Electricity Supply Enterprise
Ministry of Electric Power
Republic of the Union of Myanmar

Republic of the Union of Myanmar

Preparatory Survey on Distribution System Improvement Project in Main Cities

Final Report

July 2015

Japan International Cooperation Agency (JICA)

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

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ABBREVIATIONS

Word	Original
ABC	Aerial Bundled Cable
ACSR	Aluminum Conductor Steel Reinforced
ADB	Asian Development Bank
AIS	Air Insulated Switchgear
CB	Circuit Breaker
CEMP	Construction Environmental Management Plan
CT	Current Transformer
C-GIS	Cubicle type Gas Insulated Switchgear
D/L, D.L	Distribution Line
DOF	Department of Forest
DS	Disconnecting Switch (Isolator)
ECC	Environmental Compliance Certificate
ECD	Environmental Conservation Department
ECL	Environmental Conservation Law
ECR	Environmental Conservation Rules
EIA	Environmental Impact Assessment
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
EQG	Environmental Quality Guidelines
EQS	Environmental Quality Standards
ESE	Electric Supply Enterprise
EU	European Union
FY	Fiscal Year
GAD	General Administration Department
GCB	Gas Circuit Breaker
GDP	Gross Domestic Products
GEF	Global Environment Facility
GIS	Gas Insulated Switchgear
GPS	Global Positioning System
HDBC	Hard Drawn Bare Copper
IBC	International Business Center
IEC	International Electrotechnical Commission (International Standards)
IEE	Initial Environment Examination
IFC	International Finance Corporation
IMG	International Management Group
IUCN	International Union for Conservation of Nature
JEC	Japanese Electrotechnical Commission (Japanese Standards)
JICA	Japan International Cooperation Agency
LRT	Load Ratio Control Transformer
LV	Low Voltage
MCDC	Mandalay City Development Committee
MEPE	Myanma Electric Power Enterprise

MESC	Mandalay Electricity Supply Corporation
METI	Ministry of Economy, Trade and Industry (of Japan)
MIC	Myanmar Investment Commission
MOAI	Ministry of Agriculture and Irrigation
MOC	Ministry of Construction
MOECAF	Ministry of Environmental Conservation and Forest
MOEP	Ministry of Electric Power
MOF	Ministry of Finance
MOH	Ministry of Health
MOI	Ministry of Industry
MOU	Memorandum of Understanding
MV	Middle Voltage
NPV	Net Present Value
OCB	Oil Circuit Breaker
ODA	Official Development Assistance
PAs	Protected Areas
PAPs	Project Affected People
PCB	Polychlorinated Biphenyl (Polychlorobiphenyl)
PF	Power Factor
PMU	Project Management Unit
POPs	Persistent Organic Pollutants
PW	Public Work
ROW	Right of Way
SAC	Spaced Aerial Cable
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Acquisition
SEZ	Special Economic Zone
S/S, SS	Substation
TDC	Township Development Committee
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
VT	Voltage Transformer
WB	World Bank
W/S	Workshop
YESB	Yangon City Electricity Supply Board
YESC	Yangon Electricity Supply Corporation

Chapter 1 Background

1.1 Background

As economic development advances in Myanmar in recent years, it is being squeezed by high demand for electric power. Power shortages result in, especially during the dry season, scheduled blackouts and the like day after day, which is wreaking havoc on civic lives. The total capacity of power generation equipment for domestic use is being increased, and it stood at approximately 2,875 MW as of 2012, which was almost 2.5 times the 1,170MW capacity in 2000. The current total power output is still around 1,580 MW, making it necessary to implement scheduled blackouts, emergency shutouts due to excessive loads, and so on. Furthermore, aging of power transmission and distribution equipment, frequent instances of equipment failures due to incomplete maintenance, increasing power distribution losses and so on are impacting greatly against stable supply of electric power, As Myanmar's economy develops further, it is estimated that its demand for electric power will increase to approximately 4,800 MW in 2020 from approximately 2,800 MW in 2012. Therefore, it is necessary to build up, as soon as possible, power distribution equipment along with power transmission and substation equipment, concurrently in order to achieve stable supply of electric power.

As part of this effort, JICA carried out in 2013 its survey titled Preparatory Survey for Projects for Improving Electric Power Equipment in Yangon Metropolitan Area to prepare for its planned ODA loans to the city.

Meanwhile, implementation and planning of power equipment in main regional cities in Myanmar still remains insufficient. While demand for electric power increases, aging of substation and power distribution equipment is advancing, causing blackout incidents frequently due to shortages of power supply capabilities and failing power equipment.

The Myanmar government makes it a short-term priority in its electric power policy to eliminate scheduled blackouts through repairs and the like of existing power equipment. In March 2013, President Thein Sein gave a speech in which he singled out the electric power sector as the most important area of Myanmar's socioeconomic development. Specifically, stable supply of electric power to Yangon and Mandalay areas was deemed most urgent.

Under these circumstances, JICA has determined to draft its power distribution improvement plans for main local cities in Myanmar and carry out a preparatory survey to select priority projects which has possibilities of becoming Japanese ODA loan projects in the future.

(1) Objectives of this survey

Objective 1:	To formulate power distribution improvement plans for main cities and select priority projects
Objective 2:	To make varieties of proposals and share knowledge on implementing power distribution system improvement projects in main cities

(2) Survey areas

32 main cities in Myanmar that Electricity Supply Enterprise (ESE) proposed

Table 1-1 shows 32 main cities in Myanmar.

Table 1-1: 32 main cities in Myanmar

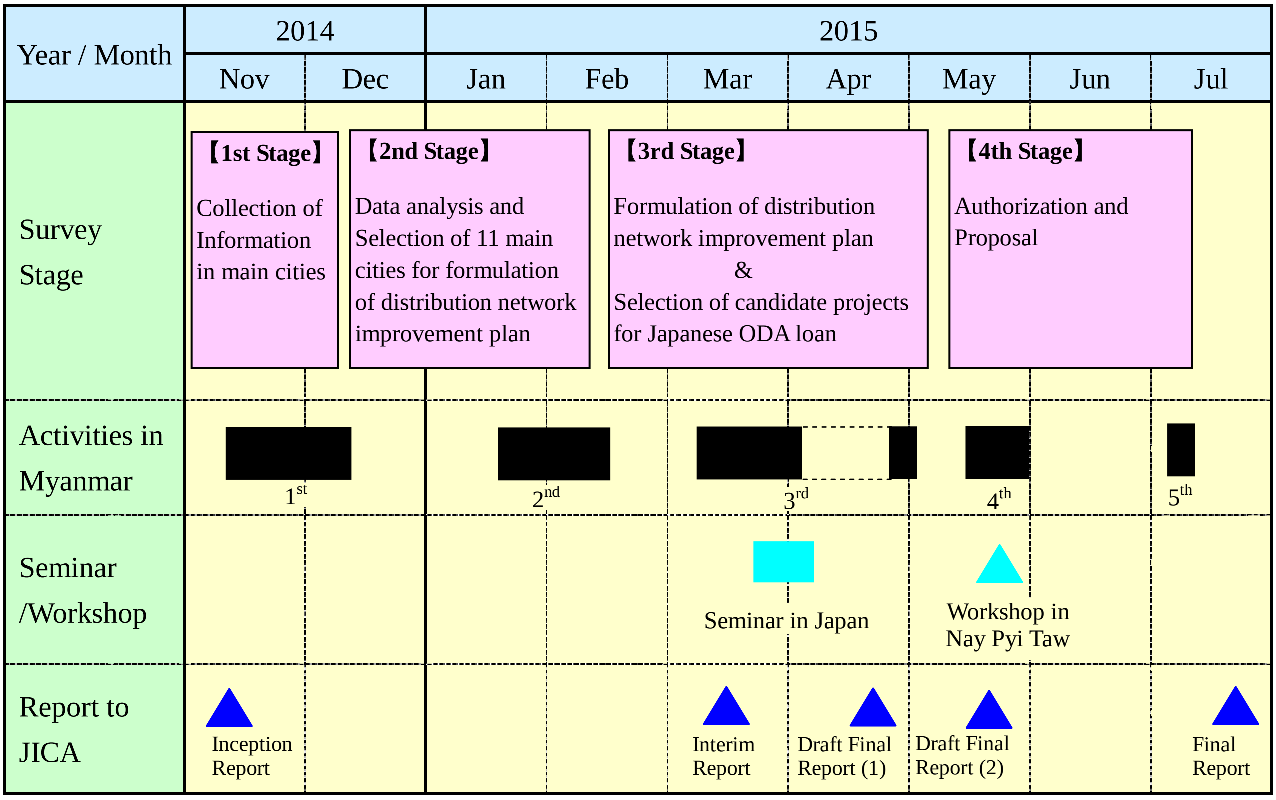
State/Region	Cities
Ayeyarwady	Hinthada, Myaungmya, Pathein
Bago	Bago, Pyay, Taungoo
Chin	Hakha
Kachin	Bhamo, Myitkyina
Kayah	Loikaw
Kayin	Hpa-An
Magway	Chauk, Magway, Minbu, Pakokku
Mandalay	Mandalay, Meiktila, Myingyan, Pyinmana, Pyinoolwin
Mon	Mawlamyine
Rakhine	Sittwe, Thandwe
Sagaing	Monywa, Sagaing, Shwebo
Shan	Aungpan, Kengtung, Lashio, Taunggyi
Tanintharyi	Dawei, Myeik

(3) Counterpart

Electric Supply Enterprise (ESE)

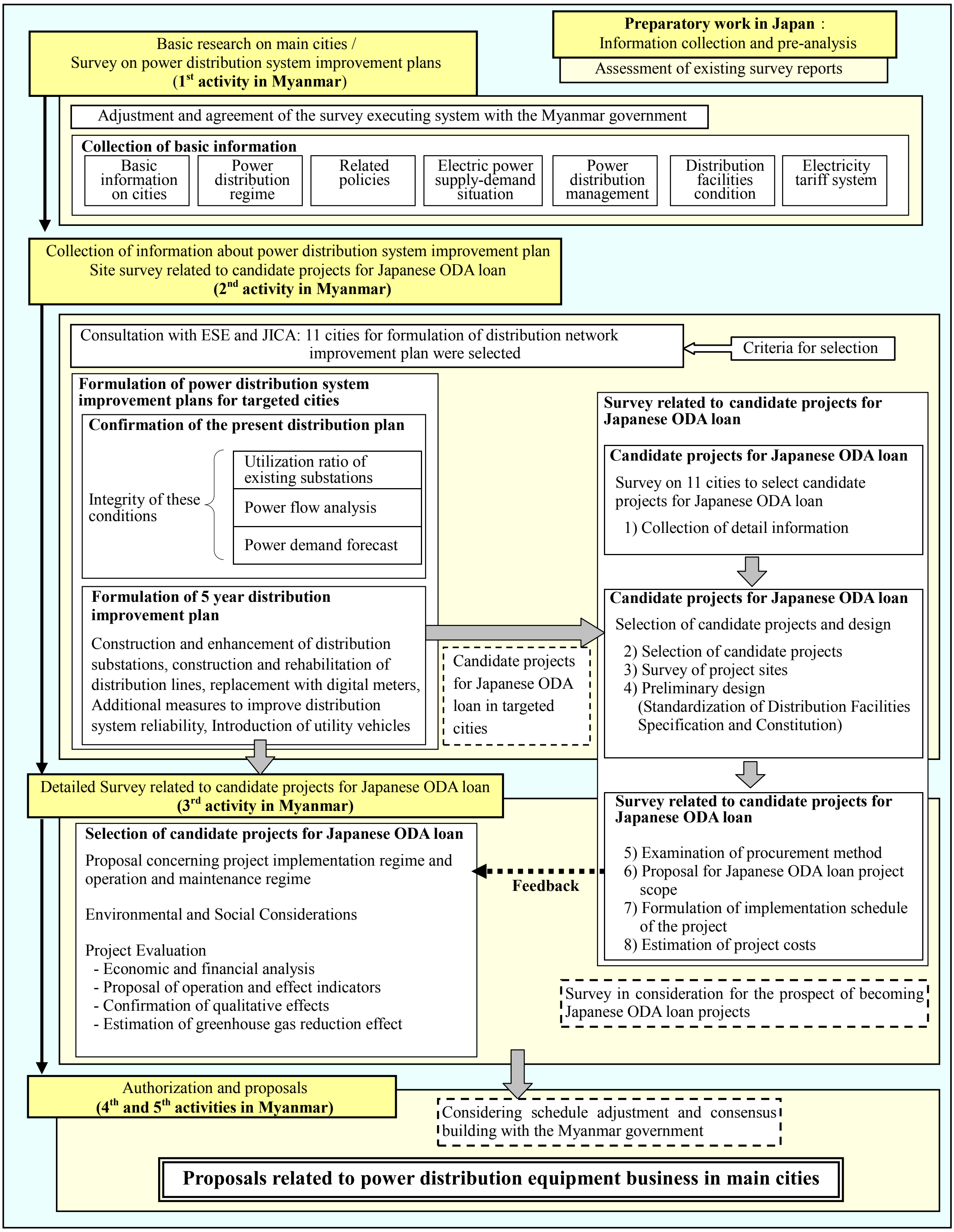
1.2 Survey schedule

The survey was conducted for 9 months from November 2014 to July 2015. This survey had four stages. In the first stage, survey team collected basic information of 32 main cities related to power distribution system. In the second stage, survey team analyzed the basic information of 32 main cities. Based on this result of analysis, 11 target cities were selected in consultation with ESE and JICA for conducting detail survey and formulating 5 year distribution system improvement plan. In the third stage, survey team supported the formulation of the 5 year plan and proposed candidate projects for Japanese ODA loan.
During the third stage, seminars were held to introduce Japanese technologies for younger engineers from 23rd March to 4th April, and for senior officer from 4th to 10th April, 2015 in Japan. In the final stage (the fourth stage), the survey team conducted the investigation for the candidate projects for Japanese ODA loan, and explained proposals related to the power distribution projects of ESE. And during the fourth stage, a workshop on the reliable and efficient operation/maintenance of distribution facilities for ESE engineers was held on 28th May, 2015. The entire schedule for survey and the overall flow of the survey are as shown in Figure 1-1 and Figure 1-2.



Source: JICA survey team based on ESE information

Figure 1-1: Survey Schedule



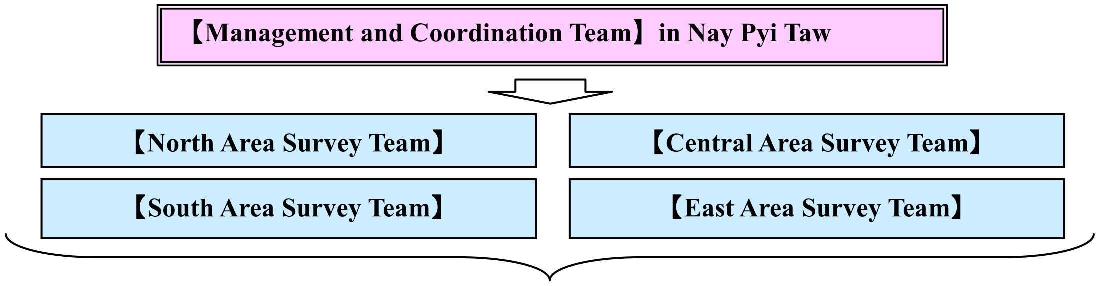
Source: JICA survey team based on ESE information

Figure 1-2: Overall flow of the survey

1.3 JICA survey team and counterpart

For the smooth and efficient implementation of the survey, survey team was organized into a Management and Coordination team and four regional area survey teams that consisted of members of the JICA survey team and local staff for 1st and 2nd activities in Myanmar. (the “Four regions” were named ‘North’, ‘Central’, ‘South’ and ‘East ’, respectively.)

Table 1-2 shows the members of JICA survey team. A team leader was assigned in each area survey team to implement the area survey.



The team visited each ESE state/regional office and site (substations or main distribution lines etc.), and collected information about the status of power facilities and the status of power demand/supply.

Table 1-2: Members of JICA survey team

Name	Assignment
Mr. Yoshitaka SAITO	Team Leader/Distribution Planning 1
Dr. Koji SHIKIMACHI	Deputy Team Leader/Distribution Planning 2/ South area survey team leader
Mr. Hitoshi EGAWA	Substation facility 1/ East & West area survey team leader
Mr. Osamu TANIHATA	Substation facility 2 / North area survey team leader
Mr. Tomohide KATO	Distribution facility 1
Mr. Kazuya MIYAKE	Distribution facility 2
Ms. Mina KOBAYASHI	Distribution facility 3
Mr. Hiromichi MOCHIZUKI	Power System Planning
Mr. Tatsuya WATANABE	Civil Engineering
Ms. Wah Wah Han Su Yin	Environmental and social considerations 1
Mr. Kengo NAGANUMA	Environmental and social considerations 2
Mr. Osamu TANIHATA (Additional posts)	Economic and financial analysis
Mr. Megumi ICHIKAWA	Distribution business management/ Central area survey team leader
Ms. Yumiko MUKOHARA	Assistance of distribution planning/Coordinator

Table 1-3: Counterpart members

Office	Name	Division
Head office (Nay Pyi Taw)	Mr. Myint Aung	Managing Director
	Mr. Than Naing Oo	Deputy Chief Engineer, Distribution Department
	Ms. Soe Soe Nwe	Director, Finance Department
	Mr. Thant Zin	Senior Engineer, Distribution Department
	Mr. Maung Maung Khaing	Executive Engineer, Distribution Department
	Mr. Nyein Chan	Assistant Engineer, Distribution Department
	Mr. Than Htike Oo	Assistant Engineer, Distribution Department
Ayeyarwady	Mr. Sa Win Nain	Assistant Engineer (Pathein Division office)
	Mr. Kyaw Thura	Township Engineer (Pathein Township Office)
	Mr. Thet Maung Maung	Assistant Engineer (Pathein Township Office)
Bago (East)	Mr. Sein Aung	Deputy Chief Engineer (Bago East Division Office)
	Mr. Hla Myo Aung	Assistant Engineer (Bago East Division Office)
	Ms. Pan Ei Phyu	Sub Assistant Engineer (Bago East Division Office)
	Mr. Zaw Zaw Win Htun	Township Engineer (Bago Township Office)
Bago (West)	Mr. Ye Myint	Deputy Chief Engineer (Bago West Division Office)
	Ms. Sandar Soe	Assistant Engineer (Bago West Division Office)
	Mr. Kyaw Swar Linn	Township Engineer (Pyay Township Office)
Kachin	Mr. Maung Maung Thin	District Engineer (Kachin District Office)
	Mr. Aung Kyaw Kyaw Moe	Township Engineer (Bhamo Township Office)
	Mr. Lin Zaw Htet	Sub Assistant Engineer (Bhamo Township Office)
Kayah	Mr. Thein Myint	District Engineer (Loikaw District Office)
	Mr. Than Gaday	Assistant Engineer (Loikaw District Office)
Kayin	Mr. Htin Kyaw	Division Engineer (Kayin Division Office)
	Mr. Than Zaw Oo	District Engineer (Hpa-An District Office)
	Mr. Kyaw Zaw Wai	Township Engineer (Hpa-An Township Office)

Office	Name	Division
Magway	Mr. Htun Wunna	Super Intending Engineer (Magway Division Office)
	Mr. Tin Aung Moe	Assistant Engineer (Magway Division Office)
	Mr. Thein Htike Mhwe	Township Engineer (Magway Township Office)
	Mr. Zaw Min Swe	District Engineer (Minbu District Office)
	Mr. Zaw Thura Aung	Township Engineer (Chauk Township Office)
	Mr. Phoe Naing	District Engineer (Pakokku District Office)
Mandalay	Mr. Hla Tun	Deputy Chief Engineer (Mandalay Division Office)
	Mr. Aung Kyaw Htoo	Superintendent Engineer (Mandalay District Office)
	Ms. Swe Zin Oo	Assistant Engineer (Mandalay Division Office)
	Ms. Pauline Htwe	Assistant Engineer (Mandalay Division Office)
Mon	Mr. Kyaw Soe	Assistant Division Engineer (Mon Division Office)
Sagaing	Mr. Myint Aung Kyaw	Assistant Deputy Engineer (Monywa Township Office)
	Mr. Sein Kyaw Tint	Executive Engineer (Monywa Township Office)
	Ms. Sanda Htwe	Deputy Director, Finance (Monywa Township Office)
	Mr. Than Myat Oo	Township Engineer (Monywa Township Office)
Shan (South)	Mr. Kyaw Hlaing Win	District Engineer (Taunggyi District Office)
Tanintharyi	Mr. Khin Lay	Division Engineer (Tanintharyi Division Office)
	Ms. Hnin Hnin Aye	Assistant Engineer (Tanintharyi Division Office)
	Mr. Minn Thiha	District Engineer (Dawei District Office)
	Mr. Kyi Swe Linn	Township Engineer (Dawei Township Office)
	Mr. Myo Naing Win	District and Township Engineer (Myeik District and Township Office)

Chapter 2 Present Status

2.1 Present status of the power distribution sector

Under Electricity Supply Act (1948), Electricity Supply Board was established in 1951. In 1984, Electricity Law (1984) was stipulated and the Ministry of Electric Power was formed on September 1997 to deal effectively in electric power sector. Until 14^{th} May 2006, the electricity generation, transmission and distribution were under responsibilities of Ministry of Electric Power.

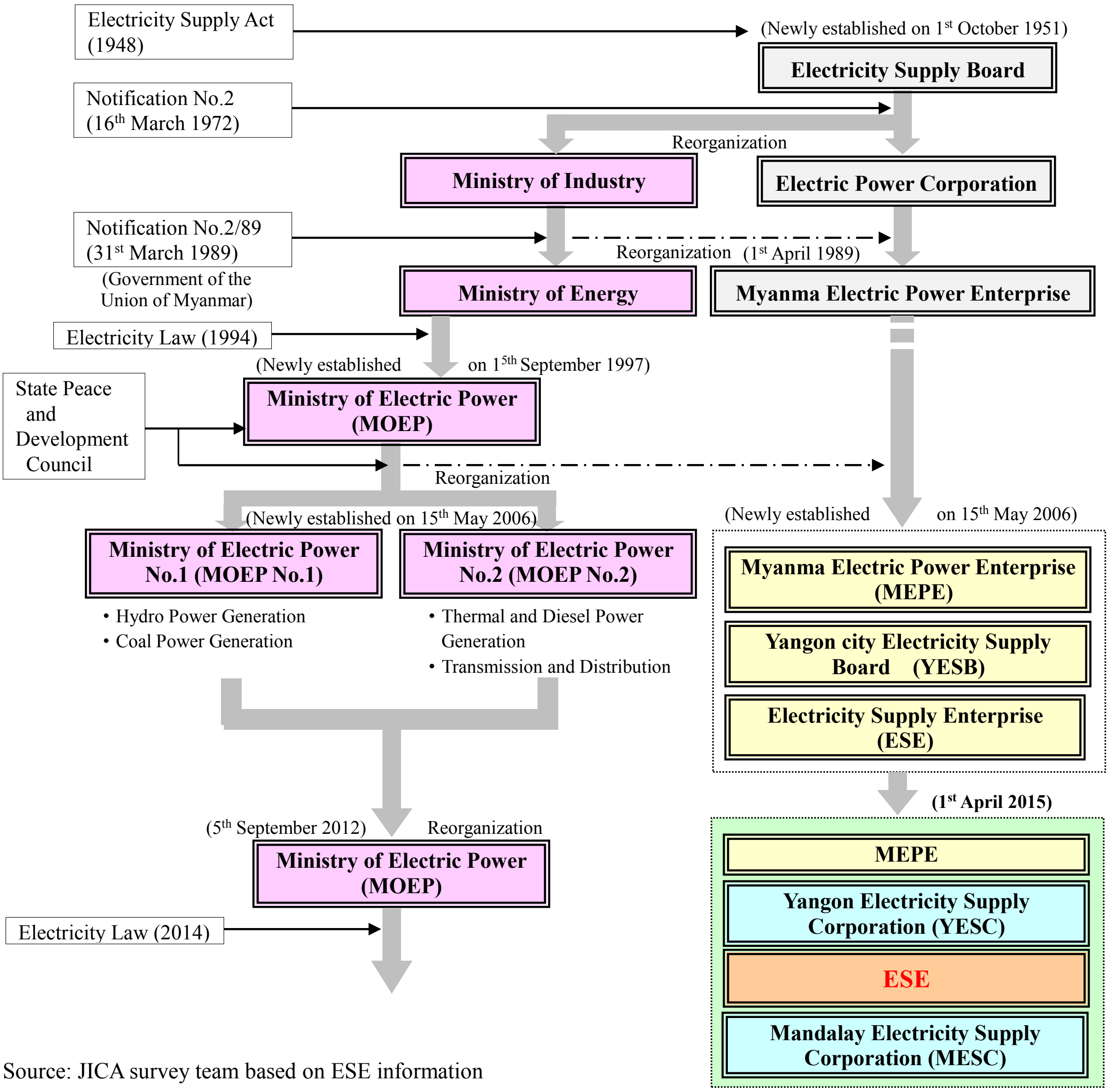
On 15th May 2006, Ministry of Electricity was reorganized as two ministries, namely Ministry of Electric Power No.1 and Ministry Electric Power No.2 and under the Ministry of Electric Power No.2 Electricity Supply Enterprise (hereinafter referred to as "ESE"), Yangon city Electricity Supply Board (hereinafter referred to as "YESB") and Myanma Electric Power Enterprise (hereinafter referred to as "MEPE") were established according to the decision of the State Peace and Development Council under direct control of the President. ESE was responsible for distribution and retail throughout the country except Yangon. Two ministries were reorganized as the Ministry of Electric Power (hereinafter referred to as "MOEP") on 5th September 2012 by the Republic of the Union Myanmar.

New Electricity Law (2014) was stipulated in 2014. New Electricity Law (2014) includes a policy to encourage investment from foreign country to Myanmar.

On April 1, 2015, the Electric Distribution Department of ESE in the Mandalay Region was changed to the Mandalay Electricity Supply Corporation (hereinafter referred to as "MESC"). On the same day, YESB was transformed into the Yangon Electricity Supply Corporation (hereinafter referred to as "YESC").

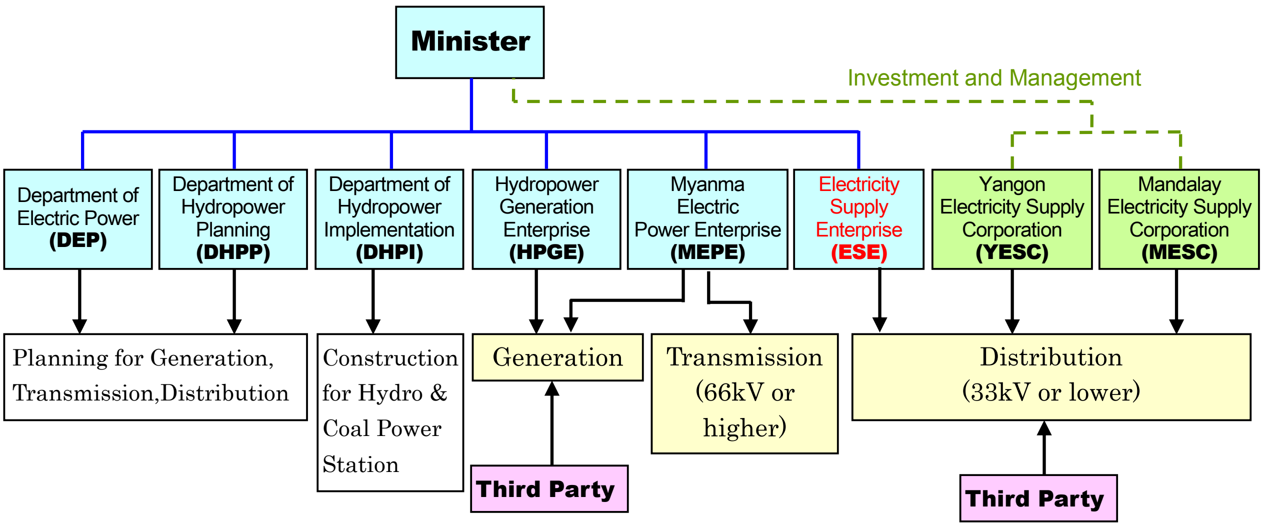
Figure 2-1 shows the background history of ESE.

Figure 2-2 shows present organization chart of the power sector.



Source: JICA survey team based on ESE information

Figure 2-1: Background history of ESE

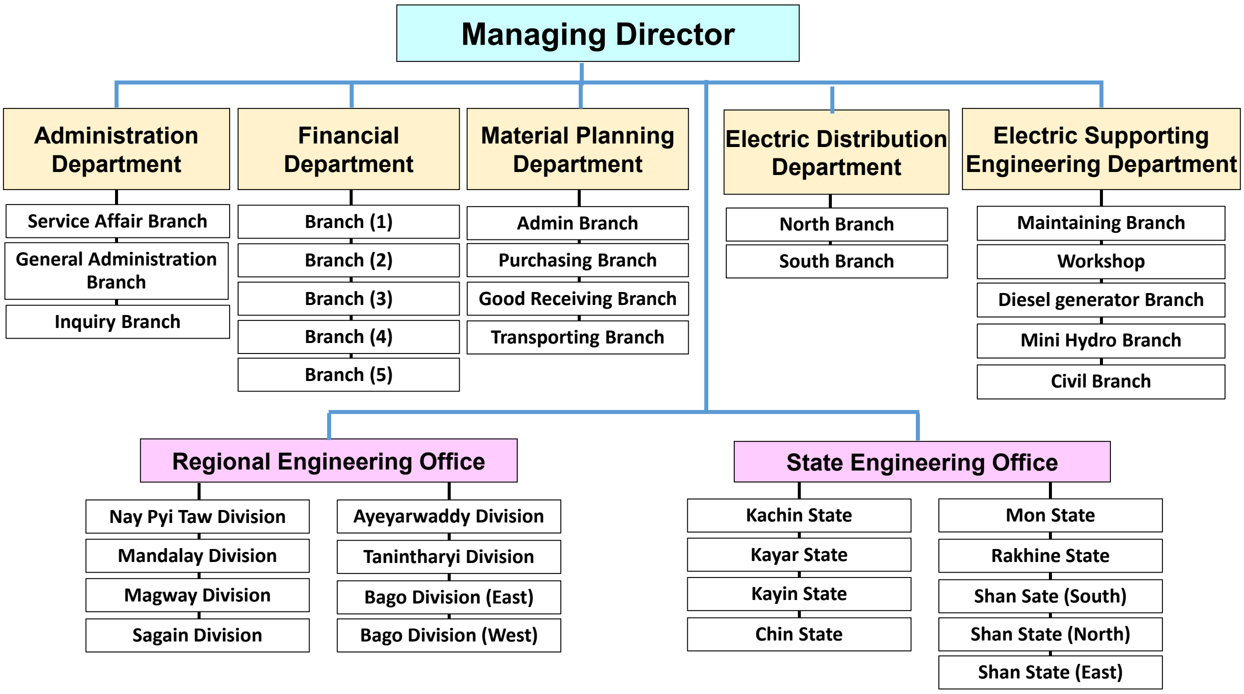


Source: JICA survey team based on ESE information

Figure 2-2: Organization Chart of the Power Sector

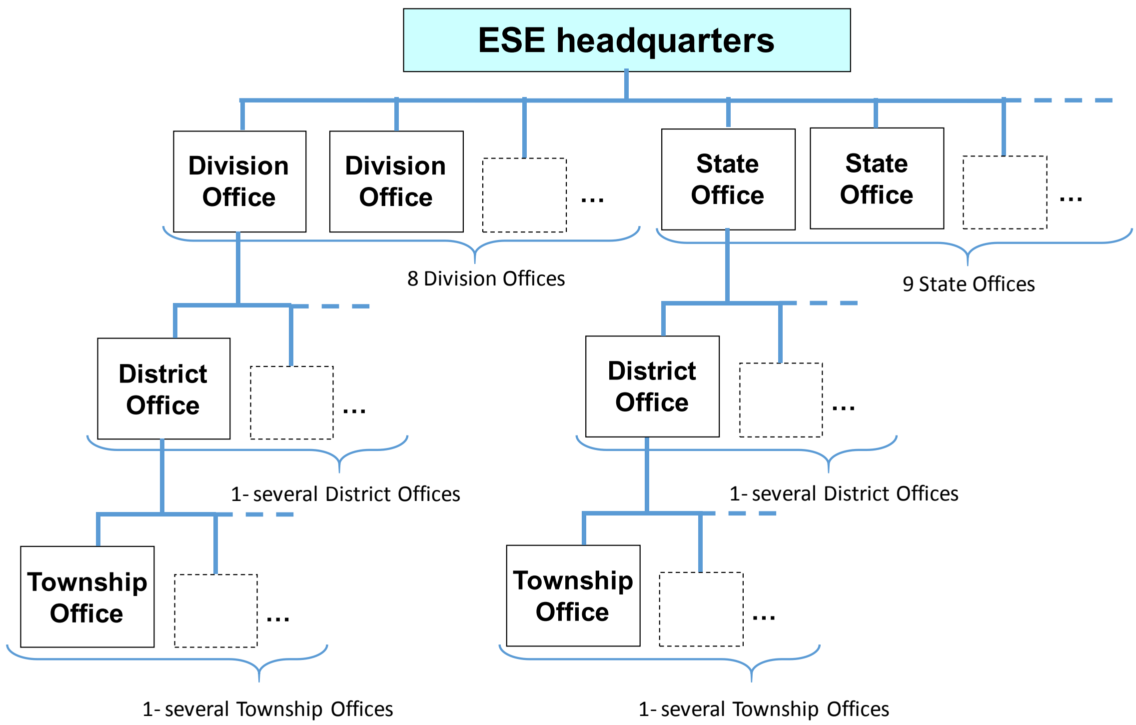
Figure 2-3 shows the organization chart of ESE, the counterpart managing the areas to be surveyed. ESE consists of 5 departments, 8 division offices and 9 state offices. The Bago Region is controlled by 2 division offices (Bago Division East office and Bago Division West office), and Shan State is controlled by 3 division offices (Shan State South office, Shan State North office and Shan State East office).

Figure 2-4 shows the lower organization chart of division and state offices. Each division or state office has several district offices, and each district office has several township offices. The township offices are responsible for the acceptance of applications for electricity use, operation, maintenance and repair of overhead power distribution lines of 11 kV or less, and the initial response in case a fault occurs under the jurisdiction of division or state offices. Figure 2-5 shows the appointed numbers of members in each lower section as of December 2014. ESE has 14,179 employees, 553 executive officers and 13,626 staff.



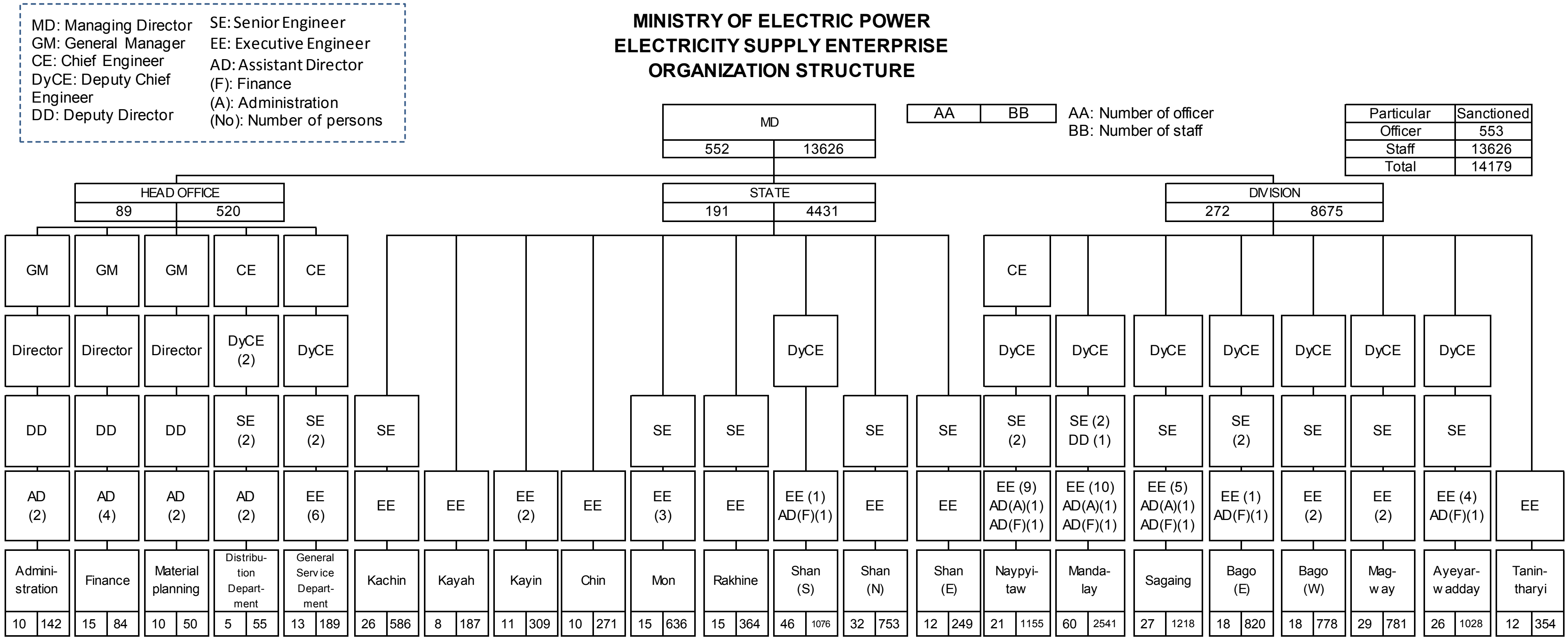
Source: JICA survey team based on ESE information

Figure 2-3: Organization Chart of ESE



Source: JICA survey team based on ESE information

Figure 2-4: Relationship Diagram of Division/State offices, District offices and Township Offices



Source: ESE Statistics (2014)

Figure 2-5: Organization Chart of ESE and employee number

2.2 Movement of Corporatization and franchising

As mentioned before, on April 1, 2015, the Electric Distribution Department of ESE in the Mandalay Region was changed to MESC. On the same day, the YESB was transformed into the YESC.
MESC spun off from ESE, becoming an entity under the direct control of MOEP. Though MESC was wholly owned by the Myanmar government at the time of its inception, it plans to accept investments from private sector funds other than the Myanmar government in the future after becoming profitable on its own account within five years.
MESC has a board of nine directors. Initially, seven Myanmar government officials have assumed the position of director to manage the operation of MESC. It plans to appoint a director from outside the corporation according to the investment ratio when accepting investments from private sector funds in the future.

Since the introduction of the franchise system in 2012, ESE has been outsourcing the management and maintenance of distribution facilities below 11 kV to private companies in some townships. The term of the outsourcing contracts is 15 years and the contracts are renewed every fiscal year.

Distribution companies entrusted by ESE (hereinafter referred to as "distribution companies") provide all the services related to distribution facilities below 11 kV, such as the reinforcement, management and maintenance of the 11 kV distribution facilities and tariff collection. Since such distribution companies purchase electricity from ESE and sell it to customers at the same tariff rate as ESE, they are required to raise profitability by taking measures to reduce distribution losses and prevent electricity theft. The price of electricity purchased from ESE is set out in the contract between ESE and each company.

Staff members in such townships, who engage in operations of 11 kV distribution facilities, are directly transferred from ESE. In accordance with the rules established by the Ministry of Labour, Employment and Social Security in 2012 (when the franchise system was introduced), distribution companies entrusted by ESE shall pay the salaries of staff members who are treated as ESE employees for five years from the transfer of operations. After five years from the transfer, the staff members themselves shall decide whether to return to ESE or remain with the distribution company they work for.

The number of cases of outsourcing of management and maintenance of distribution facilities below 11 kV under the franchise system has been gradually increased. Taking the Mandalay Region as an example, 25 townships in the Region were outsourcing their operations to seven private companies as of the end of March 2015. Since ESE in the Mandalay Region was changed to MESC in April 2015, the franchise contracts in the Mandalay Region were transferred from ESE to MESC accordingly.

And the management and operation of distribution facilities below 11 kV in the Bago East Division was outsourced on June 1, 2015.

2.3 Electricity Tariff

2.3.1 Number of Consumers

The number of consumers within ESE service area is managed by the following customer classification shown in Table 2-1.

Table 2-2 indicates changes in the number of consumers within ESE service area over five years from fiscal year 2009 to fiscal year 2013.

Table 2-1: Customer classification in ESE

(1)	General Purpose
(2)	Domestic Power
(3)	Small Power
(4)	Industrial
(5)	Bulk
(6)	Street Light
(7)	Temporary Lighting

Source : ESE statistics (2014)

Table 2-2: Changes in the number of consumers within the ESE service area

[No.]

Fiscal year	General Purpose	Domestic Power	Small Power	Industrial	Bulk contract	Street Light	Temporary Lighting	total	Increasing Ratio
2009	1,252,754	—	28,300	1,884	3,454	7,284	209	1,293,885	—
2010	1,343,063	—	27,640	2,525	3,794	7,246	377	1,384,645	7%
2011	1,478,571	1,922	27,871	2,425	4,595	7,695	324	1,523,403	10%
2012	1,626,928	3,037	29,383	3,120	5,378	7,908	251	1,676,005	10%
2013	1,827,745	3,691	30,571	3,952	6,017	7,458	300	1,879,734	12%

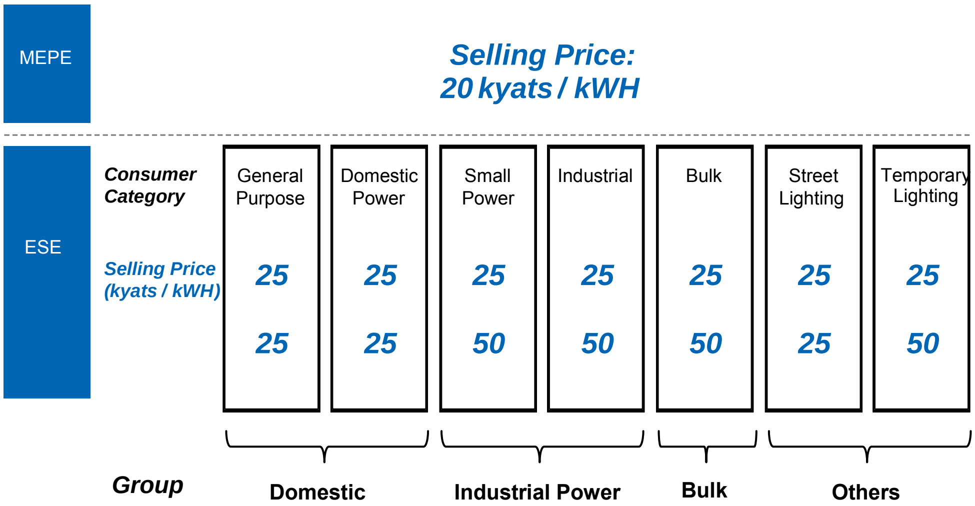
Source : ESE statistics (2014)

The number of consumers increased by a little less than 100,000 from fiscal year 2009 to fiscal year 2010, while it rose by more than 200,000 from fiscal year 2012 to fiscal year 2013. Most of the growth was attributable to the rise in the number of household consumers.

2.3.2 Tariff Structure

YESC and ESE have the same electricity rates. The electricity rates are determined according to the type of users. Both YESC and ESE revised their electricity rates in January 2012 and April 2014. In the tariff revisions in April 2014, the rise of electricity rates for household customers was suppressed while raising those for industrial customers that consume large volumes of electricity, and a new electricity rate system (in which the electricity rates change according to the electricity power consumption volume) was introduced in place of the previous flat-rate system regardless of the electricity power consumption of a customer.

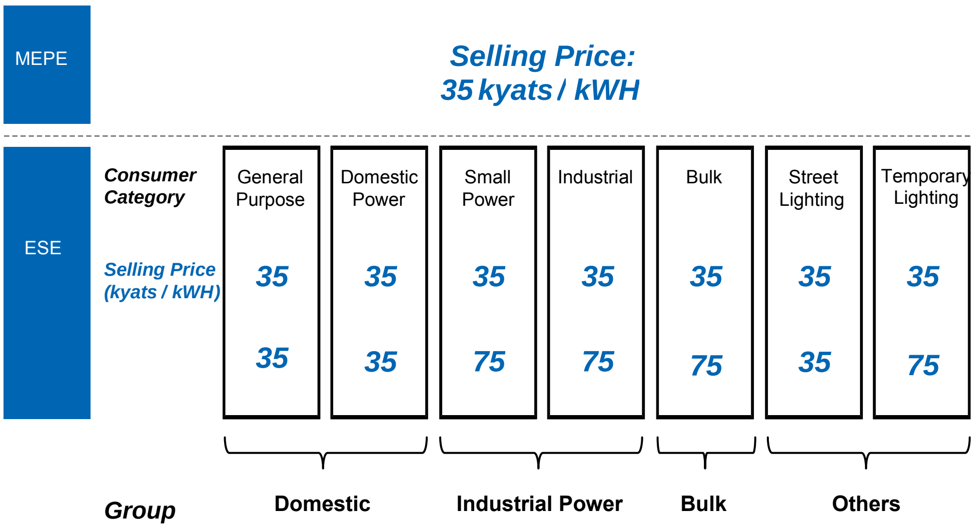
From May, 2006 to December, 2011



Upper: Rate for government department
Lower: Rate for public

Source: ESE statistics(2011)

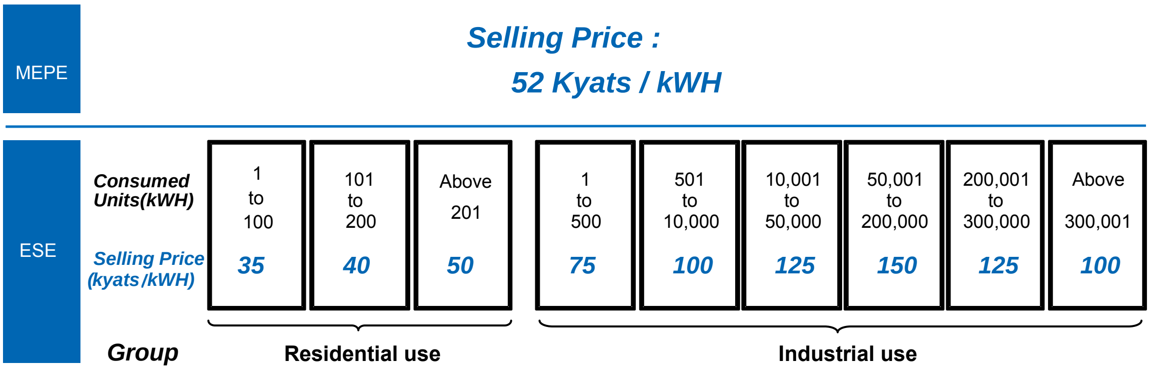
From January, 2012 to March, 2014



Upper: Rate for government department
Lower: Rate for public

Source: ESE statistics(2014)

After April, 2014



Source: JICA survey team based on ESE information

Figure 2-6: ESE's Tariff Structure

In addition to the energy consumption charge shown in Figure 2-6, customers need to pay a capacity charge proportional to the contract capacity and a meter service charge for installation cost of a meter or a current transformer. The fixed charge (capacity charge and meter service charge) is shown in Table 2-3.

Table 2-3: Fixed charge for customers in electricity tariff

	After April, 2010 to September, 2013		After October, 2013	
Type of consumer	Capacity Charge (Kyats/Horse Power)	Meter Service Charge (Kyats)	Capacity Charge (Kyats/Horse Power)	Meter Service Charge (Kyats)
General Purpose	-	Single Phase 1000 Three Phase 2000	-	Single Phase 500 Three Phase 2000
Domestic Power	-	Single Phase 1000 Three Phase 2000	-	Single Phase 500 Three Phase 2000
Small Power	200	Single Phase 1000 Three Phase 2000 CT Meter 5000	200	Single Phase 500 Three Phase 2000 CT Meter 5000
Industrial	200	Three Phase 2000 CT Meter 5000	200	Three Phase 2000 CT Meter 5000
Bulk	200	Three Phase 2000 CT Meter 5000	200	Three Phase 2000 CT Meter 5000
Street Light	-	-	-	Single Phase 500 Three Phase 2000 CT Meter 5000
Temporary Lighting	-	Single Phase 1000 CT Meter 5000	-	Single Phase 500 CT Meter 5000

Source: JICA survey team based on ESE information

The Electricity Law (2014) stipulates the method of determination of electricity tariff. The procedure for revising the electricity tariff is as follows:

(1) MOEP prepares for revising the electricity tariff;

(2) MOEP proposes a new electricity tariff to the President after deliberation at the Executive Committee (EC)[1];

(3) MOEP submits the new electricity tariff to the Myanmar Parliament after obtaining the President's approval; and

(4) MOEP publicly announces the new electricity tariff and the schedule after obtaining the Parliament's approval.

On the other hand, a local government can determine the electricity tariff in a region where it supplies electricity using its own mini-grid after consulting with the relevant ministries.

Before deliberating on the revision of the electricity tariff, MOEP should conduct meticulous investigations on the number and scale of general residents, factories, commercial facilities within ESE service area to gather data—materials necessary for calculating electricity rates. The electricity rate for general users is set at a level affordable to low-income users. The electricity rate for general users is set at 35 kyats/kWh, even though ESE purchases electricity from MEPE at 52 kyats/kWh.

In off-grid areas where ESE's distribution lines are not extended, some private companies operate electricity business by electricity generating facilities such as a diesel engine and a small hydro power station. Since the electricity supply cost differs from area to area, the electricity tariff in consideration of the supply cost is approved by a local government.

2.3.3 Tariff Collection

As is shown in Figure 2-7, payments of electricity tariff are typically made at the ESE township office where the user resides.

Meter bills are sent to customers via paper slips that ESE township staff write by hand based on meter reading values

Customers receive an invoice on the 11th to 15th day of each month, and pay it by the 16th to 25th day of every month by received date. If the payment is delinquent, then ESE has the authority to stop providing electricity to the user. If, after 4 months, the user still has not made the required payment, then ESE will cancel the electricity supply contract and physicaly remove the electricity meter from the user who has not paid. Figure 2-8 shows the schedule for Payment and Fines on late payment

The collection rate of electricity bills stood at 91% (on a value basis) in fiscal year 2013.

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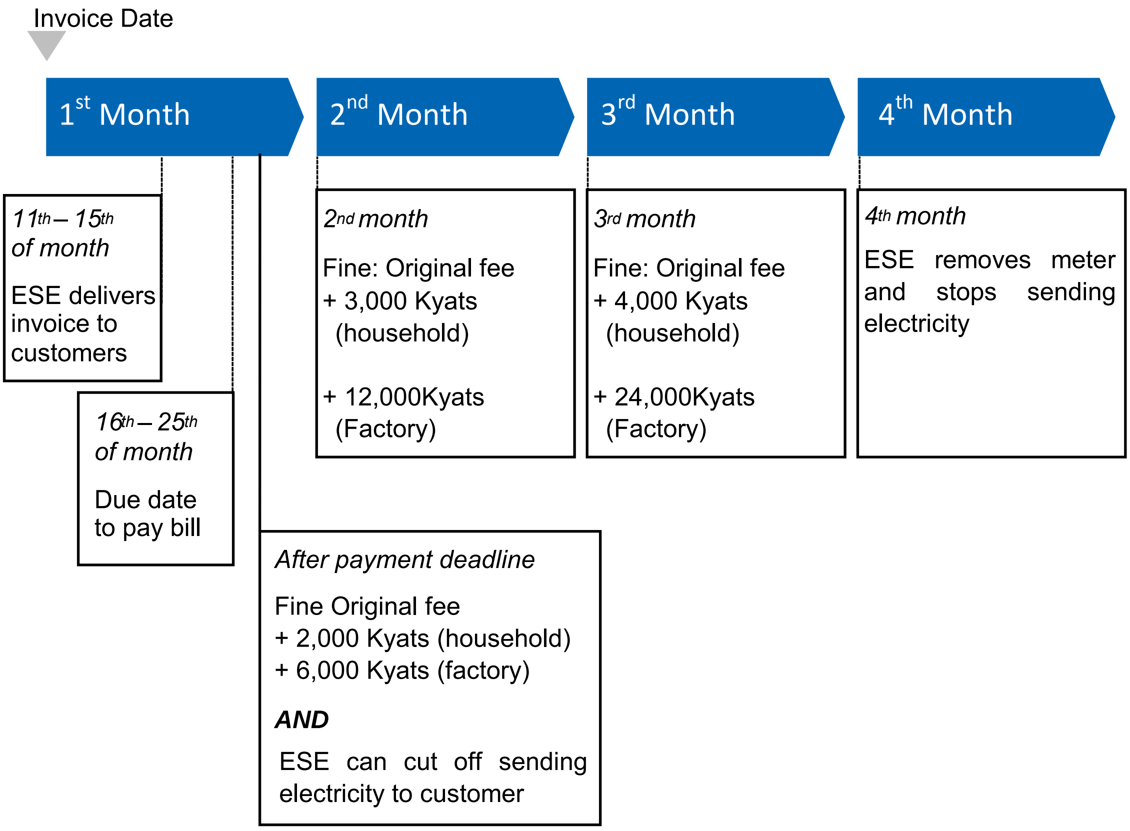
[1] The Executive Committee is a session which consists of the Minister and the Deputy Minister of Electric Power and top executives of MOEP and is held every week.

