western Province, which is about 35 km away from Colombo City in the east-northeast direction. It is also a pasture zone and is approximately 50,000 m^2.


Planned Kirindiwela GS Site

- Since the Hanwella Pugoda Weke Urapola Road beside the planned site has heavy traffic, attention is necessary to avoid related accidents.

5) Padukka GS

- The site for 220/132/33 kV Padukka GS site is located at 6° 52' 40.79'' north latitude and 80° 2' 48.00'' east longitude in the Western Province, which is about 25 km away from Colombo City in the east-southeast direction. It is also a pasture zone with vacant land, which is approximately 45,000 m^2.


Planned Padukka GS Site

- According to CEB, the construction plan for Padduka GS is being carried out under ADB loan.
- For the extension of the 220 kV TL bays, a minimum of 45,000 m^2 is necessary.
- The space for additoinal control and protection panel, etc. is to be confirmed during the planning of Padukka GS.

6) Kosgama GS

- Existing Kosgama GS is located in the Western Province, which is about 31 km away from Colombo City in the east direction.


Kosgama GS 132 kV TL Bay

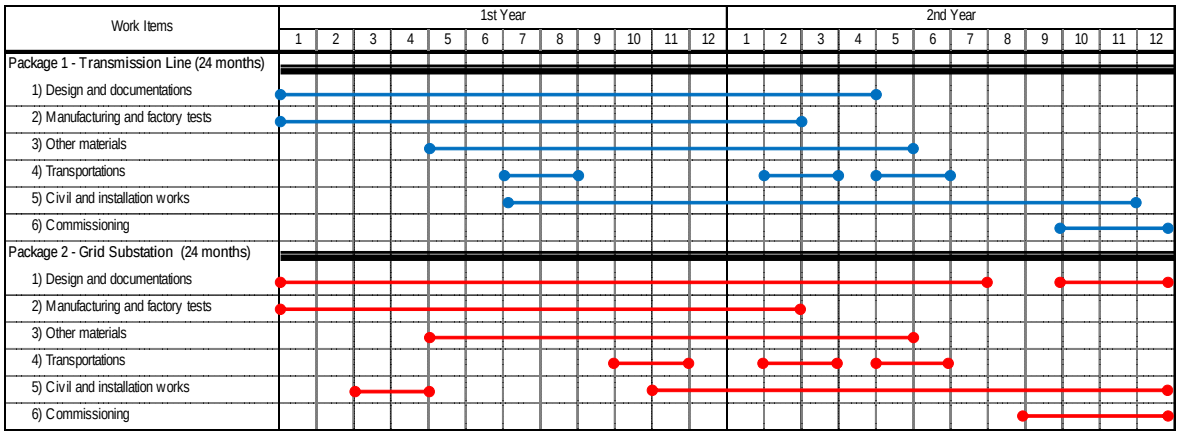

Kosgama GS
Control & Protection Panel Room

- No special consideration is necessary for the space required for the extension of existing busbar for Kirindiwela - Kosgama TL.
- Similar to Veyangoda GS, space in the existing control room is sufficient for the extension of control, protection panel, etc.

(2) Implementation Schedule

Table 7.6-1 shows the planned implementation schedule for the project. Construction period is planned to be 24 months.

Table 7.6-1 Implementation Schedule: PJT-5



(Prepared by the Survey Team)

(3) Revised Project Costs

Table 7.6-2 shows the revised base costs of the project.

Table 7.6-2 Revised Project Costs: PJT-5

Scope of the Project	CEB's Estimate (MLKR)		Survey Team's Estimate (MLKR)	
	FC	LC	FC	LC
1) Construction of 220 kV TL for Kirindiwela – Veyangoda (17.5 km)	572.9	259.3	1,021.2(*1)	213.4
2) Construction of 220 kV TL for Padukka – Kirindiwela (20.0 km)	654.8	296.4	1,167.1(*1)	243.8
3) Construction of 220 kV TL for Biyagama - Kotmale connection (4.0 km)	32.7	14.8	233.4	48.8
4) Removal of Existing 220 kV Transmission Line (2.3 km)	-	-	0.0	2.2
5) Construction of 132 kV TL for Kirindiwela – Kosgama (10.0 km)	164.6	94.8	295.0	58.7
6) Extension of 220 kV Veyangoda GS	107.7	8.6	169.9	5.6
7) Extension of 220 kV Padukka GS	107.7	8.6	169.9	5.6
8) Extension of 132 kV Kosgama GS	85.8	13.0	116.7	7.8
9) Transformers 220/132kV 2 x 150 MVA & E.TR.	308.9	22.2	606.4	20.4
10) Transformers 132/33 kV 2 x 31.5 MVA	141.0	15.8	203.3	15.0
11) 220 kV D/B line bay	430.6	34.6	101.4	0.8
12) 220 kV D/B transformer bay	84.1	8.8	100.7	0.8
13) 220 kV D/B arrangement incl. bus coupler	55.7	4.3	59.6	1.1
14) 132 kV S/B line bay	47.4	9.4	46.8	0.9
15) 132 kV S/B transformer bay	102.4	1.8	29.4	0.6
16) 132 kV S/B arrangement incl. bus section	38.4	3.6	28.7	0.9
17) 33 kV S/B transformer bay	26.5	26.5	24.3	0.6
18) 33 kV S/B feeder bay	102.3	0.9	112.1	2.2

Scope of the Project	CEB's Estimate (MLKR)		Survey Team's Estimate (MLKR)	
	FC	LC	FC	LC
19) 33 kV S/B arrangement incl. bus section	14.4	0.1	9.3	0.3
20) 2 x 5 MVar capacitor banks incl. SC bay	38.3	3.2	59.1	1.9
21) Common items for grid with spare parts	325.7	136.2	621.5	245.9
22) Substation automation GS	46.6	0.5	131.9	2.0
Total of 1) ～ 22)	3,488.5	979.6	5,307.7	879.3
Total (FC+LC) in MLKR		4,468.0		6,187.0
Total in MJPY equiv.		2,645.1		3,662.8

(Prepared by the Survey Team)

Note *1: This 220 kV TL cost applies price of LL-ACSR.

7.7 Construction of Kalutara GS (PJT-7)

(1) Site Situation

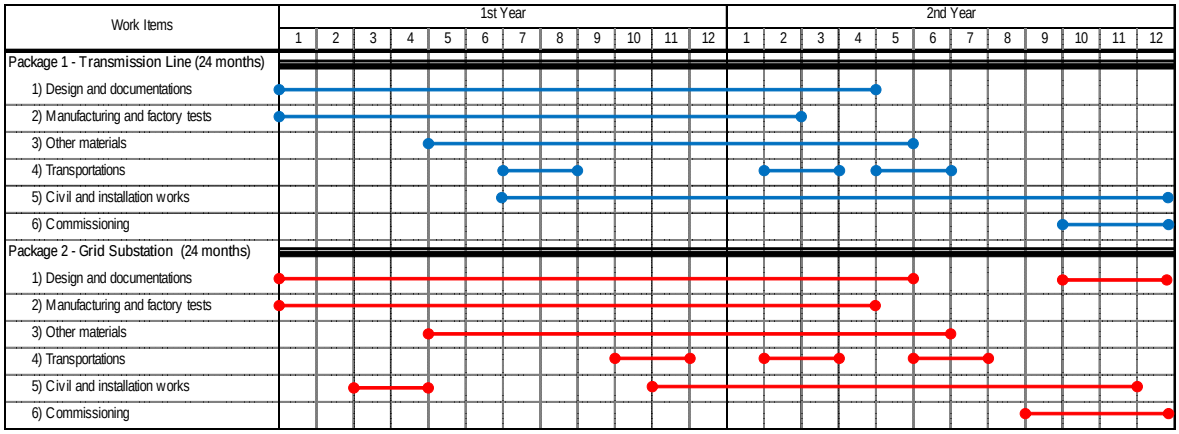
Through the site survey for the branch point of the Panadura–Matugama TL and planned Kalutara GS construction site, the following have been confirmed:

- It is necessary to investigate the structural condition of the existing tower of the branch point since said tower can be used for branching. However, since the clearance between the conductor and bank is very narrow some countermeasures need to be considered;
- Since the planned line route will run through damp areas and across a small river, the route needs careful survey in the next stage; and
- The Kalutara GS site is approximately 2,400 m^2. Since the construction site is planned along the Kalutara Horana Road, it is necessary to investigate the condition of traffic.

(2) Implementation Schedule

Table 7.7-1 shows the planned implementation schedule for the project. Construction period is planned to be 24 months.

Table 7.7-1 Implementation Schedule: PJT-7



(Prepared by the Survey Team)

(3) Revised Project Costs

Table 7.7-2 shows the revised base costs of the Kalutara GS Project.

Table 7.7-2 Revised Project Costs: PJT-7

Scope of the Project	CEB's Estimate (MLKR)		Survey Team's Estimate (MLKR)	
	FC	LC	FC	LC
1) Construction of 132 kV TL for Pannipitiya– Matugama double in & out connection (6.0 km)	98.8	56.9	177.0	35.2
2) Transformers 132/33 kV 2 x 31.5 MVA & E.TR & Aux. TR.	143.6	17.6	203.3	15.0
3) 132 kV S/B transformer bay	51.1	9.0	22.4	6.0
4) 132 kV S/B line bay	47.4	9.4	16.3	5.4
5) 132 kV S/B arrangement with bus coupler	38.4	3.6	30.0	6.3
6) 33 kV S/B transformer bay	26.5	0.3	24.3	0.6
7) 33 kV S/B feeder bay	102.3	0.9	112.1	2.2
8) 33 kV S/B arrangement incl. bus section	14.4	0.1	9.3	0.3
9) Common items for grid with spare parts	200.5	95.6	371.7	146.6
10) Substation automation	46.6	0.5	99.4	5.2
Total of 1) ～ 10)	769.6	193.9	1,065.8	222.8
Total (FC+LC) in MLKR		963.5		1,288.6
Total in MJPY equiv.		570.4		762.9

(Prepared by the Survey Team)

7.8 Construction of Battaramulla 132/33 kV GS (PJT-8)

(1) Site Situation

Through the site survey for the branch point of the Kolonnawa – Athurugiriya TL and planned Battaramulla construction site, the following information has been confirmed:

- It is necessary to investigate the structural condition of the existing tower of the branch point since said tower may be used for branching, considering its location and type. However, according to CEB, the branching point of current 132 kV TL may change;

- The route needs to be carefully surveyed since the planned route will run through a damp area, which is approximately 2,400 m^2. The branch point is similar to that of 132 kV TL; and
- Battaramulla GS is planned to be constructed along Bandaranayaka Mawatha Road where filling and ground leveling works shall be required.

(2) Implementation Schedule

Table 7.8-1 shows the planned implementation schedule for the project. Construction period is planned to be 24 months.

Table 7.8-1 Implementation Schedule: PJT-8

Work Items	1st Year												2nd Year											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Package 1 - Transmission Line (24 months)																								
1) Design and documentations																								
2) Manufacturing and factory tests																								
3) Other materials																								
4) Transportations																								
5) Civil and installation works																								
6) Commissioning																								
Package 2 - Grid Substation (24 months)																								
1) Design and documentations																								
2) Manufacturing and factory tests																								
3) Other materials																								
4) Transportations																								
5) Civil and installation works																								
6) Commissioning																								

(Prepared by the Survey Team)

(3) Revised Project Costs

Table 7.8-2 shows the revised base costs of the Battaramulla GS Project.

Table 7.8-2 Revised Project Costs: PJT-8

Scope of the Project	CEB's Estimate (MLKR)		Survey Team's Estimate (MLKR)	
	FC	LC	FC	LC
1) Construction of 132 kV TL for Kolonnawa - Athurugiriya double in & out connection (3.0 km)	49.4	28.5	88.5	17.6
2) Transformers 132/33 kV 2 x 45 MVA & E.TR & Aux. TR.	143.6	17.6	278.5	15.0
3) 132 kV S/B transformer bay	105.6	2.7	109.2	2.5
4) 132 kV S/B line bay	106.3	2.9	106.1	2.5
5) 132 kV S/B arrangement with bus coupler	54.9	1.7	55.1	1.3
6) 33 kV S/B transformer bay	31.5	0.3	24.3	0.6
7) 33 kV S/B feeder bay	14.4	0.1	112.1	2.2
8) 33 kV S/B arrangement incl. bus section	102.3	0.9	9.3	0.3
9) Common items for grid with spare parts	210.8	99.1	371.7	146.6
10) Substation automation	46.6	0.5	99.4	5.2
Total of 1) ～ 10)	865.4	154.3	1,254.2	193.8
Total (FC+LC) in MLKR		1,019.7		1,448.0
Total in MJPY equiv.		603.7		857.2

(Prepared by the Survey Team)

Project Cost Breakdown: PJT-1

US $ =JPY 78.2
LKR =JPY 0.592
Package 01 Grid Substations Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Cost		Total	(Reference) Total	
			Foreign	Local	Foreign	Local			
			JPY	LKR	JPY	LKR	JPY	LKR	USD
1. New Construction of 220/132 kV Port GS					1,245,319,280	215,286,500	1,372,768,888	2,318,866,365	17,554,589
1) 220/132/33 kV 250 MVA Auto-Transformer & E.TR and/or LA	sets	2	237,500,000	10,200,000	475,000,000	20,400,000	487,076,800	822,764,865	6,228,604
2) 220 kV GIS Double Busbar Type for Incoming Line Bay (Indoor)	sets	2	48,928,800	3,990,000	97,857,600	7,980,000	102,581,760	173,280,000	1,311,787
3) 220 kV GIS Double Busbar Type for Transformer Bay (Indoor)	sets	2	49,651,040	4,020,000	99,302,080	8,040,000	104,061,760	175,780,000	1,330,713
4) 220 kV GIS Double Busbar Type for Bus Section Bay (Indoor)	set	1	60,360,320	5,940,000	60,360,320	5,940,000	63,876,800	107,900,000	816,839
5) 132 kV GIS Double Busbar Type for Transformer Bay (Indoor)	sets	2	34,543,200	1,390,000	69,086,400	2,780,000	70,732,160	119,480,000	904,503
6) 132 kV GIS Double Busbar Type for Feeder Bay (Indoor)	sets	2	35,561,440	1,390,000	71,122,880	2,780,000	72,768,640	122,920,000	930,545
7) 132 kV GIS Double Busbar Type for Bus Section Bay (Indoor)	set	1	39,160,800	1,510,000	39,160,800	1,510,000	40,054,720	67,660,000	512,209
8) Common Items 220/132/33 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	255,329,200	163,860,500	255,329,200	163,860,500	352,334,616	595,159,824	4,505,558
9) Substation Automation System	lot	1	78,100,000	1,996,000	78,100,000	1,996,000	79,281,632	133,921,676	1,013,832
2. New Construction of 132/11 kV Colombo-L 1&2 GS					811,360,100	148,779,900	899,437,801	1,519,320,609	11,501,762
1) 132/11 kV 45 MVA OLTC Transformer & Aux.TR	sets	4	75,450,000	5,220,000	301,800,000	20,880,000	314,160,960	530,677,297	4,017,404
2) 132 kV GIS Double Busbar Type for Transformer Bay (Indoor)	sets	4	34,543,200	1,390,000	138,172,800	5,560,000	141,464,320	238,960,000	1,809,007
3) 11 kV SWG Single Busbar Type for Transformer Bay (Indoor)	sets	4	5,500,000	250,000	22,000,000	1,000,000	22,592,000	38,162,162	288,900
4) 11 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	24	4,900,000	250,000	117,600,000	6,000,000	121,152,000	204,648,649	1,549,258
5) 11 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	sets	3	6,600,000	250,000	19,800,000	750,000	20,244,000	34,195,946	258,875
6) Common Items 132/11 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	163,287,300	113,339,900	163,287,300	113,339,900	230,384,521	389,163,042	2,946,094
7) Substation Automation System	lot	1	48,700,000	1,250,000	48,700,000	1,250,000	49,440,000	83,513,514	632,225
3. New Construction of 132/11 kV Colombo-M GS					615,566,200	119,275,600	686,177,355	1,159,083,370	8,774,646
1) 132/11 kV 45 MVA OLTC Transformer & Aux.TR	sets	2	75,450,000	5,220,000	150,900,000	10,440,000	157,080,480	265,338,649	2,008,702
2) 132 kV GIS Single Busbar Type for Incoming Line Bay (Indoor)	sets	2	32,329,120	1,260,000	64,658,240	2,520,000	66,150,080	111,740,000	845,909
3) 132 kV GIS Single Busbar Type for Transformer Bay (Indoor)	sets	2	31,405,600	1,260,000	62,811,200	2,520,000	64,303,040	108,620,000	822,290
4) 132 kV GIS Single Busbar Type for Bus Section Bay (Indoor)	set	1	32,636,960	1,260,000	32,636,960	1,260,000	33,382,880	56,390,000	426,891
5) 11 kV SWG Single Busbar Type for Transformer Bay (Indoor)	sets	2	5,500,000	250,000	11,000,000	500,000	11,296,000	19,081,081	144,450
6) 11 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	18	4,900,000	250,000	88,200,000	4,500,000	90,864,000	153,486,486	1,161,944
7) 11 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	sets	1	6,600,000	250,000	6,600,000	250,000	6,748,000	11,398,649	86,292
8) Common Items 132/11 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	150,059,800	96,035,600	150,059,800	96,035,600	206,912,875	349,514,992	2,645,945
9) Substation Automation System	lot	1	48,700,000	1,250,000	48,700,000	1,250,000	49,440,000	83,513,514	632,225
4. New Construction of 132/11 kV Colombo-N GS					593,477,500	107,777,500	657,281,780	1,110,273,277	8,405,138
1) 132/11 kV 45 MVA OLTC Transformer & Aux.TR	sets	2	75,450,000	5,220,000	150,900,000	10,440,000	157,080,480	265,338,649	2,008,702
2) 132 kV GIS Single Busbar Type for Incoming Line Bay (Indoor)	sets	2	32,329,120	1,260,000	64,658,240	2,520,000	66,150,080	111,740,000	845,909
3) 132 kV GIS Single Busbar Type for Transformer Bay (Indoor)	sets	2	31,405,600	1,260,000	62,811,200	2,520,000	64,303,040	108,620,000	822,290
4) 132 kV GIS Single Busbar Type for Bus Section Bay (Indoor)	set	1	32,636,960	1,260,000	32,636,960	1,260,000	33,382,880	56,390,000	426,891
5) 11 kV SWG Single Busbar Type for Transformer Bay (Indoor)	sets	2	5,500,000	250,000	11,000,000	500,000	11,296,000	19,081,081	144,450
6) 11 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	12	4,900,000	250,000	58,800,000	3,000,000	60,576,000	102,324,324	774,629

7) 11 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	set	1	6,600,000	250,000	6,600,000	250,000	6,748,000	11,398,649	86,292
8) Common Items 132/11 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	157,371,100	86,037,500	157,371,100	86,037,500	208,305,300	351,867,061	2,663,751
9) Substation Automation System	lot	1	48,700,000	1,250,000	48,700,000	1,250,000	49,440,000	83,513,514	632,225
5. Extension of 132/11 kV Colombo-A GS					176,148,000	36,701,200	197,875,110	334,248,497	2,530,372
1) 132/11 kV 31.5 MVA OLTC Transformer & Aux.TR	set	1	53,175,000	5,220,000	53,175,000	5,220,000	56,265,240	95,042,635	719,504
2) 132 kV GIS Single Busbar Type for Transformer Bay (Indoor)	set	1	31,405,600	1,260,000	31,405,600	1,260,000	32,151,520	54,310,000	411,145
3) 11 kV SWG Single Busbar Type for Transformer Bay (Indoor)	set	1	5,500,000	250,000	5,500,000	250,000	5,648,000	9,540,541	72,225
4) 11 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	6	4,900,000	250,000	29,400,000	1,500,000	30,288,000	51,162,162	387,315
5) 11 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	set	1	6,600,000	250,000	6,600,000	250,000	6,748,000	11,398,649	86,292
6) Common Items 132/11 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	42,867,400	28,111,200	42,867,400	28,111,200	59,509,230	100,522,349	760,988
7) Modification of Substation Automation System	lot	1	7,200,000	110,000	7,200,000	110,000	7,265,120	12,272,162	92,904
6. Extension of 132/11 kV Colombo-I GS					176,148,000	36,701,200	197,875,110	334,248,497	2,530,372
1) 132/11 kV 31.5 MVA OLTC Transformer & Aux.TR	set	1	53,175,000	5,220,000	53,175,000	5,220,000	56,265,240	95,042,635	719,504
2) 132 kV GIS Single Busbar Type for Transformer Bay (Indoor)	set	1	31,405,600	1,260,000	31,405,600	1,260,000	32,151,520	54,310,000	411,145
3) 11 kV SWG Single Busbar Type for Transformer Bay (Indoor)	set	1	5,500,000	250,000	5,500,000	250,000	5,648,000	9,540,541	72,225
4) 11 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	6	4,900,000	250,000	29,400,000	1,500,000	30,288,000	51,162,162	387,315
5) 11 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	set	1	6,600,000	250,000	6,600,000	250,000	6,748,000	11,398,649	86,292
6) Common Items 132/11 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	42,867,400	28,111,200	42,867,400	28,111,200	59,509,230	100,522,349	760,988
7) Modification of Substation Automation System	lot	1	7,200,000	110,000	7,200,000	110,000	7,265,120	12,272,162	92,904
7. Extension of Line Bays to Kerawalapitiya, Kelanitissa, and Kolonnawa GS					200,924,940	12,988,300	208,614,014	352,388,536	2,667,698
1) 220 kV GIS Double Busbar Type for Incoming Line Bay (Indoor) with Extension of Protection etc.	sets	2	62,628,800	4,197,000	125,257,600	8,394,000	130,226,848	219,977,784	1,665,305
2) 132 kV GIS Dounble Busbar Type for Incoming Line Bay (Indoor) with Extension of Protection etc	set	1	42,179,840	1,597,000	42,179,840	1,597,000	43,125,264	72,846,730	551,474
3) Miscellaneous (Modification of SCADA, Spare etc.)	lot	1	33,487,500	2,997,300	33,487,500	2,997,300	35,261,902	59,564,023	450,919
8.Distribution GIS substation					213,120,000	140,000,000	296,000,000	500,000,000	3,785,166
1)33kV GIS Sub at Kelanitissa	set	1	213,120,000	140,000,000	213,120,000	140,000,000	296,000,000	500,000,000	3,785,166
9. Dispute Board Fee					11,385,920	0	11,385,920	19,232,973	145,600
1) Dispute Board Fee	set	1	11,385,920	0	11,385,920	0	11,385,920	19,232,973	145,600
Total					4,043,449,940	817,510,200	4,527,415,978	7,647,662,126	57,895,345

Package 02 Transmission and Distribution Cables

Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Cost		Total	(Reference) Total	
			Foreign	Local	Foreign	Local			
			JPY	LKR	JPY	LKR	JPY	LKR	USD
1. 220 kV XLPE Cable Transmission Line					3,181,100,000	1,131,486,000	3,850,939,712	6,504,965,730	49,244,753
1) 220 kV T/L 1,600 mm2 with End & Joint Terminals Between Kerawalapitiya and Port (14.9 km)	set	1	2,105,000,000	752,640,000	2,105,000,000	752,640,000	2,550,562,880	4,308,383,243	32,615,894
2) 220 kV T/L 1,600 mm2 with End & Joint Terminals Between Kelanitissa and Port (7.2 km)	set	1	1,023,500,000	363,692,000	1,023,500,000	363,692,000	1,238,805,664	2,092,577,135	15,841,505
3) 220kV Junction 1,200 mm2 with End Terminal Between GIS and MTR @ 2 Circuits (300 m)	set	1	52,600,000	15,154,000	52,600,000	15,154,000	61,571,168	104,005,351	787,355
2. 132 kV XLPE Cable Transmission Line					1,350,400,000	672,851,000	1,748,727,792	2,953,932,081	22,362,248
2.1 T/L of Port (Colombo-L) - Pannipitiya Route					385,000,000	206,693,000	507,362,256	857,030,838	6,488,008
1) 132kV T/L 1,200 mm2 with End & Joint Terminals Between Port (Colo-L) and Colombo-M (3.2 km)	set	1	274,600,000	140,727,000	274,600,000	140,727,000	357,910,384	604,578,351	4,576,859
2) 132kV T/L 800 mm2 with End & Joint Terminals Between Colombo-M and Colombo-E (1.5 km)	set	1	110,400,000	65,966,000	110,400,000	65,966,000	149,451,872	252,452,486	1,911,149

2.2 T/L of Port (Colombo-L) - Kolonnawa Route					795,900,000	426,578,000	1,048,434,176	1,771,003,676	13,407,087
1) 132kV T/L 1,200 mm2 with End & Joint Terminals Between Port (Colo-L) and Colombo-F (1.2 km)	set	1	108,600,000	52,773,000	108,600,000	52,773,000	139,841,616	236,218,946	1,788,256
2) 132kV T/L 800 mm2 with End & Joint Terminals Between Colombo-F and Colombo-N (2.4 km)	set	1	171,800,000	105,545,000	171,800,000	105,545,000	234,282,640	395,747,703	2,995,942
3) 132kV T/L 1,200 mm2 with End & Joint Terminals Between Colombo-N and Kolonnawa (6.1 km)	set	1	515,500,000	268,260,000	515,500,000	268,260,000	674,309,920	1,139,037,027	8,622,889
2.3 132 kV XLPE Cable for MTR connection					169,500,000	39,580,000	192,931,360	325,897,568	2,467,153
1) 132kV Junction 1,200 mm2 with End Terminals Between GIS and MTR @ 2 Circuits (500 m)	set	1	59,300,000	21,989,000	59,300,000	21,989,000	72,317,488	122,157,919	924,776
2) 132kV Junction 500 mm2 with End Terminals Between GIS and MTR @ 10 Circuits (400 m)	set	1	110,200,000	17,591,000	110,200,000	17,591,000	120,613,872	203,739,649	1,542,377
3. Optical Fiber Cable and Monitoring Equipments					225,500,000	57,480,589	259,528,509	438,392,751	3,318,779
1) Optical fiber cable for supervising underground cable and SCADA etc. 1@24 core (40 km)	set	1	80,000,000	44,200,000	80,000,000	44,200,000	106,166,400	179,335,135	1,357,627
2) Distributed System	set	3	48,500,000	4,426,863	145,500,000	13,280,589	153,362,109	259,057,616	1,961,152
4. Miscellaneous and River Crossing					195,109,200	329,137,000	389,958,304	658,713,351	4,986,679
1) Steel Support etc.	lot	1	187,605,000	230,395,900	187,605,000	230,395,900	323,999,373	547,296,238	4,143,214
2) Miscellaneous	lot	1	7,504,200	98,741,100	7,504,200	98,741,100	65,958,931	111,417,114	843,465
5. Distribution lines					1,243,200,000	576,000,000	1,584,192,000	2,676,000,000	20,258,210
1) Radial Circuit from GSS to No. 320,Union Place to De load Substation E & I	lot	1	65,120,000	30,000,000	65,120,000	30,000,000	82,880,000	140,000,000	1,059,847
2) Interconnction from GSS M to N	lot	1	65,120,000	30,000,000	65,120,000	30,000,000	82,880,000	140,000,000	1,059,847
3) Galle Face Green 3 Project Shangri-la & Sheraton Hotels, apartment and condominium center	lot	1	651,200,000	300,000,000	651,200,000	300,000,000	828,800,000	1,400,000,000	10,598,465
4) Re-development Project, Slave Island	lot	1	75,480,000	34,500,000	75,480,000	34,500,000	95,904,000	162,000,000	1,226,394
5) Development Project at Colombo Commercial	lot	1	230,880,000	105,000,000	230,880,000	105,000,000	293,040,000	495,000,000	3,747,315
6) Regal Theater Site	lot	1	108,040,000	49,500,000	108,040,000	49,500,000	137,344,000	232,000,000	1,756,317
7) Lotus Tower Line	lot	1	47,360,000	27,000,000	47,360,000	27,000,000	63,344,000	107,000,000	810,026
6. Dispute Board Fee					11,385,920	0	11,385,920	19,232,973	145,600
1) Dispute Board Fee	Set	1	11,385,920	0	11,385,920	0	11,385,920	19,232,973	145,600
							0	0	0
Total					6,206,695,120	2,766,954,589	7,844,732,237	13,251,236,886	100,316,269

Package 03 Specialized Vehicles for Distribution Works

Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Cost		Total	(Reference) Total	
			Foreign	Local	Foreign	Local			
			JPY	LKR	JPY	LKR	JPY	LKR	USD
Region 1/2 Cnstruction Vehicles	nos	15	24,750,000	0	371,250,000	0	371,250,000	627,111,486	4,747,442
Total					371,250,000	0	371,250,000	627,111,486	4,747,442

Project Cost Breakdown: PJT-2

US $ =yen 78.2
LKR =yen 0.592

Package 01 Transmission Line

Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Amount		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
1. 132 kV Transmission Line for New Anuradhapura - Trincomalee					34,928,000	11,748,000	41,882,816	70,748,000	535,586
1) 132 kV Transmission Line (2 cct. @ 2.0 km) Conductor ACSR/AS Zebra with Tower etc.	km	2.0	14,744,000	0	29,488,000	0	29,488,000	49,810,811	377,084
2) 132 kV Transmission Line (2 cct. @ 2.0 km) Civil Works and Inland Transportation etc.	km	2.0	2,720,000	5,874,000	5,440,000	11,748,000	12,394,816	20,937,189	158,501
Total					34,928,000	11,748,000	41,882,816	70,748,000	535,586

