Japan International Cooperation Agency

# National Power Transmission Network Development Project in Myanmar (Power Network System Plan) Project Completion Report

May 2015

Tokyo Electric Power Company Inc.

## Contents

# Chapter 1. Introduction

## 1.1 Member of the Mission and His Duty

Masaharu Yogo, TEPCO, Power System Planner

## 1.2 Name of the Project

National Power Transmission Network Development Project in Myanmar

## 1.3 Purpose of this Investigation

Myanmar government cited the development of 500 kV transmission lines and substations as a matter of priority and issued a request of their development by utilizing yen loan. According to the request, the Japanese Government informed Myanmar government of a new yen loan project as the donor policy on March 24, 2014 targeting "National Power Transmission Network Development Project Phase 1" in Myanmar. Furthermore, following the Phase 1, the rapid development of Phase 2 are also needed. In this survey, engaged member will carry out the supplementary investigation in cooperation with his counterpart, the Myanmar Electric Power Enterprise, in order to examine and recommend the appropriate power system plan for preparation of yean loan project by collecting and organizing the relevant information based on the current plans and implementation of the transmission lines and substation projects by Myanmar Government, power generation plans utilizing IPP and the support planning and implementation status of other donors.

## 1.4 Methodology of Investigation

The necessary investigation has been carried out for making the reports required for yen loan appraisal regarding the power system plans of Myanmar by collecting its relevant information and reviewing them through the discussion with JICA Staff and Social & Environmental Specialist who has been also assigned in this task.

## 1.5 Work Schedule

Contract term: from January 16, 2015 to May 29, 2015

The First Site Survey: From January 18, 2015 to January 28, 2015

The Second Site Survey: From March 16, 2015 to March 21, 2015

## 1.6 Survey in Myanmar

On January 19, 21 and 22, 2015, the relevant information was collected through the

discussion with Power Transmission Project Department of MEPE and DEP based on the questionnaire listed in Appendix 1.

On January 26, the site surveys of future locations of Phayargyi and Hlaingtayar substations were carried out to confirm the latest situations regarding "Phase 2 Project". On March 18 and 19, the mission team had a meeting with MEPE' engineers to discuss the cost of the transmission lines and explain the some recommendations for power network system plan. The following sections describes the relevant information and the results of the study of the power system plans.

# Chapter 2. Situations of Land Acquisition

## 2.1 500 kV Phayargyi Substation

During the first site investigation, it was found out that the location of the candidate site of 500 kV Phayargyi Substation had been moved to the outside of the military land by around 1 km in the south direction because the permission for its land usage had not been given by the military. The new site is a plane land without any hats or buildings, but with containing a wet land even in dry seasons. The 500 kV switch yard will be installed in the north and the 230 kV switch yard will be installed in the south where 230 kV transmission lines will be derived. The route of the transmission line from the original Pharyargyi substation to Hlaingtayar substation has not been changed from the results of the study in 2014. However, the new additional route from the new candidate site to the original site has to be required. The new route has no hats or buildings.

During the second site investigation, it was found out that the location of the candidate site of 500 kV Pharyargyi was moved to the north by around a hundred meter. The situations of the candidate sites of Pharyargyi are depicted in Figure 1 and 2.

## 2.2 500 kV Hlaingtayar Substation

During the first investigation, it can be found out that the land for the new 500 kV Hlaingtayar Substation was owned by seven households. The six of them had been already paid for land provision, however, one of them would not enter into negotiations with MEPE and it seemed difficult to negotiate him. Lacking of his land would increase in the cost of substation because it requires compact facilities such as Gas Insulated Switchgears (GIS). Thus, the new additional land acquisition neighbor to the original land in the east direction was proposed and MEPE was expected to study its adequacy. (Figure 3) The candidate site is a plain land with only a small hut utilized for agricultural works. The 500 kV switch yard will be installed in the north and the 230 kV switch yard will be installed in the south.

During the second site survey, it was found out that the land depicted in Figure 4 had been acquired.

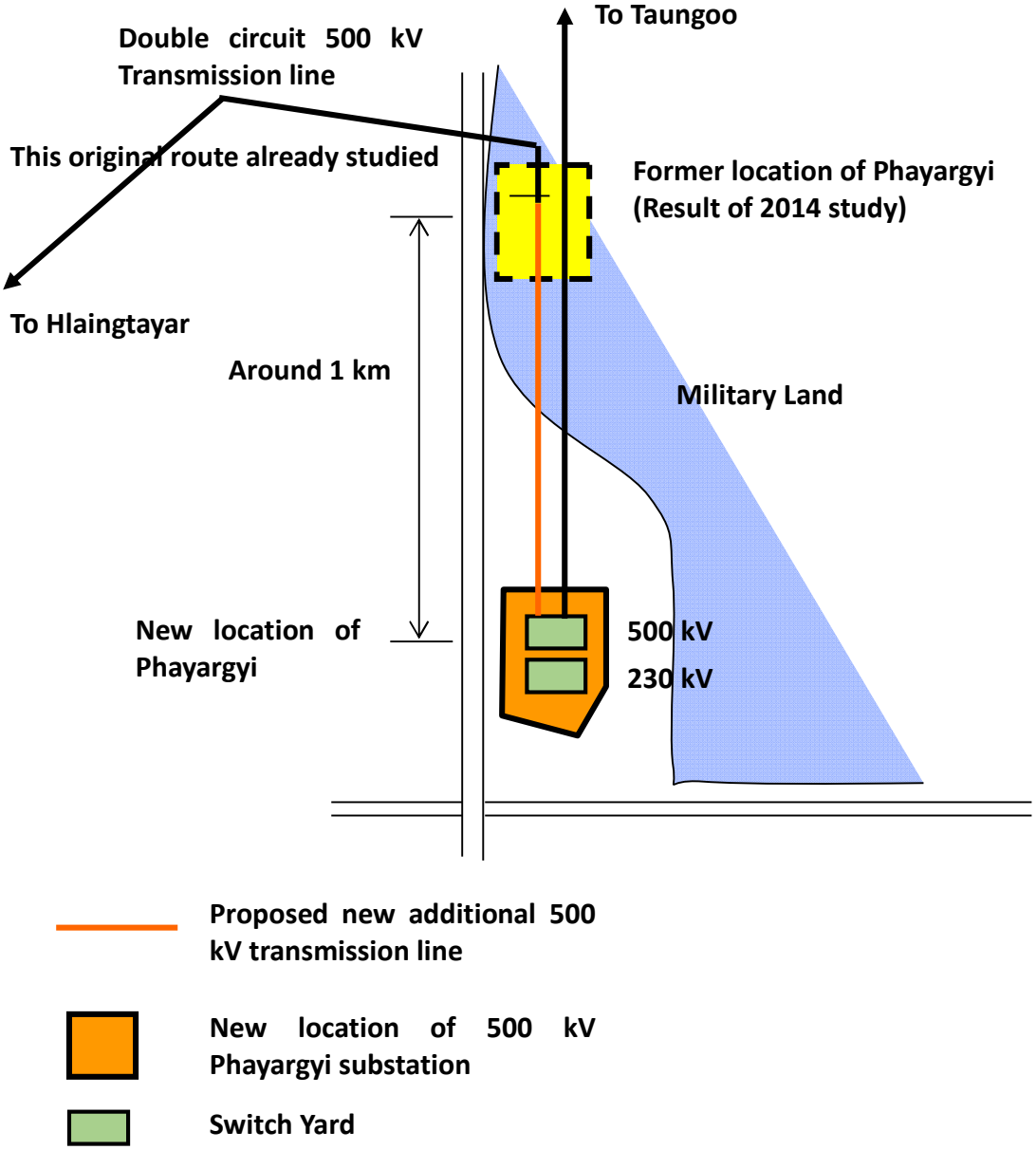



**Figure 1 New Location of 500 kV Phayargyi Substation**

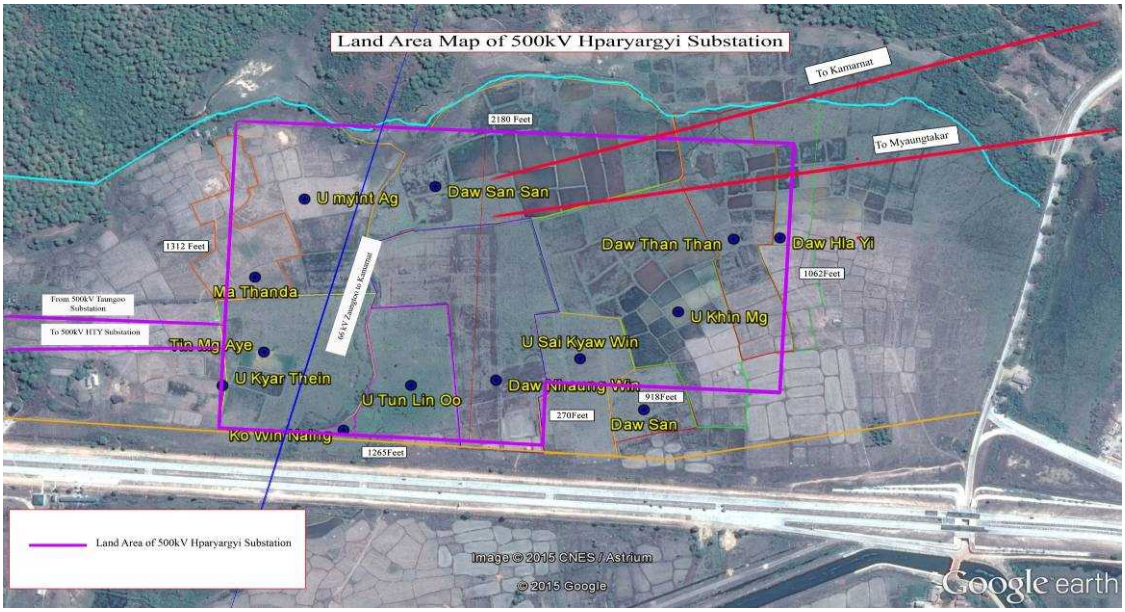
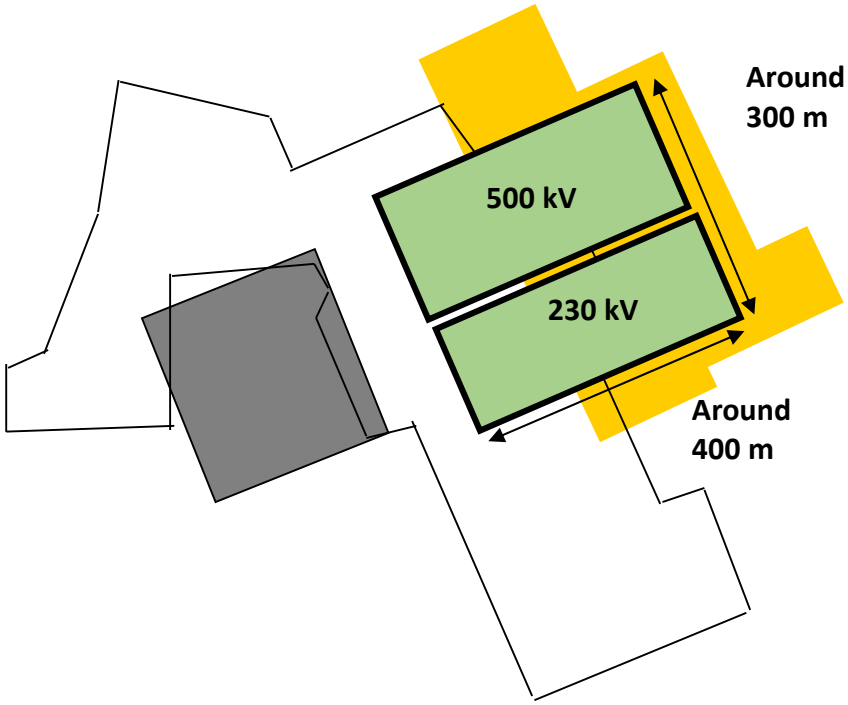



**Figure 2 Land of 500 kV Phayargyi Substation (Google earth)**




Land difficult to be negotiated

Proposed additional land to be negotiated

Land already acquired

Switch Yard

**Figure 3 Land of Hlaingtaryar**

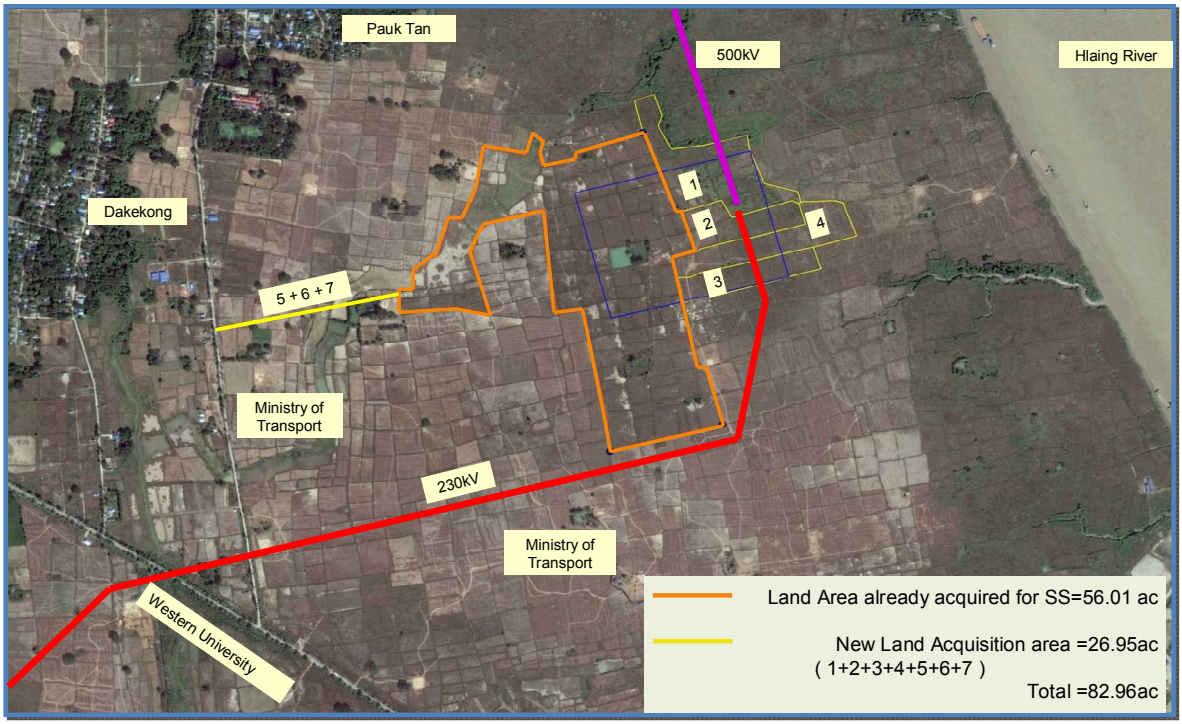



**Figure 4 Land of Hlaingtaryar (Google earth)**

# Chapter 3. Confirmation of the Latest Plans of Power Generation, Transmission lines and Substation

## 3.1 Power Demand Forecast and Power Generation Plan

The maximum electric power demand during the peak demand period of time (from March to May) in 2015 was forecasted as 1,500 MW for Yangon and 2,500 MW for the system of the whole country. From 2015, the yearly growing ratio of the maximum power demand is expected over 15%. DEP expressed an opinion that the latest demand forecast was the result of its study of the JICA Master Plan. The total generation capacity of Yangon city is currently 370 MW and expected to become 800 MW at the end of 2015.

## 3.2 Plan of 230 kV Transmission Lines and Substations in Yangon

MEPE planned 230 kV transmission lines and substations in Yangon as shown in the following table.

**Table 1 Project Plan for Yangon Division**

| No. | Name of Projects | Expected Fund |
|---|---|---|
| 1. | 230 kV Ahlone-Thidar Transmission Line & Substation | China Exim Bank |
| 2. | 230 kV Tharkata-Kyaikasan Transmission Line & Substation | ADB |
| 3. | 230 kV Tharkata -Thidar Transmission Line | ADB |
| 4. | 230 kV Ahlone Dala Transmission Line & Substation | MEPE |
| 5. | 230 kV (Hlawga-Tharketa) In/Out Transmission Line & South Oakkalar Substation | MEPE |
| 6. | 230/66/11 kV, (2x125) MVA Bayintnaung Substation Extension | Deferred |
| 7. | 230/33 kV, (2x100) MVA West University Substation | Deferred |

The number of circuits between Ahlone - Thidar was assumed two and Thidar – Thaketa single in this study according to the ADB's Report "TA 8342 MYA Preparing the Power Transmission and Distribution Improvement Project" by Fichtner".

The comments raised for the abovementioned list was as follows.

- All the projects were under discussion in the similar situation as "National Power Transmission Network Development Project Phase 2". However, MEPE hoped to complete all the project within two years. That was expected to be completed by the end of 2018.
- The 230 kV Ahlone-Dala transmission line listed in the number 4 probably to be carried out using its own funds of MEPE because the length of this transmission line was very short.
- Bayintnaung substation listed in 6 was expected to be completed in 2017 because this project contained just the expansion of substation.

- The projects of "Deferred" were still opened to the tenders.

The following comments were raised for the Project that were not listed in Table 1.

- The completion year was uncertain of 500 kV Phayargyi - Dawei transmission line because it depended on the plan of the Dawei power station.
- Shweli 3 was scheduled to be completed in 2020. There was an enterprise company that expressed an interest in the installation of 500 kV transmission line from Shweli 3 to Meiktila and said that he might implemented.
- The survey of the transmission line from Mawlamyine to Dawei has been asked to China Exim Bank. Dawei would have large power demand forecast due to its SEZ.

### 3.3 Transmission Lines connected to New 500 kV Substations of Phase 2 Project just after their completion

According the information gathered during the first site survey, MEPE said that there were no changes from the results of the study in 2014 of the transmission line connection to new 500 kV substations of Phase 2 Project.

However, some 230 kV transmission lines connected to 500 kV substations were changed. Those should be confirmed at the stage of detailed design.

Current status of the progress of 230 kV transmission line connection to 500 kV substations are as follows.

- 500 kV Phatryargyi Substation

In 2019, the 500 kV Pharyargyi substation will be connected to the newly constructed 230 kV transmission line between Tharyargone - Kamarnat where 500 kV Pharyargyi substation is located in the middle of the line. The transmission line between Pharyargyi and East Dagon was not yet decided, however, it would take normally only three years from its plan to its operation in MEPE.

- 500 kV Hlaingtyar Substation

As mentioned later, 230/33 kV West University substation will be constructed in the same location as 500 kV Hlaingtayar Substation by ADB. 230/33 kV West University substation will collect the existing transmission line from Mayungtagar - 230 kV Hleingtayar. 500 kV Hlaingtayar Substation will be installed as the expanded substation of 230/33 kV West University.

### 3.4 Main Specifications of Phase 2

The mission team had discussions with Power Transmission Project Department of MEPE regarding the main specifications of Phase 2 Project based on the previous study in 2014.

No main specifications had been changed except for pollution level of insulators.

- MEPE hoped to apply the heavy pollution level to the route around 4 to 5 km before reaching 500 kV Hlaingtayar substation. On the other hand, the light pollution level was recommended to be applied for the whole of the transmission line routes by JICA team side based on the site survey in the 2014 previous study and this study. The applied pollution levels should be discussed with MEPE during the detailed design stage.
- MEPE raised a comment that they hoped to know the O&M methodology for Oil Forced Cooling System to maintain its better insulation. (Some know-hows are considered such as Dessolved Gas Analysis and Reduce Oil Circulator Speed )

### 3.5 Reviewing ADB's Report (by Fichtner)

The ADB's report "ADB - TA 8342 MYA Preparing the Power Transmission and Distribution Improvement Project" (Fichtner, Feb.2015) has been reviewed unofficially by the mission team (not through MEPE).