Source: JICA survey team

Figure 2-7: Tariff payment at the window of ESE township office
(Bago Township Office)



Source: JICA survey team based on ESE information

Figure 2-8: Schedule for Payment and Fines on late payment

2.4 ESE's Financials

2.4.1 ESE's Budget

ESE has been paying a certain percentage of net income before taxation for each fiscal year to the Myanmar government as a state contribution: all of profit before taxation before fiscal year 2011; and 20% of profit before taxation after fiscal year 2012. ESE acquires retained earnings after payment of corporate tax as 25% of profit before taxation from fiscal year 2012. Electricity tariff income and retained earnings carried over from the previous fiscal year are allocated for electricity purchase cost from MEPE, salaries and so on.

ESE and other governmental organizations pay the state contribution to the Myanmar government at the end of each fiscal year. The government distributes the state contribution and allocates funds for ESE to make capital expenditures through MOEP. ESE raises money from the Myanmar Economic Bank according to the budget approved by the government, and uses it for capital investment or operation/maintenance expenses. A system is established under which, ESE never falls into deficit, because ESE conducts capital investment and maintenance within the range of budget approved by the government.

The process of ESE's annual budget formulation is as follows:

(1) The Myanmar government allocates the budget for the next fiscal year to each Ministry;
(2) In parallel with the allocation of the budget by the government, ESE calculates its budget amount based on its capital expenditure plan and spending plan and submits it to MOEP;
(3) MOEP determines the allocation of budget to ESE with the government allocated budget as its upper limit;
(4) MOEP submits ESE's annual budget to the Ministry of Finance (hereinafter referred to as "MOF");
(5) MOF submits ESE's annual budget to the Vice President (acting as the President's proxy);
(6) MOF submits ESE's annual budget to the Parliament to obtain its approval;
(7) If the Parliament rejects ESE's annual budget, MOEP will reexamine and submit it to the Parliament again;
(8) MOEP approves ESE's annual budget after obtaining the Parliament's approval;
(9) Based on project priorities, ESE scrutinizes and approves budgets submitted by State and Region of ESE within its annual budget approved by the Parliament and MOEP.

The financial measures for ESE's capital investment in the future will mainly depend on the governmental budget allocation. In present conditions, the government approves around half of the budget that ESE applied for. The expansion and operation/maintenance of distribution facilities are expected to be implemented as planned by the ensuring and allocation of a sufficient budget according to the financial planning of the government.

2.4.2 Distribution Losses

The power loss rates of each voltage class, when the total power loss rate was about 25%, were; about 6 to 7% in 230 kV, 132 kV transmission and substation system, about 1 to 3% in 66 kV, 33 kV transmission[2], substation system, about 5% in 11 kV, 6.6 kV distribution system, and about 10 to 15% in 400 V or less distribution facilities.

Distribution losses (33 kV or less) in the ESE area for past 5 years are shown in Table 2-4.

ESE has reduced distribution losses from over 20% before fiscal year 2009 to 14% in fiscal year 2013. MOEP gave ESE instruction to reinforce the measures for the reduction of distribution losses. Therefore, ESE introduced a multi-transformer system and digital kWh meters etc. to reduce distribution losses, and improve its distribution loss rate year by year. And it is considered that the franchise system has also contributed to reducing distribution loss.

Table 2-4: Electricity losses (past 5 years)

(GWh)

Fiscal Year	Generation+Purchase from MEPE	Consumption by station Auxiliaries	Units Sold	Loss	
				Unit	Rate (%)
	a	b	c	d=(a-c)	e=d/a
2009-10	3,468.25	5.05	2,779.42	688.83	20%
2010-11	4,139.46	7.58	3,419.14	720.32	17%
2011-12	5,065.80	11.06	4,192.07	873.73	17%
2012-13	5,420.50	10.59	4,502.70	917.80	17%
2013-14	6,218.16	9.16	5,366.11	852.05	14%

Source: ESE statistics (2014)

2.5 Assistance by other donors

The Asia Development Bank (hereinafter referred to as "ADB") and the World Bank (hereinafter referred to as "WB") have been providing assistance to improve and expand the facilities of the Myanmar power distribution sector.

2.5.1 ADB assistance in power distribution sector

ADB has been assisting the Myanmar power distribution sector in the following four regions: Yangon, Mandalay, Sagaing, and Magway. ADB and Myanmar have already concluded a loan agreement to provide a total of US$60 million to fund projects that are planned from fiscal year 2015 to fiscal year 2017. ADB assisted projects include the construction and expansion of 33 kV substations and transmission lines and the replacement and construction of distribution lines below 11 kV and 400 V

[2] ESE calls supply lines from a low voltage to 33 kV “distribution lines.” In this report, 33 kV lines and 66 kV lines are basically called “transmission lines” and lines 11 kV and lower are called “distribution lines” in order to clearly identify the target.

distribution lines. Table 2-5 shows the outline of ADB-assisted projects in each region. Update on the progress of ADB-assisted projects at the end of March 2015: ESE headquarters invited a tender for the purchase of equipment in substations

Table 2-5: Outline of ADB assisted projects for distribution system improvement

Project Name	Power Distribution Improvement Project
Loan Amount (Counterparts)	US$ 60 million (ESE and YESC(YESB))
Project Period	from 2014 to 2017
Project Area	In Mandalay Region, Sagaing Region, Magway Region and Yangon Region
Projects to be carried out	Replacement and upgrading of substation and transmission line. Upgrading of 33 kV and 66 kV substation Construction of 33 kV and 11 kV transmission/distribution line Construction of 11 kV substation Replacement of aged pole with concrete pole Replacement of 400 V line with Aerial Bundled Cable (ABC) or Hard Drawn Bare Copper (HDBC) wire Replacement of electromagnetic (analog) meter with digital meter

Source: JICA survey team based on ESE information

2.5.2 WB assistance in power distribution sector

WB has been supporting electrification in local areas. In Myanmar, the electrification ratio still stands at around 30%. The government plans to raise the ratio to 47% by fiscal year 2020 by systematically electrifying rural areas. WB-assisted local area electrification project aims to promote electrification through the extension of existing distribution line grids. According to the plan, WB aims to increase the number of households connected to electricity by 1.7 million every year over the next five years. It targets achieving 100% household electrification in Myanmar by fiscal year 2030 by extending the grids.
In the first phase of its plan, WB will provide a total of US$30 million to fund electrification projects over five years from fiscal year 2015 to fiscal year 2019.

Update on the progress of WB-assisted local area electrification project at the end of March 2015: The Parliament is taking approval procedures for a loan agreement. A list of villages where electrification work is planned in fiscal year 2015 is prepared. Upon obtaining parliamentary approval for the loan agreement, procedures for procuring equipment will be taken.

Furthermore, WB has been assisting the corporatization of YESC and MESC through International Finance Corporation (IFC).

Chapter 3 Basic Information on Main Regional Townships

3.1 Overviews of various districts and townships

The basic information on the 32 main regional Townships is shown in this section which was collected to select around 10 cities, for each of which a 5 year improvement plan would be drafted.

According to the Myanmar Constitution enacted in 2008, administrative jurisdictions or subdivisions in Myanmar are townships, districts or states/regions. In this report, a city refers to an urbanized area within a district, usually the main township area within the district.

Source: JICA survey team based on ESE information

Figure 3-1: Location map of 32 main cities in Myanmar

3.1.1 Ayeyarwady Region

(1) Hinthada

Hinthada is located about 100 km northwest of Yangon, and the population of its urban area is 160,000. Rice production and milling is a flourishing industry in the area. Hinthada port is in the township, and rice and tobacco collected from the surrounding areas are transported to the port. There is an industrial zone, Hinthada Industrial Zone, in the township.

(2) Myaungmya

Myaungmya is located about 30 km southeast of Pathein in the delta area of the Ayeyarwady River, and the population of its urban area is 90,000. This area is noted for its flourishing rice production and milling. This is also the birthplace of U Nu, the first prime minister, and Mrs. Khin Kyi, the mother of Mrs. Aung San Suu Kyi, and Myaungmya was a leading center of anti-colonialism. There is an industrial zone, Myaungmya Industrial zone, in the township.

(3) Pathein

This is the capital of Ayeyarwady Region located about 150 km toward the west from Yangon in the delta area of the Ayeyarwady River. This is the second largest port town, following Yangon, in Myanmar, and the population of its urban area is 300,000. This township is the starting point of the so-called Ayeyarwady water transport, and the terminal point of the railway from Yangon via Hinthada. Rice production flourishes in the delta area. Harvested rice is milled in Pathein and transported to the heartland. Its handcraft industry is famous as well, and parasols produced in Pathein are renowned all over Myanmar. There is an industrial zone occupying a 1.2 km^2 of area in the township, and companies, both domestic and overseas including Japanese, have located in the park.

3.1.2 Bago Region

(1) Bago

This is the central township in Bago Region situated in the region's northern part, and the population of its urban area is 460,000. The township is famous as one of the historic cities, along with Mandalay and Bagan, of Myanmar and it flourished as the capital of a Mon Kingdom from the 13th century to the 16th century. Its main industries are tourism and agriculture (tobacco). A national highway and a railway pass through the township, which connect the township, via Yangon, to Mandalay, and a road and a railway that reaches Mawlamyine branch out in the north of Bago. In the western part of the urban area of Bago, Hanthawaddy International Airport is planned for the purpose of serving some of the functions of Yangon International Airport.

(2) Pyay

This is a township on the east bank of the Ayeyarwady River in the western part of Bago Region, and the population of its urban area is 220,000. Its main industries are agriculture which produces rice and other crops, silk farming and silk production based on it and tourism. Also, it serves as a relay point for water transport on the Ayeyarwady River. Pyay is situated on national highway 2, which runs northwest from Yangon, and a trunk road heading to Rakhine State branches out in the township. Also, a railway that leads to Yangon passes through it.

(3) Taungoo

Taungoo is a township situated in the northern area of Bago Region, and the population of its urban area is 230,000. Its main industry is forestry, producing mainly teak and other hardwoods. A national highway and a railway connecting Yangon and Mandalay pass through the township. Taungoo is the area where the Taungoo Dynasty was based from around the 14th century to the middle of the 18th century.

3.1.3 Chin State

(1) Hakha

This is the central township in Chin State where Chin people live in large number, and it sits at the foot of Mt. Rung at an elevation of 1,870m. Because of its location, it has a cold winter climate with the atmospheric temperature dipping as low as -2°C and with strong winds. The population of its urban area is 30,000, and its main industries are forestry and slash-and-burn agriculture. There is a road originating in Hakha and reaching Pakokku via Gangaw in the area.

3.1.4 Kachin State

(1) Bhamo

Bhamo is located near the border with China, and the population of its urban area is 110,000. Since Bhamo is located along the logistics route between China and Mandalay, trade in goods with China is flourishing.

There are future plans for a logistics terminal for goods from China and for the implementation of a railway connecting the township to Myitkyina.

At present, implementation of a 230 kV power supply system is being advanced in the area.

(2) Myitkyina

This is the capital of Kachin State, and the population of its urban area is 310,000.

Myitkyina is located along a logistics route originating in China and reaching Mandalay and is itself a distribution hub for goods.

A highway leading to Shwebo in Sagaing Region and a railway connecting the township to Bhamo and others are planned for the area, and the township is full of potential for development as a logistics hub.

3.1.5 Kayah State

(1) Loikaw

Loikaw is the capital of Kayah State along the border with Thailand and sits at the foot of a mountainous area at an elevation of approx. 900m. It is situated along national highway 5 and is the terminal point of a railway that branches out from Aungpan, which is the midpoint between Mandalay and Taunggyi on the railway line. Loikaw Airport is located in one of the suburbs of the township.

In a location 20 km east from Loikaw is Lawpita hydropower plant built as war reparations by Japan.

3.1.6 Kayin State

(1) Hpa-An

This is the capital of Kayin State, and its population is 110,000. It is located, about 150 km toward the east from Yangon, on the east bank of the Salween River.

In the township, the development of the Hpa-An Industry Zone is now being advanced.

Previously, an entry permit was required to enter this area. Recently, however, the area is open to tourists. Hpa-An Airport is in the township area, and future development of the tourism industry is anticipated.

3.1.7 Magway Region

(1) Chauk

A township located on the left bank of the Ayeyarwady River upstream from Magway, and the population of its urban area is 190,000. The areas surrounding Chauk has been an oil-producing region since the early 20th century. The township has developed as an oil shipment port, and there are oil-related facilities such as an oil refinery and oil transport facilities. Natural gas is also produced in the area. Chauk is located toward the north on national highway 2 from Magway. There is a railway in the area that branches at Bagan.

(2) Magway

Magway is the central metropolis in Magway Region and is located on the left bank of the Ayeyarwady River. The population of its urban area is 250,000. Its main industries are automobiles, agriculture (sesames and nuts) and the refining of sesame oil. This township is located on national highway 2, which runs from Yangon toward the northwest, and there is a trunk road that branches out from it toward Nay Pyi Taw. There is also a railway that reaches Magway from Nay Pyi Taw.

In Yaenanchaung, upstream of the Ayeyarwady River from Magway, is an industrial zone. The township is also a hub of inland water transport using the river network, and improving or implementation projects for its facilities are being advanced taking advantage of ODA loans.

(3) Minbu

This is the neighbouring township of Magway located on the right bank of the Ayeyarwady River. It is connected to Magway with the Magway Bridge. The population of its urban area is 70,000, and its main industry is agriculture (rice, millet, beans, sesame and tobacco). An LNG plant constructed with ODA loan in the 1980s is located in the township. There are construction projects planned for this area such as a plan to construct a 210-megawatt solar power plant by a Thai company named Green Earth Power and a plan to construct a trunk road and a railway connecting Minbu to Sittwe in Rakhine State.

(4) Pakokku

This township is located on the right bank of the Ayeyarwady River upstream from Chauk and 30 km northwest from the most prominent tourism site in Myanmar, Bagan. The population of its urban area is 140,000. Due to a typhoon that hit the area in October 2011, the Ayeyarwady River overflowed, creating a large-scale flooding disaster. Its main industries are agriculture (tobacco and Thanaka pigment) and water transport using the Ayeyarwady River. There is a railway in Pakokku that leads to Kalay, and the township is connected, with the Pakokku Bridge, to the NyaungU-Myingyan Highway. Pakokku Airport is also located in the area (albeit there are currently no regularly-scheduled flights).

3.1.8 Mandalay Region

(1) Mandalay District

Mandalay is the capital of Mandalay Region and the second largest metropolitan area, following Yangon, in Myanmar. The population of its urban area, 1,320,000, is second only to that of the 5,160,000 of Yangon’s metropolitan area.

Mandalay was the capital of Burma during the Konbaung Dynasty until 1885 when it was annexed by the British. Even today, the remains of Mandalay Palace can be seen in the central part of the district. In the northern part is Mandalay Hill that is interspersed with Buddhist temples, and this area is one of the leading tourist spots in Myanmar.

Mandalay is situated on the Ayeyarwady River and is a logistics hub for river transport. The District is also an access hub for railways leading to the main regional townships in the northern part of Myanmar. There is an expressway that connects Mandalay with Yangon via Nay Pyi Taw as well.

There are 7 townships in Mandalay District, and the operation of power distribution for less than 11 kV of electricity is relegated to private-sector companies in each township. The Myanmar Electricity Supply Enterprise (ESE) is responsible for the construction, operation and management of 33 kV power transmission lines and substations.

(2) Meiktila

Meiktila is located south of Mandalay between Nay Pyi Taw and Mandalay. The population of its urban area is 180,000. This township is close to an expressway that connects Nay Pyi Taw to Mandalay, and access to both areas is excellent. Furthermore, the starting point of a highway to Shan State is in the township.

In Meiktila, there is a 230 kV substation, and construction of a 500 kV trunk substation is planned in the future.

(3) Myingyan

Myingyan is downstream of Mandalay on the Ayeyarwady River and located in an area planned to be part of the Bangladesh-China-India-Myanmar Economic Corridor. Its urban area has a population of 170,000.

This township is a transit point for a gas pipeline with a total length of 2,500 km, which starts in Kyuakpyu and reaches China. There is a plan to construct a thermal power plant using gas.

(4) Pyinmana

Pyinmana is a neighbouring township of Nay Pyi Taw, and the population of its urban area is 190,000. There is a 4-lane road that connects the township with Nay Pyi Taw, making access to Nay Pyi Taw excellent.

The power distribution system in Pyinmana is under the jurisdiction of the ESE headquarters in Nay Pyi Taw.

(5) Pyinoolwin

Pyinoolwin has the second largest population, 280,000, in Mandalay Region, following that of Mandalay District, the capital of the Region. Pyinoolwin is situated on the Asian highway, and it is close to Mandalay District as well. Therefore, it has a lot of potential for development in the future.

3.1.9 Mon State

(1) Mawlamyine

This is the capital of Mon State with a population of 430,000 and the third largest township in Myanmar. It has been a port town on the bank of the Salween River for a long time and is at the starting point of the East-West Economic Corridor that connects Myanmar with Thailand and Vietnam. Road bridges and railway bridges crossing the Salween River have been opened for service, and a railway that runs down the Malay Peninsula passes through the township, raising people's hopes of becoming a logistics hub for the Indochina peninsula.

3.1.10 Rakhine State

(1) Sittwe

This township in the northern part of Rakhine State is the central township of the State where Rakhine people live in large number and it is located near the river mouth of the Kaladan River on the coast of the Bay of Bengal, which is close to the border with Bangladesh. The population of the urban area of Sittwe is 130,000, and its main industries are tourism (beach), marine products and shrimp farming. There is a road in this area that reaches Minbu in Magway Region via Minbu and Ann, and there is a plan to extend the railway between Minbu and Ann to Sittwe. Sittwe Airport is in the township. The majority of the State's residents are Rakhine people, many of whom are Buddhists (Theravada Buddhism), but significant numbers of Muslims and Hindus live in the State as well. There are sometimes clashes between Buddhists and Muslims, and people have died in such riots. The township has a plan for a Sittwe Deep Water Port.

(2) Thandwe

This is a township in the southern part, along the coast of the Bay of Bengal, of Rakhine State where Rakhine people live in large number. It is the most famous beach resort town in Myanmar. Ngapali Beach is 7 km toward the south from Thandwe. The population of the urban area of Thandwe is 60,000, and its main industries are tourism (Ngapali Beach) and marine products. Thandwe Airport, which serves as the entry point for Ngapali Beach, is located in the town. There is a plan to construct a Thandwe-Gwe-Ngathaingchaung Road in the area.

3.1.11 Sagaing Region

(1) Monywa

Monywa is located northwest of Mandalay District and Sagaing, and it can be reached, via a paved road, from Mandalay in about a 3 hour drive.

Monywa is rich in tourism resources such as mountains and lakes, and many sightseers visit the township from abroad.

Monywa's main industry is agriculture.

Monywa is located right in the corridor connecting India, Myanmar and Thailand, and it has the potential of vigorous development in the future.

(2) Sagaing

Sagaing is located on the opposite side of the Ayeyarwady River to Mandalay, and the distance from Mandalay is approximately 20 km. Access to Mandalay and Mandalay International Airport is excellent. The population of its urban area is 110,000. Sagaing is on the route of highways that access main regional townships such as Monywa and Pakokku from Mandalay and possesses the potential of becoming a logistics hub.

There are many Buddhist facilities in Sagaing, and the area around Sagaing Hill is interspersed with Buddhist sites, making the area a tourist spot.

(3) Shwebo

Shwebo is located northwest of Mandalay, and the population of its urban area is 180,000.

There is a plan in this area to construct a trunk road that will connect the township to Myitkyina, the capital of Kachin State.

3.1.12 Shan State

(1) Aungpan

Aungpan is a relatively small township at the foot of a mountainous area and along Asian highway 4 heading to Taunggyi via Meiktila. There is Heho Airport between Aungpan and Taunggyi, providing excellent access to Mandalay and Yangon.

(2) Kengtung

Kengtung is situated near the borders with Laos and Thailand in a mountainous area and is served by national highway 4 and Asian highway 4. Kengtung Airport is in one of its suburbs.

(3) Lashio

Lashio Township is located in the northern part of Shan State near the border with China and is the terminal point for national highway 3 and a railway reaching Mandalay. Lashio Airport is located in one of its suburb.

Along with Bhamo, this township is a hub in the logistics route originating in China and reaching Mandalay.

(4) Taunggyi

Taunggyi is the capital of Shan State, which boasts the largest land area of all the states in Myanmar. Its elevation from sea level is 1,400m, and the area has a comparatively cool climate with a maximum atmospheric temperature of around 30°C. Shan State has a flouring agriculture industry, and agricultural products are collected in Taunggyi and shipped to various regions of Myanmar.

Taunggyi is on the route of Asian highway 2 whose construction is currently being planned, and there is a plan for implementing a railway as well. An airport in the neighboring area of Heho provides access to Yangon and so on with flights.

3.1.13 Tanintharyi Region

(1) Dawei

Dawei is the capital of Tanintharyi Region, and the population of its urban area is 110,000. Its main industries are agriculture (rice and fruits such as coconut and durian) and fisheries. Dawei is situated on national highway 8 and along a railway that runs from Yangon to Myeik via Mawlamyine, and there is an airport, Dawei Airport, in the township. Dawei is near the border with Thailand. Along the coast 15 km toward the west and 20 km toward the north from Dawei's urban area, is Dawei Special Economic Zone, and a deep water port is planned there. Since Dawei is not connected to the national power grid, electricity generated with diesel-powered generators is supplied over 11 kV distribution lines.

(2) Myeik

Myeik is situated almost in the center of Tanintharyi Region on the coast of the Andaman Sea, and the population of its urban area is 150,000, which is greater than Dawei's. Its main industries are fisheries, marine product processing and agriculture (rubber and coconut). Ethnically this is a mixed area, and, other than Burmese people, the population is made up of ethnically Chinese, Karen, Indian, Mon and other inhabitants. The township is the terminal point of national highway 8, which runs from Yangon via Mawlamyine and Dawei. There is an airport, Myeik Airport, in the township as well. Since Myeik has no connection to the national power grid, electricity generated with diesel-powered generators is supplied over 11 kV distribution lines.

Basic information sheet of each city reflecting basic data such as population, daily load curve, and single line diagram of distribution line is shown in Appendix 1.

3.2 Population of each city

The Government of Myanmar conducted its most recent census in fiscal year 2014 with the aim of providing data for effective development planning, evidence-based decision-making, and to facilitate the reform process. More than 30 years have passed since the last census in 1983.

The result of the census in 2014 shows that the total population of Myanmar is around 51.48 million persons, although it was estimated at around 62 million persons before the census was conducted. The actual population is smaller by about 20%. The result of the census includes an estimated 1.2 million persons in parts of northern Rakhine, Kachin and Kayin States where the census was not conducted.

Table 3-1 shows the distribution of population by state and region according to the census.

"State/Region" in this table does not necessarily correspond to "State/Region" in the power facilities data as described below.

Table 3-1: Distribution of Population by State and Region

State/Region	Total	Proportion of Total Population
Union	51,486,253	100.0
Union (enumerated)	50,279,900	97.7
Union (not enumerated)	1,206,353	2.3
Ayeyawady	6,184,829	12.0
Bago	4,867,373	9.5
Chin	478,801	0.9
Kachin	1,689,441	3.3
Kachin (enumerated)	1,642,841	3.2
Kachin (not enumerated)	46,600	0.1
Kayah	286,627	0.6
Kayin	1,574,079	3.1
Kayin (enumerated)	1,504,326	2.9
Kayin (not enumerated)	69,753	0.1
Magway	3,917,055	7.6
Mandalay	6,165,723	12.0
Mon	2,054,393	4.0
Rakhine	3,188,807	6.2
Rakhine (enumerated)	2,098,807	4.1
Rakhine (not numerated)	1,090,000	2.1
Sagaing	5,325,347	10.3
Shan	5,824,432	11.3
Tanintharyi	1,408,401	2.7
Nay Pyi Taw	1,160,242	2.3
Yangon	7,360,703	14.3

Source: The 2014 Myanmar Population and Housing Census, The Union Report

3.3 Current conditions of power demand and supply

3.3.1 Peak demand and annual electricity sales

Table 3-2 shows the peak demand for power over the past three years (MW) and annual quantities of electricity sales (MWh) for the regional cities included in the survey.

Mandalay City is head and shoulders above other regional cities in terms of both peak demand for power and annual quantity of electricity sales. The figures for the other regional cities in the Mandalay Region are generally higher as well. As for increases in demand for power, they are high in almost all location. It is plausible that these increases are simply expressions of latent demand that had existed before the power equipment was beefed up. Therefore, it is not always possible to simply compare these figures. However, it can be assumed that demand for power will increase continuously in the future.

As for Dawei and Myeik in Tanintharyi Region, the peak demand for power and annual quantity of electricity sales are both relatively small. A contributing factor to this phenomenon is likely that electricity tariff rates in these townships are comparatively high—several times higher than those in other townships—because they are not connected to the national grid.

Table 3-2: Peak Demand and Annual Electricity Sale (32 cities)

State/Region	City	Peak Demand [MW]			Annual Electricity Sales [MWh]	Population[3] of Township (ten thousand people)
		FY2012	FY2013	FY2014		
Ayeyarwady	Pathein[4]	23.2	26.4	31.9	117,775	28.7
	Myaungmya	6.8	7.0	7.2	23,075	29.8
	Hinthada	5.7	6.0	6.5	25,500	33.8
Bago	Bago	17.5	19.7	21.8	93,618	49.1
	Pyay	9.6	10.0	12.3	97,506	25.1
	Taungoo	10.5	11.0	11.7	42,609	26.2
Chin	Hakha	1.0	1.0	1.1	2,676	4.8
Kachin	Myitkyina	10	11	12	41,988	30.5
	Bhamo	(No data)	4.1	5.3	(No data)	13.6
Kayah	Loikaw	6.3	6.6	8.1	(No data)	12.9
Kayin	Hpa-An	31	33	35	168,794	42.1
Magway	Magway	9.5	12.1	13.1	51,614	28.9
	Minbu	6.2	6.0	5.1	36,297	18.9
	Chauk	6.2	5.9	5.5	27,363	18.5
	Pakokku	12.5	11.4	10.6	40,951	29.0
Mandalay	Mandalay	174	197	248	1,049,837	172.6
	Pyinoolwin	35.4	38.8	50.8	90,168	25.1
	Myingyan	59.9	64.9	63.4	77,278	27.6
	Meiktila	33.5	34.7	41.2	10,764	30.9
	Pyinmana	8.0	10.1	12.4	66,634	18.7
Mon	Mawlamyine	17.7	21.1	26.1	84,161	28.8
Rakhine	Sittwe	2.5	3.0	3.0	8,283	14.9
	Thandwe	(No data)	(No data)	1	275	13.3
Sagaing	Sagaing	17.8	18.4	20.5	87,227	30.7
	Shwebo	9.6	10.4	12.0	35,211	23.5
	Monywa	19.0	22.1	27.0	107,507	37.2
Shan	Kengtung	4.0	4.5	5.6	13,926	17.1
	Taunggyi	16.0	18.0	20.0	67,942	38.1
	Aungpan	3.2	3.6	3.8	14,523	(ESE's Data)19
	Lashio	16.1	17.5	20.0	77,178	32.2
Tanintharyi	Dawei	3.1	3.5	4.5	12,603	12.5
	Myeik	2.8	3.1	3.8	11,560	28.4

Source: JICA survey team based on ESE information

3 Source from "The 2014 Myanmar Population and Housing Census, The Union Report"
4 Peak demand data of Pathein shows for Pathein district.

3.3.2 Capacity Utilization rate of distribution substations

A list of 33 kV power distribution substations owned by ESE in individual regional cities, and the capacities of its transformers and their operation rates as of December 2014 is shown in Table 3-3.

In some cities, ESE manages equipment for 66 kV as well. Transformers owned by private sectors and those owned by public authorities and the like are not included in this table.

As for the capacity utilization rates of the transformers, they were calculated based on the maximum load result in 2014, assuming a 80% or 90% power factor depending on the situation of each state/region.

At power distribution substations in regional cities under ESE, the capacity of many of the transformers being used is either 5 MVA or 10 MVA. The current usage rate is over 80% in many cases for such reasons as increased demand for power. For many of the substations, some measures such as replacement of existing transformers to higher capacity ones, additional transformer installation and new substation construction are required.

When the survey started, the national grid had not yet reached to Rakhine State and Tanintharyi Region. However, supply of power through the national grid is being realized for one state/region after another using funds budgeted by the Myanmar side.

Table 3-3: List of ESE's Distribution Substations (32 cities) (1/5)

State/Region	City	Distribution Substation	Voltage [kV]	Capacity [MVA]	Maximum Load [MW]	Capacity Utilization rate [%]	Remarks
Ayeyarwady	Hinthada	Hinthada	66/11	5	3.0	67%	
				10	4.5	50%	
		Total		**15**	—	—	
	Myaungmya	Myaungmya	66/11	4	3.0	83%	
				4	3.0	83%	
				5	2.5	56%	
		Total		**13**	—	—	
	Pathein	Downtown	66/11	20	9.8	54%	
		Myat Toe	66/11	10	4.7	52%	
				10	6.5	72%	
		(Industrial Zone)		10	—	—	before operation
		Total		**50**	—	—	
Bago	Bago	Substation(1)	33/11	10	5.8	73%	
				10	5.6	70%	
		Substation(2)	33/11	10	7.5	94%	
		Substation(3)	33/11	10	2.2	28%	
		Total		**40**	—	—	
	Pyay	Pyay	66/11	10	4.5	56%	
				20	9.5	59%	
			66/33	20	9	56%	
		Total		**50**	—	—	
	Taungoo	Rakhine Su	33/11	10	5.3	66%	
				10	5.3	66%	
		Total		**20**	—	—	
Chin	Hakha	(Hakha)	66/11	5	1.1	24%	
		Total		5	—	—	
Kachin	Bhamo	Bhamo	66/11	45	5.3	13%	
		Sint Khan	66/11	5	—	—	Start of operation in 2015
		Total		**50**	—	—	
	Myitkyina	Myitkyina No(3)	66/11	20	14.2	89%	
				10	—	—	under construction
				10	—	—	under construction
		Total		**40**	—	—	
Kayah	Loikaw	500 Acre	33/11	5	3.2	70%	
		Mai Ione	33/11	1	0.2	20%	
		Yawar Tan Shae	33/11	5	3.6	80%	Upgrade Plan (to 10 MVA) in 2015
		Industrial Zone	33/11	5	No Data	—	
		Total		**16**	—	—	
Kayin	Hpa-An	Hpa-An main	66/11	10+10	15	83%	
		Myaing gale	66/6.6	2	1.2	67%	
		Industrial	66/11	20	0.2	1%	owned by the industrial zone
		Total		**42**	—	—	

Table 3-3: List of ESE's Distribution Substations (32 cities) (2/5)

State/Region	City	Distribution Substation	Voltage [kV]	Capacity [MVA]	Maximum Load [MW]	Capacity Utilization rate [%]	Remarks
Magway	Chauk	Chauk	132/66/11	40	23.5	73%	owned by MEPE
		Total		**5**	–	–	
	Magway	Makyaikan	33/11	10	4.9	61%	
		Netmauk	33/11	10	8.2	102%	
		Total		**20**	–	–	
	Minbu	Minbu	33/11	5	2.5	63%	
		Total		**5**	–	–	
	Pakokku	Pakokku(1)	66/11	10	6.3	79%	
		Pakokku(2)	66/11	5	3.7	93%	
		Total		**15**	–	–	
Mandalay	Mandalay	Naung Kwel	33/11	10 10	5.6	31%	Newly installed
		Mayangyan	33/11	10 10	5.8 6.9	64% 77%	
		ShweKyaungGyi	33/11	5 10 10	2.4 6.3 7.0	54% 70% 77%	
		HayMarZala	33/11	10 15	5.7 11.7	63% 86%	
		OweBo	33/11	10 10	5.1 6.4	56% 71%	
		Wakhingone	33/11	10 10 10	6.8 5.3 7.0	75% 59% 78%	
		TiteTaw	33/11	10 10	5.3	29%	Newly installed
		76th Street	33/11	10 5 10	7.3 3.1 5.0	81% 68% 55%	
		KyaukChaw	33/11	8	3.1	45%	
		65th Street	33/11	10	6.3	70%	
		59th Street	33/11	10	6.7	74%	
		Industrial Zone2	132/11	18	8.3	51%	
		KyaukMee	33/11	5	1.6	36%	
		MyoMa	33/11	10	3.8	43%	
		HtunTone	33/11	10	6.7	74%	
		DaNone	33/11	10	6.2	69%	
		VarGaYar	33/11	10 10	9.3	52%	Newly installed
		ThinPanKone	33/11	10	3.5	39%	
		ChiPar	33/11	10	6.2	69%	
		Total		**306**	–	–	

Table 3-3: List of ESE's Distribution Substations (32 cities) (3/5)

State/Region	City	Distribution Substation	Voltage [kV]	Capacity [MVA]	Maximum Load [MW]	Capacity Utilization rate [%]	Remarks
Mandalay	Meiktila	Industrial Zone(2)	33/11	2	1.0	69%	
		Aung Sann	33/11	10	3.0	33%	
		Winn Zinn (1)	33/11	10 5	5.0 3.0	56% 67%	
		Industrial Zone(1)	33/11	5 5	2.5 2.5	56% 56%	
		Total		**37**	—	—	
	Myingyan	Saan Lon	66/11	10	4.0	44%	
		Kan Oe	33/11	10	5.5	61%	
		Se Me Khone(1)	66/11	5	1.5	33%	
		Se Me Khone(2)	66/11	10	2.5	28%	
		Sate Nyunt	66/11	10	0.5	6%	
		Thar Pound	33/11	5	0.3	6%	
		Total		**50**	—	—	
	Pyinmana	Pyinmana	33/11	10 5	7.5	56%	
		Paung Laung(2)	33/11	10	5.5	61%	
		Taung Tha	33/11	10	1.5	17%	
		Total		**40**	—	—	
	Pyinoolwin	Myowa	33/11	10	6.2	69%	
		Ngayantchaung	33/11	5	4.5	100%	
		TatNal	33/11	10	6.5	72%	
		Padaytha	33/11	10	2.9	32%	
		Kyuntapin	33/11	5	1.3	29%	connected to Watwon Hydro P/S (0.225MW×2)
		Yadanarbon	33/11	5	0.4	9%	
		21miles	33/11	1.25	0.2	16%	
		AnisokanMain	33/11	5	3.6	80%	
		Yadanarpon	33/11	10	2.0	22%	
		Total		**61**	—	—	
Mon	Mawlamyine	Mawlamyine	66/11	10	7.5	83%	
		Nyande	66/11	24	8.5	39%	
		South	33/11	5.0+3.15	4.5	61%	
		North	33/11	5	3.8	84%	
		Minder	33/11	5+5	3.3	37%	
		Total		**57**	—	—	
Rakhine	Sittwe※	Total amount of the capacity of 11/0.4 kV Transformers(※)		9	—	—	
	Thandwe※			No data	—	—	

(※)Dawei or Myeik has its own isolated power system that is not connected to Myanmar national grid, and ESE has neither 66/11 kV nor 33/11 kV substations.

Table 3-3:List of ESE's Distribution Substations (32 cities) (4/5)

State/Region	City	Distribution Substation	Voltage [kV]	Capacity [MVA]	Maximum Load [MW]	Capacity Utilization rate [%]	Remarks
Sagaing	Monywa	Monywa Township	33/11	10	6.5	72%	Enhancement plan in FY2015 (+10 MVA)
		Aungchanthar	33/11	10 10 5 5	2.9 2.2 3.8 2.6	32% 24% 84% 58%	
		Industrial Zone 1	33/11	10 5	7.7 2.9	86% 64%	
		Nanda Wun	33/11	5	3.3	73%	
		NaMaKha	33/11	2	0.8	44%	
		Plywood Factory	33/11	5	No Data	—	
		New Mynnae (Planned)	33/11	5	—	—	expected to commission at 2015
		Total		**67**	—	—	
	Sagaing	Zeyar	33/11	10	4.7	52%	
		Min Law	33/11	10	6.3	70%	
		Toung Fela	33/11	5	1.5	33%	
		Industrial Zone (1)	33/11	5	2.7	60%	
		Industrial Zone (2)	33/11	10	5.3	59%	
		Total		**40**	—	—	
	Shwebo	Thuzar	33/11	5 5	6.1	68%	
		Ntaung Bin Mar	33/11	10	3.6	39%	
		Industrial 1	33/11	5	2.4	52%	
		Total		**25**	—	—	
Shan	Aungpan	Aung Pan	66/11	5	3.8	84%	
		Total		**5.0**	—	—	
	Kengtung	(Total amount of 6 transformers)	33/11	6.5	—	—	
		Total		**6.5**	—	—	
	Lashio	Lashio main	66/33	20	No Data	—	
		Lashio main	66/33	20	No Data	—	
		Lashio 1	33/11	10	6.5	72%	
		Lashio 2	33/11	5+5	5.5	61%	
		Lashio 3	33/11	10	6.0	67%	
		Lashio 4	33/11	2.5	1.0	44%	
		Total		**35**	—	—	
	Taunggyi	Taunggyi No.1	33/11	10	7	78%	
		Taunggyi No.2	33/11 33/11	10 2	6	56%	
		Taunggyi No.3	66/11	10	5	56%	Upgrade Plan (to 20 MVA) in 2015
		Total		**32.0**	—	—	

Table 3-3: List of ESE's Distribution Substations (32 cities) (5/5)

State/Region	City	Distribution Substation	Voltage [kV]	Capacity [MVA]	Maximum Load [MW]	Capacity Utilization rate [%]	Remarks
Tanintharyi	Dawei※	Total amount of the capacity of 11/0.4 kV Transformers(※)		11.2	4.5	45%	
	Myeik※	(ditto)		10.0	3.8	42%	
	Total			**21.2**	―	―	

(※)Dawei or Myeik has its own isolated power system that is not connected to Myanmar national grid, and ESE has neither 66/11 kV nor 33/11 kV substations.

Source: JICA survey team based on ESE information

3.3.3 Distribution loss

Table 3-4 shows the distribution loss rate of each city the value of which was collected as basic information of each city. ESE normally calculates "Distribution Loss Rate" as "(Power from Distribution transformer) – (Electricity Sales)".

Table 3-4: Distribution Loss Rate of each city

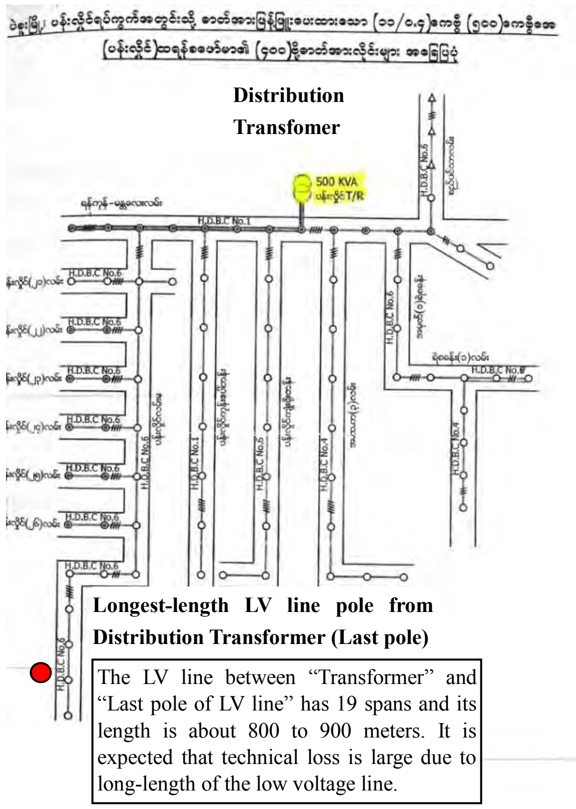
State/Region	City	Distribution Loss Rate (%)	State/Region	City	Distribution Loss Rate (%)
Ayeyarwady	Hinthada	34.5	Mandalay	Mandalay	20.5
	Myaungmya	23.0		Meiktila	18.4
	Pathein	19.8		Myingyan	29.3
Bago	Bago	23.8		Pyinmana	13.1
	Pyay	21.3		Pyinoolwin	21.1
	Taungoo	22.8	Mon	Mawlamyine	33.5
Chin	Hakha	26.0	Rakhine	Sittwe	33.0
Kachin	Bhamo	22.2		Thandwe	33.0
	Myitkyina	22.6	Sagaing	Monywa	23.5
Kayah	Loikaw	23.1		Sagaing	25.0
Kayin	Hpa-An	17.0		Shwebo	29.0
Magway	Chauk	23.9	Shan	Aungpan	24.5
	Magway	30.4		Kengtung	19.5
	Minbu	9.6		Lashio	25.1
	Pakokku	16.6		Taunggyi	24.7
			Tanintharyi	Dawei	19.0
				Myeik	19.0

Source: JICA survey team based on ESE information

High distribution losses can be attributed to technical loss caused by long-length low-voltage distribution lines (Figure 3-2) and the inadequate connection of low-voltage distribution lines (Figure 3-3), and non-technical loss, such as electricity theft [5] and inaccurate metering. Electricity theft is caused by illegal connection to low voltage bare wires or by tampering with meters. Since ESE regards distribution losses as a serious problem to be addressed, it has taken measures to reduce distribution losses, including upgrading facilities and balancing three-phase current.

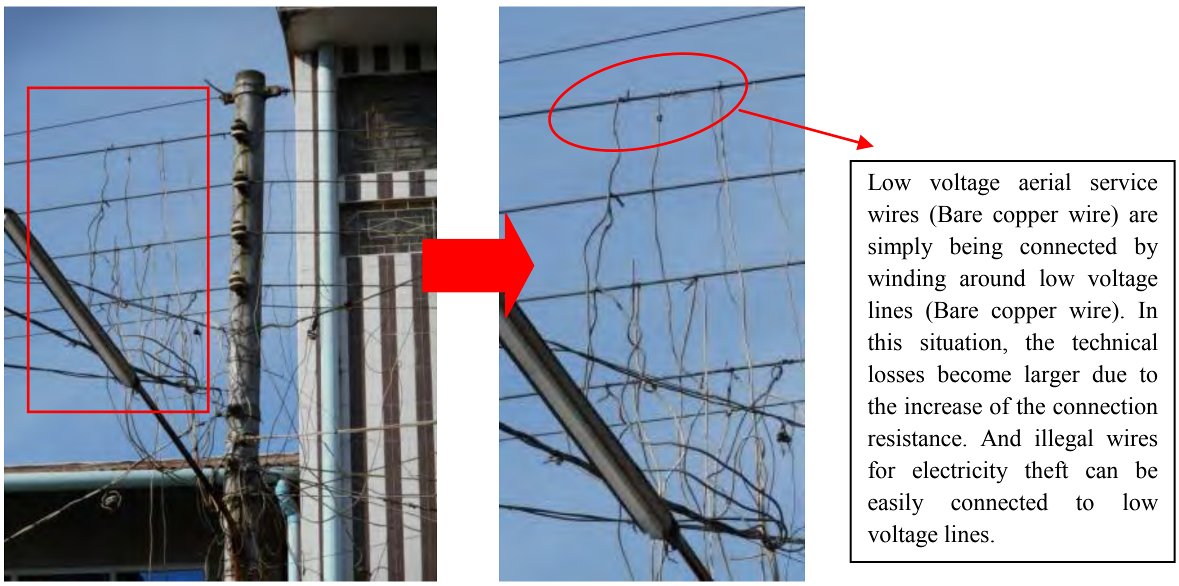
The 5 year plan includes measures that contribute to the reduction of technical loss, such as shortening the length of low-voltage distribution lines by reducing the capacity of the transformer through the introduction of a multi-transformer system and larger-size wires.

ESE has also tried to reduce non-technical loss by installing digital meters or replacement of bare wires with covered wires, which are expected to prevent an electricity theft and to improve the accuracy of meter reading.



Source: ESE Bago Township Office's drawing (Low voltage system)

Figure 3-2: Example of long-length low-voltage distribution lines



Source: JICA survey team

Figure 3-3: Example of inadequate connection of low-voltage distribution lines

[5] It is difficult to acquire measured value in which technical loss and non-technical loss are separated. The approximate value of technical loss can be calculated by using the value of wire resistance and current, but the data necessary for the calculation are so insufficient that the values of technical loss and non-technical loss cannot be separated at present.

3.4 Current conditions of distribution facilities

The quantities of distribution facilities for 33 kV, 11 kV and 400 V lines used in the 32 regional cities investigated in the survey (as of December 2014) are shown in Table 3-5.

Some power distribution facilities in local cities may break down or cause disasters to the general public due to aging or deterioration. (Figure 3-4) ESE tries to promote the replacement of the deteriorated facilities detected by visual checking in sites, even though the data about the specification or manufacturing date of each distribution facility is not usually managed. Although ESE has continuously tried to replace aged or deteriorated facilities, it has not been able to update all of them because it also needs to construct new facilities within its limited budget.

Source: JICA survey team

Figure 3-4: Example of aged or deteriorated distribution facilities
(left and center: pole with surface delamination / right: rusty crossarm for supporting wires)

Table 3-5: The Number of Distribution Facilities (33 kV, 11 kV and 400 V) (32 cities) (1/2)

State/Region	City	Transformers (11/0.4 kV)		Line Span Length [km] *(Average Span per pole* [m]*)*			No. of Poles		
		Total Capacity [MVA] *(Average*[kVA]*)*	No.	33 kV line	11 kV line	400 V line	33kV line	11 kV line	400 V line
Ayeyarwady	Hinthada	25.8 *(197)*	131		113 *(56)*	143 *(34)*		2,019	4,238
	Myaungmya	27.1 *(234)*	116		70 *(192)*	66 *(11)*		365	5,927
	Pathein	53.9 *(218)*	247		114 *(43)*	103 *(44)*		2,626	2,355
Bago	Bago	59.5 *(199)*	299	75 *(33)*	129 *(48)*	492 *(37)*	2,276	2,674	13,441
	Pyay	45.2 *(190)*	238		92 *(35)*	135 *(42)*		2,595	3,212
	Taungoo	30.8 *(186)*	166	12 *(122)*	91 *(55)*	163 *(38)*	98	1,659	4,280
Chin	Hakha	3.8 *(118)*	32		70 *(71)*	50 *(46)*		981	1,089

Table 3-5: The Number of Distribution Facilities (33 kV, 11 kV and 400 V) (32 cities) (2/2)

State/Region	City	Transformers (11/0.4kV)		Line Span Length [km] *(Average Span per pole* [m]*)*			No. of Poles		
		Total Capacity [MVA] *(Average*[kVA]*)*	No.	33 kV line	11 kV line	400 V line	33 kV line	11 kV line	400 V line
Kachin	Bhamo	16 *(174)*	92		74 *(60)*	63 *(36)*		1,225	1,750
	Myitkyina	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Kayah	Loikaw	24.9 *(201)*	124	29 *(35)*	83 *(51)*	97 *(3)*	818	1,615	38,489
Kayin	Hpa-An	33.4 *(190)*	176	24 *(53)*	173 *(61)*	232 *(37)*	453	2,831	6,336
Magway	Chauk	21.9 *(413)*	53		85 *(49)*	52 *(37)*		1,724	1,407
	Magway	39.7 *(213)*	186	28 *(39)*	75 *(42)*	137 *(47)*	722	1,768	2,908
	Minbu	12.3 *(208)*	59	4 *(10)*	41 *(76)*	49 *(48)*	372	543	1,049
	Pakokku	46.5 *(292)*	159		170 *(85)*	109 *(12)*		1,992	9,098
Mandalay	Mandalay	760.3 *(267)*	2,847	384 *(66)*	689 *(52)*	1,265 *(51)*	6,060	13,294	24,773
	Meiktila	93.0 *(213)*	436	442 *(73)*	344 *(46)*	382 *(32)*	6,070	7,458	11,864
	Myingyan	54.0 *(323)*	172	21 *(54)*	136 *(41)*	126 *(39)*	391	3,342	3,235
	Pyinmana	45.5 *(215)*	212	9 *(39)*	125 *(37)*	113 *(31)*	231	3,376	3,656
	Pyinoolwin	99.0 *(204)*	485	166 *(61)*	181 *(29)*	260 *(36)*	2,742	6,308	7,138
Mon	Mawlamyine	59.5 *(242)*	246	15 *(41)*	135 *(40)*	176 *(40)*	366	3,417	4,452
Rakhine	Sittwe	9.2 *(213)*	43		63 *(209)*	77 *(247)*		301	312
	Thandwe	No Data	No Data		No Data	No Data		No Data	No Data
Sagaing	Monywa	81.7 *(213)*	384	57 *(65)*	240 *(45)*	296 *(33)*	871	5,314	8,889
	Sagaing	71.7 *(238)*	302	32 *(68)*	229 *(67)*	215 *(38)*	470	3,400	5,615
	Shwebo	37.0 *(173)*	214	28 *(29)*	232 *(45)*	213 *(36)*	977	5,100	5,848
Shan	Aungpan	11.2 (158)	71	1 *(83)*	45 *(60)*	53 *(36)*	6	750	1,459
	Kengtung	20.4 *(169)*	121	21 *(84)*	93 *(50)*	350 *(83)*	249	1,844	4,227
	Lashio	48.8 *(190)*	256	85 *(82)*	95 *(37)*	350 *(83)*	1,040	2,534	4,227
	Taunggyi	46.6 *(224)*	208	23 *(79)*	102 *(41)*	321 *(153)*	292	2,517	2,100
Tanintharyi	Dawei	11.2 *(280)*	40		45 *(72)*	76 *(39)*		625	1,946
	Myeik	10.0 *(200)*	50		36 *(62)*	34 *(20)*		580	1,741

Source: JICA survey team based on ESE information

3.4.1 Distribution transformers (11/0.4 kV)

The ownership of distribution transformers in Myanmar varies: some are owned by ESE, others are procured and owned by villages to which distribution of power has been extended, and still others are owned by large-lot electricity users. Their capacities also vary, ranging from 50 kVA to around 500 kVA, with the average capacity being approximately 200 kVA. It seems that the problems such as distribution power losses and voltage drops caused by high-capacity transformers and long-length low LV distribution lines, which are prevalent in Yangon city, have not yet become apparent in main cities.

Degradation due to aging seems to be progressing for some of the 11 kV distribution transformers. At ESE, management of transformers based on their production years is not practiced, nor is their methodical replacement. Instead, 11 kV distribution transformers are repaired or replaced after the abnormality of them is detected by visual check in patrol, or after they break down.

3.4.2 Transmission/Distribution lines

As shown in Table 3-5, 33 kV transmission lines do not exist in some cities because 11 kV lines are used to draw power from 66/11 kV distribution substations. In other regions, 33 kV transmission lines do not exist because some cities such as Dawei and Myeik in Tanintharyi Region and Sittwe and Thandwe in Rakhine State are not connected to the national grid, and power is generated by diesel power generators and transmitted directly over 11 kV distribution lines.

Many of the wires used as 11 kV or 400 V distribution lines are bare wires. Recently, some division or state offices or township offices have begun to request a budget item for replacing bare wires with covered wires to reduce line failures due to their coming into contact with trees or the like and to secure public safety.

An overcurrent protection relay and an earth-fault current protection relay are normally installed on a 33/11 kV distribution substation as protective equipment for an 11 kV distribution line. But some of them are malfunctioning due to aging. Since the calculation for each distribution feeder is not reflected to the adjustment of a protection relay, it cannot detect a distribution line fault and break the circuit appropriately, which causes wider blackout area and longer blackout time. Therefore, the improvement of capability for relay adjustment based on accurate calculation is required so that the relay can shut the area of failure precisely.

Lately, the extension of 11 kV distribution lines to the surrounding areas of a city is being advanced. The WB has a policy of expanding the distribution grid to advance the electrification of regional areas. There are plans to extend 11 kV distribution wires into city suburbs in the future.