Package 02 Substation

Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Cost		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
2. New Construction of 132/33 kV Kappalthurai GS					894,568,460	181,118,500	1,001,790,612	1,692,213,872	12,810,622
1) 132/33 kV 63.0 MVA OLTC Transformer, E.TR & Aux.TR	set	2	110,200,000	9,520,000	220,400,000	19,040,000	231,671,680	391,337,297	2,962,553
2) 132 kV GIS Double Busbar Type for Line Bay (Indoor)	sets	4	35,561,440	1,390,000	142,245,760	5,560,000	145,537,280	245,840,000	1,861,091
3) 132 kV GIS Double Busbar Type for Transformer Bay (Indoor)	sets	2	34,543,200	1,390,000	69,086,400	2,780,000	70,732,160	119,480,000	904,503
4) 132 kV GIS Double Busbar Type for Bus Section Bay (Indoor)	set	1	39,160,800	1,510,000	39,160,800	1,510,000	40,054,720	67,660,000	512,209
5) 33 kV SWG Single Busbar Type for Transformer Bay (Indoor)	sets	2	7,186,000	281,000	14,372,000	562,000	14,704,704	24,839,027	188,040
6) 33 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	8	8,293,000	281,000	66,344,000	2,248,000	67,674,816	114,315,568	865,407
7) 33 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	sets	1	5,526,000	281,000	5,526,000	281,000	5,692,352	9,615,459	72,792
8) Common Items 220/132/33 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	278,567,500	143,914,500	278,567,500	143,914,500	363,764,884	614,467,709	4,651,725
9) Substation Automation System	lot	1	58,866,000	5,223,000	58,866,000	5,223,000	61,958,016	104,658,811	792,302
Total					894,568,460	181,118,500	1,001,790,612	1,692,213,872	12,810,622

Project Cost Breakdown: PJT-3

US $ =yen 78.2
LKR =yen 0.592

Package 01 Substation

Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Amount		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
1. Extension of 220/33 kV Kerawalapitiya GS					654,821,680	188,066,300	766,156,930	1,294,184,003	9,797,403
1) 220/33 kV 35.0 MVA OLTC Transformer, E.TR & Aux.TR	sets	2	88,700,000	9,520,000	177,400,000	19,040,000	188,671,680	318,702,162	2,412,681
2) 220 kV GIS Double Busbar Type for Transformer Bay (Indoor)	sets	2	49,651,040	4,020,000	99,302,080	8,040,000	104,061,760	175,780,000	1,330,713
3) 33 kV SWG Single Busbar Type for Transformer Bay (Indoor)	sets	2	7,186,000	281,000	14,372,000	562,000	14,704,704	24,839,027	188,040
4) 33 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	8	8,293,000	281,000	66,344,000	2,248,000	67,674,816	114,315,568	865,407
5) 33 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	set	1	5,526,000	281,000	5,526,000	281,000	5,692,352	9,615,459	72,792
6) 33 kV 5.0 MVA Static Capacitor Bank Bay (Outdoor)	sets	4	17,500,000	948,900	70,000,000	3,795,600	72,246,995	122,038,843	923,875
7) Common Items 132/11 kV for Protection, Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	173,177,600	152,849,700	173,177,600	152,849,700	263,664,622	445,379,430	3,371,670
8) Modification of Substation Automation System	lot	1	48,700,000	1,250,000	48,700,000	1,250,000	49,440,000	83,513,514	632,225
						0	0	0	0
Total					654,821,680	188,066,300	766,156,930	1,294,184,003	9,797,403

Project Cost Breakdown: PJT-5 (with Zebra)

US $ =yen 78.2
LKR =yen 0.592

Package 01 Transmission Line — Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Amount		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
1. 220 kV Transmission Line for Kirindiwela - Veyangoda					552,072,500	213,360,000	678,381,620	1,145,914,899	8,674,957
1) 220 kV Transmission Line (2 cct. @ 17.5 km) Conductor ACSR/AS Zebra with Tower etc.	km	17.5	28,537,000	0	499,397,500	0	499,397,500	843,576,858	6,386,157
2) 220 kV Transmission Line (2 cct. @ 17.5 km) Civil Works and Inland Transportation etc.	km	17.5	3,010,000	12,192,000	52,675,000	213,360,000	178,984,120	302,338,041	2,288,799
2. 220 kV Transmission Line for Padukka - Kirindiwela					630,940,000	243,840,000	775,293,280	1,309,617,027	9,914,236
1) 220 kV Transmission Line (2 cct. @ 20.0 km) Conductor ACSR/AS Zebra with Tower etc.	km	20.0	28,537,000	0	570,740,000	0	570,740,000	964,087,838	7,298,465
2) 220 kV Transmission Line (2 cct. @ 20.0 km) Civil Works and Inland Transportation etc.	km	20.0	3,010,000	12,192,000	60,200,000	243,840,000	204,553,280	345,529,189	2,615,771
3. 220 kV Transmission Line for In & Out Connection from Biyagama - Kotmale					126,188,000	48,768,000	155,058,656	261,923,405	1,982,847
1) 220 kV Transmission Line (2 cct. @ 4.0 km) Conductor ACSR/AS Zebra with Tower etc.	km	4.0	28,537,000	0	114,148,000	0	114,148,000	192,817,568	1,459,693
2) 220 kV Transmission Line (2 cct. @ 4.0 km) Civil Works and Inland Transportation etc.	km	4.0	3,010,000	12,192,000	12,040,000	48,768,000	40,910,656	69,105,838	523,154
4. Removal of Existing 220 kV Transmission Line					0	2,196,500	1,300,328	2,196,500	16,628
1) Removal of 220 kV Transmission Line (2 cct. @ 2.3 km) Conductor ACSR Zebra with Tower etc.	km	2.3	0	955,000	0	2,196,500	1,300,328	2,196,500	16,628
5. 132 kV Transmission Line for Kirindiwela - Kosgama					174,640,000	58,740,000	209,414,080	353,740,000	2,677,929
1) 132 kV Transmission Line (2 cct. @ 10.0 km) Conductor ACSR/AS Zebra with Tower etc.	km	10.0	14,744,000	0	147,440,000	0	147,440,000	249,054,054	1,885,422
2) 132 kV Transmission Line (2 cct. @ 10.0 km) Civil Works and Inland Transportation etc.	km	10.0	2,720,000	5,874,000	27,200,000	58,740,000	61,974,080	104,685,946	792,507
					0	0	0	0	0
Total					1,483,840,500	566,904,500	1,819,447,964	3,073,391,831	23,266,598

Note: Unit price of ACSR Zebra: JPY 620,000/km

Package 02 Substation — Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Cost		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
1. Extension of 220 kV Veyangoda GS					100,606,900	5,564,000	103,900,788	175,508,088	1,328,655
1) 220 kV AIS Double Busbar Type for Line Bay (Outdoor)	sets	2	30,010,000	424,000	60,020,000	848,000	60,522,016	102,233,135	773,939
2) 220 kV AIS Double Busbar for Tubelar Busbar with Post Insulator (Outdoor)	lot	1	5,513,000	264,000	5,513,000	264,000	5,669,288	9,576,500	72,497
3) Common Items 220 kV for Protection, Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	27,523,900	3,336,000	27,523,900	3,336,000	29,498,812	49,829,074	377,223
4) Modification of Substation Automation System	lot	1	7,550,000	1,116,000	7,550,000	1,116,000	8,210,672	13,869,378	104,996
2. Extension of 220 kV Padukka GS					100,606,900	5,564,000	103,900,788	175,508,088	1,328,655
1) 220 kV AIS Double Busbar Type for Line Bay (Outdoor)	sets	2	30,010,000	424,000	60,020,000	848,000	60,522,016	102,233,135	773,939
2) 220 kV AIS Double Busbar for Tubelar Busbar with Post Insulator (Outdoor)	lot	1	5,513,000	264,000	5,513,000	264,000	5,669,288	9,576,500	72,497
3) Common Items 220 kV for Protection, Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	27,523,900	3,336,000	27,523,900	3,336,000	29,498,812	49,829,074	377,223
4) Modification of Substation Automation System	lot	1	7,550,000	1,116,000	7,550,000	1,116,000	8,210,672	13,869,378	104,996
3. Extension of 132 kV Kosgama GS					69,084,400	7,816,000	73,711,472	124,512,622	942,602
1) 132 kV AIS Double Busbar Type for Line Bay (Outdoor)	sets	2	10,399,500	330,000	20,799,000	660,000	21,189,720	35,793,446	270,968
2) 220 kV AIS Double Busbar for Tubelar Busbar with Post Insulator (Outdoor)	lot	1	17,660,000	680,000	17,660,000	680,000	18,062,560	30,511,081	230,979
3) Common Items 220 kV for Protection, Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	23,075,400	5,360,000	23,075,400	5,360,000	26,248,520	44,338,716	335,659

4) Modification of Substation Automation System	lot	1	7,550,000	1,116,000	7,550,000	1,116,000	8,210,672	13,869,378	104,996
4. New Construction of 220/132/33 kV Kirindiwela GS					1,263,628,700	293,457,100	1,437,355,303	2,427,965,039	18,380,503
1) 220/132/33 kV 150 MVA Auto-Transformer & E.TR and/or LA	sets	2	179,500,000	10,200,000	359,000,000	20,400,000	371,076,800	626,818,919	4,745,228
2) 132/33 kV 31.5 MVA OLTC Transformer, E.TR & Aux.TR	sets	2	60,175,000	7,520,000	120,350,000	15,040,000	129,253,680	218,333,919	1,652,860
3) 220 kV AIS Double Busbar Type for Line Bay (Outdoor)	sets	2	30,010,000	424,000	60,020,000	848,000	60,522,016	102,233,135	773,939
4) 220 kV AIS Double Busbar Type for Transformer Bay (Outdoor)	sets	2	29,794,000	424,000	59,588,000	848,000	60,090,016	101,503,405	768,415
5) 220 kV AIS Double Busbar Type for Bus Section (Outdoor) with Tubular, Post Insulator	lot	1	35,283,000	1,056,000	35,283,000	1,056,000	35,908,152	60,655,662	459,184
6) 132 kV AIS Single Busbar Type for Line Bay (Outdoor)	sets	4	6,933,000	220,000	27,732,000	880,000	28,252,960	47,724,595	361,291
7) 132 kV AIS Single Busbar Type for Transformer Bay (Outdoor)	sets	3	5,800,000	200,000	17,400,000	600,000	17,755,200	29,991,892	227,049
8) 132 kV AIS Single Busbar Type for Bus Section (Outdoor) with Tubular, Post Insulator	lot	1	16,991,000	880,000	16,991,000	880,000	17,511,960	29,581,014	223,938
9) 33 kV SWG Single Busbar Type for Transformer Bay (Indoor)	sets	2	7,186,000	281,000	14,372,000	562,000	14,704,704	24,839,027	188,040
10) 33 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	8	8,293,000	281,000	66,344,000	2,248,000	67,674,816	114,315,568	865,407
11) 33 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	set	1	5,526,000	281,000	5,526,000	281,000	5,692,352	9,615,459	72,792
12) 33 kV 5.0 MVA Static Capacitor Bank Bay (Outdoor)	sets	2	17,500,000	948,900	35,000,000	1,897,800	36,123,498	61,019,422	461,937
13) Common Items 220/132/33 kV for Control, Protection, Grounding, Filling Work, Civil, Bldg., Materials, Spare, etc.	lot	1	367,922,700	245,920,300	367,922,700	245,920,300	513,507,518	867,411,347	6,566,592
14) Substation Automation System	lot	1	78,100,000	1,996,000	78,100,000	1,996,000	79,281,632	133,921,676	1,013,832
					0	0	0	0	0
Total					1,533,926,900	312,401,100	1,718,868,351	2,903,493,836	21,980,414

Project Cost Breakdown: PJT-5 (with LL-ACSR)

US $ =yen 78.2
LKR =yen 0.592

Package 01 Transmission Line — Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Amount		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
1. 220 kV Transmission Line for Kirindiwela - Veyangoda					604,572,500	213,360,000	730,881,620	1,234,597,331	9,346,312
1) 220 kV Transmission Line (2 cct. @ 17.5 km) Conductor LL-ACSR 550sq.mm with Tower etc.	km	17.5	31,537,000	0	551,897,500	0	551,897,500	932,259,291	7,057,513
2) 220 kV Transmission Line (2 cct. @ 17.5 km) Civil Works and Inland Transportation etc.	km	17.5	3,010,000	12,192,000	52,675,000	213,360,000	178,984,120	302,338,041	2,288,799
2. 220 kV Transmission Line for Padukka - Kirindiwela					690,940,000	243,840,000	835,293,280	1,410,968,378	10,681,500
1) 220 kV Transmission Line (2 cct. @ 20.0 km) Conductor LL-ACSR/AS Zebra with Tower etc.	km	20.0	31,537,000	0	630,740,000	0	630,740,000	1,065,439,189	8,065,729
2) 220 kV Transmission Line (2 cct. @ 20.0 km) Civil Works and Inland Transportation etc.	km	20.0	3,010,000	12,192,000	60,200,000	243,840,000	204,553,280	345,529,189	2,615,771
3. 220 kV Transmission Line for In & Out Connection from Biyagama - Kotmale					138,188,000	48,768,000	167,058,656	282,193,676	2,136,300
1) 220 kV Transmission Line (2 cct. @ 4.0 km) Conductor LL-ACSR/AS Zebra with Tower etc.	km	4.0	31,537,000	0	126,148,000	0	126,148,000	213,087,838	1,613,146
2) 220 kV Transmission Line (2 cct. @ 4.0 km) Civil Works and Inland Transportation etc.	km	4.0	3,010,000	12,192,000	12,040,000	48,768,000	40,910,656	69,105,838	523,154
4. Removal of Existing 220 kV Transmission Line					0	2,196,500	1,300,328	2,196,500	16,628
1) Removal of 220 kV Transmission Line (2 cct. @ 2.3 km) Conductor ACSR Zebra with Tower etc.	km	2.3	0	955,000	0	2,196,500	1,300,328	2,196,500	16,628
5. 132 kV Transmission Line for Kirindiwela - Kosgama					174,640,000	58,740,000	209,414,080	353,740,000	2,677,929
1) 132 kV Transmission Line (2 cct. @ 10.0 km) Conductor ACSR/AS Zebra with Tower etc.	km	10.0	14,744,000	0	147,440,000	0	147,440,000	249,054,054	1,885,422
2) 132 kV Transmission Line (2 cct. @ 10.0 km) Civil Works and Inland Transportation etc.	km	10.0	2,720,000	5,874,000	27,200,000	58,740,000	61,974,080	104,685,946	792,507
					0	0	0	0	0
Total					1,608,340,500	566,904,500	1,943,947,964	3,283,695,885	24,858,670

Note: Unit price of LL-ACSR: JPY 870,000/km

Package 02 Substation — Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Cost		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
1. Extension of 220 kV Veyangoda GS					100,606,900	5,564,000	103,900,788	175,508,088	1,328,655
1) 220 kV AIS Double Busbar Type for Line Bay (Outdoor)	sets	2	30,010,000	424,000	60,020,000	848,000	60,522,016	102,233,135	773,939
2) 220 kV AIS Double Busbar for Tubelar Busbar with Post Insulator (Outdoor)	lot	1	5,513,000	264,000	5,513,000	264,000	5,669,288	9,576,500	72,497
3) Common Items 220 kV for Protection, Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	27,523,900	3,336,000	27,523,900	3,336,000	29,498,812	49,829,074	377,223
4) Modification of Substation Automation System	lot	1	7,550,000	1,116,000	7,550,000	1,116,000	8,210,672	13,869,378	104,996
2. Extension of 220 kV Padukka GS					100,606,900	5,564,000	103,900,788	175,508,088	1,328,655
1) 220 kV AIS Double Busbar Type for Line Bay (Outdoor)	sets	2	30,010,000	424,000	60,020,000	848,000	60,522,016	102,233,135	773,939
2) 220 kV AIS Double Busbar for Tubelar Busbar with Post Insulator (Outdoor)	lot	1	5,513,000	264,000	5,513,000	264,000	5,669,288	9,576,500	72,497
3) Common Items 220 kV for Protection, Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	27,523,900	3,336,000	27,523,900	3,336,000	29,498,812	49,829,074	377,223
4) Modification of Substation Automation System	lot	1	7,550,000	1,116,000	7,550,000	1,116,000	8,210,672	13,869,378	104,996
3. Extension of 132 kV Kosgama GS					69,084,400	7,816,000	73,711,472	124,512,622	942,602
1) 132 kV AIS Double Busbar Type for Line Bay (Outdoor)	sets	2	10,399,500	330,000	20,799,000	660,000	21,189,720	35,793,446	270,968
2) 220 kV AIS Double Busbar for Tubelar Busbar with Post Insulator (Outdoor)	lot	1	17,660,000	680,000	17,660,000	680,000	18,062,560	30,511,081	230,979
3) Common Items 220 kV for Protection, Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	23,075,400	5,360,000	23,075,400	5,360,000	26,248,520	44,338,716	335,659

4) Modification of Substation Automation System	lot	1	7,550,000	1,116,000	7,550,000	1,116,000	8,210,672	13,869,378	104,996
4. New Construction of 220/132/33 kV Kirindiwela GS					1,263,628,700	293,457,100	1,437,355,303	2,427,965,039	18,380,503
1) 220/132/33 kV 150 MVA Auto-Transformer & E.TR and/or LA	sets	2	179,500,000	10,200,000	359,000,000	20,400,000	371,076,800	626,818,919	4,745,228
2) 132/33 kV 31.5 MVA OLTC Transformer, E.TR & Aux.TR	sets	2	60,175,000	7,520,000	120,350,000	15,040,000	129,253,680	218,333,919	1,652,860
3) 220 kV AIS Double Busbar Type for Line Bay (Outdoor)	sets	2	30,010,000	424,000	60,020,000	848,000	60,522,016	102,233,135	773,939
4) 220 kV AIS Double Busbar Type for Transformer Bay (Outdoor)	sets	2	29,794,000	424,000	59,588,000	848,000	60,090,016	101,503,405	768,415
5) 220 kV AIS Double Busbar Type for Bus Section (Outdoor) with Tubular, Post Insulator	lot	1	35,283,000	1,056,000	35,283,000	1,056,000	35,908,152	60,655,662	459,184
6) 132 kV AIS Single Busbar Type for Line Bay (Outdoor)	sets	4	6,933,000	220,000	27,732,000	880,000	28,252,960	47,724,595	361,291
7) 132 kV AIS Single Busbar Type for Transformer Bay (Outdoor)	sets	3	5,800,000	200,000	17,400,000	600,000	17,755,200	29,991,892	227,049
8) 132 kV AIS Single Busbar Type for Bus Section (Outdoor) with Tubular, Post Insulator	lot	1	16,991,000	880,000	16,991,000	880,000	17,511,960	29,581,014	223,938
9) 33 kV SWG Single Busbar Type for Transformer Bay (Indoor)	sets	2	7,186,000	281,000	14,372,000	562,000	14,704,704	24,839,027	188,040
10) 33 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	8	8,293,000	281,000	66,344,000	2,248,000	67,674,816	114,315,568	865,407
11) 33 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	set	1	5,526,000	281,000	5,526,000	281,000	5,692,352	9,615,459	72,792
12) 33 kV 5.0 MVA Static Capacitor Bank Bay (Outdoor)	sets	2	17,500,000	948,900	35,000,000	1,897,800	36,123,498	61,019,422	461,937
13) Common Items 220/132/33 kV for Control, Protection, Grounding, Filling Work, Civil, Bldg., Materials, Spare, etc.	lot	1	367,922,700	245,920,300	367,922,700	245,920,300	513,507,518	867,411,347	6,566,592
14) Substation Automation System	lot	1	78,100,000	1,996,000	78,100,000	1,996,000	79,281,632	133,921,676	1,013,832
					0	0	0	0	0
Total					1,533,926,900	312,401,100	1,718,868,351	2,903,493,836	21,980,414

Project Cost Breakdown: PJT-7

US $ =yen 78.2
LKR =yen 0.592

Package 01 Transmission Line — Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Amount		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
1. 132 kV Transmission Line for Kilinochchi - Chunnakkam					104,784,000	35,244,000	125,648,448	212,244,000	1,606,758
1) 132 kV Transmission Line (2 cct. @ 6.0 km) Conductor ACSR/AS Zebra with Tower etc.	km	6.0	14,744,000	0	88,464,000	0	88,464,000	149,432,432	1,131,253
2) 132 kV Transmission Line (2 cct. @ 6.0 km) Civil Works and Inland Transportation etc.	km	6.0	2,720,000	5,874,000	16,320,000	35,244,000	37,184,448	62,811,568	475,504
Total					104,784,000	35,244,000	125,648,448	212,244,000	1,606,758

Package 02 Substation — Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Cost		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
2. New Construction of 132/33 kV Kappalthurai GS					526,162,000	187,640,000	637,244,880	1,076,427,162	8,148,912
1) 132/33 kV 31.5 MVA OLTC Transformer, E.TR & Aux.TR	set	2	60,175,000	7,520,000	120,350,000	15,040,000	129,253,680	218,333,919	1,652,860
2) 132 kV AIS Single Busbar Type for Incoming Line Bay (Indoor)	sets	2	6,636,000	3,000,000	13,272,000	6,000,000	16,824,000	28,418,919	215,141
3) 132 kV AIS Single Busbar Type for Transformer Bay (Indoor)	sets	2	4,819,000	2,700,000	9,638,000	5,400,000	12,834,800	21,680,405	164,128
4) 132 kV AIS Single Busbar Type for Bus Section Bay (Indoor)	set	1	17,775,000	6,300,000	17,775,000	6,300,000	21,504,600	36,325,338	274,995
5) 33 kV SWG Single Busbar Type for Transformer Bay (Indoor)	sets	2	7,186,000	281,000	14,372,000	562,000	14,704,704	24,839,027	188,040
6) 33 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	8	8,293,000	281,000	66,344,000	2,248,000	67,674,816	114,315,568	865,407
7) 33 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	sets	1	5,526,000	281,000	5,526,000	281,000	5,692,352	9,615,459	72,792
8) Common Items 220/132/33 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	220,019,000	146,586,000	220,019,000	146,586,000	306,797,912	518,239,716	3,923,247
9) Substation Automation System	lot	1	58,866,000	5,223,000	58,866,000	5,223,000	61,958,016	104,658,811	792,302
Total					526,162,000	187,640,000	637,244,880	1,076,427,162	8,148,912

Project Cost Breakdown: PJT-8

US $ =yen 78.2
LKR =yen 0.592

Package 01 Transmission Line

Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Amount		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
1. 132 kV Transmission Line for Kolonnawa - Athurugiriya					52,392,000	17,622,000	62,824,224	106,122,000	803,379
1) 132 kV Transmission Line (2 cct. @ 3.0 km) Conductor ACSR/AS Zebra with Tower etc.	km	3.0	14,744,000	0	44,232,000	0	44,232,000	74,716,216	565,627
2) 132 kV Transmission Line (2 cct. @ 3.0 km) Civil Works and Inland Transportation etc.	km	3.0	2,720,000	5,874,000	8,160,000	17,622,000	18,592,224	31,405,784	237,752
Total					52,392,000	17,622,000	62,824,224	106,122,000	803,379

Package 02 Substation

Ratio of YEN Loa 100

item	unit	Quantity	Unit Price		Cost		Total	Total	
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
2. New Construction of 132/33 kV Battaramulla GS					690,133,400	176,240,000	794,467,480	1,342,005,878	10,159,431
1) 132/33 kV 45 MVA OLTC Transformer, E.TR & Aux.TR	set	2	82,450,000	7,520,000	164,900,000	15,040,000	173,803,680	293,587,297	2,222,553
2) 132 kV GIS Single Busbar Type for Incoming Line Bay (Indoor)	sets	2	32,329,120	1,260,000	64,658,240	2,520,000	66,150,080	111,740,000	845,909
3) 132 kV GIS Single Busbar Type for Transformer Bay (Indoor)	sets	2	31,405,600	1,260,000	62,811,200	2,520,000	64,303,040	108,620,000	822,290
4) 132 kV GIS Single Busbar Type for Bus Section Bay (Indoor)	set	1	32,636,960	1,260,000	32,636,960	1,260,000	33,382,880	56,390,000	426,891
5) 33 kV SWG Single Busbar Type for Transformer Bay (Indoor)	sets	2	7,186,000	281,000	14,372,000	562,000	14,704,704	24,839,027	188,040
6) 33 kV SWG Single Busbar Type for Feeder Bay (Indoor)	sets	8	8,293,000	281,000	66,344,000	2,248,000	67,674,816	114,315,568	865,407
7) 33 kV SWG Single Busbar Type for Bus Section Bay (Indoor)	sets	1	5,526,000	281,000	5,526,000	281,000	5,692,352	9,615,459	72,792
8) Common Items 220/132/33 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, Spare, etc.	lot	1	220,019,000	146,586,000	220,019,000	146,586,000	306,797,912	518,239,716	3,923,247
9) Substation Automation System	lot	1	58,866,000	5,223,000	58,866,000	5,223,000	61,958,016	104,658,811	792,302
Total					690,133,400	176,240,000	794,467,480	1,342,005,878	10,159,431

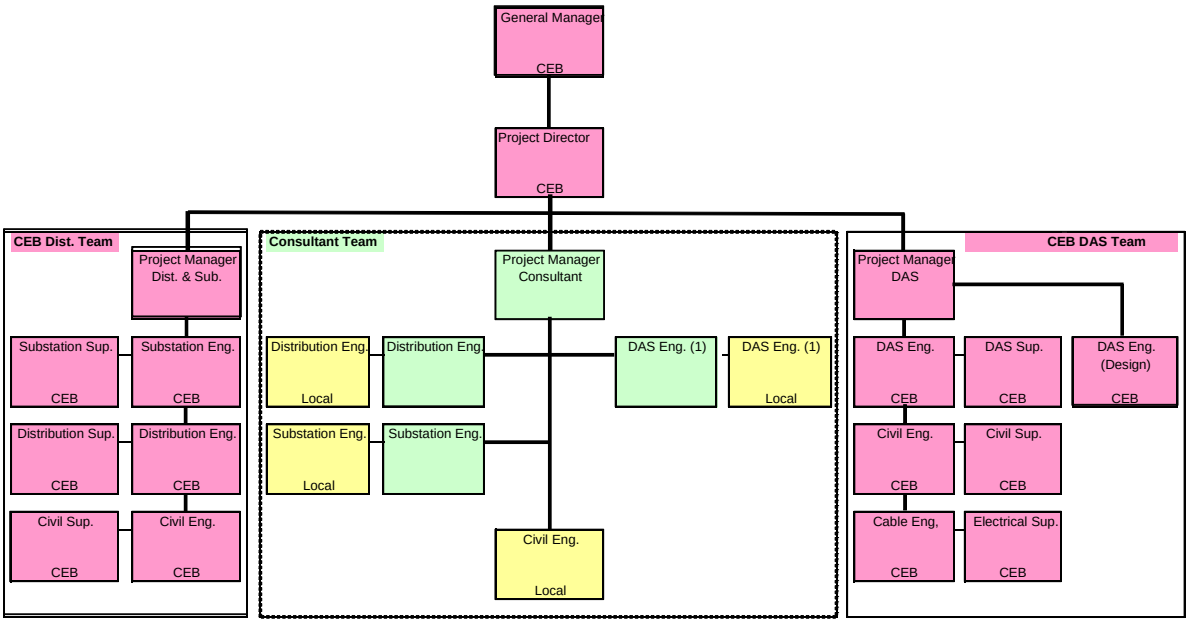
CHAPTER 8
IMPLEMENTATION PLANS FOR DISTRIBUTION PROJECTS

CHAPTER 8 IMPLEMENTATION PLAN FOR DISTRIBUTION PROJECTS

8.1 Implementation Agency

(1) Project Organization

The organizational structure for the distribution projects is shown in Figure 8.1-1.



(Source: CEB Distribution Division)

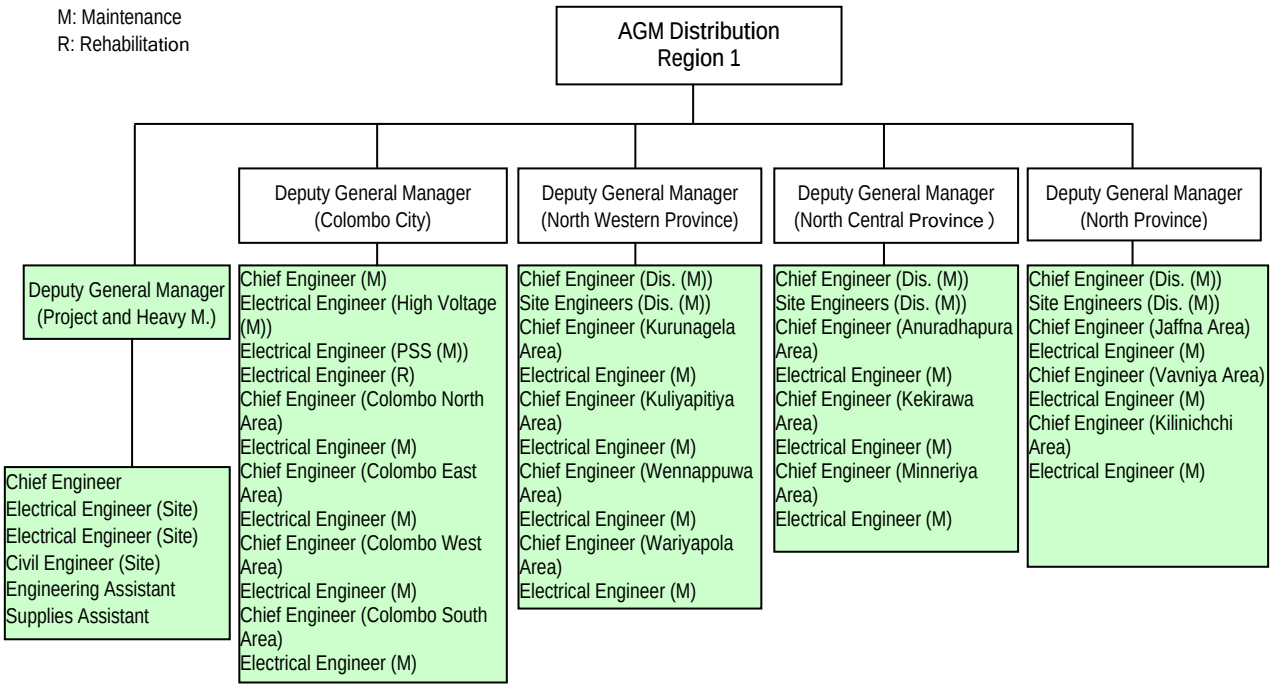
Figure 8.1-1 Distribution Projects Organizational Structure

The distribution project is divided into two groups; one is the distribution and substation, and the other is the distribution automation system (DAS). A consultant team, a distribution and substation team, and a DAS team will be organized under the Project Director of the CEB. A project manager will be assigned to each group.