The demand forecast of ADB's Report was a little bit lower than that of JICA Master Plan as follows.

- The maximum demand for the whole system in ADB's Report
  Year 2020: 3,728 MW, Year 2030：7,498 MW

- The maximum demand for the whole system in JICA Master Plan
  Year 2020: High Case 4,531 MW, Low Case 3,862 MW
  Year 2030: High Case 14,542 MW, Low Case 9,100 MW

The following projects in around Yangon were recommended in the ADB's report.
Thida - Thaketa TL、Thaketa SS (extension)、Thaketa - Kyaikasan、Kyaikasan SS (new)、South Oakkalarpa SS (new)、West University SS (new)

The 230/33kV West University Substation that is listed above, was not informed in Table 1. However, this substation would have an effect on the Phase 2 Project because the ADB report described this substation was to be installed at the same location of 500 kV Hlaingtayar substation of Phase 2. JICA mission team had a discussion with MEPE regarding this substation.

### 3.6 230/33kV West University Substation

MEPE informed that The 230/33 kV West University Substation was planned to be installed

at the same land as the candidate site of the 500 kV Hlaingtayar Substation and the bus bars of 230/33 kV West University Substation would be expanded and connected to the 500 kV Hlaingtyar substation. Its implementation schedule was not yet decided.

Points to note regarding the connection of the 230/33 kV West University Substation and the 500 kV Hlaingtayar Substation are as follows.

(The design of both projects should be coordinated regarding the methodology of the expansion of 230/33 kV West University Substation to 500 kV Hlaingtayar substation at the detailed design stage.)

- The layout of the facilities of the foregoing ADB 230 kV West University substation should be necessarily incorporated with the future layout of Phase 2 500 kV Hlaingtayar Substation.
- It is necessary to study the treatment of the protection relays and supervisory control system of the foregoing ADB 230 k West University Substation when Phase 2 500 kV Hlaingtayar substation will be installed. Generally, it is not enough for connection of bus bars not only by the connection of bus bars itself. It also requires for changing the connection of the information-telecommunication system utilized for supervisory control system in the substation. (such as the selection of the locations of control rooms for both old and new substations or the selection of the protection scheme against bus fault)

In case of difficulties, an option can be considered that connects new and old buses by installation of the circuit breakers between them to ensure their independent operation as shown in the following figure.

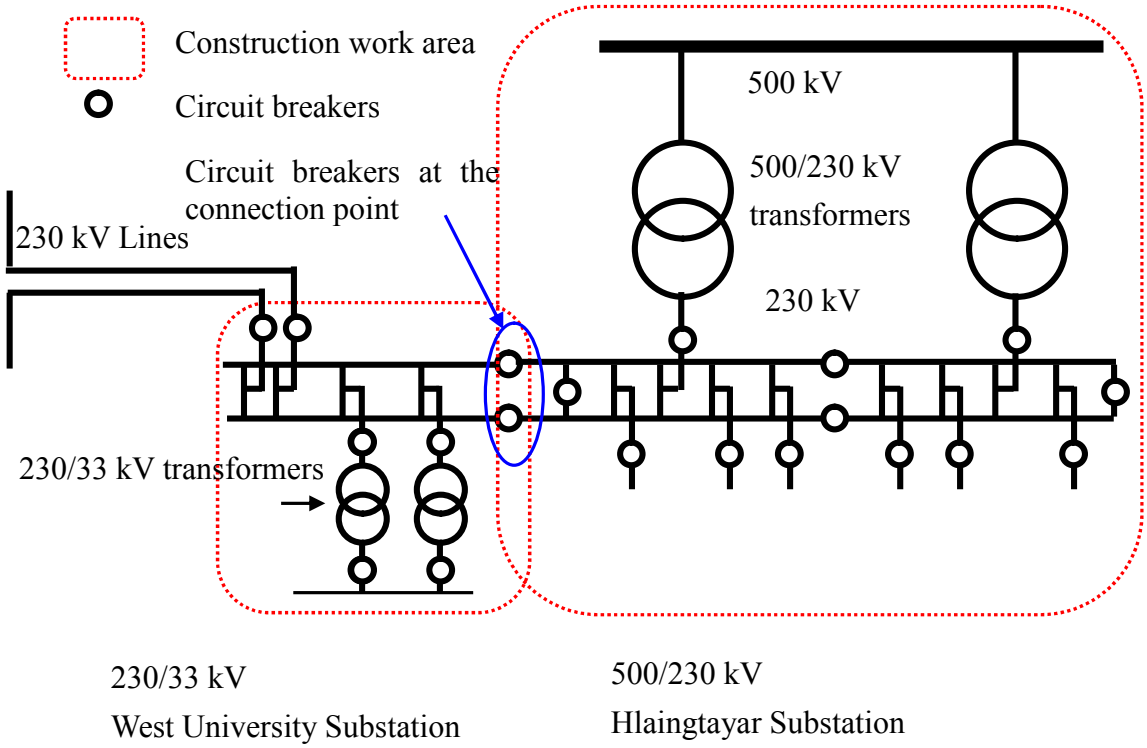



**Figure 5 Covering areas of 230/33 kV West University Substation and 500/230 kV Hlaingtayar Substation**

### 3.7 Prioritized Projects of Transmission Lines and Substations Except for the System from 500 kV Taungoo – Hlaingtayar

MEPE identified the study of the plan of the transmission lines from the hydropower stations located in the north of Meiktila substation as the prioritized projects.

### 3.8 Institutional Structure for O&M

Currently, there are fourteen Transmission Line Offices with 137 staffs per office on the average. One office maintains 700 – 800 km of lines by 30-40 persons. Safety trainings are held by Administration Office.

# Chapter 4. Power Flow Analysis for the 500 kV System of Phase 2 and 230 kV system in around Yangon

## 4.1 500kV and 230kV System in around Yangon

Figure 3 shows the plan of the 500 kV and 230 kV power network system in around Yangon around 2020 after Phase 2 500 kV Project will be completed based on the information from MEPE.

The 230 kV system of Yangon will be divided into east and west, where eastern system will have Hlawga, East Dagon, Thaketa and Thanlyin and western system will have Hlaingtayar, Ywama, Bayintnaun and Ahlone. There will be no direct interconnection of 230 kV between them.

Two 500 MVA transformers of 500/230 kV will be installed in Phayargyi and Hlaingtayar respectively.

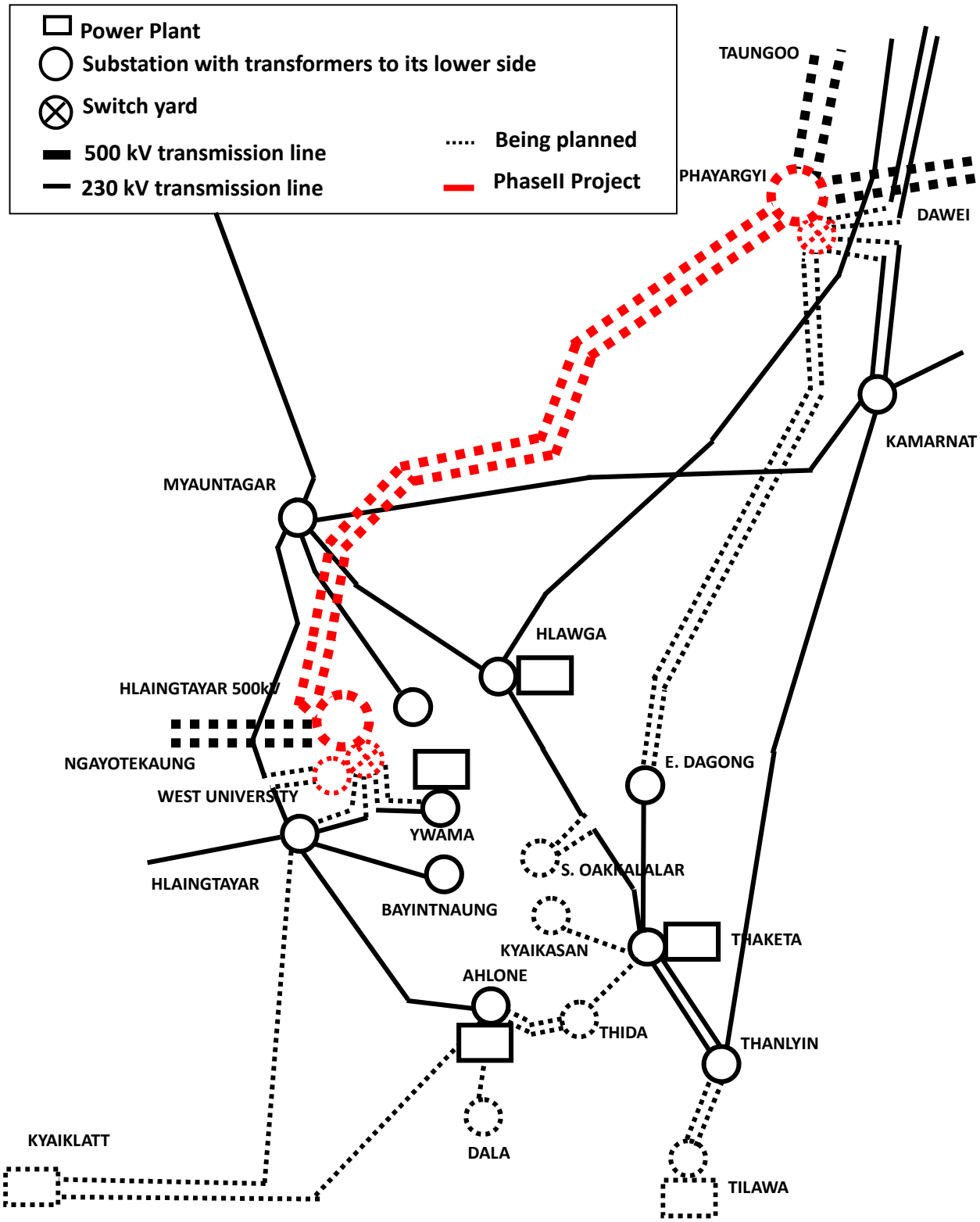



**Figure 6 500 kV and 230 kV System in around Yangon around 2020**

## 4.2 Load Forecast for 230 kV Substations in Yangon in 2020

The maximum power demand of Yangon in 2020 was set out as 2,869 MW from the result of JICA Master Plan Study. The insufficient energy will be taken from the outside of this area at Myauntagar, Payargyi and Kamarnat substations and the amount of its required energy will be determined only by the power demand supply balance in Yangon. The power generation plan outside of Yangon was used as the plan obtained in the study in 2014. Loads of 230 kV substations in Yangon were set out as follows.

- There are two ways of power supply from 230 kV substations, one is by 66 kV and another is 33 kV. Thus, the amount of loads of 230 kV substations has to be divided into loads of 66 kV system and 33 kV system. The maximum power demand in 2014 was 917 MW in Yangon. Around 40% (372 MW) was allocated to 66 kV system and around 60% (545 MW) was allocated to 33 kV system based on the current power supply information.
- The growing ratio of the maximum power demand in Yangon was assumed 20% per year for the first 5 years and 10% for the next 5 years and the growing ration of the maximum power demand of 33 kV system was assumed only 4% because the loads of 33 kV system were planned to be gradually switched to 66 kV based on the information obtained from YESB last year. This maximum power demand can be depicted as shown in Figure 7 that lies at the middle point between the high case and the low case in 2020 estimated in JICA Master Plan. The high case maximum power demand of JICA Master Plan was applied as the maximum power demand of this study for 2020.

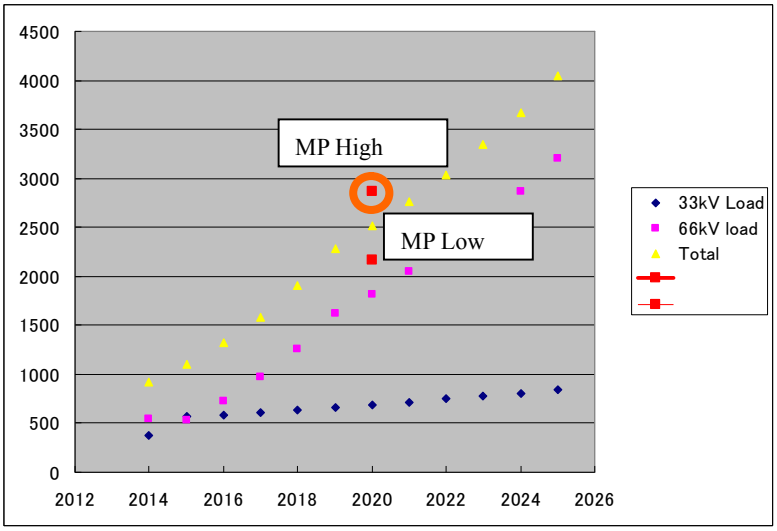



**Figure 7 Maximum Power Demand Forecast in Yangon**

- The ratio of the allocated load of 66 kV system was 72.5 % and 33kV system was 27.5%. Using those ratios, the maximum power demand of 66 kV system was calculated as around 2,081 MW and 33 kV was around 788 MW for 2020 based on the high case demand of

JICA Master Plan, 2,869 MW in 2020.

- The capacities of the facilities of 230 kV substations in Yangon in 2020 were estimated as shown in the following table. The information about the expansion of Ahlone, Thakheta, Thanlyin and Iwama was obtained at the end of 2014. It was found out that the 66 kV system could have around 2,200 MW and the 33 kV system around 1,300 MW according to the following table assuming 90% as the power factor of transformers and 80% as the power supply ability ratio to the capacities of the transformers and generators.

**Table 2 Capacities of facilities at 230/66 kV Substations**

| 230/66 kV Substation | 66 kV Power Supply Facilities | Existing Capacities | Estimated Capacities After Expansion |
|---|---|---|---|
| Ahlone | 66 kV Gen. | 194 MW | |
| | 230/66 kV Trans. | 2 x 100 MVA | 3 x 100 MVA |
| Bayintnaung | 230/66 kV Trans. | 100 MVA | 2 x 125 MVA |
| Hlawga | 230/66 kV Trans. | 60 MVA | |
| Thakheta | 66 kV Gen. | 84 MW | |
| | 230/66 kV Trans. | 2 x 100 MVA | 3 x 100 MVA |
| Iwama | 66 kV Gen. | 50 MW | |
| | 230/66 kV Trans. | - | 2 x 125 MVA |
| East Dagong | 230/66 kV Trans. | - | 2 x 125 MVA |
| South Okkalapa | 230/66 kV Trans. | - | 2 x 125 MVA |
| Kyaikkasan | 230/66 kV Trans. | - | 2 x 125 MVA |
| Thida | 230/6 6kV Trans. | - | 2 x 125 MVA |
| Tilawa | 66 kV Gen. | | 50 MW |
| | 230/66 kV Trans. | - | 2 x 100 MVA |

**Table 3 Capacities of facilities at 230/33 kV Substations**

| 230/33 kV Substation | 33 kV Power Supply Facilities | Existing Capacities | Estimated Capacities After Expansion |
|---|---|---|---|
| Ahlone | 66/33 kV Trans. | 60 MVA | |
| | 33 kV Gen. | 100 MVA | |
| Hlaingtharyar | 230/33 kV Trans. | 2 x 100 MVA | |
| Hlawga | 230/33 kV Trans. | 3 x 100MVA | |
| | 33 kV Gen. | 210 MVA | |
| Thanlyin | 230/33 kV Trans. | 100 MVA | 2 x 100 MVA |
| Wartayar | 230/33 kV Trans. | 100 MVA | |
| Thakheta | 230/33 kV Trans. | 100 MVA | |
| | 33 kV Gen. | 50 MVA | |
| Iwama | 33 kV Gen. | 36 MVA | |
| West University | 230/33 kV Trans. | 2 x 100 MVA | |

- The maximum load of around 2,081 MW for 66 kV system and the maximum load of around 788 MW for 33 kV system were assumed to be supplied from 230 kV substations in proportion to their power supply capacities. The estimated loads of 230 kV substations were listed as Table 4.

**Table 4 Maximum Power Demand Forecast for 230 kV Substations in 2020**

| 66 kV | Load (MW) | 33 kV | Load (MW) |
|---|---|---|---|
| Ahlone | 391 | Ahlone | 84 |
| Bayintnaung | 189 | Hlaingtharyar | 99 |
| Hlawga | 45 | Hlawga | 263 |
| Thakheta | 298 | Thanlyin | 99 |
| Iwama | 231 | Wartayar | 49 |
| East Dagong | 189 | Thakheta1 | 38 |
| South Okkalapa | 189 | Thakheta2 | 38 |
| Kyaikkasan | 189 | Iwama | 20 |
| Thida | 189 | West University | 99 |
| Tilawa | 168 | Total | 788 |
| Total | 2,081 | | |

The demand forecast apart from Yangon area was allocated based on the PSSE model used in "JICA Expert for Strengthening of Implementation Capacity for Transmission Line and Substation (2013)", however, the power demand of Yangon area was revised according to the results of JICA Master Plan and the power system plan of Yangon was updated according to the latest information. The system in the north and the east of Paryagyi and the north and the east of Hlaingtayar was modeled based on the previous data, however, the system model of the PSSE software by those information is considered enough for the analysis for this study because the system in around Yangon was reviewed reflecting the latest information. The following table shows the comparison of the demand forecasts between this Study and JICA Expert Study in 2013.

Power Demand Data of PSS/E used in JICA Expert Study in 2013

| Yangon Total | Other areas | Whole system |
|---|---|---|
| 1749.374 MW | 5686.009 MW | 3936.635 MW |

Power Demand Data of PSS/E used in this study

| Yangon Total | Other areas | Whole system |
|---|---|---|
| 2869.0001 MW | 6529.0927 MW | 3660.0926 MW |

### 4.3 Power Generation and Conductor of 230 kV Transmission Line

The power generators in around Yangon area were set out as shown in Table 5. The numerical values of power outputs from Thaketa, Ahlone, Ywama and Hlawga were used that were also used in the previous study.

**Table 5 Power Outputs of Generators in around Yangon Area in Base Case**

| Power Stations | In service | Out of service |
|---|---|---|
| Tilawa | 50 MW | 0 MW |
| Thakheta | 92.2 MW | 0 MW |
| Ahlone | 278.4 MW | 0 MW |
| Ywama | 223.5 MW | 0 MW |
| Hlawga | 104.7 MW | 51.1 MW |
| TWH Thailand | 500 MW | 0 MW |
| Ngayotekaung | 540 MW | 0 MW |
| Dawei | 450 MW | 0 MW |

This case can be considered as the case with large power outputs of generators in around Yangon area. Thus, this case is the case with small power outputs from the hydropower stations located in the northern side of Myanmar.

The following two types of conductors are mainly used for 230 kV transmission lines in Myanmar.

- Twin bundle conductors of 605 MCM, its capacity is 288 MVA/cct
- Single conductor of 795 MCM and its capacity is 164 MVA/cct

  The single of 795 MCM is used for Tharyargone - Hlawga that has a smaller capacity and the twin bundles of 605 MCM is mainly used for other intervals.

The ADB's Report that was mentioned in the previous section described the application of ACCC (Aluminum Conductor Composite Core) for the interval of Thida – Thaketa. This conductor can be used at high temperature with large capacity of 1,576 A (628 MVA) per circuit. Thus, only this interval was assumed to be equipped with this conductor.

(However, the ADB's report also mentioned that this conductor should not be applied for other intervals because it would produce huge losses when the power flow reached closed to its capacity.)

### 4.4 Base Case

The original plan of Yangon system by MEPE was analyzed with adding the model of part of the system of Yangon using PSS/E software that was also used in "JICA Expert for Strengthening of Implementation Capacity for Transmission Line and Substation". The

main part of the power system analysis data are listed in Appendix 3.