3.4.3 Poles

Concrete poles are generally used in the main regional cities. However, steel poles and wooden poles are also used in many cases. Many of the existing steel or wooden poles are no longer strong enough to be in service due to aging or lack of strength. Also, with concrete poles, problems occur such as peeling or cracks. Replacing aging electricity poles is one of the top-priority measures, along with replacing wires, which must be advanced from the viewpoint of securing public safety and other objectives. In some cities, the replacement of aging or deteriorated poles with new concrete poles is being advanced as a priority measure.

3.4.4 kWh Meters

As shown in Table 2-3, kWh meters are installed at the expense of customers. In the past, analog meters were installed, but meter seals were not used on analog meters, and periodical replacement of meters or control of validity term based on meter calibration system was not conducted. This situation may have contributed to non-technical losses due to electricity theft and inaccurate meter readings.

At present, digital meters are mainly installed, and the replacement of analog meters by digital meters is being conducted in the main regional cities.

One advantage is that meter reading for digital meters can be conducted by using handy terminals. This contributes to labor-saving for meter reading work, and compared to analog meters, digital meters are effective for reducing non-technical loss in the following aspects;

- Prevention of illegal tampering with a rotating disk with electromagnetic induction or illegal alternation of wire-connection by non-use of mechanical parts
- Reduction of loss due to the deficiency of rotation of disk while power consumption is very small
- Prevention of incorrect meter reading by virtue of the introduction of the remote automatic metering system
- Prevention of illegal connection by installing meters at a leading-in pole that is enabled by the remote automatic metering system

Figure 3-5 shows examples (pictures) of installation of kWh meters.


Source: JICA survey team

Figure 3-5: Example of installation of kWh meters
(Left: analog meter in Dawei city / Right: digital meters installed on a pole in Bago city)

3.5 Current policies on distribution improvement and latest improvement plan

ESE has no standard policy on the formulation of a 5 year improvement plan. Toward the construction of electricity facilities in Myanmar, the Electricity Law (2014) stipulates the purpose of the Electricity Law as follows.

The objectives of this law are as follows

(a) To systematically manage, in accordance with the present policies of the Union government, electricity activities in order to better develop the electric power sector, to satisfy the country's need for electric power and to supervise and control electricity activities ;
(b) To encourage more large-scale electric power generation and distribution projects which the Union may manage, and mid-sized and small-scale electric power generation and distribution projects in the regions and states;
(c) To enable the wider use of electric power without the occurrence of electrical hazards;
(d) To perform electricity activities in conformity with the prescribed standards and norms;
(e) To increase foreign and local investment in electricity activities;
(f) To write and promulgate equitable, transparent and reasonable rules and regulations for fixing electric power rates depending on the area;
(g) To enable power consumers to use electric power with a voltage and frequency conforming to the standards and norms, and to prevent damage and loss to their electrical appliances due to electric power this is not in conformity with the standards and norms;
(h) To respect and comply with the international conventions on environmental conservation, approved and signed by Myanmar.

Each district office has their respective policy depending on their distribution system conditions. One of the main policies in each district is the installation of additional 33 kV or 66 kV substation transformer capacities to meet increasing peak power demand. The 11/0.4 kV distribution transformer system also needs additional capacities to supply consumers demand.

- ✓ To meet increasing peak demand
  -installation of additional transformers, installation of additional transmission and distribution lines, etc.
- ✓ To reduce power distribution losses
  -larger-size wire, Multi-transformer system, installation of digital meters, etc
- ✓ To prevent electrical accidents in public
  -installing covered wire, Replacing deteriorated poles with concrete poles, etc.
- ✓ To improve distribution reliability
  -installation of N-1 policy, installation of reactive power facilities, etc.

Each ESE division or state office formulates their project budget for construction, enhancement and repair of distribution facilities according to its latest 5 year distribution network improvement plan, and submits its budget application to ESE headquarters or the local government. However, they have been required to select and invest in projects with urgent needs, because ESE headquarters or local government has approved only a part of the applied amount due to the shortage of funds. This turns into a vicious cycle whereby the ESE division or state offices are each year reluctantly forced to postpone part of their projects that cannot be implemented till the next fiscal year. For the above reason, even though the 5 year plan from 2015 to 2019 has been already formulated, the implementation schedule of many projects in the plan may be remarkably delayed. The formulation of an expansion plan based on the policy and the allocation of the budget for project implementation are required so that the formulated 5 year plan can be implemented.

In regional cities, each ESE division or state office gathers and analyzes information on power demand trends to formulate its 5 year plan and prepares a basic design of new substations. However, since the number of engineers in each division or state office is limited, the small number of engineers engages in everything from gathering information on power demand trends, forecasting power demand, formulating the 5 year plan, and preparing basic designs. The collection and analysis of information related to these tasks are not always implemented adequately. Since know-how for forecasting future demand or formulating a 5 year plan is not commoditized in the whole of ESE, the projection of power demand and the formulation of the 5 year plan owe a great deal to the engineers in charge, who possess remarkable talent.

When power demand grows along with the development of local cities in the future, the needs for power distribution systems and the amount of work for constructing new facilities inevitably increases. Taking into account the future burden trends, ESE needs to work out a synthetically low-cost and efficient 5 year plan.

It is considered necessary to formulated efficient facilities expansion plans after ESE engineers acquire the skill of the formulation of the efficient facility plan and the skill becomes commoditized in ESE whole while implementing the project with donors.

The ESE division or state office’s 5 year plan is not necessarily consistent with the upper 500 kV, 230 kV and 132 kV trunk power system’s expansion plan formulated by MEPE. This is because MEPE formulates the upper trunk power system’s expansion plan without summarizing ESE’s 5 year plan. New substations cannot be built in the location initially planned by ESE, since the ESE division or state office works out the lower system’s expansion plan in accordance with the future expansion plan prepared by MEPE. Moreover, new substations cannot be built in the year originally planned by ESE, since the completion year of the upper system facilities is not certain.

The bottom-up approach (from the forecast of lower system demand and the distribution system investment plan) is considered to be effective for formulating an efficient and effective power system expansion plan. Recently, MOEP tried planning with the bottom-up approach such as the formulation of upper power system plans base on ESE's 5 year plan.

3.6 Framework of planning, design, and construction of distribution facilities

The Electric Distribution Department in the ESE headquarters is responsible for the engineering operations of distribution facilities, including the planning of construction plans, budgeting, design, specification examination, and ordering.

3.6.1 Construction budget

The ESE division or state offices prepare a budget for the construction of distribution facilities below 11 kV based on the construction unit price list prepared by ESE headquarters and the construction work starts after obtainment of the local government's approval.

The ESE division or state offices file an application regarding construction of facilities of 33 kV or higher to the ESE headquarters. The Electric Distribution Department in the ESE headquarters chooses projects from the applications submitted by division or state offices and prepares a budget after scrutinizing their construction expenses. The ESE headquarters has a standard construction unit price list for distribution facilities and uses the price list to scrutinize the construction expenses. The construction unit price list is prepared based on past cases and is updated every year.

3.6.2 Basic design, specification examination

The Electric Distribution Department in the ESE headquarters draws up a basic design of the construction. The ESE prepares and holds the standard specification and design drawings of each facility. The Electric Distribution Department develops a basic design of each project based on these assets. The department also examines the specifications of the equipment. The Electric Supporting Engineering Department is responsible for civil design operations.

3.6.3 Project ordering

ESE places its orders for projects on a turnkey basis. The Electric Distribution Department prepares tender documents. ESE places all contracts through a tender after packaging construction work, including repair works, under a single contract. The contract for power transformers with a capacity of 33 kV or higher are independently put to tender.

ESE does not adopt a registration system for service providers, it puts all contracts out to open tender. Since ESE invites only local tender for its construction work and equipment, except in the case of a project supported by a donor, bidders must include a contractor in Myanmar in their consortium to participate in the tender. Overseas service providers need to form a joint venture with a contractor in Myanmar to respond to a solicitation for bids. ESE does not use consultants to implement its projects.

ESE evaluates the documents submitted by bidders from the perspectives of technical and cost effectiveness, giving 70% weight to technical factors and 30% to cost factors. One of the technical evaluation items is a proven track record of similar projects. Whether or not a bidder has experience of engaging in similar work ordered by ESE, MEPE or YESB in the past may hold the key to winning the contract.

3.6.4 Detailed design, construction management, and succession

The successful contractor draws out a detailed design of the construction. ESE approves the design documents.

The project manager for the construction is selected from the ESE division or state office located in the area of the construction. A team, made up of several members, manages the construction work. Persons in charge in ESE headquarters offer support as necessary and also participate in the completion inspection. There are some ESE persons in charge who have enough experience in construction site supervision, because substation construction work has been conducted in each local area in recent years.

After completion, the facilities are passed from ESE headquarters to the ESE Township Office that operates and maintains them. The staffs in each ESE township office update and manage single-line diagrams or equipment layout figures that are the basic information necessary for maintenance work. Each ESE office prepares and stores necessary drawings, although they are not necessarily the latest version.

3.7 Operation and maintenance of distribution facilities

3.7.1 Responsibility demarcation of 66 kV and 33 kV facilities

The voltage classes ESE employs include 66 kV, 33 kV, 11 kV, 6.6 kV, 400 V and 230 V. Regarding 66 kV and 33 kV facilities, responsibility demarcation between ESE and MEPE is set in aspects of construction (installation) and operation/maintenance.

Regarding transmission/distribution lines, basically 66 kV transmission lines are constructed and operated/maintained by MEPE, and 33 kV transmission lines are constructed and operated/maintained by ESE. Regarding substations, 66/11 kV substations are constructed by MEPE and operated and maintained by ESE. 33/11 kV substations are constructed and operated/maintained by ESE. That is the basic responsibility; however, small scale 66 kV transmission lines and 66 kV substations are constructed by ESE. Table 3-6 shows the responsibility demarcation points between ESE and MEPE (66 kV and 33 kV facilities).

Table 3-6: Responsibility demarcation between ESE and MEPE (66 kV and 33 kV facilities)

Facilities	Construction (Installation)	Operation and maintenance
66 kV transmission line	MEPE	MEPE
66 kV substation	MEPE	ESE
33 kV transmission line 33 kV substation Small scale 66 kV transmission line and substation (5 MVA and less substation and its incoming line)	ESE	ESE

Source: JICA survey team based on ESE information

3.7.2 Operation and maintenance of distribution facilities

ESE's distribution facilities are operated and maintained by township office engineers.

All 33/11 kV and 66/11 kV substations are manned. Engineers and linemen are engaged in 24 hour operation of substations by rotation. Load current (A), load voltage (V), maximum power (MW) and power factor (%) are recorded every hour. Electric facilities are checked by patrol though daily work. There is no checklist for patrol. Distribution lines and 11/0.4 kV transformers are checked by patrolling once a month.

Shutdown maintenance is conducted to inspect distribution facilities once in three months. The inspection is conducted for about four hours from 6 am to 10 am on a Saturday or Sunday, taking advantage of the shutdown maintenance in the upper system by MEPE. The main inspection contents are the following.

Transformer: insulation resistance test, insulation oil withstand voltage test (twice a year)

CT, PT: insulation resistance test

GCB: insulation resistance test, switching operation test, on/off time measure, gas pressure/leakage test

DS, ES: manual switching operation test, contact state test

As for distribution line inspection, insulation resistance test of a distribution transformer, cutting trees and replacement of insulators are also conducted during shutdown maintenance. These inspections are conducted by ESE township engineers and linemen. As for tree cutting, the approval for cutting problem trees against 11 kV or lower distribution lines is unnecessary, but the submission of the implementation schedule to the government and their approval for cutting trouble trees against 33 kV transmission lines are necessary.

Before shutdown inspection, a township engineer announces the shutdown outage to the residents in the outage area in the newspaper and on FM radio.

Troubleshooting is performed by ESE staff. Troubleshooting of a distribution facility is done by its contractor within the warranty period. For example, when a problem with a 33/11 kV transformer occurs out of warranty, ESE repairs it if they can. It is replaced with a spare transformer as an emergency measure, if they cannot repair it. ESE usually has some spare facilities. An order is placed for a problem transformer by bidding, and then, the repaired transformer returns to where it was. A transformer repair is bid for by several contractors usually.

There are some ESE staffs who have the ability to handle failures, because they have many opportunities to repair faulty distribution facilities by themselves. But their repairs are not sufficient so that a longer life after repair can be expected, in some cases they use unofficial parts or components for repair. There are some sites where distribution facilities with low reliability are being operated.

3.7.3 Power outage record management

ESE records and manages daily outage results on paper. The outage substation name/feeder name, outage time (starting, closing, duration), cause, done/not done are recorded in a recording format in each township office or district office. These outage results include not only a failure outage but also a scheduled outage.

A township office informs the district office of monthly outage results, and the district office informs the headquarters of monthly outage results in the district. The headquarters informs the vice minister (MOEP). Examples of electricity outage records are shown in Table 3-7 and Table 3-8.

Table 3-7: Examples of electricity outage record
(e.g.1 33kV feeders in Mandalay District Office)
List of Myaukpyin Main Power Station Electricity Shortage in 2014, October

No	Feeder Name (33 kV)	Max Load (MW)	Reason of Shortage							Remarks
			System Break	Maintenance Repair	Reduce Load	Line Fault	UFR	Shortage Time	Hours	
1	Owe Bo	13.4	-	2 8:09	-	2 02:17	1 00:06	5	10:32	
2	Tike Taw	4.7	-	1 01:50	-	-	-	1	1:50	
3	Ma Yann Chan	16.2	-	2 07:16	-	11 00:41	-	13	7:57	
4	Hay Mar Zala	16.51	-	1 01:51	-	3 01:02	-	4	2:53	
5	War Kin Gone	18.61	-	3 08:19	-	4 00:08	3 00:15	10	8:42	
6	76 Street	16.1	-	3 05:22	-	2 00:14	-	5	5:36	
7	Shwe Kyaung Gyi	15.12	-	1 01:59	-	2 01:28	3 00:15	6	3:42	

(*) UFR: The shortage occurred due to the operation of the under frequency relay (UFR) when the frequency became lower than a specified value.

Source: JICA survey team based on ESE outage record

Table 3-8: Examples of electricity outage record
(e.g.2 11 kV feeders in Bhamo Township Office, from January to October, 2014)

No	Name of month	Line Fault (hh:mm)	Shut Down (hh:mm)	System Break Down	Occurring the reason
1	Jan-14	(4) Time (5:08)	(5) Time (4:08)	-	**Fault** - Car accident (2)Time,Tree Broken (3) time.
2	Feb-14	(7) Time (12:27)	(5) Time (3:49)	-	**Fault** -Tree Broken (3) time.Tension Insulator broken (3) time, Transformer 400V cable wire shock.
3	Mar-14	(9) Time (26:02)	(5) Time (5:01)	-	**Fault** - Tree Broken (3) time,Car accident (1)time , Transformer 400V cable wire shock(1)time, Broken the Pole(1)time, Bamboo fall (3)Time.
4	Apr-14	(8) Time (26:02)	(17) Time (5:01)	-	**Fault** - 11kV Coconut tree fall on the 11 KV Line (1)Time, Car accident (2)Time, Transformer 400V cable wire shock .(2)Time,Broken the Pole(1)time; Tree contiguous (2)Time.
5	May-14	(13) Time (17:42)	(22) Time (28:36)	-	**Fault**- bamboo contiguous (2) time , Transformer 0.4 KV cable wire shock(3) time 4 Pole structure cable wire shock(3) time ,touched the 11 KV line with car (1) time,Teak broken (1) time , Contiguous the tree (2) time tension Insulator broken (1) time.
6	Jun-14	(21) Time (49:10)	(25) Time (37:44)	-	**Fault**-11 KV cross Arm broken (1) time , Transformer breaker burnt (1) time, Transformer 0.4 KV cable wire shock (2) time ,touched the 11 KV line with car (2) time, Car accident (2)Time,tree loaded (4) time , touched the tree (3) time ,touched the bamboo (3) time, broken the banyan (1) time.
7	Jul-14	(11) Time (33:30)	(11) Time (24:12)	-	**Fault**-6 pole structure cable wire shock (1) time Transformer cable wire shock(2) time, touched the 11 KV line with car (1) time,touched the tree (4) time ,touched the bamboo (2) time,Line fault in the Army (2) ti me.

Source : ESE outage record

Table 3-9 shows the breakdown of the outage cause of distribution feeders in Bhamo Township Office the part of outage record of which is shown in Table 3-8.

Table 3-9: The outage causes of distribution feeders
(from January to October, 2014 in Bhamo Township Office)

Outage Causes of distribution feeders		Number of outages
Destruction of facilities due to other objects	Vehicle crash etc.	9
	Fallen tree etc.	24
Contact with other objects	Contact between a car and a wire	4
	Contact with trees or bamboo	30
Defectiveness of facilities	Insulators	10
	Transformers, cutouts burning	6
	Defective cable	9
	Defective insulation of wires	3
	Line short-circuit	2
	Fallen poles	3
	Crossarms	1
	Fuses of disconnectors	1
	Falling of binds	1
Natural disaster	Lightning	1
	Strong wind	3
Other	Spreading faults from the accident of a customer	4

Source: JICA survey team based on ESE outage record

The monthly outage (failure outage, and scheduled cut-off) times and hours are summarized in each division or state office. The number and the durations of outages can be reduced by taking appropriate measures based on an analysis of outage data by cause or by site. It seems that ESE does not analyze outage records for specifying causes of failure and ESE cannot take measures to prevent from failure in current situation.

Table 3-9 shows that destruction of facilities due to other objects and contact with trees or bamboo are overwhelmingly the major outage causes. Therefore, the strengthening of facilities by replacement of poles and reduction of grounding faults by replacement of bare wires by covered wires are effective measures for the improvement of supply reliability.

Chapter 4 Selection of Targeted Cities for Formulation of Distribution Network Improvement Plan

4.1 Criteria for selection of target cities

After arranging basic information of each of 32 regional cities, criteria for selection of target cities were established in order to select, from the 32 regional cities, around 10 cities, for each of which a 5 year plan would be drafted. As an objective evaluation index, the following seven evaluation items were adopted and each item was given a score in its evaluation for each city, and the cities were compared based on their resultant scores according to the index.

a) Capacity utilization rate of the transformers
b) Capacity utilization rate of the whole city
c) Increase rate of peak demand
d) Electrification ratio
e) Peak power demand
f) Maximum distribution loss rate
g) Population

In the scoring of an evaluation item, a basic score, 1, 2 or 3, was given to the value of each item. For example, in case of "Capacity utilization rate of transformers", a score of "3" was given to a city with a substation whose transformer's utilization rate is 80% or more because it would need to be enhanced, "2", for 60% to 80%; and "1" was given to the city without a substation whose transformer's utilization rate is 60% or more. The basic scores for some items were weighted in consideration of the importance of improvement. The weight of “Capacity utilization rate of the transformers” or “Peak power demand” directly linked to the capacity of power supply was set at “3”. The weight of “Maximum distribution loss rate” that decreases the capacity of power supply and causes economic losses was set at “2”. And the weight of other items was set at “1”. Only "Population" of Chauk city was given a "zero" score, because no data for it could be collected at the stage of collection of basic information.

The results of the evaluation based on the scored seven criteria are shown in Table 4-1.

Table 4-1: Selection list on target cities for further survey (1/2)

State / Region	No.	City	Capacity utilization rate of the transformer Transformer no. of utilization ratio 80%	 60%	Capacity utilization rate of the whole city Power ↓ 90% [%]	Increasing rate of Maximum Demand 2012 ↓ 2014 [%]	Electrification Ratio Ratio[%] Electrified households [No.] Total households [No.]	Maximum Demand [MW] 2012	 2013	 2014	Maximum Distribution Loss Rate Monthly maximum rate [%]	Population [ten thousand people]	City Score	 Rank
								Increasing ratio in 2014[%]						
Weight				3	1	3	1	—	—	1	2	1		
Ayeyarwady	1	Hinthada	0	0 1 Point	48.1% 1 Point	14.0% 1 Point	16.7% 15,953 95,503 3 Point	5.7 — —	6.0 5% —	6.5 8% — 1 Point	34.5% 3 Point	16 2 Point	Hinthada 19 Point	15
Ayeyarwady	2	Myaungmya	0	0 1 Point	59.8% 1 Point	2.9% 1 Point	3.7% 10,689 290,000 3 Point	6.8 — —	7.0 3% —	7.0 0% — 1 Point	23.0% 2 Point	9 1 Point	Myaungmya 16 Point	27
Ayeyarwady	3	Pathein	0	0 1 Point	0.0% 1 Point	37.5% 2 Point	9.6% 29,428 307,285 3 Point	23.2 — —	26.4 14% —	31.9 21% — 2 Point	19.8% 1 Point	30 3 Point	Pathein 20 Point	8
Bago	4	Bago	0	0 1 Point	69.2% 2 Point	24.6% 2 Point	75.4% 36,473 48,356 2 Point	17.5 — Oct.	19.7 13% Dec.	21.8 11% Nov. 2 Point	23.8% 2 Point	46 3 Point	Bago 22 Point	2
Bago	5	Pyay	0	0 1 Point	39.0% 1 Point	28.1% 2 Point	94.2% 25,037 26,579 1 Point	9.6 — —	10.0 4% —	12.3 23% — 1 Point	21.3% 2 Point	22 3 Point	Pyay 19 Point	15
Bago	6	Toungoo	0	0 1 Point	65.0% 2 Point	11.4% 1 Point	44.2% 20,374 46,136 2 Point	10.5 — Oct.	11.0 5% Aug.	11.7 6% Nov. 1 Point	22.8% 2 Point	23 3 Point	Toungoo 18 Point	19
Chin	7	Hakha	0	0 1 Point	24.4% 1 Point	10.0% 1 Point	97.7% 4,502 4,608 1 Point	1.0 — Dec.	1.0 0% Dec.	1.1 10% Oct. 1 Point	26.0% 2 Point	3 1 Point	Hakha 14 Point	29
Kachin	8	Bhamo	0	0 1 Point	13.1% 1 Point	29.3% 2012 no data for 2013→2014 2 Point	84.0% 8,250 9,823 1 Point	— — —	4.1 — Sep.	5.3 29% Oct. 1 Point	22.2% 2 Point	11 2 Point	Bhamo 18 Point	19
Kachin	9	Myitkyina	0	0 1 Point	266.7% 3 Point	20.0% 2 Point	66.6% 23,294 34,972 2 Point	10 — —	11 10% —	12 9% — 1 Point	22.6% 2 Point	31 3 Point	Myitkyina 22 Point	2
Kayah	10	Loikaw	0	0 1 Point	0.0% 1 Point	28.6% 2 Point	0.0% 26,782 3 Point	6.3 — Sep.	6.6 5% Sep.	8.1 23% Nov. 1 Point	23.1% 2 Point	6 1 Point	Loikaw 19 Point	15
Kayin	11	Hpa-An	0	0 1 Point	0.0% 1 Point	12.9% 1 Point	69.3% 16,942 24,452 2 Point	31 — —	33 6% —	35 6% — 2 Point	17.0% 1 Point	11 2 Point	Hpa-An 15 Point	28
Magway	12	Chauk	0	0 1 Point	55.6% 1 Point	-11.3% 1 Point	68.9% 7,182 10,426 2 Point	6.2 — —	5.9 -5% —	5.5 -7% — 1 Point	23.9% 2 Point	—	Chauk 14 Point	29
Magway	13	Magway	0	0 1 Point	79.9% 2 Point	37.9% 2 Point	100.0% 12,060 12,060 1 Point	9.5 — —	12.1 27% —	13.1 8% — 1 Point	30.4% 3 Point	25 3 Point	Magway 22 Point	2
Magway	14	Minbu	0	0 1 Point	55.6% 1 Point	-17.7% 1 Point	99.7% 5,465 5,481 1 Point	6.2 — —	6.0 -3% —	5.1 -15% — 1 Point	9.6% 1 Point	7 1 Point	Minbu 12 Point	32
Magway	15	Pakokku	0	0 1 Point	0.0% 1 Point	-21.6% 1 Point	125.9% 17,859 14,188 1 Point	12.5 — —	11.4 -9% —	9.8 -14% — 1 Point	16.6% 1 Point	14 2 Point	Pakokku 13 Point	31
Mandalay	16	Mandalay	0	0 1 Point	0.0% 1 Point	42.5% 2 Point	70.0% 159,236 227,544 2 Point	174 — Sep.	197 13% Oct.	248 26% Sep. 3 Point	20.5% 2 Point	132 3 Point	Mandalay 22 Point	2
Mandalay	17	Meiktila	0	0 1 Point	150.8% 3 Point	23.0% 2 Point	36.7% 57,600 157,010 2 Point	33.5 — —	34.7 4% —	41.2 19% — 2 Point	18.4% 1 Point	18 2 Point	Meiktila 20 Point	8
Mandalay	18	Myingyan	0	0 1 Point	0.0% 1 Point	5.8% 1 Point	34.9% 19,622 56,150 2 Point	59.9 — Nov.	64.9 8% Oct.	63.4 -2% Nov. 3 Point	29.3% 2 Point	17 2 Point	Myingyan 18 Point	19

State / Region	No.	City	Capacity utilization rate of the transformer Transformer no. of utilization ratio 80%	60%	Capacity utilization rate of the whole city Power ↓ 90% [%]	Increasing rate of Maximum Demand 2012 ↓ 2014 [%]	Electrification Ratio Ratio[%] Electrified households [No.] Total households [No.]	Maximum Demand [MW] 2012	 2013	 2014 Increasing ratio in 2014[%]	Maximum Distribution Loss Rate Monthly maximum rate [%]	Population [ten thousand people]	City Score	 Rank
Weight				3	1	3	1	—	—	1	2	1		
Mandalay	19	Pyinmana	0	0 1 Point	34.4% 1 Point	55.0% 3 Point	54.0% 19,734 36,524 2 Point	8.0 — —	10.1 26% —	12.4 23% — 1 Point	13.1% 1 Point	19 2 Point	Pyinmana 20 Point	8
	20	Pyinoolwin	0	0 1 Point	92.2% 3 Point	43.5% 2 Point	86.0% 28,902 33,612 1 Point	35.4 — Dec.	38.8 10% Dec.	50.8 31% Oct. 3 Point	21.1% 2 Point	28 3 Point	Pyinoolwin 23 Point	1
Mon	21	Mawlamyine	0	0 1 Point	0.0% 1 Point	47.5% 2 Point	90.6% 44,077 48,631 1 Point	17.7 —	21.1 19%	26.1 24% 2 Point	33.5% 3 Point	43 3 Point	Mawlamyine 22 Point	2
Rakhine	22	Sittwe	0	0 1 Point	0.0% 1 Point	20.0% 2 Point	97.7% 4,502 4,608 1 Point	2.5 — —	3.0 20% —	3.0 0% — 1 Point	33.0% 3 Point	13 2 Point	Sittwe 20 Point	8
	23	Thandwe	0	0 1 Point	0.0% 1 Point	no data 1 Point	45.0% 2 Point	— — —	— — —	1 — — 1 Point	33.0% 3 Point	6 1 Point	Thandwe 17 Point	23
Sagaing	24	Monywa	0	0 1 Point	0.0% 1 Point	36.8% 2 Point	94.2% 31,787 33,755 1 Point	19.0 — Apr.	22.1 16% Jun.	26.0 18% Apr. 2 Point	23.5% 2 Point	24 3 Point	Monywa 20 Point	8
	25	Sagaing	0	0 1 Point	65.1% 2 Point	15.2% 1 Point	60.0% 25,937 43,261 2 Point	17.8 — —	18.4 3% —	20.5 11% — 2 Point	25.0% 2 Point	11 2 Point	Sagaing 18 Point	19
	26	Shwebo	0	0 1 Point	53.3% 1 Point	25.0% 2 Point	48.7% 21,559 44,250 2 Point	9.6 — —	10.4 8% —	12.0 15% — 1 Point	29.0% 2 Point	18 2 Point	Shwebo 19 Point	15
Shan	27	Aungpan	0	0 1 Point	84.4% 2 Point	18.8% 1 Point	77.1% 8,508 11,029 2 Point	3.2 — —	3.6 13% —	3.8 6% — 1 Point	24.5% 2 Point	19 2 Point	Aungpan 17 Point	23
	28	Kengtung	0	0 1 Point	95.7% 3 Point	40.0% 2 Point	— 9,826 3 Point	4.0 — —	4.5 13% —	5.6 24% — 1 Point	19.5% 1 Point	17 2 Point	Kengtung 20 Point	8
	29	Lashio	0	0 1 Point	63.5% 2 Point	24.2% 2 Point	66.2% 27,176 41,045 2 Point	16.1 — Dec.	17.5 9% Dec.	20.0 14% Nov. 2 Point	25.1% 2 Point	22 3 Point	Lashio 22 Point	2
	30	Taunggyi	0	0 1 Point	0.0% 1 Point	25.0% 2 Point	104.6% 30,583 29,230 1 Point	16.0 — —	18.0 13% —	20.0 11% — 2 Point	24.7% 2 Point	46 3 Point	Taunggyi 20 Point	8
Tanintharyi	31	Dawei	0	0 1 Point	39.7% 1 Point	29.0% 2 Point	62.0% 11,512 18,570 2 Point	3.1 — —	3.5 13% —	4.0 14% — 1 Point	19.0% 1 Point	11 2 Point	Dawei 17 Point	23
	32	Myeik	0	0 1 Point	42.3% 1 Point	35.7% 2 Point	39.1% 16,856 43,059 2 Point	2.8 — —	3.1 11% —	3.8 23% — 1 Point	19.0% 1 Point	15 2 Point	Myeik 17 Point	23

↑ 3 points if more than 80%, 2 points if more than 60%, and neither both 1 point

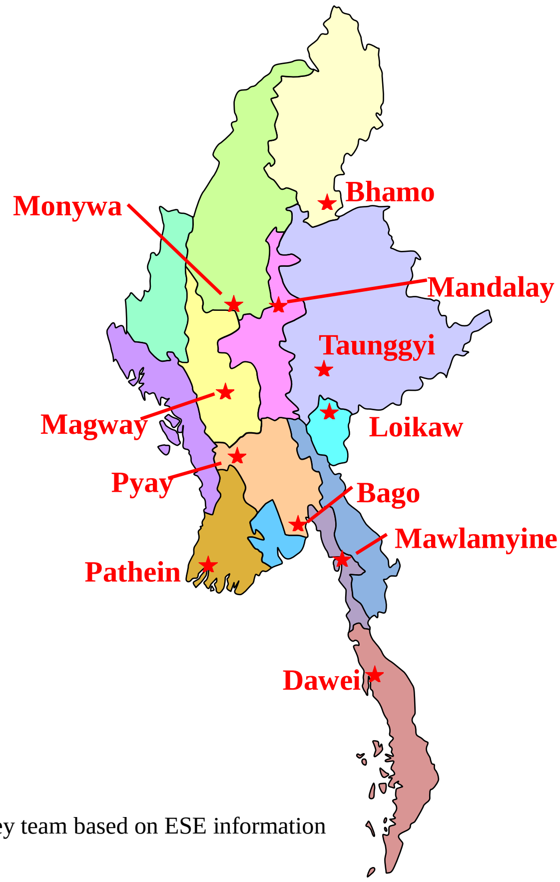
Base Score		Judgement	Capacity utilization rate of the transformer Transformer No. of utilization rate over 80%	 over 60%	Capacity utilization rate of the whole city [%]	Increasing rate of Maximum Demand 2012→2014 [%]	Electrification Ratio [%]	Maximum Demand [MW] 2012	 2013	 2014 Increasing ratio in 2014[%]	Maximum Distribution Loss Rate Monthly max. [%]	Population [ten thousand people]
3	p	More than showed value	existence	—	90%	50%	20%			50	30%	20
2	p	Middle value	—	existence	60%-90%	20%-50%	20%-80%			20-50	20%-30%	10-20
1	p	Less than showed value	None both		60%	20%	80%			20	20%	10

Source: JICA survey team based on ESE information

4.2 Selection of target Cities

Based on the results of the evaluation described in 4.1, the following 11 cities were selected for which a 5 year improvement plan would be drafted. The selected 11 cities in Table 4-1 are marked with hatching.

Pathein	(Ayeyarwady Region)
Bago	(Bago Region (Bago West))
Pyay	(Bago Region (Bago East))
Bhamo	(Kachin State)
Loikaw	(Kayah State)
Magway	(Magway Region)
Mandalay	(Mandalay Region)
Mawlamyine	(Mon State)
Monywa	(Sagaing Region)
Taunggyi	(Shan State)
Dawei	(Tanintharyi Region)



Source: JICA survey team based on ESE information

Figure 4-1: Targeted Cities for Formulation of Distribution Network Improvement Plan

The reasons for this selection are described below:

- ✓ Cities to receive a detailed investigation were narrowed down based on comprehensive judgment on such factors as peak demand, utilization rate, distribution loss, importance of the city, regional balance, etc.
- ✓ From the cities narrowed down as described above, one city was selected first from a particular state or region to maintain impartiality. Due to the limitation on the number of cities for the project, Chin, Rakhine and Kayin States were excluded from the selection because the scale of the power equipment in those states is small. Therefore, the selection was made from the remaining 10 states or regions.
- ✓ Regarding Kachin State, Myitkyina is the largest city in the state, and the government offices of the state are located in the city. However, since management of 11 kV distribution facilities had already been transferred to the private sector in the city, Bhamo, the second largest city in the state, was selected.
- ✓ Concerning Bago Region and Shan State, Bago Region used to be divided into an east division and a west division, and Shan State, into south, north and east divisions. Even today, an engineering office exists in the main city of each of the divisions. Since Pyay is the main city that has a division engineer office in the former Bago West Division, it was selected for the detailed investigation. Shan State was excluded from the selection since there are many areas that are not electrified yet in the former north and east divisions of the state.

Chapter 5 Formulation of Distribution Networks Improvement plan

5.1 Power demand forecast

5.1.1 Power demand forecast for whole Myanmar

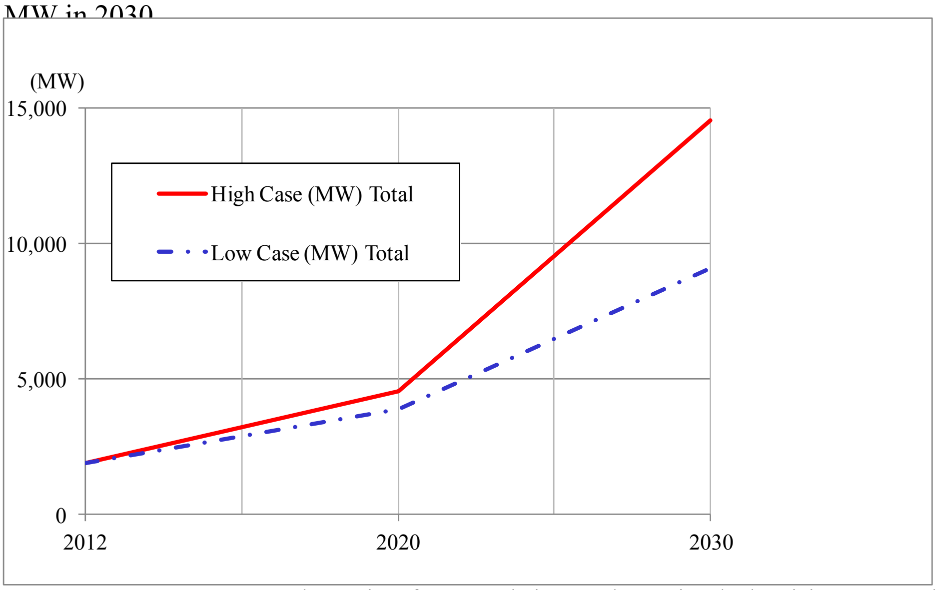
In the JICA survey "The Project for Formulation on the National Electricity Master Plan in the Republic of the Union of Myanmar" carried out in 2014 (hereinafter referred to as "the Master Plan"), it was concluded that an estimate obtained through micro analysis where detailed analyses were summed up cannot be guaranteed to be reliable due to the current conditions in Myanmar where reliable information by region and by industry are still unobtainable and a concrete development plan for the future is yet to be compiled. Because of this, an estimate of nationwide demand for power in Myanmar was made through macro analysis after GDP growth rates (high/low cases) and an elasticity rate were assumed. In the same way, the demand for power by region other than Yangon was estimated based on the power demand growth rates by region compiled by the MOEP.

Table 5-1: Forecast of demand for power in Myanmar (high/low cases)

Year	High Case (MW)			Low Case (MW)		
	Total	Non-industry	industry	Total	Non-industry	Industry
2012	1,874	1,265	609	1,874	1,265	609
2020	4,531	3,060	1,472	3,862	2,390	1,472
2030	14,542	9,819	4,723	9,100	5,631	3,468

Source: JICA survey "The Project for Formulation on the National Electricity Master Plan in the Republic of the Union of Myanmar"

Figure 5-1shows Myanmar's peak demand forecast up to 2030 in High and Low cases. In the Master Plan, It is forecasted that peak demand in Myanmar will reach a maximum of 14,542MW and will record a minimum of 9,100 MW in 2030.



Source: JICA survey "The Project for Formulation on the National Electricity Master Plan in the Republic of the Union of Myanmar"

Figure 5-1: Myanmar Peak Demand Forecast

5.1.2 Forecast of power demand for each State/Region

Estimates of demand by state or region are made based on the power demand by state or region estimated by the MOEP as shown Table 5-2 where the demand figures for states that are not connected to the power grid at present, such as Kayah State and Chin State, are adjusted through discussions held separately for each state with the Ministry.

Table 5-2: Forecast of power demand for each State/Region

State/Region	High Case (MW)		Low Case (MW)	
	FY2012	FY2030	FY2012	FY2030
Ayeyarwaddy	85	406	85	329
Bago	131	646	131	523
Chin	3	90	3	60
Kachin	21	185	21	140
Kayah	8	162	8	130
Kayin	13	165	13	135
Magway	106	293	106	238
Mandalay	457	2,731	457	2,203
Mon	45	418	45	338
Rakhine	10	243	10	180
Sagaing	98	349	98	282
Shan	103	355	103	288
Tanintharyi	52	290	52	235
Yangon	742	8,209	742	4,019
Total	1,874	14,542	1,874	9,100

Source: JICA survey "The Project for Formulation on the National Electricity Master Plan in the Republic of the Union of Myanmar"

5.1.3 Forecast of power demand for target cities

Table 5-3 shows the demand growth rate and the demand forecast for 11 target cities for formulation of a distribution network improvement plan based on the discussions with ESE.

The methodlogy of ESE which was confimed at the commencement of this survey was to forecast future power demand by a growth ratio of 11%.

Survey team has forecast the power demand of each substation in target cities by each year up to 2020 from an interview with each ESE state or division office.The power forecast results from 2015 to 2020 in each substation of the targeted 11 cities are shown in Appendix 2.

Table 5-3: Forecast of power demand for 11 target cities

City	Peak Demand as of 2014[MW]	Power Demand Forecast as of 2020 [MW]	Annual increasing rate [%]
Pathein	31.9	50.0	8%
Bago	21.8	39.4	10%
Pyay	12.3	26.2	13%
Bhamo	5.3	25.4	30%
Loikaw	8.1	18.8	15%
Magway	15.1	30.3	12%
Mandalay	248.2	574.1	15%
Mawlamyine	26.1	63.8	16%
Monywa	27.0	72.0	18%
Taunggyi	20.0	46.3	15%
Dawei	4.5	10.4	15%

Source: JICA survey team

5.2 Formulation of Distribution Network Development Plan

ESE intends to implement projects in the main cities described below. Its basic policies for power distribution improvement were established with the importance of public safety measures taken into account as well, considering the fact that there are many reported cases of people being shocked by electricity.

Table 5-4 shows the implementation of measures in each basic policy.

i) Installation or addition of brand-new transformers commensurate with increased power demand
ii) Replacement of aged power distribution facilities with new facilities
iii) Replacement of bare wires with covered wires
iv) Switching to digital meters and introduction of a multi-transformer system to reduce power distribution losses

Table 5-4: Basic policies for formulating of power distribution improvement plan

Implementation of measures	
Transformer and transmission/distribution line overload improvement	✓ Planning of additional transformers or new substation construction based on power demand forecast ✓ Planning of 33 kV or 66 kV transmission lines installation or upgrading ✓ Planning of 11 kV distribution lines installation, extension and upgrading ✓ Installation of 11 kV distribution transformers
Loss reduction in distribution line	✓ Introduction of multi-transformer system and low-loss transformer ✓ Replacing analog meters with digital meters ✓Using covered wires in 400 V distribution lines (Measures against electricity theft)
Reduction of line Faults	✓Using covered wires, securing of clearance between wires and other objects ✓Replacement of aged power distribution facilities with new facilities
Supplying reliability improvement	✓ Examination of possible implementation of reliability increasing measures for power distribution equipment for supplying power to important facility ✓Installation of new 33 kV transformer or transmission line as double sources to substation for reducing blackout duration time
Public safety improvement	✓ Implementation of public safety measures (use of covered wires, securing of clearance between wires and other objects, etc.)
Quality of Electricity improvement	✓Measures for voltage control (replacement of conductors to thicker-size ones, load balancing and so on) ✓ Introduction of phase modifying facilities (power capacitors)

Source: JICA survey team

5.2.1 Focused areas of the cities for the projects

It was focused on main townships in the selected cities on this study for formulation of 5 year distribution improvement plan, since the main townships of the cities have the major electricity demand of the cities. In Mandalay city, it is focused on district area (7 townships) to formulate 5 year plan, because all townships in Mandalay district are being developed.

In the power distribution sector in Myanmar, ADB and WB are underway to assist development of the distribution system or electrification in local area of Myanmar. Therefore, this survey mainly targeted the central area of each city.

5.2.2 Building up power equipment to reinforce interconnections between power grids

Existing 33 kV and 11 kV power distribution systems in Myanmar basically consists of radial power grids. Since there are no interconnections between these grids, power supply is interrupted for a long time once any of power equipment fails. In order to build up more reliable distribution facilities in the 11 cities, the 5 year distribution improvement plan was formulated on the basis of the duplexing of 33 kV distribution system and two independent transformer systems that will enable continuous power supply in case of a facility failure.

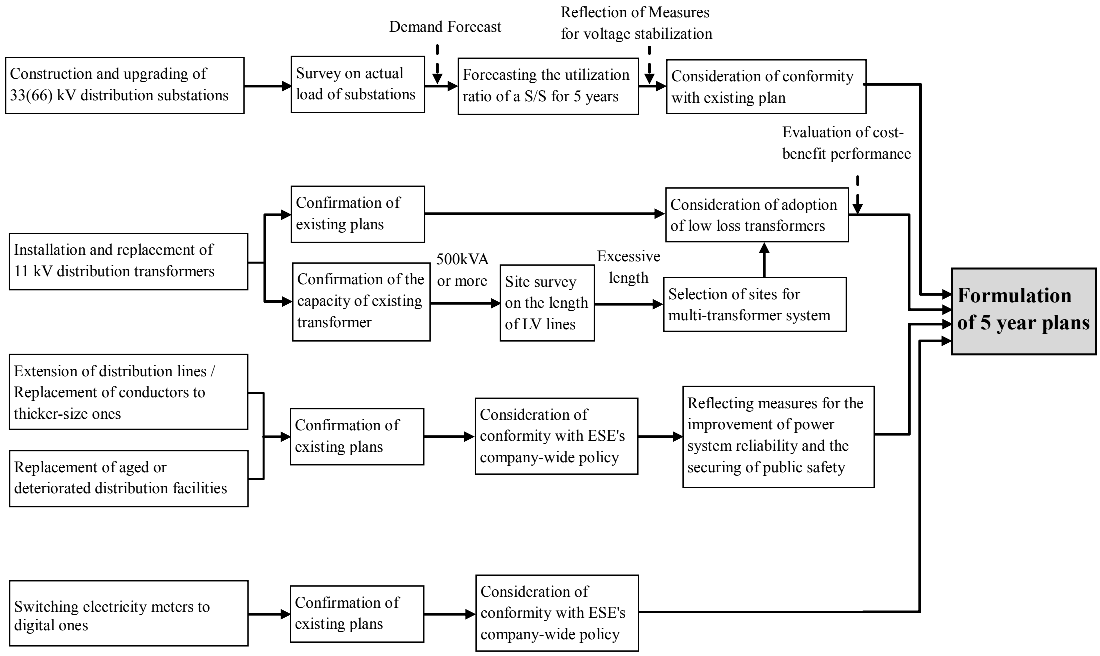
For example, In Mandalay city, it is considered to introduce a 33 kV line ring system to shorten the blackout duration time by connecting two upper systems to one substation.

5.2.3 Selecting preferred-implementation projects for formulation of 5 year plan

Existing power distribution development plans in each city specify mainly the quantities of planned power facility that are to be newly installed or replaced. The project contents must be specified in each fiscal year based on the power demand forecast and budget scale to raise the possibility of the projects. Therefore, survey team supported the formulation of 5 year distribution improvement plans for each fiscal year from fiscal year 2016 to 2020, referring to existing power distribution development plans and exchanging opinions with ESE.

The surveys to formulate the improvement plans conducted in the selected 11 main cities.

Figure 5-2 shows the flowchart for the formulation of 5 year power distribution improvement plan.



Source: JICA survey team

Figure 5-2: Flowchart for the formulation of power distribution improvement plan

(1) Construction and Upgrading of 33 kV and 66 kV power distribution substations

1) Drafting a 5 year plan based on forecast of transformer utilization ratio

Transformer utilization rate in the power distribution substations located in the 11 cities were calculated based on the peak demand forecasts over the fiscal year 2016 to 2020.

Table 5-5 shows examples of calculation for power transformer utilization ratios from fiscal year 2016 to 2020 among the substations in the city. These tables show that appropriate capacity of transformers will be installed during next 5 years in each city.

Table 5-5: Examples of calculation for power transformer utilization rate

Monywa Township

Power Factor:	0.90		demand increasing ratio :	18 % per year

Substation		2015		2016		2017		2018		2019		2020	
		Capacity [MVA]	Demand [MW] / Utilization Rate [%]	Capacity [MVA]	Demand [MW] / Utilization Rate [%]	Capacity [MVA]	Demand [MW] / Utilization Rate [%]	Capacity [MVA]	Demand [MW] / Utilization Rate [%]	Capacity [MVA]	Demand [MW] / Utilization Rate [%]	Capacity [MVA]	Demand [MW] / Utilization Rate [%]
Monywa Township	33/11	10	7.7	20	9.1	20	9.0	20	10.6	20	12.5	20	14.8
			85%		50%		50%		59%		70%		82%
Monywa Taung	33/11	–	–	10	2.3	10	2.7	10	3.2	10	3.8	10	4.5
		–	–		26%		30%		36%		42%		50%
Amyint	33/11	–	–	–	–	10	3.8	10	4.5	10	5.3	10	6.2
		–	–	–	–		42%		50%		59%		69%
Aungchanthar	33/11	10	2.2	10	2.6	10	3.1	10	3.7	10	5.9	10	7.8
			25%		29%		35%		41%		66%		87%
		10	2.6	10	3.1	10	4.4	10	5.7	10	6.7	10	7.9
			29%		34%		49%		63%		75%		88%
		5	4.5	10	5.0	10	5.0	10	6.1	10	7.2	10	8.5
			100%		56%		56%		68%		80%		94%
		5	3.1	5	3.6	5	4.3	5	4.5	5	4.0	5	4.0
			68%		80%		95%		100%		89%		89%
Industry Zone 1	33/11	10	8.7	10	9.0	10	9.0	10	9.0	10	8.0	10	8.5
			97%		100%		100%		100%		89%		94%
		5	3.9	5	4.0	5	3.8	5	4.5	10	8.1	10	8.8
			87%		89%		84%		100%		90%		98%
Nanda Wun	33/11	5	3.9	5	4.4	10	6.2	10	9.0	10	5.7	10	7.4
			87%		98%		69%		100%		63%		82%
		–	–	–	–	–	–	–	–	10	5.0	10	6.9
		–	–	–	–	–	–	–	–		56%		77%
NaMaKha	33/11	2	0.9	2	1.1	2	1.3	2	1.7	2	1.7	2	1.8
			52%		62%		73%		94%		94%		100%
New Mynnae(2015)	33/11	5	1.2	5	1.7	5	2.0	5	2.4	5	3.4	5	4.2
			26%		38%		45%		53%		76%		93%
Capacity Total [MVA]		**67**	–	**92**	–	**107**	–	**107**	–	**122**	–	**122**	–

Pyay Township

Power Factor: 0.80		demand increasing ratio :	13 % per year

Substation		2015		2016		2017		2018		2019		2020	
		Capacity [MVA]	Demand [MW] / Utilization Rate [%]	Capacity [MVA]	Demand [MW] / Utilization Rate [%]	Capacity [MVA]	Demand [MW] / Utilization Rate [%]	Capacity [MVA]	Demand [MW] / Utilization Rate [%]	Capacity [MVA]	Demand [MW] / Utilization Rate [%]	Capacity [MVA]	Demand [MW] / Utilization Rate [%]
Pyay	66/11	10	5.1	10	5.5	10	5.2	10	5.9	20	6.6	20	7.5
			64%		69%		65%		73%		41%		47%
	66/11	20	10.7	20	8.7	20	8.7	20	9.8	20	11.1	20	12.6
			67%		54%		54%		61%		69%		78%
Wettigan	33/11	–	–	10	4.0	10	4.7	10	5.3	10	6.0	10	6.8
		–	–		50%		59%		66%		75%		85%
Min Gyi Taung	66/11	–	–	–	–	10	2.0	10	2.3	10	2.6	10	2.9
		–	–	–	–		25%		28%		32%		36%
Capacity Total [MVA]		**30**	–	**40**	–	**50**	–	**50**	–	**60**	–	**60**	–
Pyay (MEPE)	66/33	20	7.3	20	11.0	20	12.4	20	7.0	20	7.9	20	8.9
			46%		69%		78%		44%		49%		56%
	66/33	–	–	–	–	–	–	20	6.6	20	7.5	20	8.4
		–	–	–	–	–	–		41%		47%		53%

*hatched cell "   " shows the tranformer which will be newly installed or replaced.

Source: JICA survey team based on ESE information

(2) Installation and replacement of 11 kV distribution transformers

Based on the forecasted peak demands over the fiscal 2016 to 2020 period, the total capacity of distribution transformers needed to be installed was estimated in each year from fiscal 2016 to 2020 in the 11 cities.

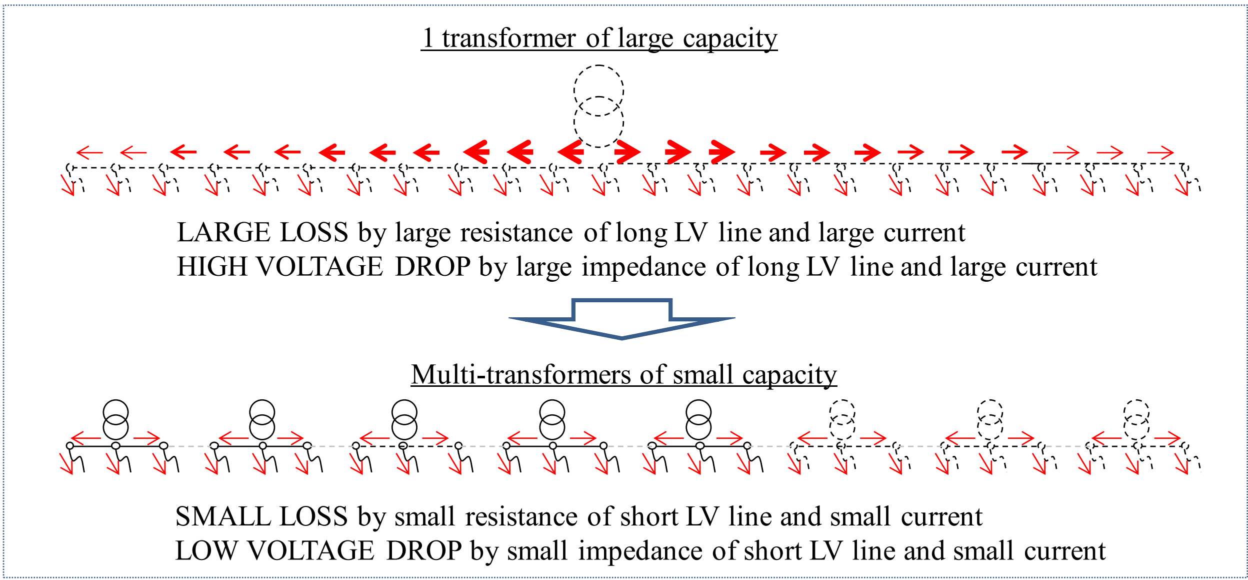
200 kVA transformers are mainly adopted and some smaller-capacity transformers are also adopted in the 5 year plan on the premise of the introduction of a multi-transformer system that is being introduced in each city, and the introduction planning quantity of transformers was calculated from estimated total capacity of distribution transformers. And a higher loss reduction effect is expected by using low-loss transformer with amorphous material.