(2) Maintenance Organization

The maintenance structure of CEB Region-1 is shown in Figure 8.1-2 as an example.

Under AGM Distribution, the deputy general manager (DGM) for project and heavy maintenance is assigned. Meanwhile, under the DGM of each region, a chief engineer and an electrical engineer for maintenance shall be assigned.



(Source: CEB Distribution Division)

Figure 8.1-2 CEB Maintenance Structure

(3) CEB Distribution Boundary

The distribution regions of CEB are divided in four areas as shown in Table 8.1-1.

Table 8.1-1 CEB Distribution Regions

Region	Province
Region 1	Colombo City North Western Northern North Central
Region 2	Western Province North Central Eastern
Region 3	Western Province South-2 UVA Sabaragamuwa
Region 4	Western Province South-1 Southern

(Source: CEB Distribution Division)

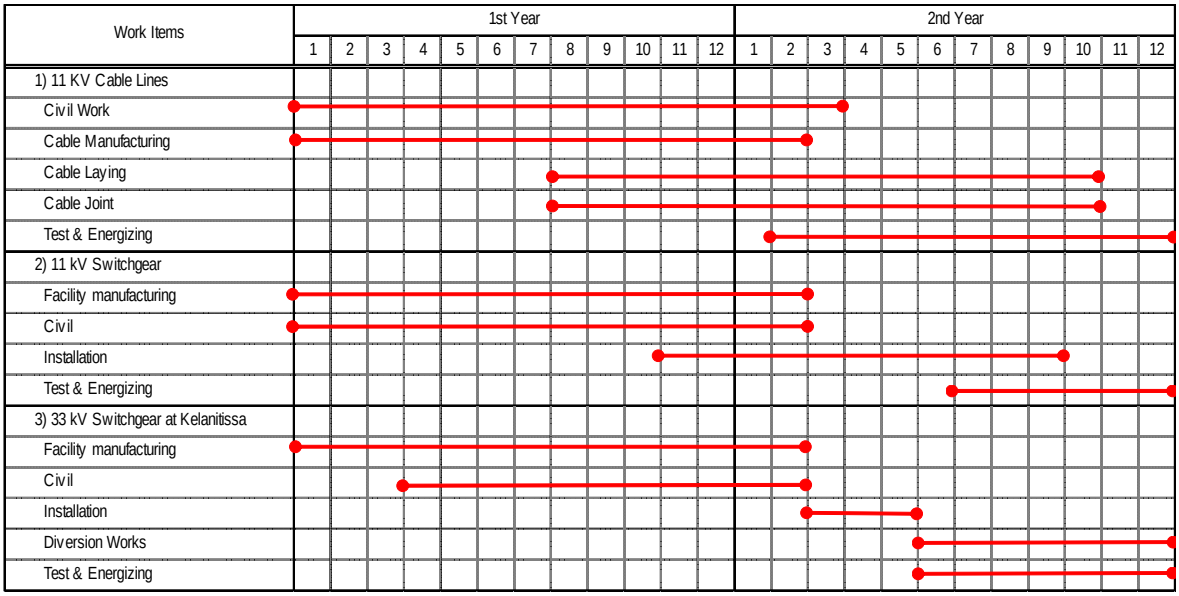
8.2 Implementation Plans

8.2.1 Implementation Schedule

(1) Colombo City 11 kV Development (Package 1)

The Colombo City 11 kV Development (Package 1) is planned to be implemented for 24 months as shown in Table 8.2-1.

Table 8.2-1 Implementation Schedule: Colombo City 11 kV Development (Package 1)

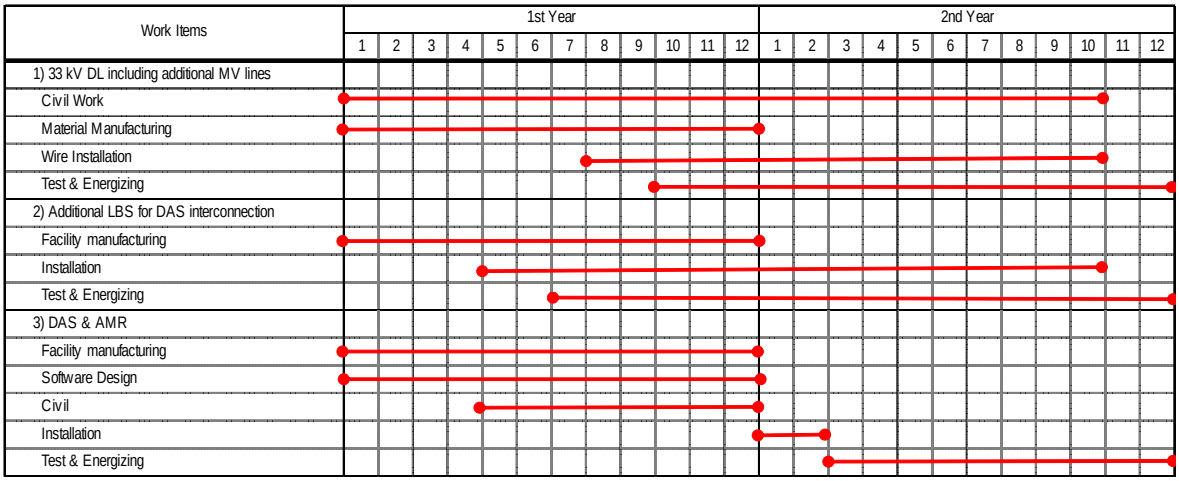


(Prepared by the Survey Team)

(2) North Western Province of Region 1 (Package 2)

The North Western Province of Region 1 (Package 2) is planned to be implemented for 24 months as shown in Table 8.2-2.

Table 8.2-2 Implementation Schedule: NWP of Region 1 (Package 2)

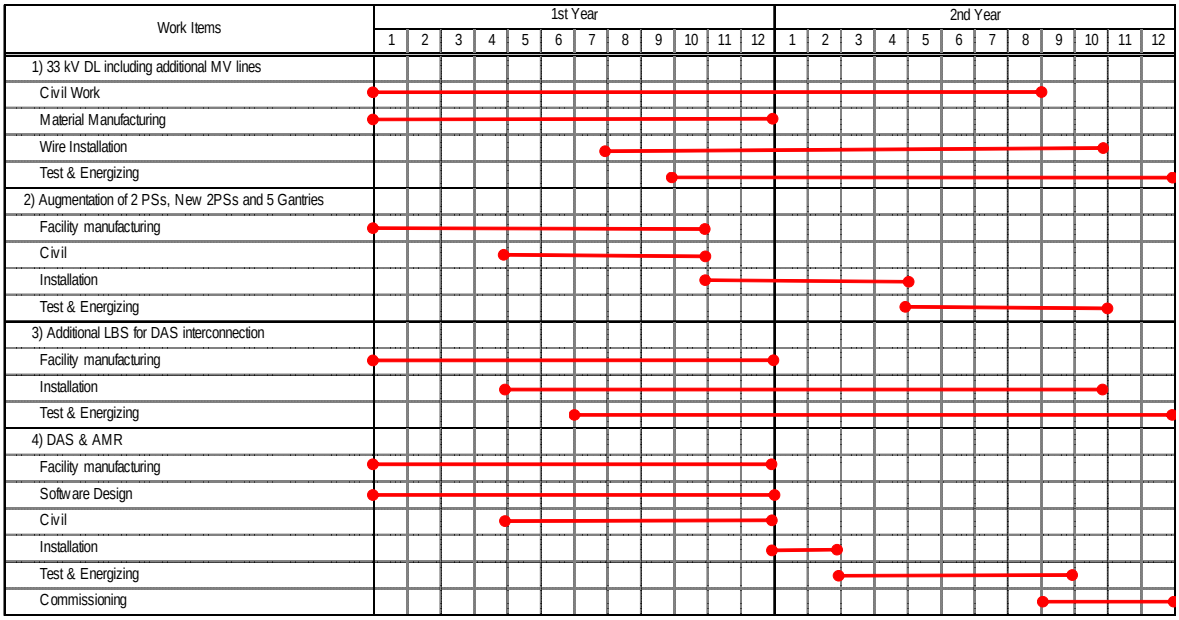


(Prepared by the Survey Team)

(3) Western Province North of Region 2 (Package 3)

The Western Province North of Region 2 (Package 3) is planned to be implemented for 24 months as shown in Table 8.2-3.

Table 8.2-3 Implementation Schedule: WPN of Region 2 (Package 3)

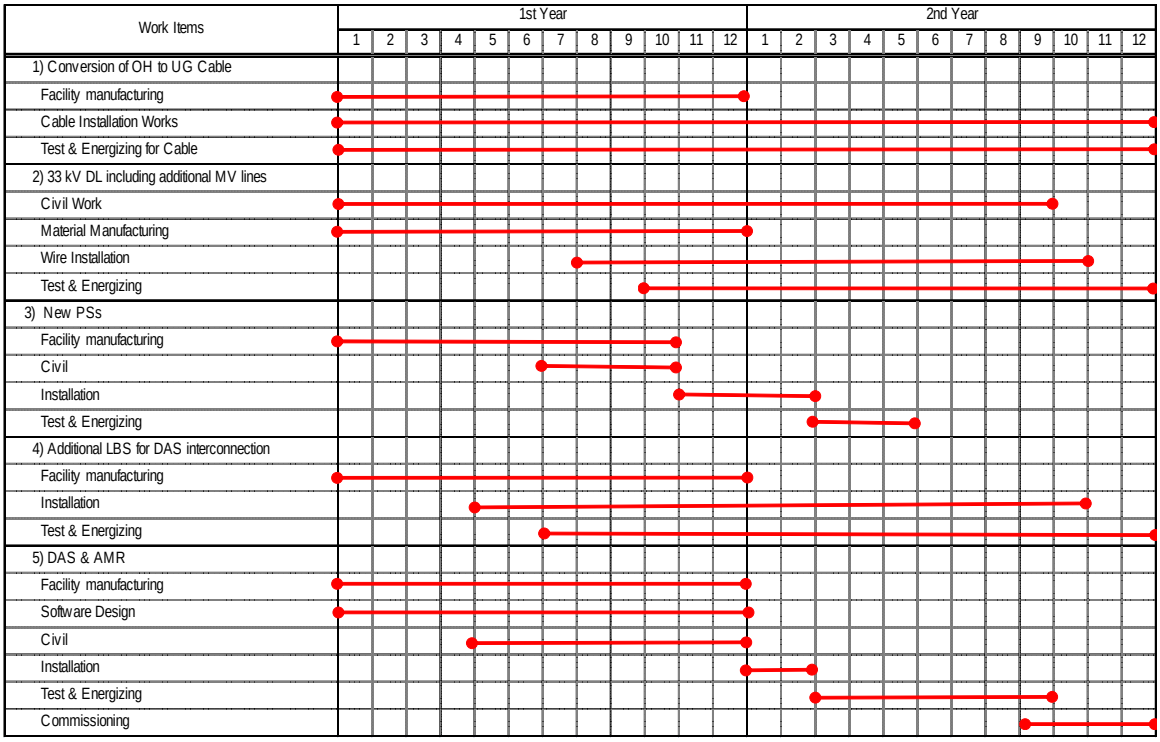


(Prepared by the Survey Team)

(4) Western Province South-2 of Region 3 (Package 4)

The Western Province South-2 of Region 3 (Package 4) is planned to be implemented for 21 months as shown in Table 8.2-4.

Table 8.2-4 Implementation Schedule: WPS-2 of Region 3 (Package 4)

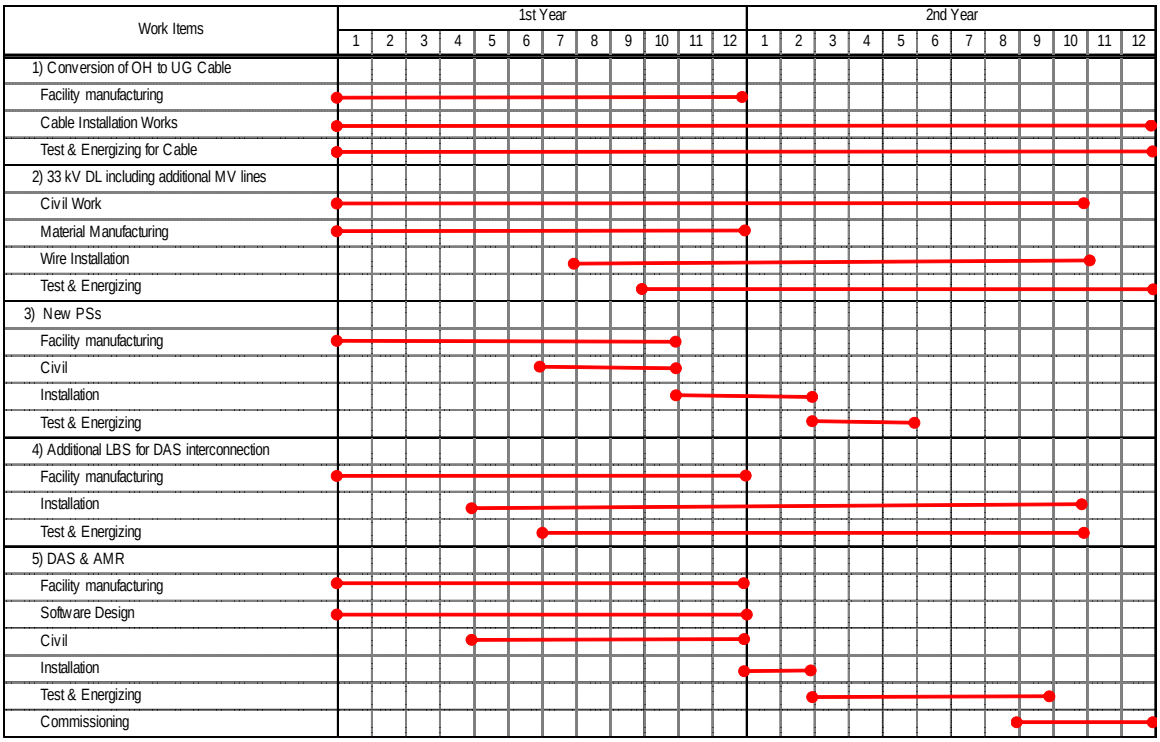


(Prepared by the Survey Team)

(5) Western Province South-1 of Region 4 (Package 5)

The Western Province South-1 of Region 4 (Package 5) is planned to be implemented for 38 months as shown in Table 8.2-5.

Table 8.2-5 Implementation Schedule: WPS-1 of Region 4 (Package 5)



(Prepared by the Survey Team)

8.2.2 Supply Source of Equipment

The supply sources of each equipment or material are as shown in Table 8.2-7 considering the following situations:

1) Most of the equipment is to be supplied from Europe, USA and Australia except for DAS/AMR.
2) It is assumed that distribution transformers are to be purchased in Sri Lanka due to the standards of CEB specifications for distribution transformers.
3) It is assumed that 33/11 kV substation equipment is to be supplied from Europe, China and Southeast Asia since prices in these countries are more economical.

Table 8.2-6 Suppliers of Distribution Equipment

System	Equipment	Countries	Manufacturers
LV schemes	Distribution transformers	Sri Lanka	LT Limited
	Insulators, etc.	USA	-
Three-phase conversion	Insulators, etc.	USA	-
Energy meters	Watt-hour meters	Europe Singapore	Secure EDMI
New PS	33/11 kV transformers	Europe/Asia	-
	33/11 kV switchgear	Europe	ABB, Siemens and others.
DAS	DAS	Japan	Toshiba, Hitachi, Mitsubishi, Fuji Elec.
	Fiber optic cables	Japan Europa China Korea	-
	Reclosers	Australia, China	Schneider Elec. Zhejiang Yuguang
	LBS	Japan France Australia	Yasukawa Novexia Export Schneider Elec
	Fault indicators	Norway Australia	Nortroll – Schneider Elec.
	Watt-hour meters	Europe Singapore USA India Slovakia	Landis & Gyr EDMI GE Secure ISKRA
	Construction vehicles	Japan	Aichi, Tadano, Hitachi, Komatsu
	Ring main units	UK India	Lucy Electric Siemens India

(Prepared by the Survey Team)

8.2.3 Subjects to be Considered during Construction Stage

1) When the equipment is installed according to standard drawings, it is necessary to provide information such as as-built drawings at each location for future traceability.
2) When the equipment is supplied separately instead of one package, care should be taken to ensure their conformity for installation.
3) Interface conditions will be coordinated between each package under the project when the project is divided into several contracts.
4) Sufficient training will be given to workers so as not to cause quality and safety problems in the construction site.
5) A safety supervisor shall be assigned in the construction site to manage safety. Especially, confirmation of de-energizing of electrical power and temporary earth works will be checked.
6) For the construction vehicles, facilities related to work safety shall be considered in the technical requirement.
7) In the planning stage, restriction of working time and work area/space due to traffic shall be considered.

8.3 Revised Project Costs

8.3.1 Individual Costs

(1) Cost of Small Distribution Transformer (DT)

The cost of small size DTs is lower than 100 kVA transformers. When a small size DT replaces the existing 100 kVA transformer, cost is minimal since said existing transformer can be used for another location. Only installation of replacing DT is costly. Installation cost of each DT is approximately LKR 40,000 in total.

Table 8.3-1 Price Breakdown of Installation Work of Small DT

	Work Category	Description	Q'ty	Unit Price (LKR)	Price (LKR)
1	Design	Designer	1	5,000	5,000
2	Installation	Crane operator	0.5	4,000	2,000
		Worker	3	3,000	9,000
		Supervisor	0.5	4,000	2,000
		Site Manager	0.5	5,000	2,500
3	Electrical works	Electrician	1	4,000	4,000
4	Material	Support Material	1	2,000	2,000
5	Equipment	Crane(3T)	0.5	5,000	2,500
6	Equipment	Cargo Truck	0.5	3,000	1,500
7	Equipment	Vehicle for transportation	0.5	3,000	1,500
8	Safety Management Cost	3% of total of 1to 10	1	960	960
9	Managing Cost	20% of Total 1 to 11	1	6,592	6,592
				Total	39,552

(Prepared by the Survey Team)

(2) Cost of New LV Scheme

Estimated costs are mentioned in the LV Proposal, applying the CEB's standard unit prices. The unit price includes costs of DTs, 33 kV or 11 kV MV lines, LV lines and other material and installation works. The cost of new LV scheme is summarized in Table 8.3-2.

Table 8.3-2 Cost of Additional LV Schemes

Region	Area	Required Q'ty	Project Cost (MLKR)
Region 1	-	N/A	0
Region 2	WPN	75	114
	Central	300	431
	Eastern	170	240
Region 3	WPS-2	75	405
	UVA	90	630
	Sabaragamuwa	125	875
Region 4	-	N/A	0
	Total	835	2,695

(Source: CEB Project Proposals of Region-1, -2, -3 and -4)

(3) Cost of Single Phase to Three Phase Conversion

As CEB proposed in the LV Proposal, the following cost is estimated using CEB's standard unit prices. The unit prices include the costs of conductors, insulators, poles and installation works. Although CEB requested for three-phase conversion in Regions 2 and 3, the Survey Team will investigate the latent requirement in other regions. The project cost is shown in Table 8.3-3

Table 8.3-3 Cost of Three-phase Conversion

Regions	Facilities	Cost (MLKR)
WPN in Region 2	3 Phase Conversion by Aerial Bundle Conductor (100 km)	50
WPS-2 in Region 3	3 Phase Conversion (400 km)	160

(Prepared by the Survey Team)

(4) Cost of Energy Meter

Cost of energy meters, boxes, Last One Mile Communication facilities and installation work are included in the LV Loss Reduction Proposal; however, the cost of the Back Born Communication for data transmission is not included in Table 8.3-3. The cost of Back Born Communication is shown in Table 8.3-4.

Table 8.3-4 Cost of Energy Meters and Installation

Region	Area	Required Q'ty of DT	FC (MLKR)	LC (MLKR)
Region 1	NWP	3227	1,421	47
Region 2	WPN	2,546	1,237	41
Region 3	WPS-2	1,657	1,098	8
Region 4	WPS-1	1,148	778	7
	Total	8,578	4,534	103

(Prepared by the Survey Team based on the MV/LV Proposal)

Note: Unit cost of energy meter includes programmable meter with communication interface, CT, enclosure and installation cost.

(5) New Primary Substations

Table 4.2-4 of Chapter 4 shows the estimated project base costs of the new PSs and 33 kV distribution lines based on the proposal from each region.

(6) DAS

The proposed system is combined with overhead distribution line and/or underground cable system. The expected cost of DAS is shown in Table 8.3-5.

Table 8.3-5 Cost of DAS

projects	scope	FC (MLKR)	LC (MLKR)
Region 1			
North Western Province	New DAS including 6 GSs, 19 PSs, 4 gantries and 150 RTU	1,131	3
Region 2			
Western Province North	New DAS including 11 GSs, 16 PSs 36 gantries and 200 RTU	1,511	6
Region 3			
Western Province South II	New DAS including 6 GSs, 9 PSs, 20 gantries and 130 RTU	1,108	2
Region 4			
Western Province South I	New DAS including 4 GSs 17 PSs, 1 gantries and 130 RTU	1,023	2

(Prepared by the Survey Team)

(7) Back Born Communication

Cost of fiber optic cables is shown in Table 8.3-6.

Table 8.3-6 Cost of Fiber Optic Cable Communication System

projects	Estimated Length of Fiber Optic Cable (km)	Unit Rate including installation work *1 (LKR/km)	Equipment Cost *2 (MLKR)	Splicing Equipment	project costs (MLKR)
Region 1					
North Western	1,700	32,000	89 (4 group)	28 (4 sets)	661
Region 2					
Western Province North	1,000	Ditto	67 (3 group)	21 (3 sets)	408
Region 3					
Western Province South II	550	Ditto	45 (2 group)	14 (2 sets)	235
Region 4					
Western Province South I	450	Ditto	45 (2 group)	14 (2 sets)	203

(Prepared by the Survey Team)

Note *1: Unit Rate = Material Cost + Installation Cost (per km) = 50 sets (iron accessories) x LKR 1,000 + 1 set (enclosure) x LKR 50,000 + 1,000 m x LKR 100 (fiber optic cable 12 cores) + 40 man-day (25 (for iron acc.) + 5 (for splicing) + 10 (for cable installation) x LKR 3,000) = LKR 320,000

Note *2: Equipment Cost = Two Bucket Trucks + One Truck (per 1 group) = MLKR 84 + MLKR 27 = MLKR 111 → 22.2 MLKR (20% of equipment cost will be estimated as cost per 1 group)

8.3.2 Cost of Packaged Projects

(1) Colombo City 11 kV Development Project (Package 1)

This project includes provision of 11 kV underground cables and necessary switchgears to distribute the electricity from 132 kV GSs which are reinforced under a transmission project. The cost of the project is shown in Table 8.3-7.

Table 8.3-7 Cost of Colombo City 11 kV Development Project

No.	Sub-projects	Specifications	Switchgear	FC (MLKR)	Local (MLKR)
1	Radial circuit from N GS to No 320, Union Place to De load Sub. E & I	XLPE 400 mm², 6 km	N/A	110	30
2	Interconnection from M GS to N GS	XLPE 400 mm², 6 km	N/A	110	30
3	33 kV GIS at Kelanitissa	N/A	33 kV GIS 18 sets	360	140
4	Galle Face Green 3 Project Shangri-La and Sheraton Hotels Apartment and Condominium Center	XLPE 400 mm², 50 km	11 kV RMU :33 sets	1,100	300
5	Re-development Project, Slave Island	XLPE 400 mm², 6 km	11 kV RMU :9 sets	127.5	34.5
6	Development Project at Colombo Commercial	XLPE 400 mm², 15 km	11 kV RMU : 26 sets	390	105
7	Regal Theater Site	XLPE 400 mm², 7.5 km	11 kV RMU :9 sets	182.5	49.5
8	Lotus Tower	XLPE 240 mm², 3 km	11 kV RMU :9 sets	80	27
9	Construction Vehicles	15 vehicles	N/A	627	-
			Total	3,087	716

(Prepared by the Survey Team based on CEB proposal)

(2) North Western Province of Region 1 (Package 2)

This package is composed of reinforcement of MV line/PSs, three-phase conversion/LV scheme/small DT, DAS, AMR, construction vehicles and other necessary facilities to reinforce the distribution systems. In addition, the Survey Team suggests providing additional MV interconnection and LSBs to increase the reliability of the distribution system. The proposed package is shown in Table 8.3-8.

Table 8.3-8 Cost of Distribution Reinforce Projects in NWP of Region 1

No.	Sub-projects	Specification	FC (MLKR)	LC (MLKR)
1	33 kV distribution lines	DC Lynx Tower Line 64 km	500	214
2	PS s and gantries	N/A	-	-
3	Ariel bundle conductor LV line (ABC)	N/A	-	-
4	Instrument for loss reduction	Test tool 35 sets	38	-
5	Additional LBS for DAS reinforcement	100 sets	240	-
6	Additional MV lines for interconnection	200 km	200	440
7	DAS	1 set	1,131	(3)
8	AMR	1set	1,421	(47)
9	Communication Infrastructure (1,700 km)	1 set	457	(204)
10	Construction Vehicle	15 vehicles	630	-
		Total	4,617	654 (254)

(Prepared by the Survey Team based on CEB proposal)

Note: ( ) shows estimated equivalent cost to be done by other source

(3) Western Province North of Region 2 (Package 3)

This project is proposed in the same manner as WPN and shown in Table 8.3-9.

Table 8.3-9 Cost of Distribution Reinforce Projects in WPN of Region 2

No.	Sub-projects	Specification	FC (MLKR)	LC (MLKR)
1	33 kV distribution lines	DC Lynx tower line 68.5 km	750	321
2	Augment of two PSs (2x5 MVA to 2x10 MVA New two PSs Gantries	2 sets 2sets 5 SBB gantries with 10 recloser	1,236	530
3	Ariel Bundle Conductor LV Line (ABC)	ABC 120 km	98	42
4	Instrument for Loss Reduction	Test tool 35 sets	38	-
5	DT and 3 phase conversion requirement	100 kVA DT 15 sets 160 KVA DT 60 sets 3 phase ABC 60 km	114	49
6	Additional LBS for DAS reinforcement	200 sets	480	-
7	Additional MV lines for interconnection	100 km	100	220
8	DAS	1 set	1,511	(6)
9	AMR	1set	1,237	(41)
10	Communication Infrastructure (1,000 km)	1 set	288	(120)
11	Construction Vehicle	15 vehicles	630	-
		Total	6,482	1,162 (167)

(Prepared by the Survey Team based on CEB proposal)

Note: ( ) shows estimated equivalent cost to be done by other source.

(4) Western Province South-2 of Region 3 (Package 4)

Overhead distribution system will be replaced by a new UGC system in Battaramulla Town. The Survey Team also suggests adding DAS and AMR system to realize effective operation of the distribution system. The proposed system is shown in Table 8.3-10.

Table 8.3-10 Cost of Distribution Reinforce Projects in WPS-2 of Region 3

No.	Sub-projects	Specifications	FC (MLKR)	LC (MLKR)
1	Conversion of OH system to UG cable system*1	11 kV UGC, switchgear	2,450	1,050
2	WPS2: 33/11 kV PSS	2X10 MVA at Thalahena	420	180
3	WPS2: 33 kV UG lines	Aurveda Junc. to Ethulkotte, Rajagiriya, UD double-circuit 3 km	245	105
4	Construction and rehabilitation of 33 kV lines	Lynx SC 32.5 km, Raccoon SC 37 km	238	102
5	Instrument for loss reduction	Test tool 35 sets	38	-
6	Additional LBS for DAS reinforcement	100 sets	240	-
7	Additional MV lines for interconnection	50 km	50	110
8	DAS	1 set	1,108	(2)
9	AMR	1 set	1,098	(8)
10	Communication infrastructure (550 km)	1 set	169	(66)
11	Construction vehicle	15 vehicles	630	-
		Total	6,686	1,547 (76)*2

(Prepared by the Survey Team based on CEB proposal)

Note*1: In Battaramulla town, existing OH distribution system will be replaced to new underground distribution system.

Note*2: ( ) shows estimated equivalent cost to be done by other source

(5) Western Province South-1 of Region 4 (Package 5)

Overhead distribution system will be replaced by a new UGC system in Dehiwala and Mount Lavenia. The Survey Team suggests adding DAS to realize effective operation of the distribution system. The proposed system is shown in Table 8.3-11.

Table 8.3-11 Cost of Distribution Reinforce Projects in WPS-1 of Region 4

No.	Sub-projects	Specifications	FC (MLKR)	LC (MLKR)
1	Dehiwala Mount Laveniya UGC	11 kV UGC (240 mm^2 x 33 km) 11 kV UGC (95 mm^2 x 3 km) Radial SS 12 locations Replace to ABC 200 km	1,487	638
2	Replace to ABC 200 km	Incl. in 1.	-	-
3	PSs (New and Augmentation)	N/A	-	-
4	Gantries	N/A	-	-
5	Instrument for Loss Reduction	Test tool 35 sets	38	-
6	Additional LBS for DAS reinforcement	100 sets	240	-
7	Additional MV lines for interconnection	50 km	50	110
8	DAS	1 set	1,023	(2)
9	AMR	1set	778	(7)
10	Communication Infrastructure (55 km)	1 set	149	(54)
11	Construction Vehicle	15 vehicles	630	-
		Total	4,395	748 (63)

(Prepared by the Survey Team based on CEB proposal)

Note: ( ) shows estimated equivalent cost to be done by other source.

8.4 Evaluation of Packaged Projects

Considering the CEB's priority for the projects, relation to transmission projects, and cost/loss reduction values, the Survey Team summarized the order of priority as shown in Table 8.4-1. Colombo City 11 kV Development Project is nominated as the first priority project considering the priority of CEB and relation to Colombo City Transmission Development (PJT-1), efficiency (MWh/MLKR) and project area.

