Republic of the Union of Myanmar
Yangon Electricity Supply Corporation
Mandalay Electricity Supply Corporation
Department of Power Transmission and System Control
Ministry of Electricity and Energy

Republic of the Union of Myanmar

Data Collection Survey on Urban Area Distribution Network Development

Final Report

September 2018

Japan International Cooperation Agency (JICA)

JERA Co., Inc.

Chubu Electric Power Co., Inc.

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Figure and Table

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ABREVIATIONS

Word	Original
ACSR	Aluminum Conductors Steel Reinforced
ADB	Asian Development Bank
B/C	Benefit by Cost
C-GIS	Cubicle type Gas Insulated Switchgear
CB	Circuit Breaker
CEO	Chief Executive Officer
COD	Commercial Operation Date
CVT	Cross-linked Polyethylene Insulated Vinyl Sheathed Triplex Type Power Cable
DEPP	Department of Electric Power and Planning
DPTSC	Department of Power Transmission and System Control
ECC	Environmental Compliance Certificate
ECD	Environmental Conservation Department
ECL	Environmental Conservation Law
ECR	Environmental Conservation Rules
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EMoP	Environmental Monitoring Plan
EPGE	Electric Power Generation Enterprise
ESE	Electricity Supply Enterprise
FIRR	Financial Internal Rate of Return
FY	Fiscal Year
GDP	Gross Domestic Product
GIS	Gas Insulated Switchgear
HQ	Headquarters
IEE	Initial Environmental Examination
JEPIC	Japan Electric Power Information Center
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
L/A	Loan Agreement
LDCs	Least Developed Countries
LRT	Load Ration Control Transformer
MCDC	Mandalay City Development Committee
MEPE	Myanmar Electric Power Enterprise
MESC	Mandalay Electricity Supply Corporation
MOECAF	Ministry of Environmental Conservation and Forestry
MOEE	Ministry of Electricity and Energy
MONREC	Ministry of Natural Resources and Environmental Conservation
NEDA	Neighboring Countries Economic Development Cooperation Agency

Word	Original
NEP	National Electrification Project
NPV	Net Present Value
O&M	Operation and Maintenance
OJT	On the Job Training
ODA	Official Development Assistance
PCB	Poly-chlorinated Biphenyl
PMU	Project Management Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Acquisition
SCF	Standard Conversion Factor
S/S	Substation
T/D	Transmission / Distribution
T/L	Transmission Line
TOR	Terms of Reference
UK	United Kingdom
USD	US Dollar
YCDC	Yangon City Development Committee
YESB	Yangon Electricity Supply Board
YESC	Yangon Electricity Supply Corporation
WACC	Weighted Average Cost of Capital
WB	World Bank

Chapter1 Introduction

1.1 Background

In the Republic of the Union of Myanmar (hereinafter referred to as "Myanmar"), the power demand is high during hot season (from March to May) when the temperature rises, and the maximum power demand was recorded about 3,075MW nationwide in May 2017. In 2030, the annual power consumption is expected to be 77, 730GWh in the high case, reflecting economic growth. Under such circumstances, in the economic policy (July 2016) of the new administration established in March 2016, "Rapid development of basic economic infrastructure such as electric power, roads and ports" is regarded as an important policy, and improvement of power supply capacity is positioned as an important issue for Myanmar.

One of the causes of the gap between power supply and demand is transmission/distribution (hereinafter referred to as “T/D”) loss due to vulnerable T/D facility. Regarding power distribution, there are many facilities that have passed more than 50 years after installation, and it is an issue that there are not enough facilities to supply power for the demand. The T/D loss rate is as high as about 15.1%.

Degradation of substation facilities is also progressing, and the risk of failure due to long-term use under overload conditions is high. In Myanmar, where power demand is expected to increase by more than 6 times as high as current demand by 2030, it is an urgent issue to reduce the T/D loss along with the increase of power supply.

In Myanmar, in the short term, the elimination of planned blackouts due to renovation of existing power facilities is listed as priority concern of electricity policy. Yangon Electricity Supply Corporation (YESC) and Mandalay Electricity Supply Corporation (MESC) formulated the 5-year plan (2010/11 - 2015/16 and 2016/17 - 2019/20 fiscal year) for the improvement of distribution network in their responsible area. The 5-year plan tries to increase the amount of power supply by upgrading distribution facilities from 33kV to 66kV and from 6.6kV to 11kV, and by the repair of existing substations.

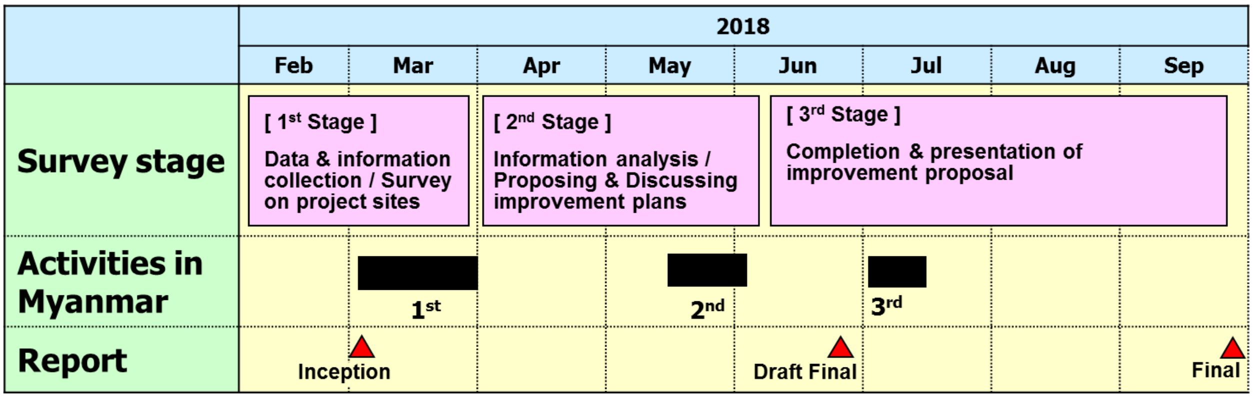
In such a situation, JICA is now supporting the improvement of distribution facilities in Yangon and in 11 major cities including Mandalay in the Japanese ODA loan projects of “Power Distribution Improvement Project in Yangon Phase I” and “Power Distribution System Improvement Project in Major Cities”, respectively. However, the need for the improvement of transmission and distribution network is high. Especially, in the two major cities of Yangon and Mandalay, degradation of distribution facilities becomes an obstacle to power supply, so urgent improvement is required.

1.2 Objective of this survey

To confirm the development status and the future development plan of the distribution network in Yangon and Mandalay and to propose recommendations for improvement of transmission and distribution network.

1.3 Survey period

February 2018 to September 2018 (about 8 months)



1.4 Survey area

- Yangon area (Yangon Electricity Supply Corporation is located)
- Mandalay area (Mandalay Electricity Supply Corporation is located)

1.5 Counterpart

- Yangon Electricity Supply Corporation (hereinafter referred to as “YESC”)
- Mandalay Electricity Supply Corporation (hereinafter referred to as “MESC”)
- Department of Power Transmission and System Control (hereinafter referred to as “DPTSC”)

1.6 JICA survey team members

No.	Name	Assignment
1	Mr. Yoshitaka SAITO	Team Leader /Transmission and distribution business management 1
2	Mr. Tomohide KATO	Deputy Team Leader /Distribution facility
3	Mr. Takao KUTSUKAKE	Power transmission and distribution system planning
4	Mr. Toshitaka YOSHIDA	Power demand forecast /Power system analysis
5	Mr. Yu NAKAHARA	Substation facility 1
6	Mr. Hoke Shein	Substation facility 2
7	Mr. Kenichiro TAKATSU	Transmission facility 1
8	Mr. Hidenobu YASUTSUNE	Transmission facility 2
9	Mr. Takeshi MURAKAMI	Economic and financial analysis
10	Mr. Kanji WATANABE	Environmental and social considerations
11	Mr. Koji NISHIKAWA	Transmission and distribution business management 2 /Coordinator

Chapter2 Present Status of YESC and MESC

2.1 Outline of Yangon and Mandalay

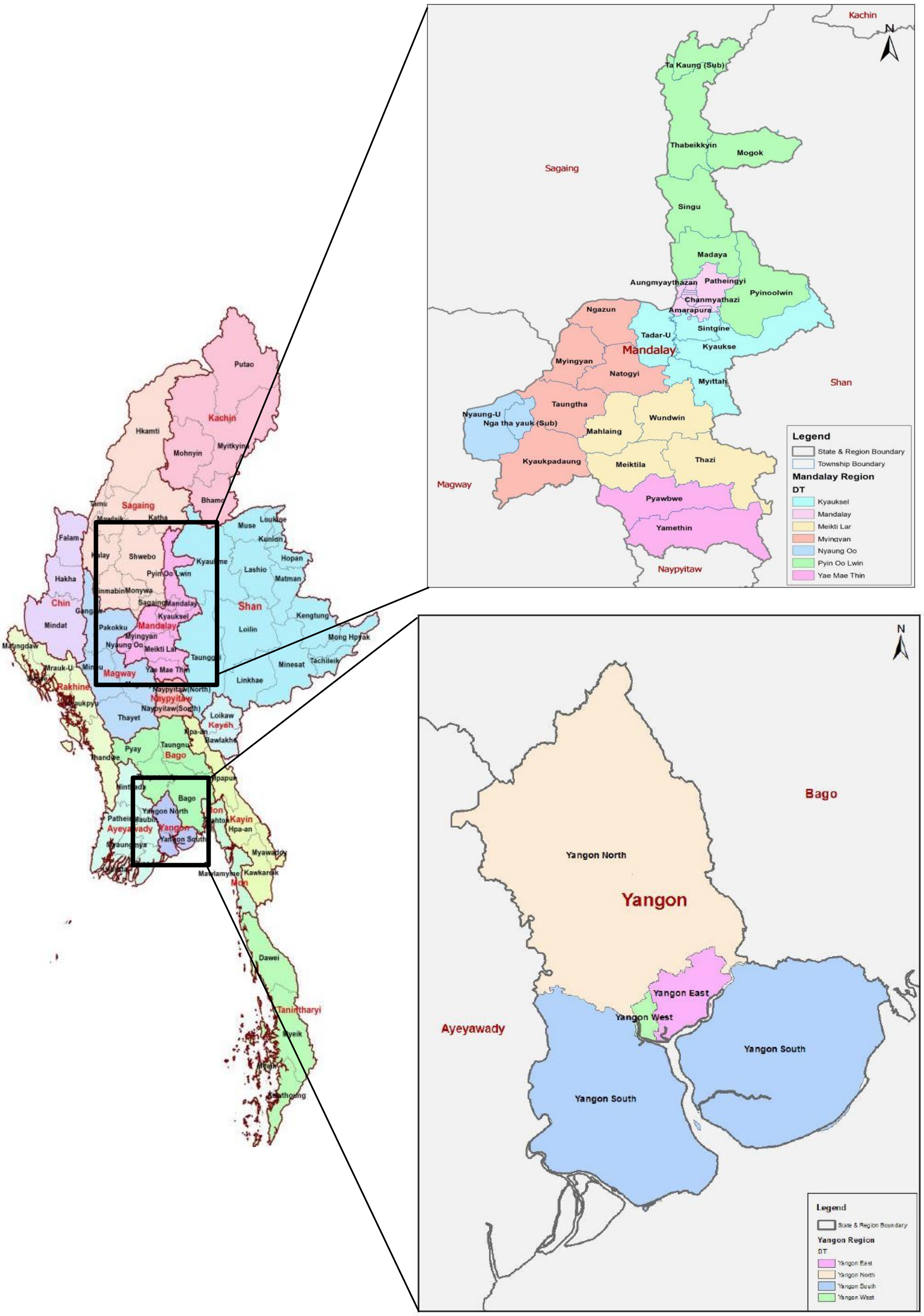


Figure 2.1-1 Location of Yangon and Mandalay

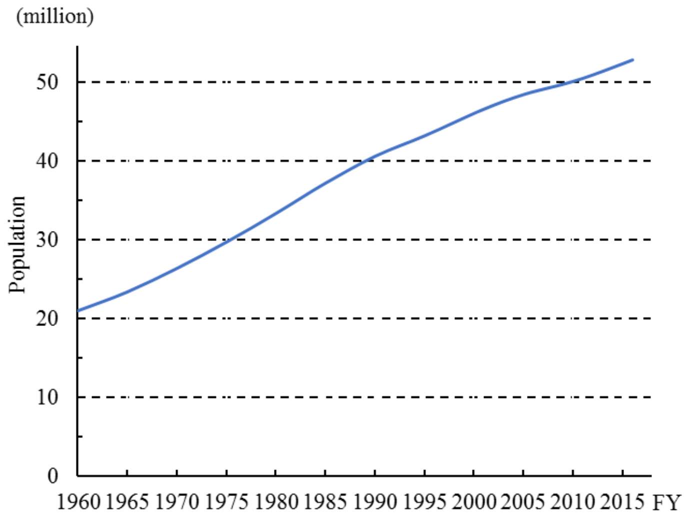
Yangon is the largest city as well as the economic center in Myanmar, with a population of 7.36 million. After consolidated in the United Kingdom (UK) because of the Second Burmese War in 1852, it developed as a political and commercial center. When Myanmar became independent from the UK, Yangon became the capital city. Then the capital moved from Yangon to Nay Pyi Taw in 2006.

There are 46 townships in Yangon, of which 17 townships have franchised the operation and management work on the distribution facilities of 11kV or less. YESC is constructing, operating, maintaining and managing transmission lines and substations of 33kV or more.

Mandalay City is the capital city of the Mandalay Region, the second largest city in Myanmar. The population of Mandalay District, the urban area, is about 1.73 million. Mandalay City was the capital of the Dynasty before consolidated in the UK because of the Third Burmese War in 1885. Mandalay Ruins can be seen at the city center and Buddhist temples are scattered on the hill called Mandalay Hill in the northern part of Mandalay City, making it one of the leading tourist attractions in Myanmar. Mandalay City is located east of the Ayeyarwady River. It is a base for logistics including river transport and it is an access base to major cities in the north by roads and railroads. The expressway is extending from Yangon through Nay Pyi Taw to Mandalay.

In Mandalay District, there are 7 townships, of which management and operations of 11kV or less are franchised in 5 townships (Aung Myay Thazan, Chan Aye Thazan, Maha Aung Myay, Chan Mya Thazi and Pyi Gyi Tagon). MESC conducts construction, operation and maintenance of transmission lines and substations with 33kV or more.

The population trend of Myanmar as a whole is shown in Figure 2.1-2. The population of each township of Yangon and Mandalay is shown in Table 2.1-1 and Table 2.1-2 respectively.