The introduction effect of a multi-transformer system is described below. The concept of reduction of loss and improvement of voltage drop by introducing a multi-transformer system is shown in Figure 5-3. Generally, large capacity transformers have a longer length of secondary low voltage distribution line. A multi-transformer system where dispersively distributed multi-transformers of small capacity supply electricity through multi-low voltage lines of short length is effective at reducing low voltage line loss and improving the voltage on terminal. However, dividing a transformer of large capacity into multi-transformers of too small capacity does not bring economic benefit, because too small a capacity of transformer results in a high ratio in "transformer price / capacity [kVA]". A rough indication of the capacity for economic benefit is 200 kVA class, considering present market price of a transformer, electricity rate, average length of low voltage line, etc. However, economic benefit will be expected even in case of applying less than 200 kVA capacity of transformer, when transformers of small capacity become widespread and their prices become down by introducing a multi-transformer system widely. And economic benefit will be also expected in case that the electricity rates go up in the future.

Next, the effect of the introduction of a transformer with amorphous cores (hereinafter referred to as "amorphous transformer") is described below.

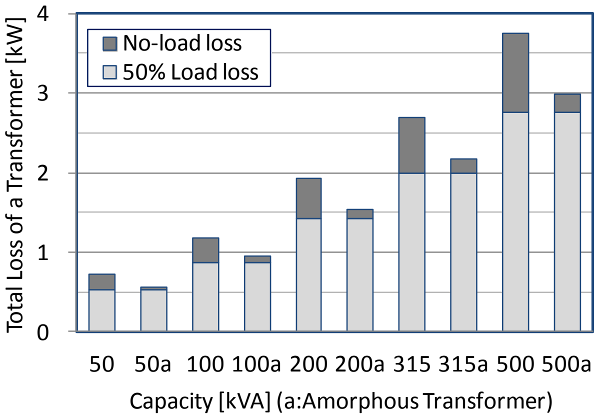
Figure 5-4 and Figure 5-5 show load loss and no-load loss of two types, conventional and amorphous core type transformers and the investment recovery time of an amorphous transformer based on the current market price. As shown in the left figure, load loss of an amorphous transformer is as the same as that of a conventional silicon-steel-lamination transformer. And no-load loss of an amorphous transformer is smaller than that of a conventional transformer. Therefore, introduction of amorphous transformers brings loss reduction.

The right figure shows the electricity rate dependency of investment recovery time. Introducing an amorphous transformer incurs a relatively high initial cost. In case that the electricity unit rate is the current level as shown in table 2-4, the initial investment cost can be recouped within fifteen years. If the electricity unit rate goes up, investment recovery time becomes shorter.



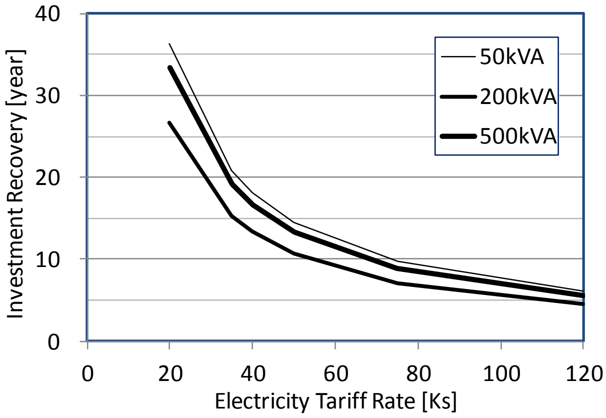
Source: JICA survey team

Figure 5-3: Concept image of loss reduction and voltage drop improvement by introducing a multi-transformer system



Source: JICA survey team

Figure 5-4: Load loss and No-load loss of two type transformers



Source: JICA survey team

Figure 5-5: Investment recovery time of an amorphous transformer

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(3) Extension of distribution lines, Replacement of conductors to thicker-size ones and Replacement of aged or deteriorated distribution facilities

For equipment that requires some measures in view of enhancing supplying reliability and public safety according to the basic policies for the formulating a power distribution improvement plan, the measures were reflected in its design. Equipment for which measures will be taken is to be selected depending on the importance of the power distribution substation in view of enhancing supply reliability or on the frequency of electrical accident occurrences in view of enhancing public safety.

The following are thought of as measures for enhancing supply reliability and public safety.

- ✓ Using thicker-sized conductors, covered conductors for both medium and low voltage lines, keeping clearances to other objects
- ✓ Replacement of aged poles with new concrete poles
- ✓ Installation of section switches in medium voltage lines and introduction of an automatic sequential reclosing system
- ✓ Introduction of enclosed primary cutout switches and overcurrent failure indicators
- ✓ Appropriate selection and adjustment of protection relays

(4) Switching electricity meters to digital ones

As described in 3.4.4, switching from analog meters to digital meters is one of the effective measures for the reduction of non-technical losses, and switching from analog meters to digital meters has proceeded in the main cities within ESE's area. Since the number of meters to be replaced is so large, the progression rate in some cities is still only 20%. On the other hand, according to staff in the Magway division office, the switching to digital meters in the central area of Magway will be finished by March 2015.

5.3 Drafting 5 year distribution improvement plan

5.3.1 Collecting information about 5 year distribution improvement plan

Survey team collected information regarding the 5 year distribution improvement plan from the ESE division or state office in the 11 main cities during the 2nd activity. The ESE division or state office has a 5 year distribution improvement plan from fiscal year 2015 to 2019. The 5 year plan projects mainly consist of the ESE division or state office plan. Survey team proposed fiscal year 2020's project to each ESE division or state office.

In the site survey, survey team collected single line system diagrams of the city for examining the location of the project site and confirming power flow in the future project. And survey team conducted a visit to the sites where 33 kV substations are planned to be newly constructed or upgraded. The information of Bhamo, one of the selected 11 cities, was obtained through ESE headquarters, because survey team could not visit Bhamo.

1) Site survey for projects

The sites for substation and transmission construction projects listed in the 5 year plan were surveyed with counterparts in order to examine preliminary designs for them and their compliance with environmental and social considerations.

As for 11 kV distribution lines, surveys were also conducted at construction sites where aged or deteriorated distribution facilities were replaced with new facilities.

2) Check on status of acquisition of land and preparations for its development

The statuses of land acquisition for construction and so on were checked for the selected preferred-implementation projects.

3) Confirmation of project costs

Information about project costs for the projects listed in the 5 year plan was collected to calculate the approximate costs. Each ESE division or state formulates its own 5 year plan. ESE headquarters collectively prepares the standard unit price of basic projects, and revises it based on procurement result every year. The standard unit price is provided on a total project basis, such as the new construction of a substation. There are some projects listed in 5 year plan the costs of which are not reflected in ESE headquarters' standard unit price, survey team complementally estimated the projects costs.

5.3.2 Drafting 5 year distribution improvement plan

1) Preparation of project lists

After a 5 year distribution improvement plan was formulated and projects were organized by type, project lists for the selected 11 cities were prepared in which the projects such as construction and upgrading of 33 kV substations, and construction and replacement of 11 kV distribution lines are classified by project type.

2) Proposal of additional measures to improve distribution system reliability

In addition to the original 5 year distribution improvement plan of ESE, survey team proposed the installation of additional equipment and measures which contribute to reduction of distribution losses, improvement of power system reliability(reduction of failures), public safety, power quality, work efficiency and work safety and discussed it with ESE. ESE agreed to the additional measures such as the installation of additional facilities for the reliability improvement, and the introduction of utility vehicles, and these additional measures were reflected in the 5 year plan of each city.

The content of additional measures is shown in Table 5-6.

These additional measures are to be firstly introduced to important distribution feeders in each of the 11 cities on a trial basis that aims at the acquiring of operation know-how by ESE staff and the verification of the effects. And, based on this trial, these measures will be expanded to other sites and the number of introduction will be gradually increased.

Table 5-6: Content of additional measures reflected in 5 year plan

Issue	Additional Measures	Effects
Improvement of power quality	**Transformer with on-load tap changer**	Secondary voltage is adjustable to correspond to the fluctuation in primary voltage without power interruption.
Reduction of distribution losses	**Low-loss transformer**	Loss (non-load loss) is reduced by adoption of amorphous core.
Reduction of distribution losses; Improvement of power system reliability (Reduction of failures); Securing of public safety	**Enclosed cutout**	Enclosed cutouts are used for the protection of primary side of a distribution transformer and expose no energized part so as to avoid contact with trees or other objects.
Improvement of power system reliability (Reduction of failures); Securing of public safety	**Material for wire connection (ex. Parallel joint connector)**	It enables the wire connection with superior connection strength without increasing connection resistance. It prevents non-technical loss due to illegal connection and public electric accidents due to wire disconnecting and falling at connection points.
Improvement of power system reliability (Reduction of failures)	**Over current indicator**	It enables easier detection of a fault section or an overload section in a distribution feeder. It requires no power source and is maintenance-free.
Improvement of power system reliability (Reduction of failures)	**Grounding Fault Point Indicator**	It enables easier detection of a ground fault point. It requires no power source and is maintenance-free.
Improvement of power system reliability (Reduction of failures)	**11 kV distribution line overload circuit breaker**	It can detect and cut off the fault current or overload current on the middle portion of an 11 kV distribution feeder, and isolates a defected section so that supply for sound sections can be recovered early.
Improvement of power system reliability (Reduction of failures)	**Mobile substation**	It can be used as a substitution when a transformer in a substation stops due to construction, inspection or failure.
Improvement of work efficiency and work safety	**Aerial work platform vehicle**	It enables the work in high places on a pole or between poles. Since man-powered pole climbing or assembling a work platform is unnecessary, work efficiency and work safety can be improved.
Improvement of work efficiency and work safety	**Excavation and pole erecting vehicle**	Since excavation and pole erecting are mechanized, work efficiency and work safety can be improved.
Improvement of work efficiency and work safety	**Mini excavator**	Since excavation is mechanized, work efficiency and work safety can be improved.

Source: JICA survey team

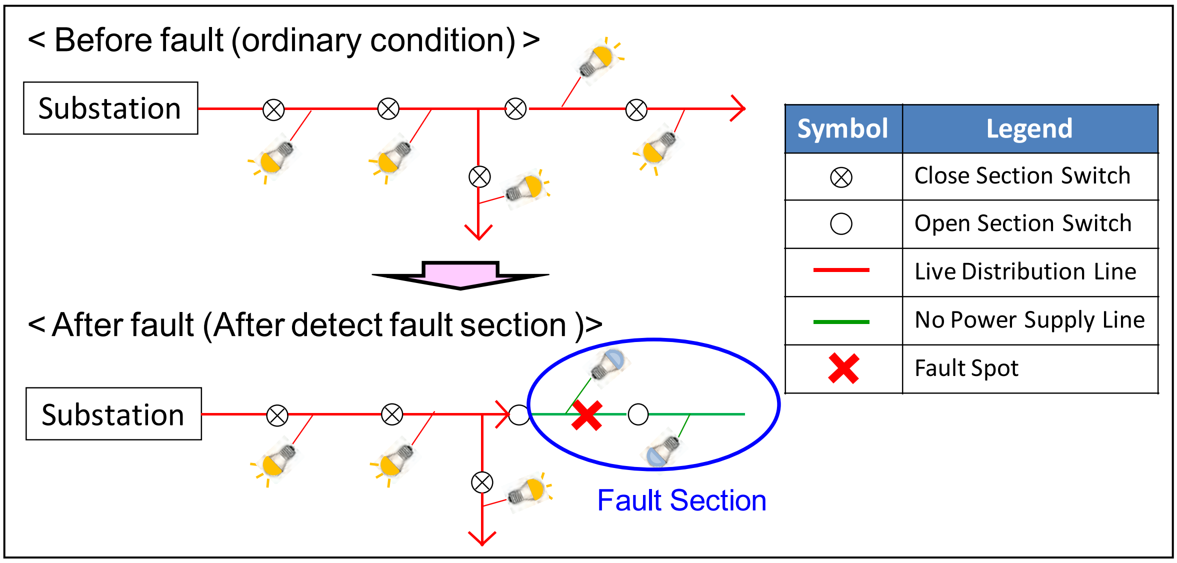
Furthermore, prospective technologies for future introduction shown in Table 5-7 were also discussed with ESE. Basically, installation and recovery of essential distribution facilities should have the first priority and these additional technologies should be introduced after maintaining the essential distribution facilities. Figure 5-6 shows an image of the Time sequential distribution system.

But installation of step voltage regulators (SVR) and introduction of a "Time sequential distribution system" were reflected in the 5 year distribution improvement plan on a trial basis, in order to acquire the operation know-how of these technologies by ESE staff. Full-scale introduction of these technologies into distribution system will be considered by ESE.

Table 5-7: Prospective technologies for future introduction to ESE

Technology	Effects	Remarks
SVR (Step voltage regulator for 11 kV distribution line)	SVR installed on the middle portion of a distribution feeder compensates for voltage drop in terminal area of a distribution feeder.	The essential facilities such as poles and wires should be installed preferentially because ESE is confronting with the problems of many system failures and voltage instability. Installation of SVR was reflected in 5 year distribution improvement plan so that it will be introduced into some of cities on a trial basis. While promoting the installation of distribution facilities, SVR will be reflected in future 5 year plan.
Time sequential distribution system	It can detect a defected section automatically and recover the power supply to sound sections early.	The installation of essential facilities takes a priority as measures for the reduction of failures and the improvement of power system reliability. Time sequential distribution system was reflected in 5 year distribution improvement plan so that it will be introduced into some of cities on a trial basis. While promoting the installation of distribution facilities, time sequential distribution system will be reflected in future 5 year plan. In addition, introduction of time sequential system to 33 kV transmission line will be examined.
Power system monitoring control system (SCADA)	SCADA supervises and controls substation or distribution feeder equipment remotely, and accumulates the data such as power flow. It contributes the efficiency and accuracy of operation and maintenance, and it enables early recovery from blackouts.	The installation of essential facilities takes a priority. In the future, starting by taking information of main substations to the system, the gradual expansion of systemization of substations is considered to be effective.
Abrasion resistant cover for conductor wire	It is installed in trees' contacting area and protects distribution wires against the insulated abrasion caused by trees. It has two-layer structure so that its replacement period can be easily recognized. It can prevent grounding faults due to contact to trees or disasters of general public due to disconnected and falling wires.	An abrasion resistant cover for conductor wire is not reflected in 5 year plan, because ESE promotes the introduction of covered wires mainly in the center area of the cities to improve public safety. The installation of abrasion resistant covers to existing bare wires is considered to be effective in the areas where covered wires are not introduced from viewpoint of the reduction of failures.

Source : JICA survey team



Source: JICA survey team

Figure 5-6: Image of Time sequential distribution system

Chapter 6 Candidate projects for Japanese ODA Loan

6.1 Selection of candidate projects for Japanese ODA loan

On the basis of 5 year distribution network improvement plan drafted for selected 11 regional cities, candidate projects for Japanese ODA loan were selected by discussing with ESE and JICA.

Projects for distribution system improvement in main cities are important because they support the economic development in these cities through electric power supply. To realize stable power supply, distribution system improvement needs to be implemented together with development of power source and expansion of the trunk transmission line system. MOEP intends to improve distribution system actively in not only Yangon city, which has the highest power demand in Myanmar, but also main local cities.

In recent years ESE has been making efforts to enhance distribution facilities to meet increasing power demand. In addition, ESE has been advancing projects for shortening of power outage time, reduction of transmission and distribution losses, prevention of public electric accidents and improvement of quality of electric power. ESE places on its 5 year improvement plan main projects to improve the distribution system, by such measures as construction and enhancement of 33 kV (66 kV) substations and transmission lines, construction and upgrade of 11 kV and 400 V distribution lines which include replacement of bare wire with covered wire and replacement of aged facilities with new ones, introduction of multi transformer system and replacement of analog meters with digital meters.
However, budget approved by the Government for distribution improvement is not enough to execute the necessary projects, therefore Japanese ODA loan needs to assist execution of the projects.

The candidate projects for Japanese ODA loan were selected from the distribution improvement projects on 5 year plan of each local city. Additional measures for the improvement of ESE distribution facilities were also selected as candidate projects for Japanese ODA loan. These additional measures use new technologies in Japan, such as reliability improvement equipment, utility vehicles for efficient work, etc.

JICA and ESE together in consultation with each other will select the Japanese ODA loan projects from the candidate projects selected in this survey.

6.1.1 Feature of distribution system improvement plan

The distribution system improvement plan has the following features. The actualization of Japanese ODA loan projects will be examined based on candidate projects in consideration for these features.

- ✓ Easy adjustment of project scale, because the number of small scale projects is large,
- ✓ Easy securing of areas designated for development projects and power equipment because the land size required for a project is relatively small and the site for it is capable of change and
- ✓ Procurement of equipment is possible in a relatively short period of time.

6.1.2 Selection of candidate projects for Japanese ODA Loan

Considering the necessity and feasibility of projects, the candidate projects for Japanese ODA loan were selected based on the distribution systems improvement plans in the 11 cities.

In the selection of candidate projects for Japanese ODA loan, several factors were considered as below.

- ✓ Land acquisition situation
- ✓ Assistance from other donors
- ✓ Project objectives: to meet demand increase, loss reduction, public safety, improvement of reliability, improvement of electricity quality
- ✓ Relationship to upper system development
- ✓ Resettlement
- ✓ Environmental impact

According to the following "Basic policy", in selecting the candidate projects for Japanese ODA loan from the 5 year plans of the 11 cities formulated in the survey, the projects assisted by other donors such as ADB and the projects that will be conducted by MEPE were excluded, and the projects assessed as much-needed such as projects for demand increase were selected on a priority basis. In addition, the survey team proposed that ESE adopt facilities in the important distribution lines to raise the reliability of the distribution system, such as section switch with over current relay, and utility vehicles to improve work efficiency and safety.

Basic policy

- ✓ All projects in the 5 year plan of the selected 11 cities are candidates for Japanese ODA loan projects.
- ✓ 5 year plan projects which related 33 kV or 66 kV substation, 11 kV distribution line, 400 V distribution line including the replacement of kWh meters, are all candidate projects for Japanese ODA loan. However, the projects assisted by other donors such as ADB, and the projects covered by MEPE, are excluded from being candidates.
- ✓ The construction and extension projects for 33 kV or 66 kV substations that have difficulty regarding land acquisition due to resettlement are excluded as candidates.
- ✓ In order to ensure effective work and maintenance, installation of reliability improvement equipment and introducing utility vehicles are considered as candidate projects for Japanese ODA loan.

The outline of Japanese ODA loan projects is shown in Table 6-1.

In Table 6-1, the reasons for exclusion as candidate for Japanese ODA loan projects are as follows;

- ✓ 66 kV transmission lines will be constructed by MEPE in Pathein and Mawlamyine.
- ✓ There is no 33 kV line construction plan in Dawei.
- ✓ Distribution facilities below 11 kV have been already outsourced to distribution companies in Bago

and Mandalay.)

✓ Switching to digital meters has been already finished in Magway.

Table 6-1: Outline of candidate projects for Japanese ODA loan (5 years total)

City	33 kV(66 kV) Substation [Nos. of projects]	33 kV(66 kV) Transmission line	11 kV Distribution line	400 V Distribution line	Replacement with digital meter	11 kV distribution line facilities to improve reliability & Introduction of utility vehicles
Pathein	–	–	Construction & Replacement	Construction & Replacement	Replacement	11 kV Distribution line equipment / material for improvement of reliability : 1set Truck Mount Aerial Work Platform :1 Pole Erection machine :1 Mini Excavator:1 for each city Mobile transformer : 3 for ESE (1 for northern, central and southern area, respectively)
Bago	Construction:1 Extension :1	Construction & Replacement	–	–	–	
Pyay	Construction:1 Extension :1	Construction	Construction & Replacement	Construction & Replacement	Replacement	
Bhamo	Construction:2	Construction	Construction & Replacement	Construction & Replacement	Replacement	
Loikaw	Extension :2	Construction & Replacement	Construction & Replacement	Construction & Replacement	Replacement	
Magway	Construction:1 Extension :3	Construction & Replacement	Construction & Replacement	Construction & Replacement	–	
Mandalay	Construction:7 Extension :21	Construction & Replacement	–	–	–	
Mawlamyine	–	–	Construction & Replacement	Construction & Replacement	Replacement	
Monywa	Construction:1 Extension :4	Construction	Construction & Replacement	Construction & Replacement	–	
Taunggyi	Construction:1 Extension :1	Construction & Replacement	Construction & Replacement	Construction & Replacement	Replacement	
Dawei	–	–	Construction & Replacement	Construction & Replacement	Replacement	

Source: JICA survey team

6.2 Examination of candidate projects for Japanese ODA loan

The simplified load flow analysis and preliminary design for 33 kV substation projects described below were implemented to check the validity of selected candidate projects for Japanese ODA loan.

6.2.1 Implementation of simplified load flow analysis

Survey team implemented the simplified load flow analysis in order to check whether the project would be scheduled in the appropriate fiscal year or not, and whether the load distribution would be unbalanced or not. The load flow analysis was implemented in a simplified manner, because the power system in local cities is a simple radial system.

(1) Implementation of simplified load flow analysis

1) Power flow analysis

Power flows for the subjected secondary substations are conducted with following conditions.

- The secondary bus (33 kV) of a primary substation is regarded as a constants-voltage source.
- The power source for each secondary substation is a single power-source.
- Only one power supply should be selected if plural power supplies reach to the subjected substation, and parallel power source operation should not be done.
- There is no power transmission and receiving among the secondary substations.

From the conditions above, power flows from a primary substation to each secondary substation in a single direction.

Power flow can be calculated on the condition of a simple power system consisting of a power source and a load, as secondary substation connected to one power source does not transfer active and reactive power among substations.

The power factors of the targeted cities except the south area in Mandalay are assumed 0.9 and 0.8, respectively, as the south area in Mandalay has a large load.

The load of 33 (66) kV substation is regarded as a constant power factor and constant impedance.

(2) Result of load flow analysis

1) Power flow except Mandalay

The power systems of 33 kV and 66 kV are single circuits and simple radial systems. The power flows from a primary substation to each secondary substation in a single direction. There is no power transmission and receiving among the secondary substations. The power flow can be calculated easily based on the information of 33 (66) kV transmission lines and load of substations connected to them.

As a result, it was confirmed that the installation and upgrading of substations are planned so that each power flow of transmission line are managed to within the range of the transmission capacities.

2) Power flow in Mandalay

The power system of Mandalay is also single circuit and simple radial system. Therefore, power flows from a primary substation to each secondary substation in a single direction. There is no power transmission and receiving among the secondary substations.

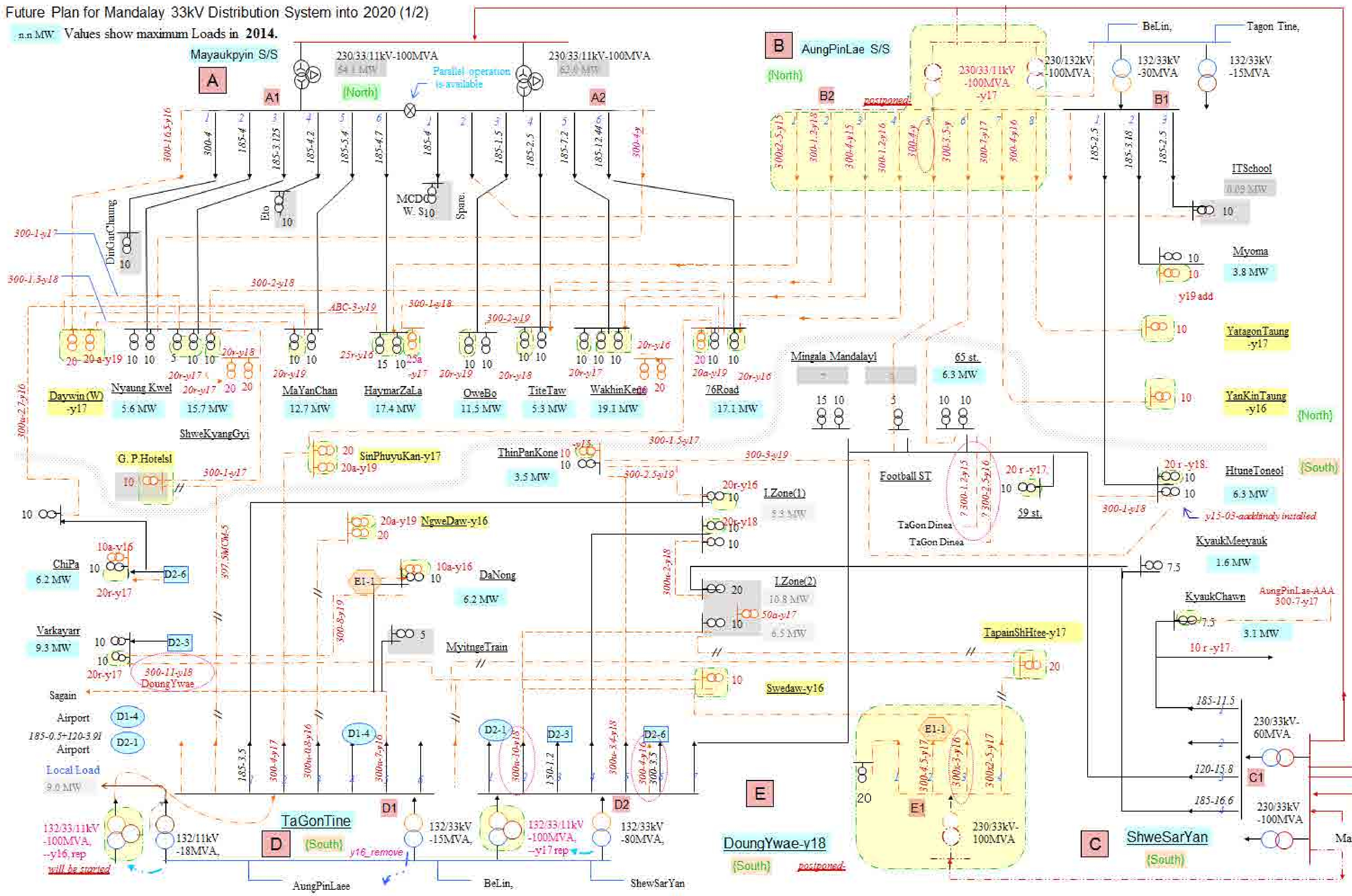
In the future plan of Mandalay system, almost secondary substations will be applied standby-sub-transmission lines from plural primary substations. But synchronized parallel operations are not planned.

Mandalay city has so many power facilities (transmission lines and substations) that its system configuration of secondly substation and sub-transmission lines is more complicated than that of other local cities.

Figure 6-1 and Figure 6-2 are the drawings that show power load flows and system configuration as of 2014 and as of 2020 (prefiguration) respectively.

The extension of 33 kV transmission lines is planned considering adjusting primary substation load. A double circuit of some of 33 kV transmission lines is planned in order to control power flow below the transmission capacity.

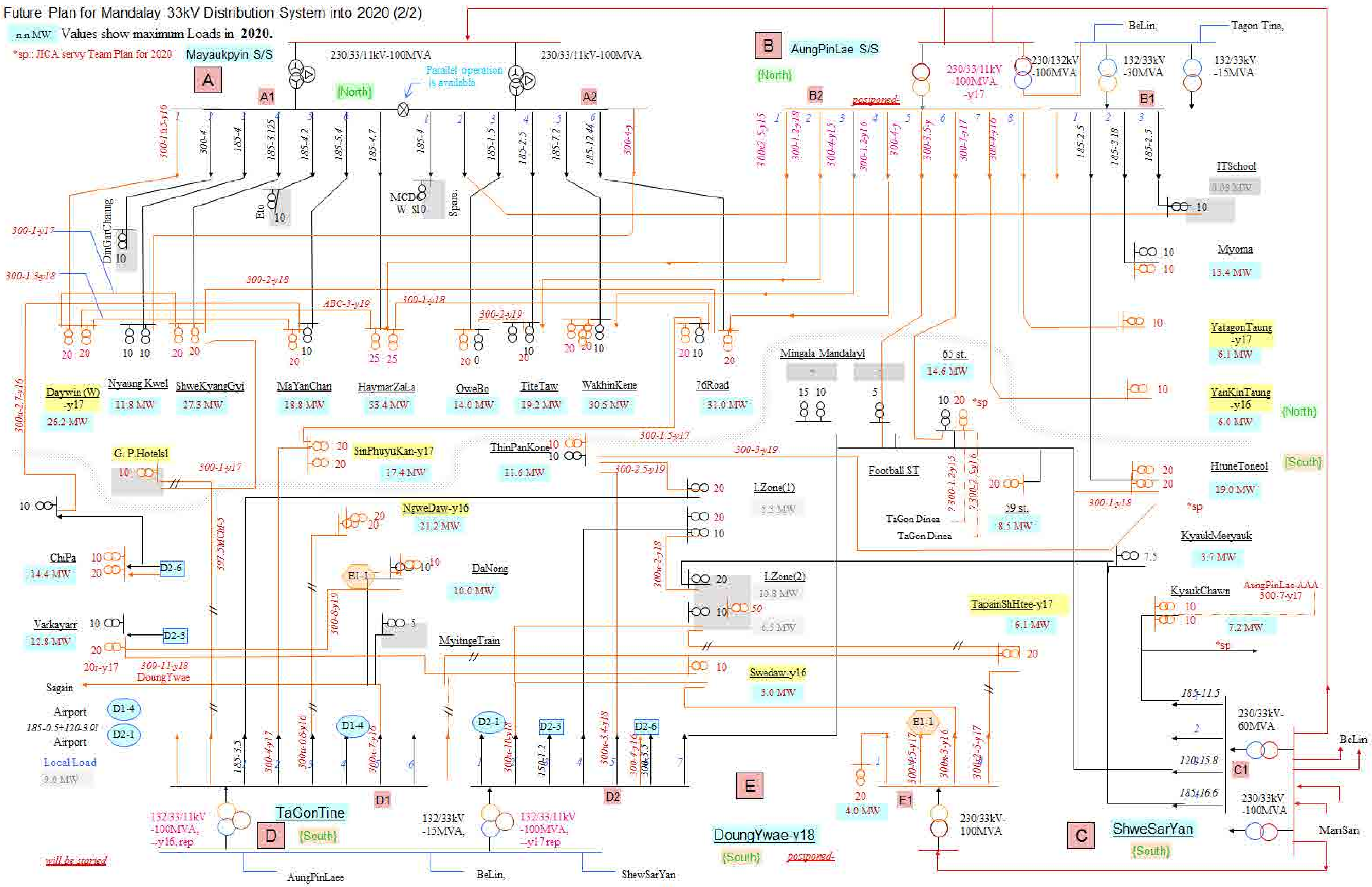
Concerning primary substation capacity, the information of a primary substation extension plan was not acquired in the survey. The capacity of the primary substations might be insufficient to supply power, judging from the power flow diagram in 2020. Practically, 5 year plan should be implemented with adjustment to the plan of installing and upgrading primary substations.



Precondtioned parameters for Load forecast:			Estimated year	year	2014
Assummed power factor in north	pf1	0.9	Assummed load increse rate per year	inc	15%
Assummed power factor in south	pf2	0.8	Considerable loading rate onTransfomer	lmt	80%

Source: JICA survey team

Figure 6-1: Future plan for Mandalay 33 kV Transmission System into 2020, Year of 2014



Precondtioned parameters for Load forecast:			Estimated year	year	2020
Assumed power factor in north	pf1	0.9	Assumed load increse rate per year	inc	15%
Assumed power factor in south	pf2	0.8	Considerable loading rate on Transformer	lmt	80%

Source: JICA survey team

Figure 6-2: Future plan for Mandalay 33 kV Transmission System into 2020, Year of 2020

6.3 Standardization of Specification & Constitution and Preliminary design

The outlines of existing standard design of various facilities and the policy of preliminary design of 33 kV substations for candidate projects for Japanese ODA loan are described as follows.

6.3.1 Standardization of Distribution Facilities Specification and Constitution

The distribution facilities specification and constitution for the preliminary design became standardized.

From the viewpoint of the compatibility with existing facilities, the standardization follows the specification and constitution determined in existing ESE specification and so on, but the recommendations from survey team were proposed and reflected in the standardization, such as the method of determination of the capacity of a transformer installed on a substation.

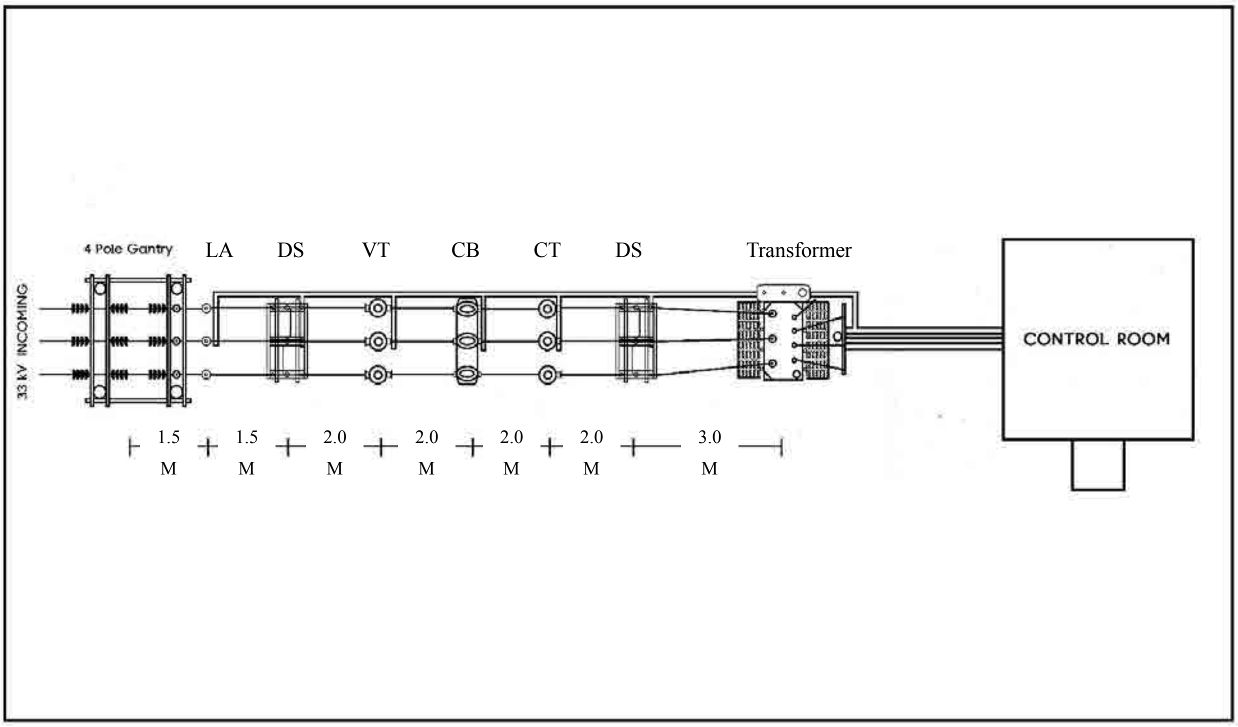
(1) 33/11 kV substations

ESE has two types of standard 33/11 kV substation specification, 5 MVA transformer and 3 MVA transformer. The standard ESE substation has 1 transformer unit. When newly installing a transformer on a substation, ESE installs small capacity transformer such as 5 MVA, and after its load increases and the transformer becomes overloaded, ESE upgrades the transformer to a larger capacity. (For example, when the load in the supply area increases, ESE plans to replace the 5 MVA transformer with a 10 MVA transformer.) The removed transformer is diverted to another substation. ESE has no policy that a larger capacity transformer is installed in advance if the demand is anticipated to increase in the future.

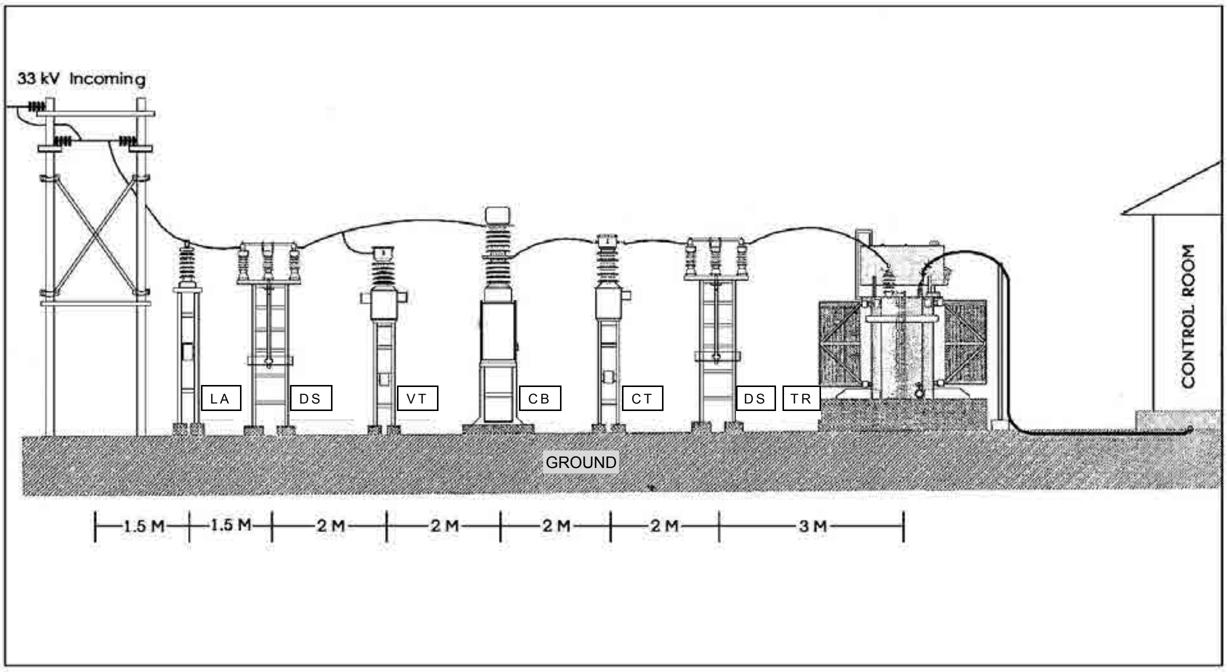
Figure 6-3 shows standard design of 33/11 kV substation.

Recently, the capacity of 5 MVA or 3 MVA power transformers will run short in a few years, since the main cities have a high demand increase. It is required to select the transformer capacity appropriate to the demand forecast from the view points of avoiding the cost increase due to repetitive construction and maintaining facility reliability. ESE builds in installations of transformers of 10 MVA or 20 MVA to the central area of main cities in the five year plan formation, in order to handle the recent high demand increase. Preliminary design reflects installing 10 MVA or 20 MVA transformers.

Plan Elevation of 33/11 kV Substation



Elevation of 33/11 kV Substation



Source: ESE's standard design

Figure 6-3: Standard design for 33/11 kV substation

A standard substation has one incoming transmission line, one set of switch bay, and one transformer unit. Air insulated switchgears (AIS) are applied for 33 kV circuits, that are called "switch bay". A gas circuit breaker (GCB) or 33 kV circuit, and oil immersed transformer are installed according to the specification. Oil circuit breakers (OCB) are still used in some existing substations. 11 kV switchgear panels are installed in the control room.

If a substation with one 10 MVA transformer becomes overloaded, another 10 MVA transformer including one set of switch bay will be installed in the substation. Regarding control and relay panels, one 33 kV remote control panel for transformers including meters and relays is installed in the control room.

Figure 6-3 shows ESE's standard design for a 33/11 kV substation. Survey team proposed the following policies for the preliminary design of candidate projects for Japanese ODA loan.

① Omission of disconnecting switch (DS) on the primary side of transformers

Although DSs are installed on the primary side of transformers under standard design, the DSs should be omitted. When stopping operation of the transformer, the range of power outage will be "DS connected with line side (cut-off) - CB - transformer - extraction point of CB on secondary side", therefore the disconnection on DSs on the primary side is unnecessary. In fact, some existing substations have no DSs on the primary side of their transformer.

②Alternation of installation point of voltage transformer (VT)

The voltage transformer (VT) for 33 kV is installed between line-side DSs and CBs in standard design. But in the preliminary design, VT is installed on the transmission line side on line-side DSs.

VT is used for the voltage measurement on the transmission line or the bus connected to a substation. In case of a standard-type substation with two banks, two 33 kV circuits shown in Figure 6-3 are arranged in two rows and two VTs need to be installed. Since the incoming transmission line is a single-unit in standard substations in ESE, the number of VTs can be saved even in the case of a substation with two banks by installing VT on the transmission line side on line-side DSs. In fact, some existing substations with two banks have only one VT on the transmission line side of DSs.

(2) 66 kV substations

ESE has two types of 66 kV substation standard specifications, 66/33 kV and 66/11 kV. The standard type of 66 kV substations is an air insulated substation. The capacity is 5 MVA in each. 66 kV substations are constructed by MEPE and operated and maintained by ESE, basically. There are some cases that small scale 66 kV substations are constructed by ESE.

Actually, ESE has 10 MVA, 20 MVA and 30 MVA transformers. They were installed according to the load in the supply area. It is better that the capacity of 66/11 kV or 66/33 kV transformers is determined by demand forecast and through discussion and coordination with MEPE.

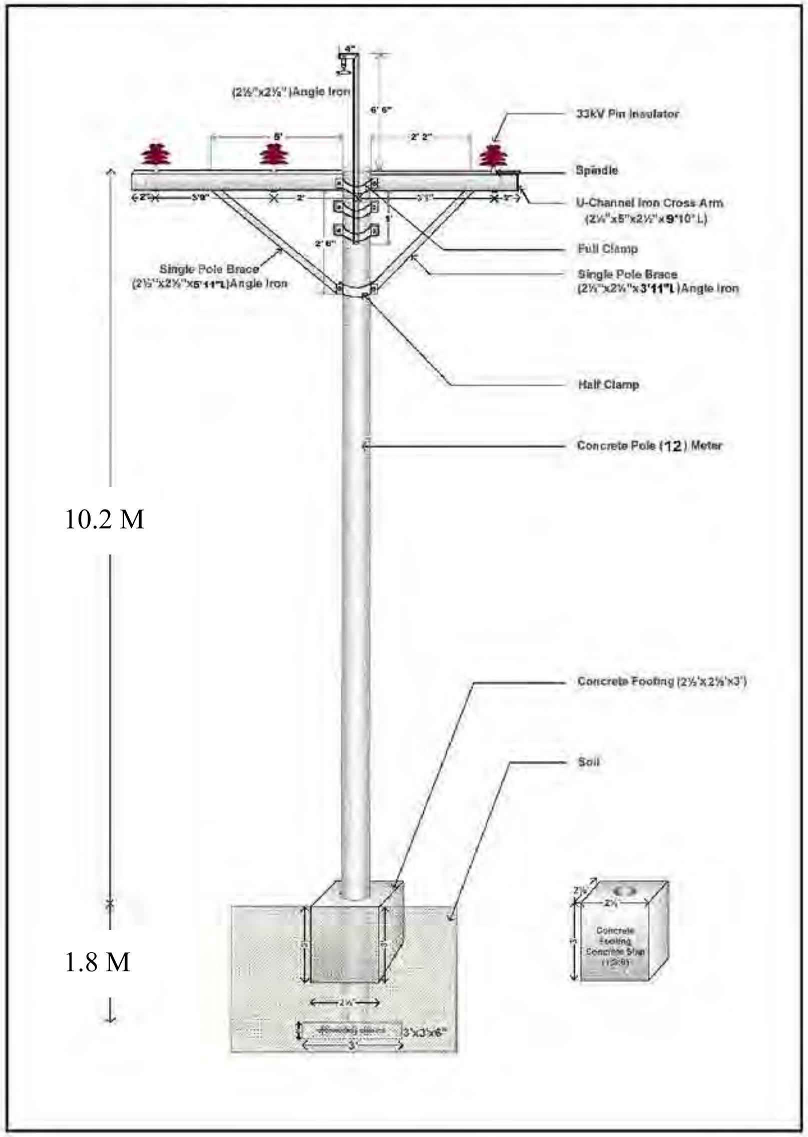
(3) 33 kV transmission lines

The type of all 33 kV transmission lines is overhead transmission line and employs Aluminum Conductor Steel Reinforced (hereinafter referred to as "ACSR") for conductors and concrete pole for line supporting structure. ACSR 150 mm^2 is applied for standard conductors, and 12 meter concrete poles are applied for standard support structure according to ESE's specification. Figure 6-4 shows examples of the standard 33 kV overhead line structure. ACSR 95 mm^2 is also installed for 33 kV lines.

(4) 11 kV distribution lines

The type of all 11 kV distribution lines is overhead transmission line and they employ ACSR for conductors and concrete pole for line supporting structure according to ESE's specification. ACSR 95mm^2 is applied for standard conductors, and 10 meter concrete poles are applied for standard support structure according to ESE's specification. Figure 6-5 shows examples of standard 11 kV overhead line structure.

Pole Design of Suspension Single Concrete Pole 12 Meter for 33 kV Line



Pole Design of Tension Concrete H-Pole 12 Meter for 33 kV Line

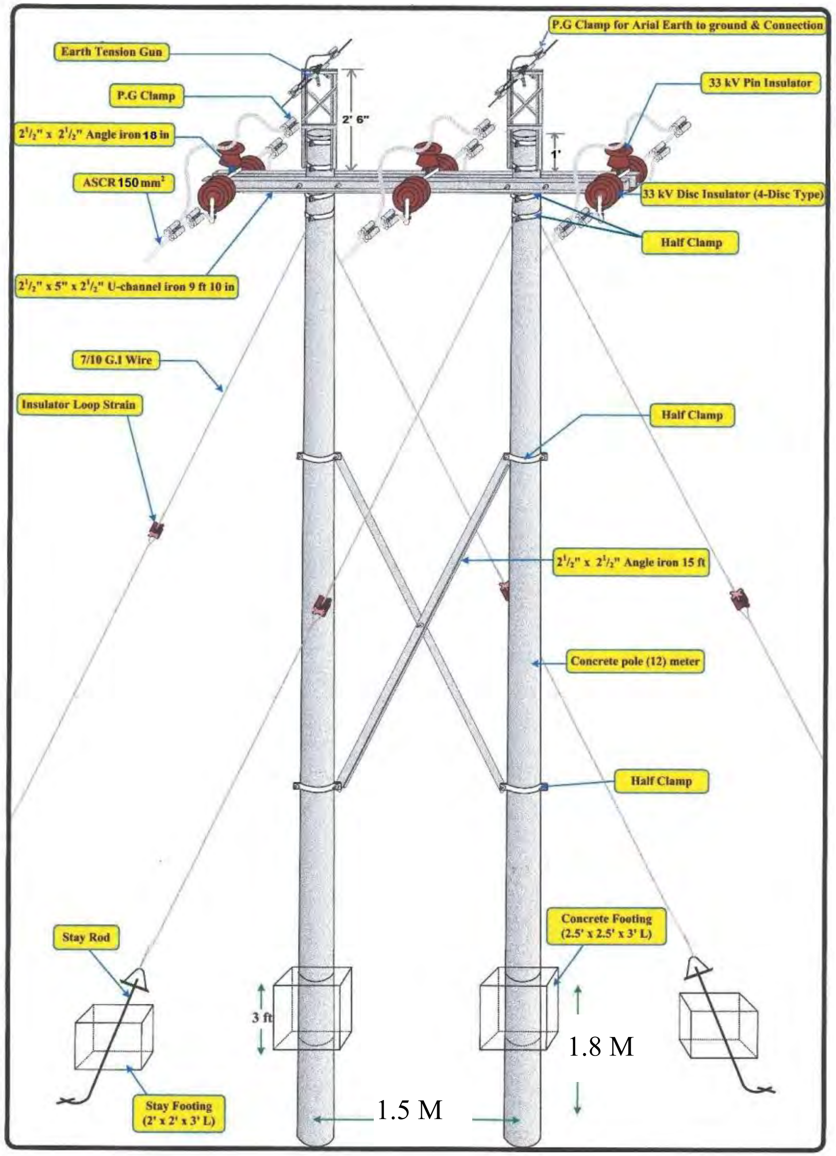
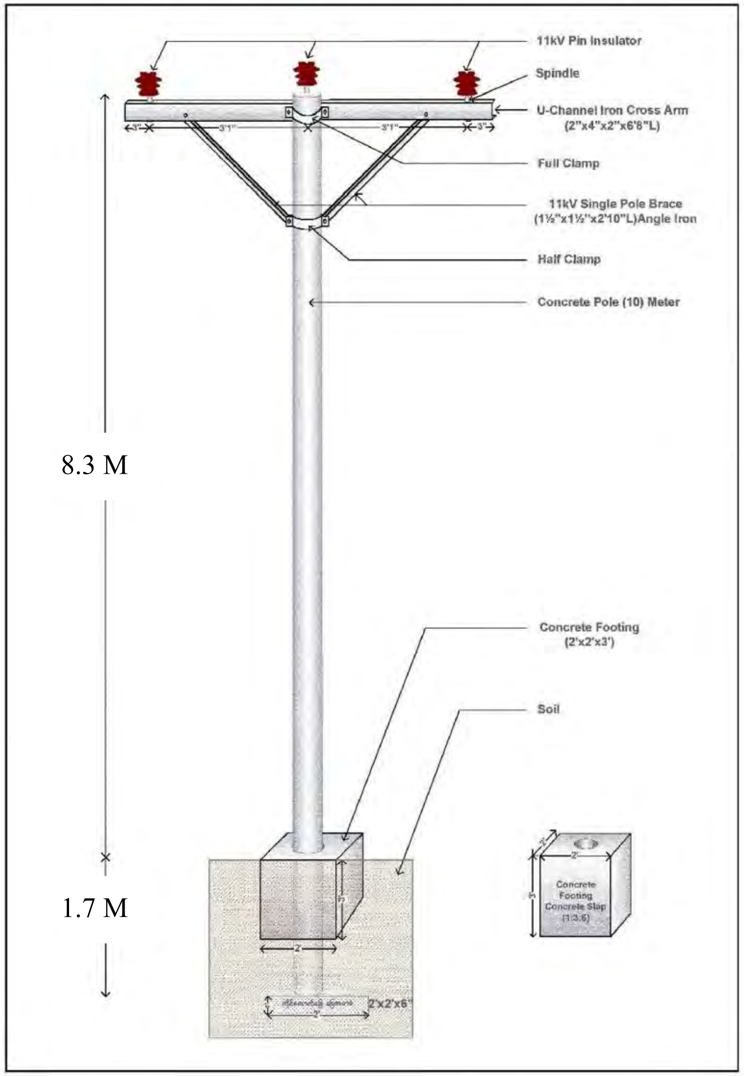


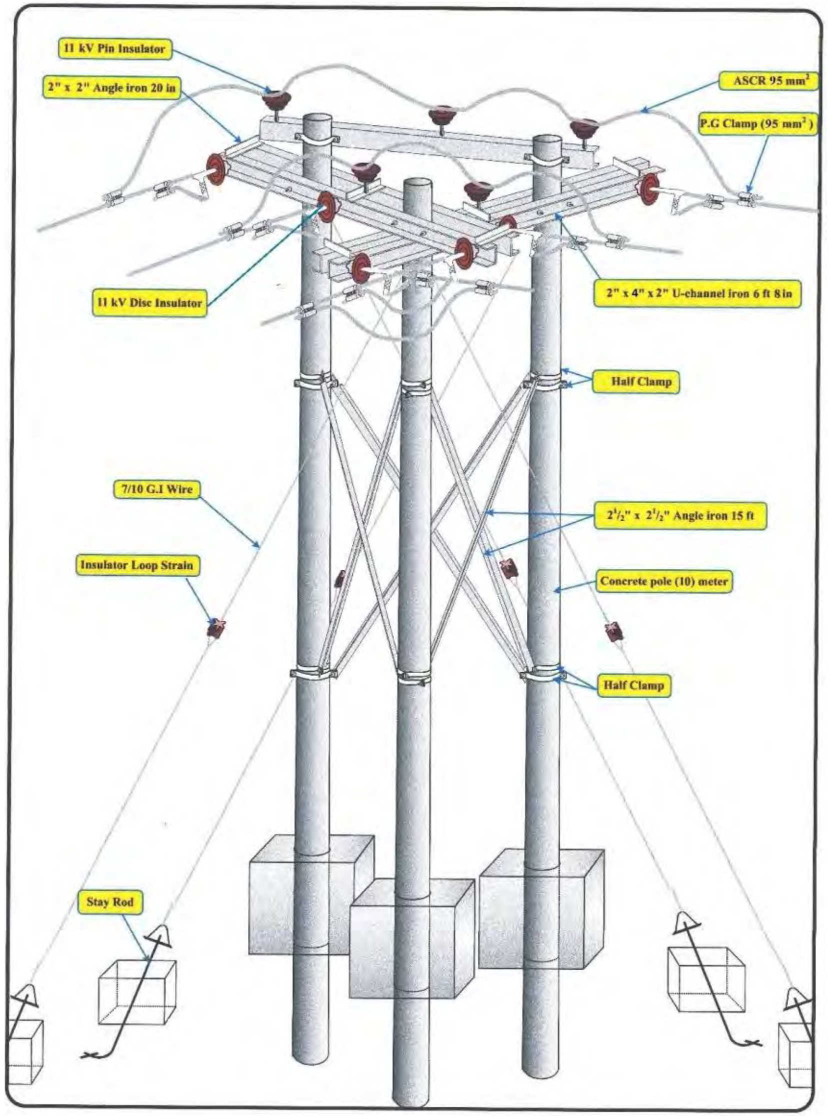
Figure 6-4: Examples of pole design of concrete pole for 33kV line

Source: ESE's standard design

Pole Design of Suspension Single Concrete Pole 10 Meter for 11 kV Line



Pole Design of Tension Concrete 3-Pole 10 Meter for 11 kV Line

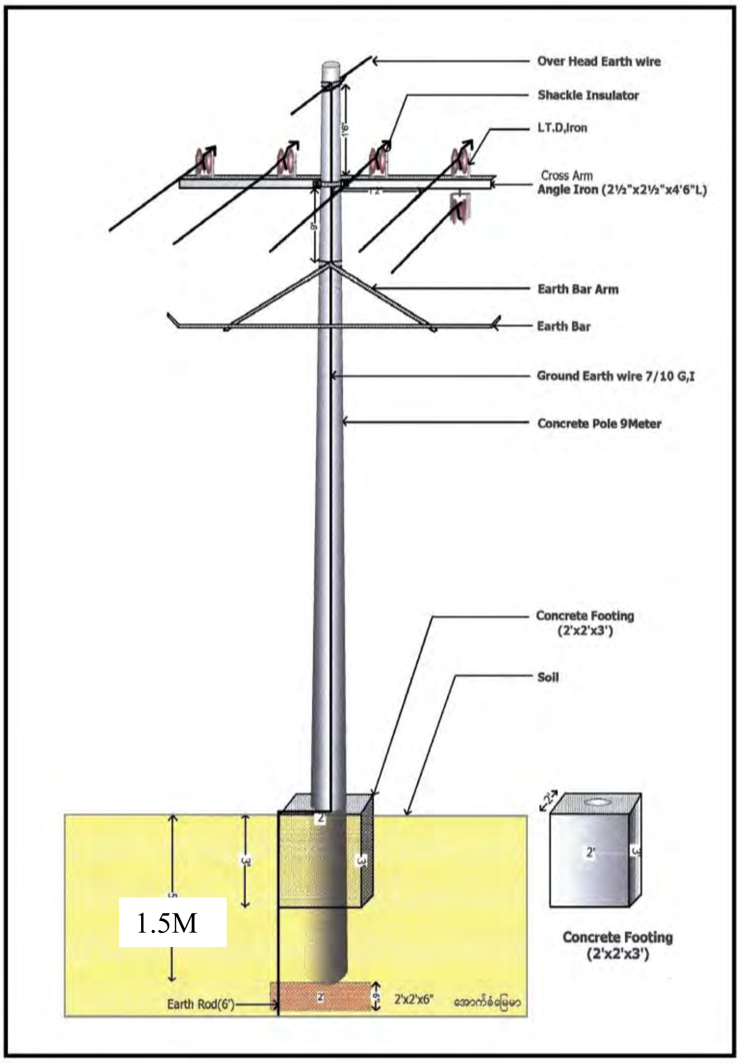


Source: ESE's standard design

Figure 6-5: Examples of pole design of concrete pole for 11 kV line

(5) 400 V distribution lines

Hard Drawn Bare Copper (hereinafter referred to as "HDBC") wire has been used for 400/230 V distribution lines. Figure 6-6 shows examples of standard pole design for 400 V line using HDBC wire.