Table 8.4-1 Priority of Candidate Projects

Packages	CEB Priority	Relation to TL projects	Project area	Loss Reduction (MWh/year)	Priority
Region 1					
1. Colombo City	1	1	Colombo City	4,605 (from Table 6.2-1)	1
2. NWP	2	2	Rural Area	16,309 (from Table 6.2-2)	5
Region 2					
3. WPN	2	2	Greater Colombo	20,293 (from Table 6.2-3)	2
Region 3					
4. WPS-2	2	2	Greater Colombo	15,973 (from Table 6.2-4)	3
Region 4					
5. WPS-1	2	2	Greater Colombo	7,396 (from Table 6.2-5)	4

(Prepared by the Survey Team)

CHAPTER 9
ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

CHAPTER 9 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

9.1 General

JICA has created coherent requirements for environmental and social considerations as stipulated in the 'JICA Guidelines for Environmental and Social Considerations' issued in April 2010 (hereinafter referred to as 'JICA Guidelines'). It encourages the proponents of Japan's yen loan projects to have appropriate considerations to avoid or minimize projects' impacts on the environment and local communities, as well as prevent the occurrence of unacceptable adverse impacts.

JICA puts emphasis on transparent and accountable processes, as well as stakeholders' participation. Below are the underlying principles of the JICA Guidelines:

a) Environmental impacts that may be caused by the projects must be assessed and examined in the earliest possible time of the planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.

b) Such examinations must be endeavored to include analyses of environmental and social costs and benefits in the most quantitative terms possible, as well as qualitative. They must be conducted in close harmony with economic, financial, institutional, social, and technical analyses of the projects.

c) The findings of the examination of environmental and social considerations must include alternatives and mitigation measures, and must be recorded as separate documents or as part of other documents. Environmental impact assessment (EIA) reports must be produced for projects in which there is a reasonable expectation of particularly large adverse environmental impacts.

d) For projects that particularly have high potential adverse impacts or that are highly contentious, a committee of experts may be formed so that JICA may seek their opinions, to increase accountability.

To confirm whether adequate environmental and social considerations are in accordance with JICA Guidelines and Sri Lanka's laws and regulations concerned are taken into account, the Survey Team carried out environmental reviews of the candidate projects.

9.2 Policy and Legal Framework in Sri Lanka

9.2.1 Prescribed Electricity Sector Projects requiring Environmental Assessment

An EIA process in Sri Lanka is mandated for prescribed projects[1] that are likely to have significant impacts on the environment as stipulated in the National Environmental Act (NEA) No. 47 of 1980. Such prescribed projects of the electricity sector are as follows: a) construction of hydroelectric power stations exceeding 50 MW, b) thermal power plants exceeding 25 MW of generation capacity at a single location or capacity addition to existing plants, c) nuclear power plants, d) all renewable energy based electricity generating stations exceeding 50 MW, and e) installation of overhead transmission lines of length exceeding 10 km and voltage above 50 kV.

9.2.2 Laws, Regulations and Standards

The legislations and organizations in the table below are pertaining and related to the natural and social environment when implementing electricity sector projects.

Table 9.2-1 Laws Pertaining and Relevant to the Environmental and Social Consideration

Laws	Objectives	Key Areas	Key Agencies
National Environmental Act No.47 of 1980 National Environment (Amendment) Acts No. 56 of 1988 and No. 53 of 2000	To protect, preserve, and conserve the environment.	Prescribed projects to undergo environmental assessment	Central Environmental Authority (CEA)
Land Acquisition Act (LAA) No. 9 of 1950 and its Amendments	To provide rules for land acquisition and compensation.	Land acquisition and compensation	Ministry of Land and Land Development Divisional Secretariat Office
National Involuntary Resettlement Policy (NIRP) * There is still no legal provision for resettlement.	To provide guidelines for the project proponents to develop and execute a comprehensive resettlement implementation plan.	Resettlement and compensation	Project Proponents Divisional Secretariat Office
Fauna and Flora Protection (Amendment) Act No.22 of 2009	Protection, conservation, prevention of commercial and other misuse of the fauna and flora and their habitats, and conservation of the biodiversity.	National park, natural reserve	Department of Wild Life Conservation, and Department of Forest
Forest Ordinance No.16 of 1907 (by British Rulers) and Amendments	Management of forests and plant protection.	Forest reserves	Department of Forest
Felling of Trees Act No.9 of 1951, amended No.1 of 2000	Prohibition, regulation, and control the removal of trees.	Regulates the removal of trees	Department of Forest
Coconut Development Act No.46 of 1971	Development and regulation of the coconut industry and the utilization of land in and for coconut plantations; to provide for the management and acquisition of coconut plantations.	Compensation for coconut trees in coconut plantations	Coconut Development Authority

[1] The prescribed projects are listed in Gazette Nos. 772/22 of June 24, 1993, 859/14 of February 23, 1995, 1104/22 of November 5, 1999, and 1108/1 of November 29, 1999.

Public Utilities Commission of Sri Lanka Act No.35 of 2002 (* See Chapter 2 for further details.)	To regulate public utilities industries pursuant to coherent national policies.	All public utilities in Sri Lanka including the electricity industry.	The Public Utilities Commission of Sri Lanka
Electricity Act No.20 of 2009	To provide for the regulations of the generation, transmission, distribution, supply, and use of electricity.	Licensees' grant application for and process of acquiring *way leaves* (right of way: ROW) for the installation of new electric lines/apparatuses or removing existing ones	Licensees of generation, transmission and distribution of electricity including CEB Divisional Secretariat Office
Coast Conservation Act No.57 of 1981	To regulate and control development activities within the coastal zone.	Coastal zone	Department of Coast Conservation Urban Development Authority
Soil Conservation (Amendment) Act No.24 of 1996	To provide for the enhancement and sustenance of productive capacity of the soil, to restore degraded land for the prevention and mitigation of soil erosion for the conservation of soil resources, and protection of land against damage by floods, salinity, alkalinity of water, logging, and drought.	Conservation area, vulnerable area to degradation	Department of Agriculture Department of Forest
National Heritage and Wilderness Areas Act No.3 of 1988	Protection and preservation of national heritage wilderness areas.	National heritage wilderness areas	Department of Cultural Affairs Department of Wild Life Conservation, and Department of Forest

(Prepared by the Survey Team)

9.2.3 Major Issues on Environmental and Social Considerations

(1) Environmental Assessment

The legal requirement for EIA in Sri Lanka is mainly provided under the regulations of NEA No. 47 of 1980. EIA then became mandatory for development projects that have significant environmental impacts throughout the country. Such procedures were subsequently specified by the National Environmental (Amendment) Act No.56 of 1988.

If the potential impacts are found to be significant, they are subjected to an EIA, which requires a detailed and comprehensive study of environmental impacts. Other than the "prescribed projects", legal provisions for EIA in Sri Lanka were also introduced to all projects within the coastal zone[2] as stipulated in the Coast Conservation Act No.57 of 1981. According to the Fauna and Flora Protection (Amendment) Act No.49 of 1993, any development activity proposed to be established within one mile[3] from the boundary of any national reserve is also required to be subjected to EIA, and written approval should be obtained from the Director General, Department of Wild Life Conservation prior to implementation of such projects. All projects located in "environmental sensitive areas" require an EIA, irrespective of the degree of magnitude.

[2] The "coastal zone" comprises of the area lying within a limit of 300 meters landward of the mean high water line and a limit of 2 kilometers seaward of the mean low water line. Under the act, identification of projects that require EIA is left to the discretion of the Director, Coast Conservation Department.

[3] One mile = approximately 1.6 km.

Projects whose environmental impacts are not very significant may be subjected to initial environmental examination (IEE), which is a relatively short and simple study.

The Central Environmental Authority (CEA), established in August 1981, has a mission to steer towards protecting and managing the quality of the environment by promoting public participation, enforcement, advanced technological interventions, and environmental education. The CEA was given wider regulatory powers under the National Environment (Amendment) Acts No. 56 of 1988 and No. 53 of 2000. Moreover, the CEA implements EIA procedures for prescribed projects and issues environmental protection licenses for prescribed activities.

(2) Land Acquisition

When land is required for a public purpose including electricity generation, transmission, and distribution, the head of the relevant department forwards an acquisition proposal to the Secretary of the Ministry of Land and Land Development via the Secretary to the Ministry which a particular institution falls under the purview. After confirming the accuracy of the proposal, the acquisition procedure is commenced upon approval of the Minister of Land and Land Development. Land and other assets are acquired under the provisions of the Land Acquisition Act (LAA) No. 9 of 1950 and its amendments[4]. Compensations and interests are paid to the land owners accordingly.

According to the LAA, the market value of land shall be the perceived amount which the land might be expected to have realized, if sold by a willing seller in the open market, as a separate entity of the date of publication as notified in the gazette.

The amount of compensation to be paid shall be based on the market value of the land where the compensation is for the acquisition or servitude over the land. It shall be proportionate to the persons' interest in that land. No additional compensation shall be allowed, considering the compulsory nature of the acquisition. The resident is notified of the amount of compensation for the land to be paid by the Project Implementing Agency (PIA) through the Divisional Secretariat (DS) office[5] where the land is located.

Depending on the land to be acquired, the person shall be entitled to the following only as indicated in Table 9.2-2:

[4] Amendment Act No.39 of 1954, No.22 of 1955, No.28 of 1964, No.20 of 1969, No.48 of 1971, No.8 of 1979, No.12 of 1983, No.13 of 1986, and Gazette No. 1596/12 of April 7, 2009.

[5] Divisions are administered by divisional secretaries, and are known as Divisional Secretariat Divisions (D.S. Divisions). The D.S. Divisions are under the 25 districts, the country's fundamental administrative units run by the Central Government; the Ministry of Public Administration and Home Affairs.

Table 9.2-2 Entitled Compensation other than Land Acquisition

Purpose of compensation other than land acquisition	Payable
Compensation for any damage sustained by reason of: - severance of the land from his other land, the severance being deemed to occur on the date on which the notice in respect of the land is published in the gazette notification; and - land acquisition injuriously affecting, in any manner other than the above, his adjoining land or any immovable property thereon, the injurious affection being deemed to occur on the aforesaid date.	- not to exceed 20% of the market value of the land to be acquired
Compensation for any such loss of earnings from any business carried on the land on the aforesaid date as may be caused by the acquisition	- not to exceed 3 times the average annual net profits from the business for the 3 calendar years immediately preceding the date on which the notice in respect of the land is published in the gazette; - No compensation shall be allowed if the business is the sale or disposal of the produce of the land to be acquired.
Any reasonable expense affecting any change of residence necessarily caused by the acquisition	

(Source: Section 46, Land Acquisition Act)

Apart from land acquisition required for the construction of power generation facilities, CEB applies for granting “way-leaves” (right of way: ROW) to the land owners or occupiers when they install new electric lines and apparatuses, or remove existing ones in order to secure access to that land for the purposes of inspecting, maintaining, adjusting, repairing, altering, removing, or replacing such electricity lines. Electricity Act No.20 of 2009 and guidelines for acquiring way-leaves are also referred in this manner.

(3) Resettlement

The National Involuntary Resettlement Policy (NIRP) was developed and approved by the Cabinet in May 2001 in Sri Lanka. Before NIRP became effective, the LAA only provided for compensation for land, structures, and crops. Other issues were not addressed like the exploration of alternative project options, compensation for those without land titles, consultation with affected people and their hosts on resettlement options, provision of successful social and economic integration of the affected people and their hosts, or full rehabilitation of the project affected persons (PAPs). The NEA and its amendments did not adequately address key resettlement issues, although they had some provisions relevant to resettlement. It also mentioned about the proponent to handle the matter (i.e., CEA) and referred to involuntary resettlement exceeding 100 families.

Since there is still no legal provision for resettlement, the PPs are encouraged to develop and execute a comprehensive resettlement implementation plan based on the key principles stipulated in the guidelines of NIRP.

Key Principles of National Involuntary Resettlement Policy

i) Involuntary resettlement be avoided or reduced as much as possible by reviewing alternatives to the project as well as alternatives within the project

ii) Affected people be assisted to re-establish themselves and improve their quality of life when involuntary resettlement is avoidable

iii) Affected persons be fully involved in the selection of relocation sites, livelihood compensation and development options at the earliest opportunity

iv) Replacement land be an option for compensation in the case of loss of land; in the absence of replacement land, cash compensation should be an option for all affected persons

v) Compensation for loss of land, structures, other assets and income is based on full replacement cost and be paid promptly. This should include transaction costs.

vi) Resettlement be planned and implemented with full participation of the provincial and local authorities

vii) Participatory measures be designed and implemented in order to assist those affected to be economically and socially integrated into the host communities,

viii) Common property resources and community and public services be provided to affected people

ix) Resettlement be planned as a development activity for the affected people

x) Affected persons who do not have documented title to land receive fair and just treatment

xi) Vulnerable groups be identified and given appropriate assistance to substantially improve their living standards

xii) Project executing agencies bear the full costs of compensation and resettlement.

(Source: *Sri Lanka National Involuntary Resettlement Policy*, Ministry of Environmental and Natural Resources, Ministry of Lands and Central Environmental Authority, 2011)

The NIRP has established a framework for project planning and implementation to ensure that the PAPs be treated in a fair and equitable manner, and that they are not impoverished in the process. It indicates that a comprehensive resettlement action plan is required where 20 or more families are affected, whereas, it also applies to cases when people do not have to be physically relocated. The CEB has elaborated resettlement action plans in the past, mostly when they construct power generation facilities, but not for transmission and distribution projects.

9.3 EIA Process in Sri Lanka and Gaps between JICA Guidelines

9.3.1 EIA Process and Procedure

Once a project is initiated by a private or state agency, the EIA process is implemented through designated "Project Approving Agencies"[6] (PAAs) as follows[7]:

[6] The NEA stipulates that the approval for a prescribed project must be granted by an appropriate project approving agency. As of 2012, 23 government agencies have been designated as PAAs by Gazette Nos. 859/14 of February 23, 1995, and 1373/6 of December 29, 2004. Ministry of Power and Energy and CEA are among them.

1) Submission of preliminary information

The project proponent shall submit to PAA the preliminary information on the proposed project for EIA process to be initiated. The PAA shall acknowledge in writing within six days upon receipt of such preliminary information[8].

2) Scoping and compiling the Terms of Reference (TOR)

The PAA will carry out scoping, solicit the participation of those affected, query the project proponent for clarifications, and decide either an EIA or IEE should be conducted as described in the NEA. Accordingly, the PAA shall convey in writing to the project proponent the TOR: within 14 days in case of IEE or 30 days in case of EIA upon receipt of preliminary information of the date of acknowledgment[9].

The issuance of the TOR for IEE requests is the simplest possible process compared to that of EIA, and should be compiled based on the guidance of CEA as shown below.

The issuance of the TOR for IEE requests the simplest possible process compared to that of EIA, and should be compiled based on the guidance of CEA as shown below.

Preparation of TOR for IEE

IEEs are intended to be brief documents, generally not longer than ten pages, which aims at helping decision makers to ensure that projects are implemented with appropriate mitigation measures to avoid significant impacts.

PAAs may wish to establish page limits, checklists, or other guides for project proponents to meet IEE requirement effectively and efficiently.

In general, IEEs should contain the following sections:

- Summary (one page)
- Proposed Action's Purpose, Needs, and Legal Requirements
  Legal actions required by the government to approve action
- Proposed Action
  Brief description of the proposed action, including any mitigation measures designated to reduce environmental impacts
- The IEEs may need to contain description of reasonable alternatives
- Affected Environment
- Environmental Consequences of the Proposed Action
- Mitigation and Monitoring Plan
- Appendices

List of IEE prepared, reference, backup data, and analysis

(Source: Guidance of CEA)

3) EIA/IEE report preparation

EIA/IEE reports should be prepared in any of the three national languages, and then submitted to the PAA for evaluation.

7 Section 23Y of the NEA.
8 Article 6-(i) of Gazette No. 772/22 of June 24, 1993.
9 Article 6-(iii) of Gazette No. 772/22 of June 24, 1993.

As per EIA report, the PAA shall determine within 14 days if all matters are fully addressed as set by the TOR. If the EIA report is determined to be inadequate, the PAA shall request the project proponent to make necessary amendments and resubmit the report.

4) Public notice, inspection and hearing

The PAA must announce that the EIA is available for inspection by the public in the gazette and in a national newspaper using all three languages[10]. The public may submit written comments on the document within 30 days[11].

Any public comments on the EIA report should be responded by the project proponent within six days[12]. The PAA can decide to hold public hearings[13] if the project is controversial as described below.

Criteria on controversial cases

- Where a proposed prescribed project is highly controversial, whether more expressions of public views are essential to make a decision;
- Whether the proposed prescribed project might cause unusual national or regional impacts;
- Whether it might threaten nationally important and environmentally sensitive areas; and
- Whether a formal request for a public hearing has been requested by an interested party.

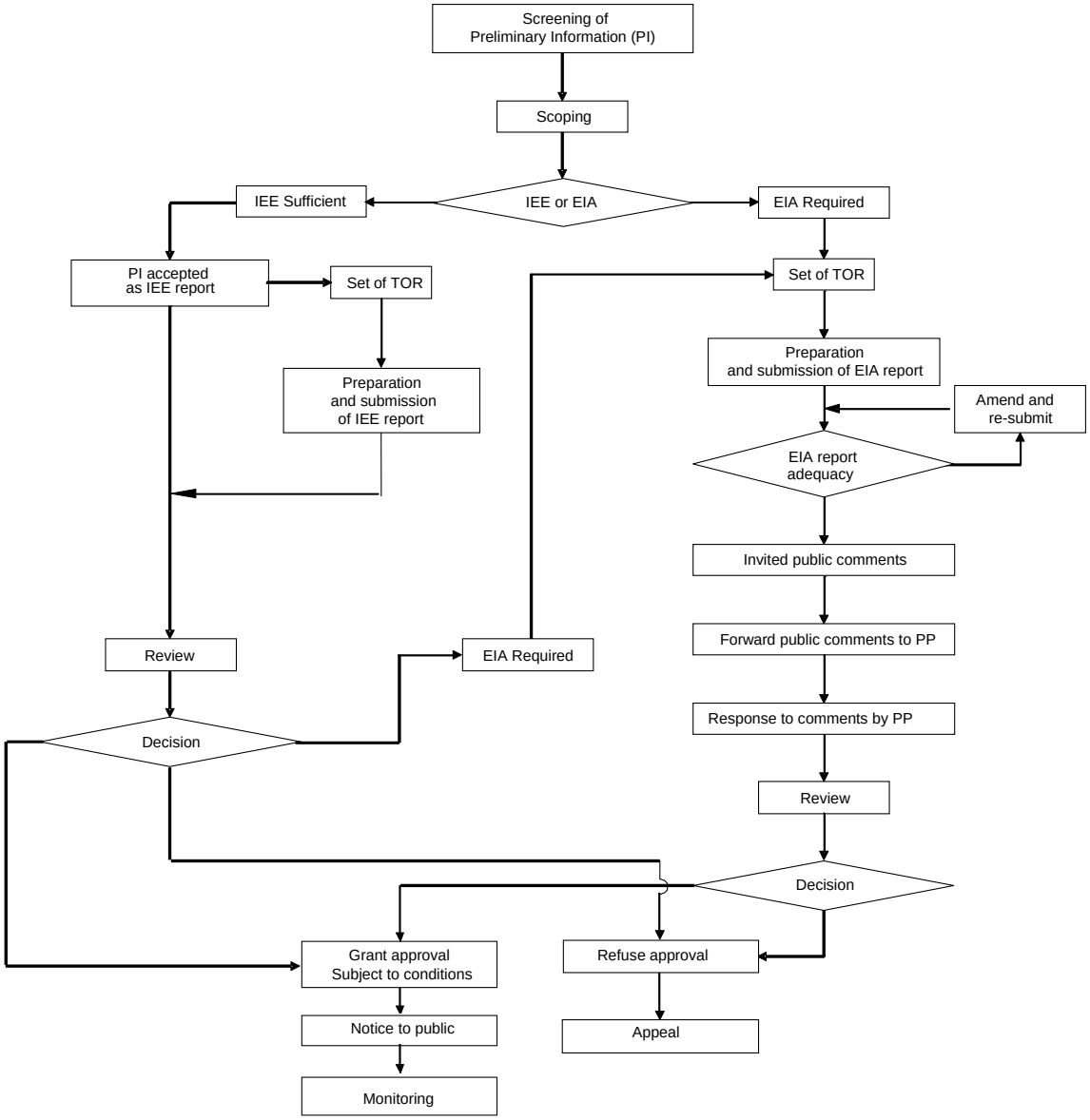
(Source: Guidance of CEA)

5) Approval

Subsequent to the public inspection period, the PAA will decide whether to grant approval for the project within 21 days in case of IEE[14] and 30 days in case of EIA[15].

Figure 9.3-1 shows the flow of EIA implementation process.

[10] Article 11-(i) of Gazette No. 772/22 of June 24, 1993. If there is a request from the public, these reports are translated to any of the other two national languages.
[11] Article 11-(i) of Gazette No. 772/22 of June 24, 1993.
[12] Article 12 of Gazette No. 772/22 of June 24, 1993.
[13] Article 12 of Gazette No. 772/22 of June 24, 1993.
[14] Article 8 of Gazette No. 1159/22, November 21, 2000.
[15] Article 13 of Gazette No. 772/22 of June 24, 1993.



(Source: CEA)

Figure 9.3-1 EIA Implementation Process

9.3.2 Comparison of JICA Guidelines with Sri Lankan Laws and Regulations

The major differences between JICA Guidelines and Sri Lanka policies regarding environmental assessment are set out in Table 9.3-1. These are the compilation of EIA documents, need of public participation, and issues regarding monitoring mechanisms.

Table 9.3-1 Comparison between JICA Guidelines and Sri Lankan Laws and Regulations

Items	National Environmental Act of Sri Lanka	JICA Guidelines
Priority alternatives and mitigation measures	(Alternatives) "Description of alternatives to the activity together with the reasons why such alternatives were rejected" are required by guidance* (Mitigation measures) Mitigation measures are required to be included in the IEE/EIA document by guidance*	Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible time of the planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.
Compiling of EIA report	The NEA (amended in 2000) requires compiling EIA document based on "Part IV C" of its article	EIA reports must be produced for projects in which there is reasonable expectation for particularly large-scale adverse impacts on the environment.
Disclosure of information and participation of affected people	The NEA (amended in 2000) requires public participation based on "Part IV C" of its article	For projects with potentially large environmental impact, sufficient consultations with local stakeholders such as local residents must be conducted via disclosure of information at an early stage at which alternatives for project plans may be examined.
Carrying out of monitoring program	Monitoring plan is required to be included in the IEE/EIA document by guidance* and required to be cleared are the "parameters to be monitored", and "institutional responsibility and procedures for reporting".	After the project begins, the project proponents, etc. should be monitored whether any unforeseeable situation occurs, and whether the performance and effectiveness of mitigation measures are consistent with the assessment's prediction.

(Prepared by the Survey Team)

Note: Guidance for implementing the environmental impact assessment process by CEA

9.4 Environmental Review on Candidate Projects

The following table shows the screened projects which were requested to JICA for Japan's ODA loan. A series of environmental examination was conducted in a step-by-step manner. First, primary scoping for each project prior to site survey and others. Second, specific survey based on the primary scoping. Third, environmental review by comparison between primary scoping and survey result.

Table 9.4-1 List of Candidate Projects

No	Project Title
#1	Colombo City Transmission Development (PJT-1 with Distribution Development Package-1)
#2	Construction of Kappalturai 132/33 kV GS (PJT-2)
#3	Construction of GSs surrounding Colombo City including Kerawalapitiya 220/33 kV GS (PJT-3), Kalutara 132/33 kV GS (PJT-7), and Battaramulla 132/33 kV GS (PJT-8)
#4	Construction of Veyangoda - Kirindiwela - Padukka 220 kV TL (PJT-5)
#5	Distribution Development for North Western Province of Region 1 (Package 2)
#6	Distribution Development for Western Province North of Region 2 (Package 3)
#7	Distribution Development for Western Province South-2 of Region 3 (Package 4)
#8	Distribution Development for Western Province South-1 of Region 4 (Package 5)

(Prepared by the Survey Team)

(1) STEP 1: Primary Scoping

The Survey Team conducted a primary scoping for the eight screened projects on all environmental items listed in the checklist of the JICA Guidelines for Environmental and Social Considerations. The anticipated degrees of impact prior to the examination or execution of

avoidance/mitigation measures are described as A, B, C, or D for each item.

"A" shows that significant positive (+) or negative (-) impact is expected. "B" indicates that to some extent positive (+) or negative (-) impact is expected. "C" means that the extent of positive (+) or negative (-) impact is unknown, which requires further examination and the impact could be clarified as the study progresses. "D" implies that there is no impact expected. The impact ranges from direct and immediate ones to secondary and accumulative ones throughout the project life cycle.

(2) STEP 2: Environmental and Social Survey based on the Primary Scoping

For the items which remain as important in the primary scoping, the Survey Team developed terms of reference and implemented specific survey for each candidate project. During the survey, CEB and the Survey Team consulted each other in order to find every possible alternative where adverse impacts could be avoided, mitigated, or minimized.

(3) STEP 3: Environmental Review and Examination of Mitigation Measures

Based on the survey outcome, the Survey Team conducted an environmental review. CEB and the Survey Team examined mitigation measures and countermeasures for the items reviewed as "B-". No major adverse impacts are so far anticipated by the implementation of any of candidate projects. Minor negative impacts, which are mostly anticipated during construction period, can be avoided by introducing appropriate management of construction works.

Presented are the outcome of primary scoping, specific survey, and environmental review for each candidate project. Apart from the environmental review, **an environmental monitoring plan** was also examined with which environmental impact should be monitored during construction period.

9.4.1 Colombo City Transmission Development Project (PJT-1 and DL Package 1)

(1) Primary Scoping

Table 9.4-2 Primary Scoping: PJT-1

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
I.	Pollution			
1	Air Pollution	B-	D	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with GS construction is anticipated. <operation phase> N/A
2	Water Pollution	B-	D	<construction phase> Waste water discharge mainly associated with the GS construction is anticipated. <operation phase> N/A

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
3	Waste generation and disposal of construction debris	B-	B-	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. <operation phase> Waste generated at GSs have to be well managed and disposed appropriately in order not to cause water quality degradation or soil contamination in the surrounding areas.
4	Soil contamination	B-	D	<construction phase> Waste water discharge mainly associated with the construction of GSs may cause soil contamination. <operation phase> N/A
5	Noise and vibration	B-	D	<construction phase> Noises and vibration associated with the GS construction and soil excavation for laying underground cables is anticipated. <operation phase> N/A
6	Subsidence	D	D	There is no work expected which causes subsidence.
7	Odor	D	D	There is no work expected which causes odor.
8	Sediment	D	D	There is no work expected which causes impact to sediment.
II.	Natural Environment			
1	Impact to coast conservation	B-	D	<construction phase> One of newly constructed GSs is designed to be located within the coastal zone (Fort). <operation phase> N/A
2	Protected areas	D	D	There is no national park or sanctuary existing in and around the project site.
3	Ecosystem	D	D	No rare species of fauna and flora exist in and around the project site so that impacts to ecosystem will not be found.
4	Hydrology	D	D	<construction phase> There is no work anticipated that change river flow or river basin. <operation phase> Electric lines will be extended along with bridges when they cross rivers, which will not make any changes in river flow.
5	Topography and geology	D	D	Shallow excavation will take place for putting cable lines underground. There is no slope failure or landslide anticipated as such works as cutting and filling are not planned.
III.	Social Environment			
1	Land acquisition and resettlement	B-	D	<construction phase> Land acquisition maybe required for GSs. <operation phase> N/A
2	Disturbance to poor people	D	B+	<construction phase> The project is unlikely to cause adverse impacts to poor residents. <operation phase> By having stable electricity supply, project beneficiaries including poor clusters will have better access to public utilities and social infrastructures.
3	Disturbance to ethnic minority groups and indigenous people	D	D	There is no ethnic minorities or indigenous people admitted in Colombo.
4	Deterioration of local economy such as losses of employment and livelihood means	D	D	This project is unlikely to cause adverse impacts to the local economy as no land is acquired for extending underground cables and land acquisition for each GS is not large-scale.
5	Land use and utilization of local resources	D	D	This project is unlikely to cause adverse impacts to local land use as no land is acquired for extending underground cables and land acquisition for each GS is not large-scale.
6	Disturbance to water usage, water rights etc	B-	D	<construction phase> Large amount of surface water will be used for the construction work of each GS. <operation phase> N/A
7	Disturbance to the existing social infrastructure and services	B-	D	<construction phase> Some residential activity interruption might be expected due to the construction of GSs and extension of underground cables. <operation phase> N/A
8	Social institutions such as	D	D	This project is unlikely to cause adverse impacts to local institutions as no land is

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
	social infrastructure and local decision-making institutions			acquired for extending underground cables and land acquisition for each GS is not large-scale.
9	Misdistribution of benefits and damages	D	D	This project is unlikely to cause misdistribution of benefits and damages as no land is acquired for extending underground cables and land acquisition for each GS is not large-scale.
10	Local conflicts of interest	D	D	This project is unlikely to cause local conflicts of interest as no land is acquired for extending underground cables, and stable electricity supply will benefit all local vicinities.
11	Cultural heritage	D	D	Although there are numerous numbers of temples and cultural monuments existing in Colombo, the project is unlikely to cause adverse impacts to them as none of project components will be too close to them, and no land is acquired for extending underground cables and land acquisition for each GS is not large-scale.
12	Landscape	D	D	The TL and DL will be laid underground so that there is no extended disturbance in the landscape. GSs are three-storied, which will not affect the city landscape.
13	Gender	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply and less power outage, project beneficiaries including women will have better access to public utilities and social infrastructures.
14	Children's Rights	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply, project beneficiaries including children will have better access to public utilities and social infrastructures.
15	Infectious diseases such as HIV/AIDS	D	D	<construction phase> As the construction activities will take place in the economic capital of the country, there will be no possibility of influx of outside labor. <operation phase> N/A
IV.	Others			
1	Working conditions	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected at any time. <operation phase> N/A
2	Accidents, injury or sickness of residents nearby or workers	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier. <operation phase> N/A
3	Impacts to trans-boundary or global issues	D	D	This project is unlikely to cause adverse impacts to trans-boundary or global issues.