Figure 4 shows the results of power flow calculation of the 500 kV and 230 kV system in around Yangon around 2020 (base case).

According to the original plan made by MEPE, the power flow at the intervals of Hlaingtayar – Ahlon and Kyaiklat-Ahlone exceed the capacity of their transmission lines. Some interval of the 230 kV transmission lines become overloaded around Hlawga, East Dagon and Ahlone when the single circuit is dropped.

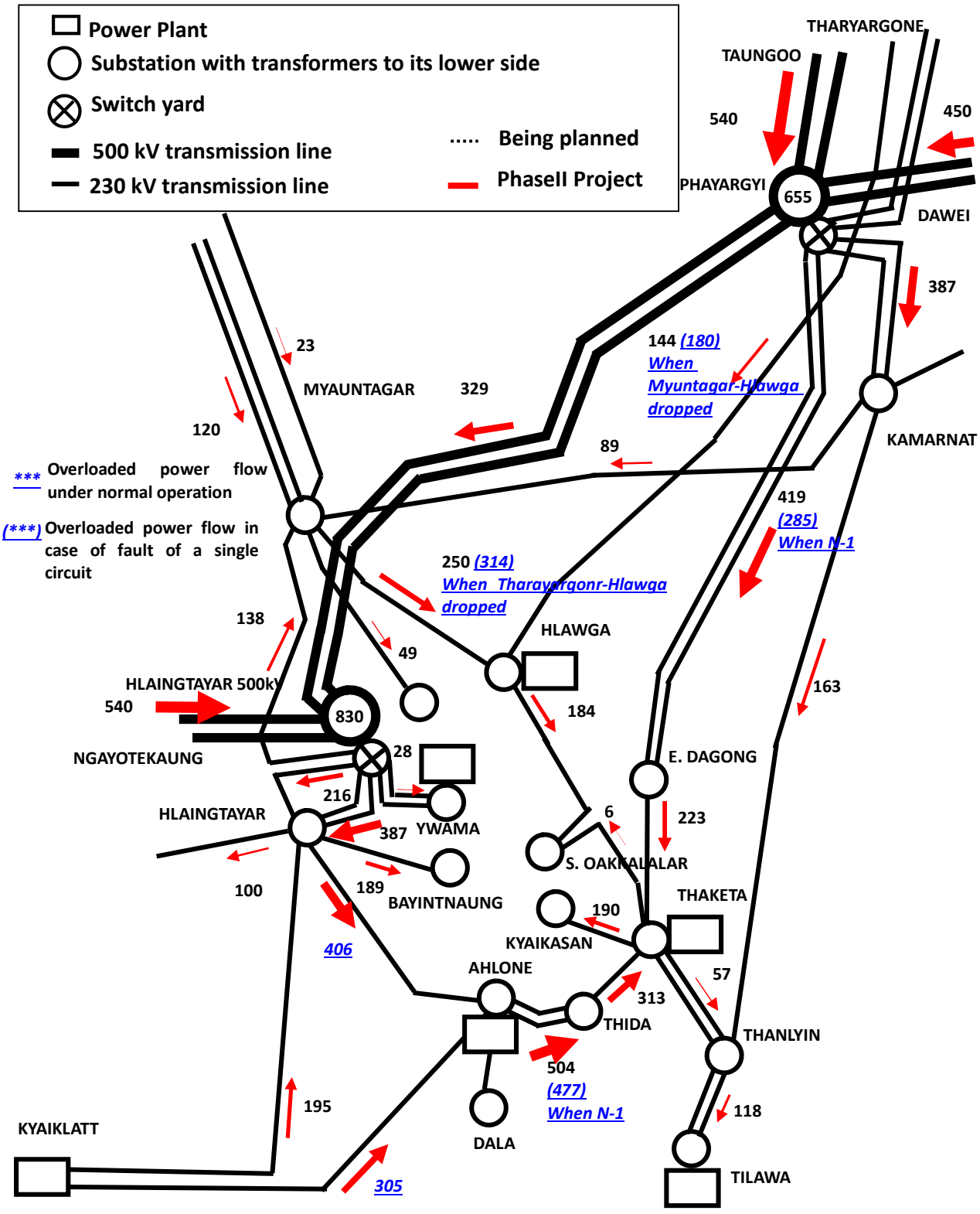



**Figure 8 Power Flow for Base Case in 2020**

### 4.5 Option of 230 kV Interconnection between East and West in Yangon around 2020

An option of the installation of the 230 kV transmission lines connecting the east and west in Yangon (they may be installed with underground cables due to their locations in a city area) is studied as a countermeasure against overloaded situations in Base Case.

This option assumes the installation of a single circuit between 230 kV Hlaingtayar and Bayintnaung and double circuits between Ywama and South Okkalar

The result of the calculation is shown in the following figure. Blue colored lines indicate newly installed transmission lines. There are no overloaded 230 kV transmission lines in normal operation although its overloaded situation still remains when a single circuit is dropped. Thus, this option can be recommended to avoid overloaded situations at normal operation.

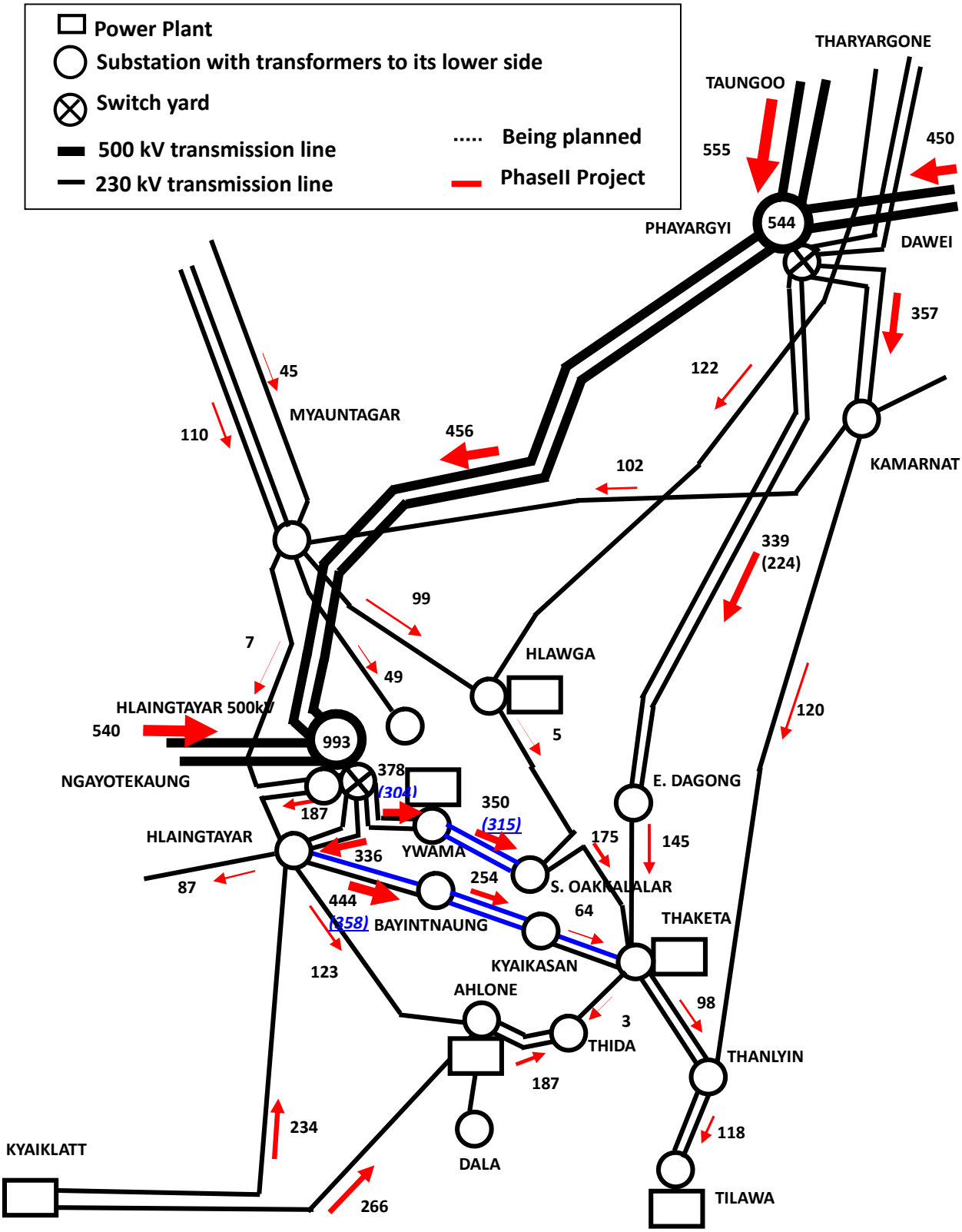


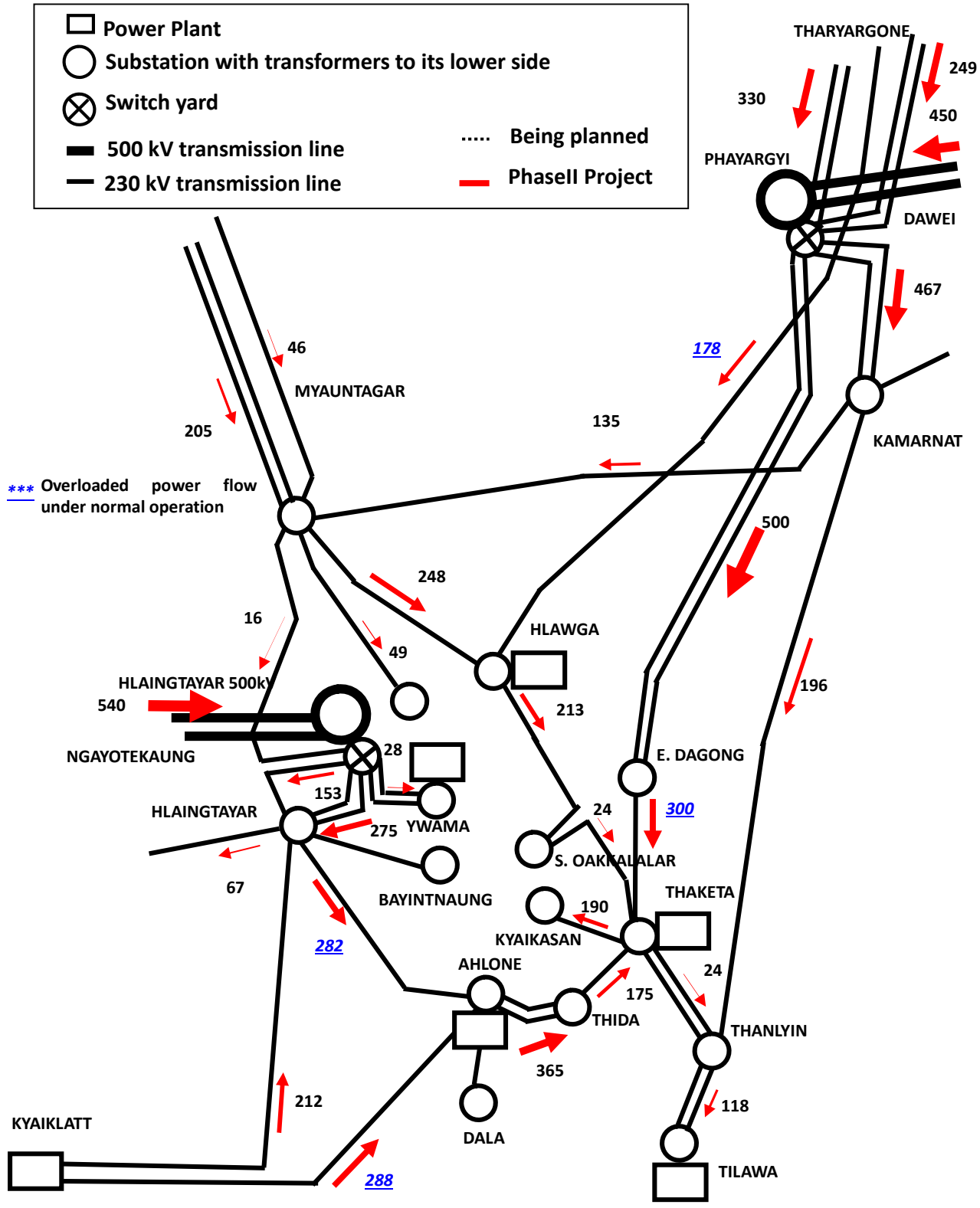

**Figure 9 Power Flow in the 230 kV System with East-West Interconnection**

### 4.6 Cases without Phase 2 Project

The power flow was calculated in case of not implementing Phase 2 Project for Base Case. Ngayotekaung and Dawei thermal power stations were assumed to be still connected to 500 kV transmission lines because they were independent from Phase 2 Project.

This case assumed that Phase 1 and the transmission line from Meikhtila to Pharyargyi through Taungoo were implemented.

From the result of the power flow analysis, the power flows at Tharyargone - Hlawga and East Dagone-Thaketa exceeded the capacities of their lines apart from Hlaingtayar - Ahlon and Kyaiklat-Ahlon if Phase 2 was not implemented.




Blue colored figures indicates over loaded power flow (MW)

**Figure 10 Power Flow in Case of Not Implementing Phase 2 Project for Base Case 2020**

### 4.7 Effects on Loss Reduction of Transmission Lines by Phase 2 Project

The implementation of Phase 2 Project can reduce the loss of transmission lines. The loss of the 500 kV and 230 kV system in Myanmar in 2020 was calculated as shown in the following table.

**Table 6 Difference of Transmission System Loss between Before and After Phase 2**

| Case | Myanmar 500 kV and 230 kV Transmission System Loss |
|---|---|
| Before Implementation | 204.4 MW |
| After Implementation | 179.9 MW |
| Difference (Effect on Loss Reduction) | 24.5 MW |
| Annual Loss Reduction | 64,386 MWh |
| Conversion for reduction of CO2 emission | 45,933 tCO2/Year |

Annual loss reduction of the system and its conversion for CO2 emission are estimated as 64,386 MWh and 45,933 tCO2/year respectively by using the loss reduction of transmission lines at the maximum power demand assuming its annual loss factor 0.3.

- 0.7134 tCO2/MWh* is used as CO2 emission factor

  *) Averaged Grid Emission Factor of China/Myanmar listed in "List of Grid Emission Factor" posted on the Web site of Institute for Global Environmental Strategies in Japan

  http://pub.iges.or.jp/modules/envirolib/view.php?docid=2136
- Loss factor is often estimated by the following formula. Assuming Load Factor of 0.48 gives a Loss Factor of 0.3.

  Loss Factor = k x Loss Factor +(1-k) x Loss Factor$^2$ (where k is often used as 0.3 for transmission system and 0.2 for distribution system)

If Phayargyi - Hlaingtayar transmission line is operated at 230 kV, its transmission line loss is increased by 2.7 MW for Base Case according to the power system analysis.

### 4.8 Power Flow in Case of Lower Power Outputs from Thermal Power Stations in 2020 (Power output from Ngayotekaug in the west is zero)

The power flow would be increased from the northern area where a lot of hydropower stations will be located to Yangon in case of the lower power outputs from the thermal power stations in Yangon. The power flow was calculated for the both cases with and without Phase 2 setting out no power outputs from Ngayotekaug power station located in the west of Yangon. The power outputs were set out as follows.

**Table 7 Power Outputs of Generators in around Yagon in Case of Lower Power Outputs from Thermal Power Stations in 2020 (Power output from Ngayotekaug in the west is zero)**

| Power Station | Operated Power Outputs | Stopping Power Outputs |
|---|---|---|
| Tilawa | 50 MW | 0 MW |
| Thakheta | 92.2 MW | 0 MW |
| Ahlone | 278.4 MW | 0 MW |
| Ywama | 223.5 MW | 0 MW |
| Hlawga | 104.7 MW | 51.1 MW |
| TWH Thailand | 500 MW | 0 MW |
| Ngayotekaung | 0 MW | 540 MW |
| Dawei | 450 MW | 0 MW |

Figure 10 shows the power flow with Phase 2 in this generation pattern.

In the similar manner to the base case, the power flows between Hlaingtayar - Ahlon and Kyaiklat – Ahlon exceed their capacity of transmission lines. There are some intervals of 230 kV transmission lines that have the over loading power flow in case of a fault of a circuit around Hlawga, East Dagon and Ahlone.

Without Phase 2, the power flow calculation was not converged. This means that the power transmission is not possible at the maximum power demand without Phase 2. Its calculation was converged when the maximum power demand was decreased.The power flow became not to exceed the capacities of the transmission lines when the power demand of Yangon was decreased by around 28%. The Figure 11 shows the results of the power flow calculation for this case.

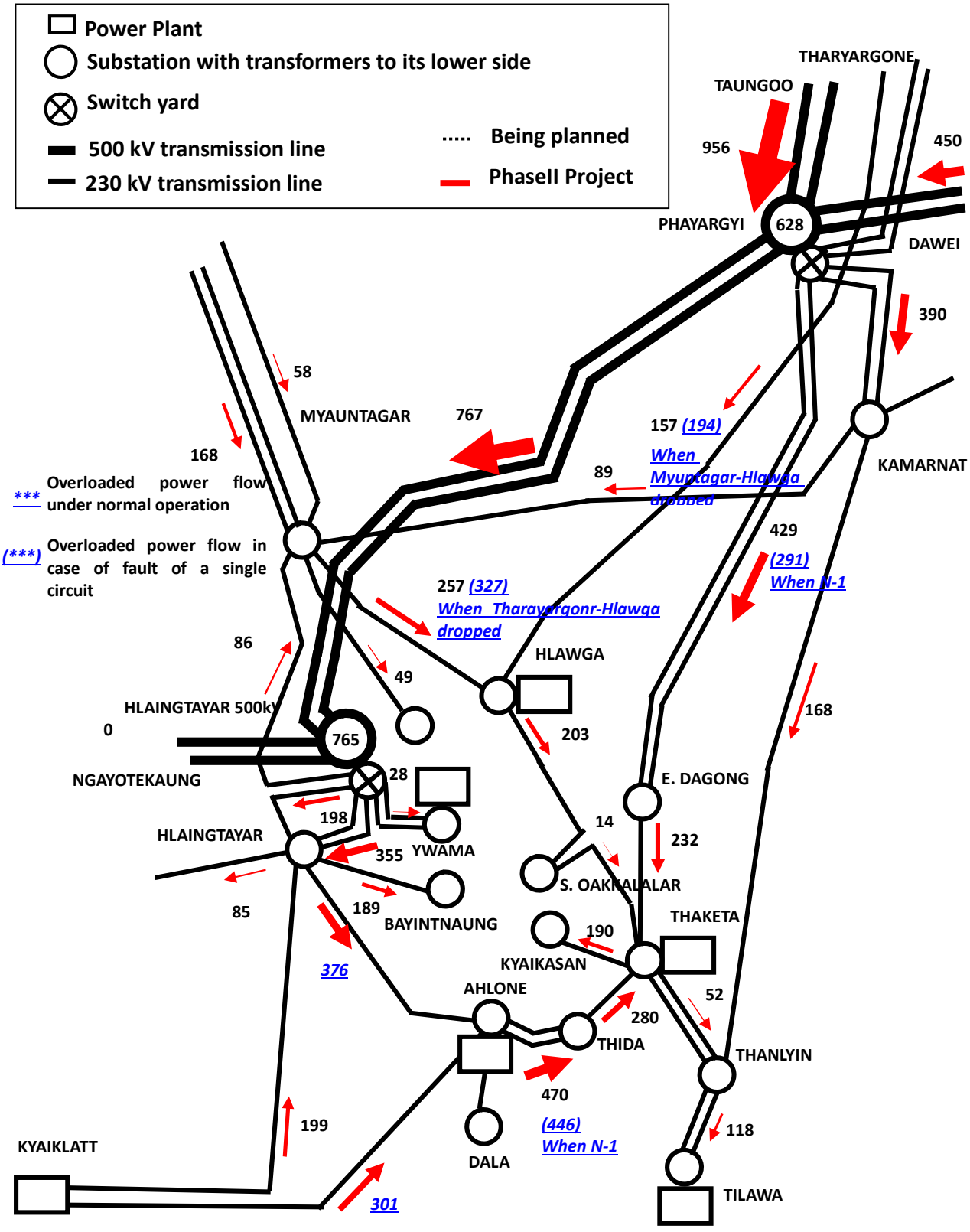



**Figure 11 Case of Lower Power Outputs from Thermal Power Stations in 2020 (Power output from Ngayotekaug in the west is zero)**