Source: ESE's standard design

Figure 6-6: Example of pole design for 400 V line using HDBC wire

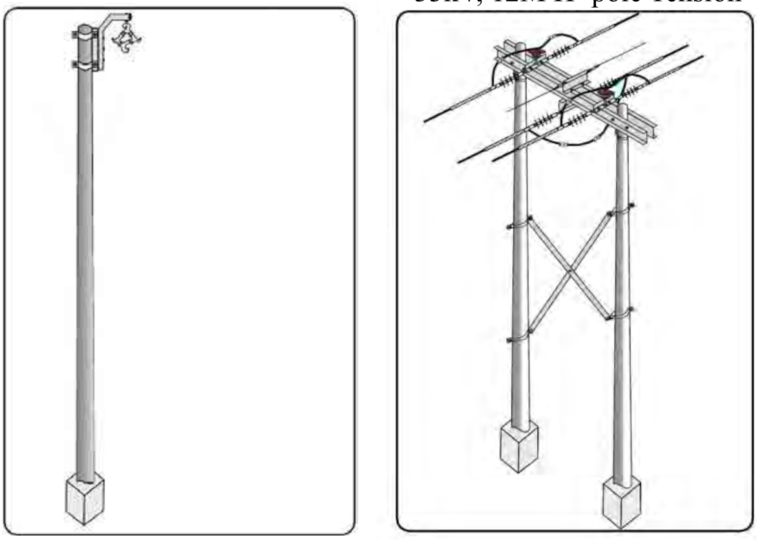
(6) New standard specification of transmission/distribution lines

The specifications of transmission/distribution lines that ESE will newly adopt in the projects are as follows.

(33 kV and 11 kV lines)

ESE plans to install insulated cable for 33 kV and 11 kV transmission/distribution lines instead of ACSR and HDBC. It is Spaced Aerial Cable (hereinafter referred to as "SAC"). The standard sizes of SAC are 1C x 120mm^2, 150mm^2, 185mm^2, and 240mm^2 of Al / XLPE. Figure 6-7 shows examples of standard design of SAC overhead line.

33kV, 12M 1- pole(Suspension)   33kV, 12M H- pole Tension



Source: ESE's standard design

Figure 6-7: Examples of pole design for concrete poles using SAC wire

Image of SAC

Source: JICA Surevey Team (Chipa Substation)

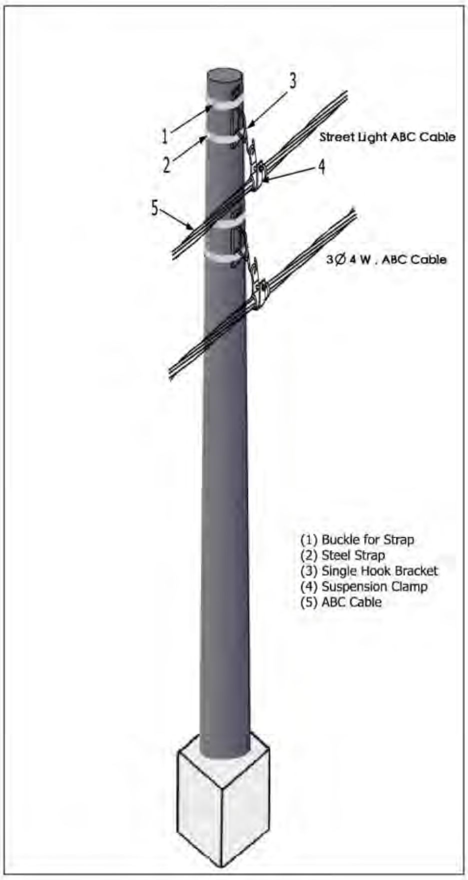
Figure 6-8: Example of a SAC wire installation site

(400 V lines)

HDBC wire had been used in 400/230 V distribution lines in the past. Nowadays, Aerial Bundled Cable (hereinafter referred to as "ABC cable") one of covered wires most widely used. The advantages of ABC cable compared to HDBC wire are as follows.

a. Electric leakage hardly occurs by virtue of the covered wire when touching trees and branches.
b. Short-circuit fault hardly occurs when two wires touches because of wind.
c. The possibility of electric shock accident is very low when an electric wire drops to the ground.
d. It is not easy to steal electricity from ABC wire and it contributes to the reduction of non-technical distribution loss.
e. Distribution lines can be installed nearer to building structures.

Figure 6-9 shows an example of a standard pole design for ABC cable as 400 V line.



Source: ESE's standard design

Figure 6-9: Examples of Pole design for 400V line (ABC cable)

Source: PR of Sun Co., Ltd. displayed in YESC

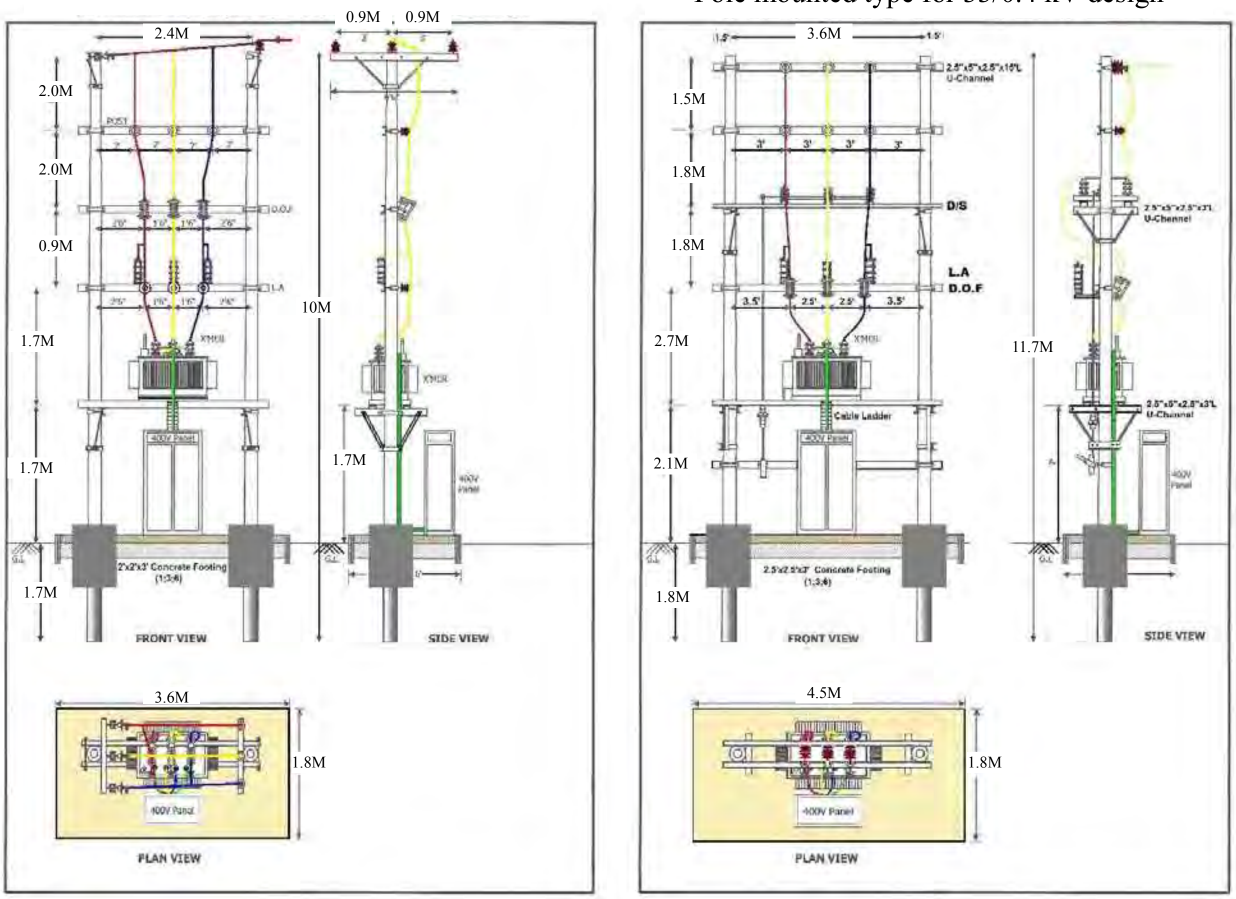
Figure 6-10: Appearance of ABC cable

(7) Distribution Transformer

ESE has two voltage types of distribution transformers, 33/0.4 kV and 11/0.4 kV. Only the 11/0.4 kV transformer with a capacity of 200 kVA is shown in ESE's standard specification. On the other hand, 33/0.4 kV and 11/0.4 kV transformers are shown in standard design (pole installation method).
Figure 6-11 shows standard pole installation designs of pole mounted type for distribution transformer.

Pole mounted type for 11/0.4 kV design

Pole mounted type for 33/0.4 kV design



Source: ESE's standard design

Figure 6-11: Standard pole installation design for distribution transformers [Pole Mounted Type]
(Left : 11/0.4 kV transformer / Right : 33/0.4 kV transformer)

6.3.2 Preliminary design

The preliminary design of 33 kV substations for construction or upgrading were implemented with ESE counterparts parallel to the site investigation for selection of candidate projects for Japanese ODA loan.

Distribution facilities are spread across a wide-area and in many cases they are constructed near the site where power demand will increase in near future. It is not the detailed design stage until the project site for construction of distribution facilities is decided. Therefore, the preliminary design of 11 kV or less distribution facilities was not implemented, and the site investigation and the design will be implemented in the detailed design stage of the project.

(1) Composition, specifications and layout design of distribution substation

Preliminary designs were carried out based on basic concepts shown in Table 6-2 for new construction of power distribution substation and for additional transformers installation into existing power distribution substations.

Table 6-2: Basic concepts of preliminary design for power distribution substation

Basic concepts of preliminary design for power distribution substation	[New construction of power distribution substation] ・Securing additional spaces for future use in consideration of final shape of substation ・Layout of equipment in consideration of maintainability and future replacement [Addition or replacement of transformers in existing power distribution substation] ・Securing additional spaces for future use in consideration of final shape of substation ・Layout of equipment in consideration of maintainability ・Effective use of existing premises to avoid acquisition of new plots as much as possible ・Equipment layout in consideration of possible appropriation of existing buildings

Source : JICA survey team

① Examination of substation layout
When considering installation of additional transformers or replacement transformers for an existing substation, whether acquisition of an additional plot is necessary or not was examined based on site investigation.

② Examination of equipment specifications
Specifically for 33 kV or 66 kV switching equipment, selection was made with installation space in mind for example, using GIS facilities.

③ Surveying of buildings
When considering installation of additional transformers or replacement transformers for an existing substation, the size of existing buildings was surveyed.

④ Drafting of substation layout drawings and summarizing of preliminary designs

Drafting of substation layout drawings and summarizing of preliminary designs. Based on the results of steps ① through ③, drawings of substation layout were drafted. When summarizing the preliminary design of a substation, its layouts of pre- and post-construction (planned), photos of the site and so on were assembled for each project so that these can be used as references for carrying out a detail design or construction plan when the project for it becomes a Japanese ODA loan.

As a result of site investigations, there was no site which would require applying 33kV GIS equipment.

(2) Layout of the facilities of 33 kV substations and design of transmission routes

The layout figures of 33 kV substations and route maps of transmission routes are prepared based on the result of the site investigations and above-mentioned policies. And survey team checked the following matters with ESE.

① 33 kV or 66 kV transmission line routes, that are to be newly constructed following new construction of power distribution substations, were checked on maps with counterpart.

② ESE staffs were interviewed about locations that require special environmental and social considerations around planned routes.

③ ESE staffs were interviewed about the situation of land acquisition of each site.

6.4 11 kV Examination of Procurement method

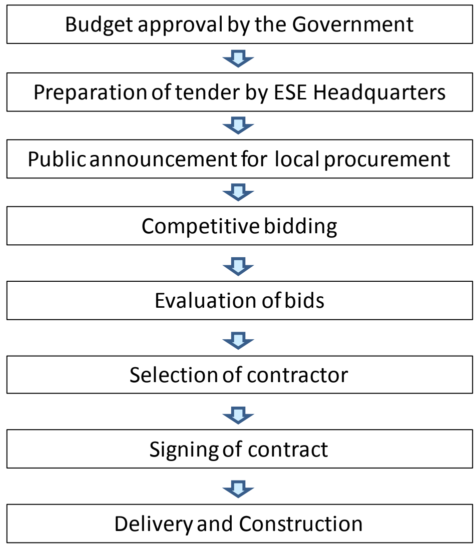
6.4.1 Procurement by ESE

In ESE, the Material Planning Department in ESE headquarters collectively manages estimation of costs for procurement of machines, equipment and construction, installation work for 33 kV projects in state or division offices. And ESE headquarters practices all tender procedures for procurement and contractors.

In recent years, ESE adopted a "turn key tender policy" for the construction of 33 kV substations or 33 kV transmission lines by which all steps of projects including detailed design, procurement of equipment, installation work, commissioning and so on are packaged for tendering. All procedures for turn key tender are practiced by ESE headquarters. In the case of usual turn-key projects, a contractor submits the specification of equipment to order and the document for confirmation in acceptance test and ESE performs final check according to the site confirmation or the checking document. Figure 6-12 shows General Flow Chart of procurement in ESE.

ESE headquarters requires the following contents to contractor at the time of bidding.

- ✓ Organization of project management team
- ✓ Organization of project implementation team
- ✓ List of material and machinery
- ✓ Schedule of material transportation to the site
- ✓ Site schedule and project working schedule
- ✓ Working experience on similar projects
- ✓ Tabulation drawing for transmission and distribution line
- ✓ Substation design and layout plan



Source: JICA survey team based on ESE information

Figure 6-12: General Flow Chart of procurement in ESE

ESE takes company profile and experience of similar projects and so on into consideration to select a contractor for the project. ESE also makes evaluation by scoring on some points of candidate contractors for the project.

6.4.2 Procurement method for Japanese ODA loan projects

"Construction and Reinforcement of 33/11 kV and 66/11 kV Substation" and "Construction and Replacement of 66 kV and 33 kV Transmission Line" are based on international procurement.

It is proposed that the procurement policy for several substation projects and transmission line projects be packaged for tendering as a "design-build system".

Design-build system is the tendering method in which the services from design to construction are collectively contracted by a single entity. As for the design-build system, it can be considered that substation and transmission line construction projects which are listed in several cities will be procured in one group so that contractor could make project implementation smoothly by applying workers and equipment efficiently on several projects. Finally, grouping of projects for procurement will be considered according to the results of selection for Japanese ODA loan projects.

6.5 Proposal related to Japanese ODA loan project scope

Priority policy for selecting candidate projects for Japanese ODA loan is shown in Table 6-3.

Table 6-3: Priority Policy for selecting candidate projects

Priority	Conditions	Subjected project
1	Facility overload (demand increase) improvement	33 kV(66 kV) substation construction and upgrading 33 kV(66 kV) transmission line construction and upgrading 11 kV distribution line construction, extension and upgrading 11 kV transformer installation
2	Power loss reduction	11 kV multi-transformer system application Low-loss type transformer installation Using covered wires in 400 V distribution lines (Measures against electricity theft) Switching to digital meters
3	Supplying reliability improvement Line fault reduction	Installation of double circuits system to transmission line Replacing 33 kV and 11 kV aged facilities Installation reliability improvement facilities to 11 kV lines Introduction of utility vehicles
4	Public safety improvement	Introducing covered wire Securing separation from ground level
5	Electricity quality improvement	Introduction of phase modifying facilities (power capacitors)

Source: JICA survey team

The policy for the prioritization is as follows. In consideration of the emergent and tight demand-increasing situation, the supply of power should take on the top priority and the priority order of "Facility overload (demand increase) improvement" was set "1". The priority order of "Power loss reduction" was set "2" because it would have an effect of improving power supply capacity that is equivalent to construction of a new power plant. The priority order of "Supplying reliability improvement / Line fault reduction" was set "3" for the stable power supply. Public safety improvement has been addressed as an important issue by MOEP, projects with high urgency should be implemented immediately not by Japanese ODA, but by the ESE's own budget. The measures for public safety improvement shown in Table 6-3 have not such high urgency, because they target distribution facilities that will be in no danger of causing disasters to the general public due to aging or deterioration after a few years. There are not so many electric accidents in regional cities except Yangon and Mandalay. In light of the above, the priority order of "Public safety improvement" was set "4", because the steady implementation of measures for "Supplying reliability improvement" would be expected to improve also public safety. And in order to give priority to ensure the quantity of power supply, the priority order of "Electricity quality improvement" was set as "5".

6.6 Proposal concerning project implementation regime and operation and maintenance regime

In order to implement Japanese ODA loan projects smoothly, it is necessary to clarify the project implementation regime and responsible persons in ESE. And it is extremely important to operate the equipment constructed in the Japanese ODA loan projects sustainably in good condition so that the equipment will remain effective far into the future. Therefore, survey team proposes operation and maintenance regimes that have been proven highly effective based on know-how on monitoring, data accumulation and analysis, periodic patrols and inspections implemented in Japan for project operation and maintenance.

(1) Enhancement of ESE technological capability through the implementation of Japanese ODA loan projects

Since the work volume of ESE is expected to increase with the implementation of these projects, in order to execute the projects smoothly, it is necessary to enhance engineers' execution technologies and secure workers under direct management and contractors. As for the enhancement of ESE engineers' technological capability, the capabilities concerning preparation of construction schedule, design, site management, inspection should be enhanced. In implementing Japanese ODA loan projects, ESE engineers will conduct the work and engage the tutelage of consultants, which will be effective to enhance the ESE engineers' technological capability.

(2) Suggestions on organization for operation and maintenance

In implementing Japanese ODA loan projects, it is necessary to strengthen the organization in which full-time persons in charge of the projects are assigned. Survey team proposes that ESE divide 3 components [i) construction and enhancement of substations and transmission line, ii) enhancement of distribution lines and iii) utility vehicles] in its distribution business in regional cities and assign staffs of executive engineer class to each component. And as for 11 kV line projects, it is preferred that ESE assigns persons in charge to each division / state office.

ESE's implementation and operation unit (project management unit) for Japanese ODA loan projects (proposed) is shown in Figure 6-13.

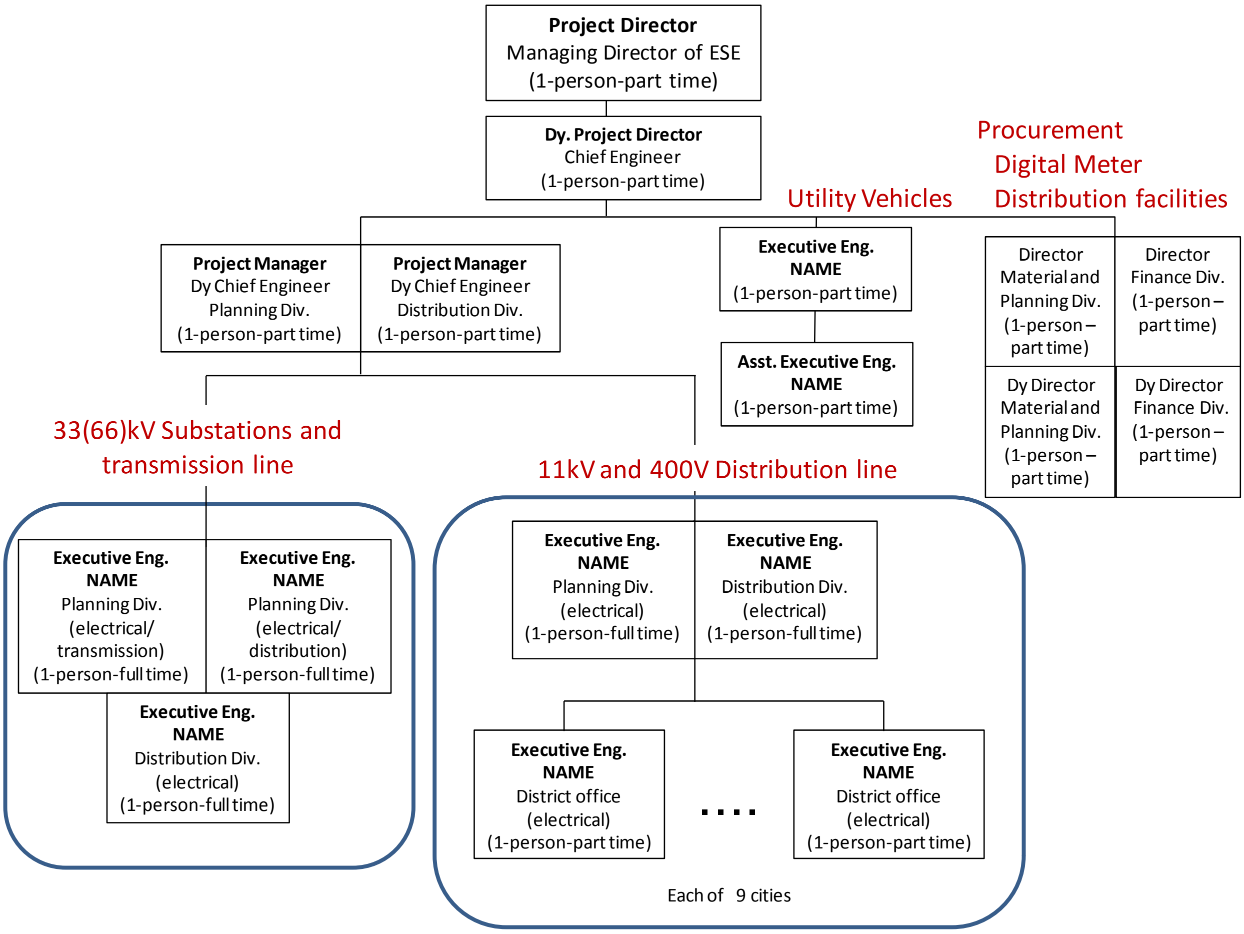
The main duties of persons in charge of project management are shown in Table 6-4.

Table 6-4: Main duties of persons in charge of project management

Item	Person in charge	Main Duties
Construction and Enhancement of 33(66) kV substations and transmission lines	Substation and transmission (Planning)	Plan and design of substation and transmission line projects [Full-time]
	Distribution (Planning)	Plan and design of distribution line projects [Full-time]
	Distribution (Construction Management)	Construction management work concerning substation, transmission line and distribution line projects [Full-time]
Construction and Enhancement of 11 kV, 400 V distribution lines	Distribution (Planning)	Administration of Plan and design work for distribution line projects [Full-time]
	Distribution (Construction Management)	Construction management work concerning distribution line projects [Full-time]
	Distribution (Construction Management, 1 person for each city)	Designing and construction management work concerning distribution line projects in each city [Full-time]
Procurement of Reliability improvement equipment and digital kWh meters	Procurement of equipment (1 manager, 1 staff)	Procurement management / Stock management for materials and equipment
	Financial (1 manager, 1 staff)	Fund management for the projects
Procurement of Utility Vehicles	Technology for distribution work (1 manager, 1 staff)	Specification management / Operation and maintenance management

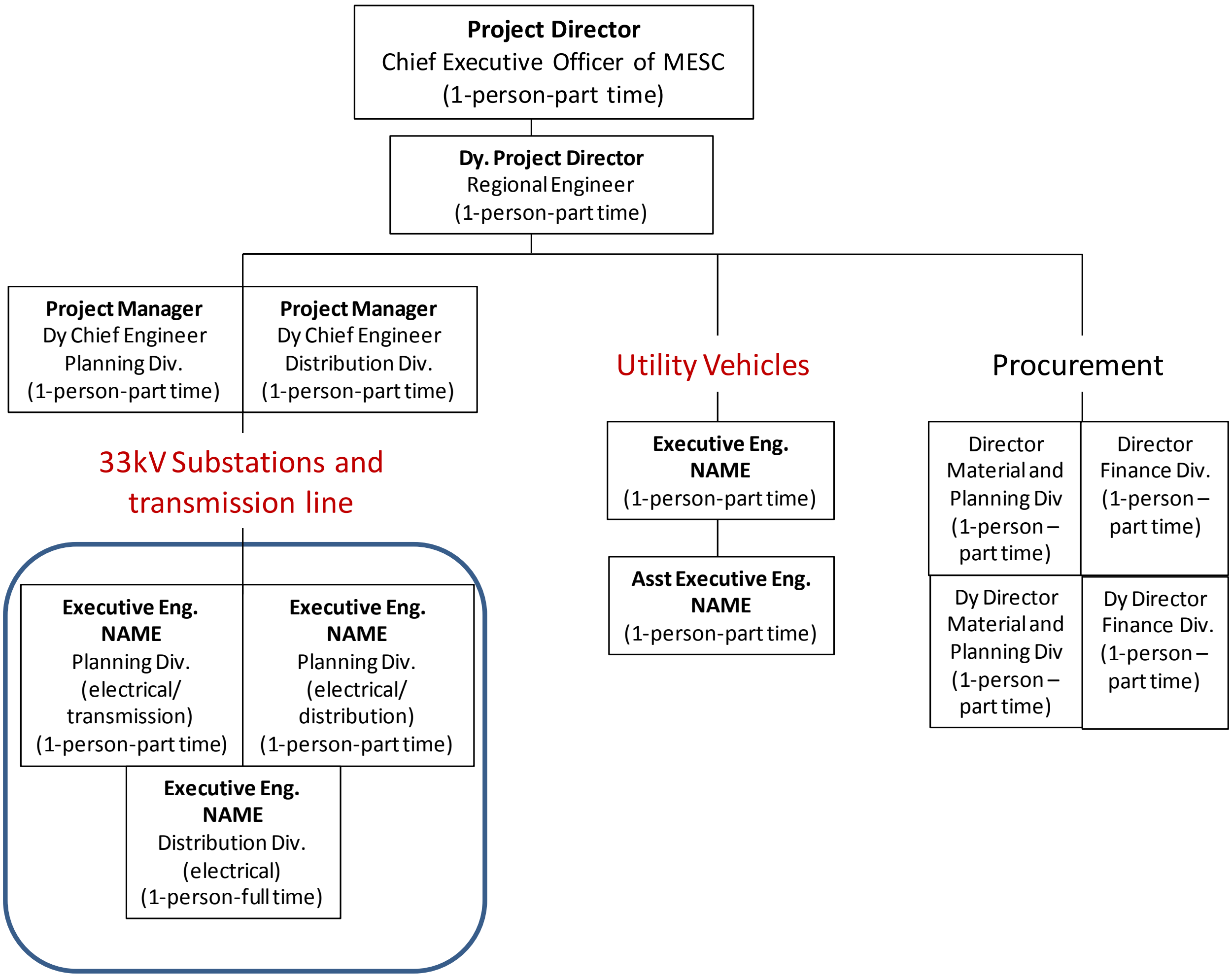
Source: JICA survey team

The distribution business in Mandalay district is managed by MESC which separated and became independent from ESE. In implementing Japanese ODA loan projects, MESC will have charge in Mandalay district, and ESE will have charge in cities other than Mandalay district. The project management unit should be established on both ESE and MESC respectively. MESC's project management unit is shown in Figure 6-14. The figure is shown as a "proposed", because the organization of MESC was not decided yet as of May 2015.



Source: JICA survey team

Figure 6-13: Proposal of Project management unit (ESE)



Source: JICA survey team

Figure 6-14: Proposal of Project management unit (MESC, proposed)

(3) Proposal of measures related to operation and maintenance structure

Operation and maintenance structure and operation rules should be stipulated in order to operate the facilities which are installed by ODA assistance in good condition for the long term. The structure and rules should cover not only new installed facilities but also existing equipment to improve reliability in the whole of ESE's distribution system. Survey team proposes measures for improvement operation and maintenance taking the current situation of ESE into consideration.

The proposed measures are shown in Table 6-5.

Table 6-5: Proposal of measures related to operation and maintenance regime

Item		Measure
Check of equipment condition		・Policies for checking main equipment to be stipulated ・Introducing method for managing inspection results and identifying degradation due to aging, etc.
Equipment management	Substation	・Organizing of data on production years and main specifications of equipment ・Management of construction and repair work records
	Power distribution	・Numbering of electric poles for managing them ・Establishment of data format to build up equipment database
Equipment drawing control		・Drafting of layout drawings of all 33 kV(66 kV) substation ・Digitization of main drawings to make looking-up of them easy
Protection coordination (substation)		・Policies for protection coordination for equipment to be clarified in order to secure public safety and equipment protection
Patrol		・Codifying of flow of patrol duties into rules ・Making detection of anomalies easy by affixing a temperature indicating tape to equipment, etc.
Blackout statistics control		・Recording of power failures and blackouts as database data to reflect them in training and equipment measures

Source: JICA survey team

The facility data management is referred to as an example for improving the operation and maintenance regime as follows.

Abnormal or accidental information found in daily inspection, historical records of inspection, etc. are very useful for understanding the conditions of power facilities and for planning prevention maintenance scheduling. Facility state management and inspection work plan can be performed efficiently if ESE engineers easily access to the database of this information.

ESE engineers can study knowledge on information management through implementation of Japanese ODA loan projects with consultants. Sharing the skills with ESE staff working in headquarters and in local offices will bring high improvement effect such as prolonging the lifecycle of facilities and reduction of facility failures.

Chapter 7 Environmental and Social Considerations

7.1 Legislative and Institutional System on Environmental and Social Consideration

7.1.1 Legislative System for Environmental and Social Consideration

(1) Laws, Rules and Regulations related to Environmental and Social Consideration

Environmental Conservation Law (2012) and Environmental Conservation Rules (2014) are recently enacted laws to determine the comprehensive environmental conservation and management in Myanmar. Following laws, rules and regulations are related to environmental and social consideration in Myanmar.

- The Water Power Act 1927 (Burma Act 11, 1927)
- The Underground Water Act (1930)
- Public Health Law (1972)
- Territorial Sea and Maritime Zone Law (1977)
- Irrigation Laws and Regulations (1982)
- Law on Aquaculture (1989)
- Marine Fisheries Law (1990)
- Freshwater Fisheries Law (1991)
- The Forest law 1992 (8/92)
- The Protection of Preservation of Cultural Heritage Region Law 1994
- The Protection of Wildlife, Wild Plant and Conservation of Natural Area Law 1994
- National Environment Policy (1994)
- Mines Law (1994)
- Myanmar Agenda 21 (1997)
- The Conservation of Water Resources and River Law (2006)
- National Sustainable Development Strategy NSDS (2009)
- Myanmar Investment Law (2011)
- The Environmental Conservation Law (2012)
- Farmland Law 2012 (Pyidaungsu Hluttaw Law No.11, 2012)
- Farmland Rules, 2012 (President Office Notification No 62, 2012)
- Vacant, Fallow and Virgin Lands Management Law 2012 (Pyidaungsu Hluttaw Law No.10)
- Vacant, Fallow and Virgin Lands Management Rules 2012 (President Office Notification No 1, 2012)
- Myanmar Investment Rule (2013)
- Investment Notification (2013)
- The Environmental Conservation Rules (2014)
- The Standard Performance and Specification Law (2014)
- The EIA Procedure (Draft)
- Environmental Quality Guidelines (Draft)

(2) Environmental Conservation Law (2012)

Environmental Conservation Law (hereinafter referred to as "ECL") in Myanmar was prepared by Ministry of Environmental Conservation and Forest (hereinafter referred to as "MOECAF") and enacted in March 2012. This is the fundamental law for environmental conservation in Myanmar. Table 7-1 Composition of the Environmental Conservation Law describes overall composition of ECL.

In article 14 and 15 of ECL (March, 2012), a person or the owner or occupier of any business shall treat, emit, discharge and deposit polluted substances with stipulated environmental quality standard by using facility or controlling equipment or by using environmentally sound method.

Table 7-1: Composition of the Environmental Conservation Law

Chapter		Sections
1	Title and Definition	1-2
2	Objectives	3
3	Formation of the Environmental Conservation Committee	4-6
4	Duties and Powers relating to the Environmental Conservation of the Ministry	7-8
5	Environmental Emergency	9
6	Environmental Quality Standards	10-12
7	Environmental Conservation	13-16
8	Management of Urban Environment	17
9	Conservation of Natural Resources and Cultural Heritages	18-20
10	Prior Permission	21-25
11	Insurance	26-27
12	Prohibitions	28-30
13	Offences and Penalties	31-34
14	Miscellaneous	35-42

Source: Environmental Conservation Law 2012

(3) Environmental Conservation Rules (June, 2014)

Environmental Conservation Rules(hereinafter referred to as "ECR") (June, 2014) emphasizes the importance of conservation of cultural heritage areas, natural heritage areas, cultural monuments, buildings and natural area and to set up the method to mitigate the impact of polluted waste during destruction, storage, placement and transportation of such waste.

ECR is detailed enforcement regulations of the ECL and enacted on 5 June, 2014. Table 7-2 describes overall composition of ECR.

Table 7-2: Composition of the Environmental Conservation Rules

Chapter		Sections
1	Title and Definition	1-2
2	Adopting Policy Relating to Environmental Conservation	3-6
3	Environmental Conservation	7-26
4	International, Regional and Bi-lateral Cooperation Relating to Environmental Conservation	27-28
5	Environmental Management Fund	29-35
6	Environmental Emergency	36-37
7	Environmental Quality Standards	38-39
8	Management of Urban Environment	40
9	Waste Management	41-46
10	Conservation of Natural Resources and Cultural Heritages	47-50
11	Environment Impact Assessment	51-61

Chapter		Sections
12	Prior Permission	62-68
13	Prohibitions	69
14	Miscellaneous	70-74

Source: Environmental Conservation Rules 2014

ECR stipulates basic policy and concept of Environment Impact Assessment (hereinafter referred to as "EIA") application in developing Projects (Chapter 11);

- To prepare the environment impact assessment report including Environmental Management Plan (hereinafter referred to as "EMP") and to submit it to the Ministry (MOECAF) (Section 55 (a)), and
- To implement and carry out EMP within the time stipulated by the Ministry and to submit the performance situation to the Ministry (Section 55 (b)).

According to the latest draft of EIA procedure, Prior Permission (Chapter 12) is required for certain categories of business, work-site or factory, workshops which may cause an impact on the environmental quality (Section 62). Businesses/ projects, which may cause hazardous impacts, and projects, are required to conduct EIA/ Initial Environmental Examination (hereinafter referred to as "IEE").

7.1.2 Environmental Impact Assessment (EIA) System and Approval Procedure in Myanmar

Recently, Myanmar has been changed in various sectors such as politic, economic, education, media, health and many more. Therefore, EIA Procedures is urgently needed to be a sustainable economic growth in Myanmar. As of Feb, 2015, the 6th draft of EIA Procedure is under preparation by MOECAF.

The draft EIA Procedure covers contents such as screening of projects, qualification for conducting IEE/EIA, preparation of IEE/EIA report, EMP, public involvement, procedure how to get an approval of IEE/EIA report from Environmental Conservation Department (hereinafter referred to as "ECD") under MOECAF, Environmental Compliance Certificate (hereinafter referred to as "ECC"), and monitoring process after getting an approval of IEE/EIA report, etc..

Though there are still considerable modifications in EIA Procedures by MOECAF as of November 2014, there seems to be of not much significant changes in the overall composition of the EIA Procedures among different versions of the draft. Table 7-3 describes overall composition of the latest EIA Procedure.

Table 7-3: Composition of the Draft EIA Procedure (November, 2014)

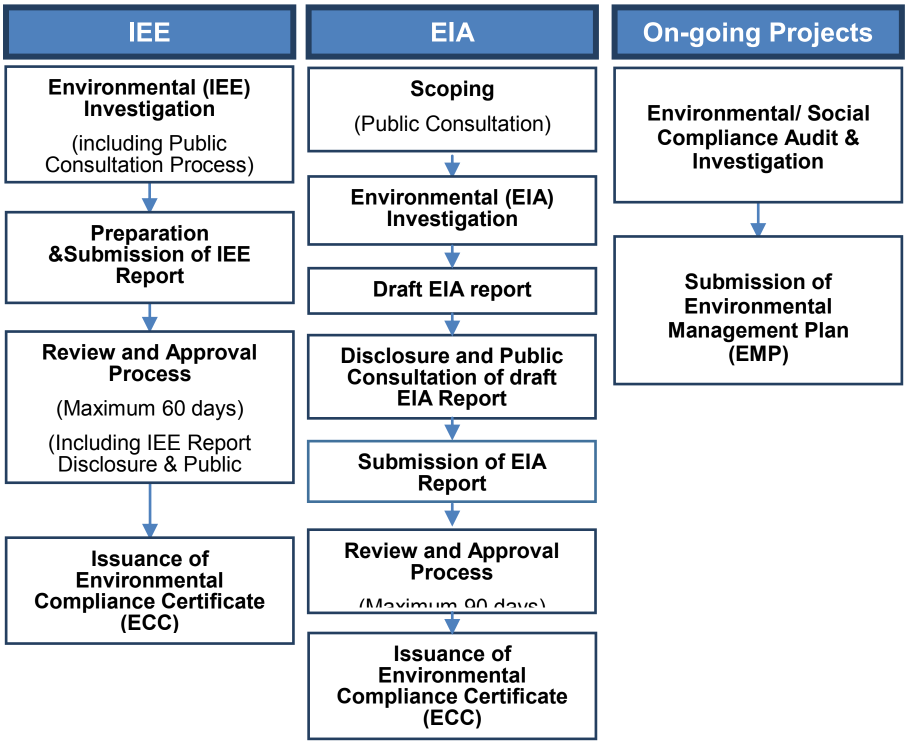
Chapter		Sections
1	Title and Definition	1-2
2-1	Establishment of Environmental Impact Assessment Process	3-14
2-2	Requirement of Third Parties to Conduct IEE/EIA	15-22
3	Screening	23-27
4	Initial Environmental Examination	28-40
5	Environmental Impact Assessment	41-73
6	Environmental Consideration in Project Approval	74-95
7	Monitoring	96-112
8	Penalties	113-120
Appendix A	Project Categorization for Assessment Purposes	
Appendix B	IEE/EIA Procedures	
Appendix C	Penalties Categorization	

Source: Draft EIA Procedures

According to the draft EIA procedure, basic framework to be laid out for EIA in Myanmar is as follows.

- All projects undertaken in Myanmar by any organizations or individuals and they have potential to cause significant adverse impacts, are required to undertake environmental impact assessment and to obtain an Environmental Compliance Certificate (ECC) in accordance with the EIA Procedure. (Article 3, 6th draft)
- The EIA Procedure does not address specific matters in relation to resettlement and indigenous people. Projects involving resettlement or potentially affecting indigenous people shall additionally comply with separate procedures issued by responsible ministries before separate procedures are issued by MOECAF, and in the absence of such procedures all such projects shall adhere to international good practice on involuntary resettlement and indigenous people.(Article 9, 6th draft)
- Existing projects or projects under construction before the issuance of the EIA Procedure shall develop an Environmental Management Plan (EMP) within a time frame prescribed by the Ministry and such EMP shall be subject to the review and approval of the Ministry. (Article 10, 6th draft)

The draft EIA Procedure determines processes for IEE and EIA studies and required actions for on-going projects (when the EIA Procedure is enacted). Following figure summarize respective processes. The process which is currently required by Myanmar Investment Commission (hereinafter referred to as "MIC") is also included in Figure 7-1.



Source: Draft EIA Procedures and MIC related documents

Figure 7-1: Overall EIA Process in draft EIA Procedures and MIC application

IEE report shall include 1) Project Description, 2) Identification of the project Proponent, 3) Identification of IEE experts, 4) Description of the surrounding environmental condition, 5) Identification and

Assessment of potential Adverse Impacts, 6) Results of public consultation/ participation, 7) Environmental protection measures, 8) Conclusion, 9) Environmental Management Plan (EMP) and 10) The budget needed for implementation of EMP.

EIA report shall include 1) Executive Summary, 2) Introduction, 3) Policy, Legal and Institutional Framework, 4) Project Description and Alternative Selection, 5) Identification of the project Proponent, 6) Identification of IEE experts, 7) Description of the surrounding environment, 8) Impact and Risk Assessment and Mitigation Measures, 9) Cumulative Impact Assessment, 10) EMP, 11) The budget needed for implementation of EMP and 12) Result of Public Consultation and Disclosure.

EMP report shall include 1) Description of the project, 2) Rules, commitment, legal requirements and arrangement for organization concerning with Environment, Social and if necessary health care of the project, 3) Impacts and summary of action for Mitigation Measures and 4) Management and monitoring plan in each project phase: pre-construction, construction, operation, decommissioning and after decommission.

EIA procedures describe types of categories of business which are necessary to carry out IEE/EIA studies before the implementation of the project. In the latest draft EIA Procedure, 24 types of projects for energy sector are determined for IEE/EIA categories. Among the categories indicated in the latest draft EIA procedures, following types of project categorization described in Table 7-4 are more likely applicable for the Project considered in the Study.

Table 7-4: Draft EIA/IEE Categorization for Electricity Sector Projects

Type of Investment Projects	Size of Project which requires IEE	Size of Project which requires EIA
Installation of Electrical power line < 230 kV	< 50 km	≥ 50 km
High voltage transformer substation	< 10 ha	≥ 10 ha

Source: Draft EIA Procedures

7.1.3 Environmental Quality Standards (EQS)

According to the Environmental Conservation Law, MOECAF will set Environmental Quality Standards (hereinafter referred to as "EQS") which are agreed by the Union Government and the Environmental Conservation Committee. Standards to be set by MOECAF are as follows:

- Suitable surface water quality standards in the usage in rivers, streams, canals, springs, marshes, swamps, lakes, reservoirs and other inland water sources of the public.
- Water quality standard for coastal and estuarine areas
- Underground water quality standards
- Atmospheric quality standards
- Noise and vibration standards
- Emission standards
- Effluent standards
- Solid wastes standards
- Other environment quality standards stipulated by the Union Government

Currently, MOECAF is in a process for establishment of National EQS in coordination with corresponding governmental departments, ADB and International Management Group (hereinafter referred to as "IMG") from EU. However, establishment of comprehensive and practical standards is quite difficult task and it may take certain time. In consideration of immediate demand of EQS, MOECAF is planning to determine “Environmental Quality Guidelines (hereinafter referred to as "EQG")”. Consultation meeting for EQG (draft) prepared in coordination with an environmental expert from ADB and from EU/IMG was held on 6^{th} January, 2015 at International Business Center (IBC) in Yangon. EQG is planned to enact at the end of March, 2015. While EQG is mandatory for projects which are necessary to undertake IEE/EIA studies, it is voluntary for existing projects. There have been respective EQS set up in each ministry for example: the Ministry of Industry (MOI) set up EQS for air, the MOEP set up EQS for air, noise and vibration, the Ministry of Health (MOH) set up EQS for air, noise and vibration. Corresponding governmental departments can decide whether to apply EQG in existing projects.

7.1.4 Hazardous Waste Management

MOECAF has a plan to make MOU with Norway government to make improvement in handling hazardous waste in Myanmar. When it comes to Persistent Organic Pollutants (hereinafter referred to as "POPs"), Myanmar became a party to the Stockholm Convention on POPs in 2004. To meet the obligations of the Convention, ECD under MOECAF in cooperation with United Nations Industrial Organization (UNIDO) implements a project by the Global Environment Facility (GEF) funding on the enabling activities to facilitate early action on the Implementation of the Stockholm Convention on POPs in Myanmar. Raising awareness on POPs related issues is one of the objectives of the project. The project also gives emphasize how to store transformers containing polychlorinated biphenyl (hereinafter referred to as "PCB") properly.

Regarding hazardous waste management, the following laws, regulation and departmental actions are related to the environmentally sound management of toxic chemical.

- Chapter 10 of Myanmar Agenda 21: Environmental Quality Management and Enhancement
- The Explosive Act (1887)
- The Oil Field Act (1918)
- The Poison Act (1991 and amended in Feb, 2014)
- The Petroleum Act (1934)
- The Factory Act (1951)
- The Motor Vehicle Law (1964)
- The Private Industrial Enterprise Law (1990)
- The Pesticide Law (1990)
- The Promotion of Cottage Industries Law (1991)
- Myanmar Mines Law (1994)

7.1.5 Key Laws, Rules and Regulations concerning Land Related Rights and Land Acquisition

The laws, rules and regulations concerning land related rights and land acquisition are described as follows. Though some laws have been already repealed, such laws are still partially applicable depending on situations.

- The (Lower Burma) Land and Revenue Act, 1879 (India Act II, 1876)
- The Upper Burma Land and Revenue Regulation, 1889
- The Land Acquisition Act, 1894 (India Act 1, 1894)
- Land Acquisition Directions
- The Lower Burma Town and Village Lands Act 1899 (Burma Act IV, 1898)
- Land and Revenue Order (Rule), 1911
- Land Acquisition Rules 1932
- Land Acquisition Manual 1947
- The Land Nationalization Act,1953 (Act No 75, 1953)*
- Land Nationalization Rules, 1954*
- The Law Safeguarding Peasant Rights (Agriculturist's Rights Protection Law) 1963 (Union Myanmar Revolutionary Council Law (No. 91, 1963)
- Farmland Law, 2012 (Pyidaungsu Hluttaw Law No.11, 2012)
- Farmland Rules, 2012 (President Office Notification No 62, 2012)
- Vacant, Fallow and Virgin Lands Management Law 2012 (Pyidaungsu Hluttaw Law No.10)
- Vacant, Fallow and Virgin Lands Management Rules 2012 (President Office Notification No 1, 2012)
  *Law itself is already repealed but some of sections are still applied depending on respective situations.

Regarding construction of distribution power poles and power distribution lines along the road which is existed within the Right of Way (hereinafter referred to as "ROW") of the road managed by the Ministry of Construction (hereinafter referred to as "MOC"), Road Law (2000) and Amendment Law to Road Law (2014) are related law. This law stated that MOC is responsible for management of all roads, which MOC announced officially that these are roads, including Right of Way (ROW) of the road and bridge. Therefore permission from MOC is necessary in case of using ROW of roads. The width of ROW of roads, which Public Works (PW) department under MOC determines, varies depending of the class of roads such as Expressway, International Highway, National Highway, Regions/States Connector Road, Districts/Townships Connector Road and Townships-Villages Connector Road.

Concerning land compensation or crop compensation for agricultural land, facts described in Farmland Law (2012), Farmland Rules (2012) and The Land Acquisition Act (1894) are applicable. However, the government has been reviewing the existing land laws as there are loopholes in archaic land laws.

To prevent occupational accidents caused by unsafe working environment and mistakes made by man, the Project complies with Occupational Safety Plan (Standing Order No. 1/95) and to perform the maximum production with high productivity by protecting all the workers against the occupational diseases and promoting their general health, the Project complies with Occupational Health Plan (Standing Order No. 2/95).

Land compensation includes 1) Land Record Department under the Ministry of Agriculture and Irrigation (MOAI) which makes a site survey to find who owns the land actually, 2) Public Works Department (PW) under the Ministry of Construction (MOC), 3) Agricultural Department under MOAI, 4) Township General Administration Department (hereinafter referred to as "GAD") concerned.

7.2 Approach and Methodology on Environmental and Social Consideration

Yen-loan financed projects are required to comply with the JICA Guidelines for Environmental and Social Considerations (hereinafter referred as to "the JICA Environmental Guidelines"). Based on the JICA Environmental Guidelines, the project was classified as a Category B project, which stipulates that "generally the proposed projects are site-specific, few, if any, are irreversible; and in most cases, normal mitigation measures can be designed more readily". For Category B projects, environmental and social considerations study is required at the IEE level including mitigation measures to avoid, minimize, or compensate for adverse impact, a monitoring plan and institutional arrangement.

7.3 General Information on Survey Area

7.3.1 Social Environment

(1) Organization Structure of State and Region

Myanmar is comprised of 7 States and 7 Regions. State and Region is composed of Districts. District consists of Townships which include Ward (or) Village Tract and villages. Table 7-5 shows townships included in each district concerned in the Project.