(Prepared by the Survey Team)

(Note) A+/-: Significant positive / negative impact is expected. B+/-: Positive / negative impact is expected to some extent. C+/-: Extent of positive / negative impact is unknown (a further examination is needed, and the impact could be clarified as the study progresses). D: No impact is expected. The following tables apply same notes.

(2) Environmental and Social Survey

For the items which remain as important in the primary scoping shown above, the following survey was planned and carried out for Colombo City Transmission Development Project:

Table 9.4-3 Terms of Reference: PJT-1

Environmental Item	Survey Item	Survey Method
EIA and Environmental Permits	i) Necessity to go through environmental clearance	i) Literature survey ii) Relevant laws and regulations iii) Interview with relevant authorities
Ambient Air Quality	i) Air quality standards in Sri Lanka, Japan and WHO ii) Present air quality iii) Increase volume of traffic iv) Locations of public utilities in and around the project site v) Impact during construction	i) Literature survey ii) Relevant laws and regulations iii) Impact forecast iv) Site visit and casual interviews where possible v) Confirmation of project components, construction schedule, method, period, location, and area
Water Quality	i) Water quality standards in Sri Lanka, Japan and WHO ii) Present water usage in the project site	i) Literature survey ii) Relevant laws and regulations iii) Site visit and casual interviews where possible
Waste	i) Waste management in Sri Lanka, Japan and WHO ii) Treatment method of construction waste	i) Literature survey ii) Site visit and casual interviews where possible
Soil contamination	i) Measures for prevention of oil leakage during construction	i) Literature survey ii) Site visit and casual interviews where possible iii) Confirmation of project components, construction schedule, method and period, usage and storage of construction equipment
Noise and vibration	i) Noise and vibration standards in Sri Lanka, Japan and WHO ii) Distance from construction sites to residential areas and other public utilities such as hospitals and schools iii) Impact during construction	i) Literature survey ii) Site visit and casual interviews where possible iii) Confirmation of project components, construction schedule, method and period, usage and storage of construction equipment
Impact to coast conservation	i) Coast conservation standards in Sri Lanka and Japan	i) Literature survey ii) Site visit and casual interviews where possible iii) Interview with relevant authority
Land acquisition and resettlement	i) Scale of land acquisition for construction of GSs and resettlement ii) Elaboration of abbreviated resettlement action plan when necessary	i) Literature survey ii) Site visit and casual interviews where possible iii) Confirmation of present land use iv) Elaboration of abbreviated resettlement action plan to fill the gap between JICA Guidelines, WB OP4.12 and laws and regulations in Sri Lanka when necessary
Disturbance to water usage, water rights etc	i) Present water usage in the project site	i) Literature survey ii) Site visit and casual interviews where possible iii) Confirmation of present water usage and its condition in the project site
Disturbance to the existing social infrastructure and services	i) Distance from construction sites to residential areas and other public utilities such as hospitals and schools	i) Literature survey ii) Site visit and casual interviews where possible
Working environment	i) Health and safety standards in Sri Lanka and Japan ii) Safety measures	i) Literature survey ii) Case studies
Accidents	i) Average number of traffic accidents in the project site ii) Distance from construction sites to residential areas, commercial areas, public utilities such as hospitals and schools.	i) Literature survey ii) Site visit and casual interviews where possible

(Prepared by the Survey Team)

The survey shows the following outcome:

1) EIA and Environmental Permits

The National Environmental Act does not include those projects with extending underground cables electric lines and constructing GSs as “prescribed projects”. An IEE/EIA is therefore not required for PJT-1. However, one of the new GSs to be

constructed under the project, Port and Colombo L, is located within the coastal zone. Such development activities within the coastal zone are required to get a permit from the Coast Conservation Department (CCD). According to an officer of the CCD, the procedure will require approximately one month or even less.

2) Ambient Air Quality

Suspended particulate matter (SPM) including dust will spread from soil excavation work, earthmoving work, and installation of equipment as well as construction vehicles.

3) Water Quality

Suspended solid (SS) and oil can be contaminated through soil excavation work, and earthmoving work. Wrong management of equipment may cause oil spillage too. Waste water should be collected from the drainage so as not to contaminate the soil.

4) Waste

Generation of materials resulting from construction activities and generation of litter from the project employees are expected. However, garbage collection is regularly conducted by the Colombo Municipal Council. In addition, absence of proper sanitation, water supply, and waste disposal facilities at the laborers' workcamp can be unhealthy.

5) Soil contamination

Waste water discharge mainly associated with the construction of GSs may cause soil contamination. Waste water should be collected from the drainage so as not to contaminate the soil.

6) Noise and vibration

Noises and vibration associated with the GS construction and soil excavation for laying underground cables is anticipated. However, noise and vibration are common in Colombo, and the impact is temporary and anticipated to be minimal. Its attributes will be monitored to minimize the noise emission and ground vibration.

7) Impact to coast conservation

As previously described, CEB will make a request to attain a permit from the CCD to construct a GS at the Port. At present there is a temporary workshop at the project location, which was constructed for laborers and workers involved in the expansion work of the Colombo Port. The workshop will be demolished after the expansion work is completed and a land with the size of 70 m x 35 m will be transferred from the Sri Lanka Port Authority (SLPA) to CEB for the construction of the GS.

According to an officer of the CCD, there is a remote possibility for an EIA requirement during the process of obtaining the said permit as the impact to the coast is expected to be minimal compared with the port expansion, and the GS facility will have no new serious impacts to the coast conservation.

The land is fenced out for the expansion works of the Colombo Port, and a workshop building is constructed for the contractor and its workers. Part of Sambodhi Chaithya is seen on the right corner of the photo (North direction).

8) Land acquisition and resettlement

Construction of three GSs will be under the project: Port and Colombo L, Colombo M and Colombo N. The identified lands require either land transfer from the government or land acquisition from a private owner.

Table 9.4-4 Land Availability for New GSs

No	New GSs	Land owner	Actions required for land acquisition
1	Construction of Port 220/132/11kV GS and L (Port) 132/11kV GS	SLPA	Transfer
2	Construction of Colombo M (Slave Island) 132/11kV GS	John Keells Holding	Acquisition
3	Construction of Colombo N (Hunupitiya) 132/11kV GS	UDA	Transfer

(Prepared by the Survey Team)

The land for Port and Colombo L GS is presently owned by SPLA and a temporary building exists as a workshop for the Colombo Port Expansion Project. It is located between the lighthouse (south) and the *Sambodhi Chaithya* (north), and a land as large as 70 m x 35 m will be transferred to CEB.

Colombo M (Slave Island) 132/11 kV GS is located in Colombo 2 area where the John Keells Group owns vast land area. They requested CEB to supply 30 MVA of power for the particular area development. In lieu of the above, CEB Colombo City Office has already consulted with the Urban Development Authority (UDA), and explicitly agreed that John Keells will provide the land to CEB. However, the procedure is complex and will take substantive time, therefore, CEB will look for a government land nearby.

The land for Colombo N (Hunupitiya) 132/11 kV GS is managed by UDA and currently used as a parking lot. For the purpose of stable power supply in the Colombo Municipality area, UDA agrees to transfer the land to CEB.

The land is presently managed by UDA. There is a plan to develop a shopping complex next to the site and it is under construction.

9) Disturbance to water usage, water rights, etc.

Through discussion with CEB officials, it has turned out that the degree of impact to water usage will remain at minimum, although a certain amount of surface water will be used for the construction works of each GS.

10) Disturbance to the existing social infrastructure and services

Some residential activity interruption might be expected due to the construction of GSs and extension of underground cables. Among all the underground cables routes and locations of GSs, Colombo-15 area will be the busiest venue which requires prudent planning of construction schedule.

11) Working environment

Increased risk of accidents associated with the construction work is expected within the site if no safety management is applied. Accidents outside the site may occur any time as the project may disturb traffic system and traffic volume becomes heavier.

12) Accidents

Increased risk of accidents associated with the construction work is expected within the site if no safety management is applied. Accidents outside the site may occur any time as the project may disturb traffic system and traffic volume becomes heavier. Unsanitary condition at the site without proper treatment facilities is unhealthy for the laborers.

(3) Environmental Review and Examination of Mitigation Measures

Based on the survey outcome as described above, CEB and the Survey Team conducted an environmental review and its results are shown in Table 9.4-5. No major adverse impacts are anticipated, but CEB and the Survey Team examined mitigation measures and countermeasures for the items reviewed as B- in the same table. An environmental checklist is also drafted in Attachment 4-1-1.

Table 9.4-5 Survey Results and Proposed Mitigation Measures: PJT-1

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
I.	Pollution					
1	Air Pollution	B-	D	B-	D	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with GS construction is anticipated. Mitigation measures: The degree of impact can be minimized by well-organized construction management. The amount of SPM will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No air pollution will be caused at GSs or throughout the underground cables.

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
2	Water Pollution	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the construction of GSs and oil spillage is anticipated. Mitigation measures: The degree of impact can be minimized by managing waste water and proper prevention of oil leakage. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No water pollution will be caused at GS or throughout the underground cables.
3	Waste generation and disposal of construction debris	B-	B-	B-	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. Mitigation measures: Waste generated at the construction site and disposal of construction debris will be collected regularly by the Colombo Municipal Council. Project staff will physically observe the waste disposal condition, and improve the way to dispose in case it is done in an inappropriate manner. <operation phase> Mitigation measures: Waste generated at GSs can be well managed and disposed appropriately, which will make no water quality degradation or soil contamination in the surrounding areas occur.
4	Soil contamination	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the construction of GSs may cause soil contamination. Mitigation measures: The degree of impact can be minimized by managing waste water properly. Project staff will physically observe the soil condition, and send the sample soil to laboratories in case there is any contamination. <operation phase> No water pollution will be caused at GS or throughout the underground cables.
5	Noise and vibration	B-	D	B-	D	<construction phase> Noises and vibration associated with the GS construction and soil excavation for laying underground cables is anticipated. Mitigation measures: Time management and appropriate shift to do particular works can reduce consecutive exposure to such noise and vibration. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No noise or vibration will be out of the GS, neither created by the underground cables.
II.	Natural Environment					
1	Impact to coast conservation	B-	D	D	D	<construction phase> One of newly constructed GSs is designed to be located within the coastal zone (Port). The land area required for the GS construction will stay minimum (2,000 – 3,000 m2) and cause no serious impacts to the coast conservation. <operation phase> It will not physically harm coastal landscape, and there will be no direct waste water discharge into the sea.
III.	Social Environment					
1	Land acquisition and resettlement	B-	D	B-	D	<construction phase> Except the construction of Colombo M GS, all lands for other GSs belong to the government and CEB, and CEB will take necessary procedures to transfer the land tenure without acquisition cost. Resettlement is unanticipated.

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						<operation phase> N/A
6	Disturbance to water usage, water rights etc	B-	D	D	D	<construction phase> Although certain amount of surface water will be used for the construction work of each GS, the degree of impact to water usage will remain minor. <operation phase> No large-scale water usage is expected at GSs.
7	Disturbance to the existing social infrastructure and services	B-	D	B-	D	<construction phase> Access to social infrastructure and services may be disturbed as traffic volume will increase due to the construction of GSs and extension of underground cables. Mitigation measures: In order not to disturb the traffic system in the city, construction work can be shifted to night time or weekends. Information disclosure well in advance on the construction schedule will also work well. <operation phase> There will be no disturbance to the social infrastructure and services.
IV.	Others					
1	Working conditions	B-	D	D	D	<construction phase> There is always a risk of accidents associated with the construction work. Unsanitary condition of the site without proper treatment facilities can make labors get sick.. Mitigation measures: A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Appropriate working hours such as three-shift a day, two days off a week etc. can keep labor' health condition well. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> CEB will follow the labor legislations with which employees' rights in terms of health and safety.
2	Accidents, injury or sickness of residents nearby or workers	B-	D	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier. Unsanitary condition of the site without proper treatment facilities can make labors get sick.. Mitigation measures: Construction at night and weekend shift can be considered not to disturb the city traffic. Information on construction schedule should be disclosed for local community to be well aware and ready, and mitigate risks of traffic accidents. Installation of 'keep out' boards where construction works are done will help passers-by to avoid possibility of site accidents. A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> Mitigation measures: With mitigation measures such as installation of "keep out" boards where underground cables runs, impacts can be avoided. Although the impact is anticipated to be minor, day-to-day safety management is essential.

(Prepared by the Survey Team)

(4) Environmental Monitoring Plan

The Project Management Unit (PMU) will monitor and report environmental parameters during construction period, and the Project Manager is the ultimate responsible person. Two measurement points will be used, namely, i) at one place per UGC line under construction and ii) at GS under construction. The total numbers of measurement points therefore depend on the construction progress. The latest results of monitoring items as shown below will be submitted as part of the quarterly progress report throughout the construction phase. The budget required for periodic monitoring is estimated at about LKR 3.3 million, which is equivalent to JPY 2 million.

Table 9.4-6 Environmental Monitoring Plan: PJT-1

Sector	Parameter	Unit cost (LKR)	Frequency	No of times (yearly)	No of point		Annual budget (LKR)	Total budget (LKR)	Implementing organization	Responsible organization
					UGC*	GS				
Water quality	Suspended solid	1,250	Quarterly	4	2	1	15,000	27,500	laboratory	CEB
	Oil & grease	1,750	Quarterly	4	2	1	21,000	38,500		
Air quality	SPM (Suspended Particulate Matter) incl. dust	10,000	Quarterly	4	2	1	120,000	220,000	laboratory	CEB
Noise	Noise (day & night)	18,750	Monthly	12	2	1	675,000	1,237,500	PMU	CEB
Vibration	Vibration (day & night)	27,500	Monthly	12	2	1	990,000	1,815,000	PMU	CEB
Solid condition	Solid condition	-	Biweekly	24	2	1	-	-	PMU	CEB
Waste	Waste	-	Quarterly	4	2	1	-	-	PMU	CEB
Working condition	Working condition	-	Quarterly	4	2	1	-	-	PMU	CEB
Traffic	Traffic volume	-	Every working day	240	2	1	-	-	PMU	CEB
Accident	No of accidents by increased traffic and construction work	-	Weekly	48	2	1	-	-	PMU	CEB
Budget (LKR)							1,821,000	3,338,500		

(Source: CEB)

(Note 1) For the sake of budget estimation, the extension work of UGC is assumed to take place at two places at the same time throughout the civil and installation work.

(Note 2) The period is assumed as the period required for the civil and installation work: 22 months for UGC and 16 months for GS.

(Note 3) Solid condition, waste, working condition, traffic and accident will be measured by the CEB staff attached to the PMU and it is included in their remunerations.

A draft format for environmental monitoring is attached in Attachment 4-2. There is no plan to monitor any parameters after the construction work is over, and monitoring will be continued for a certain period in case any of the above needs follow-up.

9.4.2 Construction of Kappalturai 132/33 kV GS (PJT-2)

(1) Primary Scoping

Table 9.4-7 Primary Scoping: PJT-2

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
I.	Pollution			
1	Air Pollution	B-	D	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the GS construction is anticipated. <operation phase> N/A
2	Water Pollution	B-	D	<construction phase> Waste water discharge mainly associated with the GS construction is anticipated. <operation phase> N/A
3	Waste generation and disposal of construction debris	B-	B-	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. <operation phase> Waste generated at GS have to be well managed and disposed appropriately in order not to cause water quality degradation or soil contamination in the surrounding areas.
4	Soil contamination	B-	D	<construction phase> Waste water discharge mainly associated with the GS construction may cause soil contamination. <operation phase> N/A
5	Noise and vibration	B-	D	<construction phase> Noises and vibration associated with the GS construction is anticipated. <operation phase> N/A
6	Subsidence	D	D	There is no work expected which causes subsidence.
7	Odor	D	D	There is no work expected which causes odor.
8	Sediment	D	D	There is no work expected which causes impact to sediment.
II.	Natural Environment			
1	Protected areas	D	D	There is no national park or sanctuary existing in and around the project site.
2	Ecosystem	D	D	No rare species of fauna and flora exist in and around the project site so that impacts to ecosystem will not be found.
3	Hydrology	D	D	There is no work anticipated that change river flow or river basin.
4	Topography and geology	D	D	There is no slope failure or landslide anticipated as such works as cutting and filling are not planned.
III.	Social Environment			
1	Land acquisition and resettlement	D	D	<construction phase> CEB has already acquired land for the GS. <operation phase> N/A
2	Disturbance to poor people	D	B+	<construction phase> The project is unlikely to cause adverse impacts to poor residents. <operation phase> By having stable electricity supply, project beneficiaries including poor clusters will have better access to public utilities and social infrastructures.
3	Disturbance to ethnic minority groups and indigenous people	D	D	There is no ethnic minorities or indigenous people admitted.
4	Deterioration of local economy such as losses of employment and livelihood means	D	D	This project is unlikely to cause adverse impacts to the local economy.
5	Land use and utilization of local resources	D	D	This project is unlikely to cause adverse impacts to local land use.
6	Disturbance to water usage, water rights etc	D	D	<construction phase> Certain amount of surface water will be used for the GS construction, but will stay minor. <operation phase> N/A

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
7	Disturbance to the existing social infrastructure and services	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply, project beneficiaries including women will have better access to public utilities and social infrastructures.
8	Social institutions such as social infrastructure and local decision-making institutions	D	D	This project is unlikely to cause adverse impacts to local land use.
9	Misdistribution of benefits and damages	D	D	This project is unlikely to cause adverse impacts to local land use.
10	Local conflicts of interest	D	D	This project is unlikely to cause adverse impacts to local land use.
11	Cultural heritage	D	D	This project is unlikely to cause adverse impacts to local land use.
12	Landscape	D	D	The GS is three-storied, which will not affect the city landscape.
13	Gender	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply and less power outage, project beneficiaries including women will have better access to public utilities and social infrastructures.
14	Children's Rights	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply, project beneficiaries including children will have better access to public utilities and social infrastructures.
15	Infectious diseases such as HIV/AIDS	B-	D	<construction phase> There may be certain influx of outside labor. <operation phase> N/A
IV.	Others			
1	Working conditions	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected at any time. <operation phase> N/A
2	Accidents, injury or sickness of residents nearby or workers	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier. <operation phase> N/A
3	Impacts to trans-boundary or global issues	D	D	This project is unlikely to cause adverse impacts to trans-boundary or global issues.

(Prepared by the Survey Team)

(2) Environmental and Social Survey

A specific survey was planned and carried out for PJT-2 for the items which remain as important in the primary scoping. As most of the items are in common and the same with PJT-1, the Survey Team omitted all duplicated surveys.

(3) Environmental Review and Examination of Mitigation Measures

CEB and the Survey Team conducted an environmental review and its result is shown in the table below. No major adverse impacts are anticipated for PJT-2, CEB and the Survey Team examined mitigation measures and countermeasures for the items reviewed as B- in the same table. An environmental checklist is attached in Attachment 4-1-2.

Table 9.4-8 Survey Results and Proposed Mitigation Measures: PJT-2

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
I.	Pollution					
1	Air Pollution	B-	D	B-	D	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with GS construction is anticipated. Mitigation measures: The degree of impact can be minimized by well-organized construction management. The amount of SPM will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No air pollution will be caused at GS.
2	Water Pollution	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the GS construction and oil spillage is anticipated. Mitigation measures: The degree of impact can be minimized by managing waste water and proper prevention of oil leakage. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No water pollution will be caused at GS.
3	Waste generation and disposal of construction debris	B-	B-	B-	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. Mitigation measures: Waste generated at the construction site and disposal of construction debris will be collected regularly by the Local Authority. Project staff will physically observe the waste disposal condition, and improve the way to dispose in case it is done in an inappropriate manner. <operation phase> Mitigation measures: Waste generated at GSs can be well managed and disposed appropriately, which will make no water quality degradation or soil contamination in the surrounding areas occur.
4	Soil contamination	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the GS construction may cause soil contamination. Mitigation measures: The degree of impact can be minimized by managing waste water properly. Project staff will physically observe the soil condition, and send the sample soil to laboratories in case there is any contamination. <operation phase> No water pollution will be caused at GS.
5	Noise and vibration	B-	D	B-	D	<construction phase> Noises and vibration associated with the GS construction is anticipated. Mitigation measures: Time management and appropriate shift to do particular works can reduce consecutive exposure to such noise and vibration. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No noise or vibration will be out of the GS.
III.	Others					
1	Working conditions	B-	D	D	D	<construction phase> There is always a risk of accidents associated with the construction work. Unsanitary condition of the site without proper

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						treatment facilities can make labors get sick.. Mitigation measures: A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Appropriate working hours such as three-shift a day, two days off a week etc. can keep labor' health condition well. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> CEB will follow the labor legislations with which employees' rights in terms of health and safety.
2	Accidents, injury or sickness of residents nearby or workers	B-	D	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier. Unsanitary condition of the site without proper treatment facilities can make labors get sick.. Mitigation measures: Construction at night and weekend shift can be considered not to disturb the city traffic. Information on construction schedule should be disclosed for local community to be well aware and ready, and mitigate risks of traffic accidents. Installation of 'keep out' boards where construction works are done will help passers-by to avoid possibility of site accidents. A tangible safety consideration is given for labor, such as wearing helmets, gloves, shoes and working clothes. This will mitigate risks of accidents of labor. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> Mitigation measures: With mitigation measures such as installation of "keep out" boards where underground cables runs, impacts can be avoided. Although the impact is anticipated to be minor, day-to-day safety management is essential.

(Prepared by the Survey Team)

(4) Environmental Monitoring Plan

The implementing arrangements will be the same as PJT-1. A measurement point will be at one place on TL route and another at GS under construction for PJT-2. The total numbers of measurement points therefore will be two. The latest results of monitoring items as shown below will be submitted as part of the quarterly progress report throughout the construction phase. The budget required for periodic monitoring is estimated at approximately LKR 1.82 million, which is equivalent to around JPY 1 million. A draft format for environmental monitoring is attached in Attachment 4-2.

Table 9.4-9 Environmental Monitoring Plan: PJT-2

Sector	Parameter	Unit cost (LKR)	Frequency	No of times (yearly)	No of point		Annual budget (LKR)	Total budget (LKR)	Implementing organization	Responsible organization
					TL	GS				
Water quality	Suspended solid	1,250	Quarterly	4	1	1	10,000	15,000	laboratory	CEB
	Oil & grease	1,750	Quarterly	4	1	1	14,000	21,000		
Air quality	SPM (Suspended Particulate Matter) incl. dust	10,000	Quarterly	4	1	1	80,000	120,000	laboratory	CEB
Noise	Noise (day & night)	18,750	Monthly	12	1	1	450,000	675,000	PMU	CEB
Vibration	Vibration (day & night)	27,500	Monthly	12	1	1	660,000	990,000	PMU	CEB
Solid condition	Solid condition	-	Biweekly	24	1	1	-	-	PMU	CEB
Waste	Waste	-	Quarterly	4	1	1	-	-	PMU	CEB
Working condition	Working condition	-	Quarterly	4	1	1	-	-	PMU	CEB
Traffic	Traffic volume	-	Every working day	240	1	1	-	-	PMU	CEB
Accident	No of accidents by increased traffic and construction work	-	Weekly	48	1	1	-	-	PMU	CEB
Budget (LKR)							1,214,000	1,821,000		

(Source CEB)

(Note 1) For the sake of budget estimation, the extension work of TL is assumed to take place at one place at the same time throughout the civil and installation work.

(Note 2) The period is assumed as the period required for the civil and installation work: 18 months for TL and 16 months for GS.

(Note 3) Solid condition, waste, working condition, traffic and accident will be measured by the CEB staff attached to the PMU and it is included in their remunerations.

9.4.3 Construction of GSs surrounding Colombo City (PJT-3, 7 and 8)

(1) Primary Scoping

Table 9.4-10 Primary Scoping: PJT-3, -7 and -8

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
I.	Pollution			
1	Air Pollution	B-	D	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the GS construction is anticipated. <operation phase> N/A
2	Water Pollution	B-	D	<construction phase> Waste water discharge mainly associated with the GS construction is anticipated. <operation phase> N/A
3	Waste generation and disposal of construction debris	B-	PJT-3: D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. <operation phase> As the GS will be constructed at the reclaimed site within the complex of Kerawalapitiya Power Station, waste is well managed.
			PJT-7:B-	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. <operation phase> Waste generated at GS have to be well managed and disposed appropriately in order not to cause water quality degradation or soil contamination in the surrounding areas.

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
			PTJ-8: B-	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. <operation phase> Waste generated at GS have to be well managed and disposed appropriately in order not to cause water quality degradation or soil contamination in the surrounding areas.
4	Soil contamination	B-	PJT-3: D	<construction phase> Waste water discharge mainly associated with the GS construction may cause soil contamination. <operation phase> As the GS will be constructed at the reclaimed site within the complex of Kerawalapitiya Power Station, waste is well managed.
			PJT-7:B-	<construction phase> Waste water discharge mainly associated with the GS construction may cause soil contamination. <operation phase> N/A
			PTJ-8: B-	<construction phase> Waste water discharge mainly associated with the GS construction may cause soil contamination. <operation phase> N/A
5	Noise and vibration	B-	D	<construction phase> Noises and vibration associated with the GS construction is anticipated. <operation phase> N/A
6	Subsidence	D	D	There is no work expected which causes subsidence.
7	Odor	D	D	There is no work expected which causes odor.
8	Sediment	D	D	There is no work expected which causes impact to sediment.
II.	Natural Environment			
1	Protected areas	D	D	There is no national park or sanctuary existing in and around the project site.
2	Ecosystem	D	D	No rare species of fauna and flora exist in and around the project site so that impacts to ecosystem will not be found.
3	Hydrology	D	D	There is no work anticipated that change river flow or river basin.
4	Topography and geology	D	D	There is no slope failure or landslide anticipated as such works as cutting and filling are not planned.
III.	Social Environment			
1	Land acquisition and resettlement	PJT-3: D	D	<construction phase> As the GS will be constructed at the reclaimed site within the complex of Kerawalapitiya Power Station, there will require no further land acquisition for the GS construction. <operation phase> N/A
		PJT-7:B-		<construction phase> Land acquisition is required for GSs. <operation phase> N/A
		PTJ-8: B-		<construction phase> Land acquisition is required for GSs.. <operation phase> N/A
2	Disturbance to poor people	D	B+	<construction phase> The project is unlikely to cause adverse impacts to poor residents. <operation phase> By having stable electricity supply, project beneficiaries including poor clusters will have better access to public utilities and social infrastructures.
3	Disturbance to ethnic minority groups and indigenous people	D	D	There is no ethnic minorities or indigenous people admitted.
4	Deterioration of local economy such as losses of employment and livelihood means	D	D	This project is unlikely to cause adverse impacts to the local economy.
5	Land use and utilization of local resources	D	D	This project is unlikely to cause adverse impacts to local land use.
6	Disturbance to water	D	D	<construction phase>

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
	usage, water rights etc			Certain amount of surface water will be used for the GS construction, but it will stay minor. <operation phase> N/A
7	Disturbance to the existing social infrastructure and services	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply, project beneficiaries will have better access to public utilities and social infrastructures.
8	Social institutions such as social infrastructure and local decision-making institutions	D	D	This project is unlikely to cause adverse impacts to local land use.
9	Misdistribution of benefits and damages	D	D	This project is unlikely to cause adverse impacts to local land use.
10	Local conflicts of interest	D	D	This project is unlikely to cause adverse impacts to local land use.
11	Cultural heritage	D	D	This project is unlikely to cause adverse impacts to local land use.
12	Landscape	D	D	The GS is three-storied, which will not affect the city landscape.
13	Gender	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply and less power outage, project beneficiaries including women will have better access to public utilities and social infrastructures.
14	Children's Rights	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply, project beneficiaries including children will have better access to public utilities and social infrastructures.
15	Infectious diseases such as HIV/AIDS	D	D	<construction phase> As the construction activities will take place in the suburb of the economic capital of the country, there will be no possibility of influx of outside labor. <operation phase> N/A
IV.	Others			
1	Working conditions	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected at any time. <operation phase> N/A
2	Accidents, injury or sickness of residents nearby or workers	PJT-3: D	D	<construction phase> As the GS will be constructed at the reclaimed site within the complex of Kerawalapitiya Power Station, there will be minimum risk for residents nearby. <operation phase> N/A
		PJT-7:B-		<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier. <operation phase> N/A
		PTJ-8: B-		<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier. <operation phase> N/A
3	Impacts to trans-boundary or global issues	D	D	This project is unlikely to cause adverse impacts to trans-boundary or global issues.

(Prepared by the Survey Team)

(2) Environmental and Social Survey

A specific survey was planned and carried out for PJT-3, PJT-7, and PJT-8 for the important

items admitted in the primary scoping shown above. As most of the items are in common with PJT-1 and PJT-2, the Survey Team omitted all duplicated surveys.

(3) Environmental Review and Examination of Mitigation Measures

CEB and the Survey Team conducted an environmental review and its result is shown in the table below. No major adverse impacts are anticipated for PJT-3 as the GS will be constructed at the reclaimed site within the complex of Kerawalapitiya Power Station. The other two sites (PJT-7 and PJT-8) will need land acquisition for the sites of GS. CEB and the Survey Team examined mitigation measures and countermeasures for the items reviewed as B- in the same table. An environmental checklist is attached in Attachment 4-1-3.

Table 9.4-11 Survey Results and Proposed Mitigation Measures: PJT-3, -7, and -8

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
I.	Pollution					
1	Air Pollution	B-	D	B-	D	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with GS construction is anticipated. Mitigation measures: The degree of impact can be minimized by well-organized construction management. The amount of SPM will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No air pollution will be caused at GS.
2	Water Pollution	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the GS construction is anticipated. Mitigation measures: The degree of impact can be minimized by managing waste water and proper prevention of oil leakage. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No water pollution will be caused at GS.
3	Waste generation and disposal of construction debris	B-	PJT-3: D PJT-7:B- PTJ-8: B-	B-	PJT-3: D PJT-7: D PTJ-8: D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. Mitigation measures: Waste generated at the construction site and disposal of construction debris will be collected regularly by the Local Authority. Project staff will physically observe the waste disposal condition, and improve the way to dispose in case it is done in an inappropriate manner. <operation phase> PJT-3: As the GS will be constructed at the reclaimed site within the complex of Kerawalapitiya Power Station, waste is well managed. PJT-7 and PJT-8: Mitigation measures: Waste generated at GSs can be well managed and disposed appropriately, which will make no water quality degradation or soil contamination in the surrounding areas occur.