Year	Population
1960	20,986,123
1965	23,391,145
1970	26,381,431
1975	29,721,967
1980	33,369,712
1985	37,222,296
1990	40,626,250
1995	43,237,792
2000	46,095,462
2001	46,627,994
2002	47,140,220
2003	47,624,894

Year	Population
2004	48,073,707
2005	48,482,614
2006	48,846,474
2008	49,479,752
2009	49,800,690
2010	50,155,896
2011	50,553,031
2012	50,986,514
2013	51,448,196
2014	51,924,182
2015	52,403,669
2016	52,885,223

Source: World Bank Database

Figure 2.1-2 Population trend of Myanmar

Table 2.1-1 Each township's population in Yangon Region

Region	District	No.	Township	Population	Households
Yangon	North Yangon		―	2,606,670	566,167
		1	Insein	305,283	61,676
		2	Mingaladon	331,586	66,303
		3	Hmawby	244,607	56,469
		4	Hlegu	270,741	58,023
		5	Taikkyi	277,268	66,999
		6	Htantabin	145,792	34,211
		7	Shwepyitha	343,526	73,775
		8	Hlinethaya	687,867	148,711
	East Yangon		―	2,366,659	486,790
		9	Thingangyun	209,486	43,320
		10	Yankin	70,946	14,637
		11	South Okkalapa	161,126	32,725
		12	North Okkalapa	333,293	64,756
		13	Thakayta	220,556	45,456
		14	Dawbon	75,325	14,409
		15	Tamway	165,313	35,360
		16	Pazuntaung	48,455	10,306
		17	Botahtaung	40,995	8,397
		18	Dagon Myothit (South)	371,646	76,984
		19	Dagon Myothit (North)	203,948	42,704
		20	Dagon Myothit (East)	165,628	33,913
		21	Dagon Myothit (Seikkan)	167,448	37,905
		22	Mingala Taungnyunt	132,494	25,918
	South Yangon		―	1,417,724	339,205
		23	Thanlyin	268,063	61,597
		24	Kyauktan	132,765	32,976
		25	Thongwa	157,876	40,087
		26	Khayan	158,019	39,314
		27	Twantay	226,836	51,602
		28	Kawhmu	119,050	29,792
		29	Kungyangon	111,632	28,352
		30	Dala	172,857	37,912
		31	Seikkyi/ Khanaungto	34,003	7,729
		32	Cocogyun	1,940	351
		33	Tada (Sub- Township)	34,683	9,493
	West Yangon		―	969,650	190,782
		34	Kyauktada	29,853	6,120
		35	Pabedan	33,336	6,563
		36	Lanmadaw	47,160	8,599
		37	Latha	25,057	4,473
		38	Ahlon	55,482	10,943
		39	Kyimyindine	111,514	23,062
		40	Sangyoung	99,619	20,635
		41	Hline	160,307	32,837
		42	Kamayut	84,569	16,299
		43	Mayangon	198,113	38,807
		44	Dagon	25,082	4,608
		45	Bahan	96,732	17,426
		46	Seikkan	2,826	410
	Total			7,360,703	1,582,944

Source: The 2014 Myanmar Population and Housing Census

Table 2.1-2 Each township's population in Mandalay

District		Township	Population	Households
Mandalay	1	Aung Myay Thazan	265,779	49,731
	2	Chan Aye Thazan	197,175	33,281
	3	Maha Aung Myay	241,113	41,927
	4	Chan Mya Thazi	283,781	53,047
	5	Pyi Gyi Tagon	237,698	43,875
	6	Amara Pura	237,618	49,626
	7	Pa Thein Gyi	263,725	52,900
		Total	1,726,889	324,477

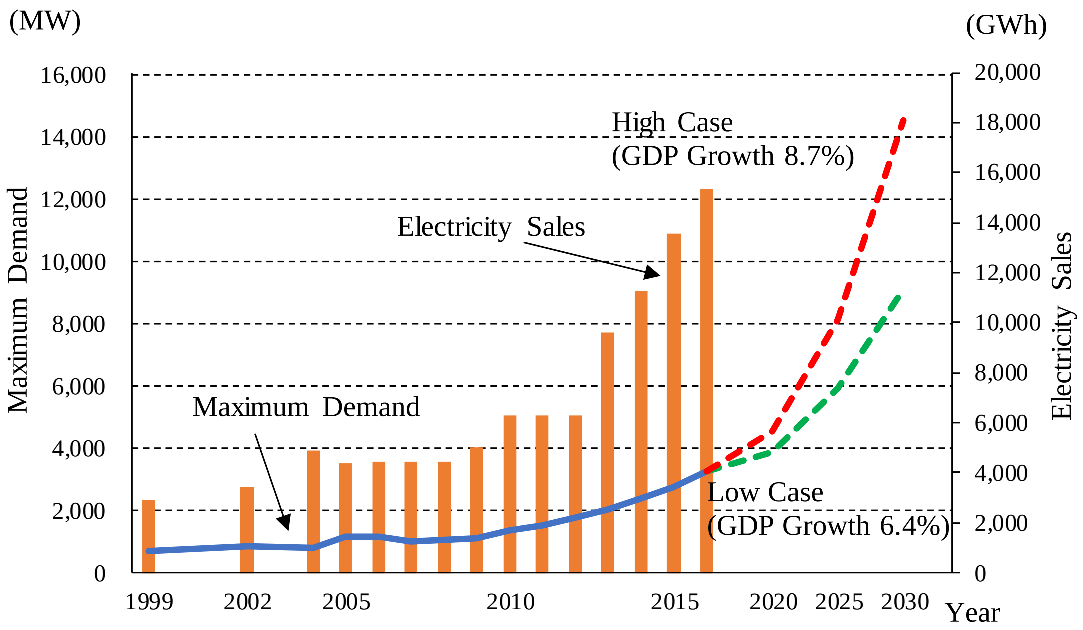
Source: The 2014 Myanmar Population and Housing Census

2.2 Supply and demand

2.2.1 Maximum demand

Due to the economic growth and improvement of electrification ratio, the demand has increased rapidly in recent years and in 2017(mid-May) the maximum demand recorded 3,075MW in the whole country. Reflecting economic growth in 2030, the maximum demand is expected to be 14,542MW in high case growth.

Figure 2.2-1 shows the transition of maximum demand and electricity sales, and Table 2.2-1 shows the forecast of the maximum demand.



Source: JEPIC data

Figure 2.2-1 Maximum demand and electricity sales

Table 2.2-1 Demand forecast

FY	Maximum demand (MW)	
	Low case (GDP growth 6.4%)	High case (GDP growth 8.7%)
2020	3,862	4,531
2025	5,930	8,121
2030	9,100	14,542

Source: OPPORTUNITIES FOR COOPERATION (Ministry of Electricity and Energy, March 2018)

2.2.2 Demand record and demand forecast

(1) YESC

Maximum demand record (2011-2017) and maximum demand forecast (2018-2022) are shown in Figure 2.2-2 and in Table 2.2-2.

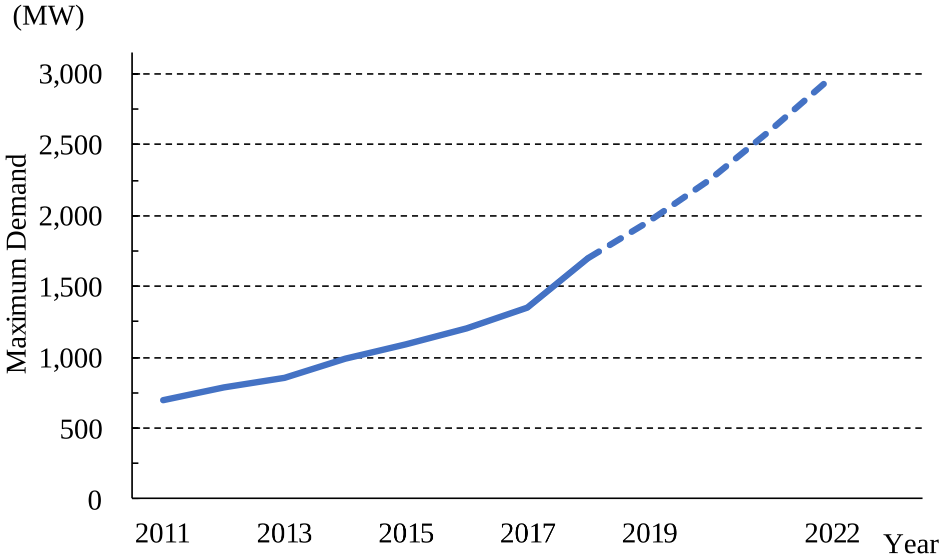


Figure 2.2-2 Maximum demand record (2011-2017) and maximum demand forecast (2018-2022) in Yangon Region

Table 2.2-2 Maximum demand record (2011-2017) and maximum demand forecast (2018-2022) in Yangon Region

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Demand (MW)	691	786	858	989	1096	1206	1351	1700	1955	2250	2600	2973
Growth rate	-	13.8%	9.1%	15.3%	10.8%	10.1%	12.0%	25.8%	15.0%	15.1%	15.6%	14.3%

Source：YESC

Demand forecast by YESC is calculated by adding demand forecast for each township. In each township, in addition to the base demand whose growth rate is different in each substation, demand for concrete projects (such as urban development and industrial parks) are added. Demand for the projects for which the development timing is not clear is not considered in demand forecast (such as new airport construction).

The average growth rate is about 11.3% during 2011 - 2017, and the average growth rate is about 17% during 2018 - 2022.

(2) MESC

Maximum demand record (2011-2017) and maximum demand forecast (2018-2022) are shown in Figure 2.2-3 and in Table 2.2-3

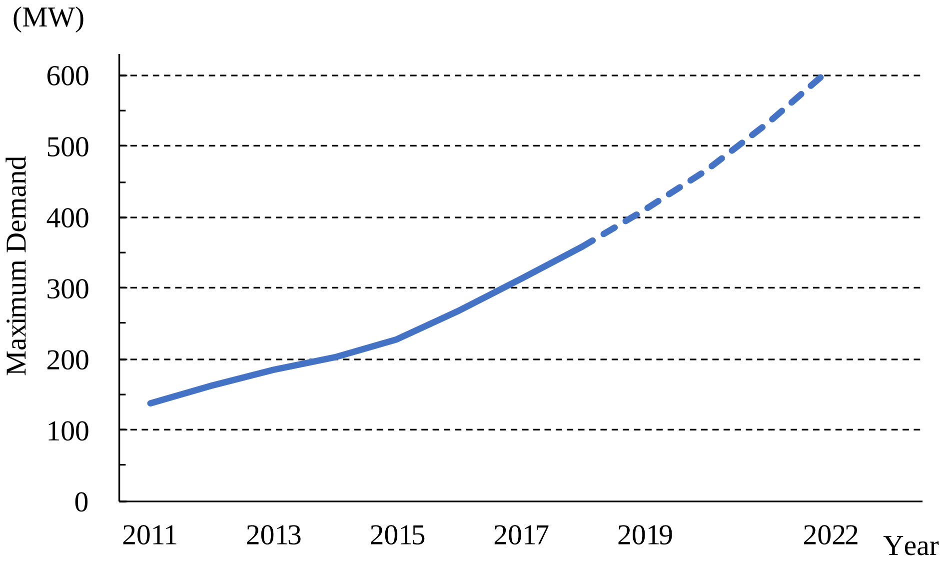


Figure 2.2-3 Maximum demand record (2011-2017) and maximum demand forecast (2018-2022) in Mandalay District

Table 2.2-3 Maximum demand record (2011-2017) and maximum demand forecast (2018-2022) in Mandalay District

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Demand (MW)	137	161	185	202	228	269	312	359	409	467	533	607
Growth rate	-	17.6%	14.4%	9.5%	12.7%	18.1%	16.0%	15.0%	14.0%	14.0%	14.2%	14.0%

Source：MESC

The demand growth at Mandalay District is estimated using 14% growth rate based on the growth rate of the past 5 years. Urban development plan is not reflected in demand forecast. Also, demand forecast for each township is not conducted.

2.2.3 Blackouts

Power outages due to distribution line accidents occur frequently in various places in Myanmar throughout the year. The main causes of distribution line accidents are caused by bird contact, tree contact, and lightning. The number of blackouts and the blackout duration at YESC are shown in Table 2.2-4.

Table 2.2-4 Number of blackouts and average blackout duration (FY2015)

	Apr. 2015	May. 2015	Jun. 2015	Jul. 2015	Aug. 2015	Sep. 2015	Oct. 2015	Nov. 2015	Dec. 2015	Jan. 2016	Feb. 2016	Mar. 2016
Number of blackouts	271	522	621	524	386	385	436	396	290	217	187	283
Average blackout duration (min.)	—	544	520	527	517	461	536	520	260	242	231	226

Source: "Baseline Survey Report" in the Project for Capacity Development of Power Transmission and Distribution Systems (Phase I)

As shown above table, the power outages in Yangon require an average of about 4 to 9 hours until recovery. Factors of delay in restoration are follow:

· The length of each distribution line is long, so it takes time to inspect the failure point.

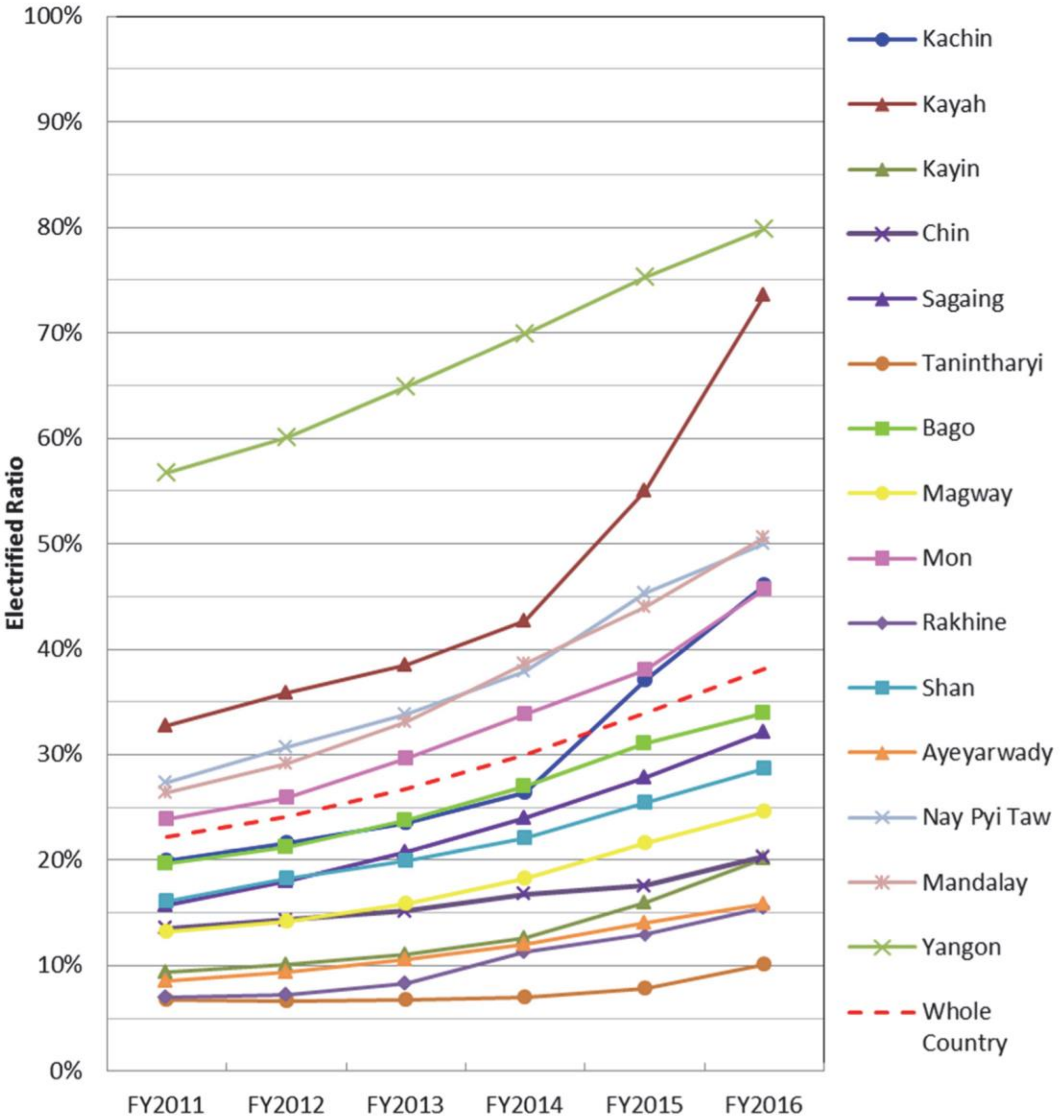
· Introduction of SCADA is not progressing, it takes time to inspect the failure location and cause.

· The skills and systems for quick failure recovery are inadequate.

· It takes time for the restoration team to arrive at the site due to traffic congestion.

2.2.4 Electrification ratio

As of March 2017, electrification ratio was 38.2%: 4.16 million households out of 10.88 million households nationwide were electrified. The most electrified area is Yangon area with an electrification ratio of 80%.



Source: JEPIC "Myanmar power sector survey 2017"

Figure 2.2-4 Electrification Ratio in Myanmar

2.3 Current conditions of the substations

The outline of substation facilities of YESC, MESC is shown in Table 2.3-1 and Table 2.3-2.

Table 2.3-1 YESC substation facilities

East area

Township		Substation		Voltage (kV)	Installed Capacity (MVA)	Demand (MW)	Operation ratio (%)
1	Shwe Pauk Kan	1	Shwe Pauk Kan	33/11(20+10)	30	12.5	46.3
		2	Kone Baung	33/11	10	2.5	27.8
2	North Okkalapa	3	Township Office	33/11(20+15+10)	45	22.0	54.3
		4	Wai Bar Gi	33/11	10	5.5	61.1
3	Dagon Myothit (North)	5	Shwe Pinlon	33/11	10	4.5	50.0
		6	Kon Padaytha	66/33(30)+66/11(20)	50	15.0	33.3
		7	Bailey	66/11	20	12.0	66.7
4	Dagon Myothit (East)	8	Dagon University	33/11	10	4.5	50.0
		9	Dagon East - 3	33/11	5	1.5	33.3
		10	Dagon East - 4	33/11	5	1.8	40.0
		11	Industrial Zone	33/11(10)+66/11(10) +66-33/11(30)	50	33.1	73.6
		12	East Pyithar	33/11	5	1.0	22.2
		13	Dagon East - 2	66/11	20	6.5	36.1
5	Dagon Myothit (Seikkan)	14	No. 1	33/11(10+10)	20	12.0	66.7
		15	No. 2	33/11	20	8.6	47.8
		16	Kyi Su	66/11(20+15+10)	45	6.3	15.6
6	Dagon Myothit (South)	17	Township Office	33/11	35	14.0	44.4
		18	Innwa	33/11	10	3.3	36.4
		19	Ywar Thar Gyi	33/11(4.5+2)	6.5	4.3	73.5
		20	Industrial Zone 2	33/11(10+5)	15	4.0	29.6
		21	Kyan Sit Thar	66/11	20	6.9	38.3
		22	Industrial Zone	66/11(30+30)	60	21.0	38.9
7	Thaketa	23	Myin Taw Tha	33/6.6(20+10)	30	14.8	54.8
		24	Thumana	33/6.6	10	7.0	77.8
		25	Nawarat	33/11	10	7.0	77.8
8	Dawbon	26	Township Office	33/6.6	10	4.15	46.1
					10	6.2	68.9
9	Pazundaung	27	Lake Kan	33/6.6(20+10)	30	15.0	55.6
		28	Nay Kyar	33/6.6	10	6.0	66.7
		29	Thida	66/6.6	20	8.0	44.4
				66/33(30+30+30+30)	120	66.0	61.1
10	Botahtaung	30	41st Street	33/6.6	10	5.0	55.6
11	Tamwe	31	Nat Chaung	33/6.6(15+10)	25	14.0	62.2
		32	Rama	33/6.6	20	7.5	41.7
		33	Kyaik Ka San	66/11-6.6	20	8.0	44.4
				66/33(30+30+30)	90	46.0	56.8
12	Mingalartaun gnyunt	34	Kennedy	33/6.6(10+10+10)	30	18.5	68.5
		35	Thein Phyu	33/6.6(10+5)	15	9.1	67.4
		36	Yuzana	33/6.6	10	6.0	66.7
				66/33	30	21.0	77.8
		37	Pathein Nyunt	66/11-6.6	20	4.0	22.2
				66/33	30	20.0	74.1
13	Thingangyun	38	Township Office	33/6.6(10+10)	20	10.5	58.3

Township		Substation		Voltage (kV)	Installed Capacity (MVA)	Demand (MW)	Operation ratio (%)
		39	North	33/6.6(10+10)	20	9.0	50.0
		40	Eaik Si Tan	33/6.6	5	2.5	55.6
		41	Mindin	66/11-6.6	30	8.0	29.6
		42	Thu Wa Na	66/11-6.6	30	8.0	29.6
14	South Okkala	43	Waizayantar	33/6.6(20+10)	30	17.0	63.0
		44	Balika	33/6.6	15	9.0	66.7
15	Yankin	45	Kokkine	33/6.6(20+10+5)	35	14.3	45.4
		46	Shwe Ohn Pin	33/6.6	10	1.5	16.7
		47	Gut Ta Lit	33/6.6(20+5)	25	10.8	48.0

West area

Township		Substation		Voltage (kV)	Installed Capacity (MVA)	Demand (MW)	Operation ratio (%)
1	Kyauktada	1	35th Street	33/6.6	10	5.50	61.1
		2	Seik Kan Thar	33/6.6	10	5.20	57.8
2	Pabedan	3	Railway	33/6.6	10	6.00	66.7
				33/11	10	1.00	11.1
		4	25th Street	33/6.6	5	2.50	55.6
3	Lanmadaw	5	220 Beds	33/6.6	10	4.10	45.6
4	Ahlone	6	Hone Hine	66/33	30	15.00	55.6
				33/11/6.6(20+20+5)	45	14.64	36.1
		7	YESC Head Office	33/11/6.6	10	3.50	38.9
5	Sanchaung	8	Shin Saw Pu	33/6.6	10	6.00	66.7
		9	Hantharwaddy	33/6.6	15	10.00	74.1
6	Kamaryut	10	MRTV-3	66/33	30	18.00	66.7
				66/6.6	30	9.00	33.3
		11	Sin Ma Laik	66/6.6(30+30)	60	28.00	51.9
		12	University	66/6.6	30	5.50	20.4
		13	Aung Myay Tharsi	33/6.6(10+5)	15	10.00	74.1
		14	U Wi Sa Ra	33/6.6(15+10)	25	9.50	42.2
7	Bahan	15	Shwe Gone Daing	33/6.6	20	6.90	38.3
		16	Thu Ye Kaung (Hero)	33/6.6	10	5.70	63.3
		17	U Htaung Bo	33/6.6	10	2.50	27.8
		18	University	33/6.6	10	2.50	27.8
8	Dagon	19	GIS	66/11-6.6	30	10.20	37.8
		20	Military History	33/6.6	13	5.80	49.6
		21	Military Office	33/6.6	5	2.80	62.2
		22	Medical Research	33/6.6	5	2.70	60.0
		23	National Museum	33/6.6	10	5.80	64.4
		24	Hluttaw	33/6.6(20+10)	30	8.00	29.6
9	Hlaing	25	RIR	66/33(30+30)	60	18.46	34.2
				33/6.6	10	6.50	72.2
		26	Middle Parami	33/6.6	15	3.00	22.2
		27	Gone Shaw	33/6.6	15	9.50	70.4

Township		Substation		Voltage (kV)	Installed Capacity (MVA)	Demand (MW)	Operation ratio (%)
		28	Mya Kantha	33/6.6	10	7.00	77.8
10	Mayangone	29	Sein Pan Myaing	66/33(30+30)	60	44.09	81.6
				33/6.6	10	7.50	83.3
		30	Taw Win	33/6.6	11	4.30	43.4
		31	North Ka Ba Aye	33/6.6(5+3.15)	8.15	3.70	50.4
		32	South Ka Ba Aye	33/6.6(10+10)	20	9.40	52.2
		33	Mayangone	33/11(5+5+5)	15	1.95	14.4
				33/6.6(20+20)	40	19.60	54.4
11	Seikkan	34	Maw Tin	66/33	30	6.00	22.2
				66/6.6	30	18.50	68.5
		35	Container (1)	33/6.6	20	6.15	34.2

South area

Township		Substation		Voltage (kV)	Installed Capacity (MVA)	Demand (MW)	Operation ratio (%)
1	Thanlyin	1	Myoma	33/6.6(10+5)	15	8.80	65.2
		2	Kha Yan Chaung	33/11	5	2.30	51.1
		3	Phaya Gone	33/6.6(10+5)	15	9.90	73.3
		4	Aung Chantha	33/11	2.5	1.50	66.7
		5	Star City Housing(Private)	33/11	10	4.10	45.6
2	Kyauktan	6	Kyauktan	33/6.6(10+3)	13	7.50	64.1
		7	Industrial Zone	33/11	20	2.50	13.9
3	Kayan	8	Township Office	33/11-6.6	10	6.00	66.7
4	Thongwa	9	Okekan Wa	33/11	10	6.00	66.7
5	Dala	10	Township Office	33/6.6(5+5+4)	14	8.50	67.5
6	Twantay	11	Mulaman	33/6.6(5+5+3)	13	6.70	57.3
		12	Zee Hpyu Kone	33/11	10	2.30	25.6
		13	Kan Ywar	33/11	5	1.70	37.8
7	Seikgyikanaungto	14	Myoma	33/6.6	2	1.10	61.1
		15	Samarduwar	33/6.6	3.15	1.30	45.9
		16	U Htun O	33/11-6.6	5	0.80	17.8
8	Kawhmu	17	Township Office	33/11	5	3.00	66.7
9	Kungyangon	18	Township Office	33/11	5	3.00	66.7

North area

Township		Substation		Voltage (kV)	Installed Capacity (MVA)	Demand (MW)	Operation ratio (%)
1	Insein	1	District Office	66/6.6	20	10	55.6
		2	10mile	33/6.6(10+5)	15	8.25	61.1
				66/33	30	8.5	31.5

Township		Substation		Voltage (kV)	Installed Capacity (MVA)	Demand (MW)	Operation ratio (%)
		3	Ywar Ma factory	33/6.6	10	6.8	75.6
		4	YCDC	33/6.6	5	2	44.4
		5	Forest Computer	66/33	30	9	33.3
				66/6.6	30	8	29.6
		6	Aung Zeya	33/6.6	10	2.5	27.8
		7	YTU	33/6.6	10	4	44.4
		8	Da Nyin Kone	33/6.6	10	3.9	43.3
		9	Khit Taya	33/6.6(10+5)	10	8.7	96.7
2	Mingaladon	10	14mile	33/6.6(10+10)	20	10.00	55.6
		11	Kha Yay Pin	33/11	10	4.50	50.0
		12	12mile	33/6.6	5	2.50	55.6
				33/6.6	10	3.50	38.9
3	Hlaingtharya	13	Substation (1)	33/11(20+20+15)	55	30.00	60.6
		14	Substation (2)	33/11(20+15+10)	45	28.50	70.4
		15	Industrial Zone (7)	33/11	10	3.00	33.3
		16	FMI	33/11	10	2.80	31.1
		17	Zone (5)	33/11(10+10)	20	12.00	66.7
		18	Kyan Sit Min	33/11	30	9.00	33.3
		19	Higher Staff Housing	33/11(20+10)	30	12.00	44.4
4	Shwe Lin Ban	20	Shwe Lin Pan	33/11(20+10+5)	35	27.10	86.0
		21	Ngwe Pinlae	33/11	15	4.00	29.6
5	Shwepithar	22	Township Office	33/11	10	5.30	58.9
				33/6.6	15	8.83	65.4
		23	Kyu Chaung	33/11	3	1.30	48.1
		24	Q/16	33/11	10	4.60	51.1
		25	Industrial Zone (1) S/S	33/11-6.6 (10+15+20)	45	15.10	37.3
		26	Industrial Zone (4) S/S	33/11(10+20)	30	12.60	46.7
6	Htantabin	27	Township Office	33/11-6.6	10	4.50	50.0
7	Htauk Kyant	28	Township Office	33/6.6(7+5)	12	6.90	63.9
		29	Palae Substation	33/6.6(10+10+10)	30	14.40	53.3
8	Hlegu	30	Township Office	33/11-6.6(10+5)	15	5.50	40.7
		31	Sar Bu Taung	33/11-6.6	5	2.73	60.7
		32	Sar Ta Lin	33/11-6.6	5	2.20	48.9
9	Inn Tine	33	Township Office	33/11	10	4.60	51.1
10	Phaung Gyi	34	Township Office	33/11	5	2.00	44.4
11	Hmawbi	35	Oat Sat (Brick Factory)	33/11	10	5.20	57.8
		36	Kyet Hpyu Kan	33/11(10+10)	20	12.60	70.0
12	Taikkyi	37	Township Office	33/11(10+10)	20	6.50	36.1
		38	Taw La Ti	33/11	5	1.50	33.3
13	Okekan	39	Township Office	33/11	5	2.50	55.6

Table 2.3-2 MESC substation facilities

Township		Substation		Voltage (kV)	Installed Capacity (MVA)	Demand (MW)	Operation ratio (%)
1	Aung Myay Thazan	1	Mayanchan	33/11(10+10+20)	40	10.2	28.2
		2	E-To	33/11	10	5.2	57.8
		3	Naung Kwel	33/11(10+10)	20	9.9	55.1
		4	Owe Bo	33/11(10+20)	30	11.6	43.0
		5	Yae Pay Yae	33/11	10	4.6	50.9
		6	Tite Taw	33/11(10+10)	20	6.8	37.7
		7	ITC	33/11	3	0.007	0.3
2	Maha Aung Myay	8	Shwe Kyaung Gyi	33/11(10+20)	30	13.9	51.5
		9	76th Street	33/11(10+10+20)	40	16.6	46.0
		10	Grand park	33/0.4	8	0.3	4.4
3	Chan Aye Thazan	11	Hay Mar Zala	33/11(10+15+20)	45	22.9	56.5
		12	Wa Khin Kone	33/11(10+10+20)	40	14.0	38.9
4	Pa Thein Gyi	13	Myo Ma	33/11	20	6.5	36.0
		14	Kyauk Chaw	33/11	10	5.5	61.1
		15	Water Resources	33/11	5	0.7	14.9
		16	Aung Pin Lae (MEPE's)	132/33	30	12.7	47.0
				132/11	32	19.1	67.4
5	Chan Mya Thazi	17	Htun Tone	33/11(10+10)	20	12.5	69.3
		18	65th Street	33/11(10+20)	30	10.8	39.9
		19	59th Street	33/11(10+10)	20	12.5	69.3
		20	Singa Hospital	33/0.4	1	0.1	22.2
		21	Chi Par	33/11	20	14.0	77.9
6	Pyi Gyi Tagon	22	Zone-1	33/11 (10+10+20+15)	55	22.9	46.3
		23	Zone-2	33/11	20	13.1	72.8
				132/11	18	12.1	74.7
		24	Kyauk Mee	33/11	8	2.0	29.6
7	Amara Pura	25	Var Ga Yar	33/11(20+10)	30	11.8	43.7
		26	Thin Pan Kone	33/11(10+10)	20	9.8	54.4
		27	Da None	33/11	20	9.4	52.2
		28	CNPC	33/11	2	0.3	16.7
		29	Ta Gong Taing (MEPE's)	132/33	30	20.0	74.1

2.4 Power generation development plans / High voltage line system development plans

2.4.1 Power generation development plans

The power generation development plans under construction are as shown in Table 2.4-1.

Table 2.4-1 Power generation development plans under construction

Power source	Project	Output (MW)
Hydropower	Upper Nanhtwan	3.5
	Shweli(3)	1,050
	Deedoke	66
	Upper Yeywa	280
	Middle Paunglaung	100
	Upper Kyaingtaung	51
	Upper Baluchaung	30.4
	Thahtay	111
Gas thermal power	Thahton	118.9
	Myingya (IPP)	225
	Thaketa	106
Solar power	Nabui, Wundwin	300
	Minbu	170

Source: OPPORTUNITIES FOR COOPERATION (Ministry of Electricity and Energy, March 2018)

Power generation development plans to be implemented near future are shown in Table 2.4-2.

Table 2.4-2 Power generation development plans to be implemented near future

Power source	Project	Output (MW)	Expected COD[1]
Hydropower (main)	Nam Paw	20	2023-2024
	Mongwa	66	2023-2024
	Upper Thanlwin (Kunlog)	1,400	2023-2024
	Gawlan	120	2026-2027
	Tongxingqiao	340	2026-2027
	Hkan Kawn	140	2026-2027
	Lawngdin	600	2026-2027
	Shweli (2)	520	2021-2022
	Naopha	1,200	2026-2027
	Mantong	225	2024-2025
	Nam Tamhpak	285	2025-2026
Gas turbine thermal power	Kyauk Phyu	135	2020-2021
	Myan Aung	20	2020-2021
	Ywama	225	2021-2022
	Ahlone	356	2020-2021
	Kanbauk	1,230	2019-2020
	Belin GEG	110	2020-2021
	Puhtonlone	12	2021-2022
	Melaunggyint	1,390	2025-2026
Solar power	Shwe Myo	10	2020-2021
	Sagaing, Mandalay	880	2020-2021
	Naypyitaw (Thapyasan)	100	2020-2021
Wind power	Chaungthar	30	2020-2021
	Rakhine, Ayeyarwady, Yangon	830	2020-2021

Source： OPPORTUNITIES FOR COOPERATION (Ministry of Electricity and Energy, March 2018)

[1] Commercial Operation Date

2.4.2 High voltage line system development plans

High voltage line system development plans under construction (500kV and 230kV) are shown in Table 2.4-3.

Table 2.4-3 High voltage line system development plants under construction

Voltage	Transmission line	Length (miles)	Target year
500kV	Meikhtila-Taungoo	145	2020
	Taungoo-Phayargyi	117	2021
	Phayargyi-Hlaingtharya	60	2021
230kV	Banmaw-Nabar-Shwebo-OwnTaw	140	2020
	Nansan-MinePyin-Kyaingtone	155	2020
	Hlaingtharya-Kyaiklat	55	2019
	Mawlamyine-Myawaddy	80	2019
	Upper Yeywa-Shwesaryan	80	2018
	Thanlyin-Thilawa	9.3	2017-Aug

Source: JICA "Project for Capacity Development of Power Sector Development Planning" (NEWJEC Inc.)

High voltage line system development plans to be implemented near future (500kV and 230kV) are shown in Table 2.4-4.

Table 2.4-4 High voltage line system development plans to be implemented near future

Voltage	Project	Start year	Target year
500kV	Phayargi-Mawlamyine-Kanbauk Transmission line 275miles & Substations	2018-2019	2023-2024
230kV	Myingyan-Kankaung-Taungdwingyi Transmission line 124miles & Substations	2018-2019	2019-2020
	Wine Maw-Nabar Transmission line 140miles & Substations	2018-2019	2019-2020
	Nyaungpyingyi-Gantgaw Transmission line 95miles & Substations	2018-2019	2019-2020
	((Ywama-Hlaingtharyar)-Wartaya)-West University Transmission line 10miles & Substations	2018-2019	2020-2021
	((Ywama-Hlaingtharyar)-Wartaya)-Hlawga Transmission line 11miles & Substations	2018-2019	2019-2020
	Ahlone-Thida Transmission line 4miles & Substations	2018-2019	2021-2022
	Mawlanmyine-Yae-Dawei Transmission line 180miles & Substations	2018-2019	2021-2022
	Mann-Taungdwingyi Transmission line 85miles & Substations	2018-2019	2021-2022
	Upper Yeywa (Shwesaryan)-Myaukpyin Transmission line 17miles & Substations	2018-2019	2020-2021
	Kalay-Tamue Transmission line 90miles & Substations	2018-2019	2020-2021
	Upper Kengtong-Nansan Transmission line 50miles & Substations	2018-2019	2020-2021
	Baluchaung(2)-Taungoo Transmission line 92miles & Substations	2018-2019	2021-2022
	Hlawgar-Tharketa Transmission line 14miles & Substations	2018-2019	2020-2021
	Baelin-DawnYway (Mandalay Industrial Zone) Transmission line 25miles & Substations	2018-2019	2020-2021
	ThaNgeDaw (Amara Pura)-(Baelin-OwnTaw) Transmission line 10miles & Substations	2018-2019	2020-2021

Voltage	Project	Start year	Target year
	DawnYway-Shwesaryan Transmission line 8miles & Substations	2018-2019	2020-2021
	Dala (Ahlone)-Kanbae Transmission line 21miles & Substations	2018-2019	2020-2021
	Shweli(3)-Kankaung (Meikhtila) Transmission line 260miles & Substations	2018-2019	2022-2023
	Mansan-Mineyal-Nansan Transmission line 190miles & Substations	2018-2019	2021-2022
	Nansan-Baluchaung(2) Transmission line 125miles & Substations	2018-2019	2021-2022
	Nansan-Taunggyi-Thapyawa (Meikhtila) Transmission line 150miles & Substations	2018-2019	2021-2022
	Minhla-Hinthada Transmission line 60miles & Substations	2018-2019	2021-2022
230kV – 500kV	Taungoo S/S-500kV Taungoo S/S Transmission line 10miles & Substations	2018-2019	2020-2021
	Meikhtila (Thapyawa)-500kV Kankaung Transmission line 14miles & Substations	2018-2019	2020-2021

Source: JICA "Project for Capacity Development of Power Sector Development Planning" (NEWJEC Inc.)

2.5 Organizational structure

2.5.1 YESC/MESC

The electric power systems of 66kV or lower are managed by YESC in Yangon City or by MESC in Mandalay City. Figure 2.5-1 and Figure 2.5-4 show the organization chart of YESC/MESC. Figure 2.5-2 and Figure 2.5-3 show the lower organization charts. YESC/ MESC has CEO (Chief Executive Officer) under the Board of Directors, and there are five departments. The five departments are Administrative Department, Financial Department, Material Planning Department, Planning Department and Distribution Department. The planning department is responsible for the planning and construction of transmission lines, substations, substation buildings, control facility, etc., and the distribution department is in charge of operation and maintenance. The point of contact for the Japanese ODA loan projects are managed by the planning department. There are 4 district offices with 45 townships in YESC and there are 7 district offices with 28 townships in MESC. A township is divided into 5 classes at YESC and 4 classes at MESC depending on jurisdiction scale, and the number of staff is different.

Organization of Yangon Electricity Supply Corporation

[The number of members of the Board shall be formed (9) Persons but initially with (7) Persons]

Board Of Director	
4	12

Chief Executive Officer	
12	40

Subject	Constitution	Appointed No. Staff	Appointed No. Work Charge	Vacancy
Officer	412	313		99
Staff	3884	2715	1580	1169
Total	4296	3028	1580	1268

	Department	
36	Administration Department General Manager	196
23	Finance Department General Manager	100
12	Material Planning Department General Manager	79
42	Planning Department General Manager	105
78	Distribution Department General Manager	547

	Eastern District Office	
8	Eastern District Office	34
57	Township Electric Manager Office	၉၄၇
4	Thingangyun	83
4	Yankin	57
4	South Okalapa	57
4	North Okalapa	83
4	Dawbon	42
4	Thakata	83
4	Tamwe	83
4	Mingalartaungnyunt	57
4	Pazundaung	57
4	Botahtaung	42
4	Dagon(Nouth)	83
4	Dagon(South)	83
4	Dagon(East)	57
4	Dagon(Seikan)	57
1	Shwepauk kan	23

District 1 + Township 14 + Town 1

	Western District Office	
8	Western District Office	33
50	Township Electric Manager Office	706
4	Kyauktada	42
4	Pabedan	57
4	Latha	42
4	Lanmadaw	57
4	Ahlone	42
4	Sanchaung	57
4	Kamayut	57
4	Kyeemyindaing	57
4	Hlaing	83
4	Mayangone	83
4	Bahan	57
3	Dagon	33
2	Seikan	16
1	Ayeywar	23

District 1 + Township 13 + Town 1

	Southern District Office	
7	Southern District Office	27
29	Township Electric Manager Office	358
4	Thanlyin	57
4	Kyauktan	42
2	Thonggwa	23
2	Khayan	23
2	Twantae	23
2	Kawmmu	23
1	kawnchankone	23
4	Dala	57
2	Seik kyee kanoung to	23
2	Kokokyun	16
1	Lakhokekone	16
1	Kyikchtaw	16
1	Tadar	16

District 1 + Township 10 + Town 2 + Half Township 1

	Northern District Office	
7	Northern District Office	31
39	Township Electric Manager Office	669
4	Insein	83
4	Mingalardon	57
4	Hmawbi	57
4	Hlegu	57
4	Teikegyi	57
2	Htantapin	23
4	Shwepyithar	83
4	Hlaingtharyar	83
2	Htauk kyant	57
1	Okekan	16
1	Darpain	16
1	Ahphauk	16
1	Phaunggyi	16
1	Myanungtaka	16
1	Inntaing	16
1	Shwelinban	16

District 1 + Township 8 + Town 8

No.	Post & Department Name	Officer	Staff	Total
1	Office of Board Of Director	4	12	16
2	Office of Chief Executive Officer	6	24	30
3	Internal Audit	6	16	22
4	Administration Department	36	196	232
5	Finance Department	23	100	123
6	Material Planning Department	12	79	91
7	Planning Department	42	105	147
8	Distribution Department	78	547	625
9	District Offices	30	125	155
10	Township Offices	175	2680	2855
	Total	412	3884	4296

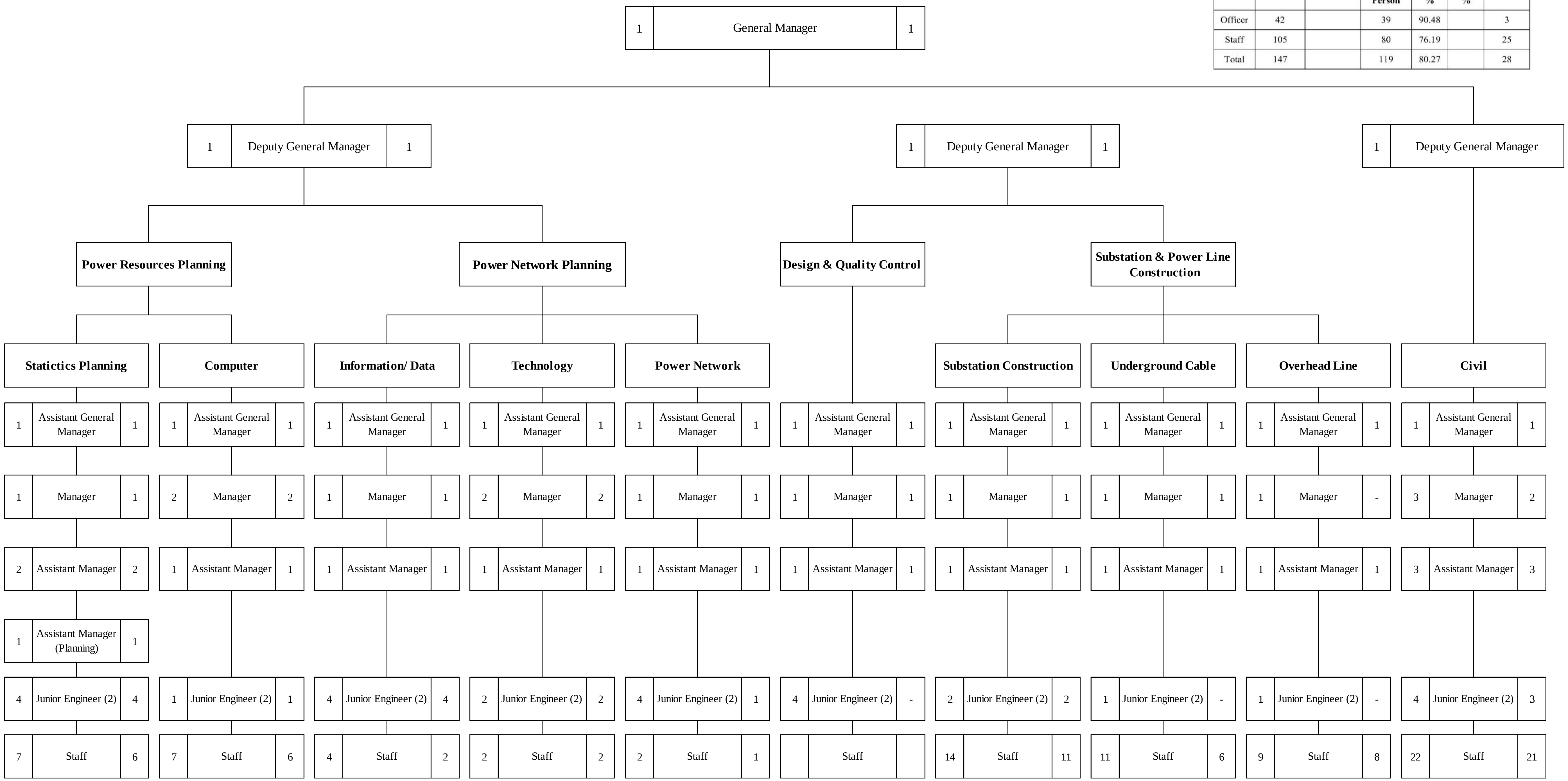
District - 4 Office
Township - 45 Office
Sub-Township - 1 Office
Town - 12 Office

Consumers – Existing (1294662) Nos to Future (2000000) Nos
Load – Existing (850) MW to Future (2000) MW
Staff – (4296) Nos

Source: Prepared by JICA survey team based on information from YESC

Figure 2.5-1 Organization of YESC

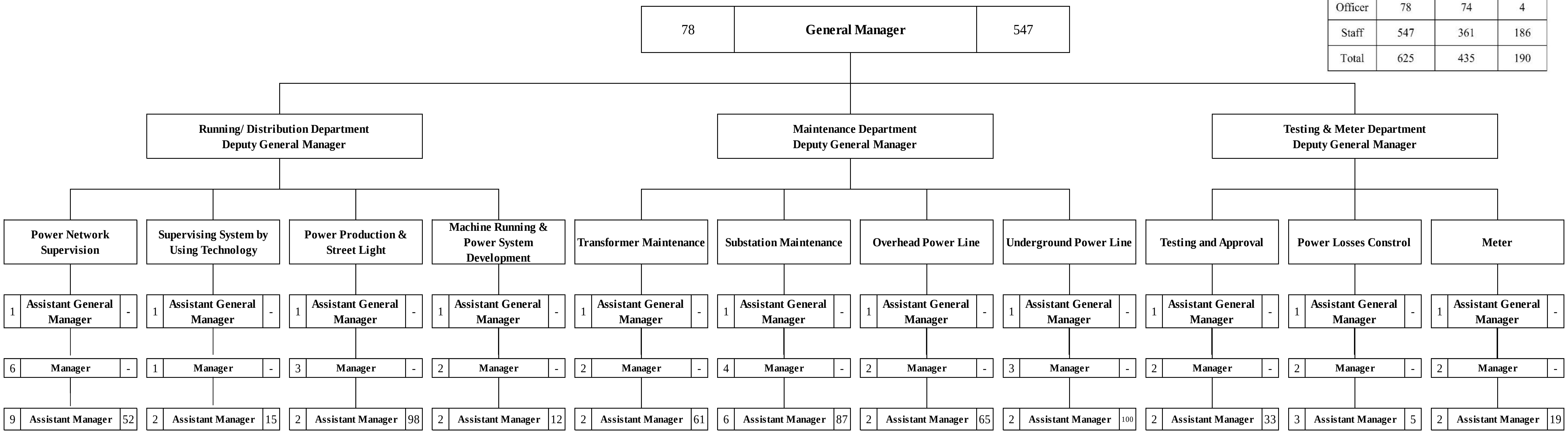
Subject	Structure	Permission	Appointed			Vacancy
			Person	%	%	
Officer	42		39	90.48		3
Staff	105		80	76.19		25
Total	147		119	80.27		28



Source: Prepared by JICA survey team based on information from YESC

Figure 2.5-2 Organization of YESC Planning Department

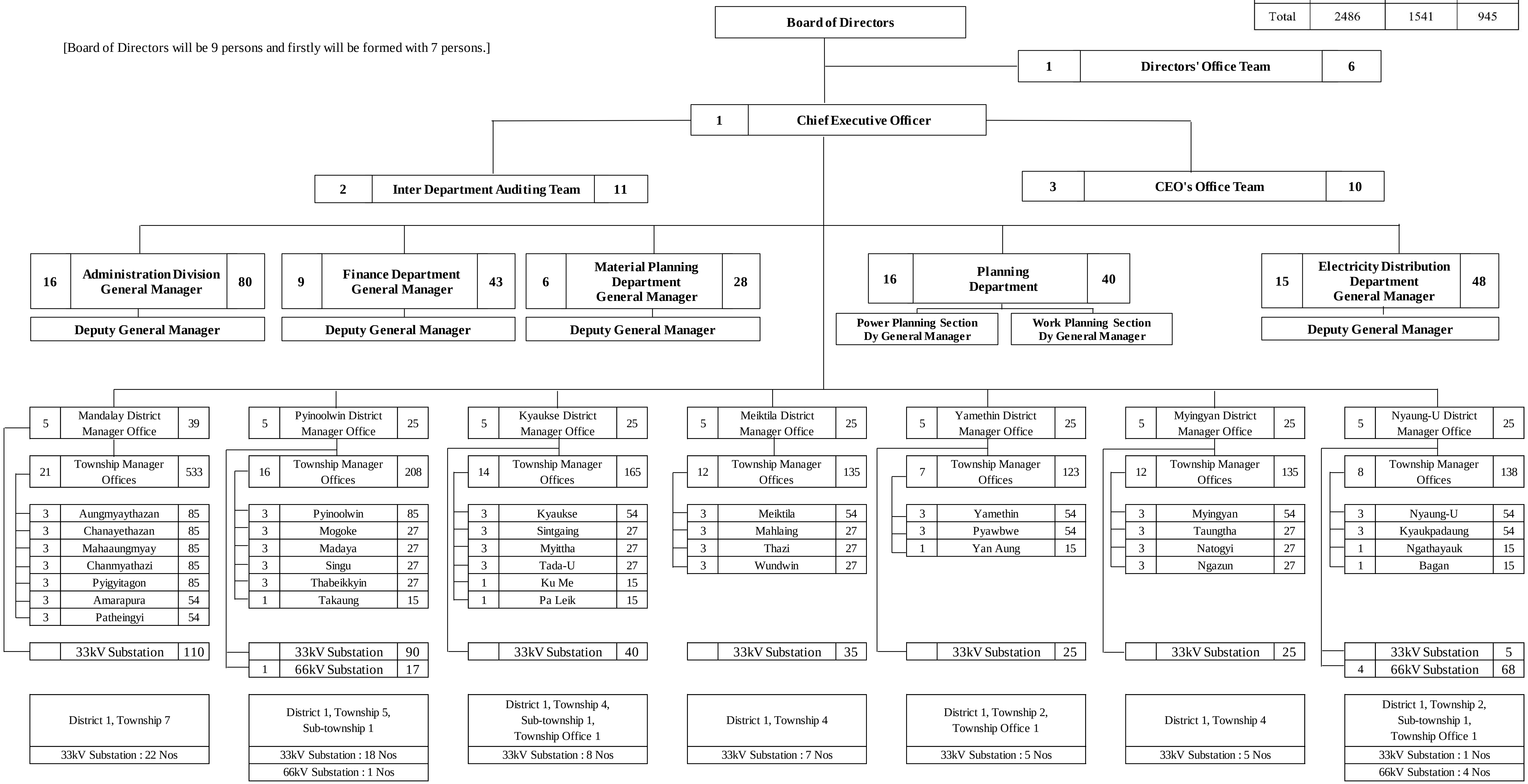
Subject	Structure	Appointed	Vacant
Officer	78	74	4
Staff	547	361	186
Total	625	435	190



Source: Prepared by JICA survey team based on information from YESC

Figure 2.5-3 Organization of YESC Electricity Supply/Distribution Department

Subject	Permission	Appointed	Vacancy
Officer	199	152	47
Staff	2287	1389	898
Total	2486	1541	945



Source: Prepared by JICA survey team based on information from MESC

Figure 2.5-4 Organization of MESC

2.5.2 Franchise Company

Distribution facilities of 11kV or less are operated and maintained by a franchise company in some townships. The franchise company also collects electricity charges. For the 11kV and 0.4kV power line, both a franchise company and YESC/MESC are responsible for the maintenance work on distribution facilities. Most of the employees of the franchise company associated with the franchise system are the employees of YESC/MESC and YESC/MESC pays their salary.

2.5.3 Procurement

The Material Planning Department in YESC/MESC headquarters collectively manages estimation of costs for procurement of machines, facility and construction, installation work for the projects. And YESC/MESC headquarters practices all tender procedures for procurement and contractors. Figure 2.5-5 shows General Flow Chart of procurement in YESC/MESC.

Budget approval by the Government → Preparation of tender by YESC/MESC Headquarters → Public announcement for local procurement → Competitive bidding → Selection of contractor → Signing of contract → Delivery and Construction

Source: Prepared by JICA survey team based on information from YESC and MESC

Figure 2.5-5 General Flow Chart of procurement in YESC/MESC

Chapter3 5-year distribution system development plan

3.1 Current status of 5-year distribution system development plan

3.1.1 Formulation of 5-year plan

(1) YESC

The 5-year plan is updated periodically. In the current 5-year plan, 2018-2019 plan, has relatively high accuracy but in future plans after 2019, there are uncertain factors including financial sources.

Most substations' voltage level is still 33kV, but they are gradually being upgraded to 66kV. Many substations are planned to be equipped with GIS in line with 66kV upgrade. YESC is proceeding the reinforcement of the supply capacity through 66kV upgrade as well as preparing for the future reinforcement needs by effectively utilizing lands in urban areas through using GIS.

(2) MESC

MESC basically uses the 5-year development plan that was formulated in JICA's "Preparatory Survey on Distribution System Improvement Project in Main Cities" as the project list as it is, which has not been updated. On the other hand, MESC is preparing the document called "Mandalay district facility development plan" which describes annual demand forecast, the increase of substation capacity, annual budget scale, etc. has been prepared and distribution network development plans are implemented based on this document.

Most projects in MESC are based on the policy of "Facility overload improvement (measures against increase demand)" to secure supply capacity as demand increases. Projects for the purpose of "Power distribution loss reduction", "Power supply reliability improvement", or "Public safety improvement" have not been implemented so much.

3.1.2 Assistance by other donors

Asian Development Bank (hereinafter referred to as "ADB") is financing to Myanmar power sector through "Power Distribution Improvement Project" of 60 million USD which consists of existing substations' rehabilitation and replacement of distribution lines. The power sector is also supported by Neighboring Countries Economic Development Cooperation Agency (hereinafter referred to as "NEDA") and WB. WB is proceeding National Electrification Project (NEP) of 400 million USD with distribution extension and off-grid electrification.

(1) YESC

ADB's Power Distribution Improvement Project at first targeted 5 townships in Yangon - Hlaingthaya, Insein, Kamayut, Mayangone and Mingalone – but the targeted area has been extended. Recent substation projects supported by ADB are shown in Table 3.1-1.

Table 3.1-1　Substation upgrade projects financed by ADB

Township	Substation	Upgrade
Mayangone	Sein Pan Myaing	66/33kV 30MVA x2 66/11-6.6kV 30MVA
	South Ka Ba Aye	66/11-6.6kV 30MVA
Dagon	Hluttaw	66/11-6.6kV GIS 30MVA x2
Bahan	Thu Ye Kaung	66/11-6.6kV GIS 30MVA x2
Yankin	Kokkine	66/11-6.6kV GIS 30MVA x2

Source: Prepared by JICA survey team based on information from YESC

NEDA is supporting YESC distribution projects in 2 townships: North Okkalapa and North Dagon.

(2)　MESC

In Mandalay, there were several substation banks constructed by ADB projects. They seemed to be developed in ADB Project "Power Transmission and Distribution Improvement Project". The capacity of most substation banks constructed by ADB is relatively small, 10MVA and as a result of the power demand forecast, some of the banks will become overloaded in the near future.

The development of urban power distribution network by WB and NEDA has not been implemented.

3.2 Demand forecast

Demand forecasts for Yangon Region and Mandalay District up to 2027 were calculated to identify the substation that needs to be reinforced.

Each substation demands up to 2027 was calculated using the demand increase rate shown in the below table.

Yangon Region	2017 to 2021: Calculated substation demand by YESC 2022 to 2027: 17.6% (Average increasing rate for 2017 to 2021)
Mandalay District	2017 to 2027: 14% (Average increasing rate for the past 5 years)

Result of demand forecasts are shown in Figure 3.2-1, Figure 3.2-2, Table 3.2-1 and Table 3.2-2.

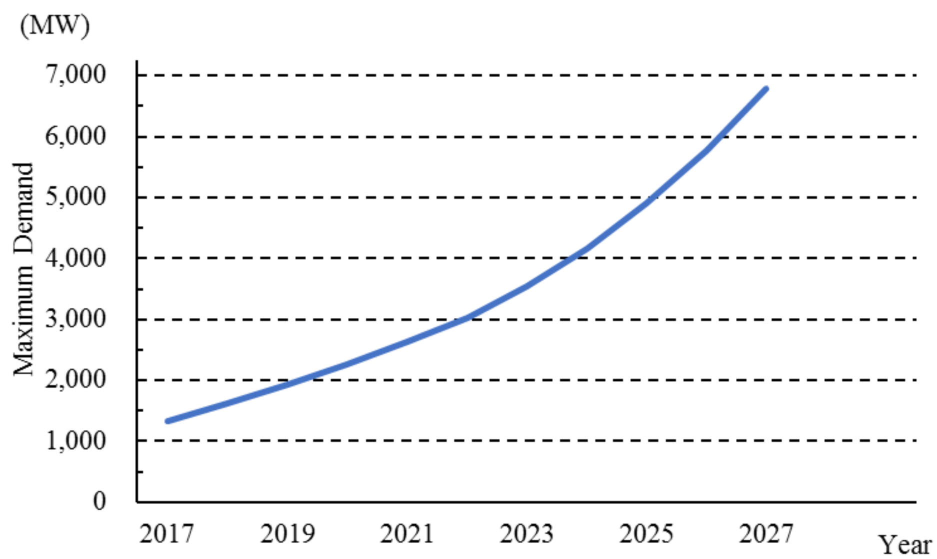


Figure 3.2-1　Yangon Region demand forecast (2017-2027)

Table 3.2-1 Yangon Region demand forecast (2017-2027)

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Demand (MW)	1339.1	1620.6	1930.3	2269.4	2630.7	3015.7	3546.5	4170.6	4904.7	5767.9	6783.0
Growth rate	-	21.0%	19.1%	17.6%	15.9%	14.6%	17.6%	17.6%	17.6%	17.6%	17.6%

Source: Prepared by JICA survey team based on information from YESC

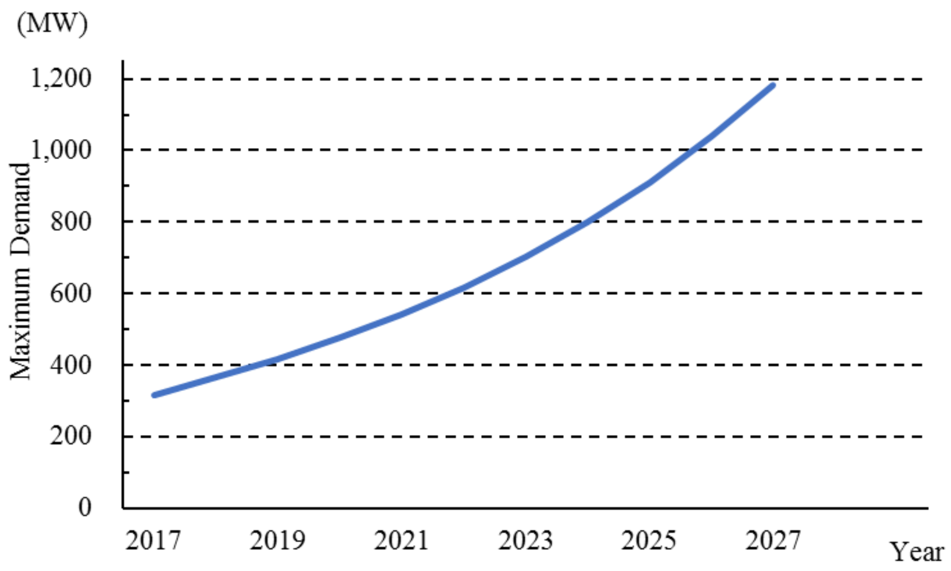


Figure 3.2-2 Mandalay District demand forecast (2017-2027)

Table 3.2-2 Mandalay District demand forecast (2017-2027)

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Demand (MW)	316.7	367.4	418.1	476.0	541.9	617.1	702.7	800.4	911.7	1038.6	1183.3
Growth rate	-	16.0%	13.8%	13.8%	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%

Source: Prepared by JICA survey team based on information from MESC

3.3 Substation reinforcement plan

In Yangon and Mandalay power demand is growing at the rate of higher than 10%, which requires relevant reinforcement of power supply capacity. Substations which have high reinforcement needs are selected by following steps.

(1) Power demand forecast is formulated for each township and substation until the fiscal year 2027 by the procedure shown in section 3.2.

(2) Townships whose load exceeds 80% in 2022 are identified, and then, in each township, substations which load exceeds 100% in 2022 are also identified.

A substation which doesn't satisfy this can be also identified depending on its importance. It should be also noted that in Yangon, the scope of examination is 33 townships in Yangon City among whole townships in Yangon Region.

3.4 Power flow analysis

3.4.1 Conditions of power flow analysis

Power flow analysis is conducted for the purpose of identifying the bottleneck at 33kV and 66kV transmission lines as well as 230kV substations connected to the lines.

The 5-year plan as well as the development plans proposed in this survey are reflected on the proposed configurations for the analysis in this section.

Power flow analysis is conducted with following conditions.

<table>
<tr><th>Item</th><th>Condition</th></tr>
<tr><td>Analysis method</td><td>Power flow confirmation by accumulating substation load
-Half of substation load should be considered if two power supplies reach to the subjected substation. (used in Yangon power system analysis in 2017)
-Only one power supply should be selected if plural power supplies reach to the subjected substation, and plural power source operation should not be done. (used in Yangon power system analysis in 2022 and 2027, Mandalay power system analysis)</td></tr>
<tr><td>Analysis year</td><td>2017, 2022, 2027</td></tr>
<tr><td>Demand value</td><td>2017: Actual load record of substation
2022 and 2027: Demand forecast data by the JICA survey team
The load of substation without actual load data was used as half of transformer capacity.</td></tr>
<tr><td>Transmission line specification</td><td>Yangon power system
<table>
<tr><th>Voltage</th><th>Type</th><th>Size</th><th>Capacity (MW)</th></tr>
<tr><td>66kV</td><td>ACSR</td><td>795MCM</td><td>98</td></tr>
<tr><td>66kV</td><td>ACSR</td><td>605MCM</td><td>76</td></tr>
<tr><td>66kV</td><td>ACSR</td><td>397.5MCM</td><td>64</td></tr>
<tr><td>66kV</td><td>XLPE</td><td>1C500mm^2</td><td>83</td></tr>
<tr><td>66kV</td><td>XLPE</td><td>1C400mm^2</td><td>74</td></tr>
<tr><td>66kV</td><td>XLPE</td><td>1C300mm^2</td><td>55.5</td></tr>
</table>
In case of newly installing or adding transmission lines, 605MCM and 1C400mm^2 are standardly used for conductor in Yangon power system in analysis.

Mandalay power system
<table>
<tr><th>Voltage</th><th>Type</th><th>Size</th><th>Capacity (MW)</th></tr>
<tr><td>33kV</td><td>ACSR</td><td>185mm^2</td><td>21.7</td></tr>
<tr><td>33kV</td><td>SAC</td><td>185mm^2</td><td>21.7</td></tr>
<tr><td>33kV</td><td>ACSR</td><td>150mm^2</td><td>19.0</td></tr>
<tr><td>33kV</td><td>ACSR</td><td>120mm^2</td><td>16.7</td></tr>
<tr><td>33kV</td><td>ACSR</td><td>240mm^2</td><td>24.5</td></tr>
<tr><td>132kV</td><td>ACSR</td><td>336.4MCM</td><td>112.7</td></tr>
</table>
In case of newly installing or adding transmission lines, SAC185mm^2 is standardly used for conductor in Mandalay power system in analysis.</td></tr>
</table>

3.4.2 Result of power flow analysis

(1) Power flow analysis in Yangon

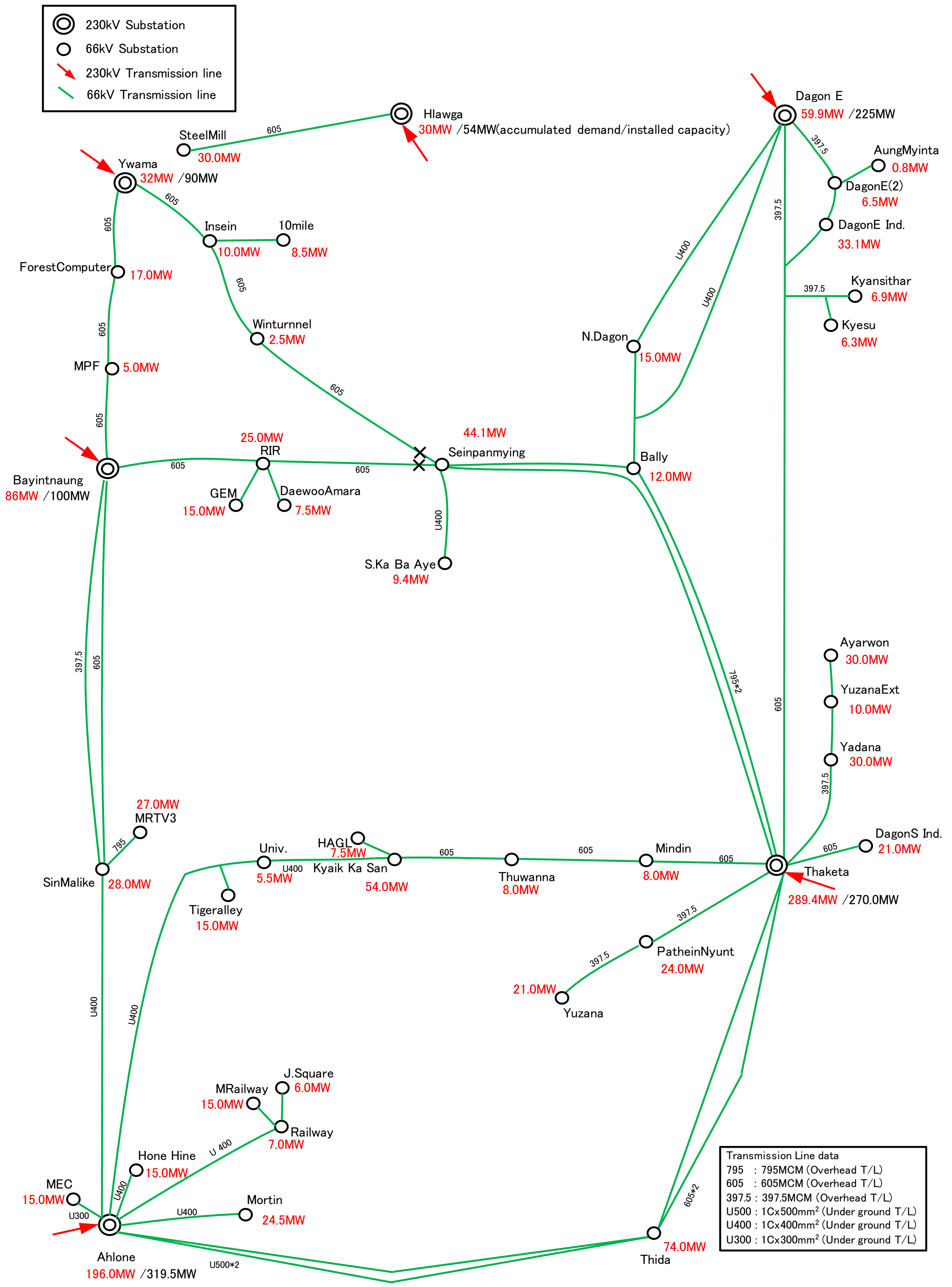
Figure 3.4-1 shows the 66kV power system in 2017 that configures the main of YESC network. On the power system in 2017, the radial configuration is basically adopted, and the loop configuration is partially adopted.

As a result of the analysis, there are no overload transmission lines in 2017. Figure 3.4-2 and Figure 3.4-3 show the 66kV power system of 2022 and 2027 based on the 5-year plan of YESC. Operation in radial power system is also considered in YESC in order to prevent increasing short-circuit capacity and complication of power system operation in the future. Therefore, power flow in 2022 and 2027 was calculated based on the assumption that the power system would be divided at proper position in consideration of load situation in order to deal it as radial power system. In the analysis result of 2022, there is no overload in the 66kV. However, 230kV Bayintnaung Substation and Dagon E Substation are overloaded. In the analysis result of 2027, Overload will occur at 18 transmission lines of 66kV and existing 230kV substations except Ahlone Substation. Overloaded transmission lines are shown in Table 3.4-1. It is necessary to review the demand forecast of each substation periodically, and then redesign the 66kV and 230kV power system of substation capacity.

Table 3.4-1 Overloaded transmission line in 2027

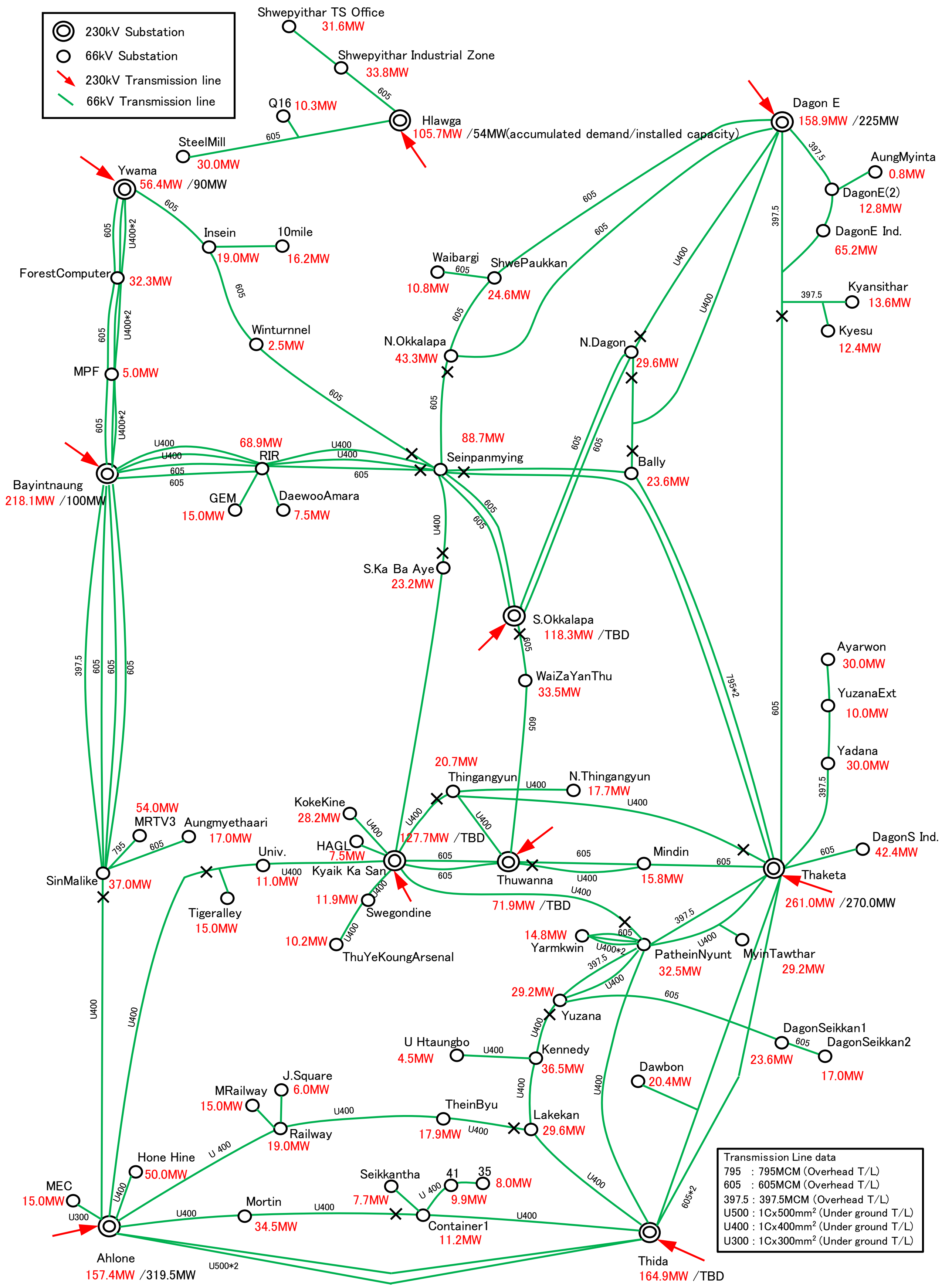
Voltage [kV]	From	To	Conductor size	No.of circuit	Capacity		Total Load [MW]	comment
					MW	%		
66	Ahlone S/S	Mortin S/S	1C 400mm^2	1	74	105.0%	77.7	1 T/L is needed
66	Ahlone S/S	TeinByu S/S	1C 400mm^2	1	74	140.8%	104.2	1 T/L is needed
66	Ahlone S/S	Hone Hine S/S	1C 400mm^2	1	74	152.2%	112.6	1 T/L is needed
66	Thida S/S	Container1 S/S	1C 400mm^2	1	74	111.6%	82.6	1 T/L is needed
66	Thida S/S	U Htaungbo S/S	1C 400mm^2	1	74	214.6%	158.8	3 T/Ls are needed
66	Thida S/S	Yarmkwin S/S	605MCM	1	76	140.1%	106.5	1 T/L is needed
66	Thaketa S/S	Yuzana S/S	397.5MCM 1C 400mm^2	1	138	158.3%	218.5	4 T/Ls are needed
66	Thaketa S/S	Dagon S Ind. Zone S/S	605MCM	1	76	122.6%	93.2	1 T/L is needed
66	Thuwanna S/S	N.Thingyangyun S/S	1C 400mm^2	1	74	116.9%	86.5	1 T/L is needed
66	S.Okkalapa S/S	Seinpanmying S/S	605MCM	2	152	131.4%	199.7	1 T/L is needed
66	Dagon East S/S	Dagon E(1)Ind. Zone S/S	397.5MCM	2	128	183.7%	235.15	2 T/Ls are needed
66	Ywama S/S	10mile S/S	605MCM	1	76	107.5%	81.7	1 T/L is needed
66	Hlawga S/S	ShwepyitharTS Office S/S	605MCM	1	76	193.6%	147.1	1 T/L is needed

Source: JICA survey team based on information from YESC



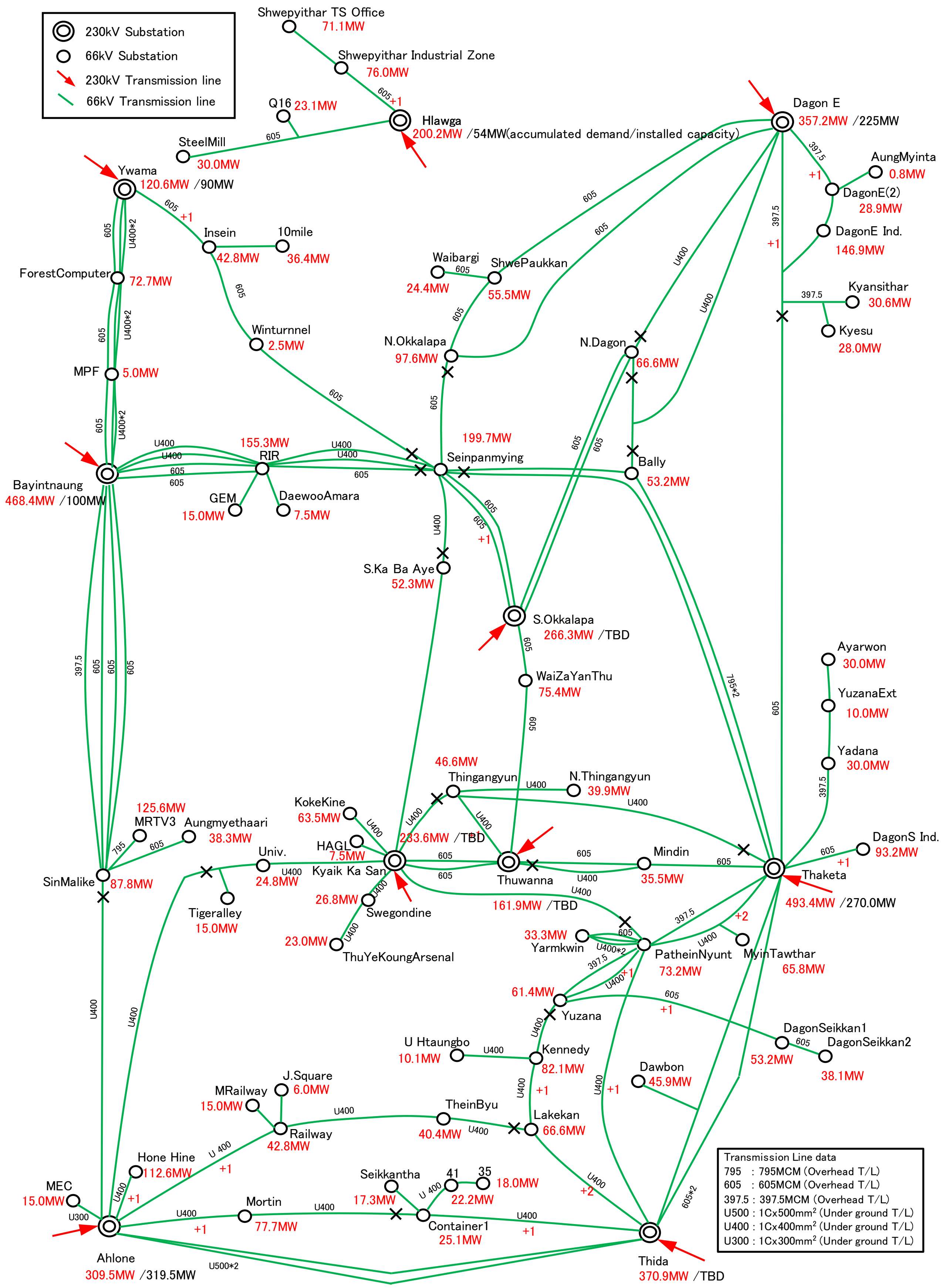
Source: JICA survey team

Figure 3.4-1 Yangon power system in 2017



Source: JICA survey team

Figure 3.4-2 Yangon power system in 2022



Source: JICA survey team

Figure 3.4-3 Yangon power system in 2027

(2) Power flow analysis in Mandalay

Figure 3.4-4 shows the 33kV power system in 2017 that consists of the load system in Mandalay District. The power system in Mandalay District is composed of radial power system. And combination of one transmission line (ACSR185mm^2 or SAC185mm^2) and one transformer (20MVA transformer) is adopted as the basic design in Mandalay. Figure 3.4-5 and Figure 3.4-6 show the 33kV system in 2022 and 2027 based on the development plan from the interview with the planning department. In the analysis of 2022, there is no overload in the 33kV transmission lines except ShweKyaungGyi line. And 230kV AungPinLe substation and 132kV TagGonTaing Substation are overloaded. In the analysis of 2027, Overload will occur at 9 transmission lines of 33kV and existing 132kV and 230kV substations. Overloaded transmission lines are shown in Table 3.4-2 and Table 3.4-3. It is necessary to review the demand forecast of each substation, and then redesign the 33kV system and DPTSC's system of substation capacity.

Table 3.4-2 Overloaded transmission line in 2022

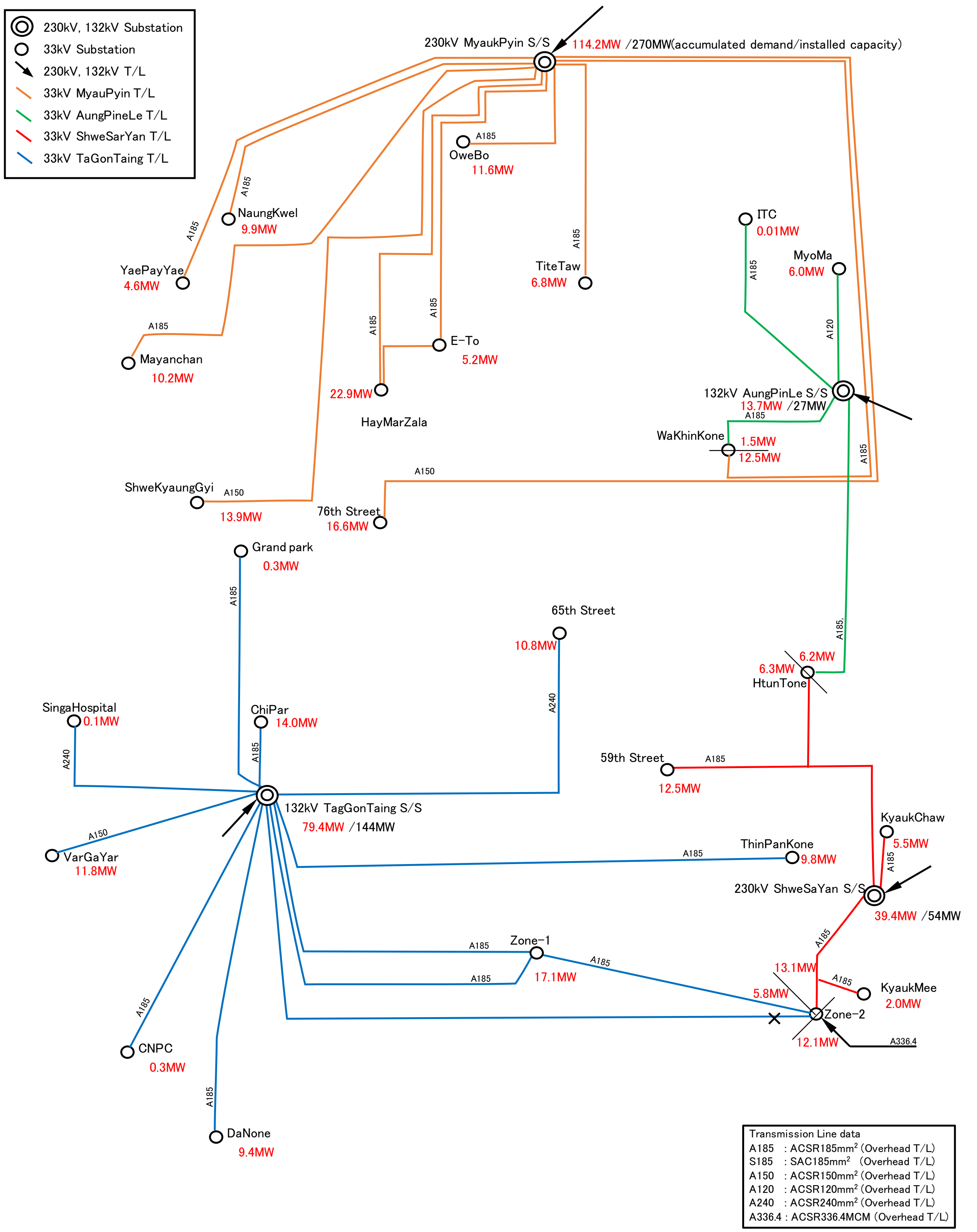
Voltage [kV]	From	To	Conductor size	No.of circuit	Capacity		Total Load [MW]	comment
					MW	%		
33	MyaukPyin S/S	ShweKyaungGyi S/S	ACSR150mm^2	1	19	161.6%	30.7	1 T/L is needed

Source: JICA survey team

Table 3.4-3 Overloaded transmission line in 2027

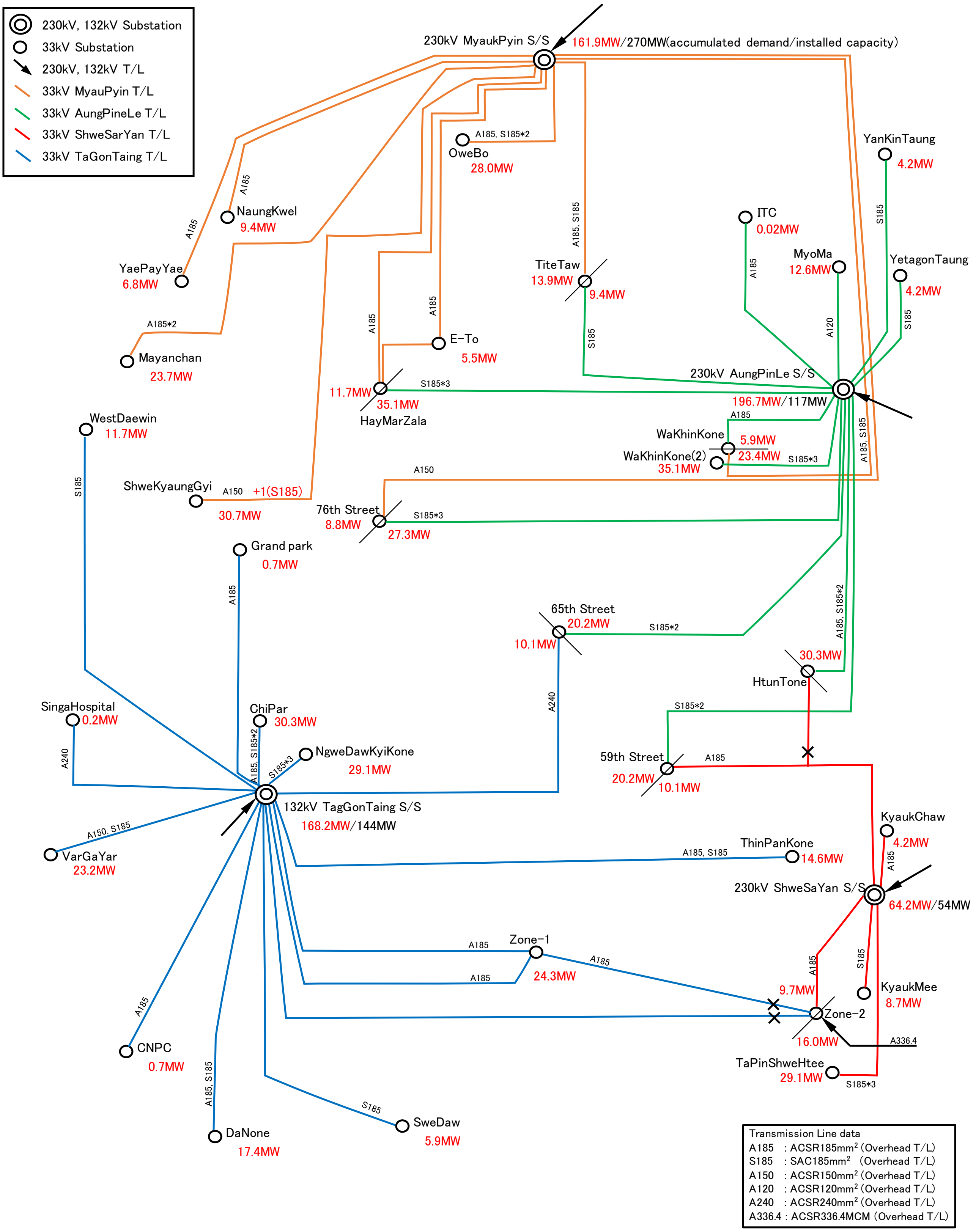
Voltage [kV]	From	To	Conductor size	No.of circuit	Capacity		Total Load [MW]	comment
					MW	%		
33	MyaukPyin S/S	Mayanchan S/S	ACSR185mm^2	2	43.4	105.1%	45.6	1 T/L is needed
33	MyaukPyin S/S	ShweKyaungGyi S/S	ACSR150mm^2	1	19	311.1%	59.1	2 T/Ls are needed
33	MyaukPyin S/S	WaKhinKone(1) S/S	ACSR185mm^2 SAC185mm^2	2	43.4	103.9%	45.1	1 T/L is needed
33	AungPinLe S/S	HayMarZala	SAC185mm^2 x3	3	65.1	103.8%	67.6	1 T/L is needed
33	AungPinLe S/S	WaKhinKone(2) S/S	SAC185mm^2 x3	3	65.1	103.8%	67.6	1 T/L is needed
33	AungPinLe S/S	MyoMa S/S	ACSR120mm^2	1	16.72	145.3%	24.3	1 T/L is needed
33	TagGonTaing S/S	WestDaewin	SAC185mm^2	1	21.7	103.7%	22.5	1 T/L is needed
33	TagGonTaing S/S	Zone-1 S/S	ACSR185mm^2	2	43.4	107.8%	46.8	1 T/L is needed
33	TagGonTaing S/S	VarGaYar S/S	ACSR150mm^2 SAC185mm^2	1	40.7	109.8%	44.7	1 T/L is needed

Source: JICA survey team



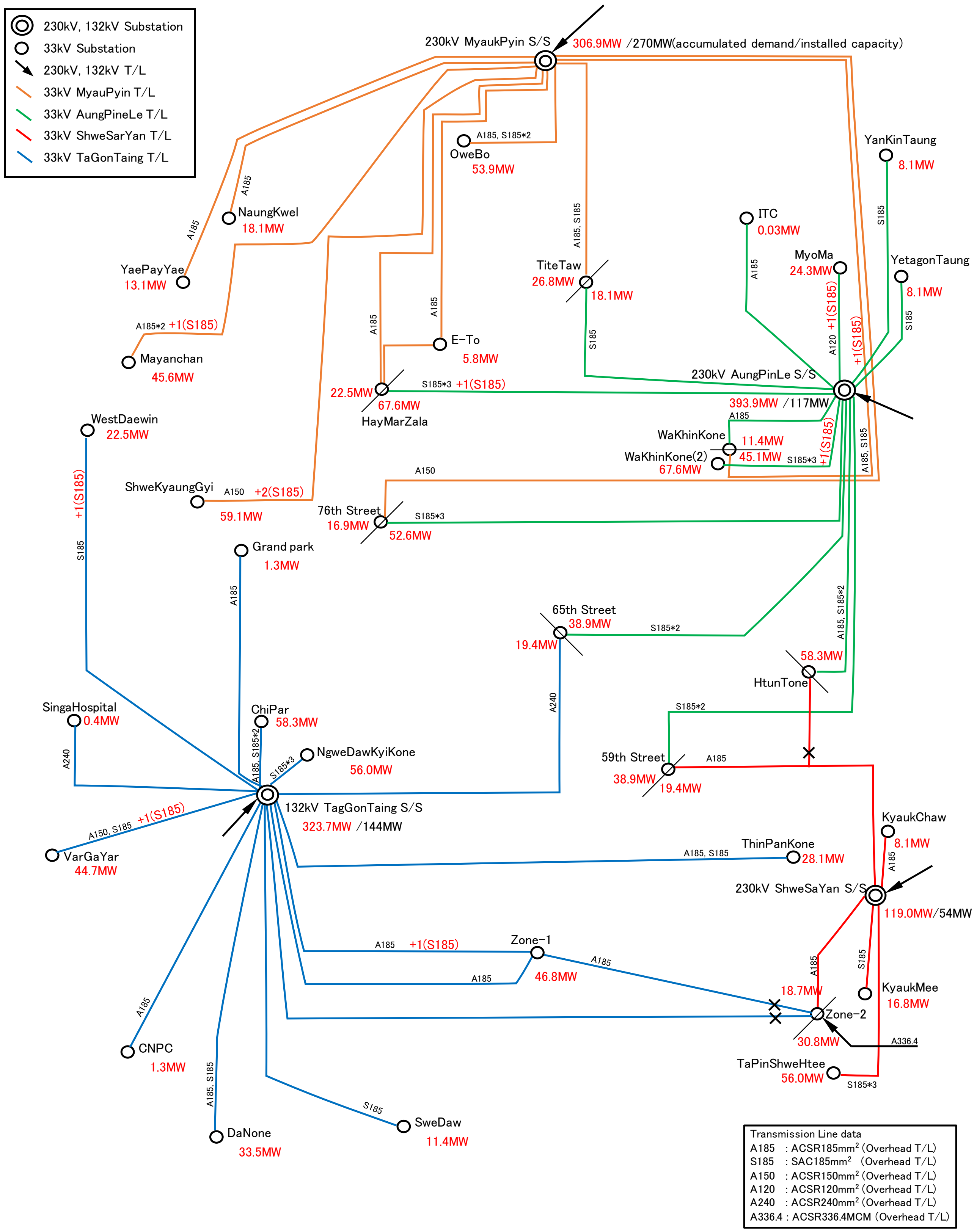
Source: JICA survey team

Figure 3.4-4 Mandalay District power system in 2017



Source: JICA survey team

Figure 3.4-5 Mandalay District power system in 2022



Source: JICA survey team

Figure 3.4-6 Mandalay District power system in 2027

Chapter4 Japanese ODA loan project

4.1 Site survey

According to the methodology described in '3.3 Substation reinforcement plan', 35 substations are identified as those with high necessity of reinforcement (YESC: 24 sites, MESC: 11 sites).
As a result of the discussion with YESC, out of 24 candidates, 10 substations will be out of scope. Because these 10 substations have been (or will be) reinforced by self finance or other donors' finance.
For the selected 25 substations (YESC: 14 sites, MESC: 11 sites) in total, site surveys were conducted in order to acquire information necessary for formulating the Japanese ODA loan project.

4.2 Applicability of Japanese technology

Table 4.2-1 shows the current state of utilization of Japanese technology in YESC and MESC.

Table 4.2-1 Utilization of Japanese technology in YESC and MESC

<table>
<tr><th rowspan="2">Japanese technology</th><th rowspan="2">Features and effect by the introduction</th><th colspan="2">The use situation/The trial situation</th></tr>
<tr><th>YESC</th><th>MESC</th></tr>
<tr><td>Concrete pole</td><td>・Products made in Japan based on JIS are of high and consistent quality because of the pre-stressed steel wire, compacted cast concrete, etc., and can be used for a long period of time (legal durable life is 40 years or longer)</td><td colspan="2">・Already introduced in Myanmar.
・There are movements to standardize concrete utility pole based on JIS.</td></tr>
<tr><td>Enclosed primary cutout (fuse)</td><td>・Enable prevention of faults, because its live parts are enclosed by insulator.
・It has long life time.</td><td>・YESC officially decided to introduce and purchased Japanese products.</td><td>・Begin purchase.</td></tr>
<tr><td>Mobile transformer & substation</td><td>・Enable quick recovery in the event of substation failures
・Decrease outage duration during replacement work.
・High possibility that the truck mount compact type can be made only by Japanese manufacturers.</td><td rowspan="3">・Application considered as one of components of the Japanese ODA loan projects "Power Distribution Improvement Project in Yangon Phase I".</td><td>—</td></tr>
<tr><td>Pole construction truck</td><td>・Significantly improved work efficiency and work safely</td><td rowspan="2">・Application considered as one of components of the Japanese ODA loan projects "Power Distribution System Improvement Project".</td></tr>
<tr><td>Aerial work vehicle</td><td>・Enable work where people cannot go up, like the place between poles.
・Japanese vehicles have long range for work, and enable efficient and safety work by double insulation.</td></tr>
<tr><td>33kV Time sequential distribution system</td><td>・Detect a fault section automatically and restore power supply without taking much time.
・Application to feeders supplying to where high reliability is required like hospital.</td><td>・YESC introduced the system (made by a Japanese manufacturer) to 33kV distribution network.</td><td>—</td></tr>
<tr><td>Distribution line overload circuit breaker with fault detection</td><td>・Enable minimization of blackout area by cutting off the fault current and overload current among a distribution line.
・Effects are expected from the needs to eliminate overload.
・Enable automatic disconnection of fault area.</td><td>・YESC has confirmed the effect of the Japanese product in field test.
・Plan to trial in actual field after training.
・Adjustment of relays in substations is needed.</td><td>—</td></tr>
<tr><td>Low-loss transformer</td><td>・Effective in reducing power distribution losses.</td><td>・YESC introduced the transformers made by</td><td>—</td></tr>
</table>

	･Investment effects can be achieved even if power demand is lower than expectation, because of constant loss reduction regardless of amount of power demand. ･For the longer it is used, the greater its effect.	SEM as a trial (Six transformers).	

Source: JICA survey team

Table 4.2-2 shows the technologies that can be applied in the Japanese ODA loan projects.

Table 4.2-2 Applicable technology in the Japanese ODA loan project

	Japanese technology	Technical specification and merit of the introduction
Transformer facility	GIS (Outdoor specification)	･Outdoor specification is technology of Japan only. ･Construction of the building is not necessary.
	GIS (Type of direct connection to transformer)	･High reliability and safety because the cable which connects GIS to a transformer is unnecessary, and there is no uncovered live part. ･More compact than standard GIS. ･Need to connect transformer with GIS on site because manufacturers of them are normally different.
	Load ratio control transformer	･300,000 times of tap changing specification. ･Because maintenance is unnecessary in the long term, it is effective for the frequent voltage fluctuation in Yangon area and Mandalay area.
	Unit type capacitor	･Since the iron plate of the frame is designed thick with the oil amount adjustment device, it has a longer life than the can type. ･Compared with the can type, it has less uncovered parts and higher reliability.
	Mobile substation	･The vehicle can be compact and lightweight by use of hybrid insulation technology.
Transmission and distribution	Concrete Pole	･Sufficient strength can be secured even when both 33kV SAC cable (2 lines)and 11kV power line (1 line) are mounted on the pole due to JIS specification. ･The 22m pole is a combination of 12m and 10m pole, ･and the 18m pole is a combination of 12m and 6m pole. Both types are transportable to Yangon and Mandalay city area.
	Pole built-type transformer (Underground wire system with pole structure)	·Method to be used for the roads with narrow sidewalks. ·Transformers are integrated with street lights or traffic signals, and advantageous in terms of city landscape. ·The 11kV type is not developed yet. Needs to be developed.
	Underground cable (CVT cable)	·CVT cable is expected to reduce the amount of excavation, shorten the construction period, reduce the construction cost, and it is effective for construction where the traffic volume is high like Yangon City. ·Products for 36kV or less have been delivered to Myanmar so far.
	Underground line duct materials	･Flame retardant, waterproof. ･For duct connection, dedicated fitting is used in order to ensure quality that does not depend on the worker's level. ･Cables are now left uncovered on the ground in many substations. Utilizing underground ducts improve reliability and work safety.
	Sealed cutout	･It is possible to protect the low-voltage system below the transformer and easy to disconnect the transformer from the 11kV distribution line.
	PJ connector	･Public accidents occurs from disconnection due to connection point failure. PJ connecter can realize easy connection and secure the strength of the connection point
	Abrasion-resistant electric wire /Anti-friction cover for distribution wire	･Used when a distribution line approaches or contacts a tree. ･By applying to the place where tree cutting is difficult, overhead wiring in contact state becomes possible. ･Japanese products have yellow internal layer for abrasion detection to show when to replace, which is advantageous for maintenance.

	Japanese technology	Technical specification and merit of the introduction
	Aerial work vehicle	・It is possible to manufacture with compact specifications compared with other country. It is effective because it is possible to go on a narrow road in Yangon City (8t truck specification). Insulation performance of 45 kV available.
	Pole construction truck	・It can be manufactured with compact specifications compared with other country. It is effective because it is possible to go on a narrow road in Yangon City. (10 t track specification)

Source: JICA survey team

The background suggesting the utilization of Japanese technology is as follows.

- There are many substations in YESC area whose land is too narrow for expansion and they have no space for installing indoor-type GIS with its building. In these cases, introduction of outdoor-type GIS is necessary for reinforcement of additional transformer bay. GISs are currently installed in five substations in YESC.
- In Myanmar where voltage fluctuation occurs much more frequently than in Japan, it is desirable that LRT based on Japanese standard specification which allows more durable operation times should be introduced.
- The capacity of capacitors for power factor improvement is insufficient in YESC. In order to deal with the surge in demand, YESC installs transformer in the vacant spaces of substations by its own budget as a stopgap measure that can be implemented in a short period of time rather than trying to increase the power supply capacity by improving the power factor. Improvement of power quality and increase of power supply capacity can be achieved if the capacity of phase modifying facility is enhanced by introducing unit-type capacitor / tank type phase modifying facility that can save space.
- Many concrete poles were collapsed due to the large cyclone in 2008. Besides, plural electric lines should be mounted on the same pole in urban areas where securing construction routes is difficult due to land restrictions. Therefore, it is necessary to adopt long reinforced concrete poles with sufficient strength conforming to JIS standard.
- Flexible tubes made in foreign countries other than Japan are used for underground line conduit pipes, but their insufficient strength against bending force and earth pressure easily causes cracks and flooding damage. The joint of the conduit pipes is conventionally treated by tape winding, and it depends on the skill of a worker. The flexible tube product with Japanese technologies is effective in this situation which has sufficient strength and weatherproof performance based on JIS, and connection work, using dedicated fitting, does not depend on the skill of the worker. In Myanmar in many cases, secondary cables in substations are laid directly on the ground without being embedded in the basement. Deterioration of a cable leads to work accidents or power failures, it is desirable to take measures such as arranging multiple cables using conduit pipe material and burying them in the basement.
- In order to prevent from delay in emergency dispatch due to traffic jam in Yangon, it is proposed that utility vehicles (Aerial work vehicle, Pole construction truck, Mobile substation) should be newly introduced into each of the eastern, western, northern and southern area of Yangon for emergency

response. Currently, YESC has four aerial work vehicles. Since introduction of skills is necessary for proper operation, introduction of products that can be easily operated and support for improving operation skills are necessary. Mobile substation is useful and effective for quick restoration from power outage and blackout in Yangon where there is a lot of power outage with long restoration duration due to facility breakdown.

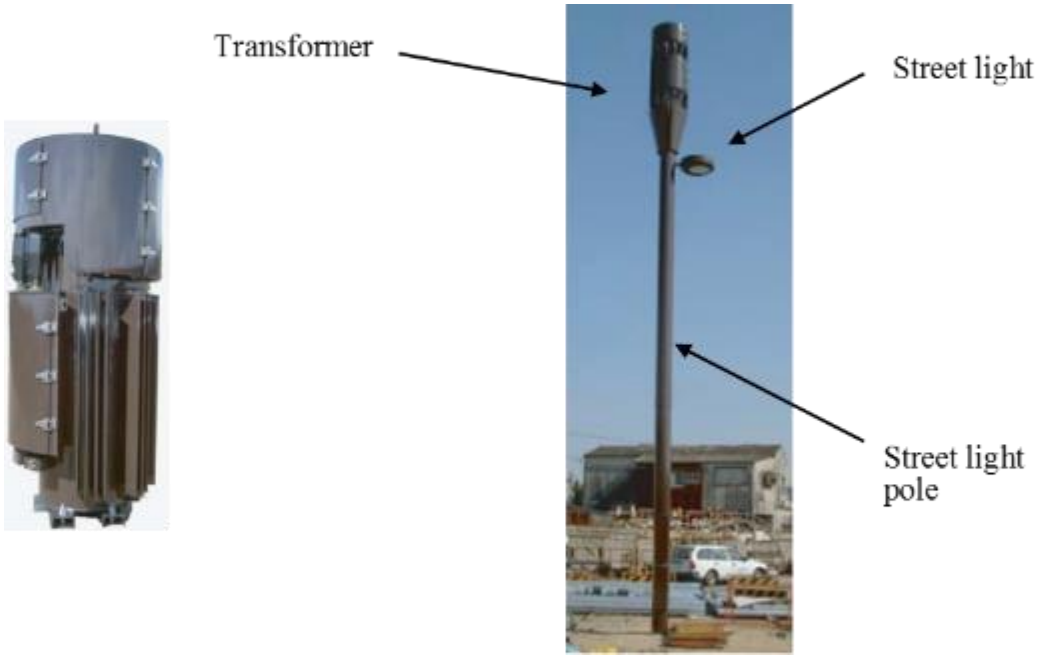
- In the projects targeted to 11kV or less distribution facilities in Amara Pura Township in MESC area, abrasion resistant electric wire or abrasion resistant polyethylene cover for wires is effective because there seems to be many places in Amara Pura Township where a tree makes contact with or gets close to an electric wire but logging the tree is difficult. Adoption of primary cutouts, wire connection materials is also considered effective to improve reliability.

Source: JICA survey team

Figure 4.2-1 Secondary cables in a substation laid directly on the ground and exposed to exterior

Source: JICA survey team

Figure 4.2-2 Distribution line approaching trees (Amara Pura Township, Mandalay)



Source: JICA survey team

Figure 4.2-3 Pole built-in type transformer (6.6kV specification)

Chapter5 Environmental and Social Considerations

5.1 Project Description

The main project components are as following:

Yangon:
- Reinforcement of 11 Substations
- Construction of 66 kV Transmission Line
- Construction and Replacement of 11 kV Distribution Line

Mandalay:
- Reinforcement of 11 Substations
- Construction of 33 kV Transmission Line
- Construction and Replacement of 11 kV Distribution Line

5.2 Legislative and Institutional System on Environmental and Social Consideration

5.2.1 Institutional Framework

The Ministry of Natural Resources and Environmental Conservation (hereinafter referred to as "MONREC") has jurisdiction over the environmental administration in Myanmar. MONREC was reformed in April 2016 from former Ministry of Environmental Conservation and Forestry (hereinafter referred to as "MOECAF"), which was also established in September 2011. The department responsible for the environment and social managements is the Environmental Conservation Department (hereinafter referred to as "ECD") under MONREC. The corresponding regional or state government is also involved in the environmental and social considerations.

5.2.2 Environmental Conservation Law and Rules

"Environmental Conservation Law" (hereinafter referred to as "ECL") and "Environmental Conservation Rules" (hereinafter referred to as "ECR") have been enacted to determine the comprehensive environmental conservation and management in Myanmar. The principal law governing environmental management in Myanmar is the ECL, issued in March, 2012. The ECR is detailed enforcement regulations of the ECL and enacted in June, 2014. The ECR 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.

5.2.3 Environmental Standards

National Environmental Quality (Emissions) Guidelines issued in 2015 regulate air emissions, waste water, noise levels and odor. The noise levels are as follows:

Table 5.2-1　Noise Environmental Standards

	Daytime (07:00 - 22:00)	Nighttime (22:00 - 07:00)
Residential, institutional, educational areas	55 dB	45 dB
Industrial, commercial areas	70 dB	70 dB

One Hour LAeq (Equivalent continuous A-weighted sound pressure level)

Source: National Environmental Quality (Emissions) Guidelines

The air quality levels are as follows:

Table 5.2-2　Ambient Air Quality Standards

Parameter	Averaging Period	Guideline Value μg/m^3
Nitrogen dioxide	1-year 1-hour	40 200
Ozone	8-hour daily maximum	100
Particulate matter PM10	1-year 24-hour	20 50
Particulate matter PM2.5	1-year 24-hour	10 25
Sulfur dioxide	24-hour 10-minute	20 500

PM 10: Particulate matter 10 micrometers or less in diameter
PM2.5: Particulate matter 2.5 micrometers or less in diameter

Source: National Environmental Quality (Emissions) Guidelines

The water quality levels are as follows:

Table 5.2-3　Water Quality of Site Runoff and Wastewater Discharges (Construction Phase)

Parameter	Unit	Maximum Concentration
Biological oxygen demand	mg/l	30
Chemical oxygen demand	mg/l	125
Oil and grease	mg/l	10
pH	-	6-9
Total coliform bacteria	100 ml	400
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Total suspended solids	mg/l	50

Source: National Environmental Quality (Emissions) Guidelines

5.2.4 Environmental Impact Assessment

Pursuant to section 21 of the ECL and Articles 52, 53 and 55 of the ECR, all projects having the potential to cause adverse impacts, are required to undertake Initial Environmental Examination (hereinafter referred to as "IEE") or Environmental Impact Assessment (hereinafter referred to as "EIA") or to develop an Environmental Management Plan (hereinafter referred to as "EMP"), and to obtain an Environmental Compliance Certificate (hereinafter referred to as "ECC") from ECD under MONREC.

"EIA Procedure" was enacted in December 2015. The EIA Procedure is composed of eleven Chapters (131 Sections) and three Annexes and stipulates the conditions under which EIA is required and the steps to be followed in conducting and assessing the EIA. The 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 Annex 1 of the EIA Procedure, guidance as to whether an IEE or an EIA is required for 141 types of projects or activities. In the Annex 1, the categorization of economic activities for the IEE or EIA relating to transmission line or transformer substation projects shown in Table 5.2-4

Table 5.2-4 Categorization of Transmission Line or Transformer Substation Project

Type of Economic Activity	Criteria for IEE Type Economic Activities	Criteria for EIA Type Economic Activities
Electrical Power Transmission Lines ≥ 115 kV but < 230 kV	≥ 50 km	All activities where the Ministry requires that the Project shall undergo EIA
Electrical Power Transmission Lines ≥ 230 kV	All sizes	All activities where the Ministry requires that the Project shall undergo EIA
High Voltage (230 kV and 500 kV) Transformer Substations	≥ 4 ha	All activities where the Ministry requires that the Project shall undergo EIA

Source: EIA Procedure, 2015

Because proposed transmission line or transformer substation projects in this survey will be 66kV and under, implementation of the IEE or EIA will not be required.

"General Environmental Impact Assessment Guideline (Version 3)" was issued from MONREC in September 2017. The primary aim of this Guideline is to guide Project Proponents and their EIA consultants in the conduct of both IEE and EIA, and to ensure that these assessments include adequate Project descriptions, assessment of potential impact significance, and mitigation measures using sound, professional and scientific tools and methods. The Guideline particularly focuses on preparation of easily understandable IEE and EIA reports, and EMP. The Guideline additionally serves as a reference document for ECD under MONREC for use in reviewing IEE and EIA reports and EMP and ensuring that the aforementioned content is satisfactorily covered. The objectives of this Guideline are to:

(i) Provide a common framework for IEE and EIA reporting and EMP preparation;
(ii) Present Project Proponents and their EIA consultants with clear guidance on the structure, content and scope of IEE and EIA reports and EMP; and
(iii) Ensure that these documents are consistent with legal requirements, good practice and professional standards.

5.2.5 Land Acquisition and Resettlement

There are many significant laws which govern land issues, land administration and land ownership in Myanmar such as Land Nationalization Act (1953), Disposal of Tenancies Law (1963), Land Acquisition Act (1894), Forest Law (1992), Farm Land Law (2012), and so on. It is said that there are approximately 70 laws and regulations related to land issues in Myanmar including laws and regulations formulated at the latter half of the 19th Century. Among them, the Land Acquisition Act (1894) is even now the core law of land acquisition. On the other hand, there is no law stipulating involuntary resettlement comprehensively. Agencies responsible for land acquisition are City Development Committee in Yangon and Mandalay Cities.

Chapter6 Issues and proposals concerning implementation of electricity distribution improvement project policy on power distribution project

6.1 Policy of power distribution project

6.1.1 The 5-year plan and individual projects

Since YESC does not grasp the situation of facility deterioration, facility repair work tends to occur suddenly. So it is necessary to properly review 5-year plan and priority of construction work. YESC also does not grasp the contents of the work that the franchise companies carry out independently as information is not shared between YESC and the franchise companies. For this reason, it is necessary to prepare a 5-year plan reflecting the deterioration situation of each substation facility and the work plan of the franchise companies.

The 5-year plan of MESC is currently managed by various multiple documents. In the documents, the cost and quantity required for each year is stated, but specific project names are not written. It is necessary to materialize the projects in the 5-year plan and to manage them centrally in a single document with prioritized forms.

Both YESC and MESC does not properly manage drawings and layout maps for substation facilities, which causes spending much efforts in site surveys when planning construction projects. Such drawings and maps are also essential for operation and maintenance. It is necessary to set up a management system which enables certain takeover of the drawings and maps when construction or repair work is completed. In addition, some substations owned by YESC are placed in very buildings. It is necessary to consider the reconstruction of the buildings as well as updating the facility.

6.1.2 Related laws and regulations

In the electricity business of Myanmar, license concerning the setting of electricity tariff and business activities are determined by the "Electricity Law", and the business related to investment is determined by the "Investment Law". In addition, there are many other related laws and regulations. The major regulations, decisions and regulations related to the electric power business are shown in Table 6.1-1. There is no policy on power distribution project in Yangon/Mandalay area.

Table 6.1-1 Major laws and regulations related to the electricity business

Approval year	Regulation	Overview
2012	Environment Conservation Law	Regulate environmental regulations in general
2014	Electricity Law	Specify general electric power
2014	Environment Conservation Rules	Rules complementing Environment Conservation Law
2016	Investment Law	Combining and reforming the former foreign investment law and domestic investment law
2017	Investment Rule	Revision rule based on renewal of investment law
2017	Companies Law	Significant revision since 1914

Source: JEPIC

6.2 Implementation system of power distribution project

6.2.1 Human resources and technical issues

Although the number of staff at YESC/MESC including franchise companies looks sufficient, there is factual human resource shortage, because of insufficient human resource development. The staff do not receive planned education for improving their skills, after two-week training, new comers are assigned to the sites, and then they receive OJT at each site. An ideal education system would be: through the test system according to the skill level, key people will be selected from the field, and the key people will educate their staff at each site, and try to bring up their successors.

6.2.2 Issues related to franchise contracts

- Profitability of the contracts should be retained

The purpose of introducing franchise system is to improve the efficiency of electricity distribution service taking advantage of experience and knowledge of private companies.

According to the interviews, some companies complain about low profitability in isolated townships and it may be the main reasons of early termination of the past contracts. To make the contracts sustainable, appropriate profit of private companies should be retained by adjusting the purchase cost from YESC or MESC and other management plans.

- Enhance the monitoring capacity

As much as the JICA survey team perceived, sufficient regulation is not implemented by either YESC/MESC or MOEE. To make the appropriate contract from signing phase to implementation phase, highly experienced officers are necessary to be employed. In the signing phase, contract conditions and purchase prices should be well elaborated as considering the technical and financial conditions of the townships. After the contract starts, the monitoring of the service output should be done carefully, and reward or punishment should be granted as needed to regulate the franchise services.

To make these works done effectively, it is recommended that special teams for reviewing and monitoring the contracts are organized in YESC, MESC or MOEE.

- Transparency should be retained

At present, the information of the signing process of the contract and service output during service period is not shared with users. In case if the incremental profit is made by the improved service, the profit should be shared in fair way among three parties, namely private company, public entity and users. To make the project socially accepted, the information of the contract should be shared in public such as the method of deciding company, purchase price, service target and its progress.

6.3 Technical level of YESC and MESC

6.3.1 Distribution facility planning

Since YESC stopped planned power outage, the outage time of construction work tends to be limited. Allowed outage duration is 6-7 hours a day and twice a week. Temporary construction is necessary to implement the construction work within limited outage duration. However, there are some substations without enough space for temporary construction, which requires more than a week outage for installation and testing work including removal.

It is necessary to install 6.6kV or 11kV cable interconnection between adjacent substations which have no enough space for temporary construction. By using that, load can be supplied from adjacent substations during the construction and outage duration can be minimized. Furthermore, it is better to install 6.6kV or 11kV circuits which interconnects adjacent transformers at the cubicles in a substation where two transformers are installed. This minimizes the outage duration.

6.3.2 Planned facility replacement

YESC replaces afacility when it is broken down or accordingly power failure occurs. As a result, circuit breakers which cannot cut the fault current are remaining without repaired. There is high possibility that a wide blackout may occur or a fault may continue for a long time because circuit breaker does not act. In fact, a facility burned black due to fault current which could not be cut by the circuit breaker in YESC.

Broken facilities, especially circuit breaker, should be fixed and replaced every time, quickly. Furthermore, when the abnormalities are found during the visual patrol and maintenance, its records should be managed continually and the repair or replace plan should be planned. And then, asset management including management of manufacturing year should be implemented because the probability becomes high as facilities gets older. Replacement at the proper timing reduces the probability of the malfunctions that same age facilities are broken at same timing.

6.3.3 Competence building for on-site workers

There are hundred times of electrical failures a month and its duration is long. The reason of long time blackout is that it takes long time for transportation of HQ engineers to the site because on-site workers cannot deal with failures. In addition, there are some accidents like electrocution and falling from high place during maintenance work because of installation defectives (deficit separation or deficit insulation) and lack of knowledge for safety work.

Training facility is required which enables on-site workers to deal with failures. If their skill is improved , the time until restore and preparing for spare facility becomes much less. Furthermore, knowledge about safety work of the on-site workers is increased and the number of work accidents are reduced.

6.3.4 Management of drawings

Drawings like single line diagram, layout, control cable connection diagram, back wiring diagram and manufacturer manual are achieved however they are not updated as the facility is replaced. Power cables are used to install extra facility and part of them is buried. So, it takes time to realize the connection of the power system.

Drawings need to be managed on the database that everyone can use them easily when the failures occur and they need to be revised every time a facility is installed or removed. Furthermore, revising and updating need to be implemented by administrator who is in charge of drawings.

6.3.5 Efficiency improvement of power system operation

YESC has 46 sites of 66kV substations and 111 sites of 33kV substations. Currently, power failure operation is implemented over the phone. As there is no SCADA, it is difficult to know where and why a failure occurred. Without SCADA, restoration may delay and real-time operation including voltage control and quick data collection is impossible.

By introducing SCADA, higher power system reliability, stable power system and data collection automation are possible. By the way, DPTSC, which deals with higher voltage power system, is now introducing SCADA. So adjacent countries like Laos and Cambodia do. Urgent SCADA introduction to YESC is hoped for.

6.3.6 Efficiency improvement of power system planning

As the number of substations increases and the power system becomes more complicated, it is becoming more and more difficult to formulate plans to build transmission lines connecting substations in addition to plans to build substations. Currently, the system analysis is not carried out, and plans are formulated based on the load on transformers, factory development near the substation, demand forecast, etc.

It is necessary to enable implementation of quantitative and reasonable system plan by introducing a system analysis software.

6.3.7 Prevention of climbing on steel tower

Transmission steel towers are built in a place where the public can easily enter and the towers are made easily to go up.

It is necessary install lifting prevention devices for steel towers in order to prevent disasters.

6.3.8 Reduction of distribution loss

YESC adopts the multi transformer system, power factor improvement and digital integration wattmeter to reduce distribution loss. On the other hand, the management of the distribution loss by YESC does not include the distribution loss in the franchised areas. The franchised areas are regions where the loss of 6.6 (11)kV is relatively large. So if the franchised areas' loss is ignored, the total loss appears as it is greatly improved.

As the number of franchised areas increases, distribution line loss in YESC's own areas appears to have decreased. For that reason, it is important to manage distribution loss rate including franchised areas, and to grasp how much the distribution loss rate has decreased by measures implemented. Further, by adopting an amorphous transformer, further loss reduction can be achieved.

6.3.9 Use of long-length and high-strength pole

In urban areas, the space for pole installation is limited. Therefore, as the power demand density of the city increases in the future and distribution network is developed, multiple distribution lines need to be constructed in one route. It is necessary to use long-length and sufficient-strength reinforced concrete poles when multiple distribution lines are to be mounted on one pole. From the experiences in Japan, in case that 33kV and 11kV power lines are installed on a same pole, in view of securing the safety distance during the work on the lower 11kV side, over 3 meters should be secured between the 33kV line and the 11kV line.

6.3.10 Pole strength calculation

Currently, it seems that pole strength calculation is not carried out when concrete poles are used for transmission and distribution lines. In the case of Myanmar, under-bracing made by pouring concrete on site is generally installed in the buried parts of a concrete pole, and it is thought that the strength of the foundation part is no problem.

However, the strength of the concrete poles themselves seems to be insufficient in many cases, and some are destroyed by strong wind as shown in Figure 6.3-1. Figure 6.3-2 shows an example of over investment : 4 poles were built for fear that the strength may be insufficient.

As mentioned above, in the future there are many cases where multiple electric wires are mounted on one pole, the horizontal lateral load applied to the pole in these cases is more severe than the case where one circuit is mounted, because wind pressure load (the load applied to the projected area of the electric line when the wind blows) increases. Therefore, pole strength calculation is extremely important in terms of facility maintenance and securing reliability.

For this reason, it is proposed that a steady implementation of pole strength calculation considering wind pressure load should be ensured.

Source: JICA expert member on "Project for Capacity Development of Power Sector Development Planning"

Figure 6.3-1 Pole collapsed by strong wind

Source: JICA survey team

Figure 6.3-2 Distribution line design using 4 concrete poles (in Mandalay City)

6.3.11 Necessity of detailed rules concerning maintenance

There are cases where a 66 (33)kV transmission line and an 11 (6.6)kV distribution line are wired on the same concrete poles. In this case, YESC or MESC is responsible for maintenance of the 66 (33)kV transmission line, and the franchise company is responsible for maintenance of the 11 (6.6)kV distribution line. Since the poles are to be owned and maintained by YESC or MESC side, detailed arrangements such as rules for setting grounding on the 11kV side are required.

In addition, during the work on 33kV line side, interruption of 11kV line may be required on account of safety. It is also necessary to formulate a rule and document about the communication procedure for such kind of site work with power interruption.