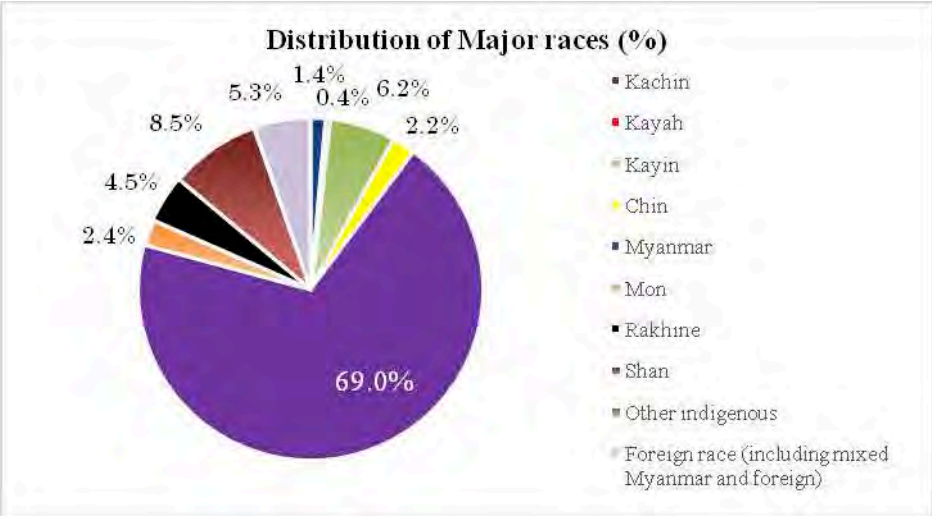
Table 7-5: Townships and Districts related to the Project

State/Region	District	Township included
Ayeyarwady	Pathein	Pathein, Kangyidaunt, Thabaung, Ngapudaw, Kyopyaw, Yegyi, Kyaunggon
Bago	Bago	Bago, Thanatpin, Kawa, Waw, Nuaunglebin, Kyauktaga, Daik-U, Shwegyin
	Pyay	Pyay, Paukkhaung, Padaung, Paungde, Thegon, Shwedaung
	Bhamo	Bhamo, Shwegu, Momauk, Mansi
Kayah	Loikaw	Loikaw, Demoso, Hpruso, Shadaw
Magway	Magway	Magway, Yenangyaung, Chauk, Taungdwingyi, Myothit, Natmauk
Mandalay	Mandalay	Aungmyaythazan, Chanayethazan, Mahaaungmyay, Chanmyathazi, Pyigyitagon,Amarapura, Patheingyi
Mon	Mawlamyine	Mawlamyine, Kyaikmaraw, Chaungzon, Thanbyuzayat, Mudon, Ye
Sagaing	Monywa	Monywa, Budalin, Ayadaw, Chaung-U, Yinmabin, Kani, Salingyi, Pale
Shan	Taunggyi	Taunggyi, Nyaungshwe, Hopong, Hsihseng, Kalaw, Pindaya, Ywangan, Lawksawk, Pinlaung, Pekon
Tanintharyi	Dawei	Dawei, Launglon, Thayetchaung, Yebyu

Source: Myanmar Information Management Unit (Place Codes)

(2) Ethnicity

The people of Myanmar are made up of 135 national races belonging to eight major ethnic groups: Kachin, Kayah, Kayin, Chin, Myanmar, Mon, Rakhine and Shan. Figure 7-2 shows percentage distribution of major ethnic people throughout Myanmar.



Source: National Census in 1983

Figure 7-2: Distribution of Major Ethnic People in Myanmar

Table 7-6 shows the distribution of major ethnic people in each township. Myanmar ethnic people population is the largest among ethnic people in below townships.

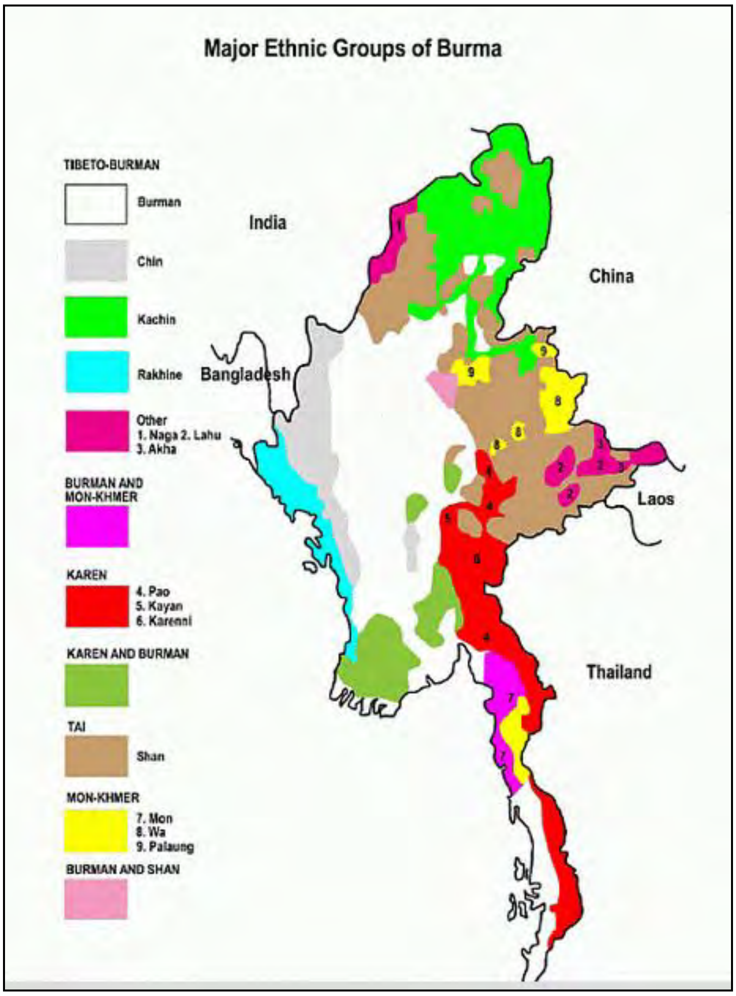
Table 7-6: Distribution of Major Ethnic People in each Township

Township	Kachin (%)	Kayah (%)	Kayin (%)	Chin (%)	Mon (%)	Myanmar (%)	Rakhine (%)	Shan (%)	Others (%)	Foreigner (%)
Pathein	0.025	0	13.450	0.145	0.018	80.994	2.716	0.048	0	2.599
Bago	0.026	0.012	3.317	0.110	1.252	91.016	0.184	0.191	1.434	2.512
Pyay	0.010	0	0.090	1.220	0.010	96.330	0.100	0.050	0.050	2.140
Bhamo	14.600	0.010	0.450	0.150	0.010	49.400	0	30.800	0	4.480
Loikaw	-	-	-	-	-	-	-	-	-	3.253
Magway	0.042	0.034	0.089	0.078	0.026	98.429	0.136	0.082	1.076	0.002
Aungmyaythazan	-	-	-	-	-	-	-	-	-	-
Chanayethazan	0.330	0.036	0.237	0.279	0.053	89.176	0.122	2.493	0	7.274
Mahaaungmyay	0.186	0.017	0.118	0.114	0.051	97.773		1.471	0	0.091
Chanmyathazi	0.147	0.018	0.132	0.093	0.029	98.601	0.095	0.569	0	0.316
Pyigyitagon	0.033	0.005	0.067	0.058	0.012	98.985	0.036	0.434	0	0.369
Amarapura	-	-	-	-	-	-	-	-	-	-
Patheingyi	0.100	0.005	0.177	0.214	0.039	98.304	0.353	0.291	0	0.516
Mawlamyine	0.005	0.007	1.090	0.012	19.000	58.000	0.090	0.299	20.900	0.048
Monywa	0.016	0	0.040	0.076	0	99.290	0.054	0.101	0	0.416
Taunggyi	0.200	0.100	0.400	0.100	0.100	38.200	0.200	5.900	Pao: 40.200 Dhanu: 2.700 Innthar: 3.000 Taungyoe: 0.600 Ko Kant: 0.500 Others: 2.400	5.000
Dawei	0.006	0.002	7.081	0.007	0.038	90.862	0.039	0	1.104	0.862

-: No data

Source: General Administration Departments in each Township in 2015

Figure 7-3 shows the distribution of major and minor ethnic groups throughout Myanmar.



Source: Website

Figure 7-3: Distribution of Major and Minor Ethnicity in Myanmar

(3) Land Use

Table 7-7 shows the total area of State and Region concerned in the project.

Table 7-7: Total Area of State and Region in Myanmar

State/Region	Total area		
	Acre	Square mile	ha
Mandalay	7,632,612	11,925.95	3,088,751
Sagaing	23,154,382	36,178.72	9,370,071
Magway	11,075,405	17,305.32	4,481,974
Bago	9,737,043	15,214.13	3,940,368
Ayeyarwady	8,656,564	13,525.88	3,503,122
Tanintharyi	10,710,757	16,735.56	4,334,409
Kachin	22,002,703	34,379.22	8,904,012
Shan	38,499,345	60,155.23	15,579,841
Chin	8,900,459	13,906.97	3,601,821
Rakhine	9,088,053	14,200.08	3,677,736
Kayin	7,507,733	11,730.85	3,038,215
Kayah	2,898,921	4,529.56	1,173,130
Mon	3,038,564	4,747.8	1,229,640

Source: Regional Development report (2013-2014) prepared by Planning department in the Ministry of National Planning and Economic Development

Myanmar is agricultural country and 70 % of the population is farmers. Therefore, most of the area is used for agriculture. For example, in Mandalay city, there are six types of land use in total: Agricultural area (36,366 acre, 46%), City area (31,908 acre, 40.47%), Village area (2,261 acre, 2.87%), River area (4,421 acre, 5.6%), Dam and lakes (3,078 acre, 3.9%), Green area (903.14 acre, 1.15%).

(4) Industry and Social Structure

Table 7-8 describes type of main industry in each State and Region and industrial zone or famous industry in each district.

Table 7-8: Type of Main Industry and Industrial Zone in each City

State/Region	Main Industry	District	Industrial Zone/ Famous Industry	Special Economic Zone
Ayeyarwady	Agriculture , Meat and Fish, Transportation	Pathein	Pathein Mirror Factory, Pathein Plywood Factory	
Bago	Agriculture, Meat and Fish, Industry, Transportation	Bago	Tin, Sweetening agent and Coffee Factory in Daik-U township, Hantharwaddy International Airport Project, Heavy industry in Nyaungchidaught Village	
		Pyay	Shwetaung Textile Mill	
Kachin	Agricultural, Mining, Trade	Bhamo	None	
Kayah	Agriculture, Meat and Fish	Loikaw	Lawpita Hydro Power, Loikaw Stone Factory	
Magway	Agriculture, Industry	Magway	Mannthanpayarkan Petroleum Industry, Kyunchaung Cement factory, Kyunchaung Electric Supply by Natural Gas, Sale Cement factory	
Mandalay	Agriculture, Meat and Fish, Industry	Mandalay	- Zone 1: Big Industries (55 No.), Medium Sized Industries (23 No.), Small sized Industries (584 No.) - Zone 2: Big Industries (31 No.), Medium Sized Industries (78 No.), Small sized Industries (527 No.) [Type of industry in Zone 1 and Zone 2 are Textile and Garment Industry, Liquor manufacturing, Sugar Industry, Battery Industry, Plastic Industry, Wire Cable Industry, Flour Industry, Cycle Tyre Industry, Wood Furnishing Industry, Agricultural Equipment Industry, Water Pump Industry, Detergent Industry, Fertilizer Industry and Car Assembly Industry (Source: Mandalay City Development Report in 2013 by Mandalay City Development Committee) - Mandalay Beer Factory, Myitnge Train Repair	
Mon	Agriculture, Industry	Mawlamyine	Sittaung Paper Mill, Sugar Mill in Mawlamyine	
Sagaing	Agriculture	Monywa	Letpadaung Copper Mining Project in Monywa	
Shan	Agriculture, Meat and Fish, Mining and Mineral Resources, Industry, Transportation	Taunggyi	Ayetharyar industrial zone, Sugar Mill in Bawkyo and Shwenyaung , Virginia Leaf Factory in Linkhay, Tigit Coal Fire Power Plant, Myanmar Belle dried vegetable factory	
		Lashio	None	
Tanintharyi	Agricultural, Meat and Fish	Dawei	Kamyalkimpin Tin and Tungsten Factory	Dawei Speical Economic Zone (to be implemented)

Source: JICA study team

The number of industrial zone, industry, factory, workshop and household industry in each Township are shown in Table 7-9.

Table 7-9: Number of Industrial Zone, Industry, Factory, Workshop and Household Industry

Township	Industrial Zone (No.)	Industry (No.)	Factory (No.)	Workshop (No.)	Household industry (No. and type)
Pathein	-	3 - Haker Garment - Dig Garment - Dolglong Garment	2 - Timber	204 - Rice mill: 147 - Edible Oil: 2 - Coconut Oil: 1 - Alcohol and Spirit: 1 - Soft drink: 2 - Mineral Water: 5 - Ice: 16 - Ice bar: 8 - Cold Storage: 1 - Salt: 17 - Vermicelli: 3	186 - Confectionary: 4 - Sewing: 30 - Coconut string: 20 - Powdering: 15 - Pathein traditional food (Halawar): 1 - Animal food: 1 - Furniture: 37 - Goldsmith: 50 - Pathein umbrella: 3
Bago	-	-	-	-	-
Pyay	-	26	3 - No. (29) Timber refinery - Rail Train Preparation - Nawaday Sugar	22 - Private	220 - Sewing: 100 - Confectionary: 47 - Goldsmith - Blacksmith - Painting
Bhamo	-	-	-	-	- Bean dividing - Edibile oil - Rice mill - Rice processing - Powdering - Car workshop - Motorcycle repairing - Aluminium - Noodle - Mineral water - Ice - Furniture - Wax - Blacksmith - Goldsmith
Loikaw	-	73	173	-	53
Magway	-	-	-	-	-
Patheingyi	-	102	35	20	30
Mawlamyine	-	-	-	-	35 - Confectionary:10 - Candle: 15 - Thanaka (Myanmar makeup): 3 - Traditional Textile: 7
Monywa	2	612 in Industrial zone	550	62	103
Taunggyi	-	-	-	-	-
Dawei	1 (to be implemented)	-	-	-	-

-: No data

Source: General Administration Departments in each Township in 2015

Important facilities including government university and college, government school, governmental Buddhism university, government hospital, and other social structures like famous natural places, community buildings and many more in each district are shown in Table 7-10.

Table 7-10: Important Facilities in Each District

State/Region	District	Important Facilities
Ayeyarwady	Pathein	- Computer University, Pathein - Pathein University - Technological University, Pathein - Pathein Education College - Military Hospital - Sa.Ya.Pha (military) - Na.Ta.Ya Office - GSM (Na.Ta.Kha)955 Camp - Mawtinsoon - Ngesaung Beach - Chaungtha Beach
Bago	Bago	- Bago Degree College - Bago Divinity School - Kanbawzathadi Palace - Moeyongyi Inn - Kawliya Hall - Bago City Hall - Bago Sittaung Canal
	Pyay	- Computer University, Pyay - Pyay University - Pyay Education College - Pyay Technological University - Pyay Buddha relic pagoda - Shwesandaw Pagoda - Akauktaung Mountain - Srikhittaya ancient city
Kachin	Bhamo	- Bhamo University - Computer University, Bhamo - Technological University, Bhamo
Kayah	Loikaw	- 16 No. of Basic Education High School - 34 No. of Basic Education Middle School - 306 No. of Basic Education Primary School - 34 No. of Rural Health Center - Loikaw University - Technological University, Loikaw - Computer University, Loikaw
Magway	Magway	- 101 nos of Education High School - 194 nos of Education Middle School - 3,647 nos of Education Primary School - Computer University, Magway - Technological University, Magway - Magway University - University of Medicine, Magway - University of Community Health, Magway - Magway Education College - Magway City Hall - 31 nos of Rural Health Center by Grand Aid of Japanese government - 1 nos of Sub-rural Health Department - Magway Mya Tha Lun Pagoda

State/Region	District	Important Facilities
Mandalay	Mandalay	- 1 no of Hospital (300 Beds) - 2 nos of Hospital (200 Beds) - 4 nos of Hospital (100 Beds) - 9 nos of Hospital (50 Beds) - 14 nos of Hospital (25 Beds) - 48 nos of District Hospital - 295 nos of Basic Education High School - 355 nos of Basic Education Middle School - 3,372 nos of Basic Education Primary School - Computer University, Mandalay - Mandalay Regional Co-operative College - Mandalay Education College - Mandalay Institute of Nursing - Nationalities Youth Resource Development Degree College, Mandalay - Mandalay Technological University - Mandalay University - State Pariyatti Sasana University, Mandalay - University of Computer Studies, Mandalay - University of Culture, Mandalay - University of Dental Medicine, Mandalay - University of Distance Education, Mandalay - University of Foreign Languages, Mandalay - University of Medical Technology, Mandalay - University of Medicine, Mandalay - University of Paramedical Science, Mandalay - University of Pharmacy, Mandalay - University of Traditional Medicine, Mandalay - The last Kingdom of Myanmar lived in Mandalay. Three Palaces: Pinya, Inwa and Amarapura - Mandalay Hill - Waterfall Hill - Deed Doat Waterfall - Mandalay Kandawgyi - Thaungthaman lake - Mandalay City Hall - Mt. Popa (dead volcano _ 4,981 feet)
Mon	Mawlamyine	- 4 No. of Basic Education High School - 3 No. of Basic Education Middle School - 81 No. of Basic Education Primary School - Mawlamyine Institute of Education - Mawlamyine University - Technological University, Mawlamyine - Computer University - Parliament
Sagaing	Monywa	- Monywa University - Monywa Education College - Monywa Institute of Economics - Technological University, Monywa - Computer University, Monywa - Giant reclining Buddha at Bodhi Tahtaung - Giant standing Buddha - Phowintaung Cave
Shan	Taunggyi	- Taunggyi University - Taunggyi Education College - Taunggyi Education College - Taunggyi University

State/Region	District	Important Facilities
		- Technological University, Taunggyi - Computer University, Taunggyi - 6 No. of hospital - 2 No. of market - Inle Lake - Shan State Clutural Museum - Minehsu-Pyinlon Gems
	Lashio	- Computer University, Lashio - Lashio University - Technological University, Lashio
Tanintharyi	Dawei	- Computer University, Dawei - Dawei Education College - Dawei University - Technological University, Dawei - Education College - Kha.Ya.Ka - Highest Mountain _ Mt.Mitmolatkat (6801 feet) - 2 nos of Private Hospital (250 Beds) - Military Hospital - Minister Housing 1 - Minister Housing 2 - Staff Housing - Logistical Army - Government Office - Maung Ma Kan Beach - Maungmakan Hot Spring

Source: JICA study team

Table 7-11 describes the number of facilities for education in some Townships.

Table 7-11: Number of Facilities for Education

Township	Primary School (No.)	Secondary School (No.)	High School (No.)	Monastery School (No.)	College (No.)	University (No.)	Technological University (No.)	Correspondence University (No.)	Nursing Training School (No.)
Pathein	249	17	3	5	1	2	1	0	0
Bago	192	13	16	18	0	1	0	1	0
Pyay	160	14	8	14	1	2	1	0	1
Bhamo	67	14	11	5	0	3	1	1	1
Loikaw	95	10	15	5	0	1	1	0	0
Magway	82	54	9	15	1	5	1	1	0
Aungmyaythazan	37	8	11	6	0	2	0	0	0
Chanayethazan	35	5	10	6	1	0	0	0	0
Mahaaungmyay	31	4	3	6	0	1	0	1	0
Chanmyathazi	20	8	6	6	1	2	0	0	0
Pyigyitagon	19	3	3	20	0	0	0	0	0
Amarapura	88	9	5	6	1	2	0	0	0
Patheingyi	93	5	3	27	1	4	2	0	0
Mawlamyine	111	14	16	7	1	1	1	1	0
Monywa	106	8	10	7	1	3	1	1	0
Taunggyi	227	42	30	10	4	3	1	0	0
Dawei	102	7	5	177	2	2	1	0	1

Source: General Administration Departments in each Township in 2015

Table 7-12 describes the number of health care facilities in some township.

Table 7-12: Number of Health Care Facilities in each Township

Township	Government Hospital (No.)	Private Hospital (No.)	Government dispensary (health center) (No.)	Government dispensary (branch of health center) (No.)	Government dispensary for Skin disease (No.)	Government dispensary for Malria (No.)	Government dispensary for Tuberculosis (No.)	Private dispensary (No.)	Child Delivery Room (No.)
Pathein	6	2	8	43	1	1	1	4	1
Bago	4	3	6	41	1	1	1	77	1
Pyay	4	6	5	30	1	1	1	4	1
Bhamo	2	3	5	21	1	1	1	12	1
Loikaw	3	0	9	28	1	1	1	23	1
Magway	5	2	7	51	1	1	1	47	1
Aungmyaythazan	3	3	1	2	0	0	-	-	1
Chanayethazan	5	15	0	4	1	1	-	-	-
Mahaaungmyay	2	2	1	2	0	0	-	-	-
Chanmyathazi	2	1	0	4	0	0	-	-	-
Pyigyitagon	0	0	1	0	0	0	-	-	-
Amarapura	4	0	5	22	0	1	-	-	-
Patheingyi	2	1	4	25	1	1	-	-	-
Monywa	3	10	7	28	1	1	1	80	3
Mawlamyine	4	6	12	3	1	1	1	98	1
Taunggyi	7	Private health center: 5	9	23	0	0	0	45	-Women and Child Hospital: 2 -Women and Child Health Center: 2
Dawei	1	0	16	1	-	-	-	-	1

-: No data

Source: General Administration Departments in each Township in 2015

Health index in some townships are shown in Table 7-13.

Table 7-13: Health Index in each Township

Township	for every 1,000 population		
	Birth rate	Mobility rate	Abortion rate
Pathein	15.00	-	2.30
Bago	14.70	4.50	0.25
Pyay	4.66	2.89	0.07
Bhamo	20.13	6.11	7.80
Loikaw	19.00	14.60	4.50
Magway	15.00	6.4	2.00
Aungmyaythazan	-	-	-
Chanayethazan	-	-	-
Mahaaungmyay	-	-	-
Chanmyathazi	-	-	-
Pyigyitagon	-	-	-
Amarapura	-	-	-
Patheingyi	-	-	-
Monywa	4.70	0.07	0.01
Mawlamyine	13.70	7.90	1.30
Taunggyi	-	-	-
Dawei	-	-	-

-: No data

Source: General Administration Departments in each Township in 2015

(5) Cultural Heritage

Myanmar is rich in cultural heritage and the department of Archaeology, National Museum and Library under the Ministry of Culture protects and preserves ancient buildings. Table 7-14 shows a list of these ancient buildings. The proposed projects will not affect the listed ancient buildings.

Table 7-14: Ancient Buildings in each City

State/Region	District	Ancient Buildings
Ayeyarwady	Pathein	-
Bago	Bago	Bago Township 1 No. of ancient building in Ancient Monumental Zone and Protected & Preserved Zone (2/1999, Kan Baw Za Thar Di Palace), other 3 No. of ancient building
	Pyay	Pyay Township 1 No. of ancient building in Ancient Monumental Zone and Ancient Site Zone (1/2001, Ancient monumental buildings in Pyay township), other 22 No. of ancient building
Kachin	Bhamo	-
Kayah	Loikaw	-
Kayin	Hpa-An	Hpa-An Township 2 No. of ancient building in Ancient Site Zone and Protected & Preserved Zone (2/2008, Kot Gon Gu, Ya Thayt Pyan Gu), other 1 No. of ancient building
Magway	Magway	Magway Township 9 Nos. of ancient buildings Taungdwingyi Township 2 No. of ancient building in Ancient Monumental Zone and Protected and Preserved Zone (1/2002, Bate Tha Noe old city) Yenangyaung Township 1 No. of ancient building
Mandalay	Mandalay	Chanmyathazi Township Monastery in Athawkayama brick building, brick stairs, Pepontaw stone inscription yard, Minpe and Pagatipe stone inscription cave and Mahaminhtin wood building Pyigyitagon Township pagoda, yard and brick fence of Lawkamanisular, the monastery and Buddhist building in Pyiminta, Mahaaungmyay Township Shweinpin monastery, Tharkawin monastery and Thingazar monastery Amarapura Township Kyauktawgyi pagoda, U Pain bridge, two numbers of brick buildings in Taungmingyi pagoda yard, Thapyaytan fort, 1 No. of ancient building in Ancient Monumental Zone, Protected and Preserved Zone (3/1999, Mahawaiyanbonthar Bargayar monastery) and other 15 No. of ancient buildings. Aungmyaytharzan Township 2 No. of ancient building in Protected and Preserved Zone (3/1999, Atumashi monastery and Shwenantaw monastery), 2 No. of ancient buildings in Protected & Preserved Zone (3/1999, Sandarmuni Pagoda and stone inscription cave monastery, Mahalawkamarazain Kuthotaw Pagoda and stone inscription cave), other 26 No. of ancient buildings.
Mon	Mawlamyine	-
Sagaing	Monywa	Pale Township 1 No. of ancient buildings in Protected and preserved zone (1/2010) Chaung-U Township 9 No. of ancient buildings in Protected and preserved zone (5/2010)
Shan	Taunggyi	Nyaungshwe Township 1 No. of ancient building Ywangan Township 1 No. of ancient building Hopong Township 1 No. of ancient building
	Lashio	-
Tanintharyi	Dawei	Launglon Township 4 No. of ancient building in Ancient Site Zone and Protected and Preserved Zone (2,2012, Tha Ga Ya old city)

-: No data

Source: Deprment of Archaeology, National Museum and Library

Cultural Heritage Building in each township is shown in Table 7-15. The proposed projects will not affect the listed cultural heritages.

Table 7-15: Cultural Hertiage in each Township

Township	Cultural Heritage Building
Pathein	Thartana Beik Mhan, City Hall, Ayeyarwaddy Library, Clock tower
Bago	Kanbawza Thardi Palace
Pyay	- Thayay Khit Ta Yar Cultural Zone (in 2013, UNESCO included in a list of World's heritage)
Bhamo	- None
Loikaw	- Thartana Beik Mhan, National museum, Kandaya Waddi Myo Maw Kun stone tower, Chi Ke Ta Gon Tai
Magway	- Kwe Chaung fortress (154 years old buildings, Constructed by French and Italy engineers and supervised by Kanaung Prince in King Mintone eara in 1861) - Myin Kun Ancient buildings (Constructed in Bagan era 13 century (Myanmar Calendar year 592-638, there exist Stone inscription of Bagan eara 13 century, one of the cities in Bagan era, the department of Archaeology approved that in Myin Kun, there are 27 numbers of pagoda constructed in Bagan era 13 century and they are cultural heritage of Bagan era)
Aungmyaythazan	-
Chanayethazan	-
Mahaaungmyay	-
Chanmyathazi	-
Pyigyitagon	-
Amarapura	-
Patheingyi	-
Mawlamyine	- Ya Tar Bone Myint Kyaung Taite (constructed by Queen of King Min Tone called Sein Tone Queen)
Monywa	- Le Ti Stone inscription
Taunggyi	-
Dawei	

-: No data

Source: General Administration Departments in each Township in 2015

Name of some famous pagodas in some Townships are described in Table 7-16. The proposed projects will not affect the listed pagodas.

Table 7-16: Name of Famous Pagodas in each Townships

Township	Famous Pagoda
Pathein	Shwe Mu Htaw, Lay Kyunn Yan Aung, Shwe Si Gone, Set Taw Yar, Tarwatainthar, Shwe Bon Thar, Yankin Taung, Pyilone Chanthar, Chanthargyi, Tat U Kyaung, Shwe Yaung Taw Kya, Pann Kyo, Kuthinaryone, Ta Gong, Mahabawthi, Laymyatnhar, Thai, Aung Pan Kha, Shwe Wat luu, Than Yaung Mahar, Pauk Kone, Pyinkatoekone, Shin Thu Ma Na, Diparyone, Hnee, Shwe Myin Tin
Bago	Shwemawdaw Pagoda, Shwethalyaung Pagoda (Recling Buddha Image), Seinthalyaung Pagoda (Recling Buddha Image), Myathalyaung Pagoda (Recling Buddha Image), Maha Zedi, Hinthargone Pagoda, Kyaikpun Four Figures Pagoda, Daysunpar Pagoda, Naungtawgyi, Shwegulay Pagoda, Mahawizayayanthi Pagoda, Shwedagonlay, Kammalawha Mahamuni Bronze Buddha, Kyaikpunyarya Pagoda
Pyay	Shwe San Taw Pagoda, Pha Yar Gyi Pagoda, Shwe Phone Pwint, Se Htet Gyi Pagoda, Yadanar Hti Phyu Pagoda, Bawbawgyi Pagoda, Phayar Mar Pagoda,
Bhamo	Thain Taw Gyi, Shwe Kyi Nar, Man Ywag
Loikaw	Taung Kwe, Myo Nen
Magway	Myathlun Pagoda
Aungmyaythazan	-
Chanayethazan	-
Mahaaungmyay	-
Chanmyathazi	-
Pyigyitagon	-
Amarapura	-
Patheingyi	-
Mawlamyine	Kyaik Tha Lan, Mahamyatmuni, U Zi Na, U Khan Ti, Kyaik Thote
Monywa	Bawthi Ta Htaung Yat Taw Mu (Standing Statue), Shwe Se Kon, Su Taung Pyae, Mohnin Than Bote Te, Kyaukkar Shwe Gu Ni
Taunggyi	Shwe Phone Pwint Pagoda
Dawei	Shwe Taung Sarr Pagoda, Shin Mot Htee Pagoda, Shin Pin Khaya, Shin Ohawa Pagoda, Shwe Tharhlaung

-: No data

Source: General Administration Departments in each Township in 2015

(6) Poverty

Nature and causes of poverty are complex and diverse but very important in drawing up a poverty alleviation strategy. Poverty index and unemployment ratio in each township are shown in Table 7-17. Myanmar government gives priority of electrification in regional areas as one of the poverty alleviation and regional development activities as it is clear that electricity plays in important role in economic and regional development. If the electricity distribution system is improved, the industry in those cities will be developed and job opportunities are available for local people. As a result, the rate of un-employment is decreased and those cities will be developed economically.

Table 7-17: Poverty Index and Un-employment Ratio in each Township

Township	Poverty index			Un-employment ratio (%)
	Downtown (%)	Urban (%)	All (%)	
Pathein	-	-	29.40	26.17
Bago	-	-	-	-
Pyay	-	-	19.17	6.40
Bhamo	-	-	28.40	2.22
Loikaw	-	-	-	-
Magway	13.30	24.28	-	43.92
Aungmyaythazan	-	-	-	43.73
Chanayethazan	-	-	-	5.99
Mahaaungmyay	-	-	-	70.25
Chanmyathazi	-	-	-	5.71
Pyigyitagon	-	-	-	7.87
Amarapura	-	-	-	81.91
Patheingyi	-	-	-	22.79
Mawlamyine	-	-	10.8 (Target)	-
Monywa	-	-	15.50	13.56
Taunggyi	-	-	-	-
Dawei	-	-	-	-

-: No data

Source: General Administration Departments in each Township in 2015

7.3.2 Natural Environment

(1) Topography and Geographical Features

Myanmar is the largest country in South East Asia with a total land area of 677,000 square kilometers (67,700,000 ha). Table 7-18 shows the topography and geographic features in each state/region.

Table 7-18: Topography and Geographic Features in each State/Region

State/Region	City	Topography Geographic Features	Sea level	Hydrology (River)
Mandalay	Mandalay	Mountainous ranges with over 6,000 feet in the east. Ayeyarwady Plain rests in the west, Mandalay-Kyaukse Plain rests in the east and Sittaung Plain is in the south.	83 m	Ayeyarwady River flows through at the west
Sagaing	Monywa	Mountain ranges. There is Monwyapale plain	81 m	Chindwin River at the west
Magway	Magway	Magway City is situated on the banks of the Irrawaddy River. It is in shrub land area.	60 m	
Bago	Bago	Except Bago Yoma, a mountain range running from north to south in the central part of the division, its eastern and western regions are Flat Plain. moderate rainfall (1,000-2,500 mm)	18 m	Ayeyarwady River flows in the western part and Sittaung and Bago Rivers in the east

State/Region	City	Topography Geographic Features	Sea level	Hydrology (River)
	Pyay	The north and northeast of the district is forest-covered, and contains numerous valleys and ravines, which unite in one large stream called the Naweng River. The most important of the plains lie in the south and southwest portions of Pyay, and extend along the whole length of the railway that runs between. There are, in addition large tracts of land covered by jungle, which are available for cultivation. The principal river is the Irrawaddy, which intersects the district from north to south; next in importance are the Thani and its tributaries and the Naweng system of rivers. In the hills near the capital the soil is of Tertiary formation, and in the plains it is an alluvial deposit.		It is at the east of the bank of Ayeyarwady River
Ayeyarwady	Pathein	It is lying at the western edge of the Ayeyarwady River delta. It is in low land area and on the eastern bank of Pathein (Ngawan) River. Pathein is accessible to large vessels and despite its distance from the ocean, it is the most important delta port outside of Yangon. The coastline along the Bay of Bengal is surrounded by the Arakan Mountains. In the area is Inye Lake, 1.5 miles (2.4 km) long and 1 mile (1.6 km) wide, which is known for its fishing. There is also an offshore reef, Diamond Island which is popular with bathers. Diamond Island is also noted as a turtle breeding ground. The city is a rice-milling and export centre. Aside from several rice mills, the town has numerous sawmills and umbrella workshops. The colourful handmade parasols are known locally as "Pathein Hti". Pathein is also known for its pottery and colourful hand-made baskets and buckets.	8 m	It is on Pathein (Ngawan) River 118 miles (190 km) west of Yangon
Tanintharyi	Dawei	Low land, mouth of rivers in coastal area	13 m	
Kachin	Bhamo	Uneven topography, hilly areas and slope land. Putao plain is existed.	115 m	
Shan	Taunggyi	It is the capital of Shan State. It lies in the west of Thanlwin River. It is in the north of Inle Lake. It is located in NaungShwe Plain. Popular tourist sites, Inle Lake and Inlay Lake Wetland Sanctuary lies in this district.	1,430 m	
	Lashio	It is the largest town in northern Shan State, about 200 kilometres (120 mi) northeast of Mandalay. It is situated on a low mountain spur overlooking the valley of the Nam Yao river. Loi Leng, the highest mountain of the Shan Hills, is located 45 km to the southeast of Lashio.	845 m	
Kayah	Loikaw	It lies on a high plateau contiguous with the Shan plateau. Report suggests that there is land contamination in it.	884 m (between 74.93 m and 152.40 m)	The raging natural watercourses are flowing through the mountainous state from the north to south. The Baluchaung originates at Inlay lake and flows through the fertile Loikaw plain where various kinds of crops are cultivated.
Mon	Mawlamyine	It is located on the western coast of South-East Myanmar. There are also coastal plains on the banks of Thanlwin River and Sittaung River mouths. The mountain ranges including Zingyaik and Taungnyo ranges are running from north to south in the state.	52 m	Andaman sea and gulf of Mottama are at the west. Thanlwin, Sittaung, Bilin, Attaran, Gyaing and Ye rivers flows

Source: JICA study team

Table 7-19 shows topography, sea level, main rivers and source of water and dam in each township.

Table 7-19: Topography, Sea Level, Maing Rivers and Source of Water and Dam

Township	Topography	Sea level (m)	Main Rivers	Source of Water and dam
Pathein	- 75% of township area is flat land. - 25% of township area at the west is filled with the West Yoma valley - Kyarlay mountain is the highest and it is 800 ft high. - The lowest and highest part of Pathein is situated at the North and South respectively	8.84	-3 main rivers: (a) Nga Wun river (or) Pathein river (22 miles long) (b) Thandwe river (161 miles long) (c) Phaye (14 miles long) river. - 12 miles far from the west bank of Nga Wun river, hills, mountains and valleys of West Yoma are existed.- - 328 numbers of streams and some are Thazin stream, Yay Thoe stream, Uto stream, Tar Kine stream and Kyauk Chaung Gyi stream. - 8 numbers of island where people live on one island and there is no person on remaining 7 numbers of island.	- Tube well (122 m ~ 213 m) - Hand driven well (37 m ~ 61 ft) - There are 6 numbers of dams which are used for agricultural
Bago	- at the west and the north, there exist hills and valleys - there is a slope from the north-west to the south-east - at te east of the Bago river, there is low and flat land until Sittaung river basin	9.14	- Bago river flows from the north to the south starting from the middle of Bago parallel to Yangon-Mandalay railway	- supply from Kantawgyi dam at the north-west of Bago - supply from ground water - Tube Well (91 m~122 m) - Well (30 m~122 m) - Kantawgyi dam (supply 1 million gallon/day)
Pyay	- 200 miles away from the sea and inner land - North: Aung Lan T/S - East: Paukkhaung T/S and Thegon T/S - South: Shwedaung T/S - West: Ayeyarwaddy River	54.86	- Ayeyarwaddy River	- Ayeyarwaddy River - Supply from well - Myauk Na Wun dam (constructed in 1967-68) - Kan Gyi Kone (constructed in 1999-2000)
Bhamo	- Flat land and there are a few valleys - There is a wide Tarpain river basin at the east and there are hills and mountain range at the north, the south and the west - East: Momauk T/S -West: Mountain, Shweku T/S - South: Mountain Mansi T/S - North:Mountain, Myitkyina District and Waimaw T/S	117.35	- Ayeyarwaddy River which flows from the North to the South - In summer, the depth of water in Ayeyarwaddy river is 840 ft and it is difficult for ship and motor boat to move inside it and it takes time for them. - There area a lot of rivers and streams which flow from the East to the West	- Well - Hand driven well - Tubewell - No dam
Loikaw	- a lot of forests and mountains and a few	899.16	- Baluchaung River flowing from the west to the east	

Township	Topography	Sea level (m)	Main Rivers	Source of Water and dam
	flat plain - East: Shadaw T/S - West: Demoso T/S - South: Bawlakhe T/S - North: Shan State			
Magway	- Flat land - East: Natmauk T/S, Myothi T/S - West: Minhal T/S-Minbu T/S -South: Taungdwingyi T/S-Sinbaungwe - North: Yenangyaung	51.82	- Ayeyarwaddy (water flow rate is 20 mile/hr) - Water flows from the North to the South	- Ayeyarwaddy River - Yin Stream - Daungnay Stream - Groundwater (182 m) - No dam
Mawlamyine	- Na Ga Wa Thi mountain range is situated from the north to the south. - Gaungsay Island and Dawei Island are famous	5.49	- Thanlwin river - Jai river - Aha Hta Yan river	-one number of dam called Shwe Nat Taung dam (earth dam, irrigated cultivation area is 122 ha)
Monywa	- Flat land except one third of the east region. - North-east region is in wave shape land - at the East, there is watershed, hills and mountains and collective term for ravines, gorgoes and gullies. - Watershed has deep slope - It is divided into three parts: lower region, flat plain region and mountainous region - Kyaukkar Mountain is the highest mountain having 32.05 m high.	76.20	- Chindwin river which flows from the North to the South in Monywa township - In rainy season, the risk sea level is sometimes over 1,000 cm - In summer, the sea level is below 46 cm and motor boat and car can go through it but ship cannot through it - Sa Te stream - Kanpyar stream - Hlepyit stream - Bukhar stream - Ken Ni stream - Streams inside Monywa township are type of sand stream and there is no water inside them. - Stream water flows through Bukhar stream and Kanpyar stream. Htanzalote dam and Tharse dam have been built. Therefore while there is no stream water flows at the downstream of the dam, there is water flows at the upstream of the dam.	- Ground water (0.13m ~ 0.21m) - Tharse dam to supply 2,671.28 ha - Htanzalet dam to supply 276 ha - Bawditahtaung dam to supply 276 ha for household and irrigation supply
Taunggyi	-	-	-	-
Dawei	-	-	-	-

-: No data

Source: General Administration Departments in each Township in 2015

(2) Meteorology

There are three seasons defined in Myanmar: the summer season (dry) starting from March to May, the rainy season starting from June to October and the winter starting from November to February. Table 7-20 shows average temperature and annual rainfall in each station.

Table 7-20: Average Temperature and Annual Rainfall in each Station

State/Region	Station	Average Temperature in 2001-2010 (˚ C)		Average Annual Rainfall in 2001-2010 (mm)
		Mean max (˚ C)	Mean min (˚ C)	
Mandalay	Mandalay	34.3	22.2	931
Sagaing	Monywa	34.5	21.6	774
Magway	Magway	34.3	19.8	964
Bago	Bago	32.6	21.0	3,278
	Pyay	34.1	22.2	1,407
Ayeyarwaddy	Pathein	33.1	22.3	3,113
Tanintharyi	Dawei	32.2	21.4	5,472
Shan	Taunggyi	25.7	14.9	1,486
	Lashio	29.5	15.6	1,088
Kayah	Loikaw	29.3	17.1	1,158
Mon	Mawlamyine	32.2	22.6	5,161

Source: Statistical Year Book 2011

(3) Natural Disasters

Myanmar is vulnerable to a wide range of hazards, including floods, cyclones, earthquakes, landslides and tsunamis. The frequency for medium to large-scale natural disasters to occur every couple of years is high, according to historical data. For the Southeast Myanmar, flooding has affected a large area including in Mon States. Major natural disasters from 1984 to 2012 are summarized in Table 7-21.

Table 7-21: Major Natural Disasters in Myanmar

Natural Disaster	Affected Place	Affected Year	Affected Facilities	Affected Living Things	Value Loss
Fire	Mandalay in Mandalay Region[1]	March, 1984	Buildings: 2,368, Household: 4,585	Victim: 22,324	780 million Kyats
	Meikhtila in Mandalay Region[1]	April, 1991	Houses: 3,261, Household: 5,026,	Victim: 25,377	685 million Kyats
	Mong Hsu in Shan State[1]	March, 1999	Houses: 658, Household: 1,847	Victim: 7,445 Loss of life: 1	550 million Kyats
	Myeik in Tanintharyi State[1]	December, 2001	Houses: 1,377, Household: 2,676,	Victim: 15,443	4,000 million Kyats
	Labutta in Ayeyarwaddy Region[1]	January, 2004	Houses: 153, Households: 157	Victim: 639	235 million Kyats
	Kyaikhtiyoe Pagoda in Kyaikto T/S in Mon State[1]	January, 2004	Shop store: 96, Huts: 30, Households: 126	Victim: 563, Loss of life: 20	400 million Kyats
	Taikkyi T/S in Yangon[1]	February, 2004	Apyauk Oil Well No. 13		
	Hlaing T/S in Yangon[1]	2005		Victim: 9,145	80 million Kyats
	Pyapon T/S in Ayeyarwaddy Region[1]	2007		Victim: 3,085	102 million kyats
	Palaw T/S in Tanintharyi Region[1]	2008		Victim:1,400	220 million Kyats
Flood	133 T/S in Myanmar[1]	1974	Houses: 35,548, Household: 420,874,	Victim: 1,355,922	
	9 T/S in Ayeyarwaddy[1]	July, 1991	Houses: 747, Household: 83,753,	Victim: 359,946	1068.09 million Kyats
	49 T/S in Myanmar[1]	1997	Houses: 89,846, Household: 991,847,	Victim: 525,997 Loss of life: 243	
	Wundwin T/S in Mandalay Region[1]	July, 2001	Houses: 463,	Victim: 2,172 Loss of life: 42	
	Myitkyina District in Kachin State[1]	July, 2004	Houses: 2,255, Household: 2,295,	Victim: 29,936	97 million Kyats

Natural Disaster	Affected Place	Affected Year	Affected Facilities	Affected Living Things	Value Loss
	Kani in Sagaing Region[1]	September, 2004	Houses: 306, Household: 306,	Victim: 1,464 Loss of life: 3	16 million Kyats
	Mandalay Region and Sagaing Region[1]	2006		Victim: 14,012 Loss of life: 16	
	Bhamo and Shwegu in Kachin State and Khanti in Sagaing Region[1]	2007		Victim: 3,060	
	Northern Rakhine State[2]	June, 2010	Houses: over 800, Household: 29,000,	Loss of life: 68	
	Magway Region[2]	October, 2011	Houses: over 3,500, Cropland: over 5,400 acres	Victim: 30,000	
	Across Myanmar[2]	August, 2012	Damaged houses, roads, bridges and over 136,000 acres of farmlands	Victim: 287,000	
Wind	Kyaukpyu District and Pathein District (Kyaukphyu Storm)[1]	May, 1967			30 million Kyats
	Sittwe, Pauktaw, Myebon and Minbya T/S in Rakhine State (Sittwe Storm)[1]	May, 1968	Houses: 57,633,	Loss of life: 1,037 Husbandry animals: 17,537	
	Pathein in Ayeyarwaddy Region (Pathein Storm)[1]	May, 1975	Houses: 246,700,	Loss of life: 303 Husbandry animals: 10,191	
	Kyaukpyu in Rakhine Region (Kyaukpyu Storm)[1]	May, 1978	Houses: 90% of township		20 million Kyats
	6 T/S in Rakhine (Gwa Storm)[1]	May, 1982	Damaged houses, husbandry animals, boats and ships	Loss of life: 5	70.55 million Kyats
	Sittwe District in Rakhine Region (Sittwe District Storm)[1]	May, 2004	Houses: 4,628, Household: 4,628,	Victim: 24,248 Loss of life: 205	183.41 million Kyats
	Ayeyarwaddy region, Yangon region and Rakhine State (Marlar Storm)[1]	2006		Victim: 42,856 Loss of life: 37 Injury: 23	1263.89 million Kyats
	Sittwe District and Kyaukpyu District in Rakhine State (Akash Storm)[1]	2007		Victim: 10,570 Loss of life: 14 Missing: 17	589.27 million Kyats
	Ayeyarwaddy, Yangon, Bago, Kayin and Mon (Nargis Cyclone)[2]	2008		Victim: 800,000 Loss of life: 84,537 Missing: 53,836 Injury: 19,359	11 trillion Kyats
	Rakhine (Cyclone Giri)[2]	October, 2010	Houses: 20,300, Agricultural land: 67,500 acres	Loss of life: 45	
Earthquake	Bago and Yangon (7.3)[1]	May, 1930	Damaged Houses and Pagoda	Loss of life: 550	
	Sagaing in Sagaing Region (6.5)[1]	6th July, 1956	Houses and pagodas are destroyed and Sagaing Bridge was moved a little.	Loss of life: 52	
	Bagan-Nyaungoo (6.8)[1]	July, 1975	Damaged cultural heritages	Loss of life: 2 Injury: 15	
	Taungdwingyi (6.7)[1]	September, 2003	Pagodas: 108, Houses: 153, Schools: 9, Railways and Bridges: 3, Dam Sluice Gate	Loss of life: 7	

Natural Disaster	Affected Place	Affected Year	Affected Facilities	Affected Living Things	Value Loss
	Shan State (6.8)[2]	March, 2011	Houses: 3,000,	Victim: 18,000 Loss of life: 74 Injury: 125	
	Northern Myanmar (6.8)[2]	November, 2012	Houses: 400, Schools: 65, Religious building: 100	Loss of life: 16 Injury: 52	
Tsunami Earthquake (9.0) and flood	Ayeyarwady Region, Tanintharyi Region, Rakhine State and Yangon Region[1]	26th Dec, 2004	Houses: 601	Victim: 2,592, Loss of life: 61	1,585.56 million kyats
Landslide	Kyunsu T/S[1]	August, 2005	Households: 4		
	Palaw T/S in Tanintharyi Region[1]	September, 2005	Houses: 2, Households: 2,	Victim: 21 Loss of life: 12	0.1 million Kyats
	Htantlang T/S in Chin State[1]	September, 2005	Houses: 2 Household: 2	Victim: 8	
	Mogoke T/S in Mandalay Region[1]	October, 2007			1.0 million Kyats
	Mogoke T/S in Mandalay Region[1]	August, 2008	House:1 Household:1	Victim: 6 Loss of life: 6	
	Thandaungyi T/S in Kayin State[1]	September, 2008	Houses: 2 Household: 4	Victim: 15 Loss of life: 3	6.2 million Kyats
	Lashio T/S in Shan State[1]	September, 2008		Loss of life: 3	

T/S= Township

Source [1]: National Disaster Prevention Committee, [2]: Myanmar Natural Disaster 2012, OCHA (Office for the Coordination of Humanitarian Affairs)

Risk of Disaster, environmental problems facing and environmental conservation activities conducted in each township are shown in Table 7-22.

Table 7-22: Risk of disaster, environmental problems and environmental conservation activities

Township	Risk of Disaster	Environment problems	Environmental Conservation
Pathein	- Flood risk - Tsunami risk - Tsunami on 29 April, 2006, value loss is 169.77 million kyats - Ngawun river flows through the Township and flood risk occurs every rainy season - Flood from 4 August, 2012 to 22 August, 2012, 12 numbers of ward and 17 numbers of village were affected. 35 numbers of temporary rescue camps looked after 2,223 numbers of household and 8,893 numbers of people.	-	- There are reserved forest and protected public forest at deep slope of hills and mountains. There are private rubber and hardwood plantation at the low land and vacant forest. Forests managed by the Department of Forest (DOF) is successfully planted. - The condition of plantation is as follows. (a) 20 number of hardwood plantation by one household: 16,400 No. (b) 1 acre plantation by a village: 2,100 No. (c) Plantation by people in rainy season: 25,000 No. (d) Plantation at either side of the road: 4,000 No. - Total number of above plantation is 47,500.
Bago	- Flood risk in rainy season as Bagon is situated at the bank of Bago River. - There were a flooe occurred two times in July and August (rainfall is 332 cm which is the highest in last 47 years) in 2011.	- There is a complaint about noise and smoke from zin roof production factory by using generators made in China inside residential area in Bago.	-
Pyay	None	- There is a few number of forest and the weathe is dry and hot.	- In every rainy season, plantation ceremony is conducted.

Township	Risk of Disaster	Environment problems	Environmental Conservation
Bhamo	- Bhamo is situated at the bank of Ayeyarwaddy River - Flood occurs every year and severe flood occurs every five year (or) ten year	- Bhamo is border area of neighbouring countries. Because of increase in population and economic condition, illegal timbering, deforestation rate is very severe compared to ten years ago	- For green campaign, timber plantation by DOF, group teak plantation along either side of the road and plantation by the public every new year (plants are provided to the public)
Loikaw	- Baluchaung river flows through Loikaw and there is natural disaster in heavy rainy season in Loikaw	-	- For environmental conservation, DOF provides nursery plants with flowers, shading trees, perennial plants to wards, village tracts by preparing a plan.
Magway	- No natural disaster risk	- Cutting trees which are planted for wind cover illegally in Magway district. - Aunglan Township, there is a butchery within the residential area and local people complained about it.	- Eucalyptus plantation (1 acre by each village) - Teak plantation (3 numbers of teak by each household) - Hardwood plantation (20 numbers of hardwood by each household) - Village firewood plantation in less rain region - Timber plantation site local people and local organization - Plantation ceremony in the rainy season
Mawlamyine	- There may be disaster risk to Kyauktan ward, Kawpauk village, Kawton village, Kawsein village, Katoe village, Kawnote village, Kawhlar village	-	- Conducting environmental conservation workshop one time per month, conduction awareness seminar, plantation and putting fish to ponds - Total number of plantation (a) Eucalyptus: 603 No. (b) Teak: 250 No. (c) Shaded Tree: 1,243 No.
Monywa	- It is situated at the bank of Chindwin river. - It is situated in a dry zone where it is hot and there is less rain - Therefore there is flood risk, fire risk, windy risk, earthquake risk and suffer from drought	- Chindwin River	- For environmental conservation and preserving green area in local, plantation condition by DOF and the Dry Zone Greening Department is as follows - The number of plant provided for public plantation in 2010, 2011, 2012 and 2013 are 69,300, 7,900, 4,000 and 96,484 respectively. - The number of nursery plant in 2010, 2011, 2012 and 2013 are 94,950, 14,400, 7,250 and 214,987 respectively.
Taunggyi	-	-	-
Dawei	-	-	-

-: No data
Source: General Administration Departments in each Township in March, 2015

(4) Forest Areas and Protected Areas

Nearly half of its total land area is covered with Forest in Myanmar (FAO 2010). Department of Forest (DOF) has systematically managed natural forest as reserved and protected public forest as shown in Table 7-23. The proposed projects will not affect these forest areas.

Table 7-23: Reserved and Protected Public Forest Area

State/Region	District	Reserved Forest and Protected Public Forest area (ha)
Ayeyarwaddy	Pathein	193,959.88
Bago	Bago	517,711.67
	Pyay	246,940.93
Kachin	Bhamo	578,287.40
Kayah	Loikaw	216,674.87
Magway	Magway	124,067.40
Mandalay	Mandalay	14,471.13
Mon	Mawlamyine	142,923.86
Sagaing	Monywa	234,612.00
Shan	Taunggyi	638,195.41
	Lashio	74,725.25
Tanintharyi	Dawei	396,994.85

Source: Department of Forest (DOF) under MOECAF

A list of the protected areas in Myanmar is shown in Table 7-24. The proposed projects will not affect these forest areas.