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
4	Soil contamination	B-	PJT-3: D PJT-7:B- PTJ-8: B-	B-	PJT-3: D PJT-7: D PTJ-8: D	<construction phase> Waste water discharge mainly associated with the GS construction may cause soil contamination. Mitigation measures: The degree of impact can be minimized by managing waste water properly. Project staff will physically observe the soil condition, and send the sample soil to laboratories in case there is any contamination. <operation phase> PJT-3: As the GS will be constructed at the reclaimed site within the complex of Kerawalapitiya Power Station, waste is well managed. PJT-7 and PJT-8: No water pollution will be caused at GS.
5	Noise and vibration	B-	D	B-	D	<construction phase> Noises and vibration associated with the GS construction is anticipated. Mitigation measures: Time management and appropriate shift to do particular works can reduce consecutive exposure to such noise and vibration. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No noise or vibration will be out of the GS.
III.	Social Environment					
1	Land acquisition and resettlement	PJT-3: D PJT-7:B- PTJ-8: B-	D	PJT-3: D PJT-7:B- PTJ-8: B-	D	<construction phase> PJT-3: As the GS will be constructed at the reclaimed site within the complex of Kerawalapitiya Power Station, it will require no further land acquisition for the GS construction. PJT-7 and PJT-8: There will be land acquisition anticipated. <operation phase>N/A
IV.	Others					
1	Working conditions	B-	D	D	D	<construction phase> Increased risk of accidents associated with the construction work is expected at any time. Mitigation measures: A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Appropriate working hours such as three-shift a day, two days off a week etc. can keep labor' health condition well. <operation phase> CEB will follow the labor legislations with which employees' rights in terms of health and safety.

(Prepared by the Survey Team)

(4) Environmental Monitoring Plan

The implementing arrangements will be the same as PJT-1 and PJT-2. The measurement points will be at one place on the TL route, except for PJT-3, and at another GS under the construction for PJT-3, PJT-7, and PJT-8. The latest results of the monitoring items as shown below will be submitted as a part of the quarterly progress report in Attachment 4-2 throughout the construction phase. In order to periodically monitor the listed parameters it shall require approximately LKR 4.6 million, which is equivalent to around JPY 2.7 million.

Table 9.4-12 Environmental Monitoring Plan: PJT-3, -7 and -8

Sector	Parameter	Unit cost (LKR)	Frequency	No of times (yearly)	No of point		Annual budget (LKR)	Total budget (LKR)	Implementing organization	Responsible organization
					TL*	GS				
Water quality	Suspended solid	1,250	Quarterly	4	2	3	25,000	37,500	laboratory	CEB
	Oil & Grease	1,750	Quarterly	4	2	3	35,000	52,500		
Air quality	SPM (Suspended Particulate Matter) incl. dust	10,000	Quarterly	4	2	3	200,000	300,000	laboratory	CEB
Noise	Noise (day & night)	18,750	Monthly	12	2	3	1,125,000	1,687,500	PMU	CEB
Vibration	Vibration (day & night)	27,500	Monthly	12	2	3	1,650,000	2,475,000	PMU	CEB
Solid condition	Solid condition	-	Biweekly	24	2	3	-	-	PMU	CEB
Waste	Waste	-	Quarterly	4	2	3	-	-	PMU	CEB
Working condition	Working condition	-	Quarterly	4	2	3	-	-	PMU	CEB
Traffic	Traffic volume	-	Every working day	240	2	3	-	-	PMU	CEB
Accident	No of accidents by increased traffic and construction work	-	Weekly	48	2	3	-	-	PMU	CEB
Budget (LKR)							3,035,000	4,552,500		

(Source: CEB)

(Note 1) For the sake of budget estimation, the extension work of TL is assumed to take place at one place at the same time throughout the civil and installation work for PJT-7 and PJT-8. There is no TL extension work for PJT-3.

(Note 2) The period is assumed as the period required for the civil and installation work: PJT-3: 18 months for GS; PJT-7: 18 months for TL and 16 months for GS, and; PJT-8 :18 months for TL and 16 months for GS.

(Note 3) Solid condition, waste, working condition, traffic and accident will be measured by the CEB staff attached to the PMU and it is included in their remunerations.

9.4.4 Construction of Veyangoda – Kirindiwela-Padukka 220 kV TL (PJT-5)

(1) Primary Scoping

Table 9.4-13 Primary Scoping: PJT-5

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
I.	Pollution			
1	Air Pollution	B-	D	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the tower and GS construction is anticipated. However, the impact is temporary and anticipated to be minor. <operation phase> N/A
2	Water Pollution	B-	D	<construction phase> Waste water discharge associated with the construction of towers and GSs is anticipated. However, the impact is temporary and anticipated to be minor. <operation phase> N/A
3	Waste generation and disposal of construction debris	B-/C	B-	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. Vegetation waste resulting from field clearance is anticipated as well. Through the IEE, information on local waste treatment needs to be collected. The extent of the impact is unknown at this stage. <operation phase> Waste generated at GSs have to be well managed and disposed appropriately in order not to cause water quality degradation or soil contamination in the

No	Impact Item	Rating		Brief Description
				surrounding areas.
4	Soil contamination	B-	D	<construction phase> Waste water discharge associated with the construction of towers and GSs may cause soil contamination. However, the impact is temporary and anticipated to be minor. <operation phase> N/A
5	Noise and vibration	B-	D	<construction phase> Noises and vibration associated with the construction of towers and GSs is anticipated. However, the impact is temporary and anticipated to be minor. <operation phase> N/A
6	Subsidence	D	D	There is no work expected which causes subsidence.
7	Odor	D	D	There is no work expected which causes odor.
8	Sediment	D	D	There is no work expected which causes impact to sediment.
II.	Natural Environment			
1	Protected areas	B-/C	D	<construction phase> The TL route is designed to avoid forest reserves and a national park. The extent of the impact is unknown at this stage. <operation phase> N/A
2	Ecosystem	B-/C	D	<construction phase> Some impacts cannot be avoided when construction of towers and GSs and extension of TLs are taken place. Although the TL route is designed to avoid forest reserves, national park and TOF (trees outside forests) and the anticipated impacts are minor, detailed information on the land use within the project area needs to be collected through the IEE. <operation phase> N/A
3	Hydrology	D	D	There is no work anticipated that change river flow or river basin.
4	Topography and geology	D	D	There is no slope failure or landslide anticipated as such works as cutting and filling are not planned.
III.	Social Environment			
1	Land acquisition and resettlement	B-/C	D	<construction phase> Although the TL route is designed to avoid settlement areas, land acquisition will be required for GS construction. It needs to be reviewed thoroughly and if necessary re-aligned based on information to be collected through the IEE. The extent of the impact is unknown at this stage. <operation phase> N/A
2	Disturbance to poor people	C	B+	<construction phase> Through conducting the IEE, information about where peoples' needs are vulnerable must to be collected. The extent of the impact is unknown at this stage. <operation phase> By having stable electricity supply, project beneficiaries including poor clusters will have better access to public utilities and social infrastructures.
3	Disturbance to ethnic minority groups and indigenous people	D	D	There is no ethnic minorities or indigenous people admitted.
4	Deterioration of local economy such as losses of employment and livelihood means	C-	B-/C	<construction phase> Temporary losses of livelihood means are anticipated during the GS construction period. The extent of the impact is unknown at this stage and further information is to be collected. <operation phase> Communication line interference via an electrostatic induced current is expected. With appropriate monitoring and mitigation measures such as the installation of additional antennas the impact is to be minimized.
5	Land use and utilization of local resources	D	D	This project is unlikely to cause adverse impacts to local land use.
6	Disturbance to water usage, water rights etc	D	D	<construction phase> Certain amount of surface water will be used for the GS construction, but it will stay minor. <operation phase> N/A
7	Disturbance to the existing social infrastructure and services	B-	D	<construction phase> Some social infrastructure disturbance is expected due to the construction of towers and GSs. However, the impact will be temporary and anticipated to be minor. <operation phase> N/A
8	Social institutions such as social infrastructure and	B-	D	<construction phase> Some social infrastructure disturbance is expected due to the construction of

No	Impact Item	Rating		Brief Description
	local decision-making institutions			towers and GSs. However, the impact will be temporary and anticipated to be minor. <operation phase> N/A
9	Misdistribution of benefits and damages	D	D	This project is unlikely to cause adverse impacts to local land use.
10	Local conflicts of interest	D	D	This project is unlikely to cause adverse impacts to local land use.
11	Cultural heritage	D	D	This project is unlikely to cause adverse impacts to local land use.
12	Landscape	B-/C	B-/C	<construction phase> Depending on the TL route, certain impact is expected. Based on information to be collected through the IEE, the TL route needs to be reviewed and if necessary, re-aligned in order to avoid destruction of landscape. The extent of the impact is unknown at this stage. <operation phase> ditto
13	Gender	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply and less power outage, project beneficiaries including women will have better access to public utilities and social infrastructures.
14	Children's Rights	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply, project beneficiaries including children will have better access to public utilities and social infrastructures.
15	Infectious diseases such as HIV/AIDS	B-/C	D	<construction phase> Temporary influx of migrant labor during the construction period increases the risk of sexual transmitted diseases incidents in the project area. Through conducting the IEE, information on infectious diseases needs to be collected. The extent of the impact is unknown at this stage. <operation phase> N/A
IV.	Others			
1	Working conditions	B-	D	<construction phase> There is always a risk of accidents associated with the construction work. Unsanitary condition of the site without proper treatment facilities can make labors get sick. <operation phase> N/A
2	Accidents, injury or sickness of residents nearby or workers	B-/C	D	<construction phase> Increased risk of accidents associated with the construction of towers and GSs is expected. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier. Unsanitary condition of the site without proper treatment facilities can make labors get sick. The extent of the impact is unknown at this stage. <operation phase> With mitigation measures such as installation of "keep out" boards at each transmission tower, impacts could be avoided. Day-to-day safety management is essential.
3	Impacts to trans-boundary or global issues	D	D	This project is unlikely to cause adverse impacts to trans-boundary or global issues.

(Prepared by the Survey Team)

(2) Environmental and Social Survey

A specific survey was planned and carried out for PJT-5 for the important items admitted in the primary scoping as presented above. As most of the items are in common and the same with other candidate projects, the Survey Team omitted all duplicated surveys.

Different outcomes from other projects are as follows:

1) EIA and Environmental Permits

The National Environmental Act includes those projects for extending overhead electricity lines over 10 km as "prescribed projects". An IEE/EIA is therefore required for PJT-5.

CEB has not launched IEE yet as of October 2012, while it is expected that they elaborate its TOR in due course of time.

2) Land acquisition and resettlement

Although CEB has identified potential sites for the construction of GSs (Padukka GS and Kirindiwela Switching Station), negotiation has not yet started for land acquisition. As the land tenure is not clear and a complicated procedure to succeed from generation to generation, CEB will contact Grama Niladhari, the smallest administrative unit under Divisional Secretariat Division in due course of time, to identify the exact people who owns the particular lands, and estimate the acquisition cost.

The land is identified as the site for Kirindiwela Switching Station. Chena cultivation is implemented and housing scheme is on-going.

There is a forest reserve between Padukka and Kirindiwela on the TL route called Kanampella Forest Reserve. CEB will try to avoid the area in order to mitigate adverse impacts on the fauna and flora in and around the reserve.

Most areas of the TL route are used for agricultural plantation such as rubber. Although people are often found collecting sands for construction where the TL crosses the Kelani River, the project implementation will not disturb their day-to-day activities. There is no transportation system existing in the river so the project will not disturb any of their day-to-day activities either.

Pahala Hanwella (where the TL crosses the Kelani River) (left and center): there are daily labor collecting sands in the river basin. Another point between Kosgama-Kirindiwela where the TL crosses the Kelani River (right): There are banana plantation around the venue. The land is identified as the site for Kirindiwela Switching Station. Chena cultivation is implemented and housing scheme is under development.

Close to Veyangoda GS, there is a national park called Horagolla National Park and Bandaranaike Memorial Park along with the A1 Road. Population density of Gampaha District is the second biggest to Colombo District, and CEB's plan is to avoid settlements in order not to cause social impacts. As

Entrance of Bandaranaike Memorial Park

a consequence, the current TL route goes approximately 200 m away from the national park and 500 m away from the memorial park.

(3) Environmental Review and Examination of Mitigation Measures

Based on the survey outcome as described above, CEB and the Survey Team conducted an environmental review and its result is shown in the table below. No major adverse impacts are anticipated, but CEB and the Survey Team examined mitigation measures and countermeasures for the items reviewed as B- in the same table. An environmental checklist is attached in Attachment 4-1-4.

Table 9.4-14 Survey Results and Proposed Mitigation Measures: PJT-5

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
I.	Pollution					
1	Air Pollution	B-	D	B-	D	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with GS construction is anticipated. Mitigation measures: The degree of impact can be minimized by well-organized construction management. The amount of SPM will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No air pollution will be caused at GS or throughout the TL route.
2	Water Pollution	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the construction of GSs and oil spillage is anticipated. Mitigation measures: The degree of impact can be minimized by managing waste water and proper prevention of oil leakage. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No water pollution will be caused at GS or throughout the TL route.
3	Waste generation and disposal of construction debris	B-/C	B-	B-/C	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. Vegetation waste resulting from field clearance is anticipated as well. Through the IEE, information on local waste treatment needs to be collected. The extent of the impact is unknown at this stage. Mitigation measures: Waste generated at the construction site and disposal of construction debris will be collected regularly by the Local Authority. Project staff will physically observe the waste disposal condition, and improve the way to dispose in case it is done in an inappropriate manner. <operation phase> Mitigation measures: Waste generated at GSs can be well managed and disposed appropriately, which will make no water quality degradation or soil contamination in the surrounding areas occur.
4	Soil contamination	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the construction of

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						GSs may cause soil contamination. Mitigation measures: The degree of impact can be minimized by managing waste water properly. Project staff will physically observe the soil condition, and send the sample soil to laboratories in case there is any contamination. <operation phase> No water pollution will be caused at GS or throughout the TL route.
5	Noise and vibration	B-	D	B-	D	<construction phase> Noises and vibration associated with the GS construction and soil excavation for laying underground cables is anticipated. Mitigation measures: Time management and appropriate shift to do particular works can reduce consecutive exposure to such noise and vibration. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No noise or vibration will be out of the GS, neither created by the TL route.
II.	Natural Environment					
1	Protected areas	B-/C	D	B-	D	<construction phase> The TL route is designed to avoid forest reserves and a national park. The extent of the impact is unknown at this stage. <operation phase> N/A
2	Ecosystem	B-/C	D	B-	D	<construction phase> Some impacts cannot be avoided when construction of towers and GSs and extension of TLs are taken place. Although the TL route is designed to avoid forest reserves, national park and TOF (trees outside forests) and the anticipated impacts are minor, detailed information on the land use within the project area needs to be collected through the IEE. <operation phase> N/A
III.	Social Environment					
1	Land acquisition and resettlement	B-/C	D	B-/C	D	<construction phase> Although the TL route is designed to avoid settlement areas, land acquisition will be required for GS construction. It needs to be reviewed thoroughly and if necessary re-aligned based on information to be collected through the IEE. The extent of the impact is unknown at this stage. <operation phase> N/A
2	Disturbance to poor people	C	B+	C	B+	<construction phase> Through conducting the IEE, information about where peoples' needs are vulnerable must to be collected. The extent of the impact is unknown at this stage. <operation phase> By having stable electricity supply, project beneficiaries including poor clusters will have better access to public utilities and social infrastructures.
4	Deterioration of local economy such as losses of employment and livelihood means	C-	B-/C	C-	B-/C	<construction phase> Temporary losses of livelihood means are anticipated during the GS construction period. The extent of the impact is unknown at this stage and further information is to be collected. <operation phase> Communication line interference via an electrostatic induced current is expected. With appropriate monitoring and mitigation measures such as the installation of additional antennas the impact is to be minimized.
6	Disturbance to water usage, water rights etc	B-	D	D	D	<construction phase> Although certain amount of surface water will be used for the construction work of each GS, the degree of impact to water

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						usage will remain minor. <operation phase> No large-scale water usage is expected at GSs.
7	Disturbance to the existing social infrastructure and services	B-	D	B-	D	<construction phase> Access to social infrastructure and services may be disturbed as traffic volume will increase due to the construction of GSs and extension of TL. Mitigation measures: In order not to disturb the traffic system in towns, construction work in and around towns can be shifted to night time or weekends. Information disclosure well in advance on the construction schedule will also work well. <operation phase> There will be no disturbance to the social infrastructure and services.
12	Landscape	B-/C	B-/C	B-/C	B-/C	<construction phase> Depending on the TL route, certain impact is expected. Based on information to be collected through the IEE, the TL route needs to be reviewed and if necessary, re-aligned in order to avoid destruction of landscape. The extent of the impact is unknown at this stage. <operation phase> ditto
15	Infectious diseases such as HIV/AIDS	B-/C	D	B-/C	D	<construction phase> Temporary influx of migrant labor during the construction period increases the risk of sexual transmitted diseases incidents in the project area. Through conducting the IEE, information on infectious diseases needs to be collected. The extent of the impact is unknown at this stage. <operation phase> N/A
IV.	Others					
1	Working conditions	B-	D	D	D	<construction phase> There is always a risk of accidents associated with the construction work. Unsanitary condition of the site without proper treatment facilities can make labors get sick. Mitigation measures: A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Appropriate working hours such as three-shift a day, two days off a week etc. can keep labor' health condition well. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> CEB will follow the labor legislations with which employees' rights in terms of health and safety.
2	Accidents, injury or sickness of residents nearby or workers	B-	D	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier. Unsanitary condition of the site without proper treatment facilities can make labors get sick. Mitigation measures: Construction at night and weekend shift can be considered not to disturb the city traffic. Information on construction schedule should be disclosed for local community to be well aware and ready, and mitigate risks of traffic accidents. Installation of 'keep out' boards where construction works are done will help passers-by to avoid possibility of site accidents. A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase>

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						Mitigation measures: With mitigation measures such as installation of "keep out" boards where underground cables runs, impacts can be avoided. Although the impact is anticipated to be minor, day-to-day safety management is essential.

(Prepared by the Survey Team)

(4) Environmental Monitoring Plan

The implementing arrangements for PJT-5 will be the same as the above three projects. The measurement points will be at one place on the TL route and another at a GS. The latest monitoring results as presented below will be submitted as a part of the quarterly progress report throughout the construction phase. It will cost approximately LKR 2.1 million, which is equivalent to around JPY 1.3 million.

Table 9.4-15 Environmental Monitoring Plan: PJT-5

Sector	Parameter	Unit cost (LKR)	Frequency	No of times (yearly)	No of point		Annual budget (LKR)	Total budget (LKR)	Implementing organization	Responsible organization
					TL	GS				
Water quality	Suspended solid	1,250	Quarterly	4	1	1	10,000	17,500	laboratory	CEB
	Oil & Grease	1,750	Quarterly	4	1	1	14,000	24,500		
Air quality	SPM (Suspended Particulate Matter) incl. dust	10,000	Quarterly	4	1	1	80,000	140,000	laboratory	CEB
Noise	Noise (day & night)	18,750	Monthly	12	1	1	450,000	787,5000	PMU	CEB
Vibration	Vibration (day & night)	27,500	Monthly	12	1	1	660,000	1,155,000	PMU	CEB
Solid condition	Solid condition	-	Biweekly	24	1	1	-	-	PMU	CEB
Waste	Waste	-	Quarterly	4	1	1	-	-	PMU	CEB
Working condition	Working condition	-	Quarterly	4	1	1	-	-	PMU	CEB
Traffic	Traffic volume	-	Every working day	240	1	1	-	-	PMU	CEB
Accident	No of accidents by increased traffic and construction work	-	Weekly	48	1	1	-	-	PMU	CEB
Budget (LKR)							1,214,000	2,124,500		

(Source: CEB)

(Note 1) For the sake of budget estimation, the extension work of TL is assumed to take place at one place at the same time throughout the civil and installation work.

(Note 2) The period is assumed as the period required for the civil and installation work: 18 months for TL and 20 months for GS.

(Note 3) Solid condition, waste, working condition, traffic and accident will be measured by the CEB staff attached to the PMU and it is included in their remunerations.

9.4.5 Distribution Development for North Western Province of Region 1 (Package 2)

(1) Primary Scoping

Table 9.4-16 Primary Scoping: DL Package 2

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
I.	Pollution			
1	Air Pollution	B-	B+	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the construction of PSs is anticipated. <operation phase> SOx, NOx, CO, O_3, soot, dust, SPM will not be discharged by the operation. The project will help reduce the number of hours of load shedding, which will mitigate air pollution caused by burning fuels for the operation of generators as customers will not have to use generators often.
2	Water Pollution	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs is anticipated. <operation phase> N/A
3	Waste generation and disposal of construction debris	B-	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. <operation phase> N/A
4	Soil contamination	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs may cause soil contamination. <operation phase> N/A
5	Noise and vibration	B-	B+	<construction phase> Noises and vibration associated with the PS construction is anticipated. <operation phase> The project will help reduce the number of hours of load shedding, which will mitigate noise and vibration caused by the operation of generators as customers will not have to use generators often.
6	Subsidence	D	D	There is no work expected which causes subsidence.
7	Odor	D	B+	<construction phase> There is no work expected which causes odor. <operation phase> The project will help reduce the number of hours of load shedding, which will mitigate offensive odors caused by burning fuels for the operation of generators as customers will not have to use generators often.
8	Sediment	D	D	There is no work expected which causes impact to sediment.
II.	Natural Environment			
1	Protected areas	D	D	There is no national park or sanctuary existing in and around the project site.
2	Ecosystem	D	D	No rare species of fauna and flora exist in and around the project site so that impacts to ecosystem will not be found.
3	Hydrology	D	D	There is no work anticipated that change river flow or river basin.
4	Topography and geology	D	D	There is no slope failure or landslide anticipated as such works as cutting and filling are not planned.
III.	Social Environment			
1	Land acquisition and resettlement	C	D	<construction phase> Land acquisition maybe required for PSs. <operation phase> N/A
2	Disturbance to poor people	D	B+	<construction phase> The project is unlikely to cause adverse impacts to poor residents. <operation phase> By having stable electricity supply, project beneficiaries including poor clusters will have better access to public utilities and social infrastructures.
3	Disturbance to ethnic minority groups and indigenous people	D	D	There is no ethnic minorities or indigenous people admitted.

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
4	Deterioration of local economy such as losses of employment and livelihood means	B+	B+	<construction phase> This project is unlikely to cause adverse impacts to the local economy as the land acquisition for PSs is small-scale. Employment opportunities for labor may benefit local community and lead to improvement of local livelihoods. <operation phase> The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage and/or low voltage. It will also help increase local employment opportunities and improve local livelihoods.
5	Land use and utilization of local resources	D	D	This project is unlikely to cause adverse impacts to local land use as the land acquisition for PSs is small-scale.
6	Disturbance to water usage, water rights etc	D	D	Not a large amount of surface water will be used for the project.
7	Disturbance to the existing social infrastructure and services	D	B+	<construction phase> The project will take place in rural areas so that no major residential activity interruption might be expected. <operation phase> The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage and/or low voltage.
8	Social institutions such as social infrastructure and local decision-making institutions	D	D	This project is unlikely to cause adverse impacts to local institutions as the scale of land acquisition for PSs will stay small.
9	Misdistribution of benefits and damages	D	D	This project is unlikely to cause misdistribution of benefits and damages as the scale of land acquisition for PSs will remain small.
10	Local conflicts of interest	D	D	This project is unlikely to cause local conflicts of interest as the scale of land acquisition for PSs will stay small, and stable electricity supply will benefit all local vicinities.
11	Cultural heritage	C	D	There is an archaeological site: Yapahuwa, located in the Mahawa Divisional Secretariat which is a prominent place in history.
12	Landscape	D	D	There is no extended disturbance in the landscape. PSs are low-stories, which will not affect the rural landscape.
13	Gender	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply and less power outage, project beneficiaries including women will have better access to public utilities and social infrastructures.
14	Children's Rights	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply, project beneficiaries including children will have better access to public utilities and social infrastructures.
15	Infectious diseases such as HIV/AIDS	D	D	<construction phase> There will be no possibility of influx of outside labor. <operation phase> N/A
IV.	Others			
1	Working conditions	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected at any time. <operation phase> N/A
2	Accidents, injury or sickness of residents nearby or workers	B-	B+	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. <operation phase> Accidents will be appropriately and immediately treated by DAS, which will help reduce the number of workers who suffer from electric shocks during their works.
3	Impacts to trans-boundary or global issues	D	D	This project is unlikely to cause adverse impacts to trans-boundary or global issues.

(Prepared by the Survey Team)

(2) Environmental and Social Survey

A specific survey was planned and carried out for the important items admitted in the primary scoping as shown above. As most items are in common and the same with the transmission projects, the Survey Team omitted all duplicated surveys.

(3) Environmental Review and Examination of Mitigation Measures

Based on the survey outcomes as described above, CEB and the Survey Team conducted an environmental review and its result is shown as presented below. No major adverse impacts are anticipated, but CEB and the Survey Team examined mitigation measures and countermeasures for the items reviewed as B- in the same table. An environmental checklist is also drafted in Attachment 4-1-5.

Table 9.4-17 Survey Results and Proposed Mitigation Measures: DL Package 2

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
I.	Pollution					
1	Air Pollution	B-	B+	B-	B+	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the construction of PSs is anticipated. But will be small-scale and less people shall be affected as the project sites are located in rural areas. Mitigation measures: The degree of impact can be minimized by well-organized construction management. The amount of SPM will be monitored periodically during the construction period, and construction method may be altered in case it exceeds the environmental standard. In addition, by using specialized vehicles for maintenance works, exhaust fumes will remain minimum for the entire period of their durable years. <operation phase> No air pollution will be caused at PSs. SOx, NOx, CO, O_3, soot, dust, SPM will not be discharged by the operation. The project will help reduce the number of hours of load shedding, which will mitigate air pollution caused by burning fuels for the operation of generators as customers will not have to use generators often.
2	Water Pollution	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs is anticipated. But the extent will stay small-scale. Mitigation measures: The degree of impact can be minimized by managing waste water and by proper prevention of oil leakage. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No water pollution will be caused at PSs.
3	Waste generation and disposal of construction debris	B-	B-	B-	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. But the extent will stay small-scale. Mitigation measures: Waste generated at the construction site and disposal of construction debris will be collected regularly. Project staff will physically observe the waste disposal condition, and improve the way to dispose in case it is done in an inappropriate manner. <operation phase> Mitigation measures: Waste generated at PSs can be well

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						managed and disposed appropriately, which will make no water quality degradation or soil contamination in the surrounding areas occur.
4	Soil contamination	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs may cause soil contamination. But the extent will stay small-scale. Mitigation measures: The degree of impact can be minimized by managing waste water properly. Project staff will physically observe the soil condition, and send the sample soil to laboratories in case there is any contamination. <operation phase> No soil contamination will be caused at PSs.
5	Noise and vibration	B-	B+	B-	B+	<construction phase> Noises and vibration associated with the PS construction is anticipated. However, the extent will stay small-scale and less population is affected as the project sites are located in rural areas. Mitigation measures: Time management and appropriate shift to do particular works can reduce consecutive exposure to such noise and vibration. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No noise or vibration will be out of the PS, neither created by the underground cables. The project will help reduce the number of hours of load shedding, which will mitigate noise and vibration caused by the operation of generators as customers will not have to use generators often.
II.	Social Environment					
1	Land acquisition and resettlement	C	D	C	D	<construction phase> Land acquisition maybe required for PSs. However, resettlement is not anticipated as the scale stays small. <operation phase> N/A
11	Cultural Heritage	C	D	D	D	<construction phase> There is an archaeological site: Yapahuwa, located in the Mahawa Divisional Secretariat which is a prominent place in history. The project is unlikely to cause adverse impacts to it as none of project components should be too close to it with guidance of the Department of Archeology. <operation phase> N/A
III.	Others					
1	Working conditions	B-	D	D	D	<construction phase> There is always a risk of accidents associated with the construction work. Unsanitary condition of the site without proper treatment facilities can make labors get sick. Mitigation measures: A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Appropriate working hours such as three-shift a day, two days off a week etc. can keep labor' health condition well. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> CEB will follow the labor legislations with which employees' rights in terms of health and safety.
2	Accidents, injury or sickness of residents nearby or workers	B-	B+	B-	B+	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						heavier. Unsanitary condition of the site without proper treatment facilities can make labors get sick. Mitigation measures: Information on construction schedule should be disclosed for local community to be well aware and ready, and mitigate risks of traffic accidents. Installation of 'keep out' boards where construction works are done will help passers-by to avoid possibility of site accidents. A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> Accidents will be appropriately and immediately treated by DAS, which will help reduce the number of workers who suffer from electric shocks during their works. Mitigation measures: With mitigation measures such as installation of "keep out" boards where underground cables runs, impacts can be avoided. Although the impact is anticipated to be minor, day-to-day safety management is essential.

(Prepared by the Survey Team)

(4) Environmental Monitoring Plan

The Project Management Unit will monitor environmental parameters and report during the construction period, and the Project Manager is the ultimate responsible person. The measurement point will be either at the MV line extension site or at the PS construction site. The results of monitoring items as shown below will be reported as part of the quarterly progress report throughout the construction phase. The budget required for periodic monitoring is estimated at LKR 1.2 million, which is equivalent to JPY 720 thousand. A draft format for environmental monitoring is attached in Attachment 4-2.