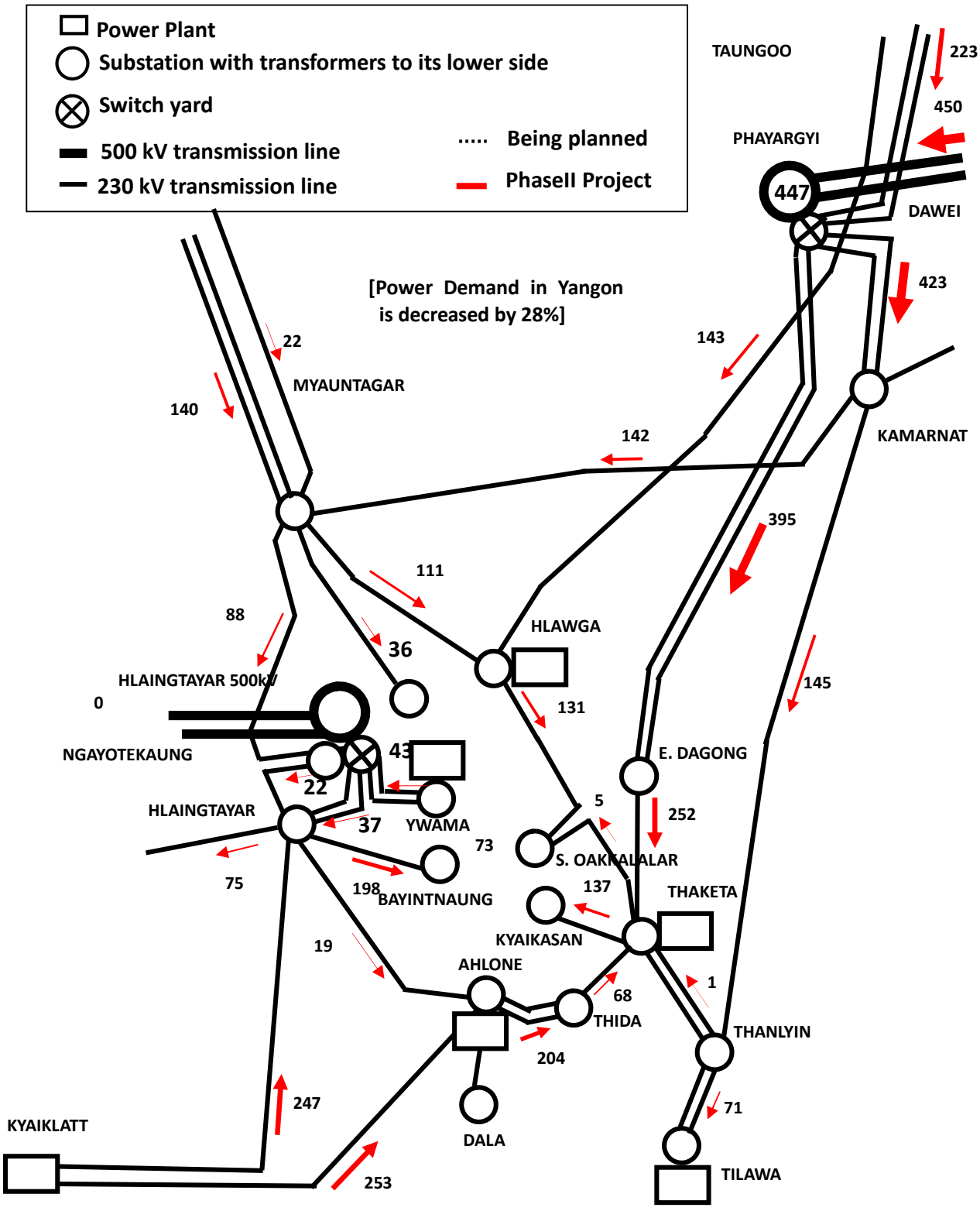



**Figure 12 Case of Lower Power Outputs from Thermal Power Stations in 2020 (Power output from Ngayotekaug in the west is zero) without Phase 2 and decreasing power demand of Yangon by 28%**

### 4.9 Recommendations for Power System Configuration in Yangon

The followings can be raised as the candidates of recommendations for power system configuration in Yangon.

- Implementation of 500 kV and 230 kV transmission lines and substations planned by MEPE including Phase 2 Project on schedule
- Installation of 230 kV transmission lines connecting the east and the west in Yangon through Ywama-S.Oakkalar and Bayintnaung-Kyaikasan and doubling circuits of Hlaigntayar-Bayintnaung and Thaketa-Kyaikasan up to around 2020. It will contribute to secure the power supply to the substations planed by MEPE responding to the rapid growing of power flow from the west to the east in Yangon.

For future power system, the followings can be recommended.

- When the maximum power demand of Yangon will reach 4,000 MW from 2,869 MW that is the maximum power demand of Yangon in 2020, it is considered that more substations at least four will be required even in consideration with the expansion of the existing substations.
- In future, Myanmar power system should become N-1 oriented system. The installation of the new 500 kV substation in the eastern part of Yangon in around East Dagon is recommended to supply power from the east to fulfill the N-1criteria. (Appendix 4) In order to prepare this, the transmission line from Pharyargi to East Dagon is considered to be constructed as 500 kV design lines. The future 500 kV and 230 kV system in Yangon is shown in the following figure.
- The further detailed studies will be required regarding the future power system in Yangon including the 500 kV new substations and 230 kV new substations from the view point of their optimization.

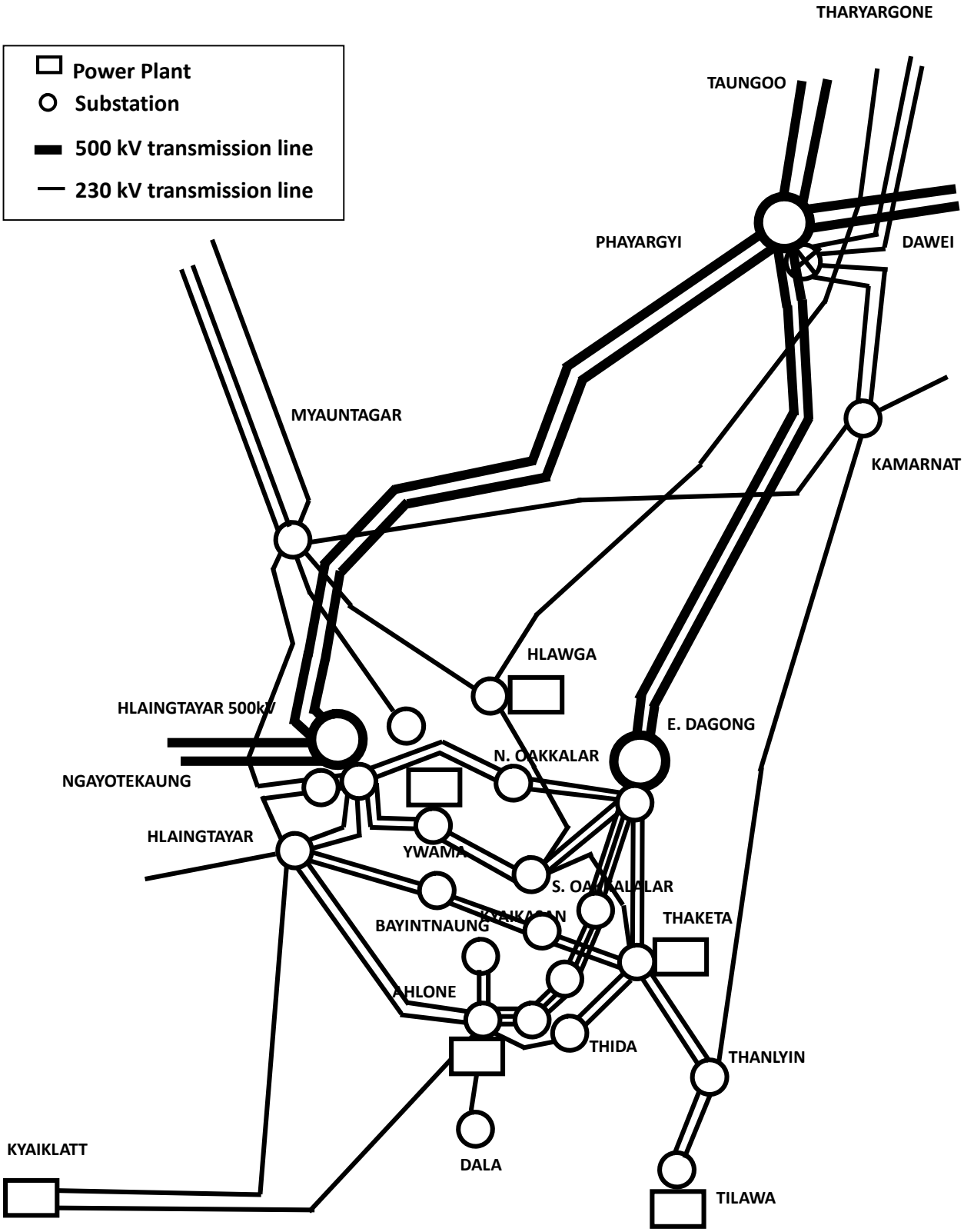



**Figure 13 Option of the Future 500 kV and 230 kV System in Yangon**

<Appendix 1>

# Questionnaire for the Counterparts during the First Site Survey

**Questionnaire (Power System Plan)**

**JICA 500 kV Phase 2**

2015/01/19

M. YOGO, TEPCO

JICA Mission

**Purpose of this Study**

To carry out the supplementary survey to prepare the JICA appraisal mission of 500 kV Phase II Project by examining and recommending the adequate system plan through reviews of the latest information.

**Questionnaire (Power System Plan)**

1. The latest nationwide power demand forecast (Maximum power as MW) (also the latest power demand forecast in Yangon)
2. The latest power generation plan and its on-going projects including their expected donors (also the latest power generation plan in around Yangon)
3. The latest bulk power transmission line/substation plan and its on-going projects including their expected donors (also the latest 230 kV power transmission line/substation plan in around Yangon))
4. The prioritized projects except for 500 kV Phase II
5. Current situations and their main specifications of 500 kV Phase II
6. Any significant changes in the route of 500 kV Hpharyargyi - Hlainghtaryar transmission line from the Previous Study?
7. Are there any significant changes in the location of 500 kV Hpharyargyi and Hlainghtaryar substations from the Previous Study?
8. Are there any significant changes in the main specifications of 500 kV transmission line from the Previous Study?
9. Are there any significant changes in the main specifications of 500 kV Hpharyargyi and Hlainghtaryar substations from the Previous Study?
10. Expected institutional arrangement for O&M
11. Current progress and main specifications of Meikhtila-Taungoo –Pharyargyi 500 kV transmission lines

- JICA 500 kV Phase II Project means “500 kV Phatyargyi and Hleigntayar substation and their connecting 500 kV transmission line”.
- Previous Study means “JICA Expert for Strengthening of Implementation Capacity for Transmission Line and Substation, 2014”.

<Reference>

**Main Specifications of the Phase II Project**

**500 kV Hpharyargyi - Hlainghtaryar transmission line**

- Conductor: Drake four (4) bundles
- Pollution level "Light"
- Insulators made in Japan
- Clearances are same as 500 kV Meikhtila – Taungoo Transmission line

**500 kV Hpharyargyi substation and 500 kV Hlainghtaryar substation**

- Number of Feeders, Transformers and Reactors

| | Hpayargyi | Hlaingtharyar |
|---|---|---|
| Number of 500 kV Line feeders | 6<br>Taungoo: 2, Hlaingtharyar: 2, Dawei: 2<br>(Final 8) | 4<br>Hpayargyi: 2, West Yangon: 2<br>(Final 8) |
| Number of 230 kV Line feeders | 6<br>Tharyargone: 2, Kamarnat: 2, Dagon East: 2<br>(Final 12) | 6<br>Myaungtagar: 1, Ywama: 2, Hlaingtharyar: 3<br>(Final 12) |
| Number of 500/230/11 kV Transformer banks | 2<br>(Final 4) | 2<br>(Final 4) |
| Reserved transformer (Single Phase) | 1 | 1 |
| Reactor (100 MVA) | 2<br>(Final 4) | 2<br>(Final 4) |

- Specifications of the 500/230/11 kV Transformers

| | |
|---|---|
| Type | Outdoor type single phase Auto transformer |
| Capacity | 500/3MVA/500/3MVA/75/3MVA |
| Shipping Mass | Less than 60t (Actual limit weight should be studied in the Detailed Design stage, Site-assembly type would be recommended.) |
| %Impedance | 12.5% (P-S) |
| Tap | ±50 kV 21 tap |
| Cooling system | OFAF (Oil Forced Air Forced) |

- Specification of the 500 kV Reactor

| | |
|---|---|
| Type | Outdoor type single phase |
| Capacity | 100/3MVA |
| Cooling system | ONAN (Oil Natural Air Natural) |
| Shipping Mass | Less than 60t(Actual limit weight should be studied in the Detailed Design stage) |
| Connected | Bus bar |

- Telecommunication

| Media | Object | Notes |
|---|---|---|
| OPGW | PCM current differential relay for transmission line protection | |
| | SCADA for National Control Center | |
| | High speed communication line in MEPE | For Intranet, VoIP |
| PLC | SCADA for National Control Center | For Backup |
| | Internal telephone line in MEPE | |

- Circuit Breaker

| | |
|---|---|
| 500 kV H-GIS50 kA | 50 kA |
| 220 kV Gas Circuit Breaker | 40 kA |

- Protection relay system

| | | |
|---|---|---|
| 500 kV Line | Main | Digital PCM current differential relay with high speed multi-phase re-closing relay system |
| | Back-up | Distance Relay (2-4 stage) |
| 230 kV line | Main | Digital PCM current differential relay with high speed re-closing relay system |
| | Back-up | Distance Relay (2-4 stage) |
| 500 kV and 230 kV bus | | Current differential relay |
| Transformer | Main | Ratio Differential Relay, OCR, OCGR (Neutral Protection) |
| | Back-up | Distance Relay (2-4 stage) |
| 500 kV Reactor | | Ratio Differential Relay, OCR, OCGR (Neutral Protection) |

- The selection of seismic design standards applied to the 500 kV transmission system in Myanmar should be discussed in the detailed design stage.
- SCS (Substation Control System) of each substation will be connected to the National Control Center (NCC) for the supervision and monitoring done by

<Appendix 2>

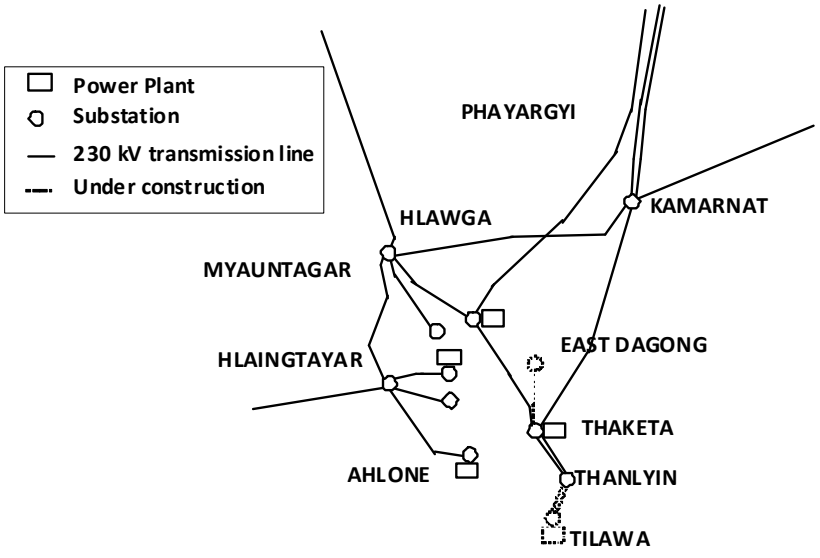
# Presentation Material for Explanation of Power System Plan to the Counterparts during the Second Site Survey