Table 7-24: PAs in Myanmar

Region/ State	Name	Areas (ha)	Location	Key Species Protected	Forest Types
Ayeyarwady region	Thamihla Kyun Wildlife Sanctuary	88.06	4. Marine N 15° 05' & E 94° 17'	Marine turtle	Evergreen forest, Mangrove
	Meinmahla Kyun Wildlife Sanctuary	13,670.03	4. Marine N 16° 05' & E 95° 18'	Crocodile, Water and Shore birds	Mangrove
Bago Region	Moeyungyi Wetland Wildlife Sanctuary	10,360.01	4. Wetland reservoir N 17° 34' & E 96° 35'	Water birds	Wetland ecosystem
	North Zamrari Wildlife Sanctuary	98,313.91	-	Elephant, Leopard, Clouded leopard, Gaur, Bear, Banteng, Avifauna	Upper deciduous forest, Dry forest
	Shinpin Kyatthaut Wildlife Sanctuary	7,189.85	Between N 15° 50' & 15° 58', Between E 96° 09' & 96° 16'	Barking deer, Hog Deer, Wild Boar, Pangolin, Wild Dog, Civet, Reptiles	Mixed deciduous forest, Evergreen forest
Chin State	Natmataung National Park	71,354.57	9 c. Terrestrial N 21° 12' & 94° 00'	Gaur, Serow, Goral and White browed Nuthatch	Evergreen forest, Hill forest, Pine forest
	Kyauk Pan Taung Wildlife Sanctuary	13,061.38	-	Serow, Goral, Sambur, Leopard, Clouded leopard, Wild cats, Barking deer, Wildboar	Evergreen forest, Hill forest, Pine forest
Kachin State	Pidaung Wildlife Sanctuary	12,206.68	9 b. Terrestrial Between N 25° 15' & 25° 35', Between E 97° 14' & 97° 20'	Elephant, Gaur, Banteng, Sambar, Leopard, Bear	Evergreen forest, Hill forest
	Hkakaborazi National Park	381,248.38	H d. Terrestrial N 28° 05' & E 97° 44'	Takin, Musked deer, Red goral, Black barking deer, Avifauna, Orchids	Evergreen forest, Hill forest, Pine forest and snow-capped mountains
	Hponkanrazi Wildlife Sanctuary	270,396.27	9 b. Terrestrial N 27° 30' & E 97° 43'	Barking deer, Avifauna, Red Goral, Gibbon, Wild dogs, Moongooses	Evergreen forest, Hill forest, Pine forest and snow-capped mountains
	Indawgyi Wildlife Sanctuary	81,499.61	9 a. Wetland/ Lake Between 24° 56' & 25° 24', Between E 96° 0' & 96° 39'	Elephant, Sambur deer, Leopard, Bear, Serow, Gaur, migratory and Residence birds	Evergreen forest

Region/ State	Name	Areas (ha)	Location	Key Species Protected	Forest Types
	Hukaung Valley Wildlife Sanctuary	637,140.64	9 b. Terrestrial N 26° 17' & E 97° 41'	Elephant, Tiger, Leopard, Gaur, Sambur, Bear, Wildboar, Serow, Birds	Evergreen forest, Hill forest
	Bumphabum Wildlife Sanctuary	185,444.19	9 b. Terrestrial N 26° 29' & E 97° 31'	Elephant, Gaur, Serow, Leopard, Clouded leopard, Golden cat, Jackal, Goral, Macaques, Civets, Bear, Avifauna	Evergreen forest, Hill forest
	Hukaung Valley Wildlife Sanctuary (extension)	433,307.43	9 b. Terrestrial	Elephant, Tiger, Leopard, Gaur, Sambur, Bear, Wild Boar, Serow, Water birds	Evergreen forest, Hill forest
	Inkhainbon National Park	30,051.80		Leopard, Gaur, Sambar Hog Deer, Leaf Deer, Red Serow, Bear, Wild Dog, Pangolin, Wild Cats, Monkeys, Wild Boar, Birds, Snakes, Aquatic fauna	Evergreen forest, Hill forest
Kayah State		0.00			
Kayin State	Kahilu Wildlife Sanctuary	16,058.02	4. Terrestrial N 17° 03' & E 97° 06'	Serow, Mouse deer, Hog deer	Evergreen forest, Hill forest
	Mulayit Wildlife Sanctuary	13,856.51	10 a. Terrestrial N 16° 07' & E 98° 30'	Leopard, Barking deer, Wild cats	Evergreen forest, Hill forest
Magway Region	Wetthikan Wildlife Sanctuary	401.45	9 a. Wetland N 20° 00' & E 96° 30'	Wetland birds	Mixed deciduous forest, Dry forest
	Shwesettaw Wildlife Sanctuary	46,410.26	9 a. Terrestrial N 20° 12' & E 94° 35'	Eld's deer, Sambar, Barking deer, Gaur	Mixed deciduous forest, Dry forest
	Chaungponkan Wildlife Sanctuary	220.15	-	Myanmar golden deer, Rabbit, Wildcat, Jackal, Avifauna	Dry forest
Mandalay	Shwe-U-Daung Wildlife Sanctuary	5,804.20	10 b. Terrestrial between N 23° 5' & 22° 57', Between E 99° 5' & 96° 22'	Elephant, Gaur, Banteng, Sambar, Serow, Bear	Mixed deciduous forest, Evergreen forest, Hill forest
	Pyinoolwin Bird Sanctuary	12,724.68	10 b. Terrestrial 22° 00' N & 96° 30'	Barking deer, Avifauna	Hill forest
	Popa Mountain Park	12,854.18	9 a. Terrestrial N 20° 53' & E 95° 15'	Barking deer, Leopard, Geomorphologic features	Dry forest, Mixed deciduous forest, Hill forest, Pine forest
	Lawkanada Wildlife Sanctuary	46.62	9 a. Terrestrial N 21° 15' & E 94° 47'	Avifauna, Cultural diversity	Dry forest
	Minsontaung Wildlife Sanctuary	2,255.89	9 a. Terrestrial N 21° 28' & E 95° 43'	Barking deer, Dhole, Reptiles, Tortoise, Wild cat	Dry forest
Mon State	Kaylatha Wildlife Sanctuary	2,263.66	4, Terrestrial N 17° 13' & E 97° 06'	Serow, Avifauna	Evergreen forest, Hill forest
	Kyaikhtiyoe Wildlife Sanctuary	15,620.31	4. Terrestrial Between N 17° 24' & 17° 34', Between E 97° 01' & 97° 10'	Goral, Gaur, Sambur, Monkey	Evergreen forest, Hill forest
Rakhine State	Rakhine Yoma Elephant Range	175,571.10	4. Terrestrial N 17° 31' & E 94° 30'	Elephant, Gaur, Leopard, Jackal, Bear	Evergreen forest, Hill forest
Sagaing Region	Chatthin Wildlife Sanctuary	26,006.22	9 a. Terrestrial N 23° 36' & E 95° 32'	Eld's deer, Sambar, Barking deer	Indaing forest
	Minwuntaung Wildlife Sanctuary	20,587.93	9 a. Terrestrial N 22° 02' & E 95° 58'	Barking deer, Avifauna	Dry forest
	Htamanthi Wildlife Sanctuary	215,073.82	9 b. Terrestrial N 25° 26' & E 95° 37'	Rhinoceros, Elephant, Gaur, Tiger	Evergreen forest, Hill forest
	Alaungdaw	140,279.72	9 a. Terrestrial	Elephant, Leopard,	Mixed deciduous

Region/ State	Name	Areas (ha)	Location	Key Species Protected	Forest Types
	Katthapa National Park		N 22° 30' & E 94° 20'	Gaur, Sambur, Serow, Bear	forest, Evergreen forest, Hill forest, Pine forest
	Hukaung Valley Wildlife Sanctuary (extension)	666,925.67	9 b. Terrestrial	Elephant, Tiger, Leopard, Gaur, Sambur, Bear, Wild Boar, Serow, Water birds	Evergreen forest, Hill forest
	Maharmyaing Wildlife Sanctuary	118,039.37	9 a. Terrestrial Between N 22° 50' & 23° 45', Between E 94° 15' & 95°00'	Elephant, Sambar, Wild Dogs, Banteng, Gibbon, Wild Boar, Mongooses	Evergreen forest, Hill forest
	Bawdi Tahtaung Nature Reserve	7,252.01	-	Wild Cats and Avifauna	Dry forest
Shan State	Shwe-U-Daung Wildlife Sanctuary	11,797.46	10 b. Terrestrial between N 23° 5' & 22° 57', Between E 99° 5' & 96° 22'	Elephant, Gaur, Banteng, Sambar, Serow, Bear	Mixed deciduous forest, Evergreen forest, Hill forest
	Taunggyi Bird Sanctuary	740.74	10 b. Terrestrial N 20° 45' & E 97° 04'	Avifauna	Hill forest, Pine forest
	Inlay Lake Wildlife Sanctuary	55,757.58	10 b. Wetland/ Lake Between N 19° 46' & 20° 38', Between E 96° 47' & 97° 06'	Water birds and Fish spp	Wetland ecosystem
	Loimwe Protected Area	4,200.98	10 b. Terrestrial N 21° 8' & E 99° 45'	Bear, Pangolin, Pheasant	Hill forest
	Parsar Protected Area	7,702.67	10 a. Terrestrial N 20° 29' & E 99° 53'	Jungle fowl, Chinese pangolin	Hill forest
	Panlaung-pyadalin Cave Wildlife Sanctuary	33,379.95	10 b. Terrestrial N 21° 10' & E 96° 28'	Elephant, Leopard, Gaur, Banteng, Golden cat, Clouded leopard, Serow, Gibbon, Orchids	Mixed deciduous forest, Evergreen forest, Hill forest
Tanintharyi Region	Moscos Islands Wildlife Sanctuary	4,921.00	4. Island marine	Barking deer, Sambar, Swiftlet	Evergreen forest, Mangrove
	Lampi Islands Marine National Park	20,484.33	7 b. Marine Between N 10° 41' & 10° 59' Between E 98° 04' & 98°18'	Coral reefs, Mouse deer and Salon ethnic culture	Mangrove forest, Evergreen forest, Marine ecosystem
	Tanintharyi Nature Reserve	170,000.00	5 a. Terrestrial	Tiger, Gurney's Pitta, Elephant, Tapir	Evergreen forest, Hill forest
	Lenya National Park	176,638.18	7 b. Terrestrial Between N 10° 48' & 99° 20', Between E 98° 49' & 99°20'	Elephant, Tiger, Tapir, Monkeys, Barking deer, Sambar, Wild Boar, Bear, Leaf Deer, Wild cats, Pangolin, Lizards, Birds	Evergreen forest, Hill forest, Mangrove
	Tanintharyi National Park	259,000.26	5 a. Terrestrial N 12° 02' & E 97° 00'	Tiger, Sambar, Barking Deer, Serow, Goral, Leopard, Elephant, Birds	Evergreen forest, Hill forest, Mangrove
	Lenya national Park (extension)	139,860.14	7 b. Terrestrial	Tiger, Elephant, Tapir, Gaur, Banteng, Sambar, Gurney's Pitta	Evergreen forest, Hill forest, Mangrove

Source: Departmet of Forest (1st Nov, 2014)

(5) Flora, Fauna and Biodiversity

Southeast Asia and this area was recognized to support at least 6,000 vascular plant species, of which perhaps 25% are endemic (Kingdon-Ward 1944-5). The plant diversity of the country as a whole is even higher: a recent version of the checklist of gymnosperms and angiosperms in Myanmar contains 11,800 species in 2,371 genera and 273 families (Kress et al, 2003).

Global threat assessments have only been conducted for a small proportion of Myanmar's plant species, principally gymnosperms and certain angiosperm families. 43 plant species recorded in Myanmar have been assessed as globally threatened (IUCN 2011). The major threats to globally threatened plant species in Myanmar are degradation and loss of forest due to unsustainable resource extraction.

Table 7-25 contains Fauna found in Myanmar.

Table 7-25: Fauna Found in Myanmar

Fauna	Places found
Kitti's Hog-nosed Bat (***Craseonycteris thonglongyai***)	Southern Myanmar
Leaf Deer (***Muntiacus putaoensis***)	Northern Myanmar
White-browed Nuthatch (***Sitta victoriae***)	Southern Chin Hills
Hooded Treepie (***Crypsirina cucullata***)	Central Dry Zone
White-throated Babbler (***Turdoides gularis***)	
Burmese Bushlark (***Mirafra microptera***)	
Sea Cow (***Dugong dugon***)	Rakhine State
Hawksbill Turtle (***Eretmochelys imbricate***)	Coastal regions of Rakhine, Ayeyawady and Taninthayi
Green Turtle (***Chelonia mydas***)	
Loggerhead Turtle (***Caretta caretta***)	
Olive Ridely Turtle (***Lepidochelys olivacea***)	
Leatherback Turtle (***Dermochelys coriacea***)	
Eld's Deer (***Cervus eldii thamin***)	Central Dry Zone
Red Panda (***Ailurus fulgens***)	Northern Myanmar
Takin (***Budorcas taxicolor***)	
Red Goral (***Naemorhedus baileyi***)	
Gurney's Pitta (***Pitta gurneyi***)	Lowland wet evergreen forests in southern Myanmar
Plain-pouched Hornbill (***Aceros subruficollis***)	
Spoon-billed Sandpiper (***Eurynorhynchus pygmeus***)	Gulf of Mottama
Pink-headed Duck (***Rhodonessa caryophyllacea***)	Upper section of the Chindwin River
Indo-pacific Hump-back Dolphin (***Sausa chinensis***)	Myanmar's coastal areas and seascapes
Bottlenose Dolphin (***Tursiops aduncus***)	
Bottlenose Dolphin (***Tursiops truncates***)	
Long-snout Spinner Dolphin (***Stenella longirostris***)	
Pan-tropical Spotted Dolphin (***Stenella attenuate***)	
Finless Porpoise (***Neophocaena phocaenoides***)	
Irrawaddy Dolphin (***Orcaella brevirostris***)	
Sperm Whale (***Physeter macrocephalus***)	
Blue Whale (***Balaenoptera musculus***)	
Fin Whale (***Balaenoptera physalus***)	
Striped Dolphin (***Stenella coeruleoalba***)	
Long-beaked Common Dolphin (***Delphinus capensis***)	
Pygmy Sperm Whale (***Kogia breviceps***)	
Pigmy Killer Whale (***Feresa attenuate***)	
Bryde's Whale (***Balaenoptera adeni***)	
Ray bamboo shark (***Chioscyillium griseum***)	Myanmar seascapes
Brown banded bamboo shark (***Chioscyillium punctatum***)	
Zebra shark (***Stegostoma fasciatum***)	
Hook tooth shark (***Chaenogaleus macrostoma***)	
Silvertip shark (***Carcharhinus albimarginatus***)	
Graceful shart (***C. amblyrhynchoides***)	
Borneo shark (***C. borneensis***)	
Spinner shark (***C. brivipinna***)	
White cheek shark (***C. dussumieri***)	
Silky shark (***C. falciformis***)	
Bull shark (***C. leucas***)	
Blacktip shark (***C. limbatus***)	
Blacktip reef shark (***C. melanopterus***)	
Sandbar shark (***C. plumbeus***)	
Spot tail shark (***C. sorrah***)	
Tiger shark (***Galeocerdo cuvier***)	
Ganges shark (***Glyphis gangetis***)	
Slit eye shark (***Loxodon macrorhinus***)	
Milk shark (***Rhizoprionodon acutus***)	
Gray sharpnose shark (***R. oligolinx***)	
Spadenose shark (***Scoliodom laticaudus***)	
Winghead shark (***Eusphyra blochii***)	
Scalloped hammerhead (***Sphyrna lewini***)	
Great hammerhead (***S. mokarran***)	

Source: National Biodiversity Strategy and Action Plan Myanmar

Flora and Fauna in each township is shown in Table 7-26.

Table 7-26: Flora and Fauna

Township	Flora	Fauna
Pathein	- Teak - Pyinkado (a kind of ironwood tree, *Xylia dolabriformis*) - Kanyin (large tree yielding wood oil, *Dipterocarpus alatus*) - Jugle Mango - Jack fruit - Tamarind - Dhani (nipa palm, *Nipa fruticans*) - Mangrove (*Sonneratia caseolaris*) - Rattan - Bamboo - Mango - Cinnamon (*Cinnamomum tamala*) - Coconut - Thapay (Jungle Eugenia tree)	- Elephant - Wild boar - Bear - Gaur (Bison) - Jungle buffalo/ox - Sambur - Hog-Deer - Rabbit - Deer - Serow - Goral - Jungle dog - Hog badger - Jungle cat - Pangolin - Iguana - Monitor lizard - Species of angama or variegated ground lizard - various kinds of monkey
Bago	-	-
Pyay	-	-
Bhamo	- Teak - Pyinkado (a kind of ironwood tree, Xylia dolabriformis) - Padauk - Tamalan - Ingyin - Thityar - In (broad –leaved tall timber tree yielding reddish resinuous wood, *Dipterocarpus tuberculatus*) - Kanyin (large tree yielding wood oil, *Dipterocarpus alatus*) - Yamane - Timber tree yielding smooth grained wood (*Gmelina arborea*) - various kind of Bamboo - Htauk Kyant (kind of large timber tree, *Terminalia tomentosa*)	- Elephant - Gaur (Bison) - Goral - Peacock - Hog-Deer - Sambur - Jungle chicken - Jungle duck - Quail - Jungle pig - Bear - Jungle dog - Jackal - various kinds of Monkey - leopard - Tiger - Porcupine - Tortoise
Loikaw	- Eucalyptus - Tamarind - Mango - Teak - Pyinkado - Ingyin - Letpan - Pine	- Tiger - Rabbit - Snake - Duck
Magway	- Eucalyptus - Than (tree from the bark of which a dye is obtained, *Terminalia oliveri*) - Thaput (Sponge Gourd, *Luffa pentadra*) - Shar (cutch, *Acacia catechu*) - Tamar (neem tree, margosa tree, *Azadirachta indica*) - Tayaw (small tree or shrub of the Grewia species such as *Grewia polgama*, the bark of which is used in preparing shampoo) - Hta Naung (a kind of throny tree with whitish bark growing in dry regions. *Acacia leucaphloea*)	- Rabbit - Dove - Snipe - Boa constrictor - Viper - Cobra - Common rat snake (*Ptyas mucosus*)
Mawlamyine	-Mahlwa - Phat lan	- Barking deer - Jungle Cat

Township	Flora	Fauna
	- Pyinma (a kind of large timber tree, *Lagerstroemia speciosa*) - Thapyay (Eugenia tree) - Kyee - Anan (a kind of hard wood tree, *Fagraea fragrans*) - Yone - Thaphan (fit tree *Ficus glomerata*) - Sit - Taungmayoe (tree yielding soft, white wood with the bark and sap having medicinal application, *Alstonia scholaris*)	
Monywa	- Tamarind - Hta Naung (a kind of throny tree with whitish bark growing in dry regions. Acacia leucaphloea) - Tamar (neem tree, margosa tree, *Azadirachta indica*) - Than (tree from the bark of which a dy is obtained. *Terminalia oliveri*) - Dhahat (kind of hard wood tree, *Tectona hamiltoniana*) - Thanaka - Padauk - Bamboo - Htauk Kyant (kind of large timber tree, *Terminalia tomentosa*) - Pyinma (a kind of large timber tree, *Lagerstroemia speciosa*) - Letpan - Chinese Tamarind - Ushit (Bael) - Mezali	- various kinds of fresh water fish - Prawn - Water Tortoise - Deer - Hog-deer - Barking deer - Rabbit - Porcupine - Tortoise - Iguana - Species of angama or variegated ground lizard - Mountain Cat - Jungle chicken - Squirrel - Monkey - Dove - Partridge - Sparrow - Crow - Parrot - Pheasant - Jungle duck - Magpie robin - Owl
Taunggyi	-	-
Dawei	-	-

-: No data

Source: General Administration Departments in each Township in March, 2015

7.3.3 Status of Pollution

The amount of solid waste in Mandalay City area, Magway Township, Monywa Township, Pathein Township, Loikaw Township, and Dawei Township are 700 ton/day, 10 ton/day, 7 ton/day, 20 ton/day, 15 ton/day, and 28 ton/day respectively. In Myanmar, there is no separation of solid waste between degradable solid waste like kitchen waste and recyclable solid waste like paper, plastic, glass, metal, can, tyre, battery, etc and all solid waste from household, hotels and restaurants are disposed at a disposal site and waste from hospital and clinics are disposed by storing underground with a concrete container with a cover or by incineration. At final disposal site, we can see some people who collect recyclable solid waste which can be sold to recycle material collecting shops which then sell them again to recycle industries. There exist various kinds of government and private recycle industries such as a metal refinery industry which produces recycled metal from big and small parts of waste metal, a paper mill which produces pulp by using waste paper, a plastic industry which produces plastic housewares from plastic waste and many more throughout the country.

7.4 Evaluation of Environmental and Social Impacts

7.4.1 Evaluation of Environmental and Social Impact

(1) No-Project Scenario

The analysis of alternatives for priority projects is generally divided into the “With Project” and “Without project” cases. The case of "Without project" means there will be no improvement activities for the existing electricity distribution network and to keep using the current existing system. The results of the examination are as follows:

Aspect of Economy- Electric power demand will be increasing in accordance with the economic development in the target townships, despite the present electricity shortage. It is clear that stable supply of electricity by the “With Project” cases helps to improve the living standard.

Aspect of Environment- Even though “With project” case, a series of the proposed projects will not need private land acquisition and involuntary resettlement in current situation, so possible social impact will not be significant. Regarding environmental negative impacts, it can be mitigated by implementation of appropriate environmental management and monitoring plan. The “With project” case expects environmental benefit. There is a possibility that the greenhouse gas emission from the electricity distribution network without renovation will worsen due to inadequate operation.

Therefore, “With project” case is recommendable from environmental and social consideration viewpoints.

(2) Evaluation of Environmental and Social Impacts by Construction and Upgrading of Substations and Constrution of Distribution Lines

Impacts by construction and upgrading of substations and construction of transmission/distribution lines before construction, during construction and operation stage are evaluated in Table 7-27.

Table 7-27: Evaluation Results in Environmental and Social Impacts of Construction or Renovation of Substations

Category	Scoping Item	Evaluation: Before/During Construction (BC/DC)	Evaluation: Operation Stage (OS)	Evaluation	Reasons for Evaluation
Pollution	Air Quality	B-	B-	New S/S	DC: There is a possibility of emission from construction equipment and dust from construction machineries and construction activities. Air pollution due to traffic congestion is also anticipated. OS: The quality of air is decreased by transformers if a new substation is constructed. The degree of air pollution becomes increased if an existing transformer is renovated or replaced with a new transformer. If a number of transformer is increased, air pollution from an additional number of transformer is anticipated. There is no impact on air quality by distribution lines.
			A+ /B-	Upgrading S/S	
			D	D.L	
	Water Quality	B-	B-	New S/S/Upgrading S/S	DC: Muddy water inflow to river/drainages along the Project area from bare land of construction site may deteriorate water quality. OS: The amount of waste water discharged from a substation is increased from a new substation. There is no waste water comes out from distribution line during operation of distribution line.
			D	D.L	

	Solid Waste	B-	B-	New S/S/Upgrading S/S	DC: Solid waste from construction is anticipated. OS: Because of an operation of a new substation, the amount of solid waste is increased. There is no solid waste comes out from operation of distribution line.
			D	D.L	
	Soil Contamination	D	D	New S/S/Upgrading S/S D.L	DC: Soil contamination has not been identified. Thus, impact on soil contamination is not expected. OS: No activities causing soil pollution is anticipated.
	Noise/Vibration	B-	B-	New S/S	DC: Noise and vibration from the operation of construction machinery and on-site vehicles are anticipated. OS: If a new substation is constructed, the level of noise and vibration will be increased due to operation of transformers. Noise and vibration from a substation will be decreased when an existing transformer is renovated or replaced with a new one. On the other hand, the impact of noise and vibration will be increased if a number of transformer is increased.
			A+/B-	Upgrading S/S	
			D	D.L	
	Ground Subsidence	D	D	New S/S/Upgrading S/S D.L	There are no excavation work and groundwater intake that would cause ground subsidence during construction and operation.
	Offensive Odor	D	D	New S/S D.L	DC: Construction causing offensive odor is not anticipated. OS: There is no offensive odor in case of operation of a new substation and a distribution line. Offensive odor of an existing old transformer is avoided by replacing or renovating with a new one.
			A+	Upgrading S/S	
	Sedimentation	D	D	New S/S/Upgrading S/S D.L	The project will not change riverbed. Therefore impact on sedimentation is not anticipated.
Natural Environment	Natural Protected Area	D	D	New S/S/Upgrading S/S D.L	According to the site survey and data collected from the Department of Forest, there is no impact on it for replacement and renovation of a substation, construction of a new substation and distribution lines.
	Flora and Fauna	D	D	New S/S/Upgrading S/S D.L	There is no impact on it for replacement and renovation of a substation and construction of a new substation and distribution lines depending on the result of survey and a list of endangered species of flora and fauna.
	Ecosystem	D	D	New S/S/Upgrading S/S D.L	It can be expected that there is no impact on ecosystem due to construction and operation of substations and distribution lines.
	Forest area	D	D	New S/S/Upgrading S/S D.L	There is no impact on it due to construction and operation of a substations and distribution lines based on site survey and data received from the Department of Forest.
	Hydrology	D	D	New S/S/Upgrading S/S D.L	The project will not change water current and riverbed. Therefore impact on hydrology is not anticipated during construction and operation.
	Topography/ Geography	B-	D	New S/S/Upgrading S/S	DC: There is no impact on topography and geography due to the replacement and renovation of a transformer and distribution line. But construction of a new substation may include boring or deep excavation. Therefore there is slight impact on topography and geography in such case. OS: The project does not require massive boring or excavation during operation and there may be no significant impact.
			D	D.L	
Social Environment	Involuntary Resettlement	D	D	New S/S/Upgrading S/S D.L	For replacement and renovation of a substation, no land acquisition is required. For construction of a new substation, involuntary resettlement is planned to avoid as much as possible. According to site visit survey, there is no illegal person living in or around proposed project sites. Therefore it can be expected that there is no resettlement in the project.

	Living standard	B+	B+	New S/S/Upgrading S/S D.L	DC: Job opportunities and commercial activities may be enhanced slightly due to construction works that would lead to increase earnings and living standard will be higher than before. OS: Higher living standard is expected if the electricity is planned to distribute to local area. Detailed information is necessary.
	Indigenous and Ethnic Minority Group	D	D	New S/S/Upgrading S/S D.L	There is no indigenous and ethnic minority groups reside in and around the proposed site according to the survey and data collected from General Administration Department.
	Local Economy such as Employment and Livelihood	B+	B+	New S/S/Upgrading S/S D.L	DC: The regional economy will be boosted. There will be job opportunities for locals. Other local resources and food will be procured on site. OS: As a result of an operation of a substation and distribution line, local economy and employment opportunities will be boosted.
	Local resources	D	D	New S/S/Upgrading S/S D.L	There may be no threat that the project use local resources.
	Water Usage	C	D	New S/S/Upgrading S/S D.L	DC: Survey is necessary to check that the construction uses local water resource or not during construction. OS: There may be no impact on water usage as the project will not use water from surrounding area.
	Existing Infrastructures and Services	B-	B+	New S/S/Upgrading S/S D.L	DC: There is an impact on it in case of replacement or renovation of a substation. A new substation will be constructed only on the land where there is no existing infrastructure on it. Thus, no impact on existing social infrastructures and services in case of construction of a new substation and distribution lines. OS: Regional distribution improvement project decreases electric loss and provides reliable and stable electricity. As a matter of fact, it helps existing infrastructures get reliable and stable electricity supply.
	Social Structures/Facilities	D	B+	New S/S/Upgrading S/S D.L	DC: As this project is development of substation and power distribution line, it is not related to social structures/ facilities during construction. OS: Because of this project, electricity distribution system in respective township is improved. Social Structures/ Facilities can get reliable and stable electricity supply.
	Uneven advantage and disadvantage to local area and target area	C	C	New S/S/Upgrading S/S D.L	If electric power is planned to distribute not only to the target area but also to local area, there is no impact on that matter. Detailed information is necessary to make clear of that matter.
	Conflict of Interest within a city	D	D	New S/S/Upgrading S/S D.L	There may be no conflict of interest within a city due to the construction and operation of a substation and distribution line.
	Cultural Heritage	D	D	New S/S/Upgrading S/S D.L	Based on site survey and information collected from the department of archeology, it can be concluded that the project does not related to cultural heritage such as ancient site zone, protected and preserved zone.
	Landscape	D	C	New S/S D.L	OS: In case of construction of a new substation, determination shall be made if there is landscape view affected or not at detailed site survey. When replacing or renovating an existing substation, impact on landscape is not expected.
			D	Upgrading S/S	
	Gender	D	A+	New S/S/Upgrading S/S D.L	OS: Significant positive impact on gender is expected by the project during operation of substation and distribution lines.
	Children's Right	D	A+	New S/S/Upgrading S/S D.L	OS: Significant positive impact on children's right can be expected by the project as the project can provide reliable and stable electricity supply. Children can be benefited by the project.

Health and Safety	Occupational Health and Safety	B-	B-	New S/S/Upgrading S/S D.L	DC: It is necessary to consider occupational health and safety during construction such as accident, salinity, and using heavy equipment. OS: Working environment during operation may be risky because working place is at high position for maintenance of distribution line and working with high voltage in case of operating substations.
	Community Health and Safety	B-	B-	New S/S/Upgrading S/S D.L	DC: It is necessary to consider community safety and health such as electrocution, dust, noise, vibration and accidents due to construction. OS: Nearby places to substations and distribution lines during operation may be risky because of high voltage. Electrocution is one of the problems to be solved.
	Risks of Infectious Disease such as AIDS/HIV	B-	D	New S/S/Upgrading S/S D.L	DC: There may be risks of infectious disease as workers from outside enter to the project site. OS: Because there is no large inflow to the site from different regions, impacts on infectious disease are not anticipated.
	Accident	B-	B-	New S/S/Upgrading S/S D.L	DC: It is necessary to consider the possibility of accidents happening during construction. OS: Careful attentions are needed as there would be some dangerous works such as working with high voltage at substations and working at high places for maintenance of distribution lines during operation stage.
Emergency Risk	Flood risk	B-	B-	New S/S/Upgrading S/S D.L	Flood risk such as heavy rain, cyclone and tsunami are expected with a fixed probability.
	Risks for fire	B-	B-	New S/S/Upgrading S/S D.L	Risks for fire are expected with a fixed probability during construction and operation of the project.
	Earthquake	C	C	New S/S/Upgrading S/S D.L	Detailed survey shall be carried out to check the possibility and the degree of earthquake around the project site.
Climate Change	Global Warming	D	B-	New S/S	DC: No significant impact on climate change by the project as the scale of construction work is not so large. OS: Whereas carbon emission will be increased because of the operation of a new substation and an additional number of transformer in an existing substation, carbon emission will be decreased due to the replacement and renovation of an existing transformer. There is no impact by operation of a distribution line.
			B+/B-	Upgrading S/S	
			D	D.L	
Direct and Indirect Impact	Electrocution	B-	B-	New S/S/Upgrading S/S D.L	DC: Impact to surrounding area due to electrocution is expected. OS: Electrocution is anticipated by operation of a new substation and distribution power lines.
	Radio interference	D	D	New S/S/Upgrading S/S D.L	No significant radio interference by distribution line. According to EHS guidelines by IFC, radio interference by distribution line is not big enough to consider.
	Visual Amenity	B-	B-	New S/S/Upgrading S/S D.L	DC: Visual Impact is expected. OS: Visual Impact due to substation, power lines and power poles is anticipated.
	Ozone	B-	D	New S/S/Upgrading S/S D.L	DC: Negative Impact to surrounding area is predicted. OS: No significant ozone is produced by a substation and distribution line
Residual Impact		D	D	New S/S/Upgrading S/S D.L	No residual impact is anticipated after termination of operation of a substation and distribution line.

Evaluation: A-: Significant negative impact A+: Significant positive impact
B-: Some negative impact B+: Some positive impact
C: Impacts are not clear, investigation will be necessary
D: No Impacts or impacts are negligible. Hence, no further study required

Source: JICA study team

7.4.2 Benefit of Electricity Destribution Improvement

It can be concluded that electricity can encourage socio-economic development of a girl, a teenager, a housewife, a working mother and a woman who runs a private small industry at home by rearing children at the same time. All of the proposed construction sites are in cities area and females at various ages can get a unique benefit in an education sector, a health sector, an economic sector and in their everyday lives from implementation of proposed projects. Table 7-28 includes detailed benefits which females can get from proposed projects during operation.

Table 7-28: Benefits for Females During Construction and Operation Phase.

Sector	Detailed benefits
Education	- It is considered that an electricity helps the education standard of a country to be higher. The more electricity, the more chance for her to study at night and the high possibility for her to become an educated one. If the distributions in those cities are improved, students especially female students in those proposed projects implementation cities can learn their lessons in good learning environment, do their laboratory experiments and many more.
Health	- There are child delivery rooms in most townships and there are two numbers of Women and Child Hospital and there are two numbers of Women and Child health center in Taunggyi. They can be supplied by reliable and stable electricity because of the proposed projects. Mother can be benefited in their health care by the proposed projects. - There are hospitals, health center and branches of health center in almost all of the cities where the proposed projects are planned to implement (See Table). These medical service facilities shall be supplied electricity 24 hours to save lives of people especially elderly women as Myanmar women lives longer life than Myanmar men. According to WHO data in 2011, the life expectancy of man and woman are 63.4 and 67.1 respectively. If there is an electricity at her home or at a hospital or at a medical health care center, an elderly woman can be saved her lives by using electric medical equipment such as an oxygen supply at her home, emergency heart beating machine, etc… When the distribution system in respective cities is improved, there is a chance for them to be cared by 24 hours health service at hospitials and at their homes.
Economic	- A number of small household industries, such as one shown as "Household Industry" in Table 7-9, are very large in all townships. A woman can run a small household industry at home while she is caring her children or her parents at home if there is a reliable electricity at her home. - In addition, when woman working under unorganized sector (self-employed and casual ownership) is concerned, it covers nearly half of the proportion of female employment according to type of ownership compiled by Central Statistical Organization and Department of Labour as shown in Table 6-35. - There is no dobut that an electricy helps to improve small household industries in cities where the proposed proejcts are planned to implement. - Furthermore, girls and women from regional area leave to urban or city area where there are more job opportunities to serve as a helper/servant in an urban or city family, as a waitress or a hostee at a night club, restaurant or a Karaoke box, as an employee in an industry, at a beauty salon and massage business with low wages ranging from 30,000 Ks to 300,000 Ks because of her lack of literacy, basic education, production skills, knowledge and many more. Due to low wages, most of them tend to become a prostitute to earn more to meet their living expenses in urban area where living expenses and commodity price are high. Moreover in severe cases, servants are raped by her man-employer. As a matter of fact, more job opportunities shall be created n regional area by encouraging the development of small household industries in them. Electricity is essential for industries whether they are big or small. As mentioned above, electricity distribution system of regional area can be better after distribution system in cities is upgraded.
Daily lives	- In Myanmar, mothers ask their teenagers daughters to do house works such as cooking, washing, ironing, cleaning and looking after their younger brothers or sisters so that they are able to do those things when they get married. Myanmar people understand these works are works of housewives. Myanmar husband is not used to help house works at home. Reliable and stable electricity helps teenagers do housework conveniently such as cooking rice by using rice cooker, cooking meals by using electric stove, washing by using a washing machine, ironing by using an electric iron, etc… - Most of the women in Myanmar especially in rural area quit their job when they get married as Myanmar people understand that responsibility of a housewife is cooking, washing, ironing, cleaning house and looking after children. This is a deep-rooted Myanmar traditional cultural. But it is not the same in cities area where it becomes difficult to depend only on a father's income due to high commodity price. Therefore, a mother needs to work while she is doing her house works and looking after her children at the same time. A working mother can save time doing house works by using household electric appliances. So a working mother is afraid of electricity cut off as every household works is in chaos without electricity. So the project helps a working mother feel free of worries from frequent electricity cut off. As a matter of fact, reliable and stable electricity helps housewives do house works conveniently as mentioned above.

Source: JICA Study Team

Table 7-29: Proportion of Female Employment by Type of Ownership

No.	Ownership	2007 (%)	2008 (%)	Source
1	Government	50.35	51.42	Central Statistical Organization
2	Joint-venture	26.33	26.05	Department of Labour (The survey covered only in the private sector that are situated in urban areas, self-empolyed and casual labour.)
3	Private	36.57	34.82	
4	Self-employed and casual	41.63	41.15	

Source: JICA Study Team

7.4.3 Public Consulation Meeting

In May and June 2015, ESE implemented the following public consultation meetins to adopt the requirement by the Draft Notification of EIA Procedure;

- Implemented a meeting for construction of 33/11 kV, 10 MVA Substation at Monywa Taung in Monywa Township on 6th May 2015,
- Implemented a meeting for construction of 33/11 kV, 10 MVA Substation at Phayarphyu Ward in Taunggyi Township on 23rd May 2015,
- Implemented a meeting for construction of 66/11 kV, 5 MVA Substation at Sint Khan in Bhamo Township on 4th May 2015,
- Implemented a meeting for construction of 33/11 kV, 5 MVA Substation at Pyigyitagon Township in Mandalay on 18th June 2015,
- Implemented a meeting for construction of 33/11 kV, 5 MVA Substation at Chanaythazan Township in Mandalay on 12th June 2015,
- Implemented a meeting for construction of 33/11 kV, 5 MVA Substation at Patheingyi Township in Mandalay on 12th June 2015, and
- Implemented a meeting for construction of 33/11 kV, 5 MVA Substation at Amarapura Township in Mandalay on 10th June 2015.

7.4.4 Preparation of Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP)

In order to avoid environmental and social impact, Environmental Management Plan (hereinafter referred to as "EMP") and Environmental Monitoring Plan (hereinafter referred to as "EMoP") during construction phase and operation phase are prepared.

Table 7-30 shows EMP for construction and upgrading of substations during construction phase.

Table 7-30: EMP for Construction and Upgrading of Substations During Construction Phase

Category	Scoping Item	Impact Evaluation	Mitigation Measure	Implementor (Cost bearing Organization)	Supervisor	Implementation Period
Pollution	Air Quality	Air pollution may arise due to emission gas from construction vehicles and machines and dust from construction work.	- Sprinkle water around preservation area such as residence, religious buildings and cultural heritage buildings. - Construction vehicles and machines shall be operated efficiently to minimize the amount of discharged air pollutants. - Transportation of construction equipment will be implemented efficiently.	Contractor	Project proponent (ESE)	Construction Period
	Water Quality	Water pollution can be anticipated from leakage of transformer oil during construction work. Therefore leakage oil from transfomers should be controlled properly, especially leakage from transformers that may have PCB in their transformer oil.	- Checking leakage of oils from replaced transformers. - Installation of cover sheet on bare lands. - Settling ponds or a simple water treatment system will be installed as necessary.	Contractor	Project proponent (ESE)	Construction Period

Category	Scoping Item	Impact Evaluation	Mitigation Measure	Implementor (Cost bearing Organization)	Supervisor	Implementation Period
	Solid Waste	- Construction waste will be generated - Solid waste of old Transformers will be generated in case of replacement of old transformers with new transformers	- For the transformers manufactured before 1978, it is better to check PCB concentration by field test kit. - For other transformers, the contractor should contact with manufacturers to confirm whether these transformers are included PCB or not by providing serial numbers on them and the year of manufacturing. If manufacturer cannot provide information on the usage of PCB, it is better to check PCB concentration by field test kit. - In case that transformers which includes PCB are found, specific storage yard will be secured and proper storage condition has to be developed. - Reusing construction soil comes out from excavation - Hygienic human waste dispose systems such as mobile toilets shall be constructed and sites shall be restored properly upon completion of work - Generated big and large construction waste will be handled in cooperation with related Township Development Committee or organization concerned - Disposed vegetable waste at designated dumping site regulated by local authorities - Make an arrangement to sort out recyclable waste such as paper, cans, thins, bottles, cardboard, and polythene at collecting points and disposed of complying with local authority's regulations	Contractor	Project proponent (ESE)	Construction Period
	Noise / Vibration	Noise and vibration due to construction work is anticipated.	- Installation of soundproof sheet around preservation areas such as residences, obeying maximum driving speed, advance notice of operations and restriction of construction time period, etc… - Construction vehicles shall be operated efficiently. - Transportation of construction equipment will be implemented efficiently	Contractor	Project proponent (ESE)	Construction Period
Social Environment	Substation land acquisition	- Crop Compensation is anticipated at some project sites (In Monywa Township, there is a corn plantation at the proposed construction site) - There may be an unequal job opportunities to local people and the contractors' usual labourer	- If there is crop at construction site, the project proponent shall make a negotiation with persons who make cultivation at the proposed site to discuss about the crops. - Crop Compensation shall be given to above crop owners by establishing crop compensation committee- The contractor shall be encouraged to use local labourers as much as possible to provide job opportunities to local people	Contractor	Project proponent (ESE)	Construction Period
Health and Safety	Occupational Health and Safety	It is necessary to consider operational health and safety during construction such as accidents, salinity, and use of heavy equipment.	- Conducting Educational training on Occupational Health and Safety to laborers - Distribution of safety equipment (helmet, gloves, earplug, mask etc.), and prevention of accidents to the third party such as an installation of a fence around construction site - Occupational Health and Safety plan will be implemented	Contractor	Project proponent (ESE)	Construction Period

Category	Scoping Item	Impact Evaluation	Mitigation Measure	Implementor (Cost bearing Organization)	Supervisor	Implementation Period
			- The above plan will be modified as necessary			
	Risks of Infectious Disease such as AIDS/HIV	Risks of infectious diseases cannot be neglected.	- Conducting awareness training of infection diseases to laborers at the beginning of the construction and periodically	Contractor	Project proponent (ESE)	Construction Period
	Accident	It is necessary to consider the possibility of accidents occurring during construction work.	- Undertaking educational accident training at site periodically - Accident avoidance plan will be prepared - The above plan will be updated as necessary	Contractor	Project proponent (ESE)	Construction Period
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare emergency plan to reduce the risk of fire during the construction phase.	- Conduction fire extinguishing practicing training at the beginning of the construction and periodically - Emergency plan for fir risk will be prepared - Recording fire risk experience and making disclosure to the public and laborers so that they can realize the danger of fire	Contractor	Project proponent (ESE)	Construction Period

Source: JICA study team

Table 7-31 contains EMP for construction and upgrading of substations during operation phase.

Table 7-31: EMP for Construction and Upgrading of Substations During Operation Phase

Category	Scoping Item	Impact Evaluation	Mitigation Measure	Implementor (Cost bearing Organization)	Supervisor	Implementation Period
Pollution	Solid Waste	- Construction waste will be generated. - Solid waste of old Transformers will be generated in case of replacement with new transformers.	- In case that transformers having PCB are found and replaced, the replaced old transformer has to be stored at appropriate storage area with the following condition: <u>Foundation of transformers</u> - Storage areas should be on a firm and impermeable base, such as concrete coated with a suitable seal having continuous curbing. The storage area must be big enough for two (2) times of the volume of the largest PCB container, or 25% of the total internal volume of the stored items, whichever is greater. <u>Contaminant</u> - Storage areas for drums, equipment such as transformers and other goods should be kerbed, and positively drained to a sealed collecting pond. - There should be no drains, joint lines, sewer lines, or other openings that would allow fluids to flow <u>Labeling / Signing</u> - All packages, drums and other PCB material must be labeled, marked and identified that they contains environmental pollutant PCB.	Manager of each substation	Project Proponent (ESE)	During operation of each substation
	Noise/ Vibration	Due to the operation of the substation facilities, noise impact is anticipated.	- The replaced facilities such as transformers will be operated appropriately and provided with proper maintenance.	Manager of each substation	Project Proponent (ESE)	During operation of each substation
Health and Safety	Occupational Health and Safety	Operation of substation facilities will need some new knowledge. As a matter of fact. Occupational health and safety needs to modified	- Occupational health and safety plan will be implemented. - Educational training program will be conducted to avoid accidents during the operation. - The above occupational health and safety plan will be reviewed and modified as necessary every year.	Manager of each substation	Project Proponent (ESE)	During operation of each substation

Category	Scoping Item	Impact Evaluation	Mitigation Measure	Implementor (Cost bearing Organization)	Super visor	Implementati on Period
	Risks of Infectious Disease such as AIDS/HIV	Risks of infectious diseases cannot be neglected	- Conducting awareness training of infection diseases to laborers at the beginning of the construction and periodically	Contractor	Project propon ent	Construction Period
	Accident	It is necessary to consider the possibility of various kinds of accidents during construction	- Undertaking educational accident training at site periodically - Accident avoidance plan will be prepared - The above plan will be updated as necessary	Contractor	Project propon ent	Construction Period
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare emergency plan to reduce the risk of fire during the construction phase.	- Conduction fire extinguishing practicing training at the beginning of the construction and periodically - Emergency plan for fir risk will be prepared - Recording fire risk experience and making disclosure to the public and laborers so that they can realize the danger of fire	Contractor	Project propon ent	Construction Period

Source: JICA study team

Table 7-32 includes EMP for construction of distribution lines during construction phase.

Table 7-32: EMP for Construction of Distribution Line During Construction Phase

Category	Scoping Item	Impact Evaluation	Mitigation Measure	Implementor (Cost bearing Organization)	Superv isor	Implementati on Period
Pollution	Air Quality	Air pollution may arise due to emission gas from construction vehicles and machines and dust from construction work.	- Sprinkle water around preservation area such as residence, religious buildings and cultural heritage buildings. - Construction vehicles and machines shall be operated efficiently to minimize the amount of discharged air pollutants. - Transportation of construction equipment will be implemented efficiently	Contractor	Project propone nt (ESE)	Construction Period
	Water Quality	Leakage of transformer oil during construction work should be controlled. Especially if transformers that may have PCB in their transformer oil are found. Therefore, water quality pollution during construction work has to be controlled carefully.	- Installation of cover sheet on bare lands. - Settling ponds or a simple water treatment system will be installed as necessary.	Contractor	Project propone nt (ESE)	Construction Period
	Solid Waste	- Construction waste will be generated - Solid waste of old Transformers will be generated in case of replacement with new transformers	- Reusing construction soil comes out from excavation - Hygienic human waste dispose systems such as mobile toilets shall be constructed and sites shall be restored properly upon completion of work - Generated big and large construction waste will be handled in cooperation with related Township Development Committee or organization concerned - Disposed vegetable waste at designated dumping site regulated by local authorities - Make an arrangement to sort out recyclable waste such as paper, cans, thins, bottles, cardboard, and polythene at collecting points and	Contractor	Project propone nt (ESE)	Construction Period

Category	Scoping Item	Impact Evaluation	Mitigation Measure	Implementor (Cost bearing Organization)	Supervisor	Implementation Period
			disposed of complying with local authority's regulations			
	Noise / Vibration	Noise and vibration due to construction work are anticipated.	- Installation of soundproof sheet around preservation areas such as residences, obeying maximum driving speed, advance notice of operations and restriction of construction time period, etc. - Construction vehicles shall be operated efficiently. - Transportation of construction equipment will be implemented efficiently	Contractor	Project proponent (ESE)	Construction Period
Social Environment	Line route	- There may be some temporary facilities which are easy to move and are located within the ROW of construction of distribution lines and they need to set back during construction - There may be an unequal job opportunities to local people and the contractors' usual labourer	- Distribution line routes shall be selected avoiding fixed facilities and structure which are difficult to remove. - Public disclosure for construction shall be undertaken in advance. - Agreement with an owner of affected facilities which are easy to move shall be got by negotiation to set back temporarily during construction - Construction time shall be informed to an owner of affected facilities in advance so that they can have time to prepare for set back. - Construction around affected area shall be finished as soon as possible to decrease impact on them - The Contractor gives man power or transportation support to affected facilities when they set back temporarily during construction and when they return to their original place after construction - Negotiation with corresponding Ministries or organization concerned shall be made in advance to get an approval to construct distribution line according to a proposed line route. For example, if a line route is planned to construct within the Right of Way (ROW) of the road which is managed by the Ministry of Construction (MOC), negotiation with MOC shall be made in advance to avoid delay in construction. - The contractor shall be encouraged to use local labourers as much as possible to provide job opportunities to local people	Contractor	Project proponent (ESE)	Construction Period
Health and Safety	Occupational Health and Safety	High risk is anticipated because of the nature of work such as working at high places with high voltage	- Conducting Educational training on Occupational Health and Safety to laborers - Distributing safety equipment such as helmet, gloves, earplug, mask etc., and prevention of accidents to the third party such as an installation of a fence around construction site - Occupational Health and Safety plan will be implemented - The above plan will be modified as necessary	Contractor	Project proponent (ESE)	Construction Period
	Risks of Infectious Disease such as AIDS/HIV	Risks of infectious diseases cannot be neglected	- Conducting awareness training of infection diseases to laborers at the beginning of the construction and periodically	Contractor	Project proponent (ESE)	Construction Period

Category	Scoping Item	Impact Evaluation	Mitigation Measure	Implementor (Cost bearing Organization)	Supervisor	Implementation Period
	Accident	It is necessary to consider the possibility of various kinds of accidents during construction	- Undertaking educational accident training at site periodically - Accident avoidance plan will be prepared - The above plan will be updated as necessary	Contractor	Project proponent (ESE)	Construction Period
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare emergency plan to reduce the risk of fire during the construction phase.	- Conduction fire extinguishing practicing training at the beginning of the construction and periodically - Emergency plan for fir risk will be prepared - Recording fire risk experience and making disclosure to the public and laborers so that they can realize the danger of fire	Contractor	Project proponent (ESE)	Construction Period

Source: JICA study team

Table 7-33 includes EMP for construction of Distribution lines during Operation Phase.

Table 7-33: EMP for Construction of Distribution Lines during Operation Phase

Category	Scoping Item	Impact Evaluation	Mitigation Measure	Implementing Administrator (Cost Burdening Organization)	Responsible Institution	Implementation Period
Health and Safety	Occupational Health and Safety	Working at high places during maintenance of distribution line lively has high risk	- Educational training on Occupational Health and Safety to electrical maintenance workers shall be conducted periodically. - Distribution of safety equipment such as helmet, gloves and other insulating equipment to line men.	Manager of substation	Project proponent (ESE)	During operation at each substation
	Community Health and Safety	Electrocution is anticipated to the community	- Conducting awareness training of danger of distribution lines and electrical facilities to the community periodically - Educational Sign board shall be installed near distribution poles to prevent electrocution - Making a fence around distribution poles to avoid touching high voltage distribution lines and electric facilities by the community	Manager of substation	Project proponent (ESE)	During operation at each substation
Social Environment	Line route	During maintenance of line route, there may be some facilities which are located within the ROW of maintenance of construction area	-			

Source: JICA study team

Table 7-34 contains EMoP for construction and upgrading of substations during costruction phase.

Table 7-34: EMoP for Construction and Upgrading of Substations During Construction Phase

Category	Scoping Item	Impact Evaluation	Items to be Monitored	Frequency of Monitoring	Implementor	Supervisor	Monitoring Period
Pollution	Solid Waste	Construction waste will be generated by the replacement of the existing facilities.	Condition of solid waste management including PCB waste if the existence of PCB is found.	Every month	Contractor	Manager of each substation	Construction period
	Noise/ Vibration	Noise and vibration due to construction work are anticipated.	Condition of construction vehicles and machines	Every week during construction work			
			Existence of complaints about noise from construction work by local people				
			Noise level at the property border of each substation	As necessary			
Direct and Indirect Impact	Electric and Magnetic Field	In the beginning of the operation phase, it is recommended to check the electric and magnetic field condition.	Magnetic field at each substation	Four or five times per week at the end of construction phase			
Health and Safety	Occupational Health and Safety	It is necessary to consider occupational health and safety during construction such as accidents, salinity, and use of heavy equipment.	Condition of construction workers' health and safety	Every week during construction work			
			Training record	Every training implemented			
	Community Health and Safety	It is necessary to avoid impact of traffic accidents due to transportation during construction work.	Existence of complaints about construction work from local residents	Every month			
	Risks of Infectious Disease	Risks of infectious diseases cannot be neglected.	Existence of patients with infectious disease	Every month			
			Record of occurrence of infectious disease	Every time when infectious disease occurs			
			Training record	Every training implemented			
	Accident	It is necessary to consider the possibility of accidents occurring during construction work.	Condition of equipment being prepared based on the accident avoidance plan	Every month			
			Record of accident	Every accident			
			Training record	Every training implemented			
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare emergency plan to reduce the risk of fire during construction phase.	Condition of equipment being prepared based on the emergency response plan	Every month			
			Record of emergency case	Every emergency case			
			Training record	Every training implemented			

Source: JICA study team

Table 7-35 contains EMoP for construction and upgrading of substations during operation stage.