Table 9.4-18 Environmental Monitoring Plan: DL Package 2

Sector	Parameter	Unit cost (LKR)	Frequency	No of times (yearly)	No of point	Annual budget (LKR)	Total budget (LKR)	Implementing organization	Responsible organization
Water quality	Suspended solid	1,250	Quarterly	4	1	5,000	10,000	laboratory	CEB
	Oil & Grease	1,750	Quarterly	4	1	7,000	14,000		
Air quality	SPM (Suspended Particulate Matter) incl. dust	10,000	Quarterly	4	1	40,000	80,000	laboratory	CEB
Noise	Noise (day & night)	18,750	Monthly	12	1	225,000	450,000	PMU	CEB
Vibration	Vibration (day & night)	27,500	Monthly	12	1	330,000	660,000	PMU	CEB
Solid condition	Solid condition	-	Biweekly	24	1	-	-	PMU	CEB
Waste	Waste	-	Quarterly	4	1	-	-	PMU	CEB
Working condition	Working condition	-	Quarterly	4	1	-	-	PMU	CEB
Traffic	Traffic volume	-	Every working day	240	1	-	-	PMU	CEB
Accident	No of accidents by increased traffic and construction work	-	Weekly	48	1	-	-	PMU	CEB
Budget (LKR)						607,000	1,214,000		

(Source: CEB)
(Note 1) For the sake of budget estimation, the extension work of DL is assumed to take place at one place at the same time throughout the wire installation work.
(Note 2) The period is assumed as the period required for the civil and wire installation works: 22 months.
(Note 3) Solid condition, waste, working condition, traffic and accident will be measured by the CEB staff attached to the PMU and it is included in their remunerations.

9.4.6 Distribution Development for Western Province North of Region 2 (Package 3)

(1) Primary Scoping

Table 9.4-19 Primary Scoping: DL Package 3

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
I.	Pollution			
1	Air Pollution	B-	B+	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the construction of PSs is anticipated. <operation phase> SOx, NOx, CO, O_3, soot, dust, SPM will not be discharged by the operation. The project will help reduce the number of hours of load shedding, which will mitigate air pollution caused by burning fuels for the operation of generators as customers will not have to use generators often.
2	Water Pollution	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs is anticipated. <operation phase> N/A
3	Waste generation and disposal of construction debris	B-	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. <operation phase> N/A
4	Soil contamination	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs may cause soil contamination. <operation phase> N/A
5	Noise and vibration	B-	B+	<construction phase> Noises and vibration associated with the PS construction is anticipated. <operation phase> The project will help reduce the number of hours of load shedding, which will mitigate noise and vibration caused by the operation of generators as customers will not have to use generators often.
6	Subsidence	D	D	There is no work expected which causes subsidence.
7	Odor	D	B+	<construction phase> There is no work expected which causes odor. <operation phase> The project will help reduce the number of hours of load shedding, which will mitigate offensive odors caused by burning fuels for the operation of generators as customers will not have to use generators often.
8	Sediment	D	D	There is no work expected which causes impact to sediment.
II.	Natural Environment			
1	Protected areas	D	D	There is no national park or sanctuary existing in and around the project site.
2	Ecosystem	D	D	No rare species of fauna and flora exist in and around the project site so that impacts to ecosystem will not be found.
3	Hydrology	D	D	There is no work anticipated that change river flow or river basin.
4	Topography and geology	D	D	There is no slope failure or landslide anticipated as such works as cutting and filling are not planned.
III.	Social Environment			
1	Land acquisition and resettlement	C	D	<construction phase> Land acquisition maybe required for PSs.

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
				<operation phase> N/A
2	Disturbance to poor people	D	B+	<construction phase> The project is unlikely to cause adverse impacts to poor residents. <operation phase> By having stable electricity supply, project beneficiaries including poor clusters will have better access to public utilities and social infrastructures.
3	Disturbance to ethnic minority groups and indigenous people	D	D	There is no ethnic minorities or indigenous people admitted.
4	Deterioration of local economy such as losses of employment and livelihood means	B+	B+	<construction phase> This project is unlikely to cause adverse impacts to the local economy as the land acquisition for PSs is small-scale. Employment opportunities for labor may benefit local community and lead to improvement of local livelihoods. <operation phase> The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage and/or low voltage. It also will help increase local employment opportunities and improve local livelihoods.
5	Land use and utilization of local resources	D	D	This project is unlikely to cause adverse impacts to local land use as the land acquisition for PSs is small-scale.
6	Disturbance to water usage, water rights etc	B-	D	<construction phase> Although certain amount of surface water will be used for the construction work of each GS, the degree of impact to water usage will remain minor. <operation phase> N/A
7	Disturbance to the existing social infrastructure and services	B-	B+	<construction phase> The project will take place in urban areas so that certain residential activity interruption might be expected. <operation phase> The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage and/or low voltage.
8	Social institutions such as social infrastructure and local decision-making institutions	D	D	This project is unlikely to cause adverse impacts to local institutions as the scale of land acquisition for PSs will stay small.
9	Misdistribution of benefits and damages	D	D	This project is unlikely to cause misdistribution of benefits and damages as the scale of land acquisition for PSs will stay small.
10	Local conflicts of interest	D	D	This project is unlikely to cause local conflicts of interest as the scale of land acquisition for PSs will stay small, and stable electricity supply will benefit all local vicinities.
11	Cultural heritage	D	D	There is no archaeological site found in the project sites.
12	Landscape	D	D	There is no extended disturbance in the landscape. PSs are low-stories, which will not affect the urban landscape.
13	Gender	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply and less power outage, project beneficiaries including women will have better access to public utilities and social infrastructures.
14	Children's Rights	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply, project beneficiaries including children will have better access to public utilities and social infrastructures.
15	Infectious diseases such as HIV/AIDS	D	D	<construction phase> There will be no possibility of influx of outside labor. <operation phase> N/A
IV.	Others			
1	Working conditions	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected any time. <operation phase> N/A
2	Accidents, injury or	B-	B+	<construction phase>

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
	sickness of residents nearby or workers			Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. <operation phase> Accidents will be appropriately and immediately treated by DAS, which will help reduce the number of workers who suffer from electric shocks during their works.
3	Impacts to trans-boundary or global issues	D	D	This project is unlikely to cause adverse impacts to trans-boundary or global issues.

(Prepared by the Survey Team)

(2) Environmental and Social Survey

A specific survey was planned and carried out for the important items admitted in the primary scoping shown above. As most of the items are similar with transmission projects, the Survey Team omitted all duplicated surveys.

(3) Environmental Review and Examination of Mitigation Measures

Based on the survey outcome as described above, CEB and the Survey Team conducted an environmental review and the result is shown in Table 9.4-20. No major adverse impacts are anticipated, but CEB and the Survey Team examined mitigation measures and countermeasures for the items reviewed as B- in the same table. An environmental checklist is also drafted in Attachment 4-1-6.

Table 9.4-20 Survey Results and Proposed Mitigation Measures: DL Package 3

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
I.	Pollution					
1	Air Pollution	B-	B+	B-	B+	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the construction of PSs is anticipated. But the extent will stay small-scale. Mitigation measures: The degree of impact can be minimized by well-organized construction management. The amount of SPM will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. In addition, by using specialized vehicles for maintenance works, exhaust fumes will remain minimum for the entire period of their durable years. <operation phase> No air pollution will be caused at PSs. SOx, NOx, CO, O_3, soot, dust, SPM will not be discharged by the operation. The project will help reduce the number of hours of load shedding, which will mitigate air pollution caused by burning fuels for the operation of generators as customers will not have to use generators often.
2	Water Pollution	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs is anticipated. But the extent will stay small-scale. Mitigation measures: The degree of impact can be minimized by managing waste water and proper prevention of oil leakage. Amount of SS and oil will be monitored periodically during

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No water pollution will be caused at PSs.
3	Waste generation and disposal of construction debris	B-	B-	B-	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. But the extent will stay small-scale. Mitigation measures: Waste generated at the construction site and disposal of construction debris will be collected regularly. Project staff will physically observe the waste disposal condition, and improve the way to dispose in case it is done in an inappropriate manner. <operation phase> Mitigation measures: Waste generated at PSs can be well managed and disposed appropriately, which will make no water quality degradation or soil contamination in the surrounding areas occur.
4	Soil contamination	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs may cause soil contamination. But the extent will stay small-scale. Mitigation measures: The degree of impact can be minimized by managing waste water properly. Project staff will physically observe the soil condition, and send the sample soil to laboratories in case there is any contamination. <operation phase> No water pollution will be caused at PSs.
5	Noise and vibration	B-	B+	B-	B+	<construction phase> Noises and vibration associated with the PS construction is anticipated. As the project sites are located in urban area, construction method should be well thought. Mitigation measures: Time management and appropriate shift to do particular works can reduce consecutive exposure to such noise and vibration. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No noise or vibration will be out of the PS, neither created by the underground cables. The project will help reduce the number of hours of load shedding, which will mitigate noise and vibration caused by the operation of generators as customers will not have to use generators often.
II.	Social Environment					
1	Land acquisition and resettlement	C	D	C	D	<construction phase> Land acquisition maybe required for PSs. However, resettlement is not anticipated as the scale stays small. <operation phase> N/A
6	Disturbance to water usage, water rights etc	B-	D	D	D	<construction phase> Although certain amount of surface water will be used for the construction work of each GS, the degree of impact to water usage will remain minor. <operation phase> No large-scale water usage is expected at PSs.
7	Disturbance to the existing social infrastructure and services	B-	D	B-	D	<construction phase> Access to social infrastructure and services may be disturbed as traffic volume will increase due to the construction of PSs. Mitigation measures: In order not to disturb the traffic system in the project sites where population density is high, construction work can be shifted to night time or weekends. Information disclosure well in advance on the construction schedule will also work well. <operation phase>

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						There will be no disturbance to the social infrastructure and services.
III.	Others					
1	Working conditions	B-	D	D	D	<construction phase> There is always a risk of accidents associated with the construction work. Unsanitary condition of the site without proper treatment facilities can make labors get sick. Mitigation measures: A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Appropriate working hours such as three-shift a day, two days off a week etc. can keep labor' health condition well. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> CEB will follow the labor legislations with which employees' rights in terms of health and safety.
2	Accidents, injury or sickness of residents nearby or workers	B-	B+	B-	B+	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier in such urban area. Unsanitary condition of the site without proper treatment facilities can make labors get sick. Mitigation measures: Information on construction schedule should be disclosed for local community to be well aware and ready, and mitigate risks of traffic accidents. Installation of 'keep out' boards where construction works are done will help passers-by to avoid possibility of site accidents. A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> Accidents will be appropriately and immediately treated by DAS, which will help reduce the number of workers who suffer from electric shocks during their works. Mitigation measures: With mitigation measures such as installation of "keep out" boards where underground cables runs, impacts can be avoided. Although the impact is anticipated to be minor, day-to-day safety management is essential.

(Prepared by the Survey Team)

(4) Environmental Monitoring Plan

The implementation arrangements will be same as the above projects. A measurement point will be either at the MV line extension site or at the PS construction site. The monitoring results as shown in the table below will be inserted into the quarterly progress report throughout the construction phase as drafted in Attachment 4-2. As project components are the same as Package-2, the required budget for periodic monitoring is estimated at LKR 1.2 million, which is equivalent to JPY 720 thousand.

Table 9.4-21 Environmental Monitoring Plan: DL Package 3

Sector	Parameter	Unit cost (LKR)	Frequency	No of times (yearly)	No of point	Annual budget (LKR)	Total budget (LKR)	Implementing organization	Responsible organization
Water quality	Suspended solid	1,250	Quarterly	4	1	5,000	10,000	laboratory	CEB
	Oil & Grease	1,750	Quarterly	4	1	7,000	14,000		
Air quality	SPM (Suspended Particulate Matter) incl. dust	10,000	Quarterly	4	1	40,000	80,000	laboratory	CEB
Noise	Noise (day & night)	18,750	Monthly	12	1	225,000	450,000	PMU	CEB
Vibration	Vibration (day & night)	27,500	Monthly	12	1	330,000	660,000	PMU	CEB
Solid condition	Solid condition	-	Biweekly	24	1	-	-	PMU	CEB
Waste	Waste	-	Quarterly	4	1	-	-	PMU	CEB
Working condition	Working condition	-	Quarterly	4	1	-	-	PMU	CEB
Traffic	Traffic volume	-	Every working day	240	1	-	-	PMU	CEB
Accident	No of accidents by increased traffic and construction work	-	Weekly	48	1	-	-	PMU	CEB
Budget (LKR)						607,000	1,214,000		

(Source: CEB)

(Note 1) For the sake of budget estimation, the extension work of DL is assumed to take place at one place at the same time throughout the wire installation work.

(Note 2) The period is assumed as the period required for the civil and wire installation works: 22 months.

(Note 3) Solid condition, waste, working condition, traffic and accident will be measured by the CEB staff attached to the PMU and it is included in their remunerations.

9.4.7 Distribution Development for Western Province South-2 of Region 3 (Package 4)

(1) Primary Scoping

Table 9.4-22 Primary Scoping: DL Package 4

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
I.	Pollution			
1	Air Pollution	B-	B+	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the construction of PSs is anticipated. <operation phase> SOx, NOx, CO, O_3, soot, dust, SPM will not be discharged by the operation. The project will help reduce the number of hours of load shedding, which will mitigate air pollution caused by burning fuels for the operation of generators as customers will not have to use generators often.
2	Water Pollution	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs and extension of underground cables is anticipated. <operation phase> N/A
3	Waste generation and disposal of construction debris	B-	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. <operation phase> N/A
4	Soil contamination	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs and extension of underground cables may cause soil contamination. <operation phase> N/A

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
5	Noise and vibration	B-	B+	<construction phase> Noises and vibration associated with the PS construction and extension of underground cables is anticipated. <operation phase> The project will help reduce the number of hours of load shedding, which will mitigate noise and vibration caused by the operation of generators as customers will not have to use generators often.
6	Subsidence	D	D	There is no work expected which causes subsidence.
7	Odor	D	B+	<construction phase> There is no work expected which causes odor. <operation phase> The project will help reduce the number of hours of load shedding, which will mitigate offensive odors caused by burning fuels for the operation of generators as customers will not have to use generators often.
8	Sediment	D	D	There is no work expected which causes impact to sediment.
II.	Natural Environment			
1	Protected areas	D	D	There is no national park or sanctuary existing in and around the project site.
2	Ecosystem	D	D	No rare species of fauna and flora exist in and around the project site so that impacts to ecosystem will not be found.
3	Hydrology	D	D	There is no work anticipated that change river flow or river basin.
4	Topography and geology	D	D	There is no slope failure or landslide anticipated as such works as cutting and filling are not planned.
III.	Social Environment			
1	Land acquisition and resettlement	C	D	<construction phase> Land acquisition maybe required for PSs. However there will be no land acquisition for the extension of underground cables. <operation phase> N/A
2	Disturbance to poor people	D	B+	<construction phase> The project is unlikely to cause adverse impacts to poor residents. <operation phase> By having stable electricity supply, project beneficiaries including poor clusters will have better access to public utilities and social infrastructures.
3	Disturbance to ethnic minority groups and indigenous people	D	D	There is no ethnic minorities or indigenous people.
4	Deterioration of local economy such as losses of employment and livelihood means	B+	B+	<construction phase> This project is unlikely to cause adverse impacts to the local economy as the land acquisition for PSs is small-scale. Employment opportunities for labor may benefit local community and lead to improvement of local livelihoods. <operation phase> The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage and/or low voltage. It also will help increase local employment opportunities and improve local livelihoods.
5	Land use and utilization of local resources	D	D	This project is unlikely to cause adverse impacts to local land use as the land acquisition for PSs is small-scale and there will be no land acquisition for the extension of underground cables.
6	Disturbance to water usage, water rights etc	B-	D	<construction phase> Although certain amount of surface water will be used for the construction work of each GS, the degree of impact to water usage will remain minor. <operation phase> N/A
7	Disturbance to the existing social infrastructure and services	B-	B+	<construction phase> The project will take place in urban area so that certain residential activity interruption might be expected. <operation phase> The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage and/or low voltage.
8	Social institutions such as social infrastructure and local decision-making institutions	D	D	This project is unlikely to cause adverse impacts to local institutions as the scale of land acquisition for PSs will stay small and there will be no land acquisition for the extension of underground cables.

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
9	Misdistribution of benefits and damages	D	D	This project is unlikely to cause misdistribution of benefits and damages as the scale of land acquisition for PSs will stay small and there will be no land acquisition for the extension of underground cables.
10	Local conflicts of interest	D	D	This project is unlikely to cause local conflicts of interest as the scale of land acquisition for PSs will stay small and there will be no land acquisition for the extension of underground cables. Stable electricity supply will benefit all local vicinities.
11	Cultural heritage	D	D	There is no archaeological site found in the project sites.
12	Landscape	D	D	There is no extended disturbance in the landscape. PSs are low-stories, which will not affect the urban landscape. Extension of underground cables will do no harm to the landscape.
13	Gender	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply and less power outage, project beneficiaries including women will have better access to public utilities and social infrastructures.
14	Children's Rights	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply, project beneficiaries including children will have better access to public utilities and social infrastructures.
15	Infectious diseases such as HIV/AIDS	D	D	<construction phase> There will be no possibility of influx of outside labor. <operation phase> N/A
IV.	Others			
1	Working conditions	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected at any time. <operation phase> N/A
2	Accidents, injury or sickness of residents nearby or workers	B-	B+	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. <operation phase> Accidents will be appropriately and immediately treated by DAS, which will help reduce the number of workers who suffer from electric shocks during their works.
3	Impacts to trans-boundary or global issues	D	D	This project is unlikely to cause adverse impacts to trans-boundary or global issues.

(Prepared by the Survey Team)

(2) Environmental and Social Survey

As most of the items are similar with transmission projects, the Survey Team omitted all duplicated surveys.

(3) Environmental Review and Examination of Mitigation Measures

No major adverse impacts are anticipated, but CEB and the Survey Team examined mitigation measures and countermeasures for the items reviewed as B- in the same table. An environmental checklist is also drafted in Attachment 4-1-7.

Table 9.4-23 Survey Results and Proposed Mitigation Measures: DL Package 4

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
I.	Pollution					
1	Air Pollution	B-	B+	B-	B+	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the construction of PSs and extension of underground cables is anticipated. Mitigation measures: The degree of impact can be minimized by well-organized construction management. The amount of SPM will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No air pollution will be caused at PSs. SOx, NOx, CO, O_3, soot, dust, SPM will not be discharged by the operation. The project will help reduce the number of hours of load shedding, which will mitigate air pollution caused by burning fuels for the operation of generators as customers will not have to use generators often.
2	Water Pollution	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs and extension of underground cables is anticipated. Mitigation measures: The degree of impact can be minimized by managing waste water and proper prevention of oil leakage. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No water pollution will be caused at PSs.
3	Waste generation and disposal of construction debris	B-	B-	B-	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. Mitigation measures: Waste generated at the construction site and disposal of construction debris will be collected regularly. Project staff will physically observe the waste disposal condition, and improve the way to dispose in case it is done in an inappropriate manner. <operation phase> Mitigation measures: Waste generated at PSs can be well managed and disposed appropriately, which will make no water quality degradation or soil contamination in the surrounding areas occur.
4	Soil contamination	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the construction of PSs and extension of underground cables may cause soil contamination. Mitigation measures: The degree of impact can be minimized by managing waste water properly. Project staff will physically observe the soil condition, and send the sample soil to laboratories in case there is any contamination. <operation phase> No water pollution will be caused at PSs.
5	Noise and vibration	B-	B+	B-	B+	<construction phase> Noises and vibration associated with the PS construction is anticipated. As the project sites are located in urban area, construction method should be well thought. Mitigation measures: Time management and appropriate shift to do particular works can reduce consecutive exposure to such noise and vibration. Amount of SS and oil will be monitored periodically during construction period, and construction method

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						can be altered in case it exceeds the environmental standard. <operation phase> No noise or vibration will be out of the PS, neither created by the underground cables. The project will help reduce the number of hours of load shedding, which will mitigate noise and vibration caused by the operation of generators as customers will not have to use generators often.
II.	Social Environment					
1	Land acquisition and resettlement	C	D	C	D	<construction phase> Land acquisition maybe required for PSs. However, resettlement is not anticipated as the scale stays small. <operation phase> N/A
6	Disturbance to water usage, water rights etc	B-	D	D	D	<construction phase> Although certain amount of surface water will be used for the construction work of each GS, the degree of impact to water usage will remain minor. <operation phase> No large-scale water usage is expected at PSs.
7	Disturbance to the existing social infrastructure and services	B-	D	B-	D	<construction phase> Access to social infrastructure and services may be disturbed as traffic volume will increase due to the construction of PSs and extension of underground cables. Mitigation measures: In order not to disturb the traffic system in the project sites where population density is high, construction work can be shifted to night time or weekends. Information disclosure well in advance on the construction schedule will also work well. <operation phase> There will be no disturbance to the social infrastructure and services.
III.	Others					
1	Working conditions	B-	D	D	D	<construction phase> There is always a risk of accidents associated with the construction work. Unsanitary condition of the site without proper treatment facilities can make labors get sick. Mitigation measures: A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Appropriate working hours such as three-shift a day, two days off a week etc. can keep labor' health condition well. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> CEB will follow the labor legislations with which employees' rights in terms of health and safety.
2	Accidents, injury or sickness of residents nearby or workers	B-	B+	B-	B+	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier in such urban area. Unsanitary condition of the site without proper treatment facilities can make labors get sick. Mitigation measures: Information on construction schedule should be disclosed for local community to be well aware and ready, and mitigate risks of traffic accidents. Installation of 'keep out' boards where construction works are done will help passers-by to avoid possibility of site accidents. A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Treatment system such as septic tank can be installed in order to keep labor' working condition in good

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						hygiene. <operation phase> Accidents will be appropriately and immediately treated by DAS, which will help reduce the number of workers who suffer from electric shocks during their works. Mitigation measures: With mitigation measures such as installation of "keep out" boards where underground cables runs, impacts can be avoided. Although the impact is anticipated to be minor, day-to-day safety management is essential.

(Prepared by the Survey Team)

(4) Environmental Monitoring Plan

A measurement point will be either at the underground cable extension site or at the PS construction site. The implementation arrangements will be same as the above projects. The monitoring results of the items shown in the table below will be kept in a format as drafted in Attachment 4-2 into the quarterly progress report during the construction phase. The required budget for periodic monitoring is estimated at LKR 1.2 million, which is equivalent to JPY 720 thousand.

Table 9.4-24 Environmental Monitoring Plan: DL Package 4

Sector	Parameter	Unit cost (LKR)	Frequency	No of times (yearly)	No of point	Annual budget (LKR)	Total budget (LKR)	Implementing organization	Responsible organization
Water quality	Suspended solid	1,250	Quarterly	4	1	5,000	10,000	laboratory	CEB
	Oil & Grease	1,750	Quarterly	4	1	7,000	14,000		
Air quality	SPM (Suspended Particulate Matter) incl. dust	10,000	Quarterly	4	1	40,000	80,000	laboratory	CEB
Noise	Noise (day & night)	18,750	Monthly	12	1	225,000	450,000	PMU	CEB
Vibration	Vibration (day & night)	27,500	Monthly	12	1	330,000	660,000	PMU	CEB
Solid condition	Solid condition	-	Biweekly	24	1	-	-	PMU	CEB
Waste	Waste	-	Quarterly	4	1	-	-	PMU	CEB
Working condition	Working condition	-	Quarterly	4	1	-	-	PMU	CEB
Traffic	Traffic volume	-	Every working day	240	1	-	-	PMU	CEB
Accident	No of accidents by increased traffic and construction work	-	Weekly	48	1	-	-	PMU	CEB
Budget (LKR)						607,000	1,214,000		

(Source: CEB)

(Note 1) For the sake of budget estimation, the extension work of DL is assumed to take place at one place at the same time throughout the wire installation work.

(Note 2) The period is assumed as the period required for the civil and wire installation works: 24 months.

(Note 3) Solid condition, waste, working condition, traffic and accident will be measured by the CEB staff attached to the PMU and it is included in their remunerations.

9.4.8 Distribution Development for Western Province South-1 of Region 4 (Package 5)

(1) Primary Scoping

Table 9.4-25 Primary Scoping: DL Package 5

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
I.	Pollution			
1	Air Pollution	B-	B+	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the construction of PSs is anticipated. <operation phase> SOx, NOx, CO, O_3, soot, dust, SPM will not be discharged by the operation. The project will help reduce the number of hours of load shedding, which will mitigate air pollution caused by burning fuels for the operation of generators as customers will not have to use generators often.
2	Water Pollution	B-	D	<construction phase> Waste water discharge mainly associated with the extension of underground cables is anticipated. <operation phase> N/A
3	Waste generation and disposal of construction debris	B-	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. <operation phase> N/A
4	Soil contamination	B-	D	<construction phase> Waste water discharge mainly associated with the extension of underground cables may cause soil contamination. <operation phase> N/A
5	Noise and vibration	B-	B+	<construction phase> Noises and vibration associated with the extension of underground cables is anticipated. <operation phase> The project will help reduce the number of hours of load shedding, which will mitigate noise and vibration caused by the operation of generators as customers will not have to use generators often.
6	Subsidence	D	D	There is no work expected which causes subsidence.
7	Odor	D	B+	<construction phase> There is no work expected which causes odor. <operation phase> The project will help reduce the number of hours of load shedding, which will mitigate offensive odors caused by burning fuels for the operation of generators as customers will not have to use generators often.
8	Sediment	D	D	There is no work expected which causes impact to sediment.
II.	Natural Environment			
1	Protected areas	D	D	There is no national park or sanctuary existing in and around the project site.
2	Ecosystem	D	D	No rare species of fauna and flora exist in and around the project site so that impacts to ecosystem will not be found.
3	Hydrology	D	D	There is no work anticipated that change river flow or river basin.
4	Topography and geology	D	D	There is no slope failure or landslide anticipated as such works as cutting and filling are not planned.
III.	Social Environment			
1	Land acquisition and resettlement	D	D	<construction phase> There will be no land acquisition for the extension of underground cables. <operation phase> N/A
2	Disturbance to poor people	D	B+	<construction phase> The project is unlikely to cause adverse impacts to poor residents. <operation phase> By having stable electricity supply, project beneficiaries including poor clusters will have better access to public utilities and social infrastructures.
3	Disturbance to ethnic minority groups and indigenous people	D	D	There is no ethnic minorities or indigenous people admitted in the suburbs of Colombo city and tourism areas.

No	Impact Item	Rating		Brief Description
		Design/ Construction Stage	Operation Stage	
4	Deterioration of local economy such as losses of employment and livelihood means	B+	B+	<construction phase> This project is unlikely to cause adverse impacts to the local economy as the land acquisition for PSs is small-scale. Employment opportunities for labor may benefit local community and lead to improvement of local livelihoods. <operation phase> The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage and/or low voltage. It also will help increase local employment opportunities and improve local livelihoods.
5	Land use and utilization of local resources	D	D	This project is unlikely to cause adverse impacts to local land use as there will be no land acquisition for the extension of underground cables.
6	Disturbance to water usage, water rights etc	D	D	<construction phase> The degree of impact to water usage will remain minor. <operation phase> N/A
7	Disturbance to the existing social infrastructure and services	B-	B+	<construction phase> The project will take place in the outskirts of Colombo city and tourism areas so that certain interruption to residential activities and tourism industry might be expected. <operation phase> The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage and/or low voltage.
8	Social institutions such as social infrastructure and local decision-making institutions	D	D	This project is unlikely to cause adverse impacts to local institutions as there will be no land acquisition for the extension of underground cables.
9	Misdistribution of benefits and damages	D	D	This project is unlikely to cause misdistribution of benefits and damages as there will be no land acquisition for the extension of underground cables.
10	Local conflicts of interest	D	D	This project is unlikely to cause local conflicts of interest as there will be no land acquisition for the extension of underground cables. Stable electricity supply will benefit all local vicinities.
11	Cultural heritage	D	D	There is no archaeological site found in the project sites.
12	Landscape	D	D	There is no extended disturbance in the landscape. Extension of underground cables will do no harm to the landscape in the tourism areas.
13	Gender	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply and less power outage, project beneficiaries including women will have better access to public utilities and social infrastructures.
14	Children's Rights	D	B+	<construction phase> The project is unlikely to cause adverse impacts to gender issues. <operation phase> By having stable electricity supply, project beneficiaries including children will have better access to public utilities and social infrastructures.
15	Infectious diseases such as HIV/AIDS	D	D	<construction phase> There will be no possibility of influx of outside labor. <operation phase> N/A
IV.	Others			
1	Working conditions	B-	D	<construction phase> Increased risk of accidents associated with the construction work is expected at any time. <operation phase> N/A
2	Accidents, injury or sickness of residents nearby or workers	B-	B+	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. <operation phase> Accidents will be appropriately and immediately treated by DAS, which will help reduce the number of workers who suffer from electric shocks during their works.
3	Impacts to trans-boundary or global issues	D	D	This project is unlikely to cause adverse impacts to trans-boundary or global issues.

(Prepared by the Survey Team)

(2) Environmental and Social Survey

As most of the items are similar with transmission projects, the Survey Team omitted all duplicated surveys.

(3) Environmental Review and Examination of Mitigation Measures

No major adverse impacts are anticipated, but CEB and the Survey Team examined mitigation measures and countermeasures for the items reviewed as B- in the same table. An environmental checklist is also drafted in Attachment 4-1-8.

Table 9.4-26 Survey Result and Proposed Mitigation Measures: DL Package 5

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
I.	Pollution					
1	Air Pollution	B-	B+	B-	B+	<construction phase> Air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the extension of 11kV underground cables is anticipated. Mitigation measures: The degree of impact can be minimized by well-organized construction management. The amount of SPM will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No air pollution will be caused at PSs. SOx, NOx, CO, O_3, soot, dust, SPM will not be discharged by the operation. The project will help reduce the number of hours of load shedding, which will mitigate air pollution caused by burning fuels for the operation of generators as customers will not have to use generators often.
2	Water Pollution	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the extension of underground cables is anticipated. Mitigation measures: The degree of impact can be minimized by managing waste water and proper prevention of oil leakage. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No water pollution will be caused at PSs.
3	Waste generation and disposal of construction debris	B-	B-	B-	D	<construction phase> Generation of materials resulting from construction activities and generation of litter due to the presence of the project employees and contractors are expected. Mitigation measures: Waste generated at the construction site and disposal of construction debris will be collected regularly. Project staff will physically observe the waste disposal condition, and improve the way to dispose in case it is done in an inappropriate manner. <operation phase> Mitigation measures: Waste generated at PSs can be well managed and disposed appropriately, which will make no water quality degradation or soil contamination in the surrounding areas occur.
4	Soil contamination	B-	D	B-	D	<construction phase> Waste water discharge mainly associated with the extension of underground cables may cause soil contamination.

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						Mitigation measures: The degree of impact can be minimized by managing waste water properly. Project staff will physically observe the soil condition, and send the sample soil to laboratories in case there is any contamination. <operation phase> No water pollution will be caused at PSs.
5	Noise and vibration	B-	B+	B-	B+	<construction phase> Noises and vibration associated with the extension of underground cables is anticipated. Mitigation measures: Time management and appropriate shift to do particular works can reduce consecutive exposure to such noise and vibration. Amount of SS and oil will be monitored periodically during construction period, and construction method can be altered in case it exceeds the environmental standard. <operation phase> No noise or vibration will be out of the PS, neither created by the underground cables. The project will help reduce the number of hours of load shedding, which will mitigate noise and vibration caused by the operation of generators as customers will not have to use generators often.
II.	Social Environment					
7	Disturbance to the existing social infrastructure and services	B-	D	B-	D	<construction phase> The project will take place in the outskirts of Colombo city and tourism areas so that certain interruption to residential activities and tourism industry might be expected. Mitigation measures: In order not to disturb the traffic system in the project sites where population density is high, construction work can be shifted to night time or weekends. Information disclosure well in advance on the construction schedule will also work well. <operation phase> There will be no disturbance to the social infrastructure and services.
III.	Others					
1	Working conditions	B-	D	D	D	<construction phase> There is always a risk of accidents associated with the construction work. Unsanitary condition of the site without proper treatment facilities can make labors get sick. Mitigation measures: A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Appropriate working hours such as three-shift a day, two days off a week etc. can keep labor' health condition well. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> CEB will follow the labor legislations with which employees' rights in terms of health and safety.
2	Accidents, injury or sickness of residents nearby or workers	B-	B+	B-	B+	<construction phase> Increased risk of accidents associated with the construction work is expected within the site in case no safety management is applied. Accidents outside of the site can occur at any time as the project may disturb traffic system and traffic volume become heavier in the suburb of Colombo and tourism areas. Unsanitary condition of the site without proper treatment facilities can make labors get sick. Mitigation measures: Information on construction schedule should be disclosed for local community to be well aware and ready, and mitigate risks of traffic accidents. Installation of 'keep out' boards where construction works are done will help passers-by to avoid possibility of site accidents.

No	Impact Item	Scoping Result		Survey Result		Brief Description
		Design/ Construction Stage	Operation Stage	Design/ Construction Stage	Operation Stage	
						A tangible safety consideration given for labor, such as wearing helmets, gloves, shoes and working clothes, will mitigate risks of accidents of labor. Treatment system such as septic tank can be installed in order to keep labor' working condition in good hygiene. <operation phase> Accidents will be appropriately and immediately treated by DAS, which will help reduce the number of workers who suffer from electric shocks during their works. Mitigation measures: With mitigation measures such as installation of "keep out" boards where underground cables runs, impacts can be avoided. Although the impact is anticipated to be minor, day-to-day safety management is essential.

(Prepared by the Survey Team)

(4) Environmental Monitoring Plan

The implementation arrangements will be the same as the projects above. A measurement point will be at an underground cable extension site. The required budget for periodic monitoring is estimated at LKR 1.2 million, which is equivalent to JPY 720 thousand. Monitoring results will be attached in a format as drafted in Attachment 4-2 into the quarterly progress report throughout the construction phase.

Table 9.4-27 Environmental Monitoring Plan: DL Package 5

Sector	Parameter	Unit cost (LKR)	Frequency	No of times (yearly)	No of point	Annual budget (LKR)	Total budget (LKR)	Implementing organization	Responsible organization
Water quality	Suspended solid	1,250	Quarterly	4	1	5,000	10,000	laboratory	CEB
	Oil & Grease	1,750	Quarterly	4	1	7,000	14,000		
Air quality	SPM (Suspended Particulate Matter) incl. dust	10,000	Quarterly	4	1	40,000	80,000	laboratory	CEB
Noise	Noise (day & night)	18,750	Monthly	12	1	225,000	450,000	PMU	CEB
Vibration	Vibration (day & night)	27,500	Monthly	12	1	330,000	660,000	PMU	CEB
Solid condition	Solid condition	-	Biweekly	24	1	-	-	PMU	CEB
Waste	Waste	-	Quarterly	4	1	-	-	PMU	CEB
Working condition	Working condition	-	Quarterly	4	1	-	-	PMU	CEB
Traffic	Traffic volume	-	Every working day	240	1	-	-	PMU	CEB
Accident	No of accidents by increased traffic and construction work	-	Weekly	48	1	-	-	PMU	CEB
Budget (LKR)						607,000	1,214,000		

(Source: CEB)

(Note 1) For the sake of budget estimation, the extension work of DL is assumed to take place at one place at the same time throughout the wire installation work.

(Note 2) The period is assumed as the period required for the civil and wire installation works: 24 months.

(Note 3) Solid condition, waste, working condition, traffic and accident will be measured by the CEB staff attached to the PMU and it is included in their remunerations.

CHAPTER 10
ECONOMIC ANALYSIS

CHAPTER 10 ECONOMIC ANALYSIS

10.1 Background and Approach

The purpose of the economic analysis is to evaluate the economic viability of the candidate projects. It therefore enables to determine whether the project provides an economic return to the country or in other words, to the national economy as a whole. The candidate projects are enumerated below.

#1 Colombo City Transmission Development (PJT-1 with Distribution Development Package-1)
#2 Construction of Kappalturai 132/33 kV GS (PJT-2)
#3 Construction of Grid Substations surrounding Colombo City including Kerawalapitiya 220/33 kV GS (PJT-3), Kalutara 132/33 kV GS (PJT-7), and Battaramulla 132/33 kV GS (PJT-8)
#4 Veyangoda-Kirindiwela-Padukka 220 kV TL (PJT-5)
#5 Distribution Development for North Western Province of Region 1 (Package 2)
#6 Distribution Development for Western Province North of Region 2 (Package 3)
#7 Distribution Development for Western Province South-2 of Region 3 (Package 4)
#8 Distribution Development for Western Province South-1 of Region 4 (Package 5)

It must be noted that as for Project #1, PJT-1 and the Distribution Development Project Package 1 were consolidated and named as Colombo City Transmission Development since their project locations are within the vicinity. This also indicates that their benefits or effects shall be further accelerated due to the consolidation. The same reasoning was applied to Project #3, which is a combination of three transmission projects (i.e., PJTs-3, 7, and 8).

Economic analysis involves cost benefit analysis, calculation of the economic internal rate of return (EIRR), and sensitivity analysis, each of which is explained in their respective sections. However, in order to carry out the cost benefit analysis, the next section first clarifies the economic costs and benefits of the candidate projects.

10.2 Economic Costs and Benefits

The economic costs and benefits and the associated rates necessary for their measurement were identified and set on the basis of the discussions amongst CEB, JICA, and the Survey Team. Moreover, the projects were analyzed on the basis of “with project” and “without project” scenarios as explained in the previous chapters.

(1) Economic Costs

Economic costs are mainly the costs for construction, operation, and maintenance of the project. The costs for the operation and maintenance were estimated at 1.0% of the project cost for transmission projects and 2.5% for distribution projects. Other costs considered in estimating the economic costs are the physical contingencies and administration costs.

The construction cost has two components, i.e. material and labor. These costs have foreign currency (FC) portion and local currency (FC) portion. A standard conversion factor (SCF) is used to convert the costs in local currency into economic costs. Moreover, the following rates were applied to estimate the economic cost of the candidate projects.

1) Price escalation: 2.1% for the FC portion and 4.0% for the LC portion;
2) Physical contingency: 5%;
3) Administration costs: 11%;
4) Income tax rate and government levies: 4%; and

The results of the estimation of the economic costs of the candidate projects are shown in Table 10.2-1. Attachment 5-1 shows the detailed calculations of the economic costs.

Table 10.2-1 Economic Costs of the Candidate Projects

	Economic Cost (LKR million)		
No of project	FC	LC	Total
# 1	18,878	5,579	24,457
# 2	1,652	374	2,026
# 3	3,605	935	4,540
# 4	5,364	1,459	6,822
# 5	4,858	1,185	6,043
# 6	6,820	1,898	8,718
# 7	7,035	2,292	9,327
# 8	4,624	1,249	5,873

(Prepared by the Survey Team)

(2) Economic Benefits

Economic benefits arise from increased efficiency in the generation, transmission and distribution process, such as reduction of sudden power outages.

The status quo of the power sector of Sri Lanka, as mentioned in previous chapters, faces power constraints due to inadequate capacity of facilities of the transmission and distribution network in particular as well as inadequate equipment for its operation and maintenance. This indicates that the network is loaded far beyond its design capacity as it cannot be monitored for its appropriate operation and maintenance. The candidate projects aim to remove such constraints, which will result in improved reliability of supply and reduce losses

of the network.

Since power outages and system energy losses bear a high economic cost in terms of lost production and output, the economic benefits can be said as the gap between the losses of "with the project" and "without the project". Moreover, it was assumed that the benefits that arise due to the reduction of distribution loss immediately starts upon project completion, which is the final year of the construction period. Thereafter, depending on the project, the benefits will gradually increase during the first 5-10 years, and after this period, the same amount of benefits or loss reduction will be sustained during the project life, which is 30 years including the final year of the construction period of the project. The economic benefits are considered as the total of the three values as explained below.

First, the unit average cost for thermal generation of CEB was used. Upon completion of the candidate projects, due to increased efficiency in operation, it can be said that such costs will decrease. Therefore, the benefit is calculated using this unit value multiplied by the "with" and "without" case electricity losses, which is also the case for the following two units as explained below. The average cost per unit is LKR 13.07 million/GWh which is based on the data of CEB.

Second, the unit discharge cost of carbon dioxide (CO_2) was used. This is because increased operational efficiency will lead to the reduction of CO_2 emissions, indicating that candidate projects save such costs resulting to economic benefit and subsequently, environmental benefit. The unit discharge cost is estimated at LKR 0.93 million/GWh, which was calculated on the basis of CEB's power demand forecast as well as the European Union Allowance (EUA).

Third, Sri Lanka's GDP per unit of electricity which is sold at LKR 604 million/GWh was used for the value of energy not served due to operational inefficiencies. This is because there is a strong positive relationship between national economies through economic development via energy consumption use. This value was further adjusted depending on the project site since the degree of contribution to the industrial sector for transmission projects and to the household sector for distribution projects will depend on the location and type of the project.

10.3 Cost Benefit Analysis and Economic Internal Rate of Return

The previous section identified and explained the economic costs and benefits of the candidate projects. Therefore, this section shows the results of the cost benefit analysis, which is to compare the economic costs and benefits of candidate projects in their net present value (NPV) to calculate the benefit cost (B/C) ratio. A discount rate of 11% was applied to calculate the NPV. Moreover, a 30-year period was set for the benefit stream. Next,

the EIRR for each candidate project was calculated.

The previous section identified and explained the economic costs and benefits of the candidate projects. Therefore, this section shows the results of the cost benefit analysis, which is to compare the economic costs and benefits of the candidate projects in their net present value (NPV) to calculate the benefit cost (B/C) ratio. A discount rate of 11% was used to calculate the NPV, since this is the discount rate is applied by CEB. Moreover, a 30-year period was set for the benefit stream. Next, the EIRR for each candidate project was calculated.

As mentioned in Section 10.1, as for Project #1 and Project #3, these are a combination of either transmission and/or distribution projects, therefore their project benefits will be enhanced by making advantage of their close locations. Moreover, as for Project #1, since it has a transmission and distribution project component, these were analyzed separately and then were aggregated to determine its overall performance.

The B/C ratio and EIRR of the candidate projects are shown in Table 10.3-1. The detailed cost benefit calculations as well as NPVs, and EIRRs for each candidate project are shown in Attachment 5-2.

Table 10.3-1 B/C Ratio and EIRR

No of project	B/C ratio	EIRR
# 1	1.59	18.63%
# 2	1.62	16.59%
# 3	1.93	17.94%
# 4	1.51	16.11%
# 5	1.13	12.92%
# 6	1.42	17.19%
# 7	1.48	18.09%
# 8	0.93	9.85%

(Prepared by the Survey Team)

As can be seen from the table, the B/C ratio ranges from 0.93 to 1.93, whereas the EIRR ranges from 9.85% to 18.63%. It can be said that the results indicate that the candidate projects will deliver economic benefits.

10.4 Sensitivity Analysis

Throughout the project life, projects are exposed to changes in the values of basic elements of the project, in particular, project costs. For this reason, a sensitivity analysis was carried out to examine to what extent the performance of a project, measured by the B/C ratio and the EIRR, will be affected due to the anticipated changes. In cases when the project

performance display sensitivity, or in other words when the changes of the basic elements have an adverse effect to the project performance, mitigation measures should be considered.

On the basis of the above, the sensitivity of the B/C ratio and the EIRR were calculated assuming a 30% increase of the total project cost, which is the cost for construction as well as the cost for operation and maintenance. Table 10.4-1 shows the B/C ratio and EIRR of the candidate projects under the sensitivity analysis.

Table 10.4-1 Sensitivity Analysis

No of project	B/C ratio	EIRR
# 1	1.22	14.68%
# 2	1.25	13.37%
# 3	1.48	14.95%
# 4	1.16	13.59%
# 5	0.87	8.87%
# 6	1.09	12.37%
# 7	1.14	13.09%
# 8	0.71	6.28%

(Prepared by the Survey Team)

The table shows that with the exception of Projects #5 and #8, the B/C ratio is above 1.0. As for the EIRR, again with the exception of Projects #5 and #8, the EIRR is over 11%. Therefore, on the basis of the above, it can be said that the candidate projects in general are economically viable, despite an increase of 30% of the total project cost.

10.5 Conclusion

The economic analysis shows that the candidate projects in general are economically viable with the B/C ratio ranging from 0.93 to 1.93 and the EIRR ranging from 9.85% to 18.63%. The sensitivity analysis also demonstrated that most projects yield a satisfactory B/C ratio and EIRR. Therefore, from an economic perspective, the candidate projects may proceed.

CHAPTER 11
CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 11 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

(1) Amount of Loss Reduction by the Candidate Projects

Table 11.1-1 summarizes the candidate projects, their project costs, amount of loss reduction and EIRR as estimated by the Survey Team.

Table 11.1-1 Summary of Candidate Projects

Projects	Projects Costs		Loss Reduction	EIRR
Transmission Projects	MLKR	MJPY eq.	MWh/year	%
#1 Colombo City Transmission Development with 11 kV DL	21,526	12,743	23,747	18.63
#2 Construction of Kappalthurai GS	1,763	1,044	10,531	16.59
#3 Construction of GSs surrounding Colombo City				17.94
A. Kerawalapitiya 220/33 kV GS	1,294	766	11,041	
B. Kalutara 132/33 kV GS	1,289	763	1,246	
C. Battaramulla 132/33 kV GS	1,448	857	1,708	
#4 Veyangoda – Kirindiwela – Padukka 220 kV TL	5,977	3,538	21,919	16.11
Total Transmission Projects	33,297	19,711	70,192	-
Distribution Projects				
#5 Distribution Development Package in NWP of Region 1	5,271	3,121	16,309	12.92
#6 Distribution Development Package in WPN of Region 2	7,644	4,526	20,293	17.19
#7 Distribution Development Package in WPS-2 of Region 3	8,233	4,874	15,973	18.09
#8 Distribution Development Package in WPS-1 of Region 4	5,143	3,045	7,396	9.85
Total Distribution Projects	26,291	15,566	59,971	-
Grand Total	59,588	35,277	130,163	-

(Prepared by the Survey Team)

As shown in the above table, the total project cost was estimated at LKR 59,588 million (JPY 35,277 million equivalent), and total loss reduction amount was estimated at 130,163 MWh/year.

(2) Environmental and Social Considerations

For all candidate projects, air pollution, noise and vibration, waste water discharge, and soil contamination are anticipated during construction period. Unsanitary conditions at the workforce camp without proper treatment facility will be unhealthy to laborers, and accidents outside the sites may occur any time as well, since the project may disturb the traffic system. The degree of such impacts, however, is just small-scale and temporary. Also, positive impacts are commonly found in the candidate projects. By having stable electricity supply, project beneficiaries including poor clusters, women, and children will have better access to public utilities and social infrastructures. It is noteworthy that distribution development projects have more positive impacts than transmission projects. There will be no SO_x, NO_x,

CO, O_3, soot, dust, or SPM discharged by their operation. The projects will improve the reliability of power supply and help reduce the number of hours of load shedding, which will not only mitigate air pollution, but also noise and vibration caused by burning fuels from the operation of generators as customers need not use generators often. Moreover, by using Japanese specialized vehicles for maintenance works of distribution lines, exhaust fumes will remain minimum for the entire period of their durable years. It will also help reduce offensive odors caused by burning fuels from such generators. Accidents will be appropriately and immediately treated by DAS, which will minimize workers suffering from electric shocks during work.

Based on the legislations of Sri Lanka and JICA Guidelines for Environmental and Social Considerations, it can be concluded that the following mitigation measures should be taken and be monitored during construction period. The degree of impact will be minimized through well-organized construction management.

Air quality: The amount of SPM has to be monitored periodically, and the construction method should be altered in case it exceeds the environmental standard.

Water quality: The amount of SS and oil has to be monitored periodically, and the construction method should be altered in case its impact exceeds the environmental standard.

Waste: Although waste generated at the construction site and disposal of construction debris will be collected regularly by the local authority, project staff has to physically observe the waste disposal condition, and improve the method of disposal in case it is done inappropriately.

Soil: Project staff has to observe the soil condition, and send the sample soil to laboratories in case there is any contamination.

Noise and vibration: Time management and appropriate work shifts for particular tasks can reduce continuous exposure to such noise and vibration.

Working condition: A tangible safety consideration should be given to laborers, such as wearing helmets, gloves, shoes, and working clothes in order to mitigate the risks of accidents. Appropriate working hours such as three-shift a day, two days off a week, etc., can keep laborers' health condition well. Treatment systems such as septic tank can be installed in order to keep a safe and hygienic working condition.

Traffic: In order not to disturb the traffic system in urban areas, in particular where projects are located, construction work in and around cities/towns can be shifted to night time or weekends. Advance information disclosure on the construction schedule will also contribute to minimizing traffic impacts.

Accidents: Project construction during night and weekend shifts can help decrease disturbance to the traffic in urban areas. Information regarding the construction schedule should be disclosed in advance so that the locals will be aware and mitigate the risks of traffic accidents. Installation of 'keep out' sign boards at locations where construction works are ongoing can keep passers-by away from accidents.

(3) Economic Evaluation

The results of the economic analysis in terms of the B/C ratio and the EIRR of each candidate project under the base case and the sensitivity analysis (under the condition of a 30% increase of the total project cost) are shown in the table below.

Table 11.1-2 B/C Ratio and EIRR of the Candidate Projects

Name of Project	B/C ratio		EIRR	
	base	sensitivity	base	sensitivity
#1 Colombo City Transmission Development Project	1.59	1.22	18.63%	14.68%
#2 Construction of Kappalthurai 132/33 kV GS with related TL	1.62	1.25	16.59%	13.37%
#3 Construction of Grid Substations surrounding Colombo City	1.93	1.48	17.94%	14.95%
#4 Construction of Veyangoda - Kirindiwela - Padukka 220 kV TL	1.51	1.16	16.11%	13.59%
#5 Distribution Project for North Western Province of Region 1	1.13	0.87	12.92%	8.87%
#6 Distribution Project for Western Province North of Region 2	1.42	1.09	17.19%	12.37%
#7 Distribution Project for Western Province South-2 of Region 3	1.48	1.14	18.09%	13.09%
#8 Distribution Project for Western Province South-1 of Region 4	0.93	0.71	9.85%	6.28%

(Prepared by the Survey Team)

The table shows that the B/C ratio ranges from 0.93 to 1.93 for the base case and 0.71 to 1.48 under the sensitivity analysis case. Thus, it can be said that the candidate projects will bring benefits, with the exception of Project #8, since its B/C ratio is below 1.0 for both cases. As for the EIRR, it ranges from 9.85% to 18.63% for the base case and 6.28% to 14.95% for the sensitivity analysis case. With the exception of Project #5 and Project #8, under the sensitivity analysis case, the results indicate that the candidate projects shall deliver economic benefits. Thus, from an economic perspective, since most projects yield satisfactory B/C ratio and EIRR under both cases, the candidate projects may proceed.

11.2 Recommendations

(1) Recommendation for Transmission Development

1) Transmission network development in Colombo City

Electricity demand of Colombo City is increasing more rapidly than expected. This is due to emerging investments and developments such as hotels, commercial complexes, port expansions, etc., after the end of the civil war in May 2009. The existing transmission network in Colombo City mainly consist of 132 kV underground cables

with several 132/11 kV GSs. However, these are old and small-sized 132 kV oil filled (OF) cables, which sometimes leak insulating oil that causes serious accidents. In addition, small-sized cables produce transmission losses.

Therefore, there is substantial need for urgent implementation of the proposed Colombo City Transmission Development (PJT-1) and 11 kV Distribution Development (Package 1). In addition, since loss reduction effects are also expected, it is recommended to implement the projects at the earliest stage possible.

2) Reconstruction of TLs with old design concept

There are many sections of the 132 kV TL designed by an old concept, which were built with thin conductors at a maximum operating temperature of 54 °C, while CEB now applies a larger size conductor (ACSR Zebra) following the standard conductor size having a maximum operation temperature of 75 °C. Some sections of the 132 kV TL are important since these sections carry the bulk power flow. However, the limitation of the current carrying capacity remains a severe obstacle in the system operation due to the maximum operation temperature ratios on the power flow. In addition, thin conductors produce transmission losses. Therefore, it is recommended to reconstruct the TLs.

3) Countermeasures for voltage drop

CEB defines the permitted voltage deviation of the 132 kV busbars as ±10% in the system planning criteria. However, voltage drops exceeding the permissible range are sometimes recorded at the substations located in the rural areas and at the end of transmission networks such as Galle, Valachchenai, and Ampara GSs. This is due to the long distance and thin conductor TLs. This situation also worsens the increment of transmission losses. In order to improve such situation, it is recommended to take necessary countermeasures such as construction of new GSs, reconstruction and augmentation of TLs, and installation of static capacitors.

4) Applicability of Japanese technologies for transmission system

As described in Section 5.8, it is recommended to introduce Japanese made gas-insulated transformers (GITs), which are suitable for indoor installation. Fully gas-insulated substations, adopting a combination of GITs and GIS, offer extra safety assurance, accident prevention, and ease of inspection/maintenance. Especially for Port and Colombo L GSs that are to be constructed under PJT-1, GITs are recommended to prevent unpredictable accidents caused by salt contamination. In addition, due to compactness, GITs can be installed in a very limited space such as inside an underground substation, which would be required in Colombo City in the near future.

It is also recommended to apply Japanese made low-loss type conductors such as LL-

ACSR/AS for both the new construction and reconstruction of important TLs. These conductors have the same outer shape as normal ACSR conductors, but their aluminum cross-section area is larger by 20%–30% in order to reduce electrical resistance. These conductors would contribute to transmission loss reduction especially on heavily loaded TLs.

(2) Recommendations for Distribution Development

1) Overloading on distribution system

In the distribution system, transformers and MV distribution lines do not have enough operation margin in their current capacities. Although the maximum load on transformers is less than 70% of the rated capacity according to CEB's internal regulation, the actual load exceeds more than 70% for many transformers. It is recommended to replace such loaded transformers with bigger capacity.

For instance in North Western Province of Region 1, planned shutdowns have been carried out in Kuriyapitiya to prevent overloading of the equipment. It is very important to reinforce the GSs, PSs, and transformers in order to increase the margin in operation. Therefore, the Survey Team recommends that the large demand of consumers applying for smart meters should be controlled in order to overcome overloading of distribution system. The Survey Team also recommends to take the following actions for the latent problems to be addressed in the development plan.

Table 11.2-1 Recommendations to Prevent Overloading

Issues	Current Situation	Recommended Procedure
Rapid growth of power demand	Demand is considered increasing linearly.	More accurate investigation of power demand considering increase in population, development and lifestyle.
Expected margin of facility is too small	Maximum load shall be less than 70% of the equipment rating	Lower limit such as 60% or 50% will be considered.
Significant delay on the schedule of reinforcement/installation	It has been observed that there are delays in several projects.	Third party which monitors the project schedule shall be provided in CEB management.
Low quality of distribution facilities	No specific management to ensure the quality of equipment and management.	Quality control mechanism shall be provided in CEB management system such as ISO9000.
	Aging of distribution facilities	Rehabilitation for aged facilities
Frequent planned shutdown have been carried out in some regions	Planned complete shutdown has been carried out in some areas.	Application of smart meters, demand control will be done to shutdown only normal load without shutting down important load

(Prepared by the Survey Team base on information from CEB)

2) Voltage drop

Voltage drop, which was observed in many locations of the distribution system, is caused by the distribution of electric power on long distribution lines and overloading.

The following countermeasures are to be considered in order to rectify voltage drop as shown in Table 11.2-2.

Table 11.2-2 Recommendations to Prevent Voltage Drop

Issues	Current Situation	Recommended Procedure
Voltage drop on MV system	Conductor size is too small	To provide additional distribution lines and/or size up the conductors
	Long distribution lines	To provide new GS to shorten the distribution lines
		To provide voltage compensation facilities such as step voltage regulators (SVR)
Voltage drop on LV system	Long LV lines	To provide additional LV transformers between existing transformers
	Single Phase LV lines	To Convert single-phase LV lines to three-phase

(Prepared by the Survey Team base on information from CEB)

3) DAS

Although the DAS is introduced in Colombo City, other regions/areas have none except simplified DAS. The DAS is one of the effective facilities to control the distribution system and to minimize the distribution losses. In addition to the advantage of loss reduction, the DAS can offer other advantages such as saving manpower for logging the event/fault records and reporting, decrease of black-out duration and area, and also safety of the workers. Therefore, it is recommended to introduce the so called full-scale DAS on a nationwide scale.

4) Communication system

CEB has used the GSM/GPRS for their simplified SCADA system. GSM/GPRS is developed for data communication such as internet or e-mail system, which does not require latency, reliability, congestion, security, etc. Therefore, it is strongly recommended to apply the optical fiber communication system to the Back Born Communication, and dedicated radio communication system such as RF mesh to the Last One Mile Communication considering technical and economical aspects.

5) Energy meters and data transmission

In order to reduce the non-technical losses, it is very important to identify the lost energy and analyze the causes. However, energy meters are not provided at most DT (LV substation) especially in rural areas. Consequently, it is impossible to know how much energy is lost. Thus, it is recommended to provide energy meters with remote monitoring facility such as smart meters at DTs and bulk consumers.

The most common modus operandi of power theft is by hanging a hook on the bear LV wires. Since the population density is very thin in rural areas, it is often difficult to find such activities in an open area. It is also difficult to discover power theft because electrical energy is not exactly monitored on the LV line. Therefore, it is crucial to provide energy meters on every LV lines to monitor energy theft.

6) Loss reduction in DT

In the existing DTs, normal silicon steel is used for iron core, which is one of the causes of transformer losses. If the technologies of low-loss transformers such as directional silicon iron cores are applied to the existing DTs and if CEB purchases such low-loss transformers continuously, it may contribute remarkably to a sustainable loss reduction of DTs. Therefore, it is recommended to apply directional silicon steel cores in DTs since these contribute about 20% of no-load loss reduction. In addition, if amorphous iron cores are applied in DTs, it is possible to reduce about 75% of no-load loss of the existing transformer.

Especially in rural areas, larger capacity transformers are used to meet the demands as CEB has not standardized the capacity of smaller transformers. This results to higher distribution losses because of the non-load loss of transformers. In order to improve the above situation, it is recommended to apply smaller capacity transformers such as 16, 25, 30 and 50 kVA.

7) Resistive losses at connection points on LV lines

During the site investigation, improper connections with volt connectors or manual winding connections on several LV lines were sometimes observed. These may cause the resistive losses on the lines. In order to avoid this, it is recommended to introduce hydraulic compression tools, by which proper compression clamp connection can be done by designated staff even without long-term experience.

It is also recommended to introduce additional C-clamp connection on existing manual winding connection to reduce contact resistance as shown in Figure 11.2-1.

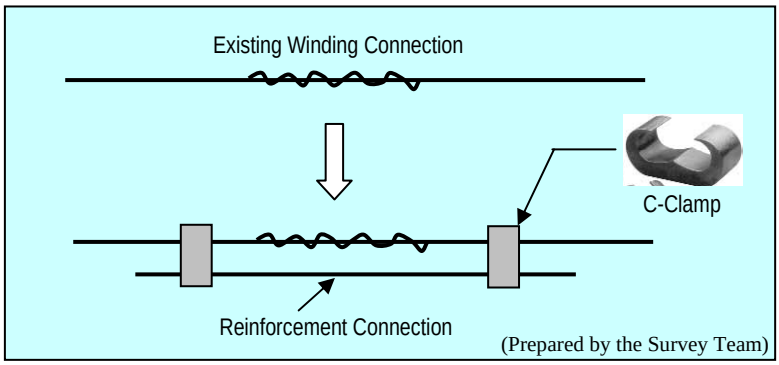


Figure 11.2-1 Improvement of Winding Connection by C-Clamp

8) Street lighting

The power for street lightings, which is a non-technical loss, is fed from LV distribution line. Tariff for the street lighting is not paid to CEB. To reduce the demand (losses), CEB proposes energy saving activities to the departments concerned in Colombo City. The Survey Team considered that such cost must not be borne by CEB and shall be paid by an appropriate authority responsible for cost management.

9) Specialized vehicles for site works

When the Survey Team visited the construction sites, workers were using normal trucks and ladders when working on electric poles. This condition increases the risk of electrical shocks, and renders the works ineffective. On the other hand, CEB workers used truck with earth drills and crane for poles installation. To carry out safe and effective works at site, the Survey Team recommends the use of specialized trucks with insulated bucket for work on poles, and trucks with earth drill and crane facilities for pole installation work.

10) Applicability of Japanese technologies for distribution system

As described in Section 6.3, it is recommended to introduce the following Japanese technologies for the distribution system:

i) DAS and AMR;
ii) Directional silicon steel cores and/or amorphous iron cores for DTs; and
iii) Specialized vehicles.