# Power System Analysis for 230 kV System in Yangon

M. YOGO, TEPCO
JICA Mission
March 2015

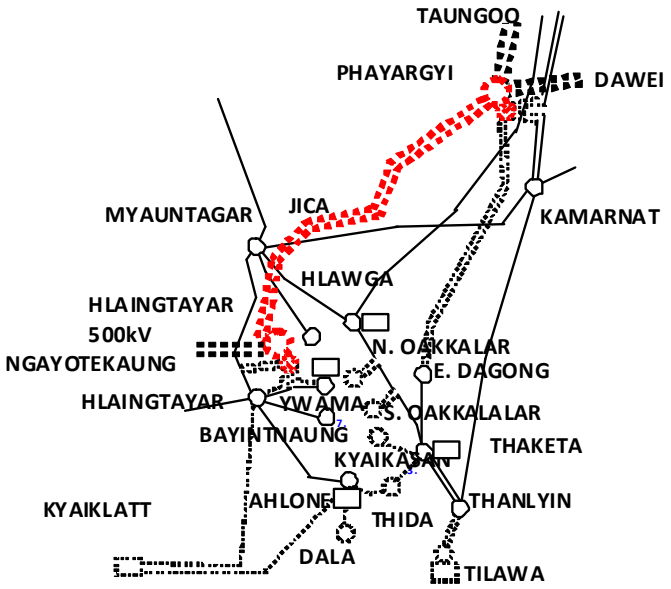
1

# Existing 230 kV System in Yangon



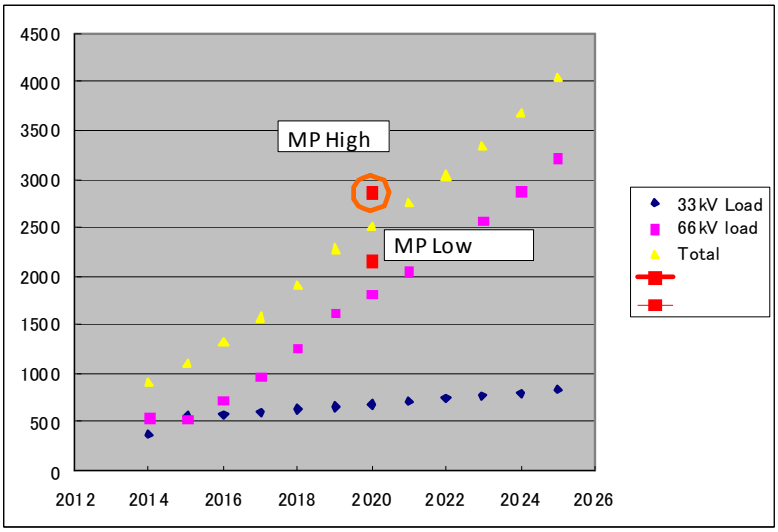

2

## Current 500kV&230 kV Yangon System Plan




3

## Power Demand Forecast for Yangon



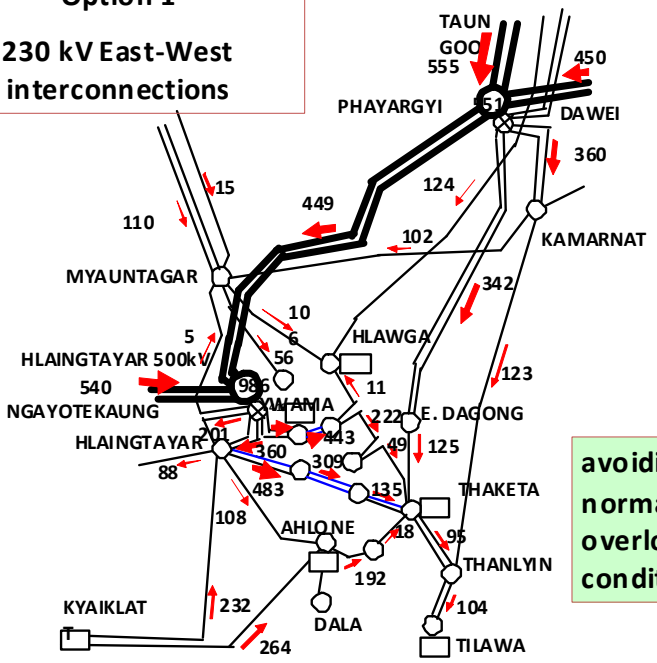

4

# Some Recommendations for 2020-2025 System

5

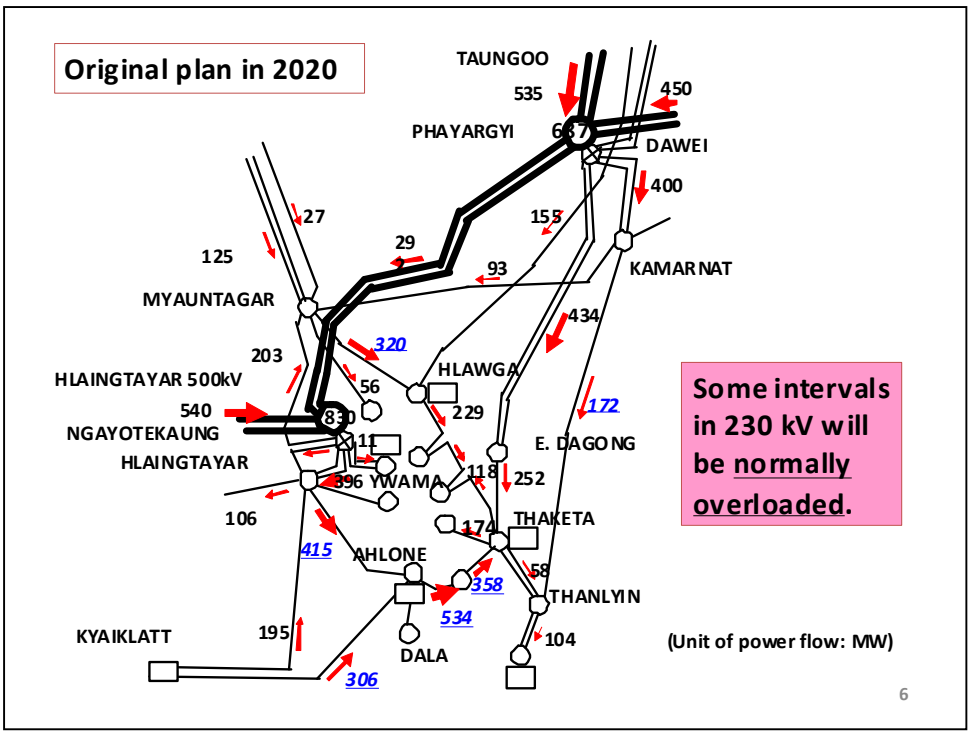
**Option 1**

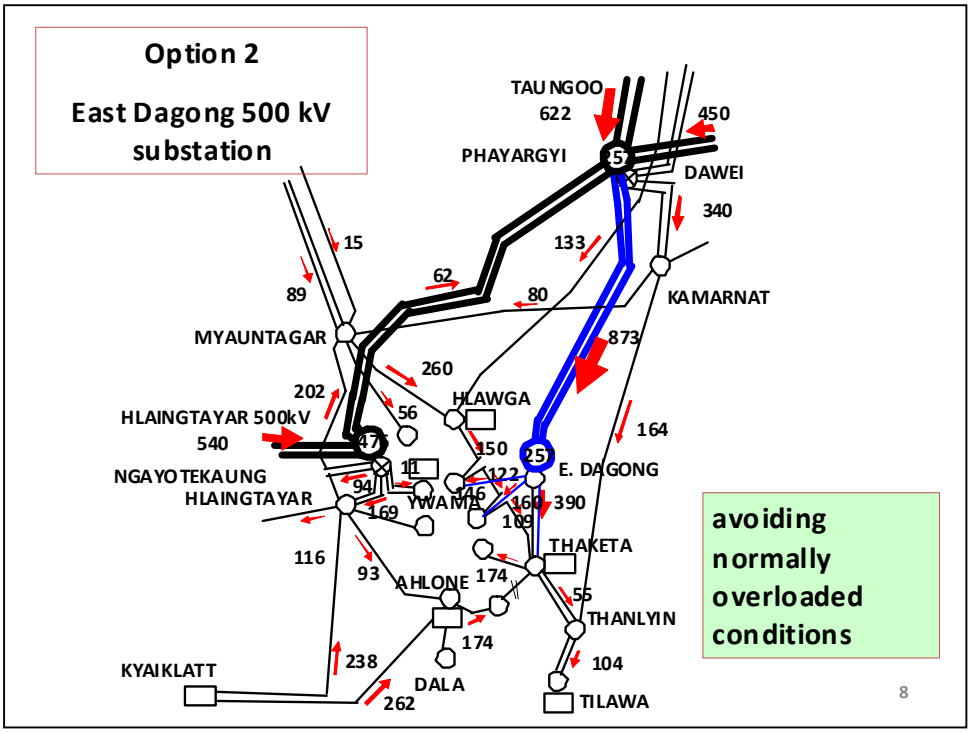
**230 kV East-West interconnections**



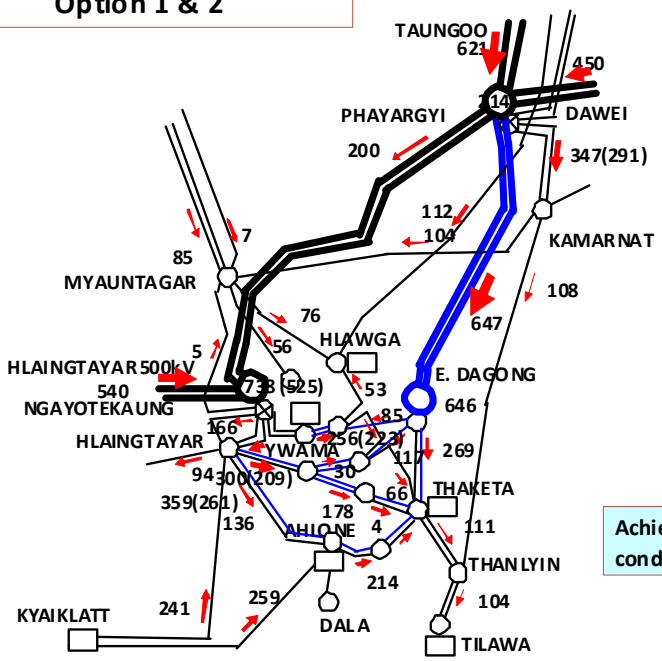

**avoiding normally overloaded conditions**

7


Original plan in 2020
TAUNGOO
535
450
PHAYARGYI
637
DAWEI
400
27
155
29
125
93
KAMARNAT
MYAUNTAGAR
434
320
203
HLAWGA
HLAINGTAYAR 500kV
56
172
540
830
229
NGAYOTEKAUNG
11
E. DAGONG
HLAINGTAYAR
118
252
396 YWAMA
106
174
THAKETA
415
AHLONE
58
358
THANLYIN
534
KYAIKLATT
195
104
DALA
306
Some intervals in 230 kV will be normally overloaded.
(Unit of power flow: MW)
6


Option 2
East Dagong 500 kV substation
TAUNGOO
622
450
PHAYARGYI
DAWEI
340
15
133
62
89
80
KAMARNAT
MYAUNTAGAR
873
260
202
HLAWGA
HLAINGTAYAR 500kV
56
164
540
150
NGAYOTEKAUNG
11
E. DAGONG
94
122
HLAINGTAYAR
YWAMA
390
169
THAKETA
116
93
AHLONE
174
55
THANLYIN
174
KYAIKLATT
238
104
DALA
262
TILAWA
avoiding normally overloaded conditions
8

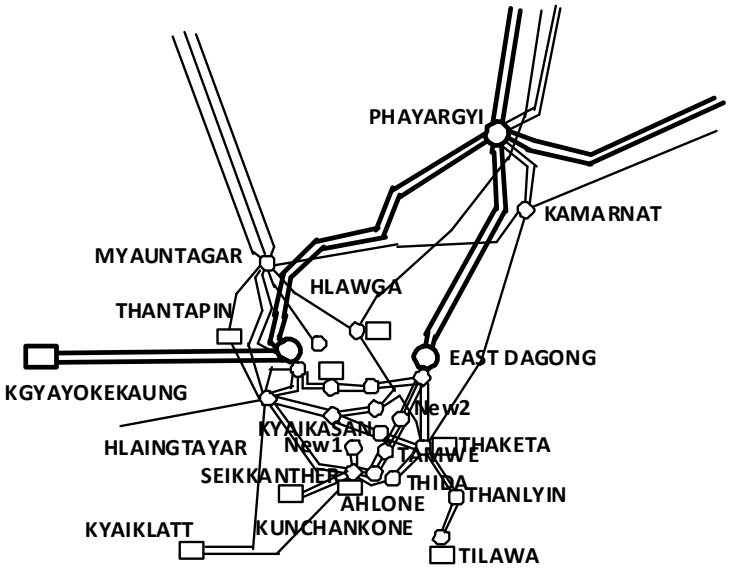
## Option 1 & 2




Achieving N-1 conditions

9

## 2025 Yangon System




10

## Recommendaitons

- Current plans of 500 kV & 230 kV substations by MEPE including JICA Phase 2
- East-west 230 kV connections such as Ywama - N.Oakkalar & Bayintnaung-Kyaikasan by 2020
- After that, 500 kV East Dagong be constructed. (The 500 kV designed line can be considered for Payargyi-East Dagong)
- More 230 kV substations for future

11

## Thank you.

12

<Appendix 3>

# Main Part of the Data for Power System Analysis of Base Case

Transmission Line Data (1)

| From Bus Number | From Bus | To Bus Number | To Bus Name | Id | Line R (pu) | Line X (pu) | Charging B (pu) | Length |
|---|---|---|---|---|---|---|---|---|
| 1001 | NPD33 | 1002 | KBL33 | 1 | 0.329913 | 0.882484 | 0.00079 | 25 |
| 1001 | NPD33 | 1002 | KBL33 | 2 | 0.329913 | 0.882484 | 0.00079 | 25 |
| 1002 | KBL33 | 1005 | TPZ33 | 1 | 0.250734 | 0.670688 | 0.0006 | 19 |
| 1002 | KBL33 | 1005 | TPZ33 | 2 | 0.250734 | 0.670688 | 0.0006 | 19 |
| 1003 | TYG33 | 1006 | YNE33 | 1 | 0.361207 | 1.08041 | 0.00079 | 27.36 |
| 1003 | TYG33 | 1006 | YNE33 | 2 | 0.361207 | 1.08041 | 0.00079 | 27.36 |
| 1004 | TGO33 | 1007 | KAP33 | 1 | 0.701326 | 0.935362 | 0.00074 | 24.95 |
| 1004 | TGO33 | 1007 | KAP33 | 2 | 0.165005 | 0.831254 | 0.00084 | 24.95 |
| 1012 | HLG33 | 1094 | YWA33 | 1 | 0 | 0.0001 | 0 | 0 |
| 2001 | TKT66 | 2002 | THD66 | 1 | 0.017976 | 0.091329 | 0.00145 | 10.9 |
| 2001 | TKT66 | 2002 | THD66 | 2 | 0.017976 | 0.091329 | 0.00145 | 10.9 |
| 2001 | TKT66 | 2017 | SPM66 | 1 | 0.02708 | 0.13758 | 0.00218 | 16.42 |
| 2001 | TKT66 | 2017 | SPM66 | 2 | 0.02708 | 0.13758 | 0.00218 | 16.42 |
| 2002 | THD66 | 2013 | AHL66 | 1 | 0.007574 | 0.016757 | 0 | 6.5 |
| 2002 | THD66 | 2013 | AHL66 | 2 | 0.007574 | 0.016757 | 0 | 6.5 |
| 2003 | BYN66 | 2015 | SML66 | 1 | 0.010045 | 0.039656 | 0.0006 | 4.62 |
| 2003 | BYN66 | 2015 | SML66 | 2 | 0.010045 | 0.039656 | 0.0006 | 4.62 |
| 2003 | BYN66 | 2017 | SPM66 | 1 | 0.018436 | 0.072409 | 0.00111 | 8.48 |
| 2004 | SHD66 | 2018 | PYA66 | 1 | 0.037628 | 0.086691 | 0.00116 | 9.64 |
| 2006 | ATB66 | 2007 | ZGY66-1 | 1 | 0.277527 | 0.678753 | 0.00971 | 76.8 |
| 2006 | ATB66 | 2031 | KLW66 | 1 | 0 | 0.0001 | 0 | 0 |
| 2007 | ZGY66-1 | 2019 | ZGY66-2 | 1 | 0.053028 | 0.130624 | 0 | 13.4 |
| 2008 | THT66 | 2009 | PAN66 | 1 | 0.129079 | 0.315691 | 0.00452 | 35.72 |
| 2009 | PAN66 | 2020 | MLM66 | 1 | 0.208218 | 0.509241 | 0.00729 | 57.62 |
| 2010 | KMN66 | 2021 | ZTU66 | 1 | 0.163517 | 0.399916 | 0.00557 | 45.25 |
| 2011 | OSP66 | 2037 | MYN66 | 1 | 0.108288 | 0.055015 | 0.00871 | 65.66 |
| 2011 | OSP66 | 2037 | MYN66 | 2 | 0.108288 | 0.055015 | 0.00871 | 65.66 |
| 2012 | N-BMW66 | 2014 | N-NBA | 1 | 0.428469 | 1.04791 | 0.01499 | 118.57 |
| 2013 | AHL66 | 2015 | SML66 | 1 | 0.010045 | 0.039656 | 0.0006 | 4.62 |
| 2014 | N-NBA | 2022 | KPT66 | 1 | 0.267445 | 0.654095 | 0.00933 | 74.01 |
| 2014 | N-NBA | 2039 | MHY66 | 1 | 0.223042 | 0.667139 | 0.007768 | 67.58 |
| 2031 | KLW66 | 2044 | U-BAL66 | 1 | 0.10621 | 0.317685 | 0.003699 | 32.18 |
| 2039 | MHY66 | 2040 | MGG66 | 1 | 0.30801 | 0.921287 | 0.010728 | 93.32 |
| 2040 | MGG66 | 2041 | MTY1_66 | 1 | 0.223042 | 0.667139 | 0.007768 | 67.58 |
| 2041 | MTY1_66 | 2043 | WGM66 | 1 | 0.159315 | 0.476528 | 0.005549 | 48.27 |
| 2045 | SID66 | 2103 | PON66 | 1 | 0.30801 | 0.921287 | 0.010728 | 93.32 |
| 2046 | WZZ66 | 2047 | GWL66 | 1 | 0.159315 | 0.476528 | 0.005549 | 48.27 |
| 2046 | WZZ66 | 2050 | HKK66 | 1 | 0.053105 | 0.158843 | 0.00185 | 16.49 |
| 3001 | APL132 | 3015 | SDG132 | 1 | 0.047465 | 0.121698 | 0.02173 | 48.6 |
| 3001 | APL132 | 3016 | TGD132 | 1 | 0.010294 | 0.026393 | 0.00471 | 10.54 |
| 3001 | APL132 | 3023 | APL_BLN_J | 1 | 0.006838 | 0.015662 | 0.003506 | 7 |
| 3002 | CHK132 | 3007 | KCH132 | 1 | 0.039857 | 0.102191 | 0.01825 | 40.81 |
| 3002 | CHK132 | 3010 | MGW132 | 1 | 0.087357 | 0.263057 | 0.04756 | 105.96 |
| 3002 | CHK132 | 3017 | TNY132 | 1 | 0.01751 | 0.075269 | 0.01536 | 32.19 |
| 3002 | CHK132 | 3017 | TNY132 | 2 | 0.01751 | 0.075269 | 0.01536 | 32.19 |
| 3002 | CHK132 | 3018 | TZI132 | 1 | 0.140675 | 0.360687 | 0.06443 | 144.04 |
| 3003 | KLW132 | 3014 | PPT132 | 1 | 0.053146 | 0.165746 | 0.02792 | 64.41 |
| 3003 | KLW132 | 3014 | PPT132 | 2 | 0.052932 | 0.165077 | 0.02781 | 64.15 |
| 3003 | KLW132 | 3019 | TKY132 | 1 | 0.023192 | 0.064477 | 0.01368 | 28.15 |
| 3003 | KLW132 | 3019 | TKY132 | 2 | 0.023192 | 0.064477 | 0.01368 | 28.15 |
| 3003 | KLW132 | 3033 | YPS132 | 1 | 0.031414 | 0.087335 | 0.018534 | 38.13 |
| 3003 | KLW132 | 3033 | YPS132 | 2 | 0.031414 | 0.087335 | 0.018534 | 38.13 |
| 3004 | LTP132-2 | 3028 | BHP132 | 1 | 0.004378 | 0.013139 | 0.0024 | 5.31 |
| 3004 | LTP132-2 | 3101 | BAL-3_132 | 1 | 0.004773 | 0.014374 | 0.002599 | 5.79 |
| 3005 | KTG132 | 3027 | NMS132 | 1 | 0.098032 | 0.294207 | 0.05383 | 118.9 |
| 3005 | KTG132 | 3027 | NMS132 | 2 | 0.098032 | 0.294207 | 0.05383 | 118.9 |
| 3006 | KDA132 | 3018 | TZI132 | 1 | 0.039666 | 0.176084 | 0.03395 | 73.06 |
| 3006 | KDA132 | 3026 | ING132 | 1 | 0.045834 | 0.117516 | 0.02099 | 46.93 |
| 3007 | KCH132 | 3013 | NBG132 | 1 | 0.120888 | 0.362772 | 0.06637 | 146.61 |

Transmission Line Data (2)

| From Bus Number | From Bus | To Bus Number | To Bus Name | Id | Line R (pu) | Line X (pu) | Charging B (pu) | Length |
|---|---|---|---|---|---|---|---|---|
| 4003 | HLG230 | 4215 | N.OKKALAPA | 1 | 0.000601 | 0.004038 | 0.012423 | 6.685 |
| 4004 | HTY230 | 4008 | MTG230 | 1 | 0.003818 | 0.02418 | 0.086078 | 42.49 |
| 4004 | HTY230 | 4034 | ATK230 | 1 | 0.010315 | 0.069304 | 0.21403 | 114.78 |
| 4004 | HTY230 | 4035 | BYN230 | 1 | 0.000998 | 0.006708 | 0.02064 | 11.11 |
| 4004 | HTY230 | 4035 | BYN230 | 2 | 0.000998 | 0.006708 | 0.02064 | 11.11 |
| 4004 | HTY230 | 4044 | AHL230 | 1 | 0.002016 | 0.013546 | 0.04183 | 22.43 |
| 4004 | HTY230 | 4044 | AHL230 | 2 | 0.002016 | 0.013546 | 0.04183 | 22.43 |
| 4004 | HTY230 | 4108 | KKL230 | 1 | 0.004339 | 0.027478 | 0.097817 | 48.28 |
| 4004 | HTY230 | 4154 | HTL230 | 1 | 0.000578 | 0.003663 | 0.01304 | 6.44 |
| 4004 | HTY230 | 4154 | HTL230 | 2 | 0.000578 | 0.003663 | 0.01304 | 6.44 |
| 4004 | HTY230 | 4154 | HTL230 | 3 | 0.000397 | 0.003302 | 0.011454 | 5.79 |
| 4004 | HTY230 | 4235 | THANTAPIN | 1 | 0.001591 | 0.010687 | 0.032882 | 17.699 |
| 4004 | HTY230 | 4250 | KYAIKLATT | 1 | 0.007447 | 0.050033 | 0.153947 | 82.864 |
| 4005 | MSN230 | 4018 | SSY230 | 1 | 0.017439 | 0.11044 | 0.3857 | 194.05 |
| 4005 | MSN230 | 4018 | SSY230 | 2 | 0.017439 | 0.11044 | 0.3857 | 194.05 |
| 4005 | MSN230 | 4051 | SHW230 | 1 | 0.00862 | 0.054591 | 0.19064 | 95.92 |
| 4005 | MSN230 | 4051 | SHW230 | 2 | 0.00862 | 0.054591 | 0.19064 | 95.92 |
| 4005 | MSN230 | 4115 | TIN230 | 1 | 0.008681 | 0.054978 | 0.195714 | 96.6 |
| 4006 | LPT230 | 4014 | SHM230 | 1 | 0.017355 | 0.10991 | 0.391266 | 193.12 |
| 4006 | LPT230 | 4017 | TGO230 | 1 | 0.020983 | 0.123341 | 0.21817 | 154.06 |
| 4006 | LPT230 | 4152 | TUG230 | 1 | 0.010775 | 0.089648 | 0.310991 | 157.28 |
| 4006 | LPT230 | 4152 | TUG230 | 2 | 0.010775 | 0.089648 | 0.310991 | 157.28 |
| 4007 | KMN230 | 4008 | MTG230 | 1 | 0.005781 | 0.038842 | 0.11995 | 64.33 |
| 4007 | KMN230 | 4019 | TLY230 | 1 | 0.00882 | 0.059101 | 0.18468 | 98.43 |
| 4007 | KMN230 | 4029 | SIT230 | 1 | 0.005278 | 0.035367 | 0.1114 | 58.9 |
| 4007 | KMN230 | 4153 | PYG230 | 1 | 0.003326 | 0.021062 | 0.074977 | 37.01 |
| 4007 | KMN230 | 4153 | PYG230 | 2 | 0.003326 | 0.021062 | 0.074977 | 37.01 |
| 4008 | MTG230 | 4016 | SHD230 | 1 | 0.018809 | 0.119119 | 0.424047 | 209.3 |
| 4008 | MTG230 | 4016 | SHD230 | 2 | 0.018809 | 0.119119 | 0.424047 | 209.3 |
| 4008 | MTG230 | 4030 | MHL230 | 1 | 0.012225 | 0.081923 | 0.256 | 136.44 |
| 4008 | MTG230 | 4154 | HTL230 | 2 | 0.00323 | 0.021646 | 0.068179 | 36.5 |
| 4008 | MTG230 | 4235 | THANTAPIN | 1 | 0.001735 | 0.011658 | 0.035871 | 19.308 |
| 4008 | MTG230 | 4245 | WARTAYAR | 1 | 0.001797 | 0.012076 | 0.037157 | 0 |
| 4009 | PMN230 | 4010 | NPT230 | 1 | 0.00184 | 0.012333 | 0.03885 | 20.54 |
| 4009 | PMN230 | 4011 | PLG230 | 1 | 0.000882 | 0.007337 | 0.025452 | 12.87 |
| 4009 | PMN230 | 4011 | PLG230 | 2 | 0.000882 | 0.007337 | 0.025452 | 12.87 |
| 4009 | PMN230 | 4014 | SHM230 | 1 | 0.004332 | 0.025755 | 0.04389 | 31.74 |
| 4009 | PMN230 | 4024 | TPU230 | 1 | 0.003752 | 0.022521 | 0.06511 | 35.98 |
| 4010 | NPT230 | 4037 | TDG230 | 1 | 0.00669 | 0.044829 | 0.1412 | 74.66 |
| 4011 | PLG230 | 4053 | NCO230 | 1 | 0.00347 | 0.021978 | 0.078237 | 38.62 |
| 4011 | PLG230 | 4055 | M-PLG230 | 1 | 0.004325 | 0.028983 | 0.09129 | 48.27 |
| 4013 | OHT230 | 4027 | NBG230 | 1 | 0.007883 | 0.050752 | 0.17088 | 87.59 |
| 4013 | OHT230 | 4027 | NBG230 | 2 | 0.007883 | 0.050752 | 0.17088 | 87.59 |
| 4013 | OHT230 | 4119 | NPD230 | 1 | 0.012146 | 0.076921 | 0.27383 | 135.16 |
| 4013 | OHT230 | 4119 | NPD230 | 2 | 0.012146 | 0.076921 | 0.27383 | 135.16 |
| 4014 | SHM230 | 4038 | TZI230 | 1 | 0.014054 | 0.083554 | 0.14239 | 102.97 |
| 4014 | SHM230 | 4124 | NPT2_230 | 1 | 0.001446 | 0.009157 | 0.032599 | 16.09 |
| 4016 | SHD230 | 4030 | MHL230 | 1 | 0.018412 | 0.123383 | 0.38556 | 205.49 |
| 4016 | SHD230 | 4037 | TDG230 | 1 | 0.012852 | 0.08612 | 0.26912 | 143.43 |
| 4016 | SHD230 | 4037 | TDG230 | 2 | 0.012852 | 0.08612 | 0.26912 | 143.43 |
| 4016 | SHD230 | 4039 | OSP230 | 1 | 0.0037 | 0.024858 | 0.07649 | 41.17 |
| 4016 | SHD230 | 4152 | TUG230 | 1 | 0.015916 | 0.100793 | 0.358809 | 177.1 |
| 4016 | SHD230 | 4152 | TUG230 | 2 | 0.015916 | 0.100793 | 0.358809 | 177.1 |
| 4017 | TGO230 | 4021 | TYG230 | 1 | 0.008666 | 0.058074 | 0.18147 | 96.72 |
| 4017 | TGO230 | 4024 | TPU230 | 1 | 0.006759 | 0.040573 | 0.117301 | 64.82 |
| 4017 | TGO230 | 4028 | KUN230 | 1 | 0.008128 | 0.062928 | 0.06368 | 59.68 |
| 4017 | TGO230 | 4032 | TYK230 | 1 | 0.002052 | 0.013451 | 0.04343 | 22.53 |
| 4017 | TGO230 | 4152 | TUG230 | 1 | 0.001772 | 0.010635 | 0.030748 | 17 |
| 4017 | TGO230 | 4152 | TUG230 | 2 | 0.001772 | 0.010635 | 0.030748 | 17 |
| 4018 | SSY230 | 4043 | MYP230 | 1 | 0.002362 | 0.015789 | 0.04949 | 26.17 |

Transmission Line Data (3)

| From Bus Number | From Bus | To Bus Number | To Bus Name | Id | Line R (pu) | Line X (pu) | Charging B (pu) | Length |
|---|---|---|---|---|---|---|---|---|
| 4018 | SSY230 | 4101 | U-YW230 | 1 | 0.01157 | 0.073276 | 0.260851 | 128.75 |
| 4018 | SSY230 | 4101 | U-YW230 | 2 | 0.01157 | 0.073276 | 0.260851 | 128.75 |
| 4019 | TLY230 | 4033 | TKT230 | 1 | 0.011135 | 0.007052 | 0.02455 | 12.39 |
| 4019 | TLY230 | 4033 | TKT230 | 2 | 0.011135 | 0.007052 | 0.02455 | 12.39 |
| 4019 | TLY230 | 4240 | THILAWA | 1 | 0.000827 | 0.005555 | 0.017092 | 9.2 |
| 4019 | TLY230 | 4240 | THILAWA | 2 | 0.000827 | 0.005555 | 0.017092 | 9.2 |
| 4020 | TPW230 | 4025 | YYW230 | 1 | 0.00769 | 0.063988 | 0.22197 | 112.26 |
| 4020 | TPW230 | 4025 | YYW230 | 2 | 0.00769 | 0.063988 | 0.22197 | 112.26 |
| 4020 | TPW230 | 4037 | TDG230 | 1 | 0.013407 | 0.090081 | 0.278188 | 149.19 |
| 4020 | TPW230 | 4038 | TZI230 | 1 | 0.002257 | 0.015125 | 0.04764 | 25.19 |
| 4020 | TPW230 | 4151 | MTL230 | 1 | 0.002241 | 0.014194 | 0.050528 | 24.94 |
| 4020 | TPW230 | 4151 | MTL230 | 3 | 0.001102 | 0.009171 | 0.031815 | 16.09 |
| 4020 | TPW230 | 4151 | MTL230 | 4 | 0.001102 | 0.009171 | 0.031815 | 16.09 |
| 4021 | TYG230 | 4028 | KUN230 | 1 | 0.006664 | 0.051593 | 0.05221 | 48.93 |
| 4021 | TYG230 | 4041 | SKY230 | 1 | 0.003704 | 0.024796 | 0.07658 | 41.07 |
| 4021 | TYG230 | 4057 | BWG230 | 1 | 0.001591 | 0.010073 | 0.035859 | 32.18 |
| 4021 | TYG230 | 4153 | PYG230 | 1 | 0.011192 | 0.070878 | 0.252314 | 124.54 |
| 4021 | TYG230 | 4153 | PYG230 | 2 | 0.011192 | 0.070878 | 0.252314 | 124.54 |
| 4027 | NBG230 | 4042 | CHU230 | 1 | 0.009467 | 0.062041 | 0.2003 | 103.9 |
| 4027 | NBG230 | 4058 | SWG230 | 1 | 0.001446 | 0.009157 | 0.032599 | 16.09 |
| 4027 | NBG230 | 4109 | KAL230 | 1 | 0.013745 | 0.087049 | 0.309881 | 152.95 |
| 4027 | NBG230 | 4109 | KAL230 | 2 | 0.013745 | 0.087049 | 0.309881 | 152.95 |
| 4028 | KUN230 | 4052 | PYC230 | 1 | 0.001442 | 0.009661 | 0.03043 | 16.09 |
| 4029 | SIT230 | 4066 | BEL230 | 1 | 0.004559 | 0.030553 | 0.096235 | 50.88 |
| 4030 | MHL230 | 4106 | HTD230 | 1 | 0.008681 | 0.054978 | 0.195714 | 96.6 |
| 4031 | THT230 | 4045 | MLM230 | 1 | 0.007209 | 0.048305 | 0.15215 | 80.45 |
| 4031 | THT230 | 4063 | HTK230 | 1 | 0.008676 | 0.054944 | 0.195593 | 96.54 |
| 4031 | THT230 | 4063 | HTK230 | 2 | 0.008676 | 0.054944 | 0.195593 | 96.54 |
| 4031 | THT230 | 4066 | BEL230 | 1 | 0.004559 | 0.030553 | 0.096235 | 50.88 |
| 4033 | TKT230 | 4107 | EDG230 | 1 | 0.001446 | 0.009157 | 0.032599 | 16.09 |
| 4033 | TKT230 | 4107 | EDG230 | 2 | 0.001446 | 0.009157 | 0.032599 | 16.09 |
| 4033 | TKT230 | 4200 | SOUTH OKK | 1 | 0.000801 | 0.005383 | 0.016565 | 8.92 |
| 4033 | TKT230 | 4205 | KYAIKKASAI | 1 | 0.000669 | 0.004492 | 0.013822 | 7.44 |
| 4033 | TKT230 | 4205 | KYAIKKASAI | 2 | 0.000669 | 0.004492 | 0.013822 | 7.44 |
| 4033 | TKT230 | 4210 | THIDA | 1 | 0.00067 | 0.004498 | 0.013841 | 7.45 |
| 4033 | TKT230 | 4210 | THIDA | 2 | 0.00067 | 0.004498 | 0.013841 | 7.45 |
| 4034 | ATK230 | 4105 | PTI230 | 1 | 0.005787 | 0.036652 | 0.130476 | 64.4 |
| 4034 | ATK230 | 4106 | HTD230 | 1 | 0.011575 | 0.073304 | 0.260952 | 128.8 |
| 4035 | BYN230 | 4200 | SOUTH OKK | 1 | 0.000289 | 0.002471 | 0.2792 | 8 |
| 4035 | BYN230 | 4200 | SOUTH OKK | 2 | 0.000289 | 0.002471 | 0.2792 | 8 |
| 4035 | BYN230 | 4205 | KYAIKKASAI | 1 | 0.00047 | 0.004015 | 0.453699 | 13 |
| 4035 | BYN230 | 4205 | KYAIKKASAI | 2 | 0.00047 | 0.004015 | 0.453699 | 13 |
| 4037 | TDG230 | 4102 | MAN230 | 1 | 0.012298 | 0.077885 | 0.277262 | 136.85 |
| 4037 | TDG230 | 4102 | MAN230 | 2 | 0.012298 | 0.077885 | 0.277262 | 136.85 |
| 4039 | OSP230 | 4056 | THA230 | 2 | 0.001212 | 0.010088 | 0.034997 | 17.7 |
| 4039 | OSP230 | 4106 | HTD230 | 1 | 0.013705 | 0.091837 | 0.289266 | 152.95 |
| 4040 | STM230 | 4151 | MTL230 | 1 | 0.007082 | 0.044847 | 0.15965 | 78.8 |
| 4044 | AHL230 | 4210 | THIDA | 1 | 0.000873 | 0.005193 | 0.00885 | 6.4 |
| 4044 | AHL230 | 4210 | THIDA | 2 | 0.000873 | 0.005193 | 0.00885 | 6.4 |
| 4044 | AHL230 | 4220 | YESB OFFIC | 1 | 0.000151 | 0.001291 | 0.145882 | 4.17 |
| 4044 | AHL230 | 4220 | YESB OFFIC | 2 | 0.000151 | 0.001291 | 0.145882 | 4.17 |
| 4044 | AHL230 | 4220 | YESB OFFIC | 3 | 0.000151 | 0.001291 | 0.145882 | 4.17 |
| 4044 | AHL230 | 4230 | KUNCHANK( | 1 | 0.000899 | 0.006038 | 0.018578 | 10 |
| 4044 | AHL230 | 4230 | KUNCHANK( | 2 | 0.000899 | 0.006038 | 0.018578 | 10 |
| 4044 | AHL230 | 4250 | KYAIKLATT | 1 | 0.007447 | 0.050033 | 0.153947 | 82.864 |
| 4044 | AHL230 | 4265 | NEW2 | 1 | 0.000361 | 0.003088 | 0.349 | 10 |
| 4044 | AHL230 | 4265 | NEW2 | 2 | 0.000361 | 0.003088 | 0.349 | 10 |
| 4045 | MLM230 | 4113 | YE230 | 1 | 0.011864 | 0.075137 | 0.267476 | 132.02 |

Transmission Line Data (4)

| From Bus Number | From Bus | To Bus Number | To Bus Name | Id | Line R (pu) | Line X (pu) | Charging B (pu) | Length |
|---|---|---|---|---|---|---|---|---|
| 4045 | MLM230 | 4118 | KKR230 | 1 | 0.00723 | 0.045787 | 0.162994 | 80.45 |
| 4051 | SHW230 | 4127 | TGG230 | 1 | 0.012146 | 0.076921 | 0.27383 | 135.16 |
| 4051 | SHW230 | 4127 | TGG230 | 2 | 0.012146 | 0.076921 | 0.27383 | 135.16 |
| 4053 | NCO230 | 4054 | U-PLG230 | 1 | 0.001591 | 0.010073 | 0.035859 | 17.7 |
| 4056 | THA230 | 4104 | TOU230 | 1 | 0.001212 | 0.010088 | 0.034997 | 17.7 |
| 4059 | MYK230 | 4060 | TNT230 | 1 | 0.005784 | 0.036629 | 0.130395 | 64.36 |
| 4059 | MYK230 | 4114 | DWI230 | 1 | 0.008676 | 0.054944 | 0.195593 | 96.54 |
| 4061 | TMT230 | 4120 | NBR230 | 1 | 0.024581 | 0.155674 | 0.554179 | 273.53 |
| 4061 | TMT230 | 4120 | NBR230 | 2 | 0.024581 | 0.155674 | 0.554179 | 273.53 |
| 4062 | MWL230 | 4109 | KAL230 | 1 | 0.005061 | 0.032051 | 0.114096 | 56.32 |
| 4064 | MPR230 | 4109 | KAL230 | 1 | 0.005061 | 0.032051 | 0.114096 | 56.32 |
| 4065 | U-TLW230 | 4115 | TIN230 | 1 | 0.011279 | 0.071427 | 0.25427 | 125.5 |
| 4065 | U-TLW230 | 4115 | TIN230 | 2 | 0.011279 | 0.071427 | 0.25427 | 125.5 |
| 4067 | CBW230 | 4068 | LAZ230 | 1 | 0.010122 | 0.064101 | 0.228191 | 112.63 |
| 4067 | CBW230 | 4068 | LAZ230 | 2 | 0.010122 | 0.064101 | 0.228191 | 112.63 |
| 4102 | MAN230 | 4110 | CHK230 | 1 | 0.010128 | 0.064141 | 0.228333 | 112.7 |
| 4102 | MAN230 | 4111 | KCH230 | 1 | 0.013022 | 0.082467 | 0.293571 | 144.9 |
| 4102 | MAN230 | 4117 | ANN230 | 1 | 0.008818 | 0.07337 | 0.254522 | 128.72 |
| 4103 | PON230 | 4117 | ANN230 | 1 | 0.013227 | 0.110056 | 0.381783 | 193.08 |
| 4104 | TOU230 | 4125 | KKP230 | 1 | 0.015906 | 0.10073 | 0.358586 | 176.99 |
| 4107 | EDG230 | 4153 | PYG230 | 1 | 0.008088 | 0.054342 | 0.167206 | 90 |
| 4107 | EDG230 | 4153 | PYG230 | 2 | 0.008088 | 0.054342 | 0.167206 | 90 |
| 4107 | EDG230 | 4200 | SOUTH OKK | 2 | 0.001114 | 0.007487 | 0.023037 | 12.4 |
| 4107 | EDG230 | 4215 | N.OKKALAPA | 1 | 0.000719 | 0.00483 | 0.014863 | 8 |
| 4107 | EDG230 | 4215 | N.OKKALAPA | 2 | 0.000719 | 0.00483 | 0.014863 | 8 |
| 4107 | EDG230 | 4260 | NEW1 | 1 | 0.000253 | 0.002162 | 0.2443 | 7 |
| 4107 | EDG230 | 4260 | NEW1 | 2 | 0.000253 | 0.002162 | 0.2443 | 7 |
| 4107 | EDG230 | 4260 | NEW1 | 3 | 0.000253 | 0.002162 | 0.2443 | 7 |
| 4110 | CHK230 | 4151 | MTL230 | 1 | 0.010852 | 0.068723 | 0.244643 | 120.75 |
| 4112 | MWD230 | 4118 | KKR230 | 1 | 0.004338 | 0.027472 | 0.097796 | 48.27 |
| 4113 | YE230 | 4114 | DWI230 | 1 | 0.007234 | 0.045815 | 0.163095 | 80.5 |
| 4117 | ANN230 | 4125 | KKP230 | 1 | 0.014894 | 0.09432 | 0.335767 | 165.73 |
| 4119 | NPD230 | 4120 | NBR230 | 1 | 0.013737 | 0.086994 | 0.309688 | 152.86 |
| 4119 | NPD230 | 4120 | NBR230 | 2 | 0.013737 | 0.086994 | 0.309688 | 152.86 |
| 4120 | NBR230 | 4121 | BMO230 | 1 | 0.012291 | 0.077837 | 0.277089 | 136.77 |
| 4120 | NBR230 | 4121 | BMO230 | 2 | 0.012291 | 0.077837 | 0.277089 | 136.77 |
| 4122 | SHW3_230 | 4123 | SHW2_230 | 1 | 0.002205 | 0.018343 | 0.063631 | 32.18 |
| 4122 | SHW3_230 | 4123 | SHW2_230 | 2 | 0.002205 | 0.018343 | 0.063631 | 32.18 |
| 4126 | YWA230 | 4154 | HTL230 | 1 | 0.001064 | 0.00674 | 0.023993 | 11.84 |
| 4126 | YWA230 | 4154 | HTL230 | 2 | 0.001064 | 0.00674 | 0.023993 | 11.84 |
| 4126 | YWA230 | 4215 | N.OKKALAPA | 1 | 0.000361 | 0.003088 | 0.349 | 10 |
| 4126 | YWA230 | 4215 | N.OKKALAPA | 21 | 0.000361 | 0.003088 | 0.349 | 10 |
| 4151 | MTL230 | 4152 | TUG230 | 1 | 0.008346 | 0.116148 | 0.545955 | 0 |
| 4151 | MTL230 | 4152 | TUG230 | 2 | 0.008346 | 0.116148 | 0.545955 | 0 |
| 4152 | TUG230 | 4153 | PYG230 | 1 | 0.006687 | 0.093077 | 0.437512 | 0 |
| 4152 | TUG230 | 4153 | PYG230 | 2 | 0.006687 | 0.093077 | 0.437512 | 0 |
| 4200 | SOUTH OKK | 4215 | N.OKKALAPA | 1 | 0.000601 | 0.004038 | 0.012423 | 6.685 |
| 4220 | YESB OFFI | 4225 | TAMWE TOW | 1 | 0.000217 | 0.001853 | 0.2094 | 6 |
| 4220 | YESB OFFI | 4225 | TAMWE TOW | 2 | 0.000217 | 0.001853 | 0.2094 | 6 |
| 4220 | YESB OFFI | 4225 | TAMWE TOW | 3 | 0.000217 | 0.001853 | 0.2094 | 6 |
| 4225 | TAMWE TOW | 4260 | NEW1 | 1 | 0.000253 | 0.002162 | 0.2443 | 7 |
| 4225 | TAMWE TOW | 4260 | NEW1 | 2 | 0.000253 | 0.002162 | 0.2443 | 7 |
| 4225 | TAMWE TOW | 4260 | NEW1 | 3 | 0.000253 | 0.002162 | 0.2443 | 7 |
| 5001 | MTL500 | 5002 | TUG500 | 1 | 0.001766 | 0.024577 | 2.580126 | 235.6 |
| 5001 | MTL500 | 5002 | TUG500 | 2 | 0.001766 | 0.024577 | 2.580126 | 235.6 |
| 5001 | MTL500 | 5006 | BLN | 1 | 0.001499 | 0.020861 | 2.189979 | 199.5 |
| 5001 | MTL500 | 5006 | BLN | 2 | 0.001499 | 0.020861 | 2.189979 | 199.5 |
| 5002 | TUG500 | 5003 | PYG500 | 1 | 0.001415 | 0.019695 | 2.067635 | 188.37 |
| 5002 | TUG500 | 5003 | PYG500 | 2 | 0.001415 | 0.019695 | 2.067635 | 188.37 |
| 5003 | PYG500 | 5004 | HTL500 | 1 | 0.000676 | 0.00941 | 0.987881 | 90 |
| 5003 | PYG500 | 5004 | HTL500 | 2 | 0.000676 | 0.00941 | 0.987881 | 90 |
| 5003 | PYG500 | 5008 | KMB500 | 1 | 0.003215 | 0.044749 | 4.697857 | 427.99 |
| 5003 | PYG500 | 5008 | KMB500 | 2 | 0.003215 | 0.044749 | 4.697857 | 427.99 |
| 5003 | PYG500 | 5115 | EAST DAGO | 1 | 0.000676 | 0.00941 | 0.987881 | 90 |
| 5003 | PYG500 | 5115 | EAST DAGO | 2 | 0.000676 | 0.00941 | 0.987881 | 90 |
| 5004 | HTL500 | 5007 | NYK500 | 1 | 0.001692 | 0.023552 | 2.472557 | 225.26 |
| 5004 | HTL500 | 5007 | NYK500 | 2 | 0.001692 | 0.023552 | 2.472557 | 225.26 |
| 5004 | HTL500 | 5110 | KGYAYOKEK | 1 | 0.001127 | 0.015683 | 1.646469 | 150 |
| 5004 | HTL500 | 5110 | KGYAYOKEK | 2 | 0.001127 | 0.015683 | 1.646469 | 150 |
| 5005 | SHW3_500 | 5006 | BLN | 1 | 0.001499 | 0.020861 | 2.189979 | 199.5 |
| 5005 | SHW3_500 | 5006 | BLN | 2 | 0.001499 | 0.020861 | 2.189979 | 199.5 |
| 5005 | SHW3_500 | 5100 | CBW500 | 1 | 0.002997 | 0.041721 | 4.379958 | 399 |
| 5005 | SHW3_500 | 5100 | CBW500 | 2 | 0.002997 | 0.041721 | 4.379958 | 399 |

Generator Data (1)

| Bus Number | Bus Name | | Id | In Service | PGen (MW) | PMax (MW) | Mbase (MVA) | X Source (pu) |
|---|---|---|---|---|---|---|---|---|
| 1018 | KDA11-1 | 11.000 | 1 | 1 | 22.4 | 28 | 32.94 | 0.25 |
| 1019 | KDA11-2 | 11.000 | 1 | 1 | 22.4 | 28 | 32.94 | 0.25 |
| 1024 | KTG11-1 | 11.000 | 1 | 1 | 14.72 | 18.4 | 23 | 0.1509 |
| 1025 | KTG11-2 | 11.000 | 1 | 1 | 14.72 | 18.4 | 23 | 0.1509 |
| 1026 | KTG11-3 | 11.000 | 1 | 1 | 14.72 | 18.4 | 23 | 0.1509 |
| 1031 | LPT11-1 | 11.000 | 1 | 1 | 28 | 28 | 31.11 | 0.23 |
| 1032 | LPT11-2 | 11.000 | 1 | 1 | 28 | 28 | 31.11 | 0.23 |
| 1033 | LPT11-3 | 11.000 | 1 | 1 | 28 | 28 | 31.11 | 0.23 |
| 1034 | LPT11-4 | 11.000 | 1 | 1 | 28 | 28 | 31.11 | 0.23 |
| 1035 | LPT11-5 | 11.000 | 1 | 1 | 28 | 28 | 31.11 | 0.23 |
| 1036 | LPT11-6 | 11.000 | 1 | 1 | 28 | 28 | 31.11 | 0.23 |
| 1050 | SDG11-1 | 11.000 | 1 | 1 | 10 | 12.5 | 13.89 | 0.2 |
| 1051 | SDG11-2 | 11.000 | 1 | 1 | 10 | 12.5 | 13.89 | 0.2 |
| 1054 | SHW11-1 | 11.000 | 1 | 1 | 80 | 100 | 117.65 | 0.2 |
| 1055 | SHW11-3 | 11.000 | 1 | 1 | 80 | 100 | 117.65 | 0.2 |
| 1056 | SHW11-6 | 11.000 | 1 | 1 | 80 | 100 | 117.65 | 0.2 |
| 1057 | SKY11-1 | 11.000 | 1 | 1 | 10.8 | 13.5 | 15 | 0.16 |
| 1058 | SKY11-2 | 11.000 | 1 | 1 | 10.8 | 13.5 | 15 | 0.16 |
| 1059 | SKY11-3 | 11.000 | 1 | 1 | 10.8 | 13.5 | 15 | 0.16 |
| 1060 | SKY11-4 | 11.000 | 1 | 1 | 10.8 | 13.5 | 15 | 0.16 |
| 1066 | THT11-1 | 11.000 | 1 | 1 | 19.904 | 19.9 | 24.88 | 0.151 |
| 1067 | THT11-2 | 11.000 | 1 | 0 | 19.904 | 19.9 | 24.88 | 0.151 |
| 1068 | THT11-3 | 11.000 | 1 | 0 | 20 | 20 | 25 | 0.14 |
| 1070 | TKT11-1 | 11.000 | 1 | 1 | 19.1 | 19.1 | 23.92 | 0.12 |
| 1071 | TKT11-2 | 11.000 | 1 | 1 | 19.1 | 19.1 | 23.92 | 0.12 |
| 1072 | TKT11-3 | 11.000 | 1 | 1 | 19.1 | 19.1 | 23.92 | 0.12 |
| 1073 | TKT11-4 | 11.000 | 1 | 1 | 34.9 | 34.9 | 43.63 | 0.13 |
| 1083 | YYW11-1 | 11.000 | 1 | 1 | 156.4 | 195.5 | 230 | 0.282 |
| 1084 | YYW11-2 | 11.000 | 1 | 1 | 156.4 | 195.5 | 230 | 0.282 |
| 1085 | YYW11-3 | 11.000 | 1 | 1 | 156.4 | 195.5 | 230 | 0.282 |
| 1086 | YYW11-4 | 11.000 | 1 | 1 | 156.4 | 195.5 | 230 | 0.282 |
| 1087 | ZGY11-1 | 11.000 | 1 | 1 | 4.8 | 6 | 7.5 | 0.175 |
| 1087 | ZGY11-1 | 11.000 | 2 | 1 | 4.8 | 6 | 7.5 | 0.175 |
| 1087 | ZGY11-1 | 11.000 | 3 | 1 | 4.8 | 6 | 7.5 | 0.175 |
| 1088 | ZGY11-2 | 11.000 | 1 | 1 | 5.12 | 6.4 | 8 | 0.19 |
| 1088 | ZGY11-2 | 11.000 | 2 | 1 | 5.12 | 6.4 | 7.5 | 0.19 |
| 1095 | MYN11-1 | 11.000 | 1 | 1 | 20.2 | 20.2 | 25.31 | 0.21 |
| 1096 | MYN11-2 | 11.000 | 1 | 0 | 19.9 | 19.9 | 24.88 | 0.12 |
| 1101 | PLG11-1 | 11.000 | 1 | 1 | 56.96 | 71.2 | 83.82 | 0.1879 |
| 1102 | PLG11-2 | 11.000 | 1 | 1 | 56.96 | 71.2 | 83.82 | 0.1879 |
| 1103 | PLG11-3 | 11.000 | 1 | 1 | 56.96 | 71.2 | 83.82 | 0.1879 |
| 1104 | PLG11-4 | 11.000 | 1 | 1 | 56.96 | 71.2 | 83.82 | 0.1879 |
| 1105 | AHL11-1 | 11.000 | 1 | 1 | 34.4 | 34.4 | 43.05 | 0.1078 |
| 1106 | AHL11-2 | 11.000 | 1 | 1 | 34.4 | 34.4 | 43.05 | 0.1078 |
| 1107 | AHL11-3 | 11.000 | 1 | 1 | 34.4 | 34.4 | 43.05 | 0.1078 |
| 1108 | AHL11-4 | 11.000 | 1 | 1 | 54.3 | 54.3 | 67.88 | 0.13 |
| 1109 | TKY11-1 | 11.000 | 1 | 0 | 60 | 60 | 75 | 0.139 |
| 1110 | TKY11-2 | 11.000 | 1 | 0 | 60 | 60 | 78 | 0.139 |
| 1111 | HLG11-1 | 11.000 | 1 | 1 | 34.9 | 34.9 | 43.58 | 0.1078 |
| 1112 | HLG11-2 | 11.000 | 1 | 1 | 34.9 | 34.9 | 43.58 | 0.1078 |
| 1113 | HLG11-3 | 11.000 | 1 | 1 | 34.9 | 34.9 | 43.58 | 0.1078 |
| 1114 | HLG11-4 | 11.000 | 1 | 0 | 51.1 | 51.1 | 63.85 | 0.13 |
| 1115 | SHD11-1 | 11.000 | 1 | 0 | 20 | 20 | 25 | 0.166 |
| 1116 | SHD11-2 | 11.000 | 1 | 0 | 20 | 20 | 25 | 0.166 |
| 1117 | SHD11-3 | 11.000 | 1 | 0 | 27.3 | 27.3 | 34.13 | 0.15 |
| 1118 | MAN11-1 | 11.000 | 1 | 0 | 20 | 20 | 25 | 0.159 |
| 1119 | MAN11-2 | 11.000 | 1 | 0 | 20 | 20 | 25 | 0.151 |
| 1120 | MON11-1 | 11.000 | 1 | 1 | 20 | 25 | 29.41 | 0.2053 |
| 1121 | MON11-2 | 11.000 | 1 | 1 | 20 | 25 | 29.41 | 0.2053 |
| 1122 | MON11-3 | 11.000 | 1 | 1 | 20 | 25 | 29.41 | 0.2053 |
| 1123 | KCH11-1 | 11.000 | 1 | 0 | 20.5 | 20.5 | 25.6 | 0.14 |
| 1124 | KCH11-2 | 11.000 | 1 | 0 | 20.5 | 20.5 | 25.6 | 0.14 |
| 1125 | KCH11-3 | 11.000 | 1 | 0 | 20.5 | 20.5 | 25.6 | 0.14 |
| 1126 | KYE11-1 | 11.000 | 1 | 1 | 34.8 | 43.5 | 51.21 | 0.261 |

Generator Data (1)

| Bus Number | Bus Name | Id | In Service | PGen (MW) | PMax (MW) | Mbase (MVA) | X Source (pu) |
|---|---|---|---|---|---|---|---|
| 1127 | KYE11-2 11.000 | 1 | 1 | 34.8 | 43.5 | 51.21 | 0.261 |
| 1128 | KUN11-1 11.000 | 1 | 1 | 17.04 | 21.3 | 25 | 0.16 |
| 1129 | KUN11-2 11.000 | 1 | 1 | 17.04 | 21.3 | 25 | 0.16 |
| 1130 | KUN11-3 11.000 | 1 | 1 | 16 | 20 | 25 | 0.16 |
| 1131 | TYK11-1 11.000 | 1 | 1 | 32 | 40 | 47.06 | 0.1879 |
| 1132 | TYK11-2 11.000 | 1 | 1 | 32 | 40 | 47.06 | 0.1879 |
| 1133 | TYK11-3 11.000 | 1 | 1 | 32 | 40 | 47.06 | 0.1879 |
| 1134 | TPZ11-1 11.000 | 1 | 1 | 8 | 10 | 12.5 | 0.19374 |
| 1135 | TPZ11-2 11.000 | 1 | 1 | 8 | 10 | 12.5 | 0.19374 |
| 1136 | TPZ11-3 11.000 | 1 | 1 | 8 | 10 | 12.5 | 0.19374 |
| 1137 | KAP11-1 11.000 | 1 | 1 | 12.4 | 15.5 | 19.4 | 0.166 |
| 1138 | KAP11-2 11.000 | 1 | 1 | 12.4 | 15.5 | 19.4 | 0.166 |
| 1139 | BHP11-1 11.000 | 1 | 1 | 14 | 14 | 15.56 | 0.26 |
| 1140 | BHP11-2 11.000 | 1 | 1 | 14 | 14 | 15.56 | 0.26 |
| 1141 | YWA11-1 11.000 | 1 | 1 | 20 | 20 | 25 | 0.166 |
| 1142 | YWA11-2 11.000 | 1 | 1 | 20 | 20 | 25 | 0.166 |
| 1143 | YWA11-3 11.000 | 1 | 1 | 24.1 | 24.1 | 28.3 | 0.12 |
| 1144 | YWA11-4 11.000 | 1 | 1 | 9.45 | 9.5 | 10.5 | 0.12 |
| 1150 | KGYAYOKEKAUN11.0 | 1 | 1 | 540 | 540 | 635.29 | 0.12 |
| 1155 | KUNCHANKONE 11.0 | 1 | 1 | 300 | 300 | 470.59 | 0.12 |
| 1160 | AHLONE 11.000 | 1 | 1 | 121 | 121 | 142.35 | 0.12 |
| 1165 | THANTAPIN 11.000 | 1 | 1 | 270 | 270 | 317.65 | 0.12 |
| 1170 | THILAWA1 11.000 | 1 | 1 | 50 | 50 | 58.82 | 0.12 |
| 1175 | THILAWA2 11.000 | 1 | 1 | 650 | 650 | 764.71 | 0.12 |
| 1180 | IWAMA 11.000 | 1 | 1 | 150 | 150 | 176.47 | 0.12 |
| 1185 | KYAIKLATT 11.000 | 1 | 1 | 500 | 500 | 588.24 | 0.125 |
| 2044 | U-BAL66 66.000 | 1 | 1 | 23.2 | 29 | 34.12 | 0.25 |
| 2045 | SID66 66.000 | 1 | 1 | 9.18 | 11.475 | 13.5 | 0.25 |
| 2046 | WZZ66 66.000 | 1 | 1 | 7.2 | 9 | 10.59 | 0.25 |
| 2047 | GWL66 66.000 | 1 | 1 | 12 | 15 | 17.65 | 0.25 |
| 3044 | CWN132 132.00 | 1 | 1 | 11.88 | 14.85 | 17.47 | 0.25 |
| 3045 | U-KTG132 132.00 | 1 | 1 | 40.8 | 51 | 60 | 0.25 |
| 3046 | U-BUY132 132.00 | 1 | 1 | 120 | 150 | 176.47 | 0.25 |
| 3048 | LGD132 132.00 | 1 | 1 | 52.2 | 65.25 | 76.76 | 0.25 |
| 3049 | TGX132 132.00 | 1 | 1 | 38.4 | 48 | 56.47 | 0.25 |
| 3050 | HKK132 132.00 | 1 | 1 | 16.8 | 21 | 24.71 | 0.25 |
| 3101 | BAL-3_132 132.00 | 1 | 1 | 41.6 | 52 | 61.18 | 0.25 |
| 3106 | TAP132 132.00 | 1 | 1 | 28.8 | 36 | 42.35 | 0.25 |
| 3107 | TAP2_132 132.00 | 1 | 1 | 20.16 | 25.2 | 29.65 | 0.25 |
| 4033 | TKT230 230.00 | 1 | 0 | 16.08 | 53.6 | 63.06 | 0.25 |
| 4033 | TKT230 230.00 | 2 | 0 | 150.9 | 503 | 591.76 | 0.25 |
| 4033 | TKT230 230.00 | 3 | 0 | 153.9 | 513 | 603.53 | 0.25 |
| 4044 | AHL230 230.00 | 1 | 0 | 36.3 | 121 | 142.35 | 0.25 |
| 4052 | PYC230 230.00 | 1 | 1 | 32 | 40 | 47.06 | 0.25 |
| 4053 | NCO230 230.00 | 1 | 1 | 32 | 40 | 47.06 | 0.25 |
| 4054 | U-PLG230 230.00 | 1 | 1 | 112 | 140 | 164.71 | 0.25 |
| 4055 | M-PLG230 230.00 | 1 | 1 | 80 | 100 | 117.65 | 0.25 |
| 4056 | THA230 230.00 | 1 | 1 | 88.8 | 111 | 130.59 | 0.25 |
| 4057 | BWG230 230.00 | 1 | 1 | 128 | 160 | 188.24 | 0.25 |
| 4058 | SWG230 230.00 | 1 | 1 | 79.2 | 99 | 116.47 | 0.25 |
| 4060 | TNT230 230.00 | 1 | 1 | 72 | 90 | 105.88 | 0.25 |
| 4061 | TMT230 230.00 | 1 | 1 | 144 | 180 | 211.76 | 0.25 |
| 4062 | MWL230 230.00 | 1 | 1 | 62.4 | 78 | 91.76 | 0.25 |
| 4063 | HTK230 230.00 | 1 | 0 | 163.2 | 204 | 240 | 0.25 |
| 4064 | MPR230 230.00 | 1 | 1 | 45.6 | 57 | 67.06 | 0.25 |
| 4065 | U-TLW230 230.00 | 1 | 1 | 168 | 210 | 247.06 | 0.25 |
| 4066 | BEL230 230.00 | 1 | 0 | 224 | 280 | 329.41 | 0.25 |
| 4068 | LAZ230 230.00 | 1 | 1 | 228 | 285 | 335.29 | 0.25 |
| 4101 | U-YW230 230.00 | 1 | 1 | 224 | 280 | 329.41 | 0.25 |
| 4117 | ANN230 230.00 | 1 | 1 | 8 | 10 | 11.76 | 0.25 |
| 4123 | SHW2_230 230.00 | 1 | 1 | 62.4 | 78 | 91.76 | 0.25 |
| 5005 | SHW3_500 500.00 | 1 | 1 | 650.58 | 1050 | 1235.29 | 0.25 |
| 5007 | NYK500 500.00 | 1 | 0 | -1004 | 1300 | 1529.41 | 0.25 |
| 5008 | KMB500 500.00 | 1 | 1 | 150 | 500 | 588.24 | 0.25 |
| 5008 | KMB500 500.00 | 2 | 1 | 300 | 1000 | 1176.47 | 0.25 |
| 5100 | CBW500 500.00 | 1 | 0 | 408 | 510 | 600 | 0.25 |

Load Data (1)

| Bus Number | Bus Name | Area Num | Pload (MW) | Qload (Mvar) | |
|---|---|---|---|---|---|
| 1012 | HLG33 33.000 | 2 | 262.7469 | 114.5287 | Yangon |
| 1014 | HTY33 33.000 | 2 | 98.5301 | 42.9483 | Yangon |
| 1069 | TKT33 33.000 | 2 | 38.3173 | 16.7021 | Yangon |
| 1074 | TKT33_2 33.000 | 2 | 38.3173 | 16.7021 | Yangon |
| 1075 | TLY33 33.000 | 2 | 98.5301 | 42.9483 | Yangon |
| 1092 | AHL33 33.000 | 2 | 84.298 | 36.7446 | Yangon |
| 1094 | YWA33 33.000 | 2 | 19.706 | 8.5897 | Yangon |
| 1190 | TILAWA 33.000 | 2 | 168.3462 | 73.3804 | Yangon |
| 1210 | WEST UNIV 33.000 | 2 | 98.5301 | 42.9483 | Yangon |
| 2001 | TKT66 66.000 | 2 | 297.9728 | 129.8833 | Yangon |
| 2003 | BYN66 66.000 | 2 | 189.3895 | 82.553 | Yangon |
| 2013 | AHL66 66.000 | 2 | 390.5632 | 170.2426 | Yangon |
| 2030 | HLG66 66.000 | 2 | 45.4535 | 19.8127 | Yangon |
| 2107 | EDG66 66.000 | 2 | 189.3895 | 82.553 | Yangon |
| 2200 | IWAMA 66.000 | 2 | 231.4761 | 100.8981 | Yangon |
| 2210 | SOUTH OKKALA66.00 | 2 | 189.3895 | 82.553 | Yangon |
| 2215 | KYAIKKASAN 66.000 | 2 | 189.3895 | 82.553 | Yangon |
| 2220 | THIDA 66.000 | 2 | 189.3895 | 82.553 | Yangon |
| 2225 | N.OKKALAPA 66.000 | 2 | 0 | 0 | Yangon |
| 4245 | WARTAYAR 230.00 | 2 | 49.265 | 21.4741 | Yangon |
| 1003 | TYG33 33.000 | 1 | 12.14 | 5.292 | Other areas |
| 1004 | TGO33 33.000 | 1 | 16.9 | 7.367 | Other areas |
| 1008 | ATB33 33.000 | 1 | 17 | 7.41 | Other areas |
| 1010 | APL33 33.000 | 1 | 11 | 4.795 | Other areas |
| 1011 | BLN33 33.000 | 1 | 15.6 | 6.8 | Other areas |
| 1016 | ING33 33.000 | 1 | 18 | 7.846 | Other areas |
| 1017 | ING33_2 33.000 | 1 | 0.98 | 0.427 | Other areas |
| 1020 | KLW33 33.000 | 1 | 8.19 | 3.57 | Other areas |
| 1021 | KMN33 33.000 | 1 | 30.1749 | 14.6144 | Other areas |
| 1023 | KPT33 33.000 | 1 | 9.12 | 3.975 | Other areas |
| 1028 | YTB33 33.000 | 1 | 1.21 | 0.527 | Other areas |
| 1030 | LPH33 33.000 | 1 | 12.9 | 5.623 | Other areas |
| 1038 | MGW33 33.000 | 1 | 7.5 | 3.269 | Other areas |
| 1040 | MGW33_2 33.000 | 1 | 7.9 | 3.444 | Other areas |
| 1041 | MTG33 33.000 | 1 | 52.3313 | 25.3452 | Other areas |
| 1043 | MYP33 33.000 | 1 | 57.7 | 25.151 | Other areas |
| 1043 | MYP33 33.000 | 1 | 38.32 | 16.703 | Other areas |
| 1045 | NPT33 33.000 | 1 | 24.41 | 10.64 | Other areas |
| 1047 | MTG33_2 33.000 | 1 | 15.6994 | 7.6036 | Other areas |
| 1048 | PMN33 33.000 | 1 | 38 | 16.564 | Other areas |
| 1049 | POL33 33.000 | 1 | 19.2 | 8.369 | Other areas |
| 1052 | PMN33 33.000 | 1 | 22 | 9.59 | Other areas |
| 1053 | SHM33 33.000 | 1 | 12.72 | 5.545 | Other areas |
| 1061 | SSY33 33.000 | 1 | 43 | 18.743 | Other areas |
| 1062 | STM33 33.000 | 1 | 42 | 18.307 | Other areas |
| 1063 | TGD33 33.000 | 1 | 19.1 | 8.325 | Other areas |
| 1064 | TGD11 11.000 | 1 | 14 | 6.102 | Other areas |
| 1065 | THT33 33.000 | 1 | 18.7 | 8.151 | Other areas |
| 1076 | TPU33 33.000 | 1 | 21.58 | 9.407 | Other areas |
| 1077 | TPW33 33.000 | 1 | 26.31 | 11.468 | Other areas |
| 1077 | TPW33 33.000 | 1 | 11.24 | 4.899 | Other areas |
| 1081 | TZI33 33.000 | 1 | 19.9 | 8.674 | Other areas |
| 1082 | YPS33 33.000 | 1 | 4.3 | 1.874 | Other areas |
| 1099 | APL11 11.000 | 1 | 16.8 | 7.323 | Other areas |
| 2002 | THD66 66.000 | 1 | 49.17 | 21.433 | Other areas |
| 2004 | SHD66 66.000 | 1 | 43 | 18.743 | Other areas |
| 2005 | MYA66 66.000 | 1 | 13.5 | 5.885 | Other areas |
| 2005 | MYA66 66.000 | 1 | 12.4 | 5.405 | Other areas |
| 2008 | THT66 66.000 | 1 | 25.5 | 11.115 | Other areas |
| 2011 | OSP66 66.000 | 1 | 23.2 | 10.113 | Other areas |

Load Data (2)

| Bus Number | Bus Name | Area Num | Pload (MW) | Qload (Mvar) | |
|---|---|---|---|---|---|
| 2016 | STTY66 66.000 | 1 | 0.86 | 0.375 | Other areas |
| 2020 | MLM66 66.000 | 1 | 5.72 | 2.493 | Other areas |
| 2026 | KCH66 66.000 | 1 | 27.3 | 11.9 | Other areas |
| 2027 | ATK66 66.000 | 1 | 45.6 | 19.877 | Other areas |
| 2028 | CHK66 66.000 | 1 | 28 | 12.205 | Other areas |
| 2031 | KLW66 66.000 | 1 | 34 | 14.82 | Other areas |
| 2032 | MAN66 66.000 | 1 | 1.89 | 0.824 | Other areas |
| 2033 | MGN66 66.000 | 1 | 17 | 7.41 | Other areas |
| 2034 | MSN66 66.000 | 1 | 23.1 | 10.069 | Other areas |
| 2035 | NMS66 66.000 | 1 | 8.71 | 3.797 | Other areas |
| 2036 | TDG66 66.000 | 1 | 15 | 6.538 | Other areas |
| 2037 | MYN66 66.000 | 1 | 17.1 | 7.454 | Other areas |
| 2038 | TNY66 66.000 | 1 | 2.79 | 1.216 | Other areas |
| 2230 | YESB OFFICE 66.000 | 1 | 242 | 117.206 | Other areas |
| 2235 | TAMWE TOWNSH66.00 | 1 | 350 | 169.5127 | Other areas |
| 2240 | NEW1 66.000 | 1 | 323 | 156.4361 | Other areas |
| 2245 | NEW2 66.000 | 1 | 164 | 79.4288 | Other areas |
| 3001 | APL132 132.00 | 1 | 78.371 | 37.96 | Other areas |
| 3002 | CHK132 132.00 | 1 | 78.935 | 38.23 | Other areas |
| 3003 | KLW132 132.00 | 1 | 166.862 | 80.81 | Other areas |
| 3009 | LPH132 132.00 | 1 | 36.366 | 17.61 | Other areas |
| 3010 | MGW132 132.00 | 1 | 43.414 | 21.03 | Other areas |
| 3016 | TGD132 132.00 | 1 | 93.312 | 45.19 | Other areas |
| 3017 | TNY132 132.00 | 1 | 7.865 | 3.81 | Other areas |
| 3018 | TZI132 132.00 | 1 | 56.1 | 27.17 | Other areas |
| 3024 | MGN132 132.00 | 1 | 47.925 | 23.21 | Other areas |
| 3026 | ING132 132.00 | 1 | 53.506 | 25.91 | Other areas |
| 3027 | NMS132 132.00 | 1 | 24.544 | 11.89 | Other areas |
| 3029 | TDG132 132.00 | 1 | 42.286 | 20.48 | Other areas |
| 3030 | MAN132 132.00 | 1 | 5.328 | 2.58 | Other areas |
| 3031 | KPT132 132.00 | 1 | 25.71 | 12.45 | Other areas |
| 3033 | YPS132 132.00 | 1 | 0.26 | 0.113 | Other areas |
| 3033 | YPS132 132.00 | 1 | 12.855 | 6.23 | Other areas |
| 3034 | POL132 132.00 | 1 | 54.127 | 26.21 | Other areas |
| 3036 | YTB132 132.00 | 1 | 3.411 | 1.65 | Other areas |
| 3037 | STTY132 132.00 | 1 | 2.424 | 1.17 | Other areas |
| 4001 | BLN230 230.00 | 1 | 43.978 | 21.3 | Other areas |
| 4005 | MSN230 230.00 | 1 | 65.121 | 31.54 | Other areas |
| 4009 | PMN230 230.00 | 1 | 169.146 | 81.92 | Other areas |
| 4010 | NPT230 230.00 | 1 | 68.814 | 33.33 | Other areas |
| 4013 | OHT230 230.00 | 1 | 180.46 | 87.4 | Other areas |
| 4014 | SHM230 230.00 | 1 | 35.859 | 17.37 | Other areas |
| 4016 | SHD230 230.00 | 1 | 121.221 | 58.71 | Other areas |
| 4017 | TGO230 230.00 | 1 | 47.643 | 23.07 | Other areas |
| 4018 | SSY230 230.00 | 1 | 121.221 | 58.71 | Other areas |
| 4019 | TLY230 230.00 | 1 | 72.25 | 34.99 | Other areas |
| 4020 | TPW230 230.00 | 1 | 105.875 | 51.28 | Other areas |
| 4021 | TYG230 230.00 | 1 | 34.224 | 16.58 | Other areas |
| 4024 | TPU230 230.00 | 1 | 60.836 | 29.46 | Other areas |
| 4027 | NBG230 230.00 | 1 | 73.015 | 35.36 | Other areas |
| 4031 | THT230 230.00 | 1 | 124.604 | 60.35 | Other areas |
| 4033 | TKT230 230.00 | 1 | 301.891 | 146.21 | Other areas |
| 4034 | ATK230 230.00 | 1 | 128.551 | 62.26 | Other areas |
| 4039 | OSP230 230.00 | 1 | 65.403 | 31.68 | Other areas |
| 4039 | OSP230 230.00 | 1 | 48.207 | 23.35 | Other areas |
| 4040 | STM230 230.00 | 1 | 118.402 | 57.34 | Other areas |
| 4043 | MYP230 230.00 | 1 | 90.23 | 43.7 | Other areas |
| 4044 | AHL230 230.00 | 1 | 137.163 | 66.43 | Other areas |
| 4045 | MLM230 230.00 | 1 | 16.125 | 7.81 | Other areas |
| 4111 | KCH230 230.00 | 1 | 76.961 | 37.27 | Other areas |

<Appendix 4>

# Option of the System Configuration with 230 kV Interconnection between East and West and the Eastern 500 kV Substation around Yangon

- **Option of the System Configuration with 230 kV Interconnection between East and West and the Eastern 500 kV Substation around Yangon**

The original plan of Yangon system by MEPE was analyzed with adding the model of part of the system of Yangon using PSS/E software that was also used in "JICA Expert for Strengthening of Implementation Capacity for Transmission Line and Substation". The main part of the power system analysis data are listed in Appendix 3.

According to the original plan made by MEPE, the power flow at the intervals of Hlaingtayar – Ahlon and Kyaiklat-Ahlone exceed the capacity of their transmission lines. Some interval of the 230 kV transmission lines become overloaded around Hlawga, East Dagon and Ahlone when the single circuit is dropped. An option of the installation of both the 230 kV Interconnection between east and west in Yangon and the eastern 500 kV substation around Yangon as an countermeasure against overloaded conditions caused by dropping a single circuit of transmission lines as show in the following figure.

This option does not cause overloaded situations even when a 230 kV single circuit is dropped except for the lines from Kyaikalat power station. The loads of 500 kV transformers can be within 120 % of their capacity even when one of their banks is dropped in this option.

Thus, it is recommended that the installation of a new 500 kV substation in the east of Yangon or an equivalent power source to supply the power both from the east and the west of Yangon in addition to the 230 kV interconnection.

The short circuit currents in this system are calculated as under 30 kA that is within their permissible levels of both 500 kV and 230 kV as shown in the following table.

**Table A4-1 Three Phase Short Circuit Current for the System with East-West Interconnection and East 500 kV Substation**

| Bus name | Voltage | 3phase shortt circuit current (kA) | Bus name | Voltage | 3phase shortt circuit current (kA) |
|---|---|---|---|---|---|
| Hlaingtayar | 230kV | 20.3 | South Okkala | 230kV | 28.2 |
| Kamanat | 230kV | 16.5 | Kyaikkasan | 230kV | 25.6 |
| Myaungtagar | 230kV | 18.5 | Thida | 230kV | 23.1 |
| Thaketa | 230kV | 28.0 | Thilawa | 230kV | 16.6 |
| Ahlone | 230kV | 22.4 | Phyaragyi | 500kV | 14.4 |
| East Dagog | 230kV | 27.5 | Hlaingtayar | 500kV | 12.4 |
| Ywama | 230kV | 27.5 | East Dagog | 500kV | 11.3 |
| Phyaragyi | 230kV | 21.8 | | | |

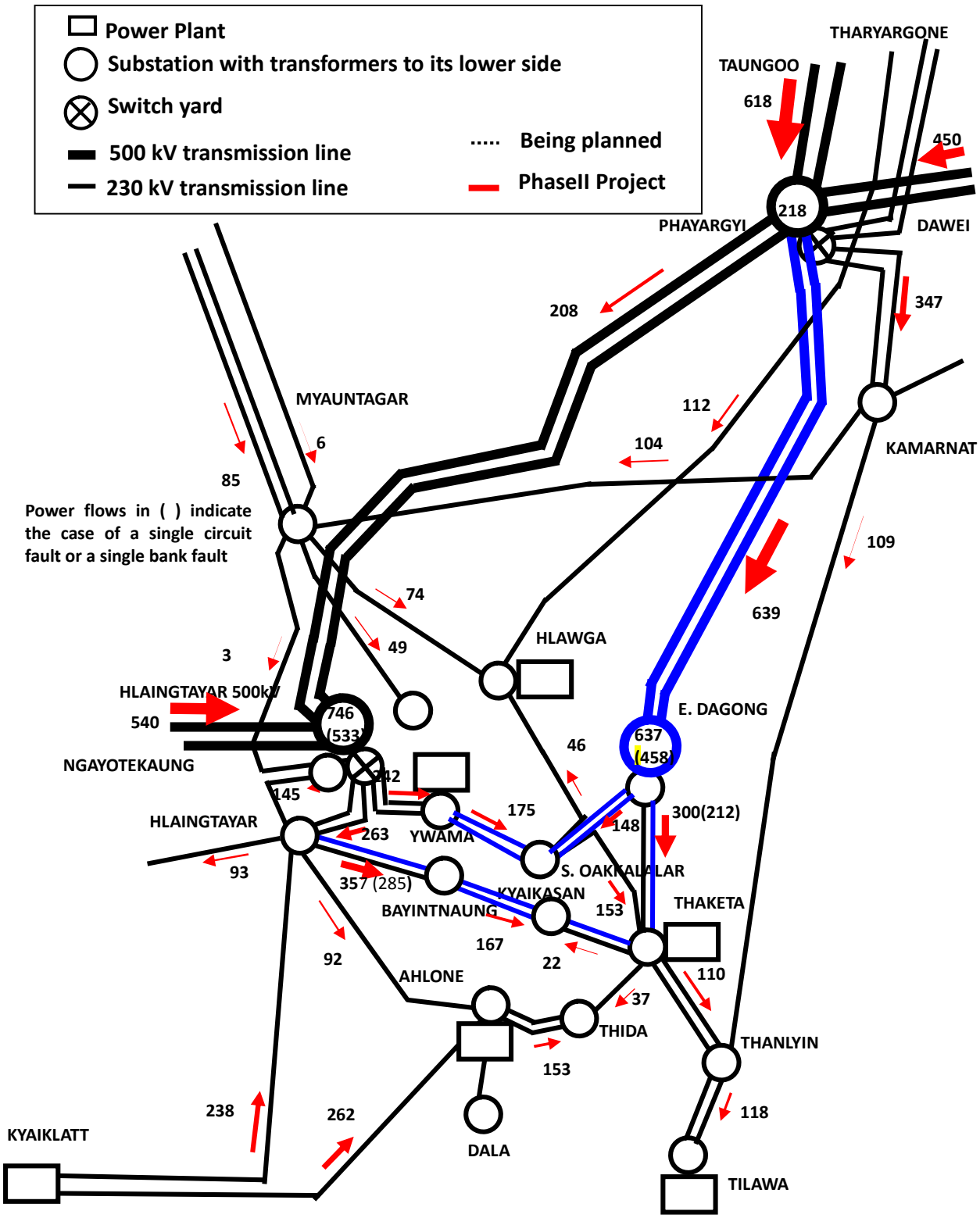



**Figure A4-1 Power Flow in the System Fulfilling N-1 Criteria (East-West Interconnection and East 500 kV substation)**