Table 7-35: EMoP for Construction and Upgrading of Substations During Operation Stage

Category	Scoping Item	Impact Evaluation	Items to be Monitored	Frequency of Monitoring	Implementor	Supervisor	Duration of Monitoring
Pollution	Solid Waste	If PCB waste is found, it should be stored appropriately under safe condition.	Condition of PCB waste storage	Every month	Manager at each substation	Project Proponent (ESE)	Reporting twice in a year during first 2 years of operation to JICA (For MOECF, once a year during operation period after enforcing EIA notification procedure)
	Noise/ Vibration	Due to the operation of substation, noise impact will arise.	Operation and maintenance condition of equipment	Every month	Manager at each substation	Project Proponent (ESE)	
			Existence of complaints from local people				
			Noise level at the property border of substation	Once a year (as necessary depending on complaints from local residents)			
Social Environment	Local Economy such as Employment and Livelihood	Improvement of power distribution will contribute to accelerate the economic condition of corresponding townships and it is expected to provide positive impacts on local economy and livelihood.	Local economic condition	At the end of first 2 years operation	Manager at each substation	Project Proponent (ESE)	
	Existing Infrastructures and Services	Improvement of power distribution system will help existing infrastructures get reliable electricity supply.	Distribution of electric power	At the end of first 2 years operation	Manager at each substation	Project Proponent (ESE)	
Health and Safety	Occupational Health and Safety	Operation of substation with modern facilities will need some new knowledge. As a matter of fact, occupational health and safety plan has to be reviewed.	Condition of operational employees' health and safety	Every month	Manager at each substation	Project Proponent (ESE)	
			Training record	Every training implemented			
	Accident	Careful attention is needed because there may be dangerous condition during operation of high voltage facilities.	Condition of equipment to be prepared based on the accident avoidance plan	Every month	Manager at each substation	Project Proponent (ESE)	
			Record of accident	Every accident			
			Training record	Every training implemented			
Climate Change	Greenhouse gas (GHG) Emission	Reduction of GHG emission is estimated by the Project.	Expected CO_2 reduction amount	At the end of the initial 2 years	Manager at each substation	Project Proponent (ESE)	

Source: JICA study team

EMoP of construction of distribution lines during construction phase is shown in Table 7-36.

Table 7-36: EMoP of Construction of Distribution Lines During Construction Phase

Category	Scoping Item	Impact Evaluation	Items to be Monitored	Frequency of Monitoring	Implementor	Supervisor	Monitoring Period
Pollution	Solid Waste	Construction waste will be generated by construction works	Condition of solid waste management	Every month	Contractor	Manager of each substation	Construction period
	Noise	Due to construction work, noise impact will arise.	Operation condition of construction vehicles and machineries	Every week during construction work			
			Existence of complaints about noise from construction work by local people				
			Noise level at the property border of construction	As necessary			
Health and Safety	Occupational Health and Safety	It is necessary to consider occupational health and safety during construction such as accidents, salinity, and use of heavy equipment.	Condition of construction workers' health and safety	Every week during construction work			
			Training record	Every training implemented			
	Community Health and Safety	It is necessary to avoid impact of traffic accidents due to transportation during construction.	Existence of complaints about traffic due to construction work from local residents	Every month			
	Risks of Infectious Disease	Risks of infectious diseases cannot be neglected.	Existence of patients with infectious disease	Every month			
			Record of an occurence of infectious disease	Every time when an infectious disease occurs			
			Training record	Every training implemented			
	Accident	It is necessary to consider the possibility of accidents during construction work.	Condition of equipment being prepared based on the accident avoidance plan	Every month			
			Record of accident	Every accident			
			Training record	Every training implemented			
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare an emergency plan to reduce the risk of fire during construction.	Condition of equipment being prepared based on the emergency response plan	Every month			
			Record of emergency case	Every emergency case			
			Training record	Every training implemented			

Source: JICA study team

EMoP of construction of distribution lines during operation phase is shown in Table 7-37.

Table 7-37: EMoP of Construction of Distribution Lines During Operation Phase

Category	Scoping Item	Impact Evaluation	Items to be Monitored	Frequency of Monitoring	Implementor	Supervisor	Monitoring Period
Pollution	Solid Waste	Construction waste will be generated by construction works	Condition of solid waste management	Every month	Contractor	Manager of each substation	Operation period
Direct and Indirect Impact	Electric and Magnetic Field	It is recommended to check the electric and magnetic field condition periodically.	Magnetic field near distribution lines	Every month			
Health and Safety	Occupational Health and Safety	It is necessary to consider occupational health and safety during operation.	Condition of health and safety	Every week			
			Training record	Every training implemented			
	Community Health and Safety	Community Safety is taken into account	Existence of complaints about operation of distribution lines from local residents	Every month			
			Public educational Training record	Every training			
	Risks of Infectious Disease	Risks of infectious diseases cannot be neglected.	Existence of patients with infectious disease	Every month			
			Training record	Every training implemented			
	Accident	It is necessary to consider the possibility of accidents during operation.	Condition of equipment to be prepared based on the accident avoidance plan	Every month			
			Record of accident	Every accident			
			Training record	Every training implemented			
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare an emergency plan to reduce the risk of fire during operation.	Condition of equipment being prepared based on the emergency response plan	Every month			
			Record of emergency case	Every emergency case			
			Training record	Every training implemented			

Source: JICA study team

7.5 Institutional System for Environmental and Social Consideration

The project's proponent (Electricity Supply Enterprise (ESE)) shall set up Project Management Unit (PMU) for the Project before construction phase. There should be one social and environmental division in PMU. In this division, one person (engineer) from ESE will be assigned as an environmental and social engineer of the Project. This environmental and social engineer will monitor and inspect the contractor's performance about mitigation activities throughout the construction phase.

In addition, the contractor establishes environmental and social division to carry out mitigation measures which are addressed in the Construction Environmental Management Plan (hereinafter referred to as "CEMP"). CEMP is prepared based on EMP. Mitigation measures during a construction phase will be implemented by environmental and social division under the contractor under close supervision of environmental and social engineer in PMU.

After completion of construction works, the Project area will be managed together with existing facilities by ESE in each division. Moreover, ESE in each division will take responsibility to implement EMP during operation. The roles and responsibilities of the environmental and social staff are shown in Table 7-38.

Table 7-38: Roles and Responsibility of Environmental and Social Staff

Construction stage	Institutional name	Roles and responsibilities
Before Construction and During Construction	PMU	- Supervise construction works implemented by the contractor - Assign a staff who deals with environmental and social issues
	Environmental and Social Staff in PMU	- Supervise the mitigation measures implemented by the contractor. Detailed mitigation measures shall be described in the Environmental Management Plan (EMP)
	Environmental Division in the Contractor	- Develop Construction Environmental Management Plan (CEMP) - Implement the mitigation measures implemented in the CEMP
Operation	ESE in each division	- Implement operation and maintenance of distribution line and handle environmental and social issues

Source: JICA Study Team

Chapter 8 Project Evaluation

8.1 Proposal of operation and effect indicators

The operation and effect indicators of the project shown in Table 8-1 should be proposed. The indicators described in Table 8-1 are used in the power transmission, transformer and distribution businesses. In case of evaluation, they are compared with the results actually monitored.

Table 8-1: Operation and effect indicator (proposed)

Indicator			Description
Operation indicator	Capacity of installed transformer	MVA	Evaluation of whether substation transformer for power distribution is installed as planned
	Transformer utilization rate	%	Evaluation of whether installed substation transformer for power distribution is operated properly
	Electricity supply	GWh/year	Evaluation of contribution to electricity supply by installed substation transformer
	SAIFI	instances/year	Evaluation of whether installed equipment is properly operated and maintained
	SAIDI	min/year	
Effect indicator	Power loss rate	%	Evaluation of effect by project implementation on reducing power transmission and distribution losses

SAIFI: System Average Interruption Frequency Index
SAIDI: System Average Interruption Duration Index
Source: JICA survey team

They are estimated basically only in case of Japanese ODA loan projects. However, power loss rate as the effect indicator is estimated on the assumption that the same kind of measures taken by Japanese ODA projects are applied to all ESE service area, because it is difficult to distinguish the effects on power loss rate in the 11 cities where Japanese ODA projects are implemented.

As the base years of them, the baseline year is 2014 and the target year is April 2023 that is two years after the Japanese ODA projects are completed.

8.1.1 Substation transformer installation capacity

The following numeric values are set as the operation indicator for determining if transformers of 33/11 kV and 66/11 kV substations are installed as scheduled. The indicator should be the total installation capacity of transformers in 33/11 kV and 66/11 kV substations enhancement works in the Japanese ODA projects except the projects by other donors such as WB, ADB and the projects by ESE's own budget in 11 cities from FY 2016 to FY 2020. While, the supply capacity at 33/11 kV substations in 11 cities is 653 MVA and the capacity installed by Japanese ODA loan projects is 0 MVA at the baseline in fiscal year 2014.

Supply capacity at substations: 515 MVA

8.1.2 Transformer utilization rate

The utilization rate of the substation transformers to be installed under the project is set as the operation indicator. The utilization rate should be averaged in whole cities. The indicator in April 2021 is set as that in April 2023 on the assumption that the same kinds of the projects are conducted for two years after the projects are completed and the indicator value is kept. The utilization rate at April 2021 was estimated as shown in the following equation. While, the utilization rate of 33/11 kV and 66/11 kV substation transformers in the 11 cities are 69% at the baseline value in fiscal year 2014.

The utilization rate of the transformers as of April 2021

$$= \frac{\text{Forecasted peak demand of the 11 cities}}{\text{Total capacity of transformers of the whole 11 cities x power factor}}$$

$$= 969 \text{ MW} / (1{,}448 \text{ MVA} \times 0.9)$$

Transformer utilization rate: 74%[1]

8.1.3 Electricity supply

The annual amount of supplied electricity (GWh/year) from the substation transformers to be installed under the projects is set as an indicator. The indicator in April 2021 is set as that in April 2023 on the assumption that the transformers installed under the projects keep operating at the same utilization rate and the same loss factor for two years after the projects are completed in fiscal year 2020. The annual supplied electricity at April 2021 was estimated as shown in the following equation. While, the annual amount of supplied power from 33/11 kV and 66/11 kV substations in the 11 cities are 1,160 GWh/year and the annual power supplied from the substations installed under Japanese ODA loan projects is 0 GWh/year at the baseline in fiscal year 2014.

Electricity supply = peak demand(at FY2020)
x rate of transformer capacity by the projects to total capacity
x loss factor[2](at FY2020) x annual hours
= 969 MW x (515 MVA/1,448 MVA) x 0.325 x 8,760 h

Electricity supply: 981 GWh / year

[1] Availability factor changes according to the differences between demand forecast and actual load. Therefore, actual demand results, etc. should be used, though 74% is set as a planned value.
[2] The loss factor was calculated by setting 0.5 as the load factor in the 11 cities in fiscal 2013 according to the daily load curve, etc.and using the Buller-Woodrow formula.

8.1.4 System average interruption frequency index (SAIFI)

This indicator is used for checking if the transmission-transformation facilities that are installed in the project are appropriately operated and maintained. Only the number of power outages resulting from accidents that occurred to the transmission lines and substation facilities that are installed in the project is counted for the indicator, and the 0 (zero) case is set as the target value.

SAIFI: 0 (zero) / year-end user

8.1.5 System average interruption duration index (SAIDI)

This indicator is used for checking the transmission-transformation facilities that are installed in the project are appropriately operated and maintained. Only the power outage time resulting from accidents that occurred to the transmission lines and substation facilities that are installed in the projects is counted for the indicator, and the 0 (zero) minute is set as the target value.

SAIDI: 0 (zero) minutes / year-customer

8.1.6 Power Loss Rate

In the candidate projects for Japanese ODA loan, enhancement of transmission/distribution lines of 33 kV, 11 kV and 400 V (i.e., making the diameter of the lines larger, dispersing the load), introduction of a multi-transformer system, adoption of amorphous transformers, replacement with digital meters, and so on are planned. Through taking such various measures, reduction of power loss can be expected; therefore the power loss rate is set as the effect indicator. Effect of reducing non-technical loss can also be expected by replacing with digital meters, etc., however assumption for estimate of the effect is difficult, therefore only the technical loss reduction is set as the effect indicator.

The indicator for April 2023 is set as the same value as that for April 2021 on the assumption that the same measures are taken for two years after the projects are completed.

(1) Setting effect indicator

Calculation conditions by respective measures are described in (2) through (6). Incidentally, power loss rate is estimated as an approximate value using the averaged data based on statistics or samples because it is difficult to estimate power loss in each individual case and add up the power loss in all the target areas. In the event that the data acquired are insufficient, loss reduction effect is calculated under assumed conditions. Respective reduction rates of power loss are calculated by the rate of the power loss reduction to the amount of power generated/purchased[3] by ESE in 2020.

[3] The generated/purchased power in fiscal year 2020 is assumed to be 16,540 GWh based on the assumed annual increase of 15% from 6,218 GWh, generated/purchased power in fiscal year 2013.

Power loss rate: 11.4%

13.7% (ESE power loss rate in fiscal year 2013)

-0.3% (Making the diameter larger and dispersing load in 33 kV transmission lines)

-0.2% (Making the diameter larger and dispersing load in 11 kV distribution lines)

-1.5% (Making the diameter of 400 V distribution lines larger and using multi-transformer systems, etc.)

-0.1% (Introduction of a low power loss transformer)

-0.2% (Elimination of power loss in service lines)

(2) Power loss in 33 kV transmission lines

The effect indicator is set for the effect of changing to larger diameter lines upon new installation and line renewals in 33 kV transmission lines. Lines of smaller diameter have been mostly used so far, but larger diameter lines shall be used as a standard from now on, and power loss reduction with larger diameter lines are calculated.

Based on the average maximum demand of a 33 kV transmission line, the reduction of annual loss per line by changing to a larger diameter wire is calculated. Further, from the number of transmission lines of candidate projects for Japanese yen loan and the total number of facilities within the ESE service areas, the respective reduction of losses is calculated. Also, the loss rate is calculated from the rate of loss reduction versus total generated/purchased power amount in ESE in fiscal 2020. The parameters used for the calculation are shown in Table 8-2 and the calculation result is shown in Table 8-3.

Table 8-2: Parameters for calculating power loss in 33 kV transmission lines

Average peak demand[4]	8.2 MW
Power factor	0.9
Load factor[5]	0.5
Loss factor[6]	0.33
Average length between substations[7]	15 km
Average size of conventional conductor	ACSR 70/10
Average size of new standard conductor	ACSR 150/25

Source: JICA survey team

[4] Power systems with 33 kV transmission lines are branched in a tree-like manner. Therefore, power is supplied to secondary substations from a single source. Also, there are no power exchanges among secondary substations. Under these conditions, the average maximum demand of 33/11 kV substations is assumed to be equal to the average maximum demand of a 33 kV transmission line.

[5] Load factor of a 33 kV transmission line was set 0.5 according to the daily load curve in the 11 cities in fiscal year 2013, etc.

[6] Loss factor was estimated by using the Buller-Woodrow formula based on the load factor.

[7] Average length of a 33 kV transmission line unit between substations was estimated based on an average transformer capacity for total transformer capacity.

Table 8-3: Calculation results of power loss in 33 kV transmission lines

	Existing line	Newly constructed line	Reduced loss
Loss per 33 kV line [MW]	0.159	0.073	0.086
Annual loss amount per 33 kV line [MWh]	1,394	641	753
Loss amount by the candidate projects [MWh]	24,439	11,237	13,202
Loss rate by the candidate projects[%]	0.15	0.07	0.08
Loss amount in ESE service area[MWh]	84,024	38,634	45,389
Loss rate in ESE service area [%]	0.51	0.23	0.27

Source: JICA survey team

(3) Power loss of 11 kV distribution lines

The effect indicator is set for the effect of changing to larger diameter lines upon new installation and line renewals in 11 kV distribution lines. Conductor wires of smaller diameter have been mostly used so far, but larger diameter wires shall be used as a standard from now on, and power loss reduction with larger diameter lines are calculated.

Based on the annual power loss reduction per unit length of 11 kV distribution lines, power loss reduction in fiscal year 2020 is calculated respectively from the number of candidate projects for Japanese ODA loan of 11 kV distribution lines and total number of facilities in ESE service areas, and then the power loss rate is calculated from the share against the total ESE generated/purchased power in 2020. The parameters used for the calculation are shown in Table 8-4 and the calculation result is shown in Table 8-5.

Table 8-4: Parameters for calculating power loss in 11 kV distribution lines

Average peak demand[8]	2.0 MW
Power factor	0.9
Load factor	0.5
Loss factor	0.33
Average length[9]	8.7 km
Average size of conventional conductor	ACSR 35/6
Average size of new standard conductor	ACSR 95/15
Low-voltage line division number	1.5
Load distribution coefficient	0.5

Source: JICA survey team

[8] Average peak demand of a 11kV dictribution feeder was estimated by reference to the average peak demand of a substation transformer and the average feeder number from a substation transformer.

[9] Based on the total length of 11 kV distribution lines, the average feeder length of 11 kV distribution lines is estimated from the average number of feeders of 11 kV distribution lines.

Table 8-5: Calculation results of power loss in 11 kV distribution lines

	Existing line	Newly constructed line	Reduced loss
Loss per 11 kV line[MW]	0.021	0.008	0.013
Annual loss amount per 11 kV line [MWh]	188	70	118
Loss amount by the candidate project [MWh]	28,797	10,700	18,097
Loss rate by the candidate projects [%]	0.17	0.06	0.11
Loss amount in ESE service area [MWh]	54,834	20,375	34,460
Loss rate in ESE service area [%]	0.33	0.12	0.21

Source: JICA survey team

(4) Power loss of 400 V distribution lines

The effect indicator is set for cases where multi-transformer systems are applied, where conductor wires of larger diameter are installed for new installation, expansion and replacement, or where unbalanced three-phase current is reduced by balancing the connection phase of low voltage service lines.

Regarding multi-transformer systems, ESE has already applied the idea of the systems, and the average capacity of existing transformers is about 200 kVA. Also, excessive reduction of capacity will lower economic efficiency under the present market price and electricity rates. Therefore, we used the same capacity for the transformers to be introduced in the candidate projects for Japanese ODA loan and calculated the power loss reduction by dividing service area of transformers (by shortening the length of 400 V distribution line for each transformer).

Concerning the diameter of conductor wire in 400 V distribution lines, wires of a diameter smaller than the standard specified have been mostly used so far similarly to the cases of 33 kV and 66 kV, but larger diameter wires shall be used as a standard from now on, and power loss reduction with larger diameter wires is calculated.

Concerning unbalanced three phase current, power loss reduction is calculated on the assumption that the three phase unbalanced current is reduced by changing the connection phase of single phase 230 V service lines.

Based on annual power loss reduction per unit length of 400 V distribution lines, power loss reduction in fiscal year 2020 is calculated respectively from the number of candidate projects for Japanese ODA loan related to 400 V distribution equipment and total number of facilities in ESE service areas, and then power loss rate is calculated from the share against the total ESE generated/purchased power in 2020. The parameters used for the calculation are shown in Table 8-6 and the calculation result is shown in Table 8-7.

Table 8-6: Parameters for calculating power loss in 400 V distribution lines

	Existing line	Newly constructed line
Supply system	3 phase 4 wire	3 phase 4 wire
Power factor	0.9	0.9
Average capacity per a 11/0.4 kV transformer	200 kVA	200 kVA
Utilization rate of 11/0.4 kV transformer	0.7	0.7
Average of maximum sending current from transformer[10]	200 A	200 A
Load factor of 400 V distribution line	0.5	0.5
Loss factor	0.33	0.33
Average length of 400 V distribution line unit[11]	800 m	570 m
Assumed specification of conductors (3 phase 3 wire)	HDBC No. 8	HDBC No. 2
Assumed specification of conductors (neutral wire)	HDBC No. 10	HDBC No. 4
Low-voltage line division number	2	2
Load distribution coefficient	0.5	0.5
Three phase unbalanced factor[12]	30%	10%

Source: JICA survey team

Table 8-7: Calculation results of power loss in 400 V distribution lines

	Existing line	Newly constructed line	Reduced loss
Loss per 400 V line [kW]	18.866	4.094	14.772
Annual loss amount per 400 V line [kWh]	54,538	11,836	42,703
Loss amount by the projects [MWh]	51,757	11,232	40,525
Loss rate by the candidate projects [%]	0.31	0.07	0.25
Loss amount in ESE service area [MWh]	319,598	69,359	250,239
Loss rate in ESE service area [%]	1.93	0.42	1.51

Source: JICA survey team

(5) Power loss of low power-loss transformers

The effect indicator is set for the effect of introducing 11/0.4 kV transformers of low power-loss type that

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10 The average of maximum sending current from a 11/0.4kV transformer was set according to the average peak demand of a 11/0.4kV transformer.

11 The yearly increase in the number of consumers based on the demand estimate is forecast to be 15%. The average yearly increase in the recent number of consumers is about 10% in ESE service areas. As a result, the annual demand increase per existing consumer excluding new consumers is calculated to be 4.5%. For applying to a multi-transformer system, transformers of 200 kVA, the same capacity as existing ones, will be used. The amount of power supplied from each transformer will be controlled to the same level (Demand factor: 0.7, Load factor: 0.5). That is, to meet the demand increase in the same area, the supply service area will be divided and 400 V distribution lines will be shortened. From the considerations above, the average feeder length in fiscal year 2020 is estimated based on the present average feeder length.

12 The current unbalanced factor was estimated by reference to the sampling measured data. The improved unbalanced factor was estimated to remain 10%, as load curves on various usage conditions cannot always fit one another.

allow the reduction of power loss inside transformers. The amount of core loss reduction is calculated on the basis of changing a conventional transformer of silicon steel core to a transformer of low power-loss type that uses an amorphous steel core.

Based on annual power loss reduction per unit of transformer, power loss reduction in fiscal year 2020 is calculated respectively from the number of candidate projects for Japanese ODA loan of 11/0.4 kV transformers and total number of facilities in ESE service areas, and then power loss rate is calculated from the share against the total ESE generated/purchased power in 2020. The parameters used for the calculation are shown in Table 8-8 and the calculation result is shown in Table 8-9.

Table 8-8: Parameters of a transformer for low voltage distribution

	Conventional type	Low loss type
Transformer capacity	200 kVA	200 kVA
Primary side voltage	11 kV	11 kV
Secondary side voltage	400 V	400 V
Transformer Iron core	Silicon lamination	Amorphous lamination
Copper loss (100% loading)	2,850 W	2,850 W
Iron loss	500 W	120 W

Source: JICA survey team

Table 8-9: Calculation results of power loss in a transformer for low voltage distribution

	Conventional conductor	New conductor	Reduced loss
Iron loss per transformer [kW]	0.50	0.12	0.38
Annual iron loss per transformer [kWh]	4,380	1,051	3,329
Loss amount by the candidate projects[MWh]	4,157	998	3,159
Loss rate by the candidate projects [%]	0.025	0.006	0.019
Loss amount in ESE service area [MWh]	25,667	6,160	19,507
Loss rate in ESE service area [%]	0.155	0.037	0.12

Source: JICA survey team

(6) Power loss of service lines

By changing the installation position of digital kWh meters from the building side to the pole side of service lines, the power loss generated in the service line is recorded in the kWh meter and is eliminated from the power loss in distribution equipment to be summed up in ESE. The effect indicator is set for the effect of power loss reduction due to the elimination of the loss from the service line.

Based on the annual power loss reduction per unit of general household (electric lights), power loss reduction in fiscal year 2020 is calculated respectively from the number of candidate projects of replacing digital watt-hour meters and total number of meters in ESE service areas, and then power loss rate is calculated from the share of against the total ESE generated/purchased power in 2020. The parameters used for the calculation are shown in Table 8-10 and the calculation result is shown in Table 8-11.

Table 8-10: Parameters of low voltage service lines

Supplying system	Single-phase two wire
Customer contract type	General purpose
Average monthly electricity consumption	330 W
Service wire type	HDBC No. 14
Average length of service wire	50 m

Source: JICA survey team

Table 8-11: Calculation results of power loss in low voltage service lines

Loss per service wire [W]	1.8
Annual loss per service wire [kWh]	15.8
Loss amount by candidate projects [MWh]	1,777
Loss rate by candidate projects [%]	0.01
Loss amount in ESE service area [MWh]	28,903
Loss rate in ESE service area [%]	0.18

Source: JICA survey team

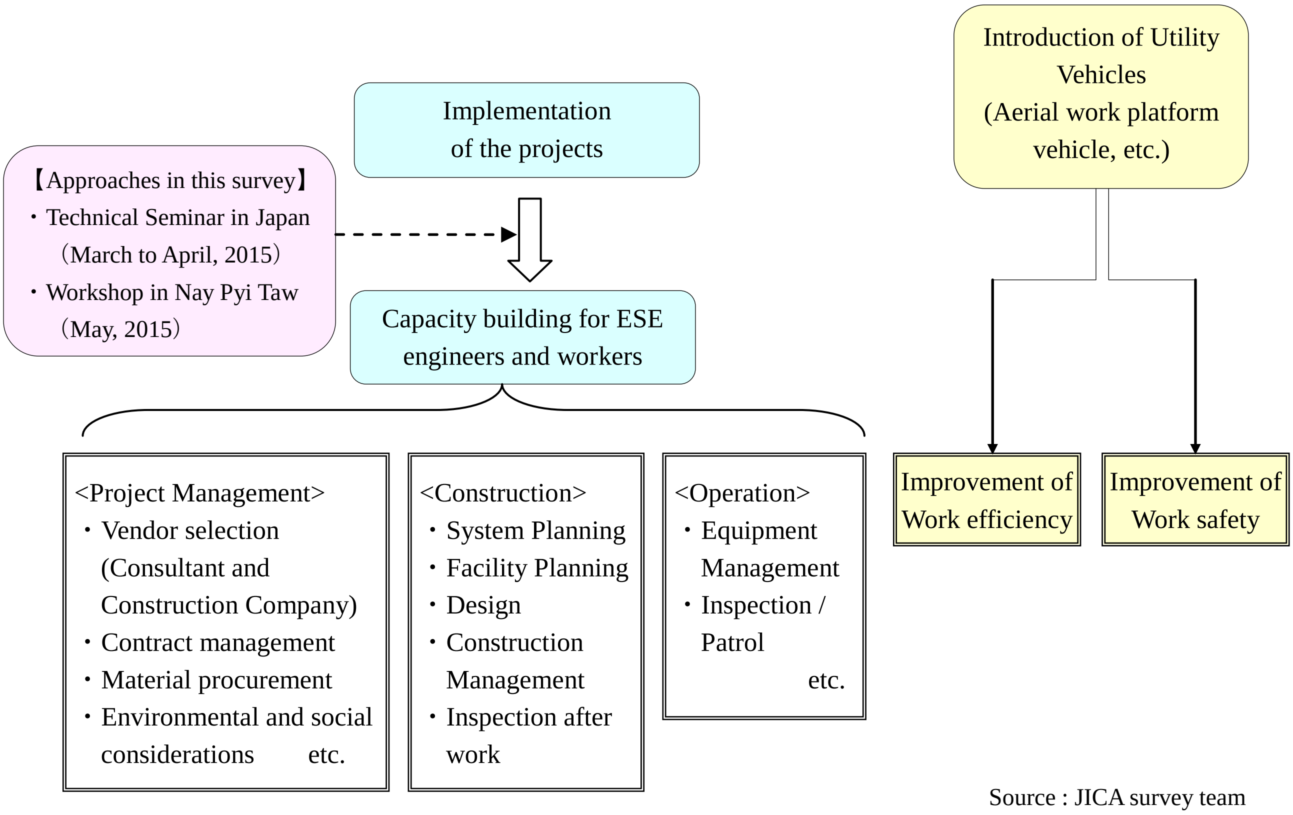
8.2 Confirmation of qualitative effects

Examinations were conducted to see whether the implementation of the projects would lead to the improvement of ESE's management and capability, and whether the improvement of distribution system would bring benefits to general users and important facilities.

Examples of effects are as follows:

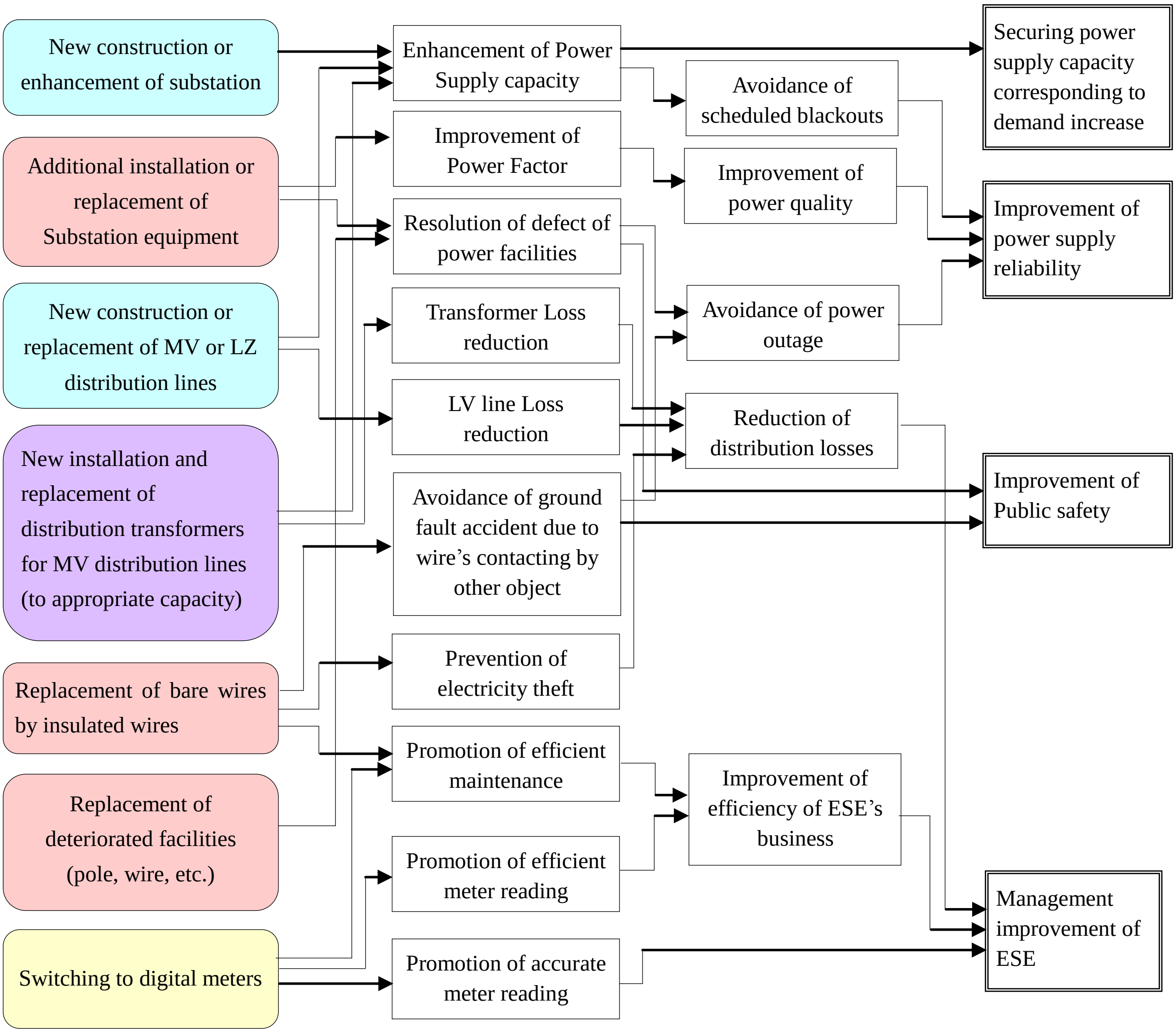
- The implementation of the projects with the support of consultants helps engineers raise their awareness of safety, enhance their technical level, and sufficiently learn specific ways to carry out operations;
- The implementation of Japanese ODA projects enables ESE engineers and workers to participate in the project to enhance their technical levels to execute the project and they can learn the systematic planning method, know-how regarding management and maintenance, and the consultant management method.
- The construction, enhancement and rehabilitation of distribution system in each city improve the reliability of the electric power system, reducing the number of failures in the distribution system. In addition, upgrading electric power facilities in Myanmar as well as raising the reliability of the distribution networks results in stable electric supply throughout the year without rolling blackouts. Furthermore, steady investment in electricity facilities to cope with a sharp rise in electricity demand in Myanmar in the future contributes to the development of industries and the improvement of people's living standards in Myanmar.

The qualitative effects of the project in terms of the improvement of management and capability are shown in Figure 8-1. The qualitative effects of the project in terms of the improvement of facilities are shown in Figure 8-2.



Source : JICA survey team

Figure 8-1: The qualitative effects of the project (Improvement of management and capability)



Source : JICA survey team

Figure 8-2: The qualitative effects of the project (Improvement of facilities)

8.3 Estimation of greenhouse gas reduction effect

Through implementation of the project, reduction of power transmission and distribution losses can be expected. Therefore, power loss amounts before and after the candidate projects for Japanese ODA loan were calculated and the greenhouse gas emission amount was calculated according to their difference. The calculation was applied on the condition that the same projects were applied over all ESE service areas, because the effect in the areas, where the projects are applied, were difficult to separate from the others. The effect of reducing CO_2 emissions estimated according to the power loss reduction amount by using CO_2 emission amount per electricity unit is 99,673 ton as shown in Table 8-12.

Table 8-12: Estimation result of greenhouse gas emission reduction

Reduction amount of CO_2 emission in fiscal 2020 through the project	99,673 [t CO_2/year]
Amount of annual CO_2 emission in fiscal 2020 in case of the baseline scenario	593,702 [t CO_2/year]
Amount of annual electricity to the distribution system after the project	16,540,429 [MWh/year]
Annual power loss rate of the baseline distribution system	13.7 [%]
CO_2 emission factor per electricity unit amount	0.262 [t CO_2/MWh] [13]
Amount of annual CO_2 emission in fiscal 2020 in case of the project scenario	494,536 [t CO_2/year]
Amount of annual power loss of the project	1,887,542 [MWh/year]
CO_2 emission factor per electricity unit amount	0.262 [t CO_2/MWh]

Source: JICA survey team

8.4 Proposal of Japanese technologies expected to be effective in Myanmar

In this survey, a special emphasis will be placed on not forcing expensive equipment on the people of Myanmar no matter how high-performing or high-quality it might be. That is preparation of basic power supplying facilities should be implemented in preference. The advanced facilities should be installed being accompanied with improvement of technology and knowledge so that ESE staff can operate and maintain them appropriately.

Table 8-13 shows examples of Japanese technologies whose superiority is expected to be acknowledged. The facilities excluding some shown in Table 8-13 are listed in the 5 year plan and planned to be installed in order.

[13]Source:IEA statistics 2012, CO_2 emissions from fuel combustion

Table 8-13: Examples of superior Japanese technologies to be acknowledged

Technology/facility	Advantages (Characteristics)	Feasibility for use
Load rate control transformer	• Transformer fitted with tap change switch made in Japan is guaranteed for frequent activations, and is more suitable for Myanmar where voltage fluctuates sharply and frequently.	Plan to introduce for substations in the central urban areas one after another.
Low-loss transformer	• The longer it is used, the more effective it is. • A transformer of this type made in Japan has already been successfully used for more than 30 years.	Plan to introduce for 11 kV distribution lines along with changing to multi-transformers.
Over current indicator	• Operates effectively in combination with section switches. • Has long been successfully used.	Applicable for all areas
Ground Fault Point Indicator	• Installed on transmission lines, it has long been successfully used and has detected many failures.	Applicable for all areas
Enclosed primary cutout switch	• This is of an enclosed type specific to Japan and has prevented numerous failures. • Has long been successfully used.	Applicable for all areas
Wire connection material	• This product made in Japan can maintain low electrical resistance as well as high strength for a long time.	Applicable for all areas
Aerial platform vehicle Digger/derrick vehicle Mini excavator	• These are manufactured to the specifications specific to Japan and specialized for respective different works, enhancing work efficiency, and safety.	Applicable for all areas
Mobile transformer	• This product made in Japan is compact and is for mounting on a truck.	Plan to deploy in major cities due to the large initial investment.
Compact GIS* (gas insulated circuit)	• Cubicle-type GIS for specifications specific to Japan is also available.	To be applied for narrow substation sites.
Automatic, sequential fault detection system	• Developed as a system specific to Japan and has long been successfully used. • Quick detection of failed sections of distribution lines and quick recovery of distribution to healthy sections are possible.	It will be effective to introduce after increasing reliability by improving the equipment for distribution lines.
33 kV and 11 kV insulator	• Quality of the products made in Japan is consistent, and the defect ratio of the products is low. • Has long been successfully used for more than 50 years in Myanmar.	Applicable for all areas
Concrete pole	• The design load required for poles is specified in technical standards in Japan, so concrete poles can be produced to meet various specified requirements with consistent quality. • Products made in Japan are of high and consistent quality because of the prestressed steel wire, compacted cast concrete, etc., and can be used for a long period of time (legal useful life is 40 years or longer).	Applicable for all areas

* Compact gas insulated switch gear, such as compact GIS or C-GIS, which can be installed in a more space-saving section.

Source: JICA survey team

Chapter 9 Suggestion on Power Distribution Business

9.1 Suggestion on distribution technology

9.1.1 Installation of distribution lines

(1) Current situation

(a) Working on the distribution loss reduction

ESE has been working on the reduction of distribution loss by introducing multi-transformer systems and digital kWh meters. On the other hand, there are some places where transformers of excess capacity are installed in low voltage lines of low level load, causing the increase of iron loss of the transformers. For example, a transformer of 315 kVA or 500 kVA is installed even where a 50 kVA transformer could sufficiently supply, and distribution loss can be reduced further by selecting a transformer of proper capacity.

(b) Optimum equipment installation

Installation of equipment in distribution lines shall be planned in proper consideration of 1) maximum utilization of equipment, 2) securing a reliable supply and 3) reduction of investment cost, and the following issues are pointed out in ESE.

- The diameter of 11 kV distribution lines from substations is small (ACSR 35 mm^2, etc.), causing voltage decrease and distribution loss. Also, wires of relatively large diameter (ACSR 95 mm^2, etc.) are used in some branch lines of load ends and the passing current of wires is not considered when installing equipment.

- Wind pressure, unbalanced tension of wires, own weight of electric poles/wires/pole-mounted apparatus, etc. are loaded on concrete poles. Poles are sometimes broken possibly because such loads were not sufficiently considered. As described in Table 7-21**,** disasters also occurred due to strong wind in Myanmar, and electric poles for large diameter wires will increase to meet demand increase, and therefore, it is necessary to take such measures as using electric poles of sufficient strength from the viewpoint of securing supply reliability and public safety.

(2) Suggestion

(a) Reduction of power loss and improvement of voltage drop

For multi-transformer systemization, amorphous transformers, which enable loss reduction by themselves alone, are recommended. Introduction of 11 kV amorphous transformers is incorporated in the 5 year plan. In addition to the introduction of amorphous transformer systems, by undertaking the following measures, reduction of technical loss/non-technical loss, improvement of public safety, reduction of failures and improvement of voltage drop can be expected.

- ✓ Change bare conductors to covered wires to prevent ground fault due to contact with trees and electricity theft.
- ✓ Change the connection phase of three-phase low voltage lines as appropriate to reduce unbalanced three-phase current.
- ✓ In order to control the voltage drop of low voltage lines, control the equipment data such as the type, diameter, length, etc. of wires together with customer contract information.
- ✓ When replacing a service line, check if the existing line matches customer contract information to prevent electricity theft.
- ✓ When connecting a low voltage line, use a wire connection device to reduce connection resistance and to prevent connection failure. The wire connection device is also effective to prevent illegal connection for electricity theft.

(b) Standardization of equipment installation

1) Type of wires for 66 kV, 33 kV and 11 kV transmission/distribution lines

Standardize the type of wires for 66 kV, 33 kV and 11 kV trunk lines and service lines. Prepare an application standard for covered wires for application in central urban areas. Standardization images are shown in Table 9-1. Through the standardization, prevention of equipment mismatch between trunk lines and branch lines and reduction of design work and equipment control work can be expected.

Table 9-1: Standardization of type of wires (Image)

Site of use	Operation current (maximum value)	Necessity of covered conductors	
		Necessary	Unnecessary
11 kV trunk line	○○○A	Covered wire○○mm^2	ACSR ○○mm^2
11 kV branch line	○○○A	Covered wire○○mm^2	ACSR ○○mm^2
11 kV ending part of line	○○A	Covered wire○○mm^2	ACSR ○○mm^2
⋮			

Source: JICA survey team

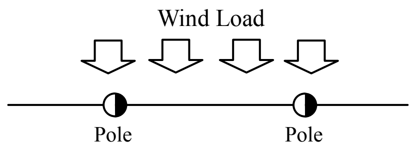
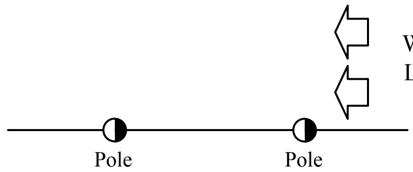
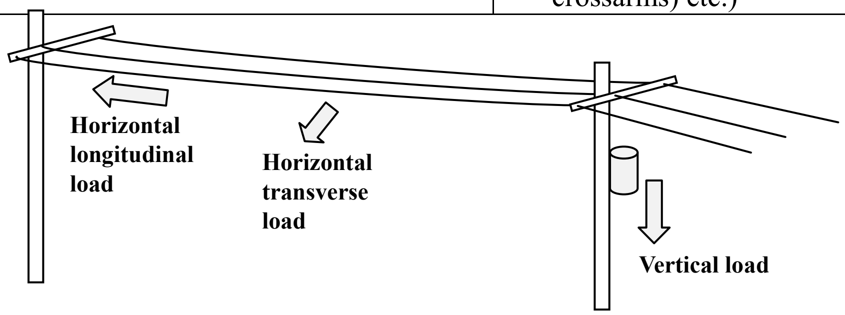
2) Calculation of the strength of supporting structures in consideration of standard wind velocity

For 66 kV, 33 kV and 11 kV transmission/distribution lines, by calculating the strength of supporting structures in consideration of standard wind velocity and use poles of sufficient strength, buckling and collapsing of the poles can be prevented.

In the electric equipment technical standards in Japan, for example, the standard wind velocity specified is 40 m/s in consideration of past typhoon wind velocity data and supporting structures must be strong enough to resist it. The concept for usual assumed load and unusual assumed load in Japan is shown in Table 9-2.

It is necessary to consider past cyclone wind velocity data in Myanmar. However, setting an excessively high standard velocity requires too much strength for poles, and pushes up the cost. Therefore, instead of using the maximum wind velocity of the past, it is necessary to determine the standard wind velocity in consideration of both equipment cost and damage risk.

Table 9-2: Assumed load on overhead distribution lines in the ordinary condition in Japan

Type of load	In case that wind load is vertically applied to distribution lines  	In case that wind load is horizontally applied to distribution lines 
Vertical load	The sum of the loads as follows (1) Weight of wires, insulator devices, poles (including crossarms) etc. on a line (2) Vertical load in case that there is vertical angle on a line (3) Load on vertical stress caused by guy's tension in case of use of guy wire (4) Weight of ice adhered on wires	
Horizontal transverse load	(1) In case that there is no horizontal angle on a distribution line Wind load vertically applied to distribution lines (Wind load on wires, insulator devices, poles (including crossarms) etc.) (2) In case that there is horizontal angle on a distribution line A horizontal transverse component of the maximum tension of wires	<In case that there is horizontal angle on a distribution line> A horizontal transverse component of the maximum tension of wires
Horizontal longitudinal load	A horizontal longitudinal component of the maximum tension of wires due to unbalanced tension of a line	(1) A horizontal longitudinal component of the maximum tension of wires due to unbalanced tension of a line (2)Wind load horizontally applied to distribution lines (Wind load on insulator devices, poles (including crossarms) etc.)
 		

Source: JEAC 7001-2012 "Power Distribution Code" (The Japan Electric Association)

9.2 Suggestion for business operation

9.2.1 Preparation and application of regulations and technical standards on voltage and frequency

(1) Present situation

It is prescribed in the Electricity Law (2014) that "To enable power consumers to use electric power with a voltage and frequency conforming to the standards and norms," but there is no prescribed standard on voltage and frequency. In this present situation, use of electric home appliances is also affected due to voltage drops and frequency fluctuation in some areas. For securing of constant quality, standards of permissible range voltage and frequency should be determined in the Electric Law or related legal system.

Also, standards for minimum separation distance/overhead height, wind load and strength of electric wires and so on, which are necessary for public safety, are not documented for national application. For example, there was an electrocution accident caused by a short separation distance, and the safety of distribution equipment is not presently ensured in some areas due to the insufficiency of technical standards.

(2) Suggestion

It is necessary to set the standard on voltage and so on in the legal system on electric utility business and to control based on it in order to maintain a stable power quality. For example, voltage fluctuation ranges are prescribed as shown in Table 9-3 in Japan, and electricity suppliers must comply with the standards.

Table 9-3: Standard voltage and permissible range in Japan

Standard voltage	Permissible range
100 V	101 V ± 6 V
200 V	202 V ± 20 V

Source: Regulation for Electricity Business Act in Japan

Together with voltage, it is required to set the standards for the minimum separation distance/overhead height of lines, wind pressure load and strength of electric wires, methods for grounding and protection, which are necessary for public safety, and should be commonly applied for electricity distribution business nationwide in Myanmar.

It is also necessary to provide laws and regulations including penalty provisions in order to enforce the technical standards.

9.2.2 Preparation and application of work safety standards

(1) Present situation

There were many electrocution/falling accidents during the work on distribution lines and public electrocution accidents. Not only the imperfect equipment such as insufficient separation distance and insulation of distribution lines, but also the insufficient work safety skills are big factors for the cause of falling and electrocution accidents. For example, there are cases where safety ropes to prevent falling were not used for work on a pole, protective gear such as helmet and safety shoes were not used, and so on, and safety work knowledge and education of safety consciousness for workers are lacking.

Presently, the Ministry of Electric Power is working on the enhancement of knowledge and consciousness of work safety, and is trying to provide work safety training not only to ESE staffs, but also to Myanmar domestic construction contractors.

(2) Suggestion

In addition to the enhancement of safety consciousness by education and training, it is also necessary for the safety of work to prepare a safety standard which prescribes fundamental matters such as a work instruction/order system, use of insulating protective/safety gear, electrical inspection before work, installation of grounding for work, etc. By applying that safety standard nationwide in ESE and establishing a system to enforce it to respective contractors and workers, a much safer work system can be established.

At the same time, as an education and training for ESE staffs, it is important to introduce a curriculum on work safety and continue to conduct both desk and on-site training. For the introduction of work safety technology, it is necessary to learn the knowledge and know-how from developed countries. Work safety technology shall be aggressively acquired not only through technology transfer from consultants of Japanese ODA loan projects, but also through support from donors.

9.2.3 PCB control

(1) Present situation

Use of PCB (Polychlorinated Biphenyl), which was used for equipment insulating oil, was stopped worldwide in 1980, since it may affect the environments. Equipment produced in and before 1980 may contain PCB, and even equipment manufactured in 1980 and later, for which repairs or oil replacement were conducted, may contain PCB.

In Myanmar, location management and disposal control of equipment containing PCB are not performed, so a lot of equipment containing PCB may still exist.

(2) Suggestion

(a) Record control of production year and repairs of equipment

Equipment produced in and before 1979 and equipment in and after 1980 that has a repair record shall be controlled as equipment that may contain PCB. That is, it is necessary to control the year and month of production and repair record of equipment that uses insulating oil. Also, when repairing equipment that uses insulating oil, used insulating oil shall never be used and it is necessary to use new oil.

(b) Storing equipment that may contain PCB

PCB needs to be decomposed at very high temperatures, and a large volume of PCB cannot be decomposed at one time. In Japan, equipment containing PCB is temporarily stored in a place that is provided with oil leakage countermeasures and is decomposed one after another.

In Myanmar, there are no facilities to decompose PCB, and it is necessary to store equipment that may contain PCB in a place provided with oil leakage countermeasures for the time being.

ESE has little knowledge on management PCB and facilities which contain PCB. ESE can study the know-how about the PCB handling through implementation of the Japanese ODA projects.

9.2.4 Fulfillment of education and training equipment and appropriate curriculum

(1) Present situation

MOEP has educational and training facility adjacent to the 230 kV transformer substation in Nay Pyi Taw. However, the present facility is only a building for classroom lecture, and has no transmitting/transforming equipment or distribution line equipment for training, and is small and is only for about thirty people.

ESE staffs get training through "On the Job Training" (OJT) in respective township offices, and no group training for the entire ESE by a systemized curriculum is conducted.

Presently, the following issues can be pointed out in ESE.

1) Developing safety consciousness, and establishing work safety methods

2) Learning the handling procedures of equipment introduced from abroad, its maintenance and operation method, and learning the operation of specialty vehicles

3) Training maintenance personnel to cope with the future increase of transformer and distribution equipment

Concerning the education and training in the electricity areas, the MOEP has the following ideas. They are planning to build a new education and training facility in the near future.

- Area of education and training shall be the entire area ranging from power generation, transmission, transformation to distribution.
- Education and training shall be provided not only to engineers and operators, but also to accounting and general affairs staff.
- Newly employed staff, including township staff, shall receive education and training intensively for one year.
- MOEP will newly build an education and training facility to be used commonly by ESE, YESC and MESC.

In the construction plan of the education and training facility by the MOEP, only the construction of a building is planned. For the installation of transformer and distribution equipment, it is inquiring of some manufacturers in Japan as well as in the US, Europe (Germany, France, etc.) and Korea, and has been informally agreed by some of the manufacturers. Also, for the preparation of education and training curriculum and lecturers, it is planned to ask international organs including JICA for technical assistance.

(2) Suggestion

For the enhancement of skills and consciousness of ESE staff, it is effective to fulfill the education and training curriculum to be conducted in the new facilities that are planned by the MOEP, and arrange a specialized organization and lecturers for a group education and training.

In the electric companies in Japan, they prepare a curriculum, which is systemized for classes like new employees, mid-level personnel, etc. in the respective fields of power generation, transmission and distribution, to conduct group education and training. In the education and training in a distribution department for example, new employees receive a group education and training for about one year to one and a half years in three fields; construction (designing, sites, and construction management), maintenance (operation, equipment control, tour of inspection/repair, etc.) and site. And mid-level engineers learn operation management and safety management skills as a work supervisor and methods to train and educate subordinates. Through group education and training, the enhancement of skills is aimed at.

The group education and training to learn skills, and the education for developing safety consciousness as conducted in Japan will be a big help for ESE staff on sites to carry out an operation safely and efficiently. For the preparation of curriculum and arrangement of lecturers, it is necessary to consider support from donors such as JICA, etc.

9.3 Suggestion concerning continuous technical cooperation

9.3.1 Support for education and training concerning the construction and maintenance management of equipment and work safety

When carrying out the improvement of distribution networks as a Japanese ODA loan project, technology transfer such as construction method, work safety, operations/maintenance etc. will be provided by consulting services according to the progress of the project. Thereby, the effect of the performed project will be fully realized into the future and its continuous reflection is expected on to the business to be conducted by ESE.

In the consulting services of the Japanese ODA loan projects, since the term, subject business and personnel are limited, and it is also difficult to provide technical assistance in detail in respective subject cities scattered over a wide area, it is effective to provide simultaneously an intensive education at the education and training facilities for the skill-up of ESE staffs.

Since MOEP is proceeding with a plan to install an education and training facility, it is effective, as support from Japan, to help with the preparation of an education and training curriculum on construction, equipment maintenance and work safety, dispatch lecturers and provide training of the local staff including on-site training. It is necessary to provide such support with the idea that Burmese staff will become leaders for the education and training in future.

9.3.2 Preparation of technical standard

As mentioned above, the Electricity Law (2014) of Myanmar prescribes that "electricity shall be usable with voltage and frequency which comply with the standard" and "damage or loss shall not be caused due to the voltage and frequency that do not comply with the standard." Setting a technical standard is one of the primary subjects of MOEP.

In order to prepare and apply a technical standard, technical assistance by a consultant experienced on the application of a foreign technical standard is necessary. JICA has experience of providing similar technical assistance in Southeast Asian countries such as Laos, Cambodia and Vietnam, and it will be useful to utilize their know-how acquired through the experience and follow-ups and to provide a similar technical assistance for Myanmar